Rocla®
Materials Pty Ltd
ABN: 30 083 169 091

# Calga Sand Quarry

# Southern Extension

# Ecological Assessment

Prepared by:
Cumberland Ecology Pty Ltd

September, 2009

Specialist Consultant Studies Compendium
Part 3

Rocla®
Materials Pty Ltd
ABN: 30 083 169 091

# Calga Sand Quarry

# Southern Extension

# Ecological Assessment

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**September, 2009**

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# EXECUTIVE SUMMARY

Rocla Materials Pty Ltd (Rocla) proposes to develop and operate the Southern Extension of the Calga Sand Quarry to allow for a further increase in sand production ("the Project"). Rocla is seeking Project approval from the Minister for Planning under Part 3A of the *Environmental Planning and Assessment Act 1979*. The purpose of this report is to assess the flora and fauna values and potential ecological impacts of the Project in accordance with the requirements of this legislation.

The existing Calga Sand Quarry and proposed southern extension ("the Project Site") is located in the Gosford Local Government Area (LGA) in the Sydney Basin Bioregion, and the Pittwater subregion of the Hawkesbury/Nepean Catchment Management Authority (CMA). The Study Area includes two blocks of land on which the proposed Southern Extension would be developed, focussing on those areas to be disturbed by the Project.

Literature and previous studies concerning flora and fauna in the local area and relevant databases such as NPWS Wildlife Atlas and the EPBC website were reviewed for information that was relevant to the locality. Additional on-ground flora, fauna and aquatic field surveys were completed by Cumberland Ecology.

These results indicate that a considerable diversity of native flora and fauna species occur within the locality. Database surveys indicated records for Glossy Black Cockatoos within the Study Area and 22 additional threatened species within 5km of the Project Site. LHCCREMS habitat modelling predicted the probability of occurrence of seven threatened fauna species as follows:

- Koala – 20-40%.
- Squirrel Glider – 10-40%.
- Yellow-bellied Glider – 0-10%.
- Tiger Quoll – 40-60%.
- Masked Owl – 0-10%.
- Powerful Owl – 20-40%.
- Sooty Owl – 0-40%.

The geology of the Study Area is Hawkesbury Sandstone, and supports a range of vegetation typical of this geology. Vegetation surveys confirmed the presence of E2 Sandstone Ranges Gully Rainforest and E54 Sandstone Hanging Swamp, both considered regionally significant (vulnerable), within the Project Site. No Endangered Ecological Communities were identified at the Project Site. Three threatened flora species (*Hibbertia procumbens*, *Darwinia glaucophylla* and *Callistemon linearifolius*) and four listed Noxious Weeds (Crofton Weed, Mist Flower, Lantana and Blackberry) were recorded at the Project Site during surveys.

The Project Site forms a small northern component of a local and regional corridor system for flora and fauna and is connected to Popran National Park which contains large areas of high quality native vegetation.

The Project Site supports a diverse range of habitat features associated with relatively intact forest and woodland communities, and supports a wide range of fauna species. The overall condition of habitats across the Project Site are generally good, although some weed and exotic fauna species were recorded. The Project Site supports diverse and relatively intact habitat for a range of birds, including suitable forage and nesting habitat for the Glossy Black Cockatoo and the Powerful Owl, both of which have been recorded in the Study Area. There is an abundance of hollow-bearing trees at the Project Site that may provide shelter and breeding sites for arboreal reptiles and mammals, microchiropteran bats, owls, cockatoos and parrots. The Yellow-bellied Sheathtail Bat and Grey-headed Flying-fox have been recorded from the Study Area. Although the Project Site does not support primary food tree species for the Koala, secondary Koala food tree species do occur and the Project Site should be regarded as potential Koala habitat for the purpose of SEPP 44. No Koalas were recorded at the Project Site during surveys. Aquatic habitats within the Project Site are represented by one main creek (Creek C) and two smaller ephemeral feeder creeks (Creeks A and B). Suitable habitat for the Red-crowned Toadlet is present at several locations at the Project Site and this species was recorded at the Project Site during surveys.

Three main key threatening processes listed by the Scientific Committee on Threatened Species would be brought into effect as a result of this Project. These are:

- Clearing of Native Vegetation;
- Alteration to Natural Flow Regimes of Rivers and Streams; and
- Loss of Hollow-bearing Trees.

A total of approximately 34.7ha (42%) of native vegetation occurring at the Project Site would be removed which is likely to result in some minor reduction and fragmentation of contiguous habitat between the Project Site and Popran National Park. However, as the area of extraction is already located on the margin of a large vegetated area, impacts of fragmentation and edge effects are likely to be limited and habitat linkages would still remain. There is an abundance of native bushland in the locality and regional habitat connectivity will not be severed.

No Endangered Ecological Communities occur at the Project Site, and impacts on Endangered Ecological Communities and Groundwater Dependent Ecosystems downstream of the Project Site are likely to be insignificant. The majority of the vegetation communities at the Project Site consist of Hawkesbury Woodland and Hawkesbury Banksia Scrub Woodland, which are likely to remain highly resilient to disturbance, however some small areas of Gahnia/Banksia Swamp (less than 0.5ha) are unlikely to recover to pre-disturbance condition. No areas identified as “high conservation value” would be impacted directly by the Project.

Some modifications to groundwater dependent vegetation communities at the Project Site may occur in the long term due to reductions in flow to Cabbage Tree Creek, however the Project Site represents only a small part of the catchment for this creek, and changes to groundwater and overall water flow to Cabbage Tree Creek are considered to not be significant. Hydrological changes due to proposed extraction activities at the Project Site may result in some impacts on riparian vegetation and nearby downstream groundwater-dependent species. However a range of mitigation measures have been proposed to offset these impacts on aquatic habitats including the establishment of a setback from an ephemeral drainage line to protect habitat for the Red-crowned Toadlet and potential habitat for the Giant Burrowing Frog.

Additionally, the implementation of surface water, sediment and erosion controls will avoid sediment runoff into local catchments.

Clearing on the Project Site will result in some loss of habitat for threatened flora and fauna species including many hollow-bearing trees with attendant impacts on hollow-dependent fauna at the Site. A number of threatened fauna species were found to be at low or moderate risk from the Project, and a small number of threatened species were found to be at high risk. No species were found to be at extreme risk as a result of the Project. The Project has the potential to reduce the long-term viability on the Project Site of a number of threatened species that have been recorded from the Project Site, in particular the Red-crowned Toadlet and *Callistemon linearifolius*.

The clearing of vegetation as a result of this Project would result in some cumulative impact on flora and fauna. Impacts on threatened plant species within the Project Site are likely to be short to medium-term, and impacts on threatened fauna habitat, ground and surface water would be medium- to long-term. Some of the impacts of the Project, particularly those associated with a reduction in water flows are likely to be permanent and irreversible. These reductions in water flows are likely to be minor due to the small area of catchment impacted. Impacts on fauna with small home ranges and low dispersal, such as threatened frog species, will be high. However, many of the impacts are not permanent and, with staging of the Project and rehabilitation of the Project Site, are reversible.

A wide range of measures are proposed to mitigate potential impacts of the Project on flora and fauna in the locality including modifications to the Project design, the dedication of large areas of bushland to conservation and the preparation and implementation of Vegetation Management Plans and Threatened Species Management Plans. The proposed extraction area layout has been designed to protect one of the ephemeral streams and to preserve frog habitat in this area. Areas of vegetation supporting the three recorded threatened flora species will be conserved on the Project Site, also providing habitat for all threatened fauna species recorded. The most significant mitigation measure is the development of a biodiversity offset strategy which will place into conservation a large area of native vegetation and provide an ecological buffer to Popran National Park. This area is approximately double the area of land that will be disturbed and therefore represents a ratio of approximately 2ha of offset for every 1ha of native vegetation to be cleared for the Project. Approximately half of this offset is already present as vegetation unaffected by the Project on the Project Site itself and the remaining half is located on a neighbouring property. Management of retained vegetation within the Project Site will occur throughout the life of the Project and prior to it being gazetted for conservation. A Vegetation Management Plan will be prepared and implemented to facilitate the active management of native vegetation zones and important habitat features to be retained on the site. Pre-clearance surveys will be carried out prior to and during the clearing for each phase of the Project, and during rehabilitation and revegetation of the extraction areas. A threatened species management plan will be prepared to manage the occurrence of species on the Project Site, and to ensure habitat remains in a viable condition. Nest boxes will be utilised to compensate for the loss of trees with hollows. These mitigation measures comply with all the Department of Environment and Climate Change's guidelines for biodiversity offsets.

Taking into consideration the compensatory measures to be implemented and the offsets proposed, it is considered that the Project will have a limited negative effect on threatened species. No Endangered Ecological Communities will be affected by the Project, and although areas of habitat for threatened species will be removed, this impact is adequately compensated for by the large offset proposed. The Project is not likely to accelerate the extinction of or place at risk of extinction any of the threatened species which are known or may occur on the Project Site.

# 1 INTRODUCTION

## 1.1 Overview

Rocla Materials Pty Ltd (Rocla) currently owns and operates the Calga Sand Quarry located off Peats Ridge Road, 1.7km north-northwest of the Calga Interchange on the F3 Freeway (see **Figure 1.1** and **Figure 1.2**). Sand extraction from Stages 1 and 2 of the Calga Sand Quarry was undertaken between 1991 and 2004, with an application to extend the quarry onto land immediately north of existing operations (Stage 3) approved as DA 94-4-2004 in November 2005. Stage 3 extraction commenced in early 2006 with production steadily increasing from that time.

Rocla now proposes to develop and operate the Southern Extension (Stages 4 and 5) to allow for a further increase in sand production. The proposed Southern Extension (the "Project") has been classified as a "Major Project" under State Environmental Planning Policy (Major Development) 2005. In order for the combined existing quarry and proposed Southern Extension to be managed in accordance with a single approval, Rocla is seeking Project Approval over both the existing Calga Sand Quarry and the land on which the proposed Southern Extension would be undertaken (herein referred to as the "Project Site").

The Project would be assessed under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

## 1.2 Scope of this Report

The purpose of this report is to assess the flora and fauna values and potential ecological impacts of the Project. The objectives of this report are to:

- identify flora and fauna species present or likely to occur within a defined Study Area comprising the entire Project Site and immediate surrounds;
- determine the presence of threatened species, endangered populations, or endangered ecological communities (as listed on the Schedules of the NSW *Threatened Species Conservation Act 1995* (TSC Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)), and map their distribution;
- describe fauna habitats and fauna usage of the Study Area, and assess the extent to which the Project Site functions as a wildlife corridor;
- formally assess the impacts of the Project in terms of Part 3A and 5A of the EP&A Act;
- assess the ecological constraints and opportunities for the Project on the Project Site; and
- where relevant, suggest mitigation measures or management recommendations to reduce the impacts of the Project on flora and fauna, and assess the adequacy of an offset strategy proposed by Rocla to ensure no net loss of flora and fauna values in the medium and long term.

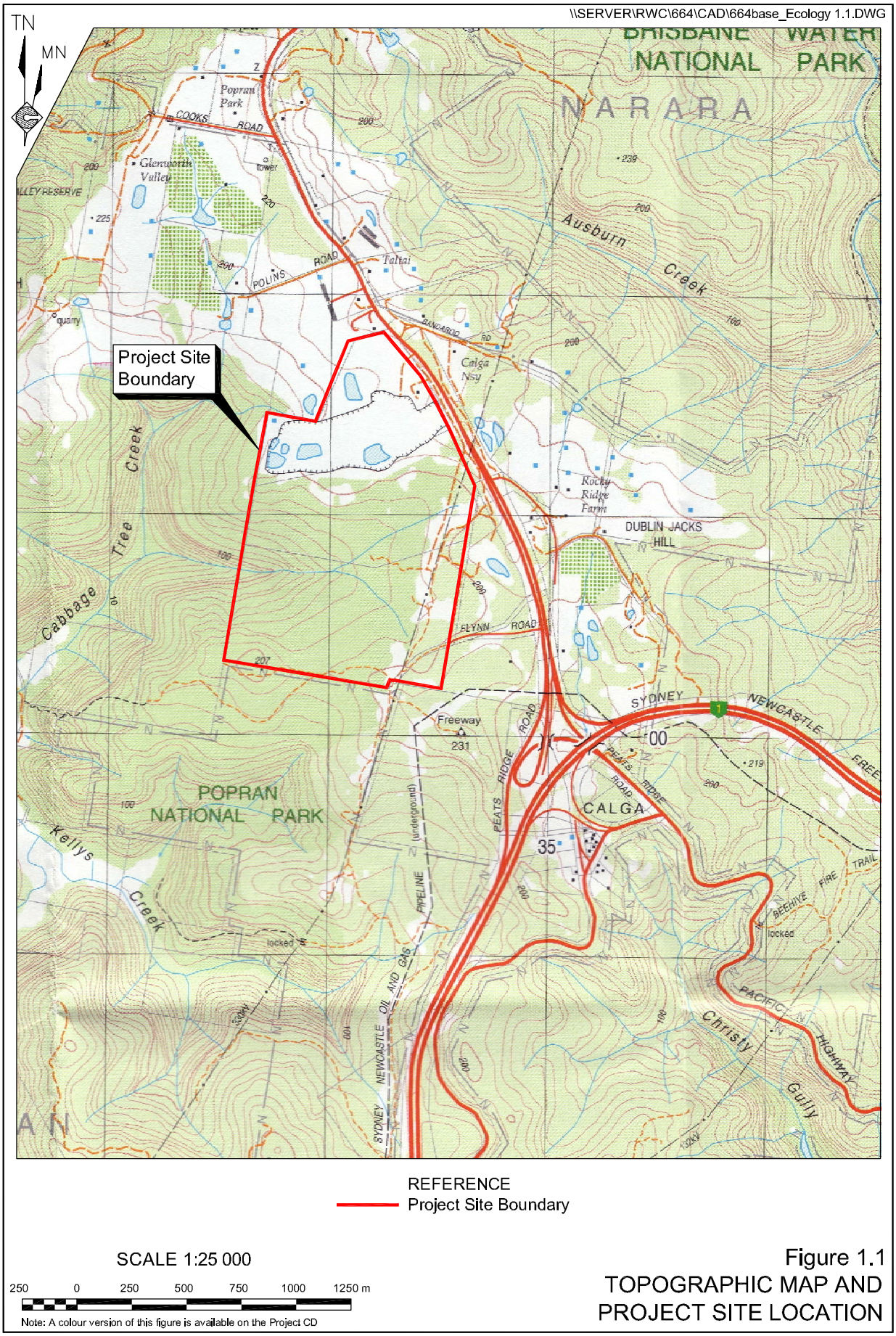



Figure 1.1
TOPOGRAPHIC MAP AND
PROJECT SITE LOCATION




Figure 1.2
AERIAL PHOTOGRAPH AND PROJECT SITE LOCATION

Note: A colour version of this figure is available on the Project CD

## 1.3 Terminology

This report uses the following terminology.

- **The Project** is the combined operation of the existing Calga Sand Quarry (Stage 3) and the proposed Southern Extension (Stages 4 and 5).
- **The Project Site** is the area within Lot 2, DP 229889 and Lots 1 and 2, DP 805358 (including all disturbance associated with the approved Calga Sand Quarry and proposed Southern Extension).
- **The Study Area** Lots 1 and 2, DP 805358 within which the proposed Southern Extension would be undertaken.
- **Subject Area** is the area directly impacted by the construction and operation of the proposed Southern Extension, including the existing quarry and associated infrastructure.
- **Locality** is the area within a 5km radius of the Project Site.
- **Subject species** means those threatened species, populations and EECs that are listed in either the EPBC Act, the NSW *Fisheries Management Act* 1994, (FM Act) or the TSC Act and are known to occur, or considered likely to occur in the Study Area.

## 1.4 Study Team

The qualifications, experience and relevant licences for fauna trapping of the study team are provided in the table below.

| Name | Qualifications | Experience/Fields of Competence | Licence | Licence No |
|---|---|---|---|---|
| Dr David Robertson | Bachelor of Science (Honours), Ecology, University of Melbourne, 1980. PhD, Ecology, University of Melbourne, 1986. | 20 years experience in ecological survey and research. Biodiversity issues, flora and fauna field surveys, aquatic ecology, biological monitoring and environmental impact assessment. | Animal Research Authority | Trim File No 04/935 |
| | | | Scientific Licence | S11164 |
| Dr Kirsten Crosby* | PhD, UNSW, 2003 BSc (Hons) Zoology, UNSW, 1998 | Threatened Species Conservation Act (1995) NSW Environment Planning and Assessment Act (1979) NSW, particularly Part 3A Environment Protection and Biodiversity Conservation Act 1999 Biodiversity issues, flora and fauna field surveys, biological monitoring and environmental impact assessment | Animal Research Authority | Trim File No 04/935 |
| | | | Scientific Licence | S11164 |

| Name | Qualifications | Experience/Fields of Competence | Licence | Licence No |
|---|---|---|---|---|
| Dr Mina Bassarova* | PhD, UNSW, 2006; BSc (Hons) Biological Science, UNSW, 1999 | Knowledge of threatened fauna of NSW and fauna surveying methods including the use of arboreal and terrestrial Elliot traps, cage traps, pit traps, hair tubes, owl broadcasters, Anabat system; Research and analytical skills; Ability to write complex documents; Ability to liaise with numerous government departments, clients and the community during preparation of documents and plans; and Biodiversity issues and environmental impact assessment. | Animal Research Authority | Trim File No 04/935 |
| | | | Scientific Licence | S11164 |
| Mrs Joanne Brownett | BSc (Environmental) Hons University of Sydney, 2003 | Knowledge of NSW flora and survey methods including identification of threatened flora; Knowledge of threatened fauna of NSW and fauna surveying methods including the use of arboreal and terrestrial Elliot traps, cage traps, pit traps, hair tubes, owl broadcasters, Anabat system; Research and analytical skills; Ability to write complex documents; Ability to liaise with numerous government departments, clients and the community during preparation of documents and plans; and Biodiversity issues and environmental impact assessment. | Animal Research Authority | Trim File No 04/935 |
| | | | Scientific Licence | S11164 |
| Mr Carl Corden | Bachelor of Environmental Management (Natural Systems and Wildlife) The University of Queensland. | Knowledge of threatened fauna of NSW and fauna surveying methods including the use of arboreal and terrestrial Elliot traps, cage traps, pit traps, hair tubes, owl broadcasters, Anabat system; Research and analytical skills; Ability to write complex documents; Ability to liaise with numerous government departments, clients and the community during preparation of documents and plans; Biodiversity issues and environmental impact assessment. | Animal Research Authority | Trim File No 04/935 |
| | | | Scientific Licence | S11164 |
| Ms Katrina Wolf | BSc (Environmental) University of Sydney, 2006 | Knowledge of NSW flora and survey methods including identification of threatened flora; Knowledge of threatened fauna of NSW and fauna surveying methods including the use of arboreal and terrestrial Elliot traps, cage traps, pit traps, hair tubes, owl broadcasters, Anabat system; Research and analytical skills; Ability to write complex documents; Ability to liaise with numerous government departments, clients and the community during preparation of documents and plans; Biodiversity issues and environmental impact assessment. | Animal Research Authority | Trim File No 04/935 |
| | | | Scientific Licence | S11164 |

| Name | Qualifications | Experience/Fields of Competence | Licence | Licence No |
|---|---|---|---|---|
| Mr Nathan Campbell | BSc (Environmental) University of Sydney, 2000<br>BSc (Marine) Hons University of Sydney, 2004 | Knowledge of NSW flora and survey methods including identification of threatened flora;<br>Knowledge of threatened fauna of NSW and fauna surveying methods including the use of arboreal and terrestrial Elliot traps, cage traps, pit traps, hair tubes, owl broadcasters, Anabat system;<br>Research and analytical skills;<br>Ability to write complex documents;<br>Ability to liaise with numerous government departments, clients and the community during preparation of documents and plans; and<br>Biodiversity issues and environmental impact assessment. | Animal Research Authority<br>Scientific Licence | Trim File No 04/935<br>S11164 |
| Mr David Thomas | Member of Ecological Consultants Association | Vegetation survey, assessment & mapping<br>Preparation of management plans for natural areas<br>Bushland reconstruction, rehabilitation & regeneration planning | N/A | N/A |
| Mr Gabor Vasarhelyi | Bachelor of Science (Honours) Environmental Science, University of New South Wales | Experience includes training, application development, spatial analysis, satellite image processing and interpretation, technical support and data collection. Application areas of GIS include environmental assessment and asset management | N/A | N/A |

* No longer employed with Cumberland Ecology

# 2 CONTEXTUAL INFORMATION

## 2.1 Location

The proposed Southern Extension of the Calga Sand Quarry is located on Lots 1 and 2, DP 805358, Peats Ridge Road, Calga, NSW. The Project Site is located in Gosford Local Government Area (LGA) in the Sydney Basin Bioregion and the Pittwater subregion of the Hawkesbury/Nepean Catchment Management Authority (CMA). The Project Site is bounded by the existing Calga Sand Quarry to the north, Peats Ridge Road to the east, undeveloped bushland on privately owned land to the west, and the Australia Wildlife Walkabout Park and Popran National Park to the south (see **Figure 1.2**).

**Figure 1.1** presents the location of the currently approved Calga Sand Quarry and the proposed Southern Extension. **Figure 1.2** presents the location of the Study Area on an aerial photograph.

## 2.2 Description of the Project

Rocla proposes to develop and operate the Southern Extension as part of the overall Calga Sand Quarry to allow for an increase in sand production from the Calga Sand Quarry to a maximum of 1Mtpa. The Southern Extension has been designed to optimise the recovery of sand whilst satisfying both operational and surrounding environmental constraints and progressively creating a final landform suited to the proposed end uses.

**Figure 1.1** displays the following principal components of the Project.

- The Stage 3 extraction areas where sand extraction would proceed generally in a manner consistent with the current approved operation.
- Two new extraction stages, namely Stages 4 and 5. Stage 4 would be a direct southerly extension of the existing Calga Sand Quarry and Stage 5 would be developed as a separate extraction area. It is envisaged that extraction within Stage 5 would only commence following the validation of various predictions relating to noise and air quality levels received at residences to the southeast of Stage 5.
- Four proposed sand processing areas. The existing 400 000tpa sand processing plant would be replaced by a 600 000tpa plant within Stage 1. As the northern area of Stage 4 is developed, a second processing plant capable of producing 600 000tpa would be established at a temporary central location within Stage 4. Both processing plants would ultimately be combined or replaced by a single processing plant capable of processing 1Mtpa at a long-term location on the floor of a completed section of Stage 4. No processing is proposed within Stage 5 as all raw sand materials would be transported to the plant(s) in Stage 4.
- Access to the Project Site would continue via the existing site entrance (referred to as the northern entrance) and site access road off Peats Ridge Road. During the early stages of extraction within Stage 4, a new site entrance (the “southern entrance”) and access road would be constructed from Peats Ridge Road to create a specific access point and road for activities within Stages 4 and 5. Whilst operations are underway within both Stages 3 and 4, it is proposed to use the southern entrance for incoming vehicles only and the northern entrance for departing vehicles only. Following the completion of activities within Stage 3 and / or the commissioning of the 1Mtpa capacity processing area, the southern entrance would become the sole entrance / exit for vehicles entering and leaving the Southern Extension, with the existing entrance retained for access to Lot 2, DP 229889 only.
- The Project Site administration area (including workshops and fuel storage) would initially be retained in its current location before being relocated adjacent to the wash plant on the floor of Stage 1 to accommodate extraction from Stages 3/3 and 3/4. In the long-term, the administration area would be relocated to Stage 4/1, coinciding with the consolidation of processing operations within the Southern Extension.

The Project Site would be progressively rehabilitated with Stage 4 incorporated into the final landform of the existing Calga Sand Quarry. It is proposed that Stage 5, should it proceed, be rehabilitated to provide long-term nature conservation and water storage for the owners of the Australia Wildlife Walkabout Park.

## 2.3 Environmental Setting

### 2.3.1 Geology and Soil

The geology of the Study Area is mapped at a scale of 1:250 000 as Hawkesbury Sandstone (Bryan, 1965). Hawkesbury Sandstone consists predominantly of medium to coarse grained quartz-dominated sandstone with numerous interbeds of mudstone, shale and fine to very fine-grained sandstone. A significant proportion of the ground in the Study Area currently comprises bare sandstone outcrops and platforms.

Murphy (1993) maps four soil landscape units on the Project Site.

- **so (Somersby):** "…gently undulating to rolling rises on deeply weathered Hawkesbury Sandstone plateau. Local relief to 40m, slopes <155…drainage lines narrow…Limitations – localised permanent and seasonal water-logging, moderate soil erosion hazard, stoniness, very low soil fertility, highly permeable soil." Occurs within Stage 3 of the approved Calga Sand Quarry and the northern section of the proposed Southern Extension.
- **st (Sydney Town):** "…undulating to rolling low hills and moderately inclined slopes on quartz sandstone along the edge of the Somersby Plateau…Local relied to 80m, slope gradients 5-25%...Limitations – very high soil erosion hazard, permanent waterlogging (localised), highly permeable, strongly acid soils with very low soil fertility." Occurs on the elevated eastern and central parts of the proposed Southern Extension.
- **ha (Hawkesbury):** "…rugged, rolling to very steep hills on Hawkesbury Sandstone. Local relief 40-200m, slopes >25%. Rock outcrops >50%. Narrow crests and ridges, narrow incised valleys, steep sideslopes with rocky benches, broken scarps and boulders…Limitations – extreme soil erosion hazard, mass movement (rock fall) hazard, steep slopes, foundation hazard, rock outcrop, shallow, stony, highly permeable soils, low soil fertility." Occurs on lower slopes in the western section of the Project Site, associated with narrow gullies.
- **of (Oxford Falls):** "…hanging valleys on predominantly Hawkesbury Sandstone. Local relief <80m, slopes <15%...Limitations – high soil erosion hazard, high run-on, perched water tables and swamps, highly permeable soils, low soil fertility, localised rock outcrop." Occurs on the southern parts of the Project Site.

### 2.3.2 Vegetation and Habitats

The Project Site is located on the Somersby Plateau, where higher elevation Hawkesbury Sandstone soils support a mosaic of open forest and woodland vegetation, interspersed with heaths and scrubs where bedrock material is close to the surface (Bell 2004). The majority of the Project Site is vegetated and the combination of different geology, soils, topography and aspect provide a wide range of microhabitats within the vegetation. Vegetation communities and a discussion of habitats can be found in **Section 4**.

### 2.3.3 Climate

The recorded mean annual daily maximum temperature for the locality is 22$^{o}$C, and the mean annual daily minimum temperature is 11$^{o}$C (recorded at the Peats Ridge, Waratah Road meteorological station, Station No 061351, elevation 280m, approximately 10km north of the Project Site). The highest mean monthly maximum temperature was recorded for January (27$^{o}$C) and the lowest mean monthly minimum temperature for July (6$^{o}$C) (Bureau of Meteorology, 2006).

The mean annual rainfall is 1 263mm at Peats Ridge meteorological station, with the highest mean monthly rainfall being recorded in February (156mm) and the lowest mean monthly rainfall being recorded in July (68mm). The mean number of rain days per annum (over 26 years) is 106 days (Bureau of Meteorology, 2006).

### 2.3.4 Topography and Drainage

The Project Site lies on the west-facing flank of a narrow ridge (less than 1km wide) which trends northwest–southeast, 2km north-northwest of Calga village. The ridge drops steeply to the west into Cabbage Tree Creek and Popran Creek, and to the east into Mooney Mooney Creek. These creeks flow south into the Hawkesbury River system. The Project Site terrain is generally elevated and undulating. The mid to lower slopes contain small cliffs and discontinuities. Vertical relief is 140m (80m AHD to 220m AHD).

## 2.4 Legislation and Policies

### 2.4.1 Environment Planning and Assessment Act 1979

Rocla is seeking approval for the Project from the Minister for Planning under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act). Part 3A applies to State government infrastructure Projects and developments classified as “Major Projects” under State Environmental Planning Policy (Major Projects) 2005. The aim of Part 3A is to facilitate major Project infrastructure delivery and encourage economic development, while at the same time strengthening environmental safeguards (Department of Infrastructure Planning and Natural Resources 2005).

The Department of Planning's (DoP) objective with this Part is to provide efficient and credible assessment of major development and infrastructure proposals in NSW to attract investment and promote employment-generating activities which are environmentally and socially sustainable. During the process, the DoP:

- maintains close links with local councils and other government agencies regarding the assessment and determination of major development and infrastructure Projects;
- facilitates community and other stakeholder input into Projects that affect the biophysical, social and economic environment; and
- develops policies, procedures and guidelines to ensure the assessment process is sound, credible and appropriate.

The DoP has provided Director-General's Requirements (DGRs) for this Project. The DGR's provide guidelines from the various departments (e.g. Department of Environment and Climate Change – DECC) which should be followed in the preparation of the *Environmental Assessment*. Relevant guidelines and other references are discussed below. The flora and fauna assessment must comply with all relevant Commonwealth and State legislation regarding threatened species and communities. Attention must also be paid to any government policies which may apply to the Study Area.

Section 5A of the EP&A Act, (which covers the assessment of impacts on threatened species, endangered populations or endangered ecological communities (EECs) and their habitats) does not apply to matters being considered under Part 3A of the EP&A. However, since Section 5A sets out the matters to be taken into account in deciding whether there is likely to be a significant impact on threatened species or communities and their habitats, this ecological impact assessment has been carried out using the 7 part Assessment of Significance listed in Section 5A (see **Appendix D**).

**Draft Guidelines for Threatened Species Assessment (DEC (NSW), 2004b)**

These draft guidelines were prepared to assist with the preparation of applications for Project approval to be assessed under Part 3A of the EP&A Act. The objective of the assessment process is to provide information to enable decision makers to ensure that developments deliver the following environmental outcomes.

- Maintain or improve biodiversity values (i.e. there is no net impact on threatened species or native vegetation).
- Conserve biological diversity and promote ecologically sustainable development.
- Protect areas of high conservation value (including areas of critical habitat).
- Prevent the extinction of threatened species.
- Protect the long-term viability of local populations of a threatened species, endangered population or EEC.
- Protect aspects of the environment that are matters of National Environmental Significance.

The following steps are required in the assessment process and can be found in this report.

1. Preliminary assessment (Section 4).
2. Field survey and assessment (Section 4).
3. Evaluation of impacts (Section 5).
4. Consideration of measures to avoid, mitigate and then offset impacts (Section 6).
5. Assessment of key thresholds (Section 6).

### 2.4.2 Threatened Species Conservation Act 1995

The TSC Act identifies and protects native plants and animals in danger of becoming extinct. Schedule 1 of the TSC Act lists threatened species, populations and EECs and species that are endangered or presumed extinct. Schedule 2 lists vulnerable species and Schedule 3 lists key threatening processes. The TSC Act is administered by the DECC.

**Threatened Biodiversity Survey and Assessment – Guidelines for Developments and Activities (Draft – November 2004) (DEC (NSW), 2004b)**

The DECC has issued draft guidelines for the assessment of threatened flora and fauna (DEC (NSW), 2004b). These working guidelines were prepared to assist in impact assessment and management of threatened biodiversity and have relevance to any animal and/or plant survey within NSW. It is intended by DECC that these guidelines be adapted to fit the requirements of individual animal and plant surveys by outlining field techniques and considerations, relevant legislation, and the relevant method of impact assessment for threatened biodiversity. The Guidelines assist applicants, proponents, investigators and decision-makers by identifying their responsibilities, outlining relevant procedures and providing considerations for the interpretation of results. These draft guidelines provide the following recommendations for surveys.

- Surveys are to be undertaken during optimal climatic and seasonal conditions, and should consider issues such as migratory species and flowering.
- Survey effort depends on the size of the area and the number of stratification units.
- Each of the stratification units (i.e. vegetation communities) must be sampled.
- A habitat assessment must be undertaken.
- A combination of transects or random meanders and plot-based surveys should be used for plants.
- A wide range of methods can be used for fauna surveys, and are dependent on the fauna species likely to be present.

More detail for each of the fauna groups can be found in the guidelines, and specific survey requirements for threatened species can be found on the DECC Threatened Species website: www.threatenedspecies.environment.nsw.gov.au.

### 2.4.3 Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act protects the environment, particularly matters of “National Environmental Significance”. It is managed by the Commonwealth Department of Environment, Water, Heritage and the Arts (DEWHA). There are eight matters of National Environmental Significance under the EPBC Act. These are:

- World Heritage properties;
- National Heritage places;

- wetlands of international importance (Ramsar Wetlands);
- listed threatened species and ecological communities;
- listed migratory species;
- the Commonwealth marine area; and
- nuclear actions, including uranium mining.

Under the EPBC Act, assessment is required for actions that are likely to have a significant impact on a matter of national environmental significance. The purpose of a referral is to determine whether the proposed action would need formal assessment and approval under the EPBC Act. The DEWHA will advise the outcome of a referral after 20 days and whether or not formal assessment and approval under the EPBC Act is needed. There are three types of decisions about the referral, namely:

- the proposed action is not likely to be significant and does not need approval - in this case no further consideration is required under the environmental assessment provisions of the EPBC Act and the action can proceed (subject to any state or local government requirements);
- the proposed action is not likely to be significant if undertaken in a specified manner – in this case compliance with the specified manner must be reported to the Department; or
- the proposed action is likely to be significant and does need approval – in this case the proposed action is subject to a public assessment process before it can be considered for approval. If the action is likely to be significant it is called a controlled action. Under a bilateral agreement with NSW, the DEWHA accepts environmental assessments produced to comply with state legislation.

No species listed under the EPBC Act were found to occur on the Project Site, however Grey-headed Flying-foxes are likely to occur, and habitat is present for the Great Burrowing Frog. Both species listed as vulnerable under the EPBC Act. A referral is not considered necessary for the Project.

### 2.4.4 National Parks and Wildlife Act 1974

The DECC manages land reserved or dedicated under the *National Parks and Wildlife Act 1974* and includes areas such as National Parks, Historic Sites, Wilderness areas, Nature Reserves, Regional Parks and State Recreation Areas. The potential for cumulative impacts from developments along DECC boundaries should be considered in addition to case by case considerations. The DECC has produced guidelines for development which adjoin these lands (DEC (NSW), 2004a).

**Guidelines for Developments Adjoining Department of Environment and Conservation Lands (DEC (NSW), 2004a)**

When assessing or managing a development which adjoins DECC managed lands, the following issues are to be addressed.

- Corridor values:
  - Vegetated areas adjoining DECC land play a complementary role in providing essential linkages for the maintenance of biodiversity, minimise potential edge effects on DECC land, have a role in maintaining the viability of local populations and species and provide valuable wildlife refuge areas. The DECC prefers that vegetation on adjoining land that exhibits these corridor values should be retained and, where necessary, rehabilitated.
- Erosion and sedimentation:
  - Removal of vegetation and disturbance of groundcover from construction activities would expose the soil and increase the risk of erosion. Changes to the hydrological behaviour of streams outside the reserve system can impact on lands managed by the DECC. The DECC suggests that clearance of native vegetation be kept to a minimum, areas of vegetation be fenced off during construction and disturbed areas be rehabilitated and stabilised as soon as possible following construction.
- Stormwater runoff to DECC land:
  - The DECC considers the discharge of stormwater to areas of DECC land poses a threat to downstream environments by dispersing weed propagules, altering the nutrient composition and pollutant levels and potentially causing erosion and sedimentation within watercourses. Where stormwater does enter DECC lands 'best practice' stormwater treatment measures should be utilised to maximise on-site pollutant retention and removal and infiltration and sub-surface discharge of stormwater.
- Management Implications and Impacts:
  - Adjoining developments can place additional pressure on maintenance of access, management of Aboriginal sites, weed management and pest control in DECC land. The DECC recommends consideration of the establishment of an appropriate buffer between any development and DECC land. Where managed effectively, a buffer may minimise the impact to conservation values of DECC land.
- Fire:
  - The DECC does not support clearing within DECC land for the creation of fuel reduced zones to protect adjoining development. Accordingly, appropriately designed fire protection zones and fire fighting access tracks should be located on the land proposed to be developed.

- Visual Impact:
  - Development adjacent to DECC land must be sympathetic with the bushland surrounds and not impact upon the recreational amenity of users. This may include measures such as landscaping with local native plant species, implementing buffer areas and use of appropriate colours and building materials.

### 2.4.5 NSW State Groundwater Dependent Ecosystems Policy (DLWC (NSW), 2002)

Increasing groundwater extraction, rising saline water tables and contamination from various anthropogenic land activities are threatening the survival of many groundwater dependent ecosystems. Activities such as sand extraction can impair or destroy the biological filtration function of the aquifer and/or the hyporheic zone where groundwater exchanges with surface water of rivers and standing wetlands

The NSW State Groundwater Dependent Ecosystems Policy (DLWC (NSW), 2002) is based around five principles.

- The scientific, ecological, aesthetic and economic values of groundwater dependent ecosystems, and how threats to them may be avoided, should be identified and action taken to ensure that the most vulnerable ecosystems are protected.
- Groundwater extractions should be managed within the sustainable yield of aquifer systems, so that the ecological processes and biodiversity of their dependent ecosystems are maintained and/or restored.
- Priority should be given to ensuring that sufficient groundwater of suitable quality is available at the times when it is needed.
- Where scientific knowledge is lacking, the Precautionary Principle should be applied to protect groundwater dependent ecosystems. The development of adaptive management systems and research to improve understanding of these ecosystems is essential to their management.
- Planning, approval and management of developments and land use activities should aim to minimise adverse impacts on groundwater dependent ecosystems.

### 2.4.6 Draft Central Coast Regional Strategy (DoP (NSW), 2006)

The Draft Central Coast Regional Strategy ("the draft Regional Strategy") is one of a number that have been prepared by the Department of Planning in consultation with local councils, other government departments and a range of additional stakeholders. This draft Regional Strategy sets capacity targets for new dwelling and employment land supply over the next 25 years and provides a framework for important environmental assets, landscape values and natural resources to be identified and protected. It requires that new development occurs in a sustainable manner (DoP (NSW), 2006).

The draft Regional Strategy recognises that the Central Coast's economy has evolved from primary industries, specifically agriculture and mining industries. The Region's valuable rural and resource lands would be maintained for their agricultural, environmental, mineral and extractive resources, recreation and tourism opportunities (DoP (NSW), 2006).

The draft Regional Strategy would protect the outstanding environmental qualities of the region by developing a Regional Conservation Plan that identifies and protects State and regional biodiversity values, including buffers to these areas, and provides certainty for development. The draft Regional Strategy would also protect the region's water supply catchment from inappropriate development or land use (DoP (NSW), 2006).

# 3 METHODS

## 3.1 Literature Review and Assessment of Data from Previous Studies

### 3.1.1 Previous Studies

#### 3.1.1.1 Introduction

Literature concerning flora and fauna in the local area and relevant databases such NPWS Wildlife Atlas and the EPBC website were reviewed for information that was relevant to the locality.

Due to both the existing adjoining Calga Sand Quarry and ongoing regional studies by government bodies such as Gosford City Council (GCC) and Lower Hunter and Central Coast Regional Environmental Management Strategy (LHCCREMS), background flora and fauna data is readily available. This data is available for both the Project Site and the locality in general.

Previous flora and fauna investigations conducted during 2004 and 2005 were prepared as part of an Environmental Impact Statement for Stage 3 of the Calga Sand Quarry. These investigations involved literature reviews, database assessments, vegetation mapping, census of flora and fauna generally and targeted surveys for threatened species. Consequently, the majority of flora and fauna that could be impacted by the Project is well known. The results of the previous studies are summarised in Section 3.1.1.2 to Section 3.1.1.6.

#### 3.1.1.2 Anne Clements & Associates (2004): Flora Assessment – Calga Quarry Extension

This study (Anne Clements and Associates, 2004) was completed in May 2004 to assess the likely impacts upon vegetation that would be affected by the proposed extraction activities within an area to the north (Stage 3) and northeast (then referred to as Stage 4) of the existing Calga Sand Quarry. Although the majority of this area has been cleared, the threatened species issues identified in this report are relevant to the current study (see Section 4.1). No threatened species or communities were identified on that site during the May 2004 survey, however, a range of species were identified within the locality.

#### 3.1.1.3 Anne Clements and Associates (2005): Target Flora Survey Parts 1 & 2 – Calga Sand Quarry Northern Extension

In response by a Department of Infrastructure, Planning and Natural Resources request for additional information on threatened species and vegetation types, targeted surveys were undertaken for the proposed northern extension (Stages 3 and 4) of the Calga Sand Quarry (Anne Clements and Associates, 2005). These surveys targeted:

- two threatened plant species *Hibbertia procumbens* and *Darwinia glaucophylla*;
- "Sedgelands" as defined by SREP 8 in the area near the north-western dam; and
- "Hanging swamps" upslope from a dam located on Lot 121, DP 755221 (as part of the then Stage 4 quarry proposal).

An intensive survey was undertaken to assess occurrences of *Hibbertia procumbens* and *Darwinia glaucophylla* using 10m x 10m squares overlain on a 100m x 80m grid laid along the western boundary of the proposed quarry extension. In addition, 50 and 100 metre lengths of 1m wide transects were used to record the location of individual plants of *H. procumbens. D. glaucophylla* was recorded in 27 of 80 grid squares searched and *H. procumbens* was recorded in 11 of the 80 grid squares searched.

No vegetation matched the criteria for sedgeland but two patches of hanging swamp were recorded.

#### 3.1.1.4 Countrywide Ecological Service (2004): Fauna Assessment – Calga Sand Quarry Northern Extension

Countrywide Ecological Service carried out fauna surveys in 2003 and 2004 for the proposed northern extension to Calga Sand Quarry (Countrywide Ecological Service 2004). Database searches for threatened fauna were accessed online for NPWS Wildlife Atlas and EPBC websites. Extensive fauna surveys were carried out in summer (January 2003 and February 2004) to record the fauna. For completeness, these surveys were supplemented with a further evening sample on the 15 March 2004. No fish sampling was conducted as there was no fish habitat on or proximal to the Project Site.

A wide range of species were recorded within the area surveyed, including six species of frogs, 31 species of birds, 16 species of mammals (four introduced), and six reptiles. Two threatened birds were recorded: the Powerful Owl (*Ninox strenua*) and the Glossy Black-cockatoo (*Calyptorrhynchus lathami*). One threatened reptile, Rosenberg's Goanna (*Varanus rosenbergi*) was recorded.

#### 3.1.1.5 Abel Ecology (2005): Red Crowned Toadlet Survey and Assessment – Calga Sand Quarry Northern Extension

This study was undertaken in early 2005 to assess the presence and potential habitat for Red-crowned Toadlets on the Project Site (in response to reporting by a Department of Planning ecologist of possible calls of the Red-crowned Toadlet nearby or on the Project Site).

Vegetated areas were traversed during daylight hours and an assessment was made of potential habitat for Red-crowned Toadlets. Particular note was made of topographical features, of vegetation quality and type, of ephemeral water bodies and of geological and soil features which indicate the possibility of Red-crowned Toadlet habitat. Likely areas were surveyed after dark in order to listen for calls.

No Red-crowned Toadlets were recorded.

#### 3.1.1.6 CM Jewell and Associates (2004): Groundwater Assessment of the Calga Sand Quarry Northern Extension, 2004

The objectives of the hydrogeological investigation were, in general, to assess the impact of the proposed northern extension (Stage 3) to the Calga Sand Quarry extension on groundwater conditions (C.M. Jewell and Associates, 2004).

A map of high priority groundwater-dependent ecosystems (GDEs), contained within the Water Sharing Plan for the Kulnura Mangrove Mountain Groundwater Sources 2003, was reviewed to indicate groundwater-dependent ecosystems in the local area. LHCCREMS vegetation maps were reviewed to determine the extent of likely groundwater-dependent vegetation communities which may be impacted by the Project.

No GDEs were identified on the site of the proposed Stage 3 extension of the Calga Sand Quarry, however, some did occur downstream, associated with Cabbage Tree Creek. Loss of shallow groundwater discharge in the upper reaches of Cabbage Tree Creek resulting from the development of the quarry was not found likely to affect any GDEs in the lower reaches of Cabbage Tree Creek.

### 3.1.2 Database Searches

The NSW Government BioNet database (NSW Government, 2009) and the NPWS Wildlife Atlas (DECC (NSW), 2009a) were searched for threatened fauna in the locality. Additional threatened species data for the area was requested from the DECC.

## 3.2 Current Study

### 3.2.1 Introduction

Although the background surveys already undertaken by Anne Clements and Associates (Anne Clements and Associates, 2004, Anne Clements and Associates, 2005), Countrywide Ecological Service (2004) and Abel Ecology (2005) (Anne Clements and Associates, 2005, Abel Ecology, 2005) provide a valuable database of threatened species records within the Study Area, additional on-ground field surveys were completed by Cumberland Ecology and Eastcoast Flora Survey. Such additional surveys have been undertaken in order to add to the knowledge of the locations of threatened species (including endangered ecological communities) on the Project Site. Survey effort and locations of Cumberland Ecology are shown in **Figure 3.1**.

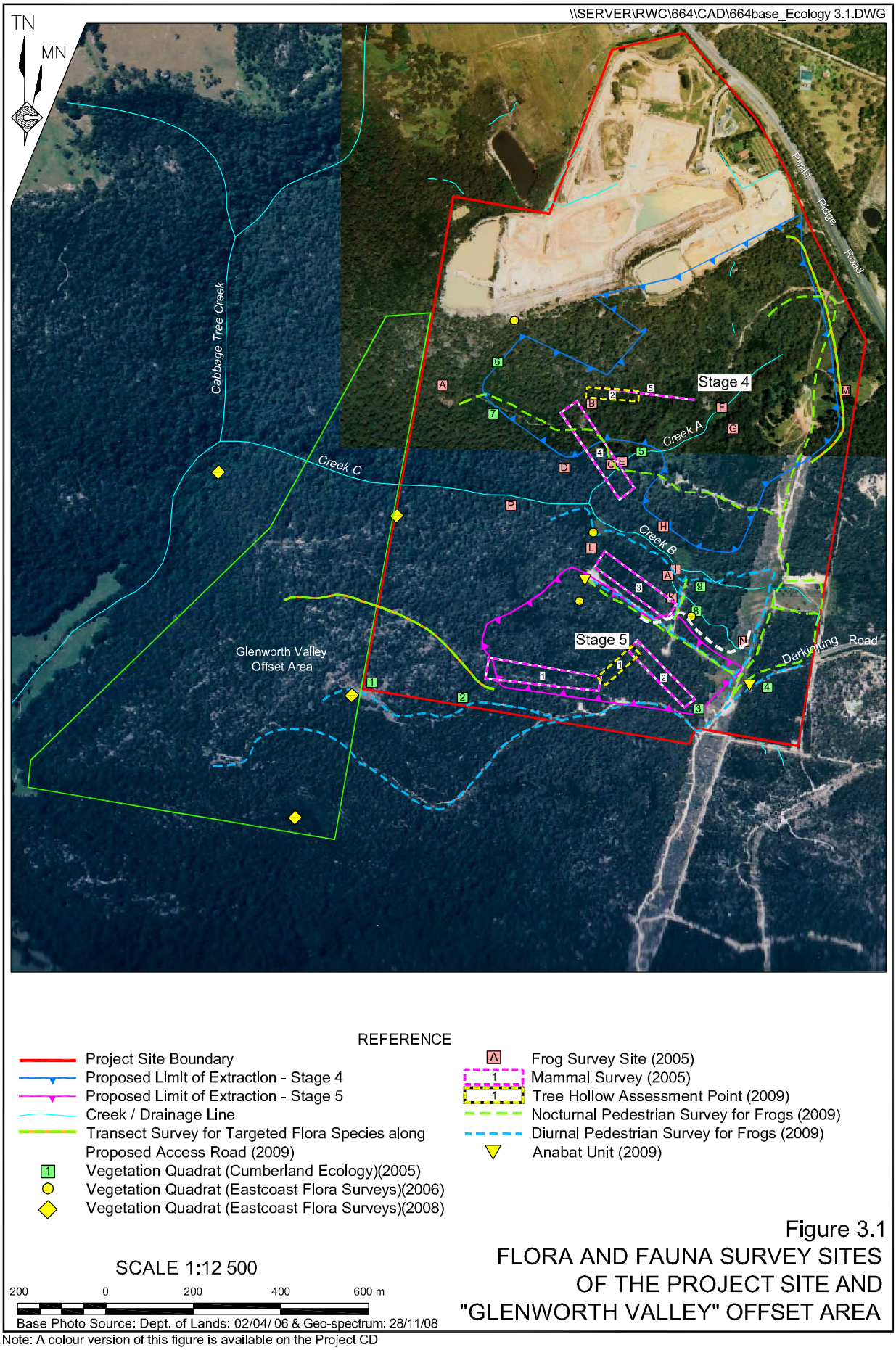



Figure 3.1
FLORA AND FAUNA SURVEY SITES OF THE PROJECT SITE AND "GLENWORTH VALLEY" OFFSET AREA

Note: A colour version of this figure is available on the Project CD

## 3.2.2 Flora

### 3.2.2.1 Cumberland Ecology Flora Surveys, 2005 and 2009

Flora surveys were conducted on the Project Site on 2nd December 2005. Mr David Thomas conducted vegetation quadrat surveys within vegetation communities identified for the Project Site by the Lower Hunter and Central Coast mapping carried out by NPWS (LHCCREMS, 2003) (see **Figure 3.1**). Some ground-truthing of these vegetation communities took place. A total of nine quadrats were sampled in the Study Area. Threatened species targeted in these surveys included *Darwinia glaucophylla* and *Hibbertia procumbens*.

The Project Site was traversed in order to assess and ground truth the LHCCREMS mapping. Quadrats of 20m x 20m in size were surveyed in each observed vegetation community in order to describe the communities accurately and to assess whether any was likely to conform to Final Determinations of Endangered Ecological Communities, under the TSC Act or EPBC Act. Notes were made regarding dominant species in each stratum, all species present, percent cover of exotic species in each stratum, details of vegetation structure, and details about topography, soil and miscellaneous features. The quadrat methodology was a modified form of, and consistent with, previous mapping by NPWS (NSW NPWS, 2000b).

Additional targeted threatened flora surveys were undertaken on 26th and 30th March 2009 along the proposed access road between Stage 4 and Stage 5, as well as the proposed access road from the Project Site onto the "Glenworth Valley" property (see **Figure 3.1**). This involved following a series of grid references along each route using a handheld GPS and searching an area approximately 40m wide along the route. This method was limited along parts of the proposed "Glenworth Valley" access road due to the steep and rugged terrain only allowing an area approximately 10m wide to be surveyed. Parts of the proposed Stage 5 access road route where threatened flora species had previously been recorded were not surveyed during this survey period.

### 3.2.2.2 Eastcoast Flora Surveys, 2006 to 2009

Additional flora surveys to those of Cumberland Ecology were undertaken by Mr Stephen Bell of Eastcoast Flora Surveys, an expert on the flora of the Gosford LGA. These surveys were conducted on the 21st November, 6th, 12th and 18th December 2006, 6th March 2007 and late July 2008. The following provides a summary of the vegetation surveys undertaken by Eastcoast.

#### Survey Effort

During November and December 2006, and March 2007, general traverses (York et al., 1991) were completed over the Project Site. Specific searches for plant species of conservation significance known from the locality were conducted in areas of potential or suitable habitat, according to the methods set out in Cropper (Cropper, 1993). All stages of the surveys (including the preliminary assessments, data and background information collection, general and threatened species field surveys and sampling techniques) were undertaken in accordance with the requirements set out in the *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities Working Draft* (DEC (NSW), 2004b).

On each survey day, up to three observers were present. All observers carried hand-held GPS units, which logged threatened species locations and the routes walked. At the completion of each day's survey, GPS data was downloaded for later use in GIS mapping.

The proposed offset area on the "Glenworth Valley" property was inspected in late July 2008. Beginning with the existing 4WD trail running in a south-westerly direction, the site was traversed as comprehensively as possible, given the rugged nature of the terrain. A hand-held GPS unit was carried at all times, and at regular intervals and where changes in vegetation were observed, Rapid Data Points (RDPs) were logged and notes taken of the dominant plant species within the three main structural layers of vegetation. The southern section in particular was examined in some detail, as the northern portion had already been inspected as part of the original flora assessments.

**Targeted Surveys**

Targeted surveys were undertaken in areas of suitable or potential habitat for threatened flora species known to occur in the region as returned in database searches (see Section 3.1.2) and for other threatened species for which the site contained suitable habitat.

A preliminary list of threatened plant species, endangered populations and endangered ecological communities was compiled and subsequently filtered based on the provision of suitable habitat within the Project Site, as well as the habitats posed by the site (see **Table B.2**, **Appendix B**). In circumstances where the site provided no suitable habitat, the species, endangered population or ecological community was assigned low or nil likelihood and omitted from the search list. The remaining species, endangered populations or ecological community were assigned moderate or high likelihood.

Specific searches were carried out for threatened species which were assigned a moderate or high chance of occurring within the Project Site based on both the species habitat requirements and the character of the habitat delineated on the Project Site The majority of threatened flora species are readily identified during spring and summer searches when not flowering.

No endangered populations of state conservation significance occur within 10km of the Project Site (DECC (NSW), 2008a).

**Vegetation Mapping Surveys (Project Site)**

Habitats were delineated during preliminary stages by means of aerial photography interpretation and were ground-truthed and mapped in accordance with the vegetation units described in Bell (Bell, 2004). Sampling was undertaken by means of a general survey (York et al., 1991)during which all vascular species encountered were recorded, together with specific 0.04ha plot-based sampling, during which all vascular plant species and their cover abundances were recorded. The following information was recorded for each vegetation community type:

- Vascular plant species characterising each stratum;
- Typical height range in each stratum;

- Typical range in the foliage projective cover of the upper strata;
- Notes on topography and geological substrate;
- Location (AMGs), distribution and abundance of any threatened flora species, endangered populations and endangered ecological communities where detected; and
- General condition of the community including evidence of fire, disturbance, presence and abundance of weeds.

The locations of the floristic plots are identified on **Figure 3.1**.

#### Vegetation Mapping Surveys ("Glenworth Valley")

As with the vegetation mapping surveys of Eastcoast (2007), prior to field survey of the offset area of the "Glenworth Valley" property interpretation of aerial photographs supplied by R.W. Corkery Pty Ltd were used to revise the LHCCREMS vegetation mapping over this area to form the base vegetation map for this section of the "Glenworth Valley" property. To ground truth this vegetation mapping, field survey was undertaken in late July 2008 where logged RDPs were downloaded onto MapInfo GIS and used to assist in the mapping process. Each logged point was classified to one of the existing Gosford LGA vegetation units (Bell, 2004), based on the dominant species in each structural layer, and used to inform map polygons.

Additional full floristic plots were undertaken within the proposed Offset Area in poorly sampled vegetation communities, to assist in their definitions. Methods used followed standard Council and NPWS guidelines, employing 0.04ha plots and recording all vascular plant species and their cover abundances. The locations of the floristic plots are identified on **Figure 3.1**.

#### Endangered Ecological Communities

The preliminary list of endangered ecological communities (EECs) was filtered based on the provision of suitable habitat within and immediately adjacent to the Project Site. In circumstances where the site provided no suitable habitat, the EEC was omitted from the search list, eg EECs known to occur on clay substrates.

The known and predicted distribution of EECs is described in accordance with the Sydney Basin subregions, of the IBRA Bioregions (Thackway and Cresswell, 1995) as defined by Morgan (Morgan, 2001) and the known and predicted distribution are provided for Hawkesbury/Nepean Catchment Management Authority Subregions.

### 3.2.3 Terrestrial Fauna

#### 3.2.3.1 Introduction

Field surveys for terrestrial fauna were undertaken by Cumberland Ecology during summer 2005/2006 and March 2009. The surveys were undertaken in order to identify the types and locations of threatened fauna throughout the Project Site. The locations of survey sites are shown in **Figure 3.1**. Survey grids were placed based on the LHCCREMS mapping of the Project Site, and sampled each of the communities on the upper elevations. As a result of

detailed vegetation surveys by Eastcoast Flora Surveys, boundaries of vegetation communities changed, and two small wetland communities were added which were not sampled as part of the mammal surveys.

#### 3.2.3.2 Frogs

In December 2005, Dr Arthur White of Biosphere Environmental Consultants Pty Ltd was engaged to carry out the surveys for frog species on the Project Site. The frog surveys were aimed at:

- assessing the diversity of the local frog populations on the Project Site;
- determining the presence or absence of habitat for the threatened frog species; and
- determining the presence or absence of threatened frog species if habitat for them was identified.

An early summer frog survey was undertaken on the 5th and 7th December 2005. The survey period was chosen to coincide with spring/summer wet weather when the two species of threatened frogs that have been identified in the locality were most likely to be active and therefore detectable. Rain had fallen on the Project Site throughout late November and a thunderstorm had brought heavy rain to the Project Site on the 2nd of December 2005.

During the survey, the days were sunny, warm and very humid with maximum temperatures in the high 20°Cs. Light rain fell on the study area on the evening of the 6th of December and the morning of the 7th of December. Thunderstorms crossed the study area on the afternoon of the 7th of December but relatively little rain fell.

**Habitat Identification:** The Project Site was traversed on the 5th of December and all freshwater sites were visited. Habitat for either of the two threatened frog species (Red-crowned Toadlet and Giant Burrowing Frog) was noted, if present, and the Project Site was revisited at night for the purpose of targeted surveys. Tadpole surveys were carried out during the day. Habitat for Giant Burrowing Frogs (Eastern Owl Frogs) was identified using specific criteria (Rescei, 1997, Rescei, 1997), i.e. perched swamp areas associated with wet or dry heath. Habitat for the Red-crowned Toadlets was located using the criteria listed in (Thumm and Mahony, 1997) comprising weeping sandstone exposures or moist sand areas on the higher parts of the plateau. Further survey was carried out on the 7th of December.

**Habitat Surveys:** A total of 16 sites of potential frog habitat within the Project Site were surveyed over the two days.

**Auditory Survey:** Areas of fresh water were visited during the day and evening on both days and all calling frogs were identified and recorded.

**Tadpole Survey:** A long-handled net was used to sample each of the freshwater habitats that contained open water. All tadpoles caught were transferred to a plastic holding bag and identified (Anstis, 2002) and released at the site of capture.

**Call Playback:** Call imitation and call playback was used for two targeted frog species at each of the survey sites (whether they contained suitable habitat or not). The mating calls were played from a small portable cassette recorder. The calls were played during the day and at night at each site on both days in an attempt to get male frogs to respond.

**Head-lamp Search:** Survey sites were traversed on foot during the night on both nights. Non-calling frogs were searched for using a head-lamp, after the mating call playbacks had been completed. Logs, rocks or other items of solid ground cover were also overturned to search for sheltering frogs.

In March 2009, Cumberland Ecology staff conducted additional frog surveys. These surveys were timed to take advantage of the remaining warmer weather prior to the onset of colder winter conditions for the year. It is also worthy of note that autumn is suitable to detect winter-breeding species such as the Red-crowned Toadlet. Methods employed during the frog surveys of March 2009 were as follows:

- Diurnal habitat searches and assessment conducted on 24th and 25th March 2009. Transects following creek lines and established tracks, as identified on **Figure 3.1** were assessed.
- Nocturnal searches, conducted on 24th to 26th March 2009, along established tracks using spotlights. Nocturnal transect searches (see **Figure 3.1**) were carried out for 2 hours on each night commencing at approximately 7.30pm.
- Call playback at points of suitable habitat for threatened frogs during nocturnal and diurnal transect searches.

Nights one and two of the survey were conducted during dry warm weather, although some rainfall had occurred in the area in recent days. The third night of survey was conducted in response to recent heavy rainfall in the area the previous day.

#### 3.2.3.3 Birds

An early summer bird survey was undertaken on 6th and 7th December 2005 by ornithologist Dr Tony Saunders of Merops Services. The Project Site was visited during a very hot and windy period, although surveys were confined to the milder parts of the day, with thunderstorms in the evening.

Data was collected from four plots, each of 100m radius, using an area search method. Plots were located in different habitats (woodland, heath, cleared land, and riparian areas). Plots were searched for between 30 and 40 minutes each survey over two days and all bird species that were positively identified by sight or call were recorded. Birds were also recorded along all tracks and accessible areas. Little sampling was done off tracks as undergrowth was very thick, progress slow and bird detection was difficult.

In addition to the survey by Dr Saunders, a record was kept of all birds observed or heard calling in the Study Area during the mammal survey periods. Records were kept of birds observed or heard calling in the vicinity of each of the locations that were used for trapping and hair tube surveys.

#### 3.2.3.4 Mammals

Mammals were surveyed using Elliott traps set in trees and on the ground, cage traps, and hair tubes. Four grids containing two parallel lines, and one grid of one line of traps were set, with separations of between 20m and 50m. Each grid contained tree traps, ground traps, cage traps and hair tubes. Elliott and cage traps were set for four consecutive nights in January/February 2006 and hair tubes were left for 10 consecutive nights.

Arboreal traps were placed in the most suitable trees in each of the trap grids. Type B Elliott traps were placed onto platforms that were attached to tree trunks approximately 2m above the ground. 10 traps per grid were set, plus one line of 5 traps, totalling 45 traps. Type E Elliott traps were placed in trees along one line of each grid (totalling 25 traps). Traps were baited with a ball of peanut butter, honey and rolled oats. Five "Faunatech" hair tubes were set and used to survey tree foraging mammals in association with the grid lines (totalling 25 traps) and left for 10 nights. Hair tubes were baited alternately with chicken or a ball of peanut butter, honey and rolled oats.

Terrestrial Type A Elliott traps were placed in association with the arboreal trap lines (totalling 45 traps). Traps were baited with peanut butter, honey and rolled oats and targeted small mammals. Two cage traps were placed in each of the trap grids, one per line (totalling 10 traps). Cage traps were baited with chicken and a ball of peanut butter, honey and rolled oats and targeted medium-sized mammals. Hair tubes were also set and used to survey for ground dwelling mammals. Five hair tubes were placed on the ground in association with the grid lines (totalling 25 traps) and left for 10 nights. Hair tubes were baited alternately with chicken or a ball of peanut butter, honey and rolled oats.

Surveys were made for microchiropteran bats using Anabat ZCAIM bat echolocation call detector units. One unit was set overnight for three nights, recording for 12 hours each night. The unit was placed at different locations each night to sample different habitat types.

An additional Anabat survey was conducted during March 2009 while the weather was still warm enough for bat activity (prior to long periods of bat inactivity during the cooler months). Anabat data was collected using an Anabat SD unit on the 24$^{th}$ and 25$^{th}$ March 2009. The anabat unit was deployed at one location each night for approximately 2 hours commencing at dusk during the nocturnal frog searches. The locations of the Anabat SD unit are shown in **Figure 3.1**.

#### 3.2.3.5 Nocturnal Mammal and Bird Spotlight Surveys and Call Playback

Spotlighting for nocturnal mammals and birds was conducted using a hand held lamp with a 100W halogen globe. This technique involved driving and walking among the heavily vegetated areas to ensure that the majority of the Study Area was sampled by spotlighting during the survey period. Spotlighting was conducted for approximately two hours per night for

three nights. During spotlighting all species of vertebrates seen or heard calling were recorded.

The Masked Owl, Sooty Owl, Powerful Owl, Barking Owl, Squirrel Glider and Yellow-bellied Glider were surveyed using call playback during evening surveys. Taped calls were broadcast through a 15 watt amplifier and played for approximately five minutes followed by listening for 10 minute periods for approximately 30 – 45 minutes at a given sampling point.

#### 3.2.3.6 Reptiles

A record was kept of all reptiles observed in the Study Area during the survey periods. Weather during the fauna survey period was hot and sunny. Reptiles seen basking were identified where possible.

#### 3.2.3.7 Incidental Records

All vertebrate fauna species that were observed, heard calling or otherwise detected on the basis of tracks, scats or signs were recorded and listed in the total species list for the Project Site.

#### 3.2.3.8 Tree Hollow and Habitat Assessment

Due to the large area of the Project Site, the dense vegetation and restricted access to areas due to vegetation and topography access it was not practical to complete a survey of tree hollows over the entire Project Site. To allow an estimation of the size and number of tree hollows over the Project Site, two 100m x 20m plots were surveyed for tree hollows. These plots were located in the dominant treed vegetation communities found within the proposed extraction areas (Plot 1 within Exposed Hawkesbury Woodland (Vegetation Community E26 and Plot 2 within Hawkesbury Banksia Scrub-Woodland (Vegetation Community E29)) and are therefore considered to provide a representative sample of the size, distribution and number of tree hollows within the areas to be disturbed by the Project.

Both plots were traversed by two ecologists using a hand-held GPS unit to locate the plot as the vegetation was too dense to mark the plots out using a measuring tape. Each hollow-bearing tree in each plot was located using the GPS unit and the species, height, diameter at breast height (DBH), number of hollows and approximate size of hollows recorded for each of these trees. The number of hollow-bearing trees within this area was then multiplied by 5 to provide a per hectare density of hollow-bearing trees for each community.

All preferred Koala feed trees according to the species listed in SEPP 44 were also recorded within each plot, with each tree being located with the GPS unit and species, height and DBH being noted. The number of trees within each plot was then multiplied by 5 to provide a per hectare density of preferred feed trees in each community.

#### 3.2.3.9 Survey Effort

A summary of survey effort undertaken by Cumberland Ecology is provided in the **Table 3.1** below. Previous surveys (e.g. Countrywide Ecological Service 2004) are not included in this summary table. A full table of survey effort for the Study Area can be found in **Appendix A**, together with a table recording compliance with the survey requirements nominated in DEC (2004b).

### 3.2.4 Aquatic Habitats and Fauna

#### 3.2.4.1 Literature and Database Search

The Co-operative Research Centre for Freshwater Ecology has recently published a management guide for assessing and monitoring aquatic biodiversity (O'Connor and Kotlash, 2005). Studies concerning the use of fish (Harris, 1995) and macroinvertebrates (Cheeseman, 1995) for ecological assessments of river health have also been reviewed. A database search of BioNet (NSW Government, 2009) and NPWS Wildlife Atlas (DEC (NSW), 2006a) revealed no records for threatened aquatic species within 5km of the Project Site.

**Table 3.1**
**Cumberland Ecology Fauna Survey Effort Summary**

| Survey Technique | Survey Effort | Threatened Fauna Targeted |
|---|---|---|
| Arboreal Elliott B Trapping | 400 trap nights in four locations | Squirrel Glider, Yellow-bellied Glider |
| Arboreal Elliott E Trapping | 200 trap nights in four locations | Eastern Pygmy Possum |
| Terrestrial Elliot A Trapping | 400 trap nights in ten locations | Rodents |
| Cage Traps | 80 trap nights in ten locations | Spotted-tailed Quoll, Southern Brown Bandicoot |
| Arboreal Hair Funnels | Minimum of 500 tube nights in ten locations | Squirrel Glider, Yellow-bellied Glider |
| Terrestrial Hair Funnels | Minimum of 500 tube nights in ten locations | Spotted-tailed Quoll, Southern Brown Bandicoot, various |
| Spotlighting | Three nights by two ecologists | Squirrel Glider, Owls, Flying-foxes, Koala, Stephen's Banded Snake |
| Call Playback | One playback location over three nights | Owls, Gliders, Koala |
| AnaBat Detection | Three detector nights (overnight recording) | Microchiropteran bats |
| Frog Surveys | Opportunistic and targeted | Red-crowned Toadlet, Giant Burrowing Frog |
| Reptile Surveys | Opportunistic | various |
| Scat, track and sign identification | Opportunistic | Spotted-tailed Quoll, Koala, Owls, various |

#### 3.2.4.2 Fauna and Habitat Surveys

The nature and quality of the aquatic habitats were determined by a survey on 13th February 2006 involving the traversing of creeks and inspection of aspects such as flow rates, vegetation, erosion and water sources within the Project Site.

The use of relative health assessments for habitat conditions in qualification of creeks was conducted, based on the AusRivAS sampling requirements to incorporate information including the presence and abundance of aquatic plants, macroinvertebrates and fish, visible signs of degradation including bank erosion, sedimentation and weeds influx, and overall water quality (Turak and Waddell, 2001, Turak et al., 2004). This technique is based on the sensitivity to pollution of particular macroinvertebrate groups. Some groups of macroinvertebrates are more tolerant to pollution than others, while other families are relatively sensitive to pollution and only occur in pristine environments. Macroinvertebrate families have been assigned a "Signal Grade" where higher grades are given to more sensitive families (Gooderham, 2002, Gooderham, 2002). The signal score for a site is worked out by calculating the average signal grade of all the families present:

| | |
|---|---|
| >6 | healthy habitat |
| 5-6 | mild pollution |
| 4-5 | moderate pollution |
| <4 | severe pollution. |

Fish were sampled using an Electrofisher unit, which was used to stun any aquatic fauna occurring in the scarce isolated ephemeral pools along the creeks on the Project Site. Stunned fish and aquatic fauna were collected using a dip net and Japanese Seine Net and identified before being released back at the point of capture.

Macroinvertebrates were also sampled using a kick net (0.25 mm mesh) to assist in determining the health of the existing aquatic systems within the Study Area. Samples were taken for 5 minutes at each location amongst water plants, sediment, rocks and logs. Macroinvertebrates were then identified and counted for later analysis.

# 4 RESULTS

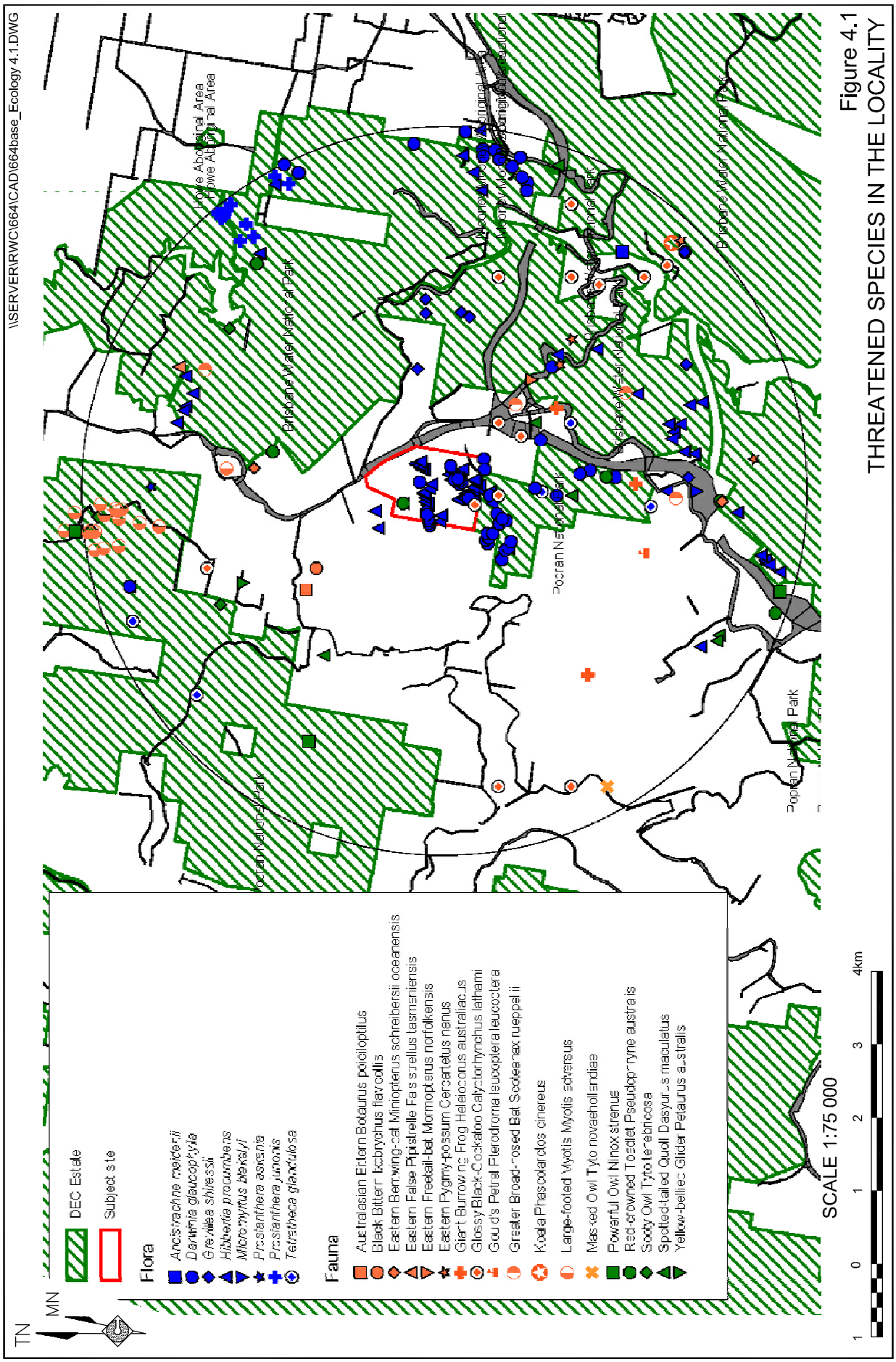
## 4.1 Database Surveys and Literature Review

### 4.1.1 Introduction

The results of the literature review, database analyses and targeted surveys are summarised in flora and fauna species lists that are provided within **Appendix A**. The fauna list provides a summary of species present within the Gosford LGA and indicates those species that have been recorded as present within the Study Area. Data from the species lists indicate that a considerable diversity of native flora and fauna species occur within the locality.

### 4.1.2 Database Surveys

The DECC database records are shown in **Figure 4.1.** The database mapping shows one threatened species as having been recorded within the Study Area (Glossy Black-cockatoo) and 22 additional threatened species within 5km of the Project Site.




Note: A colour version of this figure is available on the Project CD

A variety of threatened flora and fauna listed under the TSC Act and the EPBC Act are known or considered likely to occur on the Project Site and within the Study Area. An analysis of likely occurrence of species recorded in the Gosford LGA in the last 20 years via a BioNet database search (NSW Government, 2009, DECC (NSW), 2009) and EPBC Protected Matters Database search (DEH, 2009) can be found in **Appendices A and B**. Other species considered by Cumberland Ecology to have potential habitat, or species previously mentioned by other studies as having potential habitat, have also been listed. This analysis revealed that a number of threatened species/communities have the potential to occur on the Project Site (refer to **Table 4.1**).

### 4.1.3 LHCCREMS Habitat Modelling

As part of the LHCCREMS studies, habitat modelling for eight threatened species was undertaken (LHCCREMS, 2004). Predictive habitat was based on species records and the LHCCREMS vegetation mapping (LHCCREMS, 2003). Fauna species modelled included Koala, Squirrel Glider, Yellow-bellied Glider, Tiger Quoll, Masked Owl, Sooty Owl and Powerful Owl. The study provided maps showing the predicted probability of occurrence for these species throughout the Central Coast and Hunter region.

**Table 4.1**
**Threatened Species/Communities Recorded In Gosford LGA In The Last 20 Years**

Page 1 of 3

| | *Scientific name* | Common Name | Legal Status | | Popran NP | Study Area | Project Site |
|---|---|---|---|---|---|---|---|
| | | | TSC | EPBC | | | |
| **ANIMALS** | | | | | | | |
| **AMPHIBIANS** | *Heleioporus australiacus* | Giant Burrowing Frog | V | V | Y | | |
| | *Mixophyes balbus* | Stuttering Frog | E1 | V | | | |
| | *Mixophyes iteratus* | Giant Barred Frog | E1 | E | | | |
| | *Pseudophryne australis* | Red-crowned Toadlet | V | | Y | | Y |
| **REPTILES** | *Hoplocephalus bungaroides* | Broad-headed Snake | E1 | V | | | |
| | *Hoplocephalus stephensii* | Stephens' Banded Snake | V | | | | |
| | *Varanus rosenbergi* | Rosenberg's Goanna | V | | | Y | |
| **BIRDS** | *Pterodroma leucoptera* | Gould's Petrel | E1 | E | | | |
| | *Ixobrychus flavicollis* | Black Bittern | V | | | | |
| | *Botaurus poiciloptilus* | Australasian Bittern | V | | | | |
| | *Pandion haliaetus* | Osprey | V | | | | |
| | *Haematopus longirostris* | Pied Oystercatcher | V | | | | |
| | *Ptilinopus superbus* | Superb Fruit-dove | V | | | | |
| | *Callocephalon finbriatum* | Gang-gang Cockatoo | V | | | | |
| | *Calyptorhynchus lathami* | Glossy Black-cockatoo | V | | Y | Y | Y |
| | *Lathamus discolor* | Swift Parrot | E1 | E | | | |
| | *Neophema pulchella* | Turquoise Parrot | V | | | | |
| | *Ninox strenua* | Powerful Owl | V | | Y | Y | |
| | *Ninox connivens* | Barking owl | V | | | | |
| | *Tyto tenebricosa* | Sooty Owl | V | | Y | | |
| | *Tyto novaehollandiae* | Masked Owl | V | | | | |
| | *Climacteris picumnus* | Brown Treecreeper | V | | | | |
| | *Xanthomyza phrygia* | Regent Honeyeater | E1 | E | | | |

## Table 4.1 (Cont'd)
## Threatened Species/Communities Recorded In Gosford Lga In The Last 20 Years



| | Scientific name | Common Name | Legal Status | | Popran NP | Study Area | Project Site |
|---|---|---|---|---|---|---|---|
| | | | TSC | EPBC | | | |
| **ANIMALS (cont'd)** | | | | | | | |
| **MAMMALS Bats** | *Chalinolobus dwyeri* | Large Pied Bat | V | V | | | |
| | *Falsistrellus tasmaniensis* | Eastern False Pipistrelle | V | | | | |
| | *Miniopterus australis* | Little Bent-wing Bat | V | | | | |
| | *Miniopterus schreibersii oceanensis* | Eastern Bent-wing Bat | V | | Y | | |
| | *Mormopterus norfolkensis* | Eastern Freetail-bat | V | | | | |
| | *Myotis macropus* | Large-footed Myotis | V | | Y | | Y |
| | *Pteropus poliocephalus* | Grey-headed Flying-fox | V | V | Y | | |
| | *Saccolaimus flaviventris* | Yellow-bellied Sheathtail-bat | V | | | | |
| | *Scoteanax rueppellii* | Greater Broad-nosed Bat | V | | | | |
| **Terrestrial Mammals** | *Cercartetus nanus* | Eastern Pigmy-possum | V | | | | Y |
| | *Dasyurus maculatus* | Tiger Quoll | V | E * | Y | | |
| | *Isoodon obesulus obesulus* | Southern Brown Bandicoot | E1 | | | | |
| | *Macropus parma* | Parma Wallaby | V | | | | |
| | *Petrogale penicillata* | Brush-tailed Rock-wallaby | E1 | V | | | |
| | *Petaurus australis* | Yellow-bellied Glider | V | | | | |
| | *Petaurus norfolcensis* | Squirrel Glider | V | | Y | | |
| | *Phascolarctos cinereus* | Koala | V | | | | |
| | *Potorous tridactylus* | Long-nosed Potoroo | V | V | | | |
| | *Pseudomys gracilicaudatus* | Eastern Chestnut Mouse | V | | | | |
| **PLANTS** | | | | | | | |
| **Araliaceae** | *Astrotricha crassifolia* | | V | | | | |
| **Asteraceae** | *Olearia cordata* | | V | V | | | |
| | *Senecio spathulatus* | | E1 | | | | |
| **Dilleniaceae** | *Hibbertia procumbens* | | E1 | | | Y | Y |
| | *Tetratheca glandulosa* | | V | V | | | |
| **Elaeocarpaceae** | *Tetratheca juncea* | | V | V | | | |
| **Epacridaceae** | *Epacris purpurascens* var *purpurascens* | | V | | | | |
| **Euphorbiaceae** | *Chamaesyce psammogeton* | | E1 | | | | |
| | *Acacia bynoeana* | Bynoe's Wattle | E1 | V | | | |
| **Fabaceae** | *Acacia pubescens* | | V | | | | |
| **Haloragaceae** | *Haloragodendron lucasii* | | E1 | E | | | |
| **Juncaginaceae** | *Maundia triglochinoides* | | V | | | | |
| | *Prostanthera askania* | | E1 | | | | |
| **Lamiaceae** | *Prostanthera junonis* | Somersby Mintbush | E1 | E | | | |
| | *Callistemon linearifolius* | | V | | | | Y |
| | *Darwinia biflora* | | V | | | | |
| | *Darwinia glaucophylla* | | V | | Y | Y | Y |
| | *Eucalyptus camfieldii* | | V | V | | | |
| | *Kunzea rupestris* | | V | | | | |
| | *Melaleuca biconvexa* | | V | | | | |
| | *Melaleuca deanei* | | V | V | | | |
| | *Micromyrtus blakelyi* | | V | | | | |
| **Myrtaceae** | *Syzygium paniculatum* | | V | | | | |

**Table 4.1 (Cont'd)**
**Threatened Species/Communities Recorded In Gosford Lga In The Last 20 Years**



| | *Scientific name* | Common Name | Legal Status | | Popran NP | Study Area | Project Site |
|---|---|---|---|---|---|---|---|
| | | | TSC | EPBC | | | |
| **PLANTS (cont'd)** | | | | | | | |
| | *Caladenia tessellata* | | E1 | V | | | |
| | *Cryptostylis hunteriana* | | V | V | | | |
| | *Dendrobium melaleucaphilum* | | E1 | | | | |
| | *Diuris bracteata* | | E4 | | | | |
| **Orchidaceae** | *Diuris praecox* | | V | | | | |
| | *Rhizanthella slateri* | Underground Orchid | V | | | | |
| **Poaceae** | *Ancistrachne maidenii* | | V | | | | |
| | *Grevillea parviflora* ssp *parviflora* | | V | V | | | |
| **Proteaceae** | *Grevillea shiressii* | | V | V | | | |
| | *Persoonia hirsuta* | | E1 | E | | | |
| **Sterculiaceae** | *Lasiopetalum joyceae* | | V | | | | |
| **COMMUNITIES** | | | | | | | |
| | *River-flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and Southeast Corner Bioregions* | *River-flat Eucalypt Forest on Coastal Floodplains* | EEC | | | | |
| | *Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and Southeast Corner Bioregions* | *Swamp Oak Floodplain Forest* | EEC | | | | |
| | *Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and Southeast Corner Bioregions* | *Swamp Sclerophyll Forest on Coastal Floodplains* | EEC | | | | |
| | *Sydney Freshwater Wetlands in the Sydney Basin Bioregion* | *Freshwater Wetlands* | EEC | | | | |

*Notes* TON – Taxonomic Order Number; EEC – Endangered Ecological Community; E1 – Endangered; E4 – Presumed Extinct, E – Endangered; V – Vulnerable; * SE mainland population

The predicted probability of occurrence for these species at Calga is as follows:

- Koala: 20-40%. The main predicted occurrence of habitat for this species is in the west, near Port Stephens and along the edge of the Hawkesbury. Mid level probability is found around the Calga area.
- Squirrel Glider: 10-40%. The main occurrence of habitat for this species is further north, from Wyong to Port Stephens. The Calga area is shown mainly as very low probability, with small patches of slightly higher probability.
- Yellow-bellied Glider: 0-10%. The main predicted occurrence of habitat for this species is in the valleys either side of the Kulnura-Mangrove Mountain and Somersby Plateaus. Mid-level probabilities extend around these areas.
- Tiger Quoll: 40-60%. The main predicted occurrence of habitat for this species is in the west and southwest of the region. Mid-level probability of habitat is found throughout the southern half of the region.

- Masked Owl: 0-10%. The main predicted occurrence of habitat for this species is around Lake Macquarie. Pockets of mid-level probability of habitat exist elsewhere throughout the region.
- Powerful Owl: 20-40%. The main predicted occurrence of habitat for this species is around Lake Macquarie, in the Gosford area and near Port Stephens. Mid-level probability of habitat exists elsewhere throughout the region.
- Sooty Owl: 0-40%. The main predicted occurrence of habitat for this species is associated with the mountains and rainforest areas. Mid-level probability of habitat exists associated with these areas.

## 4.2 Terrestrial Flora

### 4.2.1 Vegetation Mapping

#### 4.2.1.1 LHCCREMS Vegetation Mapping

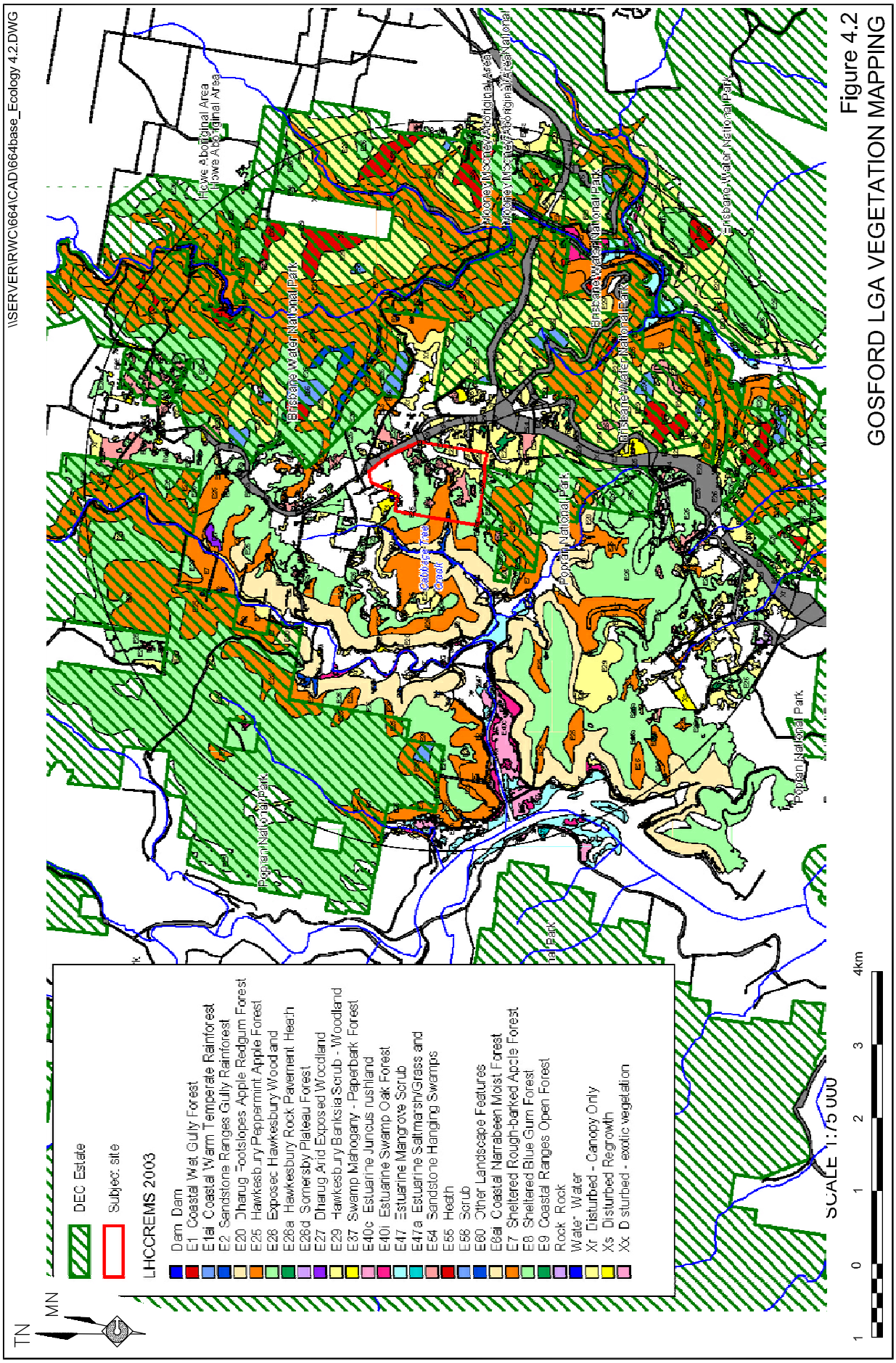
Previous mapping of the vegetation of the region by NPWS in 2003 (LHCCREMS, 2003, LHCCREMS, 2003) indicated that the Project Site generally was covered by the following plant communities (see **Figure 4.2**).

- MU 26 Exposed Hawkesbury Woodland.
- MU 25 Sheltered Dry Hawkesbury Woodland.
- MU 29 Hawkesbury Coastal Banksia Woodland.
- MU 26a Scrub [Open Scrub Hawkesbury Sandstone Complex, (Benson, 1986)].

#### 4.2.1.2 Vegetation Mapping of Gosford LGA

More detailed mapping of vegetation communities in the Gosford LGA was carried out by Stephen Bell in 2003 to assist strategic planning in the region (Bell, 2004). This study provides more accurate mapping of vegetation for the LGA than the LHCCREMS mapping discussed above. This mapping indicates that the vegetation communities of the Somersby Plateau include (see **Figure 4.2**):

- E26d Somersby Plateau Forest – predominated around Somersby and Mangrove Mountain;
- E26 Exposed Hawkesbury Woodland – common elsewhere on the plateau;
- E29 Hawkesbury Banksia Scrub-Woodland – large patches can occur;
- E26a Hawkesbury Rock Pavement Heath – typically restricted patches within E26;
- E54 Sandstone Hanging Swamps – occupy highly restricted habitats where impeded drainage creates upland swamps; and
- E25 Hawkesbury Peppermint-Apple Forest – occurs in downstream areas associated with Narrabeen sediments (Bell 2004).




Note: A colour version of this figure is available on the Project CD

E54 Sandstone Hanging Swamps is considered regionally significant (vulnerable) by Bell (2004).

#### 4.2.1.3 Previous Studies

In the flora assessment of Anne Clements and Associates (Anne Clements and Associates, 2004), two LHCCREMS vegetation communities were recorded comprising:

- MU 29 Hawkesbury Plateau Banksia Scrub; and
- MU 26 Exposed Hawkesbury Woodland.

The targeted flora study of Anne Clements and Associates (Anne Clements and Associates, 2005) identified hanging swamps on the Project Site, but no sedgelands.

Hanging swamps develop on sloping rock faces composed of sandstone which are subject to a constant supply of water - especially groundwater but also surface runoff. Slopes vary widely but commonly exceed 1 in 3 (33%). The condition of constant moisture allows a range of plant species to gradually colonise these bare rock sites over long periods of time. There are two broad types of hanging swamp - sedge swamp and shrub swamp.

Two small patches of hanging swamp each approximately 10m in diameter were observed on the hillside near the western boundary of the Study Area, each dominated by *Gymnoschoenus sphaerocephalus* (Button Grass), a characteristic species of the Blue Mountains hanging swamps described by Anne Clements and Associates (2005).

#### 4.2.1.4 Results of Current Survey

The Project Site supports a range of vegetation typical of Hawkesbury Sandstone environments on the Somersby Plateau. A vegetation map has been prepared for the Project Site by Eastcoast Flora Surveys, based on the Gosford LGA vegetation classification of Bell (2004) (Bell, 2004). Eastcoast Flora Surveys then extended the vegetation map onto the proposed offset area of the "Glenworth Valley" property, with the vegetation communities identified in accordance with Bell (2004). **Figure 4.3** shows the distribution of the identified vegetation communities on the Project Site and offset area of the "Glenworth Valley" property. Note that most of the hanging swamps mapped within the Study Area are at a long-unburnt seral stage and currently support dense stands of *Banksia ericifolia*, also frequently merging into adjacent scrub-woodlands. It is likely that a wildfire would open these areas up considerably and permit a range of other plant species to proliferate in the short term.

Communities located within the Project Site include:

- E2 Sandstone Ranges Gully Rainforest;
- E25 Hawkesbury Peppermint – Apple Forest;
- E26 Exposed Hawkesbury Woodland;
- E26a Hawkesbury Rock Pavement Heath;

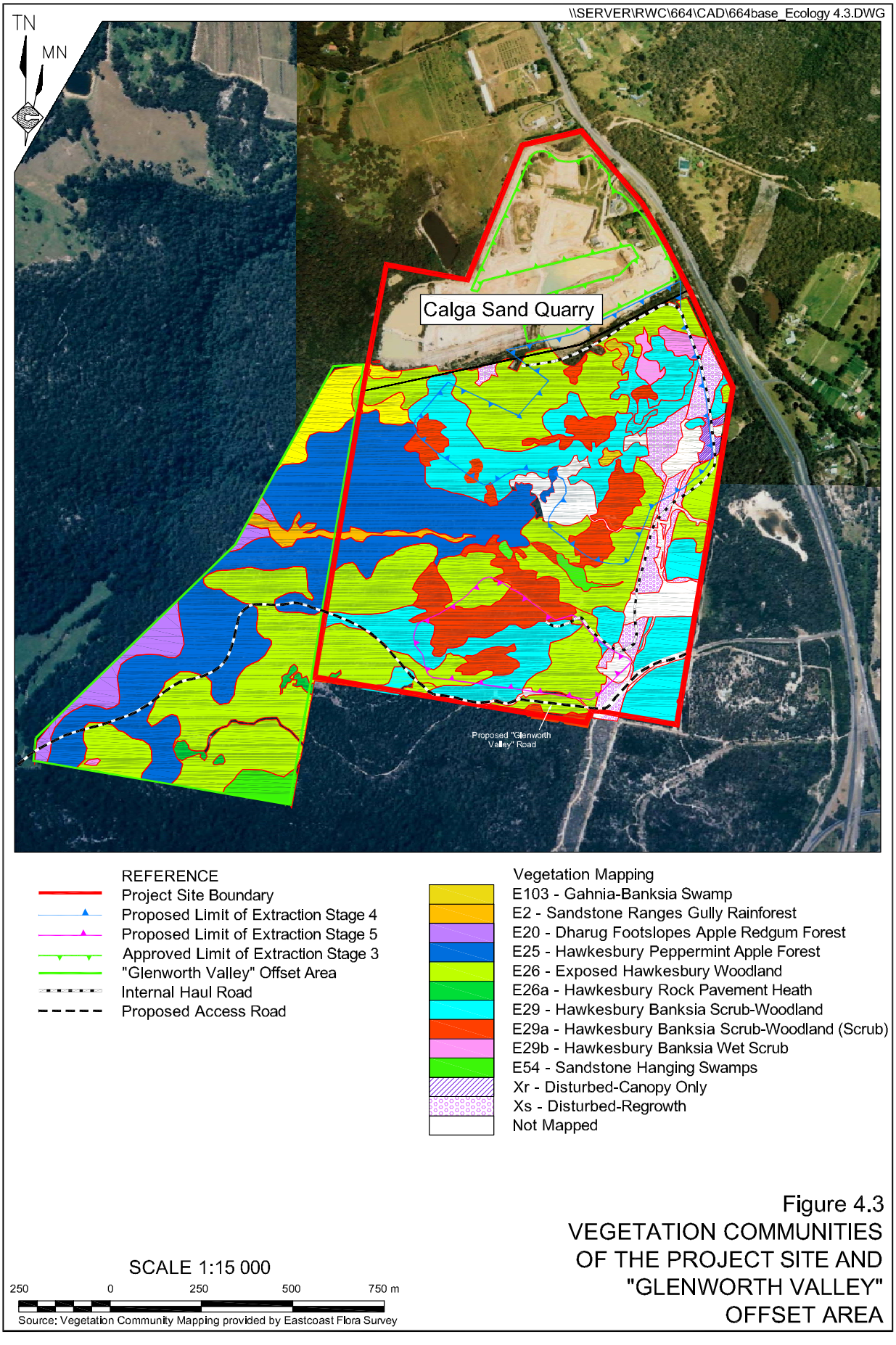



Figure 4.3
VEGETATION COMMUNITIES OF THE PROJECT SITE AND "GLENWORTH VALLEY" OFFSET AREA

- E29 Hawkesbury Banksia Scrub-Woodland;
- E29a Hawkesbury Banksia Scrub-Woodland (scrub);
- E29b Hawkesbury Banksia Wet Scrub;
- E54 Sandstone Hanging Swamp; and
- E103 Gahnia/Banksia Swamp.

Vegetation communities E2, E25, E26, E26a, E29, E29b and E54 were also identified on the "Glenworth Valley" property along with the following additional vegetation community.

- E20 Dharug Footslopes Apple-Redgum Forest.

A description of these communities (based on the descriptions provided by Bell, 2004) is as follows.

**E2 Sandstone Ranges Gully Rainforest** is equivalent to LHCCREMS MU2 Sandstone Ranges Warm Temperate Rainforest. A band of this community occurs along the lower reaches of the main drainage channel (Creek C). In general, this community is composed of a continuous canopy layer with an occasional small tree layer and a sporadic emergent tree stratum. Emergent trees include Turpentine (*Syncarpia glomulifera*) and Forest Oak (*Allocasuarina torulosa*). The groundcover is typically sparse below a dense canopy, but may increase in density and light breaks and along edges.

**E20 Dharug Footslopes Apple-Redgum Forest** is equivalent to LHCCREMS MU 20 which is generally restricted to the richer sediments of the Narrabeen Sandstone series. Dominant species present include Rough-barked Apple (*Angophora floribunda*), Grey Gum (*Eucalyptus punctata*), and in a few locations Thin-leaved Stringybark (*Eucalyptus eugenioides*) and Grey Ironbark (*Eucalyptus paniculata*). The canopy layer is generally between 20-25m in height, with a Foliage Projection Cover (FPC) of 30-40%. A mid canopy layer, dominated by Forest Oak (*Allocasuarina torulosa*) and young eucalypt trees to a height of 15m, exists along with a shrub layer supporting more mesic species. The groundcover layer is considerably more diverse.

**E25 Hawkesbury Peppermint – Apple Forest** is equivalent to MU 25 Sheltered Dry Hawkesbury Woodland. The terrain upon which this community occurs comprises sandy soils on sandstone benches on mid to lower slopes. This community provides habitat for the vulnerable *Callistemon linearifolius.* The upper canopy species, which include Smooth-barked Apple (*Angophora costata*), Sydney Peppermint (*Eucalyptus piperata*), Grey Gum (*E. punctata*), Red Bloodwood (*Corymbia gummifera*) and Scribbly Gum (*E. haemostoma*), form an open forest structure. A mid canopy layer exists and a moderately dense shrub layer. The groundcover layer is typically moderately dense and diverse.

**E26 Exposed Hawkesbury Woodland** is equivalent to MU26 Exposed Hawkesbury Woodland as mapped by LHCCREMS. This community occurs in sandy soils on sandstone benches, gentle slopes and occasional sandstone outcrops. This vegetation type constitutes a common component of the vegetation on the Project Site. This community provides habitat for

the endangered *Hibbertia procumbens* and the vulnerable *Callistemon linearifolius* and *Darwinia glaucophylla*. Two variants of this community were noted on the Project Site:

1. Scribbly Gum – Stringybark – Red Bloodwood – Sydney Red Gum Woodland; and
2. Red Bloodwood – Grey Gum Woodland/Open Forest.

The shrub stratum varies from low and patchy to very dense and the groundcover is patchy to occasionally moderately dense and diverse.

**E26a Hawkesbury Rock Pavement Heath** is a subformation of LHCCREMS MU26. This community generally occurs on large exposed sandstone outcrops on ridges and upper slopes, and provides habitat for the vulnerable *Darwinia glaucophylla*. In general, upper canopy and secondary canopy species are absent, and the shrub layer varies from low and patchy to moderately dense. A range of groundcover species occur.

**E29 & E29a. Hawkesbury Banksia-Scrub Woodland** is equivalent to LHCCREMS MU29 Hawkesbury Coastal Banksia Woodland. This community occupies sizeable areas of the Project Site. Areas with very little emergent eucalypt and dense stands of *Banksia ericifolia* have been mapped separately as E29a. Occasional, isolated stands of upper canopy species can form a sparse woodland structure in some site. Canopy species include Brown Stringybark (*Eucalyptus capitellata*), Narrow-leaved Scribbly Gum (*E. racemosa*), Red Bloodwood (*Corymbia gummifera*) and Narrow-leaved Stringybark (*E.. sparsifolia*). . The shrub stratum is typically dense and a diverse groundcover exists.

**E29b. Hawkesbury Banksia Wet Scrub** is a subformation of LHCCREMS MU29 and occupies very restricted areas within the wider mosaic of woodland and scrub on Hawkesbury Sandstone geology. Dominated by a scattered shrub stratum, typically 0.5m to 1.5m high, including species such as Banksia (*Banksia oblongifolia*), Dagger Hakea (*Hakea teretifolia*), Teatree (*Leptospermum juniperinum*), *Leptospermum polygalifolium*, Coral Heath (*Epacris microphylla*), *Pultenaea elliptica*, *Platysace linearifolia* and *Hakea laevipes*, occasional isolated individuals from surrounding woodlands, such as Red Bloodwood (*Corymbia gummifera*) and Black She-oak (*Allocasuarina littoralis*), form a scattered emergent layer to 5m in height.

The groundcover layer (to a maximum height of 1m) includes sedges such as *Lepyrodia scariosa*, *Leptocarpus tenax*, and *Dampiera stricta*.

**E54 Sandstone Hanging Swamp** is equivalent to LHCCREMS MU45 Sandstone Hanging Swamps and Heaths. Sandstone Hanging Swamps occur on gently to moderate slopes in the central part of the Project Site. No threatened species were recorded in this community. This community is typified by a dense groundcover of Button Grass (*Gymnoschoenus sphaerocephalus*). A range of shrubs and other groundcover species also occur.

**E103 Gahnia/Banksia Swamp** has no equivalent in either the Gosford LGA vegetation mapping or the LHCCREMS vegetation mapping. This community is restricted to one site on mid-slopes along one drainage channel in the central part of the Project Site. No threatened species were recorded in this community. Upper and secondary canopy are generally absent, however the shrub stratum and groundcover are dense.

### 4.2.2 Endangered Ecological Communities

None of these communities identified by Eastcoast Flora Surveys and presented on **Figure 4.3** equate to listed Endangered Ecological Communities under the TSC Act or the EPBC Act.

### 4.2.3 Regionally Significant Vegetation

According to the Hunter-Central Rivers CMA (2006) regionally significant vegetation can include:

- communities of limited distribution (have experienced greater than 50% clearing of pre-1750 distribution);
- rare communities, where the total geographic range is generally less than 10,000ha;
- communities which contain endemic plants with greater than 75% of predicted distribution within the CMA;
- communities of low reservation status (not well-represented in conservation reserves);
- communities that are disjunct or at the distributional limit of their range;
- particular structural vegetation formations (such as wetlands, headland vegetation, old growth forest, and rainforest); and
- vegetation landscapes (such as riparian vegetation, floodplain vegetation, and regional habitat and corridors).

This list is also considered to be relevant to the Hawkesbury-Nepean CMA.

Regionally significant vegetation has been listed by LHCCREMS (2003) (LHCCREMS, 2003). Within the Study Area, the Sandstone Hanging Swamps (MU54) and the Sandstone Ranges Warm Temperate Rainforest (MU2) have both been identified as vulnerable and specialised communities. On a more local scale, Bell (2004) lists E2 Sandstone Ranges Gully Rainforest, E25 Hawkesbury Peppermint Apple Forest, E26 Exposed Hawkesbury Woodland, E26a Hawkesbury Rock Pavement Heath, E29 Hawkesbury Banksia Scrub-Woodland and E54 Sandstone Hanging Swamps as being locally significant due to threatened species habitat, restricted distribution or development pressure.

### 4.2.4 Threatened Species

Much of the Project Site is almost impenetrable due to the extensive and dense stands of *Banksia ericifolia* var. *ericifolia*, which respond to wildfire through vigorous seedling emergence from the seed bank. Consequently, searches for threatened plant species in this environment are difficult.

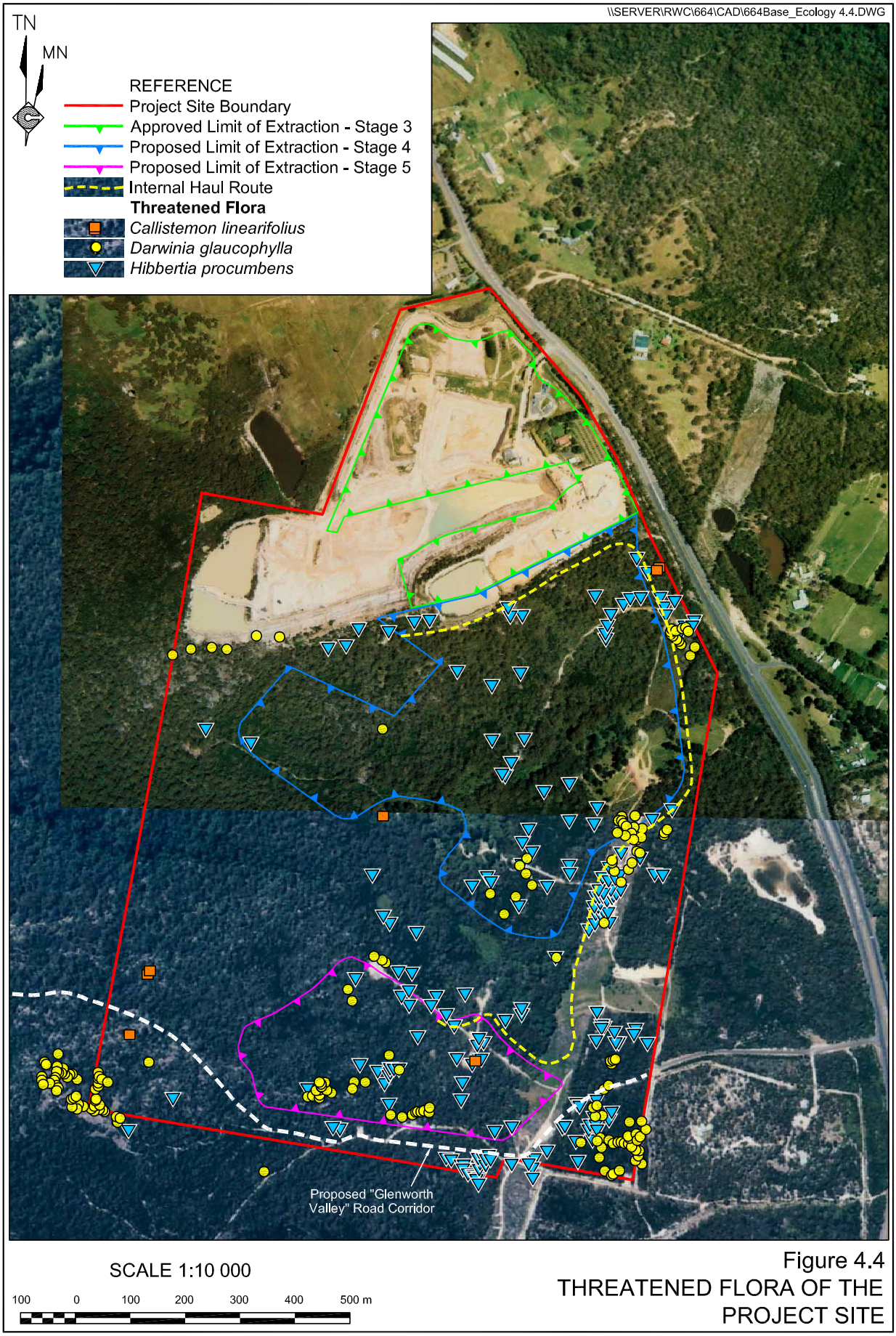



Figure 4.4
THREATENED FLORA OF THE PROJECT SITE

Two of the four target species, *Hibbertia procumbens* and *Darwinia glaucophylla*, were detected on the Project Site in many locations, and a third threatened species, *Callistemon linearifolius*, was also present in small groups in four scattered locations (see **Figure 4.4**). The northeastern record of this species is of 10 plants, the records in the centre and the southeast are of a single plant, and in the southwest there were 13 plants spread over 3 close locations. *H. procumbens* and *D. glaucophylla* were found throughout the higher elevations of the Study Area. Targeted searches were not carried out at the lower elevations.

None of the stringybark trees present on the Project Site were identified as *Eucalyptus camfieldii*, despite known records from elsewhere in the local area. While the more common *Tetratheca ericifolia* was flowering in many areas, none of the material examined could be attributed to *Tetratheca glandulosa*. *Prostanthera junonis* was not recorded on the Project Site.

Other threatened plant species have the potential to occur at the Project Site. These are discussed in **Appendix C**.

### 4.2.5 Introduced Species

Introduced species present in cleared and disturbed areas of the Project Site include Lantana (*Lantana camara*), Blackberry (*Rubus fruticosus*), Crofton Weed (*Ageratina adenophora*), Eastern Cottonbush (*Gomphocarpus fruticosus*), Cape Weed (*Arctotheca calendula*), Fireweed (*Senecio madagascariensis*), Jo-Jo (*Soliva pterosperma*), Cat's Ears (*Hypochaeris radicata*), Hairy Bird's Foot Trefoil (*Lotus suavolens*), Monterey Pine (*Pinus radiata*), Petty Spurge (*Euphorbia peplus*), Japanese Honeysuckle (*Lonicera japonica*), Red-flowered Mallow (*Modiola caroliniana*), Fleabanes (*Conyza* spp.), Winter Senna (*Senna pendula* var. *glabrata*), Paddys Lucerne (*Sida rhombifolia*) and Moth Vine (*Araujia sericifolia*).

One specimen of Large-leaved Privet (*Ligustrum lucidum*) was located in E2 Sandstone Ranges Gully Forest. A range of weeds were also located in E25 Hawkesbury Peppermint-Apple Forest, including Lantana (*Lantana camara*), Mist Flower (*Ageratina riparia*), Crofton Weed (*Ageratina adenophora*), Large-leaved Privet (*Ligustrum lucidum*), and Fleabanes (*Conyza bonariensis* and *C. canadensis* subsp. *canadensis*).

A number of these species are considered "Environmental Weeds" (Muyt, 2001). Four species are listed under the Noxious Weeds Act 1993 as noxious in the Gosford LGA.

- Crofton Weed – locally controlled weed.
- Mist Flower – locally controlled weed.
- Lantana – restricted plant.
- Blackberry – locally controlled weed.

## 4.3 Habitats

### 4.3.1 Habitat available in the Project Site

#### 4.3.1.1 General Description

A wide range of flora and fauna habitats are present within the Project Site. Previous studies (Countrywide Ecological Service 2004) and (Abel Ecology, 2005) have identified a range of fauna habitats within the Study Area. As a result of reviewing these previous studies and inspection of the Project Site, the following habitat components have been identified.

- Various plant communities and their ecotones.
- Trees with hollows.
- Rock outcrops.
- Logs.
- Leaf litter.
- Creeklines and ephemeral drainage areas.

Such habitat features are extensive throughout the Project Site and are likely to be relied on by a suite of native fauna, including a number of threatened species.

The Project Site consists of eight main vegetation communities, within each of which there is some variation apparent. The vast majority of the habitat is forest and woodland, with areas cleared for access roads and along the power line easement. Some vegetated areas are impenetrable due to thick growth of *Banksia ericifolia* and *Angophora hispida*.

One main creek (Creek C) runs east to west through the lower elevations of the Project Site. Two smaller creeks (Creeks A and B) feed into the main creek and are located on the higher elevations. The smaller creeks are ephemeral, with some seepage from the sandstone supplying some of the water for the main creek.

A cliff line exists in the central part of the Project Site and other large rock outcrops provide many crevices. Large sandstone pavements are found in some areas, particularly towards the southern end.

#### 4.3.1.2 History of Use

The main use of the Project Site to date has been for access to the transmission line which runs through the eastern side of the property. Prior to its purchase by Rocla, the property was owned by RTA with some limited extraction of gravel undertaken.

#### 4.3.1.3 Habitat Condition

Habitat condition is generally good for native flora and fauna across a high proportion of the Project Site that has retained native forest and woodlands. The factors that detract most from habitat condition in these areas are as follows.

- Weed invasion: weeds are not currently a major issue in the Project Site although some weed species do occur in patches throughout. Small-leaved Privet, Blackberry and a range of exotic grasses are present (see Section 4.2.5).
- Exotic animals: introduced (feral) fauna species are generally not prevalent throughout the Project Site. Three introduced species were recorded in the Project Site (Brown Rat, House Mouse and European Fox). Cats and dogs are also likely to be present. These carnivorous pests are likely to be predating on native fauna.
- Fire history: the Project Site shows evidence of many fires, however, there have been no fires in recent years. Too frequent fires are likely to have lowered the density of the understorey of some areas, and reduced the quality of fire-sensitive habitats and the abundance of fire sensitive species, while encouraging fire-dependent species (such as *Banksia ericifolia*).
- Past clearing and other perturbation of habitats: areas such as transmission line easements provide little cover for animals, and may form a barrier for dispersal for some species.
- Rubbish: there are some areas where rubbish dumping has occurred within the Project Site. Rubbish components included dumped cars. Rubbish is unlikely to have had a major negative impact on flora and fauna, although some contaminants may have leached into the surrounding area. Some rubbish in fact probably provides dwelling places for frogs and reptiles.

### 4.3.2 Corridors

#### 4.3.2.1 Regional

Regional corridors or pathways aim to link primary landscape features and large areas of similar habitat. Popran National Park is one of a large group of predominantly sandstone parks and reserves surrounding Sydney and completes a corridor of bushland extending from Brisbane Water to the western side of the Blue Mountains (NSW NPWS, 2000a). Popran National Park is part of a system of parks and reserves which together conserve the biodiversity and catchment values of the lower Hawkesbury River and provide a vegetation and wildlife link between the national parks to the east and west (NSW NPWS, 2000a). The Project Site is located at the northern end of the Calga section of Popran National Park and provides native vegetation which intergrades with the vegetation of Popran National Park, and is therefore a small part of the regional corridor system for flora and fauna.

DECC is in the process of identifying a network of priority fauna habitats and regional corridors in the Hawkesbury-Nepean CMA, as part of a study of the Greater Southern Sydney Region (HNCMA 2007). The Project Site is part of the Hunter Valley to Hawkesbury River Regional Corridor, which is a latitudinal link between the southern and eastern parts of the Hunter Valley and the Hawkesbury River (DEC 2005). No maps have yet been produced as part of this Project. This corridor is particularly important to the Regent Honeyeater, Square-tailed Kite, Swift Parrot, Turquoise Parrot, Barking owl, Masked Owl, Powerful Owl, Spotted-tailed Quoll (HNCMA 2007).

#### 4.3.2.2 Local

Gosford City Council is in the process of preparing a corridors map for the Gosford LGA. However, at the time of writing, information on vegetation/fauna habitat corridors was not yet available. A Pilot Gosford Corridors Project was run between 2002 and 2004 to identify support for wildlife corridors in the LGA. This Project aimed to support and educate community members to effectively manage and protect areas of conservation value on their own land and thereby increase conservation on private land. There were no legally binding conservation agreements as part of the pilot corridors Project, although conservation covenants were promoted (Drudge, 2004).

Native vegetation on the Project Site intergrades with the vegetation of Popran National Park. Native vegetation also exists on the opposite side of Peats Ridge Road on private land which adjoins Brisbane Water National Park. As such, the Project Site forms part of a local corridor between the Calga sections of Popran and Brisbane Water National Parks.

### 4.3.3 Vegetation

#### 4.3.3.1 Vegetation Structure

The Project Site supports a range of vegetation typical of Hawkesbury Sandstone environments on the Somersby Plateau. These range from dry and wet sclerophyll woodlands to scrub and swamps. A similar range of vegetation communities and structures occur on the proposed offset area of the "Glenworth Valley" property. **Table 4.2** details the vegetation structure of communities present on the Project Site and proposed offset area of the "Glenworth Valley" property (based on descriptions provided by Eastcoast Flora Surveys, 2007 and 2009).

**Table 4.2**
**Vegetation Structure on the Project Site**

| | | E2 | E20 | E25 | E26 | E26a | E29/E29a | E29b | E54 | E103 |
|---|---|---|---|---|---|---|---|---|---|---|
| Emergents | Height | 25-30m | | | | | | 5m | | |
| | Occurrence | Sporadic | Absent | Absent | Absent | Absent | Absent | Sporadic | Absent | Absent |
| Canopy | Height | 12-15m | 20-25m | 18-22m | 12-17m | | 12-15m | | | |
| | PFC | 70-80% | 30-40% | 30-35% | 10-25% | | <15% | | | |
| | Occurrence | Continuous | Continuous | Open Forest | Woodland | Occasional | Occasional | Absent | Absent | Absent |
| Small tree | Height | 8-10m | 15m | 3-6m | 3-6m | | 3-6m | | | |
| | Occurrence | Occasional | Occasional | Occasional | Occasional | Occasional | Sparse | | Absent | Absent |
| Shrub | Height | 2m | 2-5m | 0.5-3m | 0.5-3m | 0.5-1.5m | 0.5-3m | 0.5-1.5m | 1-3m | 2-4m |
| | Occurrence | Sporadic | Moderately dense | Moderately dense | Variable | Variable | Dense | Scattered | Variable | Dense |
| Groundcover | Occurrence | Sparse | Moderately dense | Moderately dense | Variable | Sparse-moderately dense | Moderately dense | Variable | Dense | Dense |

Source: Modified after Eastcoast Flora Surveys (2007, 2009)

#### 4.3.3.2 Bird Habitats

Bird habitats within the Project Site are diverse and generally not degraded. In most areas, the ground or shrub cover was very dense, providing good quality bird habitat. As the Project Site contains varied and good quality habitat, species diversity is likely to be high for this site. It is

surrounded on three sides by similar contiguous habitat and it is unlikely many species would be confined to the Project Site.

Glossy Black-cockatoos feed exclusively on the seeds of *Allocasuarina* and *Casuarina* species (Clout, 1989). Species of *Allocasuarina* are found in patches across the Project Site within the main vegetation communities. Hollows in eucalypts of the Project Site are likely to provide nesting opportunities for this species. These are winter breeders, and it is quite possible that their nesting hollow is in a tree within the forest on site. As this species is highly mobile, it is likely to forage in surrounding areas of habitat as well as those on the Project Site.

#### 4.3.3.3 Hollow-bearing Trees and Stags

Hollow-bearing trees are vital to many fauna species in Australia, ranging from invertebrates (e.g. bees), to snakes, birds and mammals. Hollows are used for diurnal and nocturnal shelter and as breeding sites. In terms of threatened species in the locality, hollow-bearing trees are essential for the Squirrel Glider, Yellow-bellied Glider, forest owl species, Glossy Black-cockatoos and some microchiropteran bats. Owls and Cockatoos require much larger hollows associated with old growth trees, while gliders and bats utilise smaller hollows. The Project Site supports a large number of hollow-bearing trees. Relatively undisturbed woodland can contain approximately 7 to 17 hollow-bearing trees per hectare (Gibbons and Lindenmayer, 2002).

The Project Site contains significant areas of relatively undisturbed woodland within both the proposed extraction areas and the proposed offsets and therefore would be expected to contain a high density of hollow-bearing trees. The tree hollow survey of the two plots within the proposed extraction areas of the Project Site identified that both woodland communities contained a high proportion of hollow-bearing trees with the main hollow-forming species including:

- Broad-leaved Scribbly Gum (*Eucalyptus haemastoma);*
- Narrow-leaved Scribbly Gum (*E. racemosa*);
- Grey Gum (*E. punctata*); and
- Smooth-barked Apple (*Angophora costata*).

The E29 - Hawkesbury Banskia Scrub-Woodland (Plot 1) contained approximately 175 hollows per hectare which would result in approximately 2,013 hollows being cleared for the two extraction areas from approximately 1,093 hollow-bearing trees in this community. The E29a – Hawkesbury Banksia Scrub-Woodland (Scrub) is a related community that is dominated by tall shrubs (*Banksia ericifolia*) but contains sparsely distributed low trees. It is estimated that this community contains approximately 60% of the trees hollows that the woodland form contains, which would result in approximately 903 hollows being cleared from approximately 490 hollow-bearing trees.

The Exposed Hawkesbury Woodland (Plot 2) contained approximately 165 hollows per hectare which would result in the loss of approximately 2,229 hollows from the proposed extraction areas from approximately 1,215 hollow-bearing trees. A summary of tree hollow results is

provided in **Table 4.3** and plot data provided in **Appendix E**. Tree hollows mapped in plots and incidentally during other surveys are shown in **Figure 4.5**.

**Table 4.3**
**Tree Hollows in Proposed Extraction Area**

| Hollow size | Hollows per plot | Hollows per hectare | Hollows to be cleared |
|---|---|---|---|
| Plot 1 – E29 - Hawkesbury Banksia Scrub-Woodland | | | |
| <5cm | 12 | 60 | 690 |
| 5-10cm | 9 | 45 | 518 |
| 10-15cm | 4 | 20 | 230 |
| 15-20cm | 6 | 30 | 345 |
| >20cm | 4 | 20 | 230 |
| Total | 35 | 175 | 2013 |
| Estimate for E29a Hawkesbury Banksia Scrub – Woodland (Scrub) | | | |
| Total | 21 | 105 | 903 |
| Plot 2 – Exposed Hawkesbury Woodland | | | |
| <5cm | 15 | 75 | 1013 |
| 5-10cm | 5 | 25 | 338 |
| 10-15cm | 7 | 35 | 473 |
| 15-20cm | 2 | 10 | 135 |
| >20cm | 4 | 20 | 270 |
| Total | 33 | 165 | 2229 |

It is important to note that the tree hollows occurred in a range of sizes, predominantly small (less than 5cm entrance diameter) and that not all hollows would be suitable for the full range of hollow-dependent fauna that has the potential to occur on the project site. The majority of hollows are not suitable for the Powerful Owl, which requires hollows at least 0.5m deep in trees with DBH 80-240cm. Various entrance diameters have been reported for the Powerful Owl from greater than 10cm (DEC (NSW), 2005z) to 45cm (DEC (NSW), 2006b) to 76-130cm (Gibbons and Lindenmayer, 2002). Only one tree recorded from Plot 1 meets the criteria for Powerful Owl nesting hollows and this does not occur in suitable habitat required by the species for roosting. The Glossy Black Cockatoo has been reported as using hollows of approximately 21cm entrance diameter, hence suitable nesting hollows are provided on the Project Site at a frequency of approximately 20 per hectare. Possums and gliders are able to use the smaller hollows from about 5cm entrance diameter or larger, and microchiropteran bats may use the smallest hollows including those of less than 5cm entrance diameter (Gibbons and Lindenmayer, 2002).

Several significant hollow-bearing trees with numerous large hollows were also recorded incidentally while traversing the Project Site as part of other flora or fauna surveys. The details of these trees are recorded in **Appendix E** and presented on **Figure 4.5**. As noted in Section 3.2.3.8, due to the size, density of vegetation and frequency at which hollow-bearing trees occurred across the Project Site, it was not practical to record every hollow-bearing tree encountered.

The proposed Offset Areas (Project Site East, Project Site West and Glenworth Valley) also contain significant areas of relatively undisturbed vegetation and are expected to contain high densities of hollow-bearing trees. Tree hollow densities in vegetation communities represented in the proposed Offset Areas are expected to be equivalent to the densities of tree hollows in vegetation communities represented in the proposed extraction areas and access road routes.

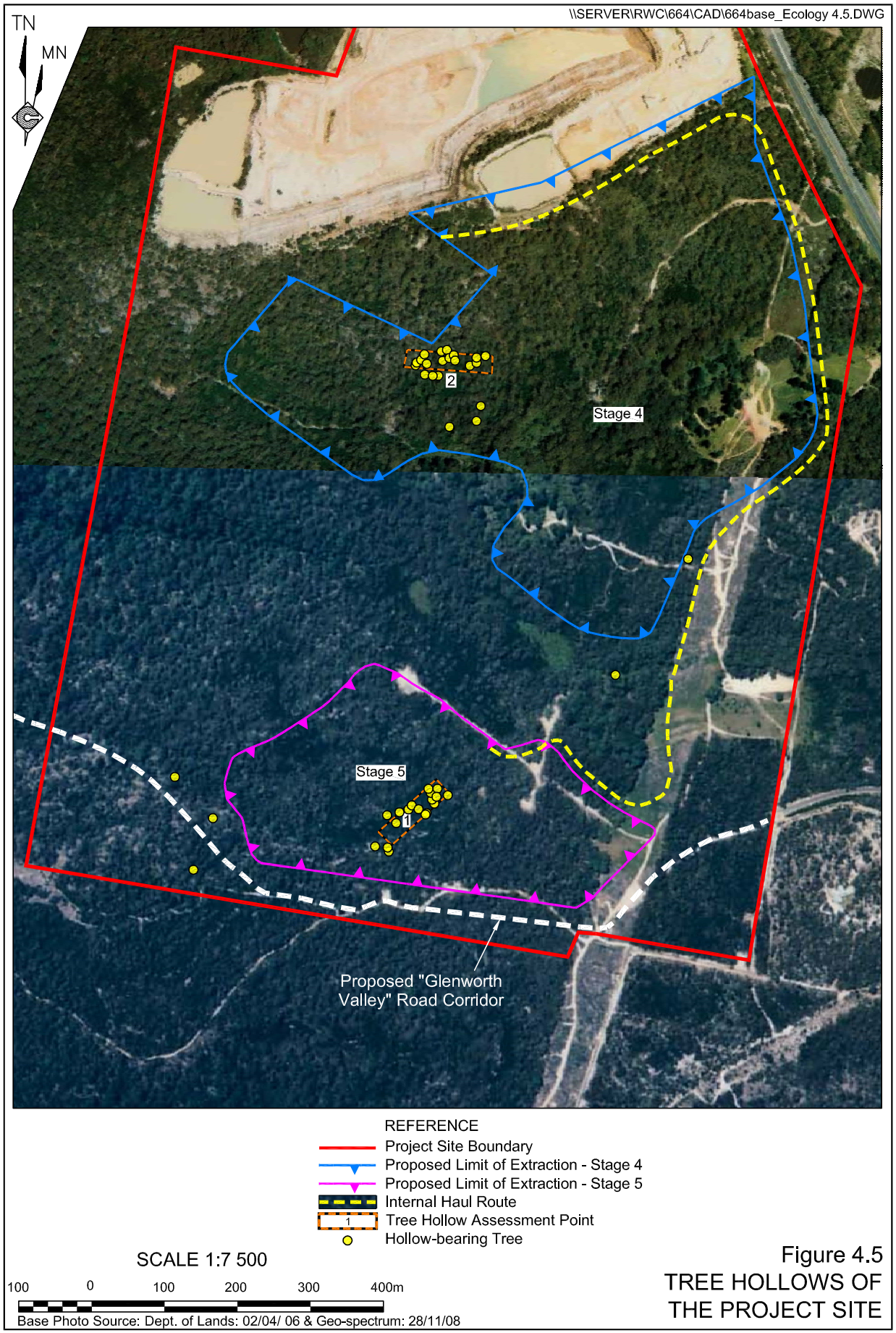



Figure 4.5
TREE HOLLOWS OF THE PROJECT SITE

Vegetation communities only represented in the proposed Offset Areas may contain more frequent tree hollows, depending on past logging regimes and fire history, as these communities are forest communities and contain a high density of trees. Tree hollow densities in vegetation communities in the proposed offset areas will be surveyed post public exhibition of this report.

#### 4.3.3.4 Koala Feed Trees

Two Koala preferred feed tree species listed on the Schedules of SEPP 44 – *Koala Habitat* occurred on the Project Site: *Eucalyptus punctata* and *E. haemastoma*. These species occur relatively frequently in woodland although neither species is dominant in the communities in which they occur. The Koala Recovery Plan (DECC (NSW), 2008b) lists additional food species that may be used by the Koala in the Central Coast region. None of the primary Koala feed species for the Central Coast occurs on the Project Site. *E. punctata* is listed as a secondary feed species in the Recovery Plan. The Recovery Plan also names several stringybarks as supplementary species, including *E. oblonga, E. capitellata* and *E. sparsifolia* that have been recorded from the Project Site.

According to the SEPP 44 definition, the Project Site consists of Potential Koala Habitat but because it does not show signs of use by any Koalas, it does not qualify as Core Koala Habitat.

Some vegetation communities on the Project Site would qualify as Secondary Habitat Class B according to the Recovery Plan because they do not contain any primary food trees, only secondary food trees with some supplementary species as listed in the Recovery Plan. These communities only have the potential to support low densities of Koalas in the order of less than 1 per hectare.

Koala food trees were recorded in tree hollow plots at densities of 25 per hectare in Plot 1 and 20 per hectare in Plot 2. Although the total number of trees was not recorded per plot, this equates to less that 21% of trees for Plot 1 and less than 24% of trees for Plot 2. Preferred Koala feed trees located within plots are mapped in Figure 4.5.

#### 4.3.3.5 Tree Species and Flowering Patterns

The Project Site supports a range of plant species within the different vegetation communities which provide pollen and nectar for animals. **Table 4.4** below provides examples of trees that flower in different seasons. Many animal species rely on flowers for food, including the threatened Grey-headed Flying Fox, Yellow-bellied and Squirrel Gliders, and a number of threatened birds. Preferred food trees for the Swift Parrot and the Regent Honeyeater (Swamp Mahogany*, Eucalyptus robusta,* and Spotted Gum, *Corymbia maculata*) were not found on the Project Site.

## Table 4.4
## Flowering Season of Selected Plants in the Project Site



| Family | Species | Name | Community | | | | | | | Flowering |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | E2 | E25 | E26 | E26a | E29 | E54 | E103 | |
| Fabaceae | *Acacia binervia* | Coast Myall | | | | | | | | Winter, Spring |
| | *Acacia brownei* | | | x | x | | | | | Winter, Spring |
| | *Acacia echinula* | | | | x | | | | | Winter, Spring |
| | *Acacia elata* | Cedar Wattle | | x | | | | | | Summer |
| | *Acacia elongata* | Swamp Wattle | | | | | x | x | x | Winter, Spring |
| | *Acacia floribunda* | White Sally-Wattle | | x | | | | | | Winter, Spring |
| | *Acacia implexa* | Hickory | | x | | | | | | Summer, Autumn |
| | *Acacia irrorata* | Green Wattle | | x | x | | | | | Autumn, Winter |
| | *Acacia linifolia* | Flax Wattle | | x | x | | x | x | | Summer, Autumn |
| | *Acacia longifolia* | Sydney Golden Wattle | | x | x | | x | x | | Winter, Spring |
| | *Acacia longissima* | Long-leaf Wattle | | x | | | | | | Spring to Autumn |
| | *Acacia myrtifolia* | Myrtle-leaved Wattle | | x | x | x | x | x | | Winter |
| | *Acacia oxycedrus* | Spike Wattle | | x | x | x | x | x | | Winter, Spring |
| | *Acacia suaveolens* | Sweet-scented Wattle | | x | x | x | x | x | x | Winter |
| | *Acacia terminalis* | Sunshine Wattle | | | x | | | | | Winter, Summer |
| | *Acacia ulicifolia* | Prickly Moses | | x | x | x | x | | | Autumn, Winter |
| Myrtaceae | *Angophora costata* | Smooth-barked Apple | | x | x | | | | | Spring, Summer |
| | *Angophora hispida* | Dwarf Apple | | | x | | | | | Spring, Summer |
| | *Callistemon citrinus* | Lemon-scented Bottlebrush | | x | x | | x | x | x | Spring, Summer |
| | *Callistemon linearifolius* | | | ? | x | | | | | Spring, Summer |
| | *Callistemon rigidus* | Stiff Bottlebrush | | x | x | | x | | | Spring |
| | *Corymbia gummifera* | Red Bloodwood | | x | x | | | | | Summer |
| | *Eucalyptus capitellata* | Brown Stringybark | | | x | | x | | | Summer |
| | *Eucalyptus haemastoma* | Scribbly Gum | | x | x | | | | | Spring |
| | *Eucalyptus oblonga* | Stringybark | | | x | | | | | Summer, Autumn |
| | *Eucalyptus piperita* | Sydney Peppermint | | x | x | | | | | Summer |
| | *Eucalyptus punctata* | Grey Gum | | x | x | | | | | Summer, Autumn |
| | *Eucalyptus racemosa* | Narrow-leaved Scribbly Gum | | | | | x | | | Summer, Autumn |
| | *Eucalyptus sparsifolia* | Narrow-leaved Stringybark | | | x | | x | | | Summer, Autumn |
| | *Eucalyptus squamosa* | Scaly Bark | | | x | | | | | Winter, Spring |
| | *Kunzea ambigua* | Tick Bush | | x | x | x | x | x | | Spring, Summer |
| | *Kunzea capitata* | Pink Kunzea | | | x | | | | | Spring, Summer |
| | *Leptospermum arachnoides* | | | | | x | x | | | Spring, Summer |
| | *Leptospermum continentale* | Prickly Teatree | | | | | | x | x | Spring, Summer |
| | *Leptospermum juniperinum* | Prickly-leaved Tea Tree | | | | | | x | | Spring, Summer |
| | *Leptospermum polygalifolium* | Yellow Tea Tree | x | x | x | x | x | x | x | Spring, Summer |
| | *Leptospermum trinervium* | Paperbark Tea Tree | | x | x | x | x | | | Spring |
| | *Melaleuca thymifolia* | Thyme Honey-myrtle | | | | | | | | Summer |
| | *Ochrosperma olifomerum* | | | | x | | | | | Spring, Summer |
| | *Rhodamnia rubescencs* | Scrub Terpentine | x | | x | | | | | Winter, Spring |
| | *Syncarpia glomulifera* | Turpentine | x | | x | | | | | Spring |
| | *Tristaniopsis laurina* | Water Gum | x | | | | | | | Summer |
| Proteaceae | *Banksia ericifolia* | Heath Banksia | | x | x | x | x | x | x | Winter |
| | *Banksia oblongifolia* | Fern-leaved Banksia | | x | x | | x | x | | Autumn, Winter |
| | *Banksia palusdosa* | | | | | | | x | x | Autumn, Winter |
| | *Banksia robur* | Swamp Banksia | | x | | | | x | x | Summer, Autumn |
| | *Banksia serrata* | Old Man Banksia | | x | x | | | | | Summer, Autumn |
| | *Banksia spinulosa* | Hairpin Banksia | | x | x | | x | x | | Winter |

**Table 4.4 (Cont'd)**
**Flowering Season of Selected Plants in the Project Site**



| Family | Species | Name | Community | | | | | | | Flowering |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | E2 | E25 | E26 | E26a | E29 | E54 | E103 | |
| Proteaceae (cont'd) | *Grevillea buxifolia* | Grey Spider Flower | | x | x | x | | | | Spring to Autumn |
| | *Grevillea diffusa* | | | x | x | x | x | | | Winter, Spring |
| | *Grevillea mucronulata* | | | x | | | | | | Autumn to Spring |
| | *Grevillea speciosa* | Red Spider Flower | | x | x | x | | | | Most months, mainly Spring |
| | *Grevillea sericea* | Pink Spider Flower | | x | x | | x | x | | Winter to Summer |
| | *Hakea dactyloides* | Finger Hakea | | x | | x | x | | | Spring, Summer |
| | *Hakea gibbosa* | Needlebush | | x | x | x | | | | Spring |
| | *Hakea laevipes* | Finger Hakea | | x | x | | | | | Spring, Summer |
| | *Hakea sericea* | Silky Hakea | | x | x | | x | x | x | Winter, Spring |
| | *Hakea salicifolia* | Wouldow-leaved Hakea | | x | | | | | | Spring |
| | *Hakea teretifolia* | Dagger Bush | | x | x | | x | x | x | Spring, Summer |
| | *Isopogon anemonifolius* | Drumsticks | | x | x | x | | | | Spring, Summer |
| | *Lambertia formosa* | Mountain Devil | | x | x | x | x | x | | Most months |
| | *Telopea speciosissima* | Waratah | | x | | | | | | Spring |
| Xanthor-rhoeaceae | *Xanthorrhoea minor* | Grasstree | | | ? | x | x | | | Spring |
| Xanthor-rhoeaceae | *Xanthorrhoea resinifera* | Grasstree | | x | | | | x | x | Winter, Spring |

Notes: Flowering Season from Robinson, (1991) and Botanic Gardens Trust (2004).

#### 4.3.3.6 Logs

Some species are likely to use logs and rock outcrops for dens, in particular the Spotted-tailed Quoll and Rosenberg's Goanna. The woodland supplies fallen branches and logs across the Project Site.

### 4.3.4 Geological Features

There are many rock outcrops, particularly in the southern portion of the Project Site and associated with the cliff line that runs in a curve in the middle of the Project Site. The Red-crowned Toadlet could also utilise rock outcrops in the Project Site, particularly those associated with drainage lines.

### 4.3.5 Waterways

#### 4.3.5.1 Creeks

Two creeks are present in the upper part of the Project Site, namely Creeks A and B. These drop over a high cliff in the centre of the Project Site, and meet to form Creek C which flows down to Cabbage Tree Creek. The creek lines and swamp areas that head them provide important habitat and an ephemeral water source for many species in the locality, and may be of particular habitat value to the two threatened frog species. Other creeks within the locality may have similar properties.

A number of the pools along the creeks have a sandstone base and may be fed with water from seepage. The riparian vegetation is in good condition and there is no sign of bank erosion or other signs of disturbance. At the time of the survey, there was a trickle of water over the two water falls visited.

#### 4.3.5.2 Swamps

Most of the hanging swamps mapped within the Project Site (see **Figure 4.3**) are at a long-unburnt seral stage and currently support dense stands of *Banksia ericifolia*, which frequently merge into adjacent scrub-woodlands. It is likely that a wildfire would open these areas up considerably and permit a range of other plant species to proliferate in the short term. These swamps provide habitat for frogs and invertebrates, and thus provide foraging resources for other animal groups.

## 4.4 Terrestrial Fauna

### 4.4.1 Survey Results

#### 4.4.1.1 General

A wide range of fauna species were recorded in the Study Area by Cumberland Ecology. Only three threatened species were recorded, namely:

- Glossy Black-cockatoo;
- Red-crowned Toadlet; and
- Eastern Pygmy Possum.

The Anabat survey also yielded a possible call of the Large-footed Myotis (*Myotis macropus*), a threatened microchiropteran bat. This call may have also been from a *Nyctophilus* species, as the calls of these species are not easily distinguishable.

A complete list of the fauna species recorded in the Study Area is provided in **Appendix A** (**Table A.2**) with the location of the threatened species identified presented on **Figure 4.6**. Threatened species previously recorded in the locality or Study Area are summarised in **Section 4.4.2.**

The following sub-sections summarise the results of the surveys described in **Sections 3.2.3** and **3.2.4**.

#### 4.4.1.2 Mammals

A variety of mammalian fauna have been detected either by the current survey of the Study Area by Cumberland Ecology or previous studies undertaken within the locality (Countrywide Ecological Service 2004 and Abel Ecology 2005) (Abel Ecology, 2005, Abel Ecology, 2005).

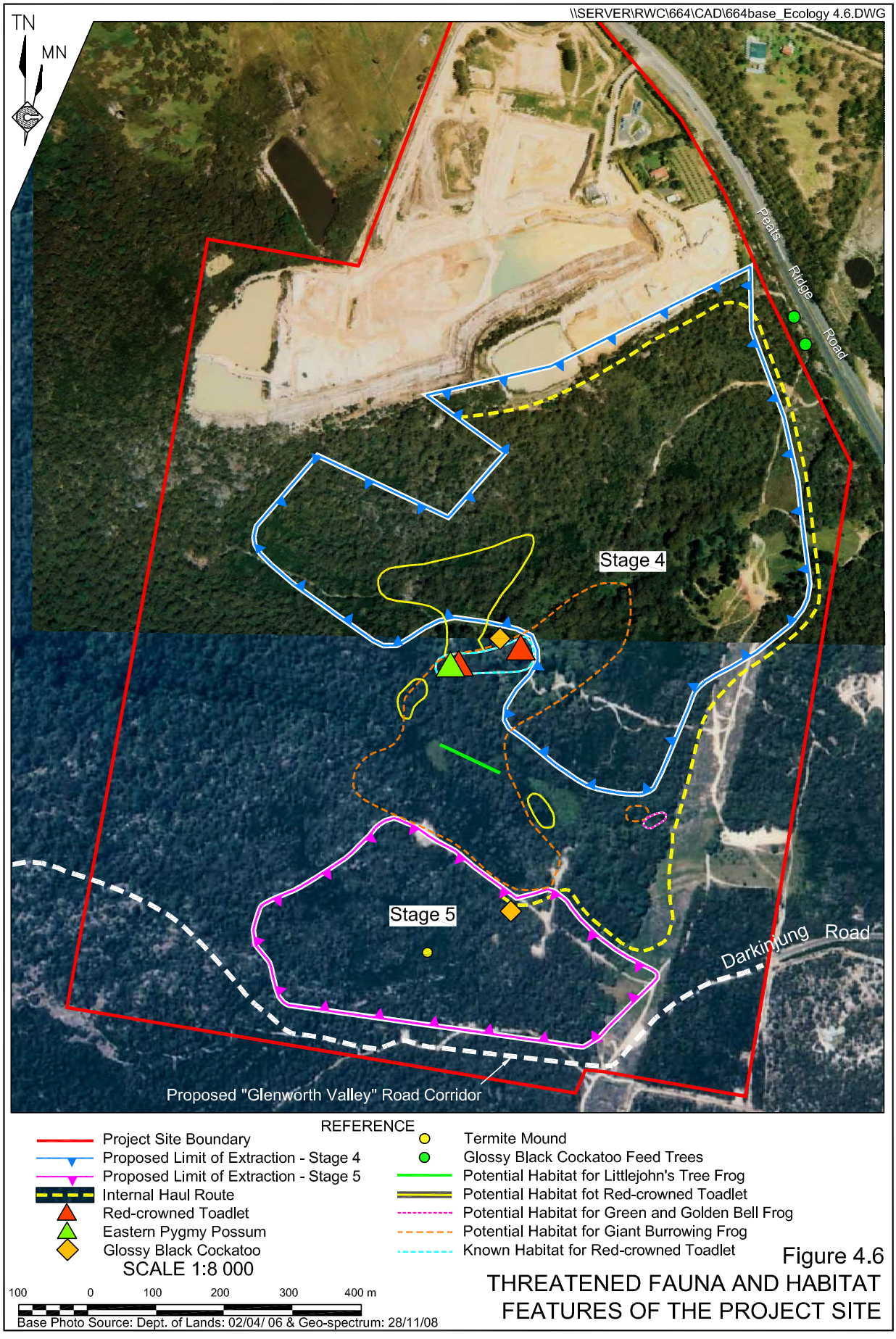



Figure 4.6
THREATENED FAUNA AND HABITAT FEATURES OF THE PROJECT SITE

Arboreal fauna species previously recorded in the Study Area include the Ring-tailed Possum (*Pseudocheirus peregrinus*) and Common Brushtail Possum (*Trichosurus vulpecula*) (Countrywide Ecological Service 2004) (Countrywide Ecological Services, 2004). During the current survey Ringtail Possums (*Pseudocheirus peregrinus*) (spotlighting) and Sugar Gliders (*Petaurus breviceps*) (responding to owl-call playback) were recorded on the Project Site. No Koala activity has been recorded on the Project Site as part of the previous or current surveys, despite potential Koala habitat being present. One Eastern Pygmy Possum (*Cercartetus nanus;* vulnerable under TSC Act) was observed during spotlighting during the March 2009 surveys near where Creek A crosses a track (see **Figure 4.6**).

Bush Rats (*Rattus fuscipes*) and Brown Antechinus (*Antechinus stuartii*) were the most common species caught in traps (all grids). Dusky Antechinus (*Antechinus swainsonii*) and Common Dunnart (*Sminthopsis murina*) were also detected from hair tubes. One Long-nosed Bandicoot (*Perameles nasuta*) was caught in a cage trap (Grid 1) and one individual was also observed during the survey (Grid 2). Grid 2 in particular showed many signs of bandicoot digging. Terrestrial fauna species recorded on the site of the Calga Sand Quarry proposed northern extension are similarly diverse and include the Bush Rat (*Rattus fuscipes*), Long-nosed Bandicoot (*Perameles nasuta*), Red-necked Wallaby *(Macropus rufogriseus)* and Swamp Wallaby (*Wallabia bicolor*) (Countrywide Ecological Service 2004). A number of introduced species have also been recorded in the Study Area, including Foxes, Cats, Dogs and House Mice (Countrywide Ecological Service 2004).

A wide range of bat species has been previously recorded on the site of the northern extension of the Calga Sand Quarry including Gould's Wattle Bat *(Chalinolobus gouldii),* Little Mastiff-bat *(Mormopterus planiceps)*, Yellow-bellied Sheathtail Bat *(Saccolaimus flaviventris)*, Large Forest Bat *(Vespadelus darlingtoni)*, Eastern Forest Bat *(V. pumilus)*, Grey-headed Flying-fox *(Pteropus poliocephalus)* (Countrywide Ecological Service 2004). Of these species, the Yellow-bellied Sheathtail Bat and Grey-headed Flying Fox are listed as threatened under the TSC Act and EPBC Act respectively.

During the 2006 and 2009 surveys, three species of bats, none of which are threatened were identified, namely:

- Gould's Wattled Bat (*Chalinolobus gouldii*);
- Chocolate Wattled Bat (*C. morio*);
- Little Forest Bat (*Vespadelus vulturnus*); and
- Eastern Horseshoe Bat (*Rhinolophus megaphyllus*).

There were also possible records of *Nyctophilus* sp. and *Myotis macropus*.

#### 4.4.1.3 Birds

33 species of birds have previously been recorded in the Study Area (Countrywide Ecological Service 2004). 51 bird species were recorded in the Project Site over two days by Cumberland Ecology (**Appendix A**, **Table A.3**). It could be expected that between 100 and 150 bird species would be recorded within the Project Site with extensive survey effort over different seasons.

Bird habitats within the Project Site are diverse and generally not degraded (see Section 4.3.1).

Two thornbill species were recorded on the Project Site, namely the Striated Thornbill (*Acanthiza lineata)* and Brown Thornbill (*Acanthiza pusilla)*.

Honeyeaters were also commonly encountered and included the Eastern Spinebill (*Acanthorhynchus tenuirostris),* Little Wattlebird (*Anthochaera chrysoptera),* Yellow-faced Honeyeater (*Lichenostomus chrysops),* Noisy Miner (*Manorina melanocephala),* Lewin's Honeyeater (*Meliphaga lewinii),* Brown-headed Honeyeater (*Melithreptus brevirostris),* White-eared Honeyeater (*Lichenostomus leucotis),* Noisy Friarbird (*Philemon corniculatus),* White-cheeked Honeyeater (*Phylidonyris nigra)* and New Holland Honeyeater (*Phylidonyris novaehollandiae).*

Parrots recorded were the Crimson Rosella (*Platycercus elegans),* Rainbow Lorikeet (*Trichoglossus haematodus),* and Glossy Black-cockatoo (*Calyptorrhynchus lathami)*. Of these, the Glossy Black-cockatoo is listed as vulnerable under the TSC Act.

Tawny Frogmouths (*Podargus strigoides*) were observed during spotlighting surveys in February 2006. No other nocturnal birds were detected, however, the threatened Powerful Owl (*Ninox strenua*) has been recorded in the Study Area (Countrywide Ecological Service 2004).

#### 4.4.1.4 Reptiles

Several reptiles were recorded previously for the proposed northern extension of Calga Sand Quarry (Countrywide Ecological Service 2004) including Eastern Snake-necked Turtle (*Chelodina longicollis*), Copper-tailed Skink (*Ctenotus taeniolatus*), Water Skink (*Eulamprus quoyii*), Weasel Skink (*Saproscincus mustelinus*), and Red-bellied Black Snake (*Pseudechis porphyriacus*). One threatened reptile species, Rosenberg's Monitor (*Varanus rosenbergi*), was also recorded.

During the current survey, one Lace Monitor (*Varanus varius*) was caught in a cage trap and an Eastern Water Skink was caught in a Type A Elliot trap. Many small skinks (*Lampropholis delicata*) were observed across the Project Site, and Water Skinks were observed near Creek C and other drainage lines (e.g. Creek A).

#### 4.4.1.5 Amphibians

Species of amphibian recorded previously for the northern extension of Calga Sand Quarry (Countrywide Ecological Service 2004) (Abel Ecology, 2005) included Common Eastern Froglet (*Crinia signifera*), Striped Marsh Frog (*Limnodynastes peronii*), Smooth Toadlet *(Uperoleia laevigata),* Spotted Marsh Frog *(Limnodynastes tasmaniensis),* Rocket Frog *(Litoria nasuta)* and Dwarf Tree Frog *(Litoria fallax)*

During the current survey several tree and ground frogs were detected across the Project Site however the abundance and diversity of frogs was not high and reflected the limit of open, freshwater habitats available. The sandstone in this area is deeply weathered and the sand

beds formed appear to soak and retain large amounts of ground water (especially in the area between Creek A and B). Frog species that are able to utilize ground water (such as Red-crowned Toadlets and Giant Burrowing Frogs) are more likely to persist in these areas, whereas other frog species are forced to concentrate around the more permanent sections of creeks, permanent ponds or dams in the area.

Seven frog species were located during the 2005 survey, five tree frog species (genus *Litoria*) and two species of ground frog (**Appendix A**, **Table A.5**). The species recorded were Peron's Tree Frog (*Litoria peronii*), Bleating Tree Frog (*Litoria dentata*), Leaf Green Tree Frog (*Litoria phyllochroa*), Broad-palmed Frog (*Litoria latopalmata*), Eastern Dwarf Tree Frog *(Litoria fallax*), Striped Marsh Frog (*Limnodynastes peronii*) and the Red-crowned Toadlet (*Pseudophryne australis*). The latter is discussed below under Threatened Species (**Section 4.4.2**).

The following species were recorded during the 2009 survey:

- Common Eastern Froglet (*Crinia signifera*);
- Striped Marsh Frog (*Limnodynastes peronii*);
- Freycinet's Tree Frog (*Litoria freycineti*);
- Broad-palmed Frog (*Litoria latopalmata*);
- Verreaux's Tree Frog (*Litoria verreauxii*); and
- Banjo Frog (*Limnodynastes dumerili*).

Potential habitat for threatened species was also identified during the 2005 and 2009 surveys; for Red-crowned Toadlet, Giant Burrowing Frog, Green and Golden Bell Frog (*Litoria aurea*) and Littlejohn's Tree Frog (*Litoria littlejohni*). See **Figure 4.6** for the locations of known and potential habitat for threatened frog species.

#### 4.4.1.6 Fish

Three species of fish were found during the fish survey, two native (Flat-headed Gudgeon, *Philypnodon grandiceps,* and the Shortfinned Eel, *Anguilla australis*) and one introduced (Plague Minnow, *Gambusia holbrooki*).

#### 4.4.1.7 Macroinvertebrates

A total of nine families of invertebrates were recorded from eight orders. A complete list of the results of the preliminary macroinvertebrate survey is provided in **Appendix A** (**Table A.7**).

The aquatic habitat in the ephemeral pools at the time of sampling was relatively poor with a Signal Grade from macroinvertebrate families indicating 'moderate pollution'. This is likely to be due to a range of factors, such as the locations of the pools tested being on the upper elevations of the Project Site and therefore receiving less runoff, and also being nearer to the road.

### 4.4.2 Threatened Species

The Yellow-bellied Sheathtail Bat and Grey-headed Flying Fox, both vulnerable under the TSC Act, have both been recorded previously in the Study Area (Countrywide Ecological Service 2004). The Yellow-bellied Sheathtail Bat and other microbats rely on tree hollows for roosting. A diverse forest structure encourages bat diversity, as different bat species prefer to forage in different strata of the canopy. Grey-headed Flying-foxes rely on flowering eucalypts and fruit for feeding.

Three Glossy Black-Cockatoos (*Calyptorrhynchus lathami*), listed as vulnerable under the TSC Act, were seen in the Project Site on two occasions. This trio comprised a family i.e. male, female and juvenile, which was seen at dawn in the forest (E25 Hawkesbury Peppermint – Apple Forest) and again at sunset drinking at a waterhole along the creek. This species is reliant on species of She-oak (*Allocasuarina spp.*) for food, and many *Allocasuarina littoralis* trees were observed on the Project Site. There was evidence of feeding by these cockatoos at several of these trees across the site at the locations identified in **Figure 4.6**.

The Powerful Owl (*Ninox strenua*), listed as vulnerable under the TSC Act, has been recorded in the Subject Area (Countrywide Ecological Service 2004), but not the Project Site. This species has a home range of up to 1400ha (DEC (NSW), 2005z) and therefore may utilise the Project Site for nesting or foraging.

It is unlikely that the Project Site contains suitable habitat for the Regent Honeyeater or the Swift Parrot as very few of their favoured food trees were evident. The Regent Honeyeater inhabits dry open forest and woodland, particularly Box-Ironbark woodland, and riparian forests of River Sheoak (DEC (NSW), 2006c). Every few years non-breeding flocks are seen foraging in flowering coastal Swamp Mahogany and Spotted Gum forests on the Central Coast (NSW NPWS, 1997). Favoured feed trees of the Swift Parrot 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* (DEC (NSW), 2005f1), of which only Red Bloodwood is found on the Project Site.

Rosenberg's Monitor (*Varanus rosenbergi*), listed as vulnerable under the TSC Act, has been recorded in the Study Area (Countrywide Ecological Service 2004), and may occur in the Project Site. This species is found in heath, woodland and open forest habitats. Termite mounds are a critical habitat component for the species, as they lay their eggs in the mounds (DEC (NSW), 2005b1). Termite mounds were not recorded in the Project Site, however, may occur in the field areas not traversed in surveys.

One threatened frog was recorded on the Project Site, the Red-crowned Toadlet. This species is listed as vulnerable under the TSC Act and was detected at two locations on the Project Site (see **Figure 4.6**). Potential habitat was also identified along the northern tributary and at one point along the southern tributary. The northern tributary passes through areas of stepped sandstone that are overlain in several sections by a thick bed of sand. This creek does not appear to be a permanent creek but the banks retain moisture for long periods, as evidenced by the growth of Coral Fern (*Glychenia sieberi*), Swamp Rose (*Bauera ruboides*) and Saw-sedge (*Gahnia* sp). It is possible that habitat for this species extends northwards from the northern tributary, towards the nearby sandstone exposures. Habitat for Red-crowned Toadlets appears to be lacking on the southern side of the Project Site as it is drier, with only one area of potential habitat identified there.

The Giant Burrowing Frog, listed as vulnerable under the TSC Act, was not detected on the Project Site, although potential habitat areas were found (**Appendix A**, **Table A.6**). Potential habitat for the Giant Burrowing Frog appears to be confined between the 170m and 190m AHD contours between Creek A and B (**Figure 4.6**). This area has a hanging swamp nested in deep sand. Above the 190m contour, the sandstone layer does not seem to retain ground moisture and, similarly, below the 180m contour, the sandstone is not deeply weathered and also appears unsuitable. The 170m to 190m zone contains two discrete hanging swamp ecosystems, one being dominated by Tea Trees (*Leptospermum* sp), and the other by Saw-sedges (*Gahnia* sp). These vegetative communities do not appear to retain open water and breeding may not be possible in this area. If Giant Burrowing Frogs are present, then breeding is most likely to occur in pools in the upper parts of Creek A. No tadpoles of this species were found during this survey.

Potential habitat was also identified for the Green and Golden Bell Frog and Littlejohn's Tree Frog (see **Figure 4.6**). However, these are not considered likely to occur on the Project Site. There are no records of either the Green and Golden Bell Frog or Littlejohn's Tree Frog from within 10km of the Project Site. The nearest Green and Golden Bell Frog record is at Gosford. The nearest Littlejohn's Tree Frog record is at Ourimbah State Forest.

The potential Green and Golden Bell Frog on the Project Site consists of a very small pond area of marginal habitat (semi-permanent pool with emergent reeds/sedges). There were however some trees growing immediately adjacent to and overhanging the pool, and the species does not typically occur where vegetation overhangs pools. The pool was searched intensely for GGBF. If not for the unsuitable timing of the survey (i.e. during autumn), it could be concluded that the GGBF does not occur at the site.

Habitat for Littlejohn's Tree Frog was limited to semi-permanent rocky pools. However, this habitat was limited within the subject site and was intensively surveyed for this species, which was not detected. It is not possible to discount this species, however it is very unlikely to occur. Suitable habitat for this species is fairly well represented in other areas to the north (e.g., Ourimbah and Olney SFs, The Watagans)

### 4.4.3 Migratory Species

A search of the EPBC Protected Matters database indicated that a range of migratory birds may utilise the Project Site. These include migratory wetland birds such as Great Egret, Cattle Egret, Latham's Snipe and Painted Snipe, and the migratory terrestrial birds White-bellied Sea-Eagle, White-throated Needletail, Rainbow Bee-eater, Black-faced Monarch, Satin Flycatcher and Rufous Fantail (DEH, 2006).

# 5 IMPACT ASSESSMENT

## 5.1 Director-General's Requirements

The DGRs (Department of Planning) issued on the 15th of December 2006 for the Project details the following for inclusion in the assessment of impacts:

> ***Flora and Fauna*** *– Impacts on critical habitats (including riparian habitat), threatened species, populations or ecological communities; groundwater dependent ecosystems; native vegetation; and the adjacent National Park estate.*

## 5.2 Introduction

This section provides an assessment of the likely impacts of the Project on threatened species and addresses **Step 3** of the Draft Guidelines for Threatened Species Assessment (DEC (NSW), 2004b). This step involves identifying not only the magnitude and extent of impacts, but also the significance of the impacts as related to the conservation importance of the habitat, individuals and populations likely to be affected. Impacts would be more significant if:

- areas of high conservation value are affected;
- individual animals and/or plants and/or subpopulations that are likely to be affected by the Project play an important role in maintaining the long-term viability of the species, population or ecological community;
- habitat features that are likely to be affected by the Project play an important role in maintaining the long-term viability of the species, population or ecological community;
- the duration of impacts are long-term; and
- the impacts are permanent and irreversible.

## 5.3 Key Threatening Processes

### 5.3.1 Introduction

Key threatening processes are listed under the Schedule 3 of TSC Act. These are processes that threaten or could threaten the survival of native species, populations or communities. Key threatening processes can adversely affect two or more threatened species, populations or communities, or cause non-listed species, populations or communities to become threatened.

Three main key threatening processes listed by the Scientific Committee on Threatened Species would be brought into effect as a result of this Project. A range of additional key threatening processes would also impact the Project Site as a result of the Project.

### 5.3.2 Clearing of Native Vegetation

Clearing of native vegetation can include the following impacts (NSW Scientific Committee, 2004b):

- Destruction of habitats resulting in the loss of local populations of species.
- Fragmentation of habitat.
- Expansion of dryland salinity.
- Riparian zone degradation.
- Increased greenhouse gas emissions.
- Increases in habitat for invasive species.
- Loss of the leaf litter layer.
- Loss or disruption of ecological function.
- Changes to soil biota.

Clearing to make way for the proposed Southern Extension of the Calga Sand Quarry is the chief impact that would result from the Project, as it would lead to a reduction in available habitat for a number of threatened species which currently utilise the Project Site.

### 5.3.3 Alteration to Natural Flow Regimes of Rivers and Streams

Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands can include the following impacts (NSW Scientific Committee 2004a) (NSW Scientific Committee, 2004a).

- Reduction of habitat due to changes in area, frequency and/or duration of flooding.
- Increased flows causing more permanent flooding of some wetlands.
- Riparian zone degradation through altered flow regimes.
- Increases in habitat for invasive species.
- Loss or disruption in ecological function.

The interruption of the flow of creeks A and B into the main creek as a result of the Project may impact on some vegetation communities, and has the potential to reduce habitat for threatened frogs on the Project Site. However, Evans and Peck (2008) predicts surface flows of Creek B to not be reduced on average (27% reduction at most), which would allow the Red-crowned Toadlet to persist because surface moisture would still be available. The Giant Burrowing Frog may experience a reduction in breeding habitat as it requires pools in slow-flowing creeks for breeding. These pools are often charged by see[ages and may be affected by groundwater drawdown. The proposed offset areas will be investigated for potential habitat in spring.

### 5.3.4 Loss of Hollow-bearing Trees

Loss of hollow-bearing trees has been given a preliminary listing as a key threatening process by the Scientific Committee (NSW Scientific Committee, 2006). In NSW, terrestrial vertebrate species that are reliant on tree hollows for shelter and nests include at least 46 mammals, 85 birds, 32 reptiles and 16 frogs (Gibbons and Lindenmayer, 2002). Of these, 45 species are listed as threatened on Schedule 1 and Schedule 2 of the TSC Act.

As hollows are required for breeding for many of these species, the loss of hollow-bearing trees has the potential to limit or halt breeding of certain species, which can cause species to become locally extinct. The Project Site would lose hollows which may be used by the threatened Powerful Owl, Glossy Black-cockatoo and microchiropteran bats, as well as Sugar Gliders, Brush-tailed Possums and a range of non-threatened parrots.

### 5.3.5 Other Key Threatening Processes

Other key threatening processes relevant to the Study Area are as follows.

- Predation by the Plague Minnow (*Gambusia holbrooki*) {NSW Scientific Committee 1999 #159}.
    - The Plague Minnow preys on eggs and tadpoles of native frogs, and on native fish.
- Removal of dead wood and dead trees (NSW Scientific Committee, 2004f).
    - Removal of dead wood limits shelter sites for a range of species, and is a known threat to Rosenberg's Goanna, Glossy Black cockatoos and Powerful Owls which do or may occur on the Project Site, and could cause a number of non-threatened species to become threatened.
- Predation by the European Red Fox *Vulpes vulpes (NSW Scientific Committee, 1999)*.
    - Numerous native species are at risk of predation by foxes, including threatened species which do or may occur on the Project Site.
- Predation by the Feral Cat, *Felis catus (NSW Scientific Committee, 2004e)*.
    - Feral cats are capable of killing vertebrates up to 3kg, which could include Glossy Black-cockatoos and young owls.
- Ecological consequences of high frequency fire (NSW Scientific Committee, 2004c).
    - A high frequency of fire may result in the disruption of life cycle processes in plants and animal and loss of vegetation structure and composition. This is of particular significance to the threatened plants recorded from the Project Site.

- Invasion by *Lantana camara (NSW Scientific Committee, 2005)*.
    - *Lantana* invades plant communities and can alter fire regimes. It is recognised as a threat to *Hibbertia procumbens* which occurs on the Project Site, and also to several EECs downstream on Cabbage Tree Creek.

### 5.3.6 Threat Abatement Plans

Two threat abatement plans have been written that are potentially relevant to the Project. Suggested management activities for the Plague Minnow (*Gambusia holbrooki*) within the Plague Minnow threat abatement plan (NSW National Parks Wildlife Service, 2003) include:

- minimising further dispersal of the species;
- removing *Gambusia* (where practical) from areas occupied by key populations of priority frog species; and
- creating supplementary *Gambusia*-free habitat for priority frog species, adjacent to where *Gambusia* currently occur.

Notably, there are no known key populations of priority frog species in the Project Site and therefore the Project is unlikely to lead to an increase in *Gambusia*.

A fox threat abatement plan also exists (NSW NPWS, 2001c), which suggests the following management measures.

- NPWS should oversee the implementation of fox control programs in priority areas.
- The response of native fauna to fox control should be measured.

The locality is not listed as a priority area for fox control. Nearby priority areas includes Brisbane Water National Park to enable protection of the Bush Stone-curlew and the Pied Oystercatcher. Rocla needs to limit any food rubbish in the Subject Area to discourage any increases in the local fox population.

## 5.4 Impacts on the Adjacent Popran National Park

The Project Site is located adjacent to Popran National Park. Popran National Park is one of a large group of predominantly sandstone parks and reserves surrounding Sydney and is part of a large corridor linking Brisbane Water National Park and the Blue Mountains (Morgan, 2001). The Project Site provides native vegetation which is continuous with the vegetation of Popran National Park, and is therefore part of the local corridor system for flora and fauna and an ecological buffer for the conservation values of the national park.

Popran National Park currently consists of five separate areas of land and covers 3 970ha. The Calga section of the park, which is one of the smaller portions, protects part of the Kellys Creek catchment, a tributary of Popran Creek. The remnants of native vegetation on lower

shale slopes and alluvium that the park conserves are particularly important as many such communities have been cleared along the Hawkesbury River. The protection of undisturbed catchments of tributaries to the Hawkesbury River is also critical to the persistence of aquatic life and natural systems associated with the river. The park provides areas of substantially natural habitats that support a wide range of species (Morgan, 2001).

A number of industries surrounding Popran National Park may impact on the Park as a result of their activities. To the north of the Park, there are a number of companies extracting groundwater for bottling as mineral water, which has the potential to affect the level of the water table within the park and the flow of springs and creeks within the park during periods of drought. Sandstone quarries adjoining or near the Park in the Mt White and Calga area (including those in the Study Area) have the potential to increase siltation in creeks flowing through the park and also affect groundwater.

The Project has the potential to create a number of issues that may negatively impact on the adjacent section of Popran National Park including:

- the potential loss or degradation of habitat;
- inadequate provision of buffers;
- unsuitable provision of bushfire measures; and
- the potential to impact on the life cycles, foraging and/or movement patterns of mobile threatened species that occur in the national park.

There is some potential for secondary impacts from the Project on Popran National Park such as habitat fragmentation and increased edge effects including weed invasion, dust, noise and feral animals. However, a secure conservation area will be created on the Project Site and proposed offset area of the “Glenworth Valley” property which will maintain habitat connectivity to the northwest (**Section 6.5** provides further detail on the proposed biodiversity offset strategy proposed for the Project). It is recommended that a Vegetation Management Plan be implemented to minimise edge effects such as weed invasion and feral animals along the park boundary, and operate an appropriate fire regime to avoid high frequency fires impacting on the park (**Section 6.4.3.2** provides further detail on the recommended Vegetation Management Plan for the Project).

Popran National Park is not expected to be affected by groundwater drawdown as a result of the Project. The Project Site forms an amphitheatre type topographic feature facing west, and as such any water on the southern portion of the Project Site drains to the northwest. Creek C drains west to Cabbage Tree Creek, which does not flow through the park. While the Stage 5 quarry is located near the southern boundary of the Project Site, there would be little impact on groundwater or surface water to Popran National Park, as water supply to this area is unlikely to originate on the Project Site. Vegetation communities and species habitat are contiguous between Popran National Park and the Project Site and will be buffered from impacts of the Project by the proposed biodiversity offset. Clearing on the Project Site would lead to some reduction in habitat available for certain species, particularly any fauna which have defended home-ranges. The Project would fragment some habitat, however, linkages would still remain in the area.

The proposed biodiversity offset will provide an ecological buffer to Popran National Park from the effects of the Project of a distance of at least 50m wide along the southern edge of the proposed Stage 5 extraction area. The proposed offset areas will form a wider buffer to the park to the east and west of the Stage 5 extraction area. Although the proposed Glenworth Valley access road will follow the edge of the park within the buffer around the southern edge of the Stage 5 extraction area, this section follows an existing track and will not further fragment the existing native vegetation.

The Project does not require the provision of asset protection zones. The ecology of the study area is adapted to fire and the landscape would have been periodically burned by wildfire. Many of the threatened flora species that occur or have the potential to occur in the study area require fire to regenerate, although frequent burning would result in a loss of soil seed bank, decreasing the numbers of these species. It is recommended that any Vegetation Management Plan implemented in the Offset Areas include provisions for ecological burns and that this is coordinated with burns planned for Popran National Park.

Habitat for threatened fauna species that may use both Popran National Park and the Project Site is provided in the adjoining offset areas. Although it is unknown as to whether threatened species are using the proposed offset areas, the habitats provided there are similar or contiguous with the habitats provided in the proposed extraction areas.

The Project is not likely to significantly impact on threatened fauna that may use Popran National Park. The types of species that are likely to use both the Project Site and the National Park are relatively mobile with large ranges, for example microchiropteran bats, owls and gliders. The Project will remove some nesting and roosting habitat that may be used by bats and gliders, however, hollow-bearing trees occur throughout the Project Site, including offset areas and this type of habitat will be maintained in the offset areas. Owls are unlikely to roost on the Project Site due to a lack of large tree hollows within tall trees. Threatened fauna species will not be restricted from moving out of the park through a lack of habitat because a vegetated buffer and the proposed offset area, which will adjoin the park, provide connectivity to the north and west.

## 5.5 Impacts on Endangered Ecological Communities

No EECs are present on the Project Site. Swamp Sclerophyll Forest on Coastal Floodplains EEC and Swamp Oak Floodplain Forest EEC are present downstream along Cabbage Tree Creek. The impacts on these communities are discussed in Section 5.6 under groundwater dependent ecosystems.

## 5.6 Impacts on Groundwater Dependent Ecosystems

There is a wide range of ecosystem types that can be considered groundwater dependent (Lembit, 2007). The degree of dependence can include:

- aquatic ecosystems which are partially or occasionally dependent on groundwater, such as a river ecosystem where some portion of the dry-season base flow may be derived from an adjacent groundwater body;

- temporary or permanent springs, seeps and surface wetlands wholly fed by groundwater; and
- terrestrial ecosystems, with no surface water generally being present, but whose persistence in the environment is dependent on the presence of groundwater and on the depth of the groundwater table in relation to the root zone of key vegetation species (Fox, 1992).

GDEs are common in the Kulnura-Calga area. Wetlands, scrub and woodlands on the ridges rely on groundwater from the underlying porous sandstone. Vegetation on the Project Site is likely to be partially dependent on groundwater for ecosystem functioning. In particular, rainforest vegetation (E2 Sandstone Gully Rainforest) occurring within Creek C is dependent on maintaining sufficient soil moisture, which is recharged via the existing stream channel and within sandstone rock stratas. Such vegetation should be considered as a facultative GDE (i.e. partially dependent on groundwater). Higher up on the plateau, E54 Sandstone Hanging Swamp and E103 Gahnia/Banksia Swamp are likely to be examples of perched, obligate GDEs (ie. totally dependent on groundwater). These areas support plant species that cannot survive for long periods without adequate soil moisture and water logging.

Long-term trends to increasing depth-to-water would allow an ecosystem to adapt accordingly, however, a catastrophic loss of water availability would result in the death of an ecosystem. As part of a groundwater impact assessment completed for the Project, GeoTerra Pty Ltd (2008) note that the quantity of groundwater seepage toward the west-southwest into the Cabbage Tree Creek system is likely to reduce as a consequence of the groundwater depressurisation during extraction (resulting in a reduced standing water level) and altered recharge conditions created by the extraction area, silt cells and water storages. The following is an excerpt from GeoTerra Pty Ltd (2008) that summarises the modelled changes to groundwater base flows over the life of the Project.

> "*Groundwater base flow currently received by the creeks of the Project Site and surrounds were modelled as steady-state rates, which should be regarded as long term averages, with approximately 7L/sec (in total) discharging to Cabbage Tree Creek and approximately 4.5L/sec discharging into Creeks A and B, which join and flow into Creek C. The actual groundwater contribution to stream flow would be higher during wet periods and lower during dry seasons.*
>
> *Development of the Project is likely to reduce groundwater base flow to the local streams, with a seepage reduction in the order of 15% of flow into Creeks A and B, which join and flow into Creek C, and with a resultant reduction of approximately 7% of flow into Cabbage Tree Creek.*"

While dependent on groundwater base flows, availability of surface water flows will also influence the viability of any local GDEs, in particular the facultative E2 Sandstone Gully Rainforest community on the Project Site and those located further downstream. Evans & Peck Pty Ltd have included in their surface water assessment of the Project (Evans & Peck, 2008) a surface water balance to determine the relative availability of water for operational purposes at six sequential operational stages of the Project (Years 2, 5, 9, 12, 18 and 22). An excerpt from this water balance is provided as **Table 5.1** which illustrates that during most years, even during the driest 10$^{th}$ %ile rainfall years, surface flows to the local creek system

would not decrease by more than 27%, and on average would not decrease. Also notable is that in the post-quarry landform, the flow would exceed that of the existing landform.

**Table 5.1**
**Annual Flow Statistics in Creeks B and C**

| Rainfall Conditions | Rainfall | Quarry Year | Existing | Developed | Difference[1] | |
|---|---|---|---|---|---|---|
| | (mm/y) | | (ML/y) | (ML/y) | (ML/y) | (%) |
| Average | 1,243 | Y2 | 395 | 415 | +20 | +5% |
| Average | 1,243 | Y5 | 395 | 389 | -6 | -1% |
| Average | 1,243 | Y9 | 395 | 336 | -58 | -15% |
| Average | 1,243 | Y12 | 395 | 337 | -58 | -15% |
| Average | 1,243 | Y18 | 395 | 370 | -25 | -6% |
| Average | 1,243 | Y22 | 395 | 324 | -71 | -18% |
| Average | 1,243 | Post Quarry | 395 | 485 | +90 | +23% |
| 10% Dry | 854 | Y2 | 84 | 101 | +18 | +21% |
| 10% Dry | 854 | Y5 | 84 | 78 | -6 | -7% |
| 10% Dry | 854 | Y9 | 84 | 67 | -16 | -19% |
| 10% Dry | 854 | Y12 | 84 | 67 | -16 | -19% |
| 10% Dry | 854 | Y18 | 84 | 65 | -18 | -22% |
| 10% Dry | 854 | Y22 | 84 | 61 | -22 | -27% |
| 10% Dry | 854 | Post Quarry | 84 | 160 | +76 | +91% |
| 90% Wet | 1,628 | Y2 | 864 | 887 | +23 | +3% |
| 90% Wet | 1,628 | Y5 | 864 | 864 | 0 | 0% |
| 90% Wet | 1,628 | Y9 | 864 | 712 | -152 | -18% |
| 90% Wet | 1,628 | Y12 | 864 | 701 | -163 | -19% |
| 90% Wet | 1,628 | Y18 | 864 | 850 | -14 | -2% |
| 90% Wet | 1,628 | Y22 | 864 | 716 | -148 | -17% |
| 90% Wet | 1,628 | Post Quarry | 864 | 955 | +90 | +10% |

Considering the proposed clearing of the Project, and predicted impacts on groundwater and surface water flows, the following assesses the potential impacts of the Project on the Facultative and Obligate GDEs of the Project Site, as well as the GDEs located downstream of the Project Site.

### Facultative Project Site GDE (E2 Sandstone Gully Rainforest)

GeoTerra (2008) predicts that the standing water level of groundwater below this community may reduce by between 1m and 10m over the life of Project with the E2 Sandstone Gully Rainforest losing access to some groundwater during this time. Notably, however, the reduction in surface water flows to Creek B, along which this community is located would only be reduced during the driest years.

Therefore, given the E2 Sandstone Gully Rainforest community is only partially dependent on groundwater, and surface water supplies would remain relatively stable over the life of the Project, it is assessed as unlikely to be significantly impacted or altered as a consequence of the Project (although some modifications to the community may occur in the long term).

**Obligate GDE's (E54 Sandstone Hanging Swamp and E103 Gahnia/Banksia Swamp)**

Potential adverse effects on these GDEs due to the proposed extraction activities would include:

- the removal of a small area of community E103 Gahnia / Banksia Swamp within the Stage 4 extraction area (0.4ha); and
- a decrease in the local groundwater levels beneath Creek B, potentially reducing the availability of water to community E54 Sandstone Hanging Swamp community in this area (0.6ha).

Groundwater modelling completed by Geoterra (2008) predicts that the groundwater level below Creeks B and C of the Project Site would:

- decrease by 1m to 5m due to the influence of extraction from Stage 3;
- decrease by up to 25m below its current level at the completion of Stage 4; and
- decrease by up to 30m below its current level on completion of Stage 5.

This may have some adverse impact on the vegetation of Community E54. The potential impact of this reduction in groundwater would be mitigated by the following factors.

(i) The reduction in groundwater level would occur over a period of greater than 20 years, allowing time for the vegetation of the community to adapt to the reduced levels.

(ii) Flows within Creek B, which recharges the groundwater as it seeps through the sandy substrate and represents the primary source of water to this community, would be reduced by <20% over the life of the Project (see **Table 5.1**).

Therefore, considering the length of time over which the groundwater level reduction would occur, and the limited impact on surface flows (which ultimately provide the recharge to the groundwater accessed by this vegetation community), the impact on Community E54 is likely to be restricted to a temporary loss of some of the most groundwater dependent species. As groundwater levels and flows return to pre-extraction levels, these species may well return.

The impact on Community E103 Gahnia – Banksia Swamp, would be total as the small area of this community on the Project Site (0.4ha) would be cleared for the Stage 4 extraction. The impacts of groundwater drawdown are therefore not considered further for this community

**Additional Downstream GDEs**

A number of groundwater dependent ecosystems also occur in the area which could be indirectly affected by the Project. In particular, MU1 Coastal Wet Gully Forest, MU37 Swamp Mahogany – Paperbark Swamp Forest, and MU40 Swamp Oak – Rushland Forest are mapped as occurring in the lower reaches of Cabbage Tree Creek (600m due west of the south-western boundary of the Project Site). These communities rely on water flowing through Cabbage Tree Creek, which is highly dependent on groundwater discharge. MU37 is a form of *Swamp Sclerophyll Forest on Coastal Floodplains* EEC (NSW Scientific Committee, 2004h)and MU40 is a form of *Swamp Oak Floodplain Forest* EEC (NSW Scientific Committee, 2004g).

The impact on these GDEs is likely to be minimal however, for the following reasons.

- The reduction in surface water flows into Cabbage Tree Creek would be relatively small and only reduced during the driest of years.
- The reduction in groundwater base flows to the Cabbage Tree Creek catchment has been predicted to be less 15% for the life of the Project.
- These two limited impacts would only affect a very small part of the catchment for Cabbage Tree Creek, and therefore the minor changes to groundwater and surface water flows as a result of the Project are unlikely to significantly affect overall water flow along Cabbage Tree Creek,.

## 5.7 Impacts on Vegetation and Habitats

### 5.7.1 Conservation Value of the Project Site

No areas of "high conservation value" would be impacted directly by the Project. The Project Site supports a range of vegetation typical of Hawkesbury Sandstone environments on the Somersby Plateau. No communities in the Project Site are currently considered EECs under the TSC Act or the EPBC Act, although, a number of the vegetation communities in the locality are considered regionally significant (LHCCREMS, 2003). Within the Project Site, communities comparable to the Sandstone Hanging Swamps (MU54) and the Sandstone Ranges Warm Temperate Rainforest (MU2), listed by LHCCREMS (2003) as vulnerable and specialised communities (and therefore regionally significant) have been identified. On a more local scale, Bell (2004) lists E2 Sandstone Ranges Gully Rainforest, E25 Hawkesbury Peppermint Apple Forest, E26 Exposed Hawkesbury Woodland, E26a Hawkesbury Rock Pavement Heath, E29 Hawkesbury Banksia Scrub-Woodland and E54 Sandstone Hanging Swamps as being locally significant due to threatened species habitat, restricted distribution or development pressure. GDEs downstream from the Project Site which rely in part on water from the Project Site include two endangered ecological communities (Swamp Sclerophyll Forest and Swamp Oak Forest EECs).

### 5.7.2 Extent of Habitat Removal

The greatest potential for impact upon the threatened species of the Project Site from the Project would be a result of vegetation clearance. The areas of vegetation that exist within the Project Site and the areas proposed for clearance are provided in **Table 5.2**. The vegetation map of **Figure 4.3** provides an indication of where the Project would result in such vegetation clearances and where vegetation would be conserved in the long term.

Stage 4 would result in the clearance and removal of approximately 32.1ha of vegetation consisting mostly of native forest and woodland (approximately 9.9ha is of previously disturbed areas and regrowth). This is 26.6% of the native vegetation on the Project Site. Stage 5 would clear an additional 11.4ha (13.6%) of native vegetation plus 0.3ha disturbed vegetation/regrowth. The access roads would clear 1.1ha (1.4%) of native vegetation plus 0.8ha of disturbed vegetation/regrowth, bringing the total area of native vegetation cleared to approximately 34.7ha or 41.6% of the Project Site. An additional 0.9ha of native vegetation

would be cleared from the Glenworth Valley property to provide an access road to the property, bringing the total vegetation clearance for the Project to 35.7ha. This area has been excluded from the Glenworth Valley Offset Areas.

The vegetation communities that would experience the greatest proportional losses through vegetation clearing are those in the upper portions of the Project Site:

- E26 Exposed Hawkesbury Woodland – 41.5% cleared,
- E29/E29a/E29b Hawkesbury Banksia-Scrub Woodland – 57.7%; and
- E103 Gahnia/Banksia Swamp - 100%.

E2 Sandstone Ranges Gully Rainforest, E25 Hawkesbury Peppermint-Apple Forest, E26a Hawkesbury Rock Pavement Heath and E54 Sandstone Hanging Swamp would not be directly affected by clearing of vegetation. Threatened species that would be affected by the clearing include the plants *Hibbertia procumbens, Darwinia glaucophylla* and *Callistemon linearifolius,* the Glossy Black-cockatoo, Eastern Pygmy Possum and the Red-crowned Toadlet. A range of microbats, the Grey-headed Flying Fox, forest owls, arboreal and terrestrial mammals, and the Great Burrowing Frog are also likely to be affected. The implications of habitat loss for each species are assessed individually within the threatened species risk assessment which is provided in **Section 5.8**.

### 5.7.3 Hydrological Changes due to Proposed Extraction Activities

In addition to direct impacts of vegetation clearing, some minor changes would be expected to occur to the hydrology of receiving waters and/or proximate areas (see **Section 5.6**, which has been summarised from Evans & Peck, 2008). This could potentially lead to the alteration of existing hydrological conditions in those areas that contain areas of hanging swamp (Community E54) between Creek A and B, noted as potentially important habitat for birds and frogs by Dr Tony Saunders and Dr Arthur White during surveys of the Project Site in December 2005. There could also been some impacts on riparian vegetation within the Project Site.

The predicted changes to local flows in the tributaries of Cabbage Tree Creek would be relatively minor, generally less than 20% but possibly peaking at a reduction of 27% (should Year 22 operations coincide with a 10$^{th}$ percentile dry year) (see **Table 5.1**). With the exception of the vegetation cleared, riparian vegetation on the Project Site is unlikely to be significantly impacted as a result of the changes to local hydrology (see **Section 5.6**). As also noted in Section 5.6, downstream changes to surface and groundwater flows would be minimal and as such impacts on riparian vegetation downstream of the Project Site is unlikely.

### 5.7.4 Erosion and Sedimentation

Surface water and sediment and erosion controls would be installed prior to clearing activities. These controls would be especially important on the down slope side of the Stage 4 and 5 quarries to avoid any sediment-laden runoff from flowing directly into the local catchments of ephemeral drainage lines within the Cabbage Tree Creek catchment.

### 5.7.5 Tree Hollows and Stags

A significant number of hollow-bearing trees, including an estimated 5145 tree hollows ranging in size from <5cm to >20cm, and some stags would be lost from the Project Site. These are likely to provide habitat for a variety of species, including microbats, sugar gliders, parrots and owls. Depletion of hollow-bearing trees, combined with fragmentation and clearing, is likely to impact on populations of hollow-using fauna and reduce the number of species that an area can support (Gibbons and Lindenmayer, 2002). The overall loss of hollow-bearing trees will be offset, however, by the conservation of the proposed biodiversity offset area which will increase the area of habitat for hollow-dependent species in long-term conservation. It is estimated that the proposed Offset Areas contain similar densities of tree hollows compared with densities surveyed in the proposed extraction areas.

### 5.7.6 Fragmentation and Edge Effects

Fragmentation is the breaking down of large areas of habitat into smaller parcels. Larger areas of habitat can support greater numbers of species and higher levels of abundance within species. Fragmentation can affect plants and animals on a variety of scales. Fragmentation can affect the size of populations (and in some cases leads to local extinction of a species), can limit movement of species between areas, and can reduce genetic diversity of a population. Fragmentation also leads to greater edge effects.

"Edge effects" is the term given to impacts that occur at the interface between two contrasting landscape elements, such as woodland and cleared areas (Yahner, 1988). Changes to ecological processes within the vegetation can extend between 10m and 100m from the edge. Certain species, such as Noisy Miners, are edge-specialists, and can take over an area, driving out other species of native birds. Edge effects include (Yahner, 1988, Yahner, 1988):

- invasion by weeds;
- habitat reduction or fragmentation;
- increased predation;
- reduction in tree health; and
- barriers to dispersal or distribution.

**Table 5.2**
**Vegetation to be Cleared on the Project Site**

| Vegetation Community | Project Site Vegetation (ha) | Stage 4 | | | Stage 5 | | | Internal Access Roads | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Area Cleared (ha) | % Cleared | % Retained | Area Cleared (ha) | % Cleared | % Retained | Area Cleared (ha) | % Cleared | % Retained | Area Cleared (ha) | % Cleared | % Retained |
| **E103** | 0.4 | 0.4 | 100.0% | 0.0% | 0.0 | 0.0% | 100.0% | 0.0 | 0.0% | 100.0% | 0.4 | 100.0% | 0.0% |
| **E2** | 0.5 | 0.0 | 0.0% | 100.0% | 0.0 | 0.0% | 100.0% | 0.0 | 0.0% | 100.0% | 0.0 | 0.0% | 100.0% |
| **E25** | 11.5 | 0.0 | 0.0% | 100.0% | 0.0 | 0.0% | 100.0% | 0.0 | 0.0% | 100.0% | 0.0 | 0.0% | 100.0% |
| **E26** | 31.8 | 8.4 | 26.4% | 73.6% | 4.1 | 12.9% | 87.1% | 0.7 | 2.1% | 97.9% | 13.2 | 41.5% | 58.5% |
| **E26a** | 1.4 | 0.0 | 0.0% | 100.0% | 0.0 | 0.0% | 100.0% | 0.0 | 0.0% | 100.0% | 0.0 | 0.0% | 100.0% |
| **E29** | 23.8 | 8.0 | 33.6% | 66.4% | 3.1 | 13.0% | 87.0% | 0.4 | 1.5% | 98.5% | 11.5 | 48.1% | 51.9% |
| **E29a** | 12.4 | 4.4 | 35.5% | 64.5% | 4.2 | 33.9% | 66.1% | 0.0 | 0.1% | 99.9% | 8.6 | 69.6% | 30.4% |
| **E29b** | 1.2 | 1.0 | 80.5% | 19.5% | 0.0 | 0.0% | 100.0% | 0.1 | 4.8% | 95.2% | 1.1 | 85.3% | 14.7% |
| **E54** | 0.6 | 0.0 | 0.0% | 100.0% | 0.0 | 0.0% | 100.0% | 0.0 | 0.0% | 100.0% | 0.0 | 0.0% | 100.0% |
| **Xr** | 0.6 | 0.3 | 49.9% | 50.1% | 0.0 | 0.0% | 100.0% | 0.1 | 20.0% | 80.0% | 0.4 | 69.9% | 30.1% |
| **Xs** | 5.4 | 2.1 | 38.7% | 61.3% | 0.1 | 1.8% | 98.2% | 0.6 | 11.6% | 88.4% | 2.8 | 52.2% | 47.8% |
| **Unmapped (exotic)** | 15.0 | 7.5 | 49.8% | 50.2% | 0.2 | 1.3% | 98.7% | 0.0 | 0.0% | 100.0% | 7.7 | 51.1% | 48.9% |
| **Total** | **104.7** | 32.1 | 30.7% | 69.3% | 11.7 | 11.2% | 88.8% | **1.9** | 1.8% | 98.2% | 45.7 | 43.6% | 56.4% |
| **Total (native)** | **83.7** | 22.2 | 26.6% | 73.4% | 11.4 | 13.6% | 86.4% | **1.1** | 1.3% | 98.7% | 34.7 | 41.5% | 58.5% |

For example, roads fragment a landscape and create edge effects. Specific impacts from roads include (Andrews 1990) (Andrews, 1990):

- habitat loss;
- intrusion of edge effects into the natural vegetation;
- fragmentation of populations by division;
- disturbance;
- increased road-kills; and
- increased human access.

Some of these impacts are likely to result from the Project, however, as the area of extraction is already located on the margin of a large vegetated area, impacts of fragmentation and edge effects are likely to be limited to the proposed access roads.

The Project would also require the construction of two access roads:

- one to access the "Glenworth Valley" property from Flynn Road; and
- an internal haul road to provide access between the Southern Entrance and the two extraction stages.

Both access roads have been aligned to minimise impacts on threatened flora species and minimise vegetation clearance. For example, the "Glenworth Valley" access road traverses around the top of the hill near the southern corner of the Project Site in order to avoid impacts on large populations of *Darwinia glaucophylla* and *Hibbertia procumbens* near the southwestern corner of the Project Site and southeastern corner of the "Glenworth Valley" offset area. The internal access roads are generally located within a powerline easement, or where there has already been disturbance to the native vegetation (Communities Xs and Xr of **Figure 4.3**), to avoid larger patches of threatened plants and avoid disturbance to native vegetation (see **Figure 4.4**).

The access roads would cause some fragmentation to the vegetation of the Project Site and proposed biodiversity offset areas of the Project Site and "Glenworth Valley" property. However, this fragmentation is unlikely to be of significance when considering the following

- The section of the Project Site offset area to the south of the "Glenworth Valley" access road would be contiguous with Popran National Park and part of the "Glenworth Valley" offset area (see **Figure 4.3**). Notably, wherever this access road would be located it would divide the offset areas on the "Glenworth Valley" property and Project Site into northern and southern portions.
- The areas of native vegetation within the eastern offset of the Project Site are already separated from native vegetation to the west by the powerline corridor (see **Figure 4.3**).

Based on the above, and given the narrow width of clearance and separation between areas of native vegetation, the fragmentation effects of the access roads are considered minor. It is

recommended that any residual edge effects resultant or exacerbated by the construction of these access roads be managed through the preparation and implementation of a Vegetation Management Plan.

### 5.7.7 Corridors

The purpose of corridors is to facilitate important ecological processes such as migration, colonisation and interbreeding of plants and animals between two or more larger areas of such habitat. Not all the corridors are continuous, in that corridors may be crossed by roads and cleared land, however, these still provide important "stepping-stone" links (Scotts 2003).

The Project Site is located adjacent to Popran National Park which is part of a large corridor linking Brisbane Water National Park and the Blue Mountains (Morgan, 2001). The Project Site provides native vegetation which is continuous with the vegetation of Popran National Park, and is therefore part of the local corridor system for flora and fauna.

Due to the abundance of native bushland in the locality, regional connectivity is unlikely to be severed.

### 5.7.8 Resilience

Resilience, or the ability of native vegetation to recover to a pre-disturbance condition is assessed using the *In Situ Resilience and Anticipated Recovery Capacity Assessment* developed by (Perkins 2002), a methodology that was adopted for the Cumberland Plain in Western Sydney. Using this method, sites are classified as having low, medium or high resilience depending upon the nature and extent of existing native vegetation, the abundance of weeds and the known site history, particularly factors that could impact upon the soils and seed bank.

Sites with original native vegetation and low weed invasion have high in situ resilience. However, sites that may have had the forest or woodland cut down can still have high resilience if the soils and the seed bank of native plant species are intact. Conversely, some sites that have the canopy intact can be classified as having low resilience if the understorey and ground cover have been severely modified and weed invaded. This is particularly so where the soils have been subject to ploughing or major enrichment via fertilizer application.

Two communities currently dominate the Project Site: E26 Exposed Hawkesbury Woodland and E29 Hawkesbury Banksia-Scrub Woodland. According to mapping for the Gosford LGA, these communities are widespread, particularly in the locality. Significant areas of these communities would remain adjacent to the proposed extraction areas and therefore would be likely to eventually recover to pre-disturbance condition, i.e. highly resilient.

E103 Gahnia/Banksia Swamp is a small-sized vegetation community currently restricted to the more elevated portions of the Project Site. The entire of this community would be removed as a result of the Project. Given this community is patchily distributed in the region, it is unlikely to recover to pre-disturbance condition in the Project Site.

## 5.8 Impacts on Threatened Species

### 5.8.1 Background

In addition to the Assessments of Significance prepared to meet the requirements of Section 5A of the EP&A Act (see **Appendix D**), a risk assessment has been prepared to analyse the threatened species issues for the Project Site and identify those species which are considered would be at a real threat of extinction in the locality as a result of the Project.

The risk assessment is based on the abundances of the different threatened species known to occur in the locality, whether they occur in the Study Area or Project Site, and knowledge of their habitat preferences. Some information can be inferred about the likely impacts of the Project based on this risk assessment. However, such inferences should be drawn with care and a precautionary approach should be taken.

A risk assessment was developed and performed to determine the risk posed by the Project to the threatened species / communities considered either highly likely to occur or those that are already known to occur. This was based upon the Risk Management AS/NSS4360: 1999 (Joint Technical Committee OB/7 - Risk Management, 1999) as shown within **Tables 5.3** and **5.4**.

**Table 5.3**
**Likelihood that the Project would Significantly Impact a Threatened Species or Community**

| Level | Descriptor | Description of likelihood |
|---|---|---|
| A | Almost certain | Expected to occur in most circumstances |
| B | Likely | Likely to occur at some time |
| C | Unlikely | Could occur at some time |
| D | Rare | May occur only in exceptional circumstances |
| Notes: Source = Risk Management AS/NZS 4360:1999. | | |

The likely impacts arising from the Project were assigned a risk level for each vegetation community and for threatened species in the Study Area based on the likelihood and consequence of the impacts of the Project upon those species using the matrix shown in **Table 5.5**. This matrix is based on the risk matrix in the *Australian Standard AS/NZ 4360:1999 Risk Management (Joint Technical Committee OB/7 - Risk Management, 1999)*.

**Table 5.4**
**Measures and Consequences of Impacts of the Project Upon Threatened Species or Vegetation Communities**

| Level | Descriptor | Description of consequence |
|---|---|---|
| A | Major | Major loss of known or highly likely potential habitat and irreversible damage to the species in the locality / bioregion – offset by significant guaranteed conservation outcomes (such as like for like green offset conservation) |
| B | Moderate | High loss of environmental values and impacts to the species in the locality – offset by combination of site specific amelioration measures combined with green offsets |

**Table 5.4 (Cont'd)**
**Measures and Consequences of Impacts of the Project Upon Threatened Species or Vegetation Communities**

| | | |
|---|---|---|
| C | Minor | Medium impact on environmental values and impacts to threatened species – requires site-specific amelioration measures |
| D | Insignificant | Low impact on environmental values and threatened species, no amelioration or further investigation considered to be required |
| Notes: Adapted from Risk Management AS/NZS 4360:1999. | | |

**Table 5.5**
**Qualitative Risk Matrix**

| **Likelihood** | | **Consequence** | | | |
|---|---|---|---|---|---|
| | | **D** | **C** | **B** | **A** |
| | | **Insignificant** | **Minor** | **Moderate** | **Major** |
| A | Almost certain | 3 | 3 | 4 | 4 |
| B | Likely | 2 | 3 | 3 | 4 |
| C | Unlikely | 1 | 2 | 3 | 3 |
| D | Rare | 1 | 1 | 2 | 3 |
| Notes: Source = Risk Management AS/NZS 4360:1999. | | | | | |

The risk matrix assigns the following four different levels of risk.

1. **Low Risk** – not an important issue but requiring some attention and monitoring to avoid adverse impacts.
2. **Moderate Risk** – an issue that requires regular management, resourcing and monitoring.
3. **High Risk** – an important issue of high priority.
4. **Extreme Risk** – an important issue with highest priority that requires high level planning and action.

The species identified as being of high to extreme risk are considered to require reliable targeted surveys to have been undertaken in order to enable sufficient confidence in the predicted level of impacts.

### 5.8.2 Risk Assessment

Factors taken into account to assess the likelihood and potential impacts of the Project on threatened species include the following.

- Presence of occurrence of the species/community (either on site or within 5km of the Project Site), and potential habitat on site.
- Presence or occurrence of species is based on the current study, previous studies for Calga Sand northern quarry extension and database searches of Bionet and the EPBC Protected Matters Search Tool within the last 20 years from the Gosford LGA (DECC (NSW), 2009) and (DEH, 2009).
- Identification of potential habitat is based on the current study and information on habitat requirements provided in profiles for TSC Act and EPBC Act listed threatened species and EECs.

In assessing the risk posed by the Project to the threatened species known or considered highly likely to occur on the Project Site, several key points can be made.

- The Project may result in the complete removal of up to 34.7ha of predominantly native vegetation from the Project Site.
- Some of the threatened plants are dependent on communities likely to be substantially impacted by the Project, while other threatened plants may be located in areas subject to lower level impacts.

**Table 5.6** summarises the risk assessment to evaluate the potential risk to species of conservation significance identified on the Project Site, or previously recorded within the locality. It also assesses the risk to species not yet found to occur in the locality, but which have habitat present on the Project Site. Species marked in bold have been recorded in the Study Area.

**Table 5.6**
**Risk Assessment to Evaluate the Potential Risk from the Project to Threatened Species**



| Species/Common name | Confirmed Presence in Project Site | Likelihood of Occurrence | Consequence of Impacts | Risk Level |
|---|---|---|---|---|
| **Plants** | | | | |
| *Olearia cordata* | No | D | D | Low |
| *Astrotricha crassifolia* | No | D | D | Low |
| *Senecio spathulatus* | No | D | D | Low |
| ***Hibbertia procumbens*** | **Yes** | **B** | **B** | **High** |
| *Tetratheca glandulosa* | No | C | B | High |
| *Tetratheca juncea* | No | C | D | Low |
| *Epacris purpurascens var. purpurascens* | No | D | D | Low |
| *Chamaesyce psammogeton* | No | D | D | Low |
| *Acacia bynoeana* | No | D | D | Moderate |
| *Acacia pubescens* | No | D | D | Low |
| *Haloragodendron lucasii* | No | D | D | Low |
| *Maundia triglochinoides* | No | D | D | Low |
| *Prostanthera askania* | No | C | D | Low |
| *Prostanthera junonis* | No | C | C | Moderate |
| ***Callistemon linearifolius*** | **Yes** | **B** | **B** | **High** |
| *Darwinia biflora* | No | D | D | Low |
| ***Darwinia glaucophylla*** | **Yes** | **B** | **B** | **High** |
| *Eucalyptus camfieldii* | No | D | C | Moderate |
| *Kunzea rupestris* | No | D | C | Moderate |
| *Melaleuca biconvexa* | No | D | D | Low |
| *Melaleuca deanei* | No | D | D | Moderate |
| *Micromyrtus blakelyi* | No | D | C | Moderate |
| *Syzygium paniculatum* | No | D | D | Low |
| *Caladenia tessellata* | No | D | D | Low |
| *Cryptostylis hunteriana* | No | D | C | Low |
| *Diuris bracteata* | No | C | C | Moderate |
| *Diuris praecox* | No | D | D | Low |
| *Rhizanthella slateri* | No | D | C | Low |
| *Ancistrachne maidenii* | No | C | D | Moderate |
| *Grevillea parviflora subsp parviflor* | No | D | D | Low |
| *Grevillea shiressii* | No | D | D | Moderate |
| *Persoonia hirsuta* | No | D | C | Moderate |
| *Baloskion longipes* | No | D | C | Low |
| *Lasiopetalum joyceae* | No | C | C | Moderate |

**Table 5.6 (Cont'd)**
**Risk Assessment to Evaluate the Potential Risk from the Project to Threatened Species**



| Species/Common name | Confirmed Presence in Project Site | Likelihood of Occurrence | Consequence of Impacts | Risk Level |
|---|---|---|---|---|
| ***Birds*** | | | | |
| Osprey | No | D | D | Low |
| Australasian Bittern | No | D | D | Low |
| Black Bittern | No | D | D | Low |
| Gang-gang Cockatoo | No | C | C | Moderate |
| Glossy Black-cockatoo | Yes | B | C | High |
| Brown Tree-creeper | No | D | D | Low |
| Superb Fruit Dove | No | D | D | Low |
| Regent Honeyeater | No | D | D | Low |
| Gould's Petrel | No | D | D | Low |
| Swift Parrot | No | D | D | Low |
| Turquoise Parrot | No | D | D | Low |
| Barking Owl | No | C | C | Moderate |
| Powerful Owl | No | B | C | High |
| Masked Owl | No | C | C | Moderate |
| Sooty Owl | No | D | D | Low |
| ***Mammals – bats*** | | | | |
| Yellow-bellied Sheathtail Bat | No | C | C | Moderate |
| Eastern Freetail-bat | No | C | C | Moderate |
| Grey-headed Flying-fox | No | B | C | High |
| Large-eared Pied Bat | No | C | C | Moderate |
| Eastern Falsistrelle | No | D | C | Low |
| Little Bent-wing Bat | No | C | C | Moderate |
| Eastern Bent-wing Bat | No | C | D | Low |
| Large-footed Myotis | No* | B | C | High |
| Greater Broad-nosed Bat | No | C | C | Moderate |
| ***Mammals – other*** | | | | |
| Eastern Pygmy-possum | Yes | B | C | High |
| Spotted-tailed Quoll | No | C | C | Moderate |
| Parma Wallaby | No | D | D | Low |
| Brush-Tailed Rock-wallaby | No | D | C | Low |
| Eastern Chestnut Mouse | No | D | C | Low |
| Southern Brown Bandicoot | No | D | C | Low |
| Yellow Bellied Glider | No | C | C | Moderate |
| Squirrel Glider | No | C | C | Moderate |
| Koala | No | D | C | Low |
| Long-nosed Potoroo | No | C | C | Moderate |
| ***Frogs*** | | | | |
| Stuttering Frog | No | D | D | Low |
| Giant Barred Frog | No | D | D | Low |
| Red-crowned Toadlet | Yes | B | B | High |
| Giant Burrowing Frog | No | B | B | High |
| ***Reptiles*** | | | | |
| Broad-headed Snake | No | D | C | Low |
| Stephen's Banded Snake | No | D | C | Low |
| Rosenberg's Goanna | No | B | C | High |
| ***Fish*** | | | | |
| Australian Grayling | No | D | D | Low |
| Macquarie Perch | No | D | D | Low |
| ***Invertebrates*** | | | | |
| Giant Dragonfly | No | D | D | Low |

*"Possible" record from Anabat survey but could instead be *Nyctophilus* sp.

#### 5.8.2.1 Species at Low Risk

A number of threatened species were found to be at low risk from the Project. These species have potential habitat in the Project Site, but have not been recorded within 5km of the Project Site and were not found during the current survey or the Project Site does not contain potential habitat. These species include the following.

- *Olearia cordata* (vulnerable under the TSC Act and vulnerable under the EPBC Act);
- *Astrotricha crassifolia* (vulnerable under the TSC Act and vulnerable under the EPBC Act);
- *Senecio spathulatus* (endangered under the TSC Act);
- *Tetratheca juncea* (vulnerable under the TSC Act and vulnerable under the EPBC Act);
- *Epacris purpurascens* var. *purpurascens* (vulnerable under the TSC Act);
- *Chamaesyce psammogeton* (endangered under the TSC Act);
- *Acacia pubescens* (vulnerable under the TSC Act and vulnerable under the EPBC Act);
- *Haloragodendron lucasii* (endangered under the TSC Act and endangered under the EPBC Act);
- *Maundia triglochinoides* (vulnerable under the TSC Act);
- *Prostanthera askania* (endangered under the TSC Act and endangered under the EPBC Act);
- *Darwinia biflora* (vulnerable under the TSC Act and vulnerable under the EPBC Act);
- *Melaleuca biconvexa* (vulnerable under the TSC Act and vulnerable under the EPBC Act);
- *Syzygium paniculatum* (vulnerable under the TSC Act and vulnerable under the EPBC Act);
- *Caladenia tessellata* (endangered under the TSC Act and vulnerable under the EPBC Act);
- *Cryptostylis hunteriana* (vulnerable under the TSC Act and vulnerable under the EPBC Act);
- *Diuris praecox* (vulnerable under the TSC Act and vulnerable under the EPBC Act);
- *Rhizanthella slateri praecox* (vulnerable under the TSC Act and endangered under the EPBC Act);
- *Grevillea parviflora* subsp. *parviflora* (vulnerable under the TSC Act and vulnerable under the EPBC Act);
- *Baloskion longipes* (vulnerable under the TSC Act);

- Osprey (*Pandion haliaitus*) (vulnerable under the TSC Act);
- Australasian Bittern (*Botaurus poiciloptilus*) (vulnerable under the TSC Act);
- Black Bittern (*Ixobrychus flavicollis*) (vulnerable under the TSC Act);
- Brown Treecreeper (*Climacteris picumnus*) (vulnerable under the TSC Act);
- Superb Fruit-dove (*Ptilinopus superbus*) (vulnerable under the TSC Act);
- Regent Honeyeater (*Anthochaera* (*Xanthomyza) phrygia*) (endangered under the TSC Act and endangered under the EPBC Act);
- Gould's Petrel (*Pterodroma leucoptera*) (endangered under the TSC Act and endangered under the EPBC Act);
- Swift Parrot (*Lathamus discolor*) (endangered under the TSC Act and endangered under the EPBC Act);
- Turquoise Parrot (*Neophema pulchella*) (vulnerable under the TSC Act);
- Sooty Owl (*Tyto tenebricosa*) (vulnerable under the TSC Act);
- Eastern Bentwing Bat (*Miniopterus schreibersii oceanensis*) (vulnerable under the TSC Act);
- Eastern False Pipistrelle (*Falsistrellus tasmaniensis*) (vulnerable under the TSC Act);
- Parma Wallaby (*Macropus parma*) (vulnerable under the TSC Act);
- Brush-tailed Rock-wallaby (*Petrogale penicillata*) (endangered under the TSC Act and vulnerable under the EPBC Act);
- Eastern Chestnut Mouse (*Pseudomys gracilicaudatus*) (vulnerable under the TSC Act);
- Southern Brown Bandicoot (*Isoodon obesulus obesulus*) (endangered under the TSC Act and endangered under the EPBC Act);
- Koala (*Phascolarctos cinereus*) (vulnerable under the TSC Act);
- Stuttering Frog (*Mixophyes balbus*) (endangered under the TSC Act and vulnerable under the EPBC Act);
- Giant Barred Frog (*Mixophyes iteratus*) (endangered under the TSC Act and endangered under the EPBC Act);
- Broad-headed Snake (*Hoplocephalus bungaroides*) (endangered under the TSC Act and vulnerable under the EPBC Act);
- Stephen's Banded Snake (*Hoplocephalus stephensii*) (vulnerable under the TSC Act);
- Australian Grayling (*Prototroctes maraena*) (vulnerable under the EPBC Act);
- Macquarie Perch (*Macquaria australasica*) (endangered under the EPBC Act); and
- Giant Dragonfly (*Petalura gigantea*) (endangered under the TSC Act).

A significant impact is not considered likely for these species.

#### 5.8.2.2 Species at Moderate Risk

A number of threatened species were found to be at moderate risk from the Project. While most of these may not have been recorded in the Study Area, they have been recorded within the locality and therefore may move into or forage over the Project Site.

- *Acacia bynoeana* (endangered under the TSC Act and vulnerable under the EPBC Act);
- *Prostanthera junonis* (endangered under the TSC Act and endangered under the EPBC Act);
- *Eucalyptus camfieldii* (vulnerable under the TSC Act and vulnerable under the EPBC Act);
- *Kunzea rupestris* (vulnerable under the TSC Act and vulnerable under the EPBC Act);
- *Melaleuca deanei* (vulnerable under the TSC Act and vulnerable under the EPBC Act);
- *Micromyrtus blakelyi* (vulnerable under the TSC Act and vulnerable under the EPBC Act);
- *Diuris bracteata* (endangered under the TSC Act);
- *Ancistrachne maidenii* (vulnerable under the TSC Act);
- *Grevillea shiresii* (vulnerable under the TSC Act and vulnerable under the EPBC Act);
- *Persoonia hirsuta* (endangered under the TSC Act and endangered under the EPBC Act);
- *Lasiopetalum joyceae* (vulnerable under the TSC Act and vulnerable under the EPBC Act);
- Gang Gang Cockatoo (*Calocephalon fimbriatum*) (vulnerable under the TSC Act);
- Masked Owl (*Tyto novaehollandiae*) (vulnerable under the TSC Act);
- Barking Owl (*Ninox connivens*) (vulnerable under the TSC Act);
- Eastern Freetail-bat (*Mormopterus norfolkensis*) (vulnerable under the TSC Act);
- Yellow-bellied Sheath-tail Bat (*Saccolaimus flaviventris*) (vulnerable under the TSC Act) – recorded in the Study Area;
- Greater Broad-nosed Bat (*Scoteanax rueppellii*) (vulnerable under the TSC Act).
- Large-eared Pied Bat (*Chalinolobus dwyeri*) (vulnerable under the TSC Act and vulnerable under the EPBC Act);
- Little Bentwing Bat (*Miniopterus australis*) (vulnerable under the TSC Act);
- Spotted-tailed Quoll (*Dasyurus maculatus*) (vulnerable under the TSC Act and endangered under the EPBC Act);

- Long-nosed Potoroo (*Potorous tridactylus*) (vulnerable under the TSC Act and vulnerable (SE mainland) under the EPBC Act);
- Squirrel Glider (*Petaurus norfolcensis*) (vulnerable under the TSC Act); and
- Yellow Bellied Glider (*Petaurus australis*) (vulnerable under the TSC Act).

A significant impact is considered unlikely for these species since the Project would not result in the removal of known occurrences of these species. Potential habitat may, however, be indirectly impacted by the proposed extraction activities.

#### 5.8.2.3 Species at High Risk

A small number of species were found to be at high risk should the Project proceed. These species have been recorded within the locality, are known or considered likely to occur within the Study Area, and have habitat which would be removed or indirectly impacted as a result of the Project.

- *Callistemon linearifolius* (vulnerable under the TSC Act);
- *Darwinia glaucophylla* (vulnerable under the TSC Act);
- *Hibbertia procumbens* (endangered under the TSC Act);
- *Tetratheca glandulosa* (endangered under the TSC Act and endangered under the EPBC Act);
- Red-crowned Toadlet (*Pseudophryne australis*) (vulnerable under the TSC Act).
- Giant Burrowing Frog (*Heleioporus australiacus*) (vulnerable under the TSC Act and vulnerable under the EPBC Act).
- Glossy Black-cockatoo (*Calyptorhynchus lathami*) (vulnerable under the TSC Act).
- Powerful Owl (*Ninox strenua*) (vulnerable under the TSC Act) – recorded in the Study Area.
- Large-footed Myotis (*Myotis adversus*) (vulnerable under the TSC Act);
- Grey-headed Flying-fox (*Pteropus poliocephalus*) (vulnerable under the TSC Act and vulnerable under the EPBC Act) – recorded in the Study Area.
- Eastern Pygmy-possum (*Cercartetus nanus*) (vulnerable under the TSC Act).
- Rosenberg's Goanna (*Varanus rosenbergi*) (vulnerable under the TSC Act) – recorded in the Study Area.

The Project may result in the removal of known occurrences of these species and/or preferred habitat may be indirectly impacted by the proposed extraction activities. However, it should be noted that significant areas of habitat exist for all these species in the locality, and thus the Project would not be likely to place them at risk of extinction. Species at high risk are assessed for significance of impacts later in this chapter. A full assessment of impacts on these species can be found in **Appendix D**.

#### 5.8.2.4 Species at Extreme Risk

No species were found to be at extreme risk as a result of the Project.

### 5.8.3 Significance of Impacts on Threatened Species

#### 5.8.3.1 Introduction

The significance of impact from the project has been assessed for high and moderate risk species. The significance of impact is generally based on:

- the importance of individuals, subpopulations or populations that are likely to be affected by the Project in maintaining the long-term viability of the species or population; and
- the importance of habitat features that are likely to be affected by the Project in maintaining the long-term viability of the species or population.

Full profiles for each high and moderate risk threatened species can be found in **Appendix C** and Assessments of Significance for these species are found in **Appendix D.**

#### 5.8.3.2 Callistemon linearifolius

On the Project Site, *Callistemon linearifolius* was recorded in small groups in four scattered locations (see **Figure 4.4**), of which only one (within Stage 5) would be cleared as part of the Project, resulting in the loss of a single plant (see **Figure 4.4**). The remainder of the specimens recorded from the Project Site comprise thirteen plants spread over three close locations within the southwest, a single plant located towards the centre, and 10 plants located at the northeastern perimeter of Stage 4. These would not be directly impacted by the Project (see **Figure 4.4**). No targeted surveys for this species have been carried out in the adjacent Popran National Park, however, it is likely that it occurs there. The proposed access roads have been aligned to avoid clearance of any *Callistemon linearifolius* plants.

There are currently only five or six populations of this species known in the Sydney area, of the 22 populations recorded in the past. There are 44 records of the species in the last 20 years in the Sydney Basin Bioregion, with only 8 records from Gosford LGA, and additional populations near Kurri Kurri, Budgewoi and Wollongong (NSW Government, 2009). Based on these records, the occurrence of this species on the Project Site forms a disjunct local population, as other records in the LGA are further to the east, around Gosford. This species has also been recorded in Brisbane Water National Park. *Callistemon linearifolius* typically occurs sporadically within sandstone communities, and although not recorded within the adjacent Popran National Park, it is likely that it is represented there as large areas of suitable habitat are present.

*Callistemon linearifolius* occurs in vegetation communities on the Project Site which are common in the sandstone plateaus at Calga and surrounding areas. E26 Exposed Hawkesbury Woodland (within which this species occurs in the Project Site) is mapped as being widespread within the Gosford, Central Coast and Sydney Regions. This species has

also been recorded in this vegetation community on Lion Island Nature Reserve and in the Patonga area within Gosford LGA (Bell, 2004). While a sizable area of habitat would be removed from the Project Site, approximately 17,200ha of similar habitat are present within Gosford LGA. Habitat is protected in Brisbane Water National Park (Bell, 1998), (Bell, 2004), and potential habitat exists in Dharug and Yengo National Parks (Clarke and Benson, 1986, Bell et al., 1993). Habitat within the Project Site is contiguous with Popran National Park, and fragmentation and isolation of habitat would not occur. In addition, there may be scope for this species to be replanted in the Project Site during the rehabilitation stage.

#### 5.8.3.3 Darwinia glaucophylla

*Darwinia glaucophylla* has been recorded throughout communities E26 Exposed Hawkesbury Woodland and E29 Hawkesbury Banksia-Scrub Woodland within the Project Site. 167plants have been counted in the study area, including along the edge of Popran National Park. This only includes plants for which the location was recorded with a GPS and there is likely to be many more individuals in the study area that were not encountered and therefore not recorded. Less than half of the recorded locations within the Project Site would be impacted by vegetation clearing with approximately 59 plants in total proposed for clearance (19 within Stage 4, 28 within Stage 5 and 12 along access road routes), and other sites would not be impacted, retaining at least 109 plants. These include the cleared area along the power line easement, along Creek B, in the southeast corner adjacent to Australian Wildlife Walkabout Park, the northwest section between the Stage 3 and 4 extraction areas, within the power line easement to the north and south of the Stage 4 extraction area and along the access road to Popran National Park on the southern border of the Project Site, particularly the southwest corner. The proposed access roads have been aligned to avoid clearance of the majority of the *Darwinia glaucophylla* plants identified (see **Figure 4.4**). Potential habitat exists for this species in the proposed Offset Areas and further surveys for threatened flora species will be conducted in the proposed Offset Areas in spring.

*Darwinia glaucophylla* is a highly restricted species that occurs entirely within the Gosford LGA, and is only known from approximately 15 sites, several within or near Brisbane Water National Park and one within Popran National Park (NSW Government, 2009). It is listed with a conservation code of 2RCi by Briggs and Leigh (Briggs and Leigh, 1995), indicating a rare species with a geographical distribution of less than 100km$^2$ and with inadequate representation in conservation reserves.

*Darwinia glaucophylla* occurs in sandy heath, scrub and woodlands often associated with sandstone rock platforms or near hanging swamps and friable sandstone shallow soils (DEC (NSW), 2005e). It occurs in vegetation communities on the Project Site which are common in the sandstone plateaus at Calga and surrounding areas. While a sizable area of habitat would be removed from the Project Site, approximately 20,000ha of similar habitat are present within Gosford LGA. All communities within which this species occurs on the Project Site are also present in Brisbane Water National Park and Popran National Parks{Bell 1998 #3550}{Bell 2004 #3551}. Habitat to be retained within the Project Site (in the southern and north-western parts) is contiguous with habitat within the adjacent Popran National Park, and therefore fragmentation and isolation of habitat would not occur. The majority of the recorded specimens of *Darwinia glaucophylla* will be retained on the Project Site and there is a strong likelihood of additional unrecorded specimens being present in the large areas of suitable

habitat for this species that are present in nearby conservation reserves. It is unlikely therefore that the Project will have an important negative impact on this species.

It is recommended that the revegetation of the Project Site should be managed to encourage the growth of *Darwinia glaucophylla*, which is a disturbance specialist. The seeds of this species require heat for germination, so it is important that an appropriate fire regime is maintained as part of efforts to conserve this species.

#### 5.8.3.4 Hibbertia procumbens

This species is widespread across the Project Site, and occurs in similar densities in other areas of the Somersby Plateau (Bell and Driscoll, 2005). *Hibbertia procumbens* has been recorded throughout communities E26 Exposed Hawkesbury Woodland and E29 Hawkesbury Banksia-Scrub Woodland within the Project Site, and these communities are widespread in the Gosford, Central Coast and Sydney regions. 196 individuals of this species have been counted in the study area. This only includes plants of which the location was recorded with a GPS and there is likely to be many more individuals in the study area that were not encountered and therefore not recorded. Clearing of the habitat supporting *Hibbertia procumbens* would impact the species within the Project Site. Approximately half of the recorded locations would be impacted by clearing for the Project, with approximately 91 plants in total proposed for clearance (41 within Stage 4, 28 within Stage 5 and 22 along access road routes), and other sites will not be impacted, retaining at least 105 plants. These include the cleared area along the power line easement, along Creek B, in the southeast corner adjacent to Australian Wildlife Walkabout Park, the northwest section between the Stage 3 and 4 extraction areas, and along the access road to Popran National Park on the southern border of the Project Site. The proposed access roads have been aligned to avoid clearance of the majority of the *Hibbertia procumbens* plants identified (see **Figure 4.4**). Potential habitat exists for this species in the proposed Offset Areas and further surveys for threatened flora species will be conducted in the proposed Offset Areas in spring.

*Hibbertia procumbens* has been recorded from 22 locations in the Gosford LGA and 45 locations in the Sydney Basin Bioregion (NSW Government, 2009). Recently a large population was recorded in Yengo National Park, and smaller populations are also known from Popran and Brisbane Water National Parks (Bell, 2004). There is currently no information available on the presence of this species within Popran National Park, which lies adjacent to the Project Site, although it is likely that similar densities may occur there. Clearing of habitat would negatively affect the species in the immediate vicinity, however, the viability of the species as a whole is not at risk as a result of the Project. *Hibbertia procumbens* occurs in vegetation communities on the Project Site which are typical of the sandstone plateaus at Calga and surrounding areas. While extensive areas of habitat for this species would be removed from the Project Site, approximately 20,800ha of similar habitat are present within Gosford LGA. All communities within which this species occurs on the Project Site are also present in Brisbane Water National Park and Popran National Parks (Bell, 1998); (Bell, 2004), and potential habitat exists to the west in Dharug and Yengo National Parks (Clarke and Benson, 1986, Bell et al., 1993). Habitat to be retained within the Project Site (along the southern and western boundaries) is contiguous with habitat within the adjacent Popran National Park, and fragmentation and therefore isolation of habitat would not occur.

The revegetation of the Project Site should be managed to encourage the growth of *Hibbertia procumbens*, which is a disturbance specialist.

#### 5.8.3.5 Tetratheca glandulosa

*Tetratheca glandulosa* has not been recorded on the Project Site, although it has been recorded close to the northern boundary of the adjacent Popran National Park. Potential habitat does exist for this species on the Project Site within the E26 Exposed Hawkesbury Woodland, E25 Hawkesbury Peppermint Apple Forest, E26a Hawkesbury Rock Pavement Heath, E29 Hawkesbury Banksia Scrub-Woodland and E29a Hawkesbury Banksia Scrub-Woodland (Scrub), and it is possible that this species occurs on the Project Site but has remained undetected. Approximately 33.3ha (41%) of potential habitat on the Project Site will be removed as a result of the Project. Potential habitat would remain in the Project Site East and Project Site West Offset Areas, as well as the powerline easement and the Glenworth Valley Offset Area.

*Tetratheca glandulosa* is considered to be adequately reserved north of the Hawkesbury River, with large populations occurring in Dharug National Park, Parr State Conservation Area, Yengo National Park and Ourimbah State Forest{NSW NPWS 2000 #2008}. This species has also been recorded at Mt White, Popran National Park and in the Mangrove Mountain area in the Gosford LGA{NSW Government 2009 #4158}.

The types of habitats *Tetratheca glandulosa* occurs in are common on the sandstone plateaus at Calga and in surrounding areas. Large areas of suitable habitat will be retained in the proposed Biodiversity Offset Areas and the habitat to be retained is contiguous with habitat within Popran National Park and therefore no isolation of habitat will occur. It is unlikely that the Project would have a negative impact on this species.

It is recommended that the revegetation of the Project Site be managed to encourage the growth of *Tetratheca glandulosa*, which is a disturbance specialist. It is important that an appropriate fire regime is maintained in an effort to conserve this species.

#### 5.8.3.6 Red-crowned Toadlet

Red-crowned Toadlets were recorded from two locations within the Project Site along Creek A. The Project is likely to affect Red-crowned Toadlets along Creek A as the extraction in Stage 4 would remove a large portion of this ephemeral drainage line.

Creek B would be retained and Evans & Peck (2008) predicts the reduction in surface flows within the retained creeks of the Project Site would be (at worst) 27% and on average not reduced. While vegetation corridors are being maintained through the Project Site, movement of Red-crowned Toadlets is restricted to rock outcrops and damp areas. Creek B is being retained to enable water flow to continue into Creek C, which should maintain habitat for this species. Potential habitat is also likely to be available in areas surrounding Creek C, which will be surveyed in spring as part of the habitat assessment of the proposed Offset Areas. The Project may therefore impact some individuals, although these individuals are not significant for the viability of the species as a whole, and the sub-population would be likely to persist on the Project Site.

The Red-crowned Toadlet has been recorded from 145 locations in the Gosford LGA and 756 locations in the Sydney Basin Bioregion (NSW Government, 2009). The species is limited to the Sydney Basin Bioregion and the northern margin of the South Eastern Highlands Bioregion, with its known distribution extending from Pokolbin State Forest and Wollemi National Park in the north, to the Nowra district in the south and Mt Victoria in the west (NSW NPWS, 2001b, NSW NPWS, 2001a).

The Red-crowned Toadlet generally occurs on the sandstone escarpment areas and plateaus in the Sydney basin, usually within 100m of the ridge top. Red-crowned Toadlets utilise moist microhabitats rather than permanent water, such as under bushrock, logs on soil, thick ground litter and horizontal rock crevices along the ground. They are usually found along permanently moist soaks in ephemeral feeder creeks (NSW NPWS, 2001b). Large areas of habitat for this species exist throughout the Somersby Plateau and habitat is protected within the adjacent Popran National Park.

#### 5.8.3.7 Giant Burrowing Frog

Potential habitat exists for this species in the centre of the Project Site where the two ephemeral creeks B and C come together. Creek B would be retained and Evans & Peck (2008) predicts the reduction in surface flows within the retained creeks of the Project Site would be (at worst 27%) and more likely on average not reduced. The retention of Creek B would enable water flow to continue into Creek C, which should maintain some habitat for this species. The Project may therefore negatively impact some individuals, however, these individuals are not significant for the viability of the species as a whole, and a sub-population (if present) would be likely to persist on the Project Site.

The Great Burrowing Frog has been recorded from 144 locations in the Gosford LGA and 417 locations in the Sydney Basin Bioregion, including Popran, Brisbane Water, Dharug and Yengo National Parks (NSW Government, 2009).

The Giant Burrowing shows a preference for sandstone ridge top habitat and broader upland valleys. In these locations, the frog is associated with small headwater creek lines and along slow flowing to intermittent creeklines. The species often spends significant periods of time underground during unfavourable conditions (NSW NPWS, 2001a). Limited observations on this species suggest an ability to range widely, frequently being observed on roads at considerable distance from suitable riparian breeding, or other moist habitat. Corridors are being maintained on the Project Site, and habitat is unlikely to be fragmented or isolated, which would enable this species to move around. Habitat for this species exists throughout the Somersby Plateau and habitat is protected within the adjacent Popran National Park.

#### 5.8.3.8 Glossy Black-cockatoo

The Glossy Black-cockatoo was recorded on the Project Site during the current study and has been recorded in the locality previously. The Glossy Black-cockatoo characteristically inhabits forests on sites with low soil nutrient status, reflecting the distribution of key *Allocasuarina* species (DEC(NSW), 2005l). Species of *Allocasuarina* are found throughout the Project Site, being present in vegetation communities E25, E26, E26a, and E29, and are likely to be

present throughout the locality. As the Glossy Black-cockatoo is highly mobile, it is likely to forage in the abundant surrounding areas of habitat as well as those on the Project Site.

One family group (three birds) has been recorded utilising the Project Site, and also may be nesting on the Project Site. Clearing for the Project may remove foraging habitat and potential nesting habitat for this species, however, it is likely to persist in the locality as large areas of suitable habitat will remain. Approximately 20,000ha of similar habitat is present in the Gosford LGA. Habitat to be retained within the Project Site is contiguous with habitat within the adjacent Popran National Park, and fragmentation and isolation of habitat would not occur. It is therefore not considered likely that this species will be placed at risk of extinction as a result of the Project.

The Glossy Black-cockatoo has been recorded from 216 locations in the Gosford LGA and 1469 locations in the Sydney Basin Bioregion. Locally nomadic, small flocks roam in search of feeding areas and roost communally.

Replanting areas with Casuarina trees and promotion of their growth and development during the rehabilitation stage would replace some of the foraging habitat lost. Installation of nest boxes may also benefit this species by replacing lost tree hollows.

#### 5.8.3.9 Powerful Owl

The Powerful Owl has been recorded calling from Popran National Park in response to playback in the Study Area (Countrywide Ecological Service 2004). This species has very large home ranges and therefore it is likely that an individual or breeding pair may use the Project Site for foraging and nesting. Powerful Owls have a home range of between 400ha to 1500ha and have high fidelity to a small number of hollow-bearing nest trees, some of which may occur on the Project Site. Some large stags were noted at the end of a track on the northern part of the Project Site, and other trees bearing large hollows are likely to exist on the Project Site. Call playback and spotlighting was carried out near the stags, however no owls were recorded. The Project may impact on the breeding potential of a pair if a nest tree in the Project Site would be removed, however, under the Project, clearing would only impact on up to 34.7ha of habitat and nesting is more likely to occur off-site.

The Powerful Owl has been recorded from 79 locations in the Gosford LGA and 860 locations in the Sydney Basin Bioregion. Powerful Owls have been recorded nearby in Popran National Park (Countrywide Ecological Service 2004) (Countrywide Ecological Services, 2004). The Powerful Owl inhabits a range of vegetation types, from woodland and open sclerophyll forest to tall open wet forest and rainforest.

The species hunts in open or closed sclerophyll forest or woodlands and occasionally hunts in open habitats, with the main prey being Ring-tailed Possums, gliders and small birds (DEC (NSW), 2005e). The Project Site probably makes up a small portion of the home range of an individual or breeding pair, which may use the Project Site for foraging and possibly also nesting. Vast areas of habitat exist within the LGA, including habitat protected within the adjacent Popran National Park, and habitat exists throughout Brisbane Water, Dharug and Yengo National Parks. These areas are likely to support a number of breeding pairs, and the removal of a relatively small area of potential habitat is unlikely to have a serious detrimental impact on this species in the locality.

#### 5.8.3.10 Large-footed Myotis

An echolocation call, possibly from the Large-footed Myotis, was recorded in the eastern part of the Project Site. However, the Large-footed Myotis is more likely to occur in habitats surrounding permanent water as they forage over open water, catching fish and insects. The eastern boundary of the Project Site is relatively high ground, and if the species was recorded there, was more likely to have been foraging over ephemeral puddles. Creek C is more likely to contain suitable habitat for the species with more permanent water holes being provided. Potential roosting habitat is provided in hollow-bearing trees on the Project Site but the species is usually recorded roosting in close proximity to aquatic foraging habitats{DEC (NSW) 2005 #2866}.

There have been 43 records of the Large-footed Myotis in the Gosford LGA and 969 records from the Sydney Basin Bioregion in the last 20 years{NSW Government 2009 #4158}. The species has not been recorded from Popran National Park.

The Large-footed Myotis roosts close to water in caves, mine shafts, hollow-bearing trees, stormwater channels, buildings and dense foliage. The species forages over water, raking its feet across the surface to catch insects and small fish{DEC (NSW) 2005 #2866}. Only small areas of potential habitat occur on the Project Site for this species, in the form of ephemeral pools. More permanent pools would provide more suitable habitat further downstream in Creek C. The species is also more likely to roost in the gully surrounding Creek C compared with the proposed extraction areas and therefore not likely to be significantly impacted by the Project.

#### 5.8.3.11 Grey-headed Flying-fox

The Grey-headed Flying-fox was recorded flying over land to the north of the Project Site. The Project Site provides suitable foraging habitat for the species but does not contain a roosting camp. The Grey-headed Flying-fox forages over large areas and the Project Site is likely to form part of a large foraging range for the species.

There are many records of the Grey-headed Flying-fox from the Gosford LGA, in urban and rural areas, and in conservation reserves such as Dharug, Popran and Brisbane Water National Parks{NSW Government 2009 #4158}.

The Grey-headed Flying-fox forages in subtropical and temperate rainforest, tall sclerophyll forest and woodland, heaths, swamps, urban gardens and orchards. It roosts in camps with high site fidelity. Camps are established in gullies with dense vegetation{DEC (NSW) 2005 #3469}. Grey-headed Flying-foxes foraging across the Project Site are likely to roost at a camp near Mangrove Mountain.

The Project is not likely to significantly impact on this species. The removal of 34.7ha of potential habitat is a small proportion of the home foraging range of this highly mobile species.

#### 5.8.3.12 Eastern Pygmy Possum

The Eastern Pygmy Possum was recorded along Creek A on the Project Site, near the southern edge of the Stage 4 extraction area. Heath and woodland are the preferred habitats of the species on the Central Coast but the individual observed during spotlighting surveys was in open forest. Large areas of potential heath and woodland habitat are available throughout the Project Site and Offset Areas, and it is likely that the Eastern Pygmy Possum also occurs in these habitats.

The Project is not likely to significantly impact on this species. The removal of 34.7ha of potential habitat is offset by the proposed conservation of similar habitat within and adjacent to the Project Site.

#### 5.8.3.13 Rosenberg's Goanna

This species has been found previously in the Project Site, and although not recorded during the current survey, is likely to utilise it for foraging and breeding. Risk to this species is considered moderate as extensive habitat areas of habitat exist in the locality. Foraging and possible nesting habitat would be retained on the Project Site. In the absence of sufficient data for the adjacent Popran National Park, it is possible that a significant impact may be felt on a local population of this species, however, the viability of the species is not at risk as a result of the Project.

The Rosenberg's Goanna has been recorded from 7 locations in the Gosford LGA and 82 locations in the Sydney Basin Bioregion. Recorded locations within the LGA are mainly along the Hawkesbury River, as well as one northeast of Gosford. This species relies on termite mounds for laying its eggs, and shelter in hollow logs, rock crevices and burrows (DEC (NSW), 2005b1). Home range for this species is approximately 20ha (King and Green 1999).

Rosenberg's Goanna is found in heath, open forest and woodland and relies on termite mounds for laying its eggs, and shelters in hollow logs, rock crevices and burrows (DEC (NSW), 2005b1). Rosenberg's Goanna relies on termite mounds for laying its eggs, and shelter in hollow logs, rock crevices and burrows (DEC (NSW), 2005b1). Home range for this species is variable, averaging approximately 20ha (King and Green, 1999). Foraging and nesting habitat would be retained on the Project Site. Similar habitat exists throughout the adjacent Popran National Park, and habitat would not be isolated as a result of the Project.

#### 5.8.3.14 Species at Moderate Risk

In general, species of moderate risk from the Project have not been recorded on the Project Site. Although potential habitat may occur on the Project Site, many of these species are more likely to occur in the tall forested gully of Creek C, which will be conserved, for example, *Grevillea shiresii,* Gang-gang Cockatoo and Yellow-bellied Glider. In the case of species that have potential to occur in the woodland and heath habitats, large areas of potential habitat will be retained in the Project Site East and Project Site West Offset Areas, as well as being conserved in the Glenworth Valley Offset Area and Popran National Park. These conservation areas will remain connected to each other, as well as other areas of native vegetation to the west of the study area. The Project is not Considered to have a significant impact on these species.

## 5.9 Cumulative Impacts

Cumulative impacts result when many small-scale alterations to the environment combine to cause an overall greater level of impact. Cumulative impacts can arise from either persistent losses of one resource, or the compounding effects of two or more impacts. Such cumulative impacts are prevalent in the Central Coast due to the recent rapid increase in population and industry. Key environmental challenges of the Central Coast region include:

- providing a sustainable long-term water supply;
- providing a balance between future development and important conservation values; and
- improving identification, protection and enhancement of natural environments including significant biodiversity corridors, regionally significant vegetation, coastal lakes and estuaries, and landscape values (DoP (NSW) 2006).

In terms of biodiversity, the clearing of vegetation from land in the locality as a result of different developments is likely to cause a cumulative impact on flora and fauna. Vegetation clearing in the locality has occurred as a result of urban expansion, agriculture, forestry, sand extraction and other industry. Further clearing is likely to occur in the locality in the future, resulting in cumulative impacts on flora and fauna as habitats are reduced and fragmented.

Cumulative impacts of vegetation clearing on the Project Site would include:

- reducing patch size;
- losses of specific habitat features;
- limiting migration and dispersal; and
- interrupting corridors.

The Project would contribute in some way to this cumulative loss of vegetation, however, most vegetation which is to be cleared from the Project Site is widespread throughout the Somersby Plateau and is not likely to add significantly to the cumulative reduction in native vegetation. **Table 5.7** lists the extent of the vegetation communities known in the region (Bell, 2004). In all cases (except E103 where the total extent is unknown) clearing on the Project Site is less than 1% of the known extent of the vegetation community in the region.

**Table 5.7**
**Extent of Vegetation Communities in the Region and Cumulative Impact of Clearing**

| Vegetation Communities | Extent in Region (ha) | Stage 4 Clearing (ha) | Impact (% of total) | Stage 5 Clearing (ha) | Impact (% of total) | Access Roads Clearing (ha) | Impact (% of total) | Total Clearing (ha) | Cumulative Impact (% of total) |
|---|---|---|---|---|---|---|---|---|---|
| **E2 - Sandstone Ranges Gully Rainforest** | 740 | 0.4 | 0.05 | 0 | 0 | 0 | 0.000 | 0.4 | 0.1 |
| **E25 - Hawkesbury Peppermint Apple Forest** | 13,061 | 0 | 0.00 | 0 | 0 | 0.1 | 0.001 | 0.1 | 0.0 |
| **E26 Group** | 17,284 | 8.4 | 0.05 | 4.1 | 0.02 | 0.7 | 0.004 | 13.2 | 0.08 |
| **E 29 Group** | 3,609 | 13.4 | 0.37 | 7.3 | 0.20 | 0.5 | 0.014 | 21.2 | 0.59 |
| **E54 - Sandstone Hanging Swamps** | 662 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **E103 - Gahnia-Banksia Swamp** | ? | 0.4 | ? | 0 | ? | 0 | ? | 0.4 | ? |

Other cumulative effects involve impacts to the aquatic environment. Polluted run-off from the extractive industry and farming, as well as sedimentation from clearing and management of the Project, have the potential to adversely affect creek health, aquatic communities and also terrestrial plants and animals.

## 5.10 Duration of Impacts

Impacts on threatened plant species within the Project Site are likely to be short to medium-term. The life of the Project as a whole is expected to be approximately 28 years, however, each extraction stage would be progressively rehabilitated and revegetated. All threatened plants that have been recorded from the Project Site can be included in the replanting of the affected areas. In the case of *Callistemon linearifolius,* this has the potential to greatly increase the abundance of this species in the locality in the long-term. More impact would be felt by *Darwinia glaucophylla* and *Hibbertia procumbens*, which are both likely to take longer to repopulate the area, and in lower abundance. Impacts on these populations are therefore likely to last many years. Retention of the seed bank would greatly assist with reducing impacts on these plants.

Impacts on threatened bird habitat within the Project Site would be medium- to long-term. Species of *Allocasuarina* would also be included in the revegetation of the Project Site, which would assist in providing foraging habitat for the Glossy Black-cockatoo population in the area, however, pre-clearance abundance of the trees is not likely to be regained. Clearing of vegetation would initially reduce the habitat for this species, both through loss of foraging habitat and also potential nesting sites. Impacts on this species are likely to last into the medium term (at least 10 years), until feed trees grow sufficiently. Loss of tree hollows from the Subject Area (potentially used by both Glossy Black-cockatoos and Powerful Owls) constitute a long-term impact (if these species are nesting in the Subject Area), as the age at which large hollows suitable for these species form in eucalypts is over 200 years (Gibbons and Lindenmayer, 2002). This impact may be ameliorated by the provision of nest boxes and by placing sections of hollow logs from cleared areas in areas of vegetation to be retained. Hollows would of course remain in the unaffected areas of the Project Site. Loss of foraging habitat for the Powerful Owl is also likely to be long-term, as possums would take many years to move back into the affected area.

Impacts on threatened frog habitat within the Project Site would be long-term. Both the Red-crowned Toadlet and the Giant Burrowing Frog would lose habitat, and reduction in water levels may also reduce available habitat for these species.

Impacts on Rosenberg's Goanna within the Project Site would be medium- to long-term as this species required termite mounds and habitat features such as hollow logs and rock crevices.

Impacts on groundwater and surface water within the Project Site would be long-term, and therefore follow-on impacts on vegetation communities which rely on these water sources would also be long-term. In particular, E54 - Sandstone Hanging Swamps which relies on water within Creek B would be impacted to some degree by the reduction in water available. Similar long-term effects may be felt downstream by other groundwater-dependent ecosystems, however as these source water from a much larger area than the Project Site, the impacts are unlikely to be significant.

### 5.11 Permanence and Reversibility of Impacts

Some of the impacts of the Project are likely to be permanent and irreversible. Reduction in water flow may cause some permanent changes to vegetation communities downstream within the Subject Area. Impacts may include small changes to the extent of the community and to the distribution and/or abundance of particular plant species within the communities. Impacts on fauna with small home ranges and low dispersal will be high. These include the Red-crowned Toadlet which occurs on the Project Site, and possibly the Great Burrowing Frog, which has habitat on the Project Site, but has not been recorded from it. The Project would remove areas of known and potential habitat respectively for these species, and the local populations would be likely to reduce in size for the long term. Loss of rock outcrops within the Project Site would be permanent and would reduce habitat for Red-crowned Toadlets and Rosenberg's Goannas. Changes to water flow and vegetation cover may also prevent recolonisation of the Subject Area by the threatened frogs. *Callistemon linearifolius* would also be likely to be permanently affected as one of the four locations containing a single plant would be removed and a stochastic event such as a fire could remove the remaining plants.

Many of the impacts are not permanent and, with staging of the Project and rehabilitation of the Subject Area, are reversible. In particular, as mentioned above, use of the seed bank and planting of threatened plants known from the Project Site would reduce impacts on these species. Salvaging and planting the threatened species in the rehabilitated areas will enable recovery of these species on the Project Site. Reduction in available habitat for threatened birds is reversible also by the replanting of the Subject Area, particularly with species of *Allocasuarina*, as well as with hollow-forming eucalypts. Use of nest boxes would provide nesting habitat, however these would need to be maintained over a very long period of time to replace lost hollows. Growth of plants which provide foraging habitat for possums would indirectly provide foraging habitat for Powerful Owls in the long-term. Rehabilitation of the Subject Area would eventually provide habitat for termites which would provide nesting habitat for Rosenberg's Goanna in the long-term, and eventual use of the Subject Area by small mammals and birds would provide foraging habitat for this species. New ephemeral watercourses would appear over time in the rehabilitated areas, which may provide additional habitat for the threatened frogs in the long-term. Groundwater and surface water would also flow downstream to vegetation communities.

## 6 MITIGATION MEASURES

### 6.1 Director-General's Requirements

The DGRs (Department of Planning) issued on the 15th of December 2006 for the Project details the following to mitigate and offset the Project:

> ***Flora and Fauna*** *– As part of the mitigation measures for the Project, a comprehensive offset strategy which detailed the measures proposed to ensure that there is no net loss of flora and fauna values in the area in the medium to long term must be included.*

***Rehabilitation, Final Landform and Final Void Management*** *– including a detailed description of how the Project Site would be progressively rehabilitated, revegetated, and integrated into the surrounding landscape; a justification of the proposed final landform and use in relation to any strategic land use objectives (including the draft Central Coast Regional Strategy and Popran National Park Plan of Management); and a detailed description of final void management, the measures that would be put in place to ensure sufficient measures are available to implement the proposed rehabilitation measures, and the ongoing management of the Project Site following the cessation of quarrying activities.*

## 6.2 Overview

A range of measures are proposed to mitigate potential impacts of the Project on flora and fauna in the area. Some of the proposed measures are more critical than others for reducing the impact on flora and fauna.

The NSW Government is committed to encouraging development that does not result in losses to biodiversity. It is widely recognised that conservation cannot occur only in government parks and reserves; some conservation of species and communities has to occur on private property. Incremental loss of biodiversity on private property is a significant issue and mitigation measures are required for developments that result in loss of native vegetation.

This section discusses measures to minimise impacts of the Project on threatened species and addresses **Steps 4 and 5** of the Draft Guidelines for Threatened Species Assessment (DEC (NSW), 2004b). These steps involve the following.

**Step 4. Avoid, mitigate and then offset**

- This step requires the description and justification of measures to mitigate any adverse effects. Consideration would be given to measures to avoid or minimise the impacts. The measures must be practical, must be implemented and there needs to be a reasonable level of confidence in their effectiveness. Acknowledged authorities with particular species or conservation practices should be consulted to determine if the measures proposed constitute appropriate management.
- Where measures to avoid and mitigate are not possible, then offset strategies need to be considered. These may include offsite or local area proposals that contribute to the long term conservation of the threatened species.
- Offset strategies are a last resort and should only be considered where the impacts cannot be avoided or mitigated.
- Considerable research indicates that relocation of flora or fauna is not successful in the medium or longer term.
- The extent to which measures avoid, mitigate or offset impacts upon threatened species must reflect the conservation value of the feature including its formal status as a critically endangered, endangered or vulnerable species, population or ecological community.

**Step 5. Key thresholds**

The development application needs to contain a justification of the preferred option based on whether:

- the Project, including actions to avoid or mitigate impacts or compensate to prevent unavoidable impacts, would maintain or improve biodiversity values;
- the Project is likely to reduce the long-term viability of a local population of the species, population or ecological community;
- the Project is likely to accelerate the extinction of the species, population or ecological community or place it at risk of extinction; and
- the Project would adversely affect critical habitat.

## 6.3 Measures to Avoid Impacts

The proposed Southern Extension of the Calga Sand Quarry would be completed in stages over an approximate 28 year period. Extraction would commence at the northern end the Project Site and proceed southwards. As each stage is completed, the area would be backfilled and rehabilitated with native vegetation. Contouring of the land would also take place, returning the quarry to as natural topography as possible.

The Project has been designed to limit impacts on threatened species and communities, particularly the threatened frogs. The proposed extraction area layout has been designed to protect Creek B and preserve frog habitat. Initially one large extraction area was proposed, however, this would have significantly impacted on frog habitat and the hydrology of the area. The Southern Extension now includes two extraction areas (Stage 4 and Stage 5), separated by Creek B.

The southwestern perimeter of the Stage 4 extraction area is setback at least 50m from Creek B and is also set back slightly where Creek B joins with Creek A to form Creek C .This setback is designed to avoid disturbance to an Aboriginal heritage site and to protect habitat for the Red-crowned Toadlet and potential habitat for the Great Burrowing Frog.

The northeastern perimeter of the Stage 4 extraction area has been “indented” slightly to avoid disturbing a group of 10 *Callistemon linearifolius* and population of *Darwinia glaucophylla*.

The northern perimeter of the Stage 5 extraction area has also been modified to avoid direct impact on the known habitat of the Red-crowned toadlet and potential habitat of the Giant Burrowing Frog.

The proposed access roads have been located so as to avoid clearance of as many threatened plants as possible.

Vegetated areas to be conserved on the Project Site include a number of locations where *Darwinia glaucophylla* and *Hibbertia procumbens* have been recorded, as well as habitat where these species are likely to occur. In addition, measures to conserve the potential habitat of the threatened frogs would also conserve potential habitat for *Darwinia glaucophylla* and *Hibbertia procumbens* on the Project Site. Potential habitat for *Callistemon linearifolius* would also be preserved in these areas.

## 6.4 Mitigation Measures

### 6.4.1 Introduction

Mitigation measures as part of the Project include the retention of native vegetation where possible; including areas of significant habitat for known threatened flora and fauna species on the Project Site. Vegetation retained on the Project Site will provide habitat for all threatened species recorded from the Study Area, as well as other species which may occur in the area. This includes:

- Tree hollows which provide nesting and roosting habitat for Powerful Owls, Glossy Black-cockatoos, threatened bats, and a range of other vertebrate fauna;
- Dead wood which provides den sites for Rosenberg's Goanna and other fauna;
- Flowering trees which provide foraging habitat for threatened woodland birds;
- Species of *Allocasuarina* which provide foraging habitat for Glossy Black-cockatoos;
- Rock outcrops and creeks which provide habitat for threatened frogs;
- General habitat for threatened plants including *Callistemon linearifolius, Darwinia glaucophylla* and *Hibbertia procumbens*, and
- Other general biodiversity values.

Other specific mitigation measures include pre-clearance surveys to be carried out prior to and during the clearing for each phase within each Stage, and rehabilitation and revegetation of the extraction areas. It is recommended that a Vegetation Management Plan, to facilitate the active management of native vegetation zones and important habitat features to be retained on the Project Site, be prepared and implemented by a suitably qualified person. These mitigation measures are covered in more detail in the following sections.

### 6.4.2 Pre-clearance Surveys

During the initial clearing phase for each extraction stage, native fauna rehabilitation and protection would be considered, with an aim to provide for the protection and humane removal of any native fauna disturbed by clearing.

Provisions would be made to protect such immobile native fauna by the following means.

- All personnel would be briefed about the possible fauna present at the time of clearing, and what procedures should been undertaken in the event of an animal being injured or disturbed.
- A qualified animal rescue person would be on-call at all times during clearing.
- Immediately prior to clearing, a brief pre-clearance survey would be made for animals that could be killed or injured by the felling of trees. The inspection would be made by a suitably qualified person.
- If any such animals are detected within trees, the trees would not be cleared until the animals have moved from the trees of their own volition.

- Animals disturbed or dislodged during the clearance but not injured would be assisted to move to vegetation close by that is identified for retention.
- If animals are inadvertently injured during the vegetation clearance the wildlife carer would be responsible for taking appropriate steps to humanely treat the animal.

### 6.4.3 Rehabilitation and Revegetation of the Quarry

#### 6.4.3.1 Final Landform and Use

The final landform of the Stage 4 extraction area would be an extension of the landform created for Stage 3 and would be free draining to west and southwest. The void created by the extraction along the western perimeter of Stage 4 would be raised through the progressive placement and capping of silt cells against the in-situ sandstone face. The final landform of Stage 4 would be vegetated with predominantly native groundcover species and final land use permitting, trees and other native species along the final internal drainage channel.

The final landform of the Stage 5 quarry would be water holding and drain to a water storage zone against the western face. The final landform would be approximately 15m to 20m below existing surface level. The final landform of Stage 5 would be vegetated with native tree and shrub species with a fire trail style access track retained to allow access to the water storage.

The Project Site would be progressively rehabilitated with Stage 4 incorporated into the final landform of the existing Calga Sand Quarry. It is proposed that Stage 5, should it proceed, be rehabilitated to provide long-term nature conservation and water storage. In time, this rehabilitation will provide significant habitat for native species, and will contribute towards the maintenance of biodiversity in the region.

#### 6.4.3.2 Vegetation Management Plan

This section of the report provides recommendations for the vegetation management strategy for the Project Site. A Vegetation Management Plan will be required prior to the commencement of disturbance to native vegetation on the Project Site.

Of particular importance in the rehabilitation of the quarry is the issue of no net loss of biodiversity values and preventing a reduction in the long-term viability of any of the species or communities. It is recommended that planting of *Callistemon linearifolius* occur throughout the rehabilitation area, which would enable an increase in abundance of this species within the Project Site in the long-term. Similarly, planting species of *Allocasuarina* would provide foraging habitat for the Glossy Black-cockatoo. The revegetation of the Project Site should be managed to encourage the growth of *Hibbertia procumbens* and *Darwinia glaucophylla*. The management of threatened species on the Project Site requires due regard to appropriate fire regimes as many species require specific periods between burns to sustain viable populations. It is also recommended to conduct additional surveys for these species following bushfire since it is possible that locations that are currently unsuitable for *Darwinia glaucophylla* and *Hibbertia procumbens* could become suitable following fire.

Vegetation covering areas required for the ensuing 6 to 12 months operations would be either chainsaw felled or cleared using the Project Site bulldozer. Collection of available seed for rehabilitation purposes would occur immediately after the vegetation is felled. The small tree limbs and tree trunks would be set aside for use in habitat improvement on site. Where hollows are present in trees to be removed, these would be salvaged and placed in the offset areas to provide habitat for hollow dwelling fauna. The larger trees not used for habitat construction/improvement as part of progressive rehabilitation, would be either cut into manageable log lengths or mulched/chipped for future internal or external use. Wherever possible, these materials would be managed on site as part of the progressive rehabilitation activities, however, they may be sold as firewood or landscaping materials externally.

Understorey vegetation such as grasses, low shrubs and forbs would be managed in combination with the Project Site soil resources.

The soil in each stage would be stripped following removal of the main vegetation. Small shrubs and groundcovers would be removed with the topsoil. In those areas where natural soils remain on the Project Site, Rocla would remove approximately 0.15m of topsoil and up to 0.5m of subsoil. Where practical, Rocla would remove topsoil and directly transfer it to rehabilitation and revegetation areas. This practice would avoid double handling and maximise natural regeneration. All excess topsoil and subsoil removed during operations would be stockpiled around the processing area within Stage 1 for subsequent use in progressive revegetation.

Any disturbance in or adjacent to native vegetation is likely to encourage weed growth. A weed management program should be instigated to prevent weed invasion and to maintain the biodiversity values of the retained vegetation.

Revegetation work should focus on the re-creation of an understorey and ground stratum for each recreated vegetation community, as well as the planting of typical canopy trees. Key performance objectives should be developed to provide a target for the minimum percentage cover to be achieved prior to mine closure. Plans should be developed for replanting of all known species of threatened plant species within the proposed rehabilitation and recreation areas.

### 6.4.4 Threatened Species and Habitat Management Plan

A Threatened Species and Habitat Management Plan should be prepared to manage the occurrence of species on the Project Site, and to ensure habitat remains in a viable condition throughout the life of the Project. This plan would be used to manage the proposed offset areas and to ensure that potential impacts on the adjoining Popran National Park are minimised. The plan would include management of access, weed and feral animal control, implementation of fire regimes, installation of nest boxes, and salvage of individual plants.

All workers on the Project Site should be properly inducted and made aware of the sensitive nature of frog habitat, threatened plants and potential roost and nest sites for bats and birds. Fencing should be erected between the Stage 4 and Stage 5 extraction areas to further discourage access by people or machinery. Similarly, access to the western portions of the Project Site should also be discouraged. This will also prevent erosion and disturbance to vegetation communities which are retained on the Project Site.

Although the vegetation of the Project Site is generally in good condition, weed control should be undertaken in potentially problem areas such as disturbed clearings in the east of the Project Site, the powerline easement and along creeks. Weed monitoring and management should be implemented focussing on fragmented habitat edges such as along the access roads and along the vegetated buffer to Popran National Park.

Measures should be taken to improve habitat for native fauna and discourage feral animals such as rehabilitation of cleared grassy areas and the correct storage of rubbish. Feral animal control may be implemented if considered necessary.

The majority of the native vegetation communities to be retained within the offset area are adapted to occasional burning but many species are sensitive to frequent burning as they may take longer than the fire interval to mature. The Threatened Species and Habitat Management Plan should provide appropriate fire regimes to maintain a high species diversity.

Nest boxes can be utilised to compensate for the loss of trees with hollows from the Project Site. Nest boxes can be of various sizes and contain various sized openings. Such design features provide habitat for a various range of threatened and non-threatened fauna. However, selection of nest boxes will be aimed at providing compensatory habitat for the following threatened fauna known or considered likely to occur within the Project Site and / or Study Area.

- Powerful Owl and Glossy Black-cockatoo; and
- Microchiropteran Bats including Eastern False Pipistrelle (*Falsistrellus tasmaniensis*), Eastern Freetail-bat (*Mormopterus norfolkensis*), and Yellow-bellied Sheath-tail Bat (*Saccolaimus flaviventris*).

The DECC does not consider that translocation of threatened species, populations and ecological communities is an appropriate ameliorative strategy for the purposes of considering impacts of a particular development/activity. The DECC strongly supports the view that development proposals which may impact on a significant local population of threatened species, populations or ecological communities should aim to:

- minimise the impacts by considering all possible alternatives to the development, such that a significant impact is not likely; and
- manage the remaining habitat (if any) to ensure that the local population continues to exist in the long term.

Translocation is not proposed as a mitigation measure, however if salvage of any of the *Callistemon linearifolius* is possible, this will be worthwhile in protecting the local population of this species.

Other habitat management strategies, such as weed and feral animal control, and protection of specific habitat features (e.g. termite nests), should also be included in this plan.

## 6.5 Offset Strategies

### 6.5.1 Introduction

Biodiversity offsets represent a method by which an impact on biodiversity is compensated for or "offset" by the conservation of similar biodiversity values elsewhere. Where a development will cause losses to biodiversity, offset schemes are often implemented within the region to mitigate these losses. There are currently no direct guidelines or criteria for designing and/or implementing a biodiversity offset strategy outside of the new biobanking scheme and therefore the style of offset may vary from direct conservation of native vegetation/habitat to contributions to ongoing conservation programs or research. However, according to the Department of Environment and Climate Change (DECC) document "*Principles for the use of Biodiversity Offsets in NSW*" (DECC, 2007), offsets must be:

- *used to address impacts remaining after mitigation or prevention measures have been undertaken;*
- *complementary to other government programs such as national parks and reserves;*
- *underpinned by sound ecological principles;*
- *aimed to result in a net improvement in biodiversity over time;*
- *enduring – they must offset the impact of the development for the period that the impact occurs;*
- *agreed upon prior to the impact occurring;*
- *quantifiable – the impacts and benefits must be reliably estimated;*
- *targeted – they must offset the impacts on a "like for like or better" basis;*
- *located appropriately – they must offset the impact in the same region;*
- *supplementary – beyond existing requirements and not already funded by another scheme;*
- *enforceable – through development consent conditions, licence conditions, covenants or a contract;*
- *meet all regulatory requirements; and*
- *never reward ongoing poor performance*.

### 6.5.2 Proposed Calga Biodiversity Offsets Strategy

**Figure 6.1** presents the proposed offset strategy developed for Calga, which primarily involves the conservation of native vegetation unaffected by the Project, on the Project Site itself in three blocks (north, south and east) as well as an area on the neighbouring "Glenworth Valley" property. In total, 76.4 ha of native vegetation (and 83.8ha in total) are proposed to be conserved to offset the clearing of approximately 34.7ha of vegetation as part of the Project.

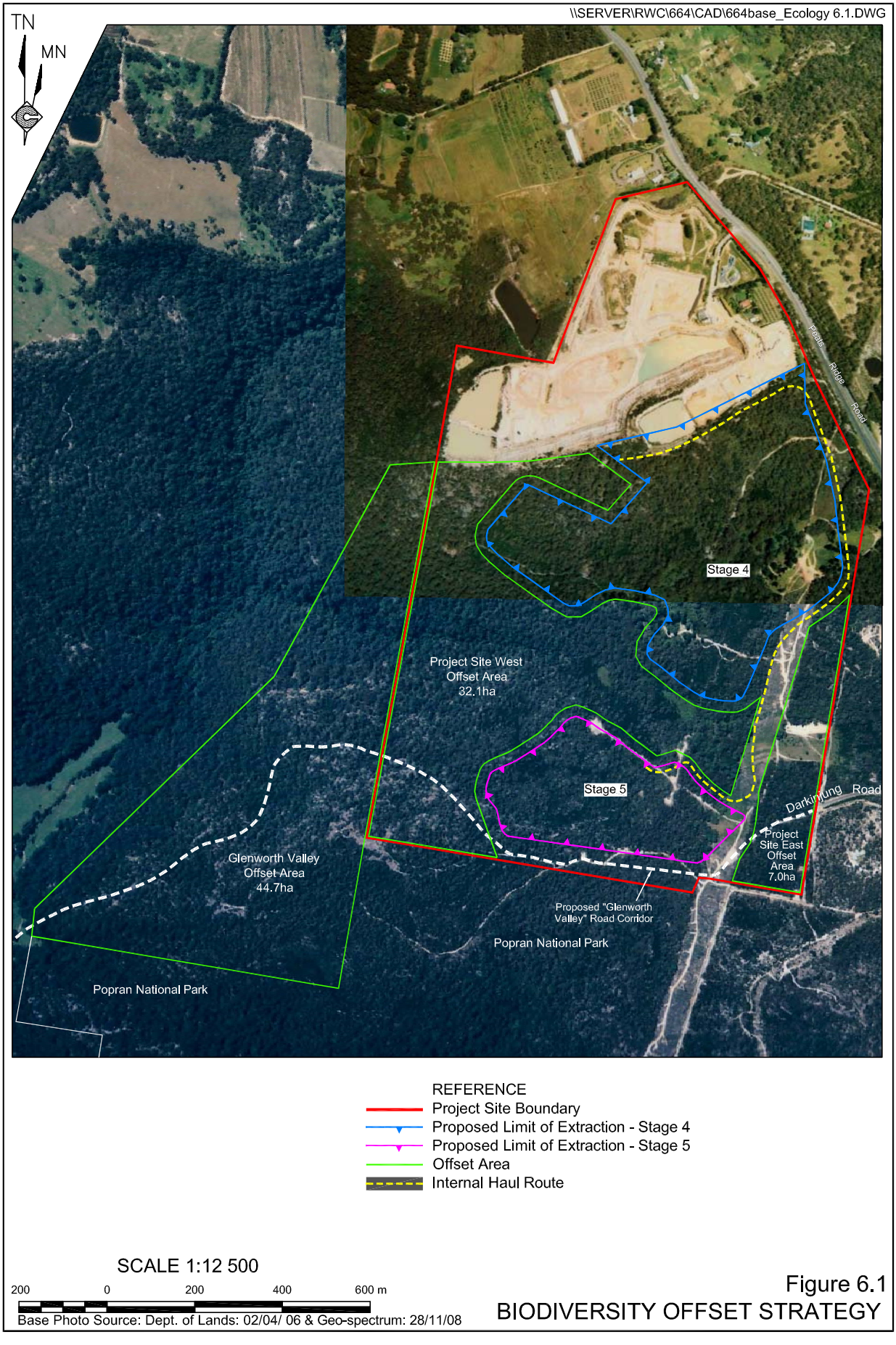



Figure 6.1
BIODIVERSITY OFFSET STRATEGY

This equates to a total offset ratio of approximately 2ha of offset for every 1ha of native vegetation to be cleared. Approximately half the offset required (39.1ha) is present on the Project Site itself and the remaining land required for the offset is on "Glenworth Valley," which provides 44.7ha. The areas of vegetation to be conserved would be protected in perpetuity from future disturbance through the implementation of an enduring covenant or restriction on the use of the land under Section 88B of the *Conveyancing Act 1919,* Part 4, Division 12 of the *National Parks and Wildlife Act 1974* or similar arrangement. The conservation arrangement would continue beyond the life of the Project and would remain valid until such time as either:

- the covenant or restriction is legally removed from the land title;
- the offset is replaced by another more suitable conservation agreement, eg. Biobanking; and/or
- the NSW government agency responsible for administering/managing the offset provides written advice indicating the cessation of the offset arrangement.

To compensate the owners of “Glenworth Valley” for this long-term conservation of land on their property, Rocla will provide the owners of “Glenworth Valley” with unrestricted access within a corridor near the southern side of Lot 2, DP805358, which is owned by Rocla.

**Table 6.1** provides a comparison of the vegetation to be disturbed and conserved.

**Table 6.1**
**Vegetation Clearance and Offsets**

| Vegetation Community | Vegetation Disturbance | | | | Biodiversity Offset | | | |
|---|---|---|---|---|---|---|---|---|
| | Stage 4 | Stage 5 | Access Roads | Total Area | On-site | | Off-site | Total Area |
| | | | | | West | East | Glenworth Valley | |
| E103 Gahnia-Banksia Swamp | 0.4 | 0 | 0.0 | **0.4** | 0.0 | 0.0 | 0.0 | **0.0** |
| E2 Sandstone Ranges Gully Rainforest | 0 | 0 | 0.0 | **0.0** | 0.5 | 0.0 | 0.8 | **1.3** |
| E20 Dharug Footslopes Apple Redgum Forest | 0 | 0 | 0.0 | **0.0** | 0.0 | 0.0 | 3.3 | **3.3** |
| E25 Hawkesbury Peppermint Apple Forest | 0 | 0 | 0.0 | **0.0** | 11.3 | 0.0 | 19.2 | **30.5** |
| E26 Exposed Hawkesbury Woodland | 8.4 | 4.1 | 0.7 | **13.2** | 10.4 | 1.0 | 19.1 | **30.5** |
| E26a Hawkesbury Rock Pavement Heath | 0 | 0 | 0.0 | **0.0** | 1.0 | 0.0 | 0.8 | **1.8** |
| E29 Hawkesbury Banksia Scrub-Woodland | 8 | 3.1 | 0.4 | **11.5** | 0.4 | 4.0 | 0.0 | **4.4** |
| E29a Hawkesbury Banksia Scrub-Woodland (Scrub) | 4.4 | 4.2 | 0.0 | **8.6** | 2.5 | 0.0 | 0.0 | **2.5** |
| E29b Hawkesbury Banksia Wet Scrub | 1 | 0 | 0.1 | **1.1** | 0.0 | 0.0 | 0.1 | **0.1** |
| E54 Sandstone Hanging Swamp | 0 | 0 | 0.0 | **0.0** | 0.6 | 0.0 | 1.4 | **2.0** |
| Xr Disturbed- Canopy Only | 0.3 | 0 | 0.1 | **0.4** | 0.0 | 0.0 | 0.0 | **0.0** |
| Xs Disturbed - Regrowth | 2.1 | 0.1 | 0.6 | **2.8** | 0.1 | 0.0 | 0.0 | **0.1** |
| Unmapped (exotics) | 7.5 | 0.2 | 0.0 | **7.7** | 5.3 | 2.0 | 0.0 | **7.3** |
| **Total (ha)** | 24.6 | 11.5 | 1.9 | **45.7** | 32.1 | 7.0 | 44.7 | **83.8** |
| **Total (native only)** | 22.2 | 11.4 | 1.1 | **34.7** | 26.7 | 5.0 | 44.7 | **76.4** |

Conserving the areas shown on **Figure 6.1** will ensure a total offset ratio of approximately 2ha of offset for every 1ha of native vegetation to be cleared, as well as satisfying the requirements

listed in 6.5.1 above. Management of retained vegetation within the Project Site will be required throughout the life of the Project and prior to it being gazetted for conservation.

## 6.6 Assessment of Adequacy of Offsets

The following considers the adequacy of the proposed Biodiversity Offset Strategy against the principles for development of biodiversity offsets identified by DECC (2007).

**Offsets must be used to address impacts remaining after mitigation or prevention measures have been undertaken.**

> *Offsets are then used to address remaining impacts. This may include modifying the proposal to avoid an area of biodiversity value or putting in place measures to prevent offsite impacts.*

The design of the proposed extraction areas has been modified substantially from that originally considered to ensure that areas of particular conservation significance, including local tributaries to Cabbage Tree Creek, identified and potential habitat of threatened frog species (Red-crowned Toadlet habitat and Giant Burrowing Frog habitat), and known populations of threatened flora species (*Callistemon linearifolius*, *Darwinia glaucophylla* and *Hibertia procumbens*) were avoided.

Rocla will also provide for the preparation and implementation of a Vegetation Management Plan and Threatened Species and Habitat Management Plan to minimise and mitigate impact on native vegetation and threatened species, both on the Project Site and offsite.

**Offsets must be complementary to other government programs such as national parks and reserves.**

> *A range of tools is required to achieve the NSW Government's conservation objectives, including the establishment and management of new national parks, nature reserves, state conservation areas and regional parks and incentives for private landholders.*

The areas of conserved vegetation proposed as an offset are not currently part of any Government program and do not fall within any existing National Park or Reserve. These areas do share a boundary with Popran National Park, which is managed under the Popran National Park plan of management (POM), a legal document required under the *National Parks and Wildlife Act 1974* that outlines how the park will be managed. While primarily focused on the management of lands within the Popran National Park, the Popran National Park POM also provides policies for the management of adjacent lands, as these might impact on the national park. The proposed offset areas of conserved native vegetation would be managed to comply with these policies.

**Offsets must be underpinned by sound ecological principles.**

> *They must:*
>
> - *include the consideration of structure, function and compositional elements of biodiversity, including threatened species;*
> - *enhance biodiversity at a range of scales;*
> - *consider the conservation status of ecological communities; and*
> - *ensure the long-term viability and functionality of biodiversity.*

> *Biodiversity management actions, such as enhancement of existing habitat and securing and managing land of conservation value for biodiversity, can be suitable offsets. Reconstruction of ecological communities involves high risks and uncertainties for biodiversity outcomes and is generally less preferable than other management strategies, such as enhancing existing habitat.*

The proposed Calga Biodiversity Offset Strategy is consistent with this point as it will conserve similar structural and compositional elements of biodiversity to that which will be removed. As illustrated in **Table 6.1**, with limited exception, each vegetation type (and corresponding habitat components) to be disturbed is represented in the proposed offset area. Accordingly, these areas will provide habitat for the same range of species currently utilising habitat within the areas to be disturbed, including threatened species. The majority of the vegetation within the offset area is directly linked to large areas of native vegetation already conserved, thereby reducing the potential detrimental impacts of fragmentation and edge effects on the conserved areas. This also has the benefit of enhancing biodiversity at a range of scales. The establishment of the offset areas would reduce the distance between conserved vegetation within Popran National Park to the southeast and Brisbane Waters National Park to the northwest, thereby improving the connectivity between these two major conservation areas and improving the ability of native species to disperse between these two large remnants.

For the above reasons, it is considered that the benefits to be obtained from the conservation of the areas of offset native vegetation will contribute significantly to ensuring the long term viability and functionality of biodiversity in the locality, As pointed out by DECC, the efficacy of reconstructing ecological communities is uncertain, and therefore the Calga biodiversity offset strategy primarily involves securing and managing land for biodiversity, and does not focus on reconstruction of ecological communities.

**Offsets must be aimed to result in a net improvement in biodiversity over time**

> *Enhancement of biodiversity in offset areas should be equal to or greater than the loss in biodiversity from the impact site.*
>
> *Setting aside areas for biodiversity conservation without additional management or increased security is generally not sufficient to offset against the loss of biodiversity. Factors to consider include protection of existing biodiversity (removal of threats), time-lag effects, and the uncertainties and risks associated with actions such as revegetation.*
>
> *Offsets may include enhancing habitat, reconstructing habitat in strategic areas to link areas of conservation value, or increasing buffer zones around areas of conservation value and removal of threats by conservation agreements or reservation.*

By conserving the areas identified as offsets, a total offset ratio of approximately 2ha of conservation for every one hectare of native vegetation to be cleared would be created, ie. the area conserved would be twice the area of that disturbed. In addition, Rocla would progressively rehabilitate some of the mined areas with native vegetation. Although this is not part of the offset strategy it will still provide significant benefits to biodiversity in the region and over time is likely to provide significant habitat for native species.

As mentioned above Rocla will develop a Vegetation Management Plan and a Threatened Species and Habitat Management Plan to be implemented prior to development occurring. These plans will outline the management actions to be taken to enhance these areas of vegetation, including weed control activities, feral animal control activities and enhancement of habitat by placing nest boxes or hollow logs into the offset areas. These actions will ensure that the biodiversity values of the offset areas are maintained over time.

In addition, due to its location adjacent to Popran National Park, the offset area would also provide a buffer to the established conservation area. As weeds and feral pests will be controlled within the offset area, the risk of these infiltrating the National Park would be reduced. Secondly, the offset area would assist in linking the conserved vegetation of Popran and Brisbane Waters National Parks, thereby improving the connectivity between these two major conservation areas.

Rocla will undertake progressive rehabilitation of native vegetation over the Project Site after the resource is mined. Although it may not be possible to completely recreate the community that has been lost, the rehabilitation will provide important resources for native flora and fauna and over time will develop into important and valuable habitat. There is potential for threatened flora species to be deliberately planted into the rehabilitated areas with the goal of producing viable and secure populations in the long term.

**Offsets must be enduring – they must offset the impact of the development for the period that the impact occurs.**

> *As impacts on biodiversity are likely to be permanent, the offset should also be permanent and secured by a conservation agreement or reservation and management for biodiversity. Where land is donated to a public authority or a private conservation organisation and managed as a biodiversity offset, it should be accompanied by resources for its management. Offsetting should only proceed if an appropriate legal mechanism or instrument is used to secure the required actions.*

By conserving existing native vegetation in good condition, the proposed Calga Biodiversity Offset Strategy will provide the immediate offsetting of disturbance, which would be maintained for the life of the Project and beyond.

The Proponent would secure Calga Biodiversity Offset Area through an enduring covenant or restriction on the use of the land under Section 88B of the *Conveyancing Act 1919,* Part 4, Division 12 of the *National Parks and Wildlife Act 1974* or similar arrangement, to the satisfaction of DECC. The purpose of such an arrangement would be to restrict the use of the offset area for the purposes of native vegetation conservation in perpetuity. The proposed biodiversity offset area would be accompanied by resources for its management and would be managed in accordance with a Vegetation Management Plan prepared for this area prior to commencement of development. The proposed offset measures would result in the offsets continuing longer than the period of impact associated with the Project.

**Offsets must be agreed prior to the impact occurring.**

> *Offsets should minimise ecological risks from time-lags. The feasibility and in-principle agreements to the necessary offset actions should be demonstrated prior to the approval of the impact. Legal commitments to the offset actions should be entered into prior to the commencement of works under approval.*

The offset measures, and a timeframe for putting the appropriate legal arrangements and management strategies in place, would be agreed with the relevant government agencies prior to Project-related disturbance occurring.

**Offsets must be quantifiable – the impacts and benefits must be reliably estimated.**

> *Offsets should be based on quantitative assessment of the loss in biodiversity from the clearing or other development and the gain in biodiversity from the offset. The methodology must be based on the best available science, be reliable and used for*

*calculating both the loss from the development and the gain from the offset. The methodology should include:*

- *the area of impact;*
- *the types of ecological communities and habitat/species affected;*
- *connectivity with other areas of habitat/corridors;*
- *the condition of habitat;*
- *the conservation status and/or scarcity/rarity of ecological communities;*
- *management actions; and*
- *level of security afforded to the offset site.*

*The best available information/data should be used when assessing impacts of biodiversity loss and gains from offsets. Offsets will be of greater value where:*

- *they protect land with high conservation significance;*
- *management actions have greater benefits for biodiversity;*
- *the offset areas are not isolated or fragmented; and*
- *the management for biodiversity is in perpetuity (e.g. secured through a conservation agreement).*

*Management actions must be deliverable and enforceable.*

The offsets proposed for the Project have been calculated based on the quantified area of land that is proposed to be disturbed. The relative areas of disturbance and proposed conservation are provided in **Table 6.1**. It is considered that the offsets meet the criteria for this point as this report has provided a reliable and quantifiable assessment of the biodiversity of the Project Site that may be affected by the Project including the types of ecological communities, habitats and species affected, the condition of the habitat, connectivity with other areas of habitat, and the conservation status of the ecological communities present.

Also included in this report are quantified data on the proposed offset sites, the ecological communities present on the sites and the level of security proposed to be afforded them. As discussed previously and also quantified in **Table 6.1**, the communities that will be disturbed by the Project are nearly all represented in the areas set aside for an offset. By providing an offset ratio of 2:1, the proposed Calga Biodiversity Offset Strategy addresses these impacts by providing for the long-term conservation of similar vegetation and habitat to that disturbed. This will ensure habitat for the identified threatened species is maintained locally, increasing the viability of local populations of these species as well as regionally significant communities. The lands proposed as offsets contain vegetation communities of high conservation significance that are linked to Popran National Park, and will therefore have wider benefits for conservation in the locality. They will be managed in perpetuity via a binding agreement on the title of the land and the management actions are deliverable and enforceable.

**Offsets must be targeted – they must offset the impacts on a "like for like or better" basis.**

*They must offset impacts on the basis of like-for-like or better conservation outcome. Offsets should be targeted according to biodiversity priorities in the area, based on the conservation status of the ecological community, the presence of threatened species or their habitat, connectivity and the potential to enhance condition by management actions and the removal of threats. Only ecological communities that are equal or*

> *greater in conservation status to the type of ecological community lost can be used for offsets. One type of environmental benefit cannot be traded for another: for example, biodiversity offsets may also result in improvements in water quality or salinity but these benefits do not reduce the biodiversity offset requirements.*

The Calga biodiversity offset strategy provides for a better than "like for like" conservation outcome as a total offset ratio of approximately 2ha of offset for every one hectare of native vegetation to be cleared would be established. In particular, an equivalent area or better of each individual vegetation community to be disturbed will be preserved (with limited exception). As they are the same ecological community, they provide very closely that which is being lost in terms of habitat for flora and fauna. Additionally these areas will be managed according to a Vegetation Management Plan and a Threatened Species and Habitat Management Plan to further enhance their value by removing the threats of weeds and feral animals. The lands proposed as offsets contain vegetation communities of high conservation significance that are linked to Popran National Park, and will therefore have wider benefits for conservation in the locality.

The proposed offset areas contain the majority of communities that will be cleared for the extraction areas and access roads with only E103 Gahnia – Banksia Swamp not represented. The offset areas also contain some vegetation communities that are not represented in the extraction areas, namely, E25 Hawkesbury Peppermint Apple Forest, E20 Dharug Footslopes Apple Redgum Forest and E2 Sandstone Ranges Gully Rainforest.

Habitats for all threatened species known or having the potential to occur in the proposed extraction areas are represented in the proposed offset areas. Further investigation will be carried out to determine the extent to which threaten flora species occur in the offsets and whether threatened fauna species use these areas. **Table 6.2** demonstrates how habitat for all threatened species occurring or with the potential to occur within the Project Site is represented within offsets.

**Table 6.2**
**Comparison of Offset Ecological Values**

Page 1 of 4

| Threatened Species | Occurrence in Proposed Extraction Area | Occurrence in Project Site Offset | Occurrence in Glenworth Valley Offset Area | Occurrence in Popran NP |
|---|---|---|---|---|
| *Hibbertia procumbens* | Present - at least 92 plants in extraction areas and along access road routes | Present - at least 94 plants. Further surveys to be conducted. | Potential habitat present | At least 19 plants recorded at northern edge adjacent Project Site |
| *Tetratheca glandulosa* | Potential habitat present, species not recorded | Potential habitat present, species not recorded. Further surveys to be conducted. | Potential habitat present, species not recorded. Further surveys to be conducted. | Has been recorded here |
| *Acacia bynoeana* | Potential habitat present, species not recorded | Potential habitat present, species not recorded. Further surveys to be conducted. | Potential habitat present, species not recorded. Further surveys to be conducted. | Potential habitat present, species not recorded |
| *Prostanthera junonis* | Potential habitat present, species not recorded | Potential habitat present, species not recorded. Further surveys to be conducted. | Potential habitat present, species not recorded. Further surveys to be conducted. | Potential habitat present, species not recorded |
| *Callistemon linearifolius* | Present - one plant recorded in Stage 5 extraction area | Present - 24 plants recorded, Project designed to avoid clearance. Further surveys to be conducted. | Potential habitat present, species not recorded. Further surveys to be conducted. | Potential habitat present, species not recorded in adjacent section of park but does occur in northern section |

## Table 6.2 (Cont'd)
## Comparison of Offset Ecological Values



| Threatened Species | Occurrence in Proposed Extraction Area | Occurrence in Project Site Offset | Occurrence in Glenworth Valley Offset Area | Occurrence in Popran NP |
|---|---|---|---|---|
| *Darwinia glaucophylla* | Present - over 200 plants recorded in extraction areas and along access road routes | Present - at least 67 plants recorded. Further surveys to be conducted. | Present - at least 23 plants recorded. Further surveys to be conducted. | Present - at least 19 plants recorded. |
| *Eucalyptus camfieldii* | Potential habitat present, species not recorded | Potential habitat present, species not recorded. Further surveys to be conducted. | Potential habitat present, species not recorded. Further surveys to be conducted. | Potential habitat present, species not recorded in adjacent section of park but does occur in northern section |
| *Kunzea rupestris* | Potential habitat present, species not recorded | Potential habitat present, species not recorded. Further surveys to be conducted. | Potential habitat present, species not recorded. Further surveys to be conducted. | Potential habitat present, species not recorded |
| *Melaleuca deanei* | Potential habitat present, species not recorded | Potential habitat present, species not recorded. Further surveys to be conducted. | Potential habitat present, species not recorded. Further surveys to be conducted. | Potential habitat present, species not recorded |
| *Micromyrtus blakelyi* | Potential habitat present, species not recorded | Potential habitat present, species not recorded. Further surveys to be conducted. | Potential habitat present, species not recorded. Further surveys to be conducted. | Potential habitat present, species not recorded |
| *Diuris bracteata* | Potential habitat present, species not recorded | Potential habitat present, species not recorded. Further surveys to be conducted. | Potential habitat present, species not recorded. Further surveys to be conducted. | Potential habitat present, species not recorded |
| *Ancistrachne maidenii* | Potential habitat present, species not recorded | Potential habitat present, species not recorded. Further surveys to be conducted. | Potential habitat present, species not recorded. Further surveys to be conducted. | Potential habitat present, species not recorded |
| *Grevillea shiressii* | No potential habitat present | Potential habitat present, species not recorded. Further surveys to be conducted. | Potential habitat present, species not recorded. Further surveys to be conducted. | No potential habitat present in section adjacent to Project Site |
| *Persoonia hirsuta* | Potential habitat present, species not recorded | Potential habitat present, species not recorded. Further surveys to be conducted. | Potential habitat present, species not recorded. Further surveys to be conducted. | Potential habitat present, species not recorded |
| *Lasiopetalum joyceae* | Potential habitat present, species not recorded | Potential habitat present, species not recorded. Further surveys to be conducted. | Potential habitat present, species not recorded. Further surveys to be conducted. | Potential habitat present, species not recorded |
| Gang-gang Cockatoo | Potential habitat present, species not recorded | | | Potential habitat present, species not recorded in adjacent section of park but does occur in northern section |
| Glossy Black Cockatoo | Recorded within Stage 5 extraction area | Recorded near junction of Creek A and C. Potential habitat present. Further surveys to be conducted. | Potential habitat present, species not recorded. Further surveys to be conducted. | Has been recorded here |
| Powerful Owl | Potential foraging habitat present, species not recorded | Potential habitat present, species not recorded. Further surveys to be conducted. | Potential habitat present, species not recorded. Further surveys to be conducted. | Potential habitat present, species not recorded in adjacent section of park but does occur in northern and southern sections |
| Masked Owl | Potential habitat present, species not recorded | Potential habitat present, species not recorded. Further surveys to be conducted. | Potential habitat present, species not recorded. Further surveys to be conducted. | Potential habitat present, species not recorded |

## Table 6.2 (Cont'd)
## Comparison of Offset Ecological Values



| Threatened Species | Occurrence in Proposed Extraction Area | Occurrence in Project Site Offset | Occurrence in Glenworth Valley Offset Area | Occurrence in Popran NP |
|---|---|---|---|---|
| Sooty Owl | Potential foraging habitat present, species not recorded | Potential habitat present, species not recorded. Further surveys to be conducted. | Potential habitat present, species not recorded. Further surveys to be conducted. | Potential habitat present, species not recorded in adjacent section of park but does occur in northern section |
| Yellow-bellied Sheathtail Bat | Potential habitat present, species not recorded | Species recorded to the north of existing quarry. Potential habitat present. Further surveys to be conducted. | Potential habitat present, species not recorded. Further surveys to be conducted. | Potential habitat present, species not recorded |
| Eastern Freetail Bat | Potential habitat present, species not recorded | Potential habitat present, species not recorded. Further surveys to be conducted. | Potential habitat present, species not recorded. Further surveys to be conducted. | Potential habitat present, species not recorded |
| Large-eared Pied Bat | Potential habitat present, species not recorded | Potential habitat present, species not recorded. Further surveys to be conducted. | Potential habitat present, species not recorded. Further surveys to be conducted. | Potential habitat present, species not recorded |
| Little Bentwing Bat | Potential habitat present, species not recorded | Potential habitat present, species not recorded. Further surveys to be conducted. | Potential habitat present, species not recorded. Further surveys to be conducted. | Potential habitat present, species not recorded |
| Eastern Bentwing Bat | Potential foraging habitat present, species not recorded | Potential habitat present, species not recorded. Further surveys to be conducted. | Potential habitat present, species not recorded. Further surveys to be conducted. | Potential habitat present, species not recorded in adjacent section of park but does occur in northern section |
| Greater Broad-nosed Bat | Potential habitat present, species not recorded | Potential habitat present, species not recorded. Further surveys to be conducted. | Potential habitat present, species not recorded. Further surveys to be conducted. | Potential habitat present, species not recorded |
| Grey-headed Flying-fox | Potential habitat present, species not recorded | Species recorded to the north of existing quarry. Potential habitat present. Further surveys to be conducted. | Potential habitat present, species not recorded. Further surveys to be conducted. | Potential habitat present, species not recorded in adjacent section of park but does occur in southern section |
| Eastern Pygmy Possum | Potential habitat present, species not recorded | Recorded near junction of Creek A and C. Potential habitat present. Further surveys to be conducted. | Potential habitat present, species not recorded. Further surveys to be conducted. | Potential habitat present, species not recorded |
| Spotted-tailed Quoll | Potential habitat present, species not recorded | Potential habitat present, species not recorded. Further surveys to be conducted. | Potential habitat present, species not recorded. Further surveys to be conducted. | Has been recorded here |
| Yellow-bellied Glider | Potential habitat present, species not recorded | Potential habitat present, species not recorded. Further surveys to be conducted. | Potential habitat present, species not recorded. Further surveys to be conducted. | Potential habitat present, species not recorded |
| Squirrel Glider | Potential habitat present, species not recorded | Potential habitat present, species not recorded. Further surveys to be conducted. | Potential habitat present, species not recorded. Further surveys to be conducted. | Potential habitat present, species not recorded in adjacent section of park but does occur in northern section |
| Long-nosed Potoroo | Potential habitat present, species not recorded | Potential habitat present, species not recorded. Further surveys to be conducted. | Potential habitat present, species not recorded. Further surveys to be conducted. | Potential habitat present, species not recorded |

**Table 6.2 (Cont'd)**
**Comparison of Offset Ecological Values**



| Threatened Species | Occurrence in Proposed Extraction Area | Occurrence in Project Site Offset | Occurrence in Glenworth Valley Offset Area | Occurrence in Popran NP |
|---|---|---|---|---|
| Red-crowned Toadlet | Potential habitat present, species not recorded | Recorded along side of Creek A. Further surveys to be conducted. | Potential habitat present, species not recorded. Further surveys to be conducted. | Has been recorded here |
| Giant Burrowing Frog | Potential habitat present, species not recorded | Potential habitat present, species not recorded. Further surveys to be conducted. | Potential habitat present, species not recorded. Further surveys to be conducted. | Has been recorded here |
| Rosenberg's Goanna | Potential habitat present, species not recorded | Potential habitat present, species not recorded. Further surveys to be conducted. | Potential habitat present, species not recorded. Further surveys to be conducted. | Potential habitat present, species not recorded |

**Offsets must be located appropriately – they must offset the impact in the same region.**

> *Wherever possible, offsets should be located in areas that have the same or similar ecological characteristics as the area affected by the development.*

The offset is located adjacent to both the area of disturbance and Popran National Park and includes the same vegetation community types.

**Offsets must be supplementary – beyond existing requirements and not already funded by another scheme.**

> *They must be beyond existing requirements and not already funded under another scheme. Areas that have received incentive funds cannot be used for offsets. Existing protected areas on private land cannot be used for offsets unless additional security or management actions are implemented. Areas already managed by the government, such as national parks, flora reserves and public open space cannot be used as offsets.*

The proposed offset measures have not been provided for by any other scheme. No funding has been received and the lands are not currently under protection. The lands are not currently being managed by the government.

The proposed offset measures would supplement native vegetation conservation managed by DECC (NPWS) within Popran National Park.

**Offsets must be enforceable – through development consent conditions, licence conditions, covenants or a contract.**

> *Offsets must be audited to ensure that the actions have been carried out, and monitored to determine that the actions are leading to positive biodiversity outcomes.*

Rocla has committed to the proposed Calga Biodiversity Offset Strategy and envisages this would be included as a condition of any Project approval granted. In addition, it is anticipated that the conditions to any Project approval would include a requirement for Rocla to undertake an independent compliance audit of the Project against the conditions of the Project approval.

**The offset must meet all regulatory requirements.**

> *Offsets cannot be used to satisfy approvals or assessments under other legislation, e.g. assessment requirements for Aboriginal heritage sites, pollution or other environmental impacts (unless specifically provided for by legislation or additional approvals).*

Rocla would meet all regulatory requirements related to the construction, operation and rehabilitation of the Project. The offset would not be used to satisfy any other approval or assessment under any other legislation.

**The offset must never reward ongoing poor performance.**

> *Offset schemes should not encourage landholders to deliberately degrade or mismanage offset areas in order to increase the value from the offset.*

Rocla has not deliberately degraded or mismanaged any land under its control.

## 6.7 Key Thresholds

The Project has been designed to limit the impact on biodiversity values. Proposed placement of the Stage 4 and 5 extraction areas has been determined in such a way as to limit the impact of the extraction areas on threatened frog and flora species, and to allow water flow along Creek B and downstream to groundwater dependent ecosystems outside the Project Site. Retention of native vegetation on the Project Site would provide habitat for all threatened species recorded in the Study Area, as well as a range of threatened species which have been recorded in the locality and which may travel into the Project Site. Mitigation measures and offsets proposed here would enable no net loss of biodiversity values in the locality.

The Project has the potential to reduce the long-term viability on the Project Site of a number of threatened species that have been recorded from or may occur in the Project Site, in particular the Red-crowned Toadlet, Giant Burrowing Frog and *Callistemon linearifolius*. The Project has been designed to limit the impact on these species where possible, however the abundance of these species on the Project Site is likely to decrease. Linkages are being retained with habitat in the immediate vicinity, such as that protected in Popran National Park, and as such the local populations of these species are likely to remain viable in the long-term.

The Project is not likely to accelerate the extinction of or place at risk of extinction any of the threatened species which are known or may occur on the Project Site.

# 7 CONCLUSIONS AND RECOMMENDATIONS

The Project Site incorporates a range of vegetation communities which provide habitat for a number of threatened plants and animals, as well as providing general biodiversity values. Additionally, groundwater from the Project Site is important for supporting vegetation on the Project Site and groundwater dependent communities downstream along Cabbage Tree Creek.

Threatened species which would or would be likely to suffer impacts as a result of the Project include:

- *Callistemon linearifolius;*
- *Darwinia glaucophylla;*
- *Hibbertia procumbens;*
- *Glossy Black-cockatoo;*
- *Powerful Owl;*
- *Red-crowned Toadlet;*
- *Great Burrowing Frog;* and
- *Rosenberg's Goanna.*

A suite of mitigation measures are proposed to minimise impacts within the Project Site, including:

- design of the two extraction areas to avoid important habitat and retain one of the ephemeral creeks;
- design of the access road alignments to avoid and minimise impacts on threatened plant species;
- staging of the quarry;
- rehabilitation and revegetation of the extraction areas;
- implementation of a Vegetation Management Plan; and
- implementation of a Threatened Species and Habitat Management Plan.

In addition, a biodiversity offset strategy has been developed which provides for the conservation of 2ha of native vegetation for every 1ha disturbed. The conserved vegetation is of comparative type and conservation value as that to be disturbed, with all communities proposed for clearance being represented in the offset areas except for E103 Gahnia – Banksia Swamp. It is assessed that this adequately offsets the disturbance which would result from the development and operation of the Project.

It is recommended that these mitigation measures and the offset strategy are implemented in order to reduce the impacts of the Project on the native vegetation communities present and threatened species that occur on the Project Site.

It is considered that the Project has included actions to avoid or mitigate impacts on biodiversity and has presented a comprehensive compensatory offset package to mitigate the impacts to biodiversity that will occur. It is considered that the development will maintain or improve biodiversity values and that no net loss of habitat will occur as a result of the Project. No critical habitat would be affected by the Project. The Project is considered unlikely to reduce the long-term viability of threatened species or ecological communities, and is unlikely to place any at risk of extinction.

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# Appendices

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Appendix A Fauna Survey Results

Appendix B Flora Survey Results

Appendix C Threatened Species Profiles

Appendix D Assessments of Significance

Appendix E Tree Hollow Plot Data

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# Appendix A

## Fauna Survey Results

(No. of pages excluding this page = 13)

Table A1 Analysis of Likelihood of Threatened Fauna Occurring at the Project Site

Table A2.1 Fauna Survey Effort in the Study Area

Table A2.2 Fauna Trapping Grid Locations

Table A3 Mammals and Reptiles recorded in Project Site

Table A4 Bird Survey Results

Table A5 Frog Survey Results

Table A6 Freshwater Macroinvertebrates

## Table A1 Analysis of Likelihood of Threatened Fauna Occurring at the Project Site



| | *Scientific name* | Common Name | Legal Status | | Locality | Popran NP | Study Area | Project Site | Habitat | Habitat present in Project Site | Likelihood of Occurrence |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | TSC | EPBC | | | | | | | |
| **INSECTS** | | | | | | | | | | | |
| | *Petalura gigantea* | Giant Dragonfly | E1 | | | | | | Permanent swamps, bogs - some free water, open vegetation. | Yes | Low |
| **FISH** | | | | | | | | | | | |
| | *Prototroctes maraena* | Australian Grayling | | V | | | | | Mid-water species-clear, gravelly streams-moderate flow. Prefers deep, slow flowing pools. | No | Low |
| | *Macquaria australiacus* | Macquarie Perch | E1 | E | | | | | River, lake habitats- upper reaches of rivers and tributaries. | No | Low |
| **AMPHIBIANS** | *Heleioporus australiacus* | Giant Burrowing Frog | V | V | | Y | | | Small creeks, pools-sandstone ridgetop woodland, heath | Yes | Possible |
| | *Litoria aurea* | Green and Golden Bell Frog | E1 | E | | | | | Open areas with non-permanent waterways and cover (e.g. Typha) | No | Low |
| | *Litoria brevipalmata* | Green-Thighed Frog | V | | | | | | Rainforest to woodland, breeds in grassy semi-permanent ponds and flood-prone grassy areas | Yes | Possible |
| | *Mixophyes balbus* | Stuttering Frog | E1 | V | | | | | Rainforest, wet, tall open forest | No | Low |
| | *Mixophyes iteratus* | Giant Barred Frog | E1 | E | | | | | rainforests, moist eucalypt forest, nearby dry eucalypt forest, breed -shallow, flowing rocky streams | No | Low |
| | *Pseudophryne australis* | Red-Crowned Toadlet | V | | | Y | | Y | Triassic sandstones-Sydney basin permanently moist soaks, ephemeral headwater stream beds. | Yes | Present |

## Table A1 Analysis of Likelihood of Threatened Fauna Occurring at the Project Site (Cont'd)



| | Scientific name | Common Name | Legal Status | | Locality | Popran NP | Study Area | Project Site | Habitat | Habitat present in Project Site | Likelihood of Occurrence |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | TSC | EPBC | | | | | | | |
| **REPTILES** | *Hoplocephalus stephensii* | Stephens' Banded Snake | V | | | | | | Rainforest, eucalypt forests, rocky areas - to 950 m, shelters under bark | Yes | Possible |
| | *Varanus rosenbergi* | Rosenberg's Goanna | V | | | | Y | | Heath, open forest, woodland habitats. Termite mounds-critical-nesting. shelter-hollow logs, rock crevices, burrows | Yes | Probable |
| **BIRDS** | | | | | | | | | | | |
| 76 | *Pterodroma nigripennis* | Black-winged Petrel | V | | | | | | Marine, nests in burrows on the coast | No | Low |
| 103 | *Puffinus assimilis* | Little Shearwater | V | | | | | | Marine, breeds on islands | No | Low |
| 154 | *Ixobrychus flavicollis* | Black Bittern | V | | | | | | Terrestrial, estuarine wetlands-permanent water, dense vegetation | No | Low |
| 155 | *Botaurus poiciloptilus* | Australasian Bittern | V | | | | | | Permanent freshwater wetlands-tall, dense vegetation | No | Low |
| 163 | *Pandion haliaetus* | Osprey | V | | | | | | Clear, open water of large rivers, lagoons, lakes- coastal areas | No | Low |
| 264 | *Burhinus grallarius* | Bush Stone-curlew | E1 | | | | | | Open forests and woodlands with sparse grassy groundlayer | Yes | Low |
| 266 | *Haematopus longirostris* | Pied Oystercatcher | V | | | | | | Intertidal flats, beaches | No | Low |
| 267 | *Haematopus fuliginosus* | Sooty Oystercatcher | V | | | | | | Rock shelves, rocky headlands | No | Low |
| 313 | *Sterna albifrons* | Little Tern | E1 | MMB | | | | | Almost exclusively coastal, also inlets and rivers | No | Low |
| 316 | *Sterna fuscata* | Sooty Tern | V | | | | | | Marine, breeds on islands | No | Low |
| 324 | *Gygis alba* | White Tern | V | | | | | | Vagrant to coastal NSW | No | Low |
| 346 | *Ptilinopus superbus* | Superb Fruit-dove | V | | | | | | Rainforest, closed forest; forage high in the canopy | No | Low |
| 347 | *Ptilinopus regina* | Rose-crowned Fruit-dove | V | | | | | | Subtropical rainforest to swamp forest where fruit is plentiful | No | Low |
| 355 | *Calyptorhynchus lathami* | Glossy Black-cockatoo | V | | | Y | Y | Y | Dry forests-*Allocasuarina,* nest in tree hollows | Yes | Present |
| 390 | *Lathamus discolor* | Swift Parrot | E1 | E | | | | | Box-ironbark forests, woodlands | Yes | Possible |

## Table A1 Analysis of Likelihood of Threatened Fauna Occurring at the Project Site (Cont'd)



| | Scientific name | Common Name | Legal Status | | Locality | Popran NP | Study Area | Project Site | Habitat | Habitat present in Project Site | Likelihood of Occurrence |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | TSC | EPBC | | | | | | | |
| 402 | *Neophema pulchella* | Turquoise Parrot | V | | | | | | Eucalypt woodlands, open forests- grasses and shrubs understorey | Yes | Possible |
| 420 | *Ninox strenua* | Powerful Owl | V | | | Y | Y | | Woodland, open sclerophyll forest, tall open wet forest, rainforest | Yes | Probable |
| 422 | *Ninox connivens* | Barking owl | V | | | | | | Swamp, eucalypt woodland, open forests. | Yes | Possible |
| 426 | *Tyto tenebricosa* | Sooty Owl | V | | | Y | | | Dry, subtropical, warm temperate rainforests, moist eucalypt forests; very large tree hollows-for nesting. | Yes | Possible |
| 428 | *Tyto novaehollandiae* | Masked Owl | V | | | | | | Eucalypt forests, woodlands, nesting tree hollows, caves | Yes | Possible |
| 511 | *Climacteris picumnus* | Brown Treecreeper | V | | | | | | Open grassy understorey-eucalypt woodlands, dry open forests and mallee; | Yes | Possible |
| 556 | *Pyrrholaemus sagittatus (Chthonicola sagittata)* | Speckled Warbler | V | | | | | | Eucalyptus-dominated communities with grassy understorey | Yes | Possible |
| 591 | *Xanthomyza phrygia* | Regent Honeyeater | E1 | E, MTS | | | | | Box-ironbark eucalypt associations, wet lowland coastal forests | Yes | Possible |
| 621 | *Melithreptus gularis gularis* | Black-chinned Honeyeater | V | | | | | | Dry open forests and woodlands | Yes | Possible |
| 443 | *Apus pacificus* | Fork-tailed Swift | | MMB | | | | | Species or species habitat may occur within area | | |
| 172 | *Haliaeetus leucogaster* | White-bellied Sea-Eagle | | MTS | | | | | Estuaries, inlets, coastlines inland lakes. | No | Low |
| 442 | *Hirundapus caudacutus* | White-throated Needletail | | MTS | | | | | Non-breeding migrant to eastern Australia | Yes | Low |
| 455 | *Merops ornatus* | Rainbow Bee-eater | | MTS | | | | | Open forest, woodland, and farmland; nests excavated in creek banks, walls of quarries etc | Yes | Low |

## Table A1 Analysis of Likelihood of Threatened Fauna Occurring at the Project Site (Cont'd)



| | Scientific name | Common Name | Legal Status | | Locality | Popran NP | Study Area | Project Site | Habitat | Habitat present in Project Site | Likelihood of Occurrence |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | TSC | EPBC | | | | | | | |
| 704 | *Monarcha melanopsis* | Black-faced Monarch | | MTS | | | | | Rainforests, moist eucalypt forests and gullies | Yes | Low |
| 712 | *Myiagra cyanoleuca* | Satin Flycatcher | | MTS | | | | | Wet forests -.Great Dividing Range. | No | Low |
| 716 | *Rhipidura rufofrons* | Rufous Fantail | | MTS | | | | | Undergrowth of forest gullies | Yes | Low |
| 145 | *Ardea alba* | Great Egret | | MWS, MMB | | | | | Shallow water, including damp grasslands | No | Low |
| 147 | *Ardea ibis* | Cattle Egret | | MWS, MMB | | | | | Follows feeding cattle | No | Low |
| 219 | *Gallinago hardwickii* | Latham's Snipe | | MWS | | | | | Permanent and ephemeral wetlands | Yes | Low |
| 260 | *Rostrula benghalensis* | Painted Snipe | | MWS | | | | | Temporary or infrequently filled freshwater wetlands | Yes | Low |
| **MAMMALS** | | | | | | | | | | | |
| **Bats** | *Chalinolobus dwyeri* | Large-eared Pied Bat | V | V | | | | | Roosts in caves or crevices in cliffs, frequents low to mid elevation dry open forest and woodland | Yes | Low |
| | *Falsistrellus tasmaniensis* | Great Pipistrelle | V | | | | | | Moist habitats, trees taller than 20 m. roosts in hollows, under loose bark, or in buildings. | No | Low |
| | *Kerivoula papuensis* | Golden-tipped Bat | V | | | | | | Rainforest and adjacent sclerophyll forest, roost in Yellow-throated Scrubwren or Brown Gerygone nests | Yes | Possible |
| | *Miniopterus australis* | Little Bent-wing Bat | V | | | | | | Moist eucalypt forest, rainforest, dense coastal banksia scrub. roost in caves, sometimes tree hollows | Yes | Possible |
| | *Miniopterus schreibersii oceanensis* | Eastern Bent-wing Bat | V | | | Y | | | Roost in caves; hunt above canopy in forested areas. | Yes | Possible |
| | *Mormopterus norfolkensis* | Eastern Little Mastiff-bat | V | | | | | | Dry sclerophyll forest, woodland; roost in tree hollows or under bark. | Yes | Possible |

## Table A1 Analysis of Likelihood of Threatened Fauna Occurring at the Project Site (Cont'd)



| | Scientific name | Common Name | Legal Status | | Locality | Popran NP | Study Area | Project Site | Habitat | Habitat present in Project Site | Likelihood of Occurrence |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | TSC | EPBC | | | | | | | |
| | *Myotis macropus* | Large-footed Myotis | V | | | Y | | | Forage over streams and pools; roost in caves, hollow-bearing trees, | Yes | Possible |
| | *Pteropus poliocephalus* | Grey-headed Flying-fox | V | V | | Y | | | Riparian rainforest, Paperbark, Casuarina forest-roosting . | Yes | Possible |
| | *Saccolaimus flaviventris* | Yellow-bellied Sheathtail-bat | V | | | | | | Roosts in tree hollows | Yes | Possible |
| | *Scoteanax rueppellii* | Greater Broad-nosed Bat | V | | | | | | Woodland - moist and dry eucalypt forest, rainforest, roosts in tree hollows, | Yes | Possible |
| **Terrestrial Mammals** | *Cercartetus nanus* | Eastern Pigmy-possum | V | | | | | | Heath, woodland, sclerophyll forest, rainforest habitats . | Yes | Possible |
| | *Dasyurus maculatus* | Tiger Quoll | V | E (SE mainland population) | | Y | | | Rainforest, open forest, woodland, coastal heath, inland riparian forest roost: tree hollows, small caves, | Yes | Possible |
| | *Isoodon obesulus obesulus* | Southern Brown Bandicoot | E1 | | | | | | Heathland, shrubland, dry sclerophyll forest -heathy understorey, sedgeland, woodland habitats; | Yes | Possible |
| | *Macropus parma* | Parma Wallaby | V | | | | | | Moist eucalypt forest | Yes | Low |
| | *Petaurus australis* | Yellow-bellied Glider | V | | | | | | Tall mature eucalypt forest coastal forests, dry escarpment forests, moist coastal gullies, creek flats | Yes | Low |
| | *Petaurus norfolcensis* | Squirrel Glider | V | | | Y | | | Blackbutt-Bloodwood forest-heath understorey-coastal areas/old growth Box, Box-Ironbark woodlands | Yes | Possible |
| | *Phascolarctos cinereus* | Koala | V | | | | | | Eucalypt woodlands, forests. | Yes | Possible |
| | *Potorous tridactylus* | Long-nosed Potoroo | V | V | | | | | Coastal heaths, dry, wet sclerophyll forests sandy loam soil. | Yes | Possible |
| | *Pseudomys gracilicaudatus* | Eastern Chestnut Mouse | V | | | | | | Heathland, dense wet heath, swamps. | Yes | Low |

*Notes: E, E1 - endangered; V – vulnerable; MTB – migratory terrestrial species; MWS – migratory wetland species; MMB – migratory marine bird*

**Table A2.1 Fauna Survey Effort in the Study Area**



| Survey Method | Target Threatened Species | Company | Site | Survey Effort | Summary | Date |
|---|---|---|---|---|---|---|
| Elliot A (ground) | Small mammals, Eastern Pygmy Possum | Cumberland Ecology | Project Site | 4 grids x 10 traps x 4 nights | | Jan/Feb 2006 |
| Elliot A (ground) | Small mammals, Eastern Pygmy Possum | Cumberland Ecology | Project Site | 1 line x 5 traps x 4 nights | 180 trap nights | Jan/Feb 2006 |
| Elliot A (ground) | Small mammals, Eastern Pygmy Possum | Countrywide Ecological Service | Study Area | 5 lines x 10 traps x 4 nights | 100 trap nights | Jan/Feb 2004 |
| Elliot B (tree) | Squirrel Glider, Yellow-bellied Glider | Cumberland Ecology | Project Site | 4 grids x 10 traps x 4 nights | | Jan/Feb 2006 |
| Elliot B (tree) | Squirrel Glider, Yellow-bellied Glider | Cumberland Ecology | Project Site | 1 line x 5 traps x 4 nights | 180 trap nights | Jan/Feb 2006 |
| Elliot E (tree) | Eastern Pygmy Possum | Cumberland Ecology | Project Site | 5 lines x 5 traps x 4 nights | 100 trap nights | Jan/Feb 2006 |
| Hair funnels (ground) | Southern Brown Bandicoot, Tiger Quoll | Cumberland Ecology | Project Site | 5 grids x 5 traps x 4 nights | 100 trap nights | Jan/Feb 2006 |
| Hair tubes (ground) | Southern Brown Bandicoot, | Countrywide Ecological Service | Study Area | 10 traps x unspecified nights (probably at least 4) | at least 40 trap nights | Jan/Feb 2004 |
| Hair funnels (tree) | Squirrel Glider, Yellow-bellied Glider, Eastern Pygmy Possum | Cumberland Ecology | Project Site | 5 grids x 5 traps x 4 nights | 100 trap nights | Jan/Feb 2006 |
| Hair tubes (tree) | Squirrel Glider, Yellow-bellied Glider, Eastern Pygmy Possum | Countrywide Ecological Service | Study Area | 10 traps x unspecified nights (probably at least 4) | at least 40 trap nights | Jan/Feb 2004 |
| Cage traps | Southern Brown Bandicoot, Tiger Quoll | Cumberland Ecology | Project Site | 5 grids x 2 traps x 4 nights | 40 trap nights | Jan/Feb 2006 |
| Pitfall traps | Frogs, small mammals and reptiles | Countrywide Ecological Service | Study Area | 4 lines x 2 10lt buckets x 4 nights | 32 trap nights | Jan/Feb 2004 |
| Pitfall traps | Frogs, small mammals and reptiles | Countrywide Ecological Services | Study Area | 4 lines x 2 tube traps x 4 nights | 32 trap nights | Jan/Feb 2004 |
| Spotlighting | Gliders, Owls, Koala, Grey-headed Flying-fox, Stephen's Banded Snake | Cumberland Ecology | Project Site | 2 hours x 2 people x 3 nights | 12 person hours | Jan/Feb 2006 |

**Table A2.1 Fauna Survey Effort in the Study Area (Cont'd)**



| Survey Method | Target Threatened Species | Company | Site | Survey Effort | Summary | Date |
|---|---|---|---|---|---|---|
| Spotlighting | Gliders, Owls, Koala, Grey-headed Flying-fox, Stephen's Banded Snake | Countrywide Ecological Service | Study Area | 3 hours x 2 people x 4 nights | 24 person hours | Jan/Feb 2004 |
| Call playback | Forest Owls, Koala, Squirrel Glider, Yellow-bellied Glider | Cumberland Ecology | Project Site | 2 hours x 2 people x 3 nights | 12 person hours | Jan/Feb 2006 |
| Call playback | Forest owls, Bush-stone Curlew, Koala, Squirrel Glider, Yellow-bellied Glider | Countrywide Ecological Service | Study Area | 2 sites x unspecified nights (probably at least 2) | at least 4 sessions | Jan/Feb 2004 |
| Anabat | Microbats | Cumberland Ecology | Project Site | 1 anabat x 2 nights x 12 hours | 24 hours | Jan/Feb 2006 |
| Anabat | Microbats | Countrywide Ecological Service | Study Area | 3 hours x 4 nights | 12 hours | Jan/Feb 2004 |
| Harp trap | Microbats | Countrywide Ecological Service | Study Area | 1 trap x unspecified nights (probably at least 2) | at least 2 trap nights | Jan/Feb 2004 |
| Frog habitat assessment | Red-crowned Toadlet, Great Burrowing Frog | Cumberland Ecology | Project Site | 1 person x 6 hours | 6 person hours | Dec 2005 |
| Frog habitat assessment | Red-crowned Toadlet | Abel Ecology | Study Area | area traversed over 2 days | at least 8 person hours | Feb 2005 |
| Call recognition | Red-crowned Toadlet, Great Burrowing Frog | Cumberland Ecology | Project Site | 1 person x 6 hours | 6 person hours | Dec 2005 |
| Call recognition | Red-crowned Toadlet | Countrywide Ecological Service | Study Area | unspecified | unspecified | Jan/Feb 2004 |
| Call recognition | Red-crowned Toadlet | Abel Ecology | Study Area | 1 person x 2 nights | at least 8 person hours | Feb 2005 |
| Opportunistic hand capture | Red-crowned Toadlet | Countrywide Ecological Service | Study Area | unspecified | unspecified | Jan/Feb 2004 |

**Table A2.1 Fauna Survey Effort in the Study Area (Cont'd)**



| Survey Method | Target Threatened Species | Company | Site | Survey Effort | Summary | Date |
|---|---|---|---|---|---|---|
| Diurnal bird sampling | General diurnal bird fauna | Cumberland Ecology | Project Site | 1 person x two days (morning and afternoon/evening) | 13.5 person hours | Dec 2005 |
| Diurnal bird sampling | General diurnal bird fauna | Countrywide Ecological Service | Study Area | 2 transects x 2 times in 2 days | 8 transects | Jan/Feb 2004 |
| Tracks, scats & traces | General terrestrial fauna | Cumberland Ecology | Project Site | 3 hours x 2 people x 4 days | 24 person hours | Jan/Feb 2006 |
| Tracks, scats & traces | General terrestrial fauna | Countrywide Ecological Service | Study Area | unspecified | unspecified | Jan/Feb 2004 |
| Fish | General | Cumberland Ecology | Project Site | 2 people x 4 hours | 8 person hours | 38749 |
| Macroinvertebrates | General | Cumberland Ecology | Project Site | 2 people x 4 hours | 8 person hours | 38749 |

**Table A2.2 Fauna Trapping Grid Locations**

| Site | AMGs - Easting | AMGs - Northing | Vegetation Community | Site | AMGs - Easting | AMGs - Northing | Vegetation Community |
|---|---|---|---|---|---|---|---|
| 1a | 333989 | 6300309 | 29 | 1f | 333865 | 6300285 | 29 |
| 1b | | | 29 | 1g | | | 29a |
| 1c | | | 26 | 1h | | | 29a |
| 1d | | | 26 | 1i | | | 29a |
| 1e | 333903 | 6300236 | 29 | 1j | 333974 | 6300343 | 29a |
| | | | | | | | |
| 2a | 334240 | 6300299 | 26 | 2f | 334292 | 6300390 | 29 |
| 2b | | | 26 | 2g | | | 26 |
| 2c | | | 26 | 2h | | | 26 |
| 2d | | | 29 | 2i | | | 26 |
| 2e | 334258 | 6300299 | 29 | 2j | 334222 | 6300323 | 26 |
| | | | | | | | |
| 3a | 334204 | 6300486 | 29 | 3f | 334050 | 6300594 | 29a |
| 3b | | | 29a | 3g | | | 29a |
| 3c | | | 29a | 3h | | | 29a |
| 3d | | | 29a | 3i | | | 29a |
| 3e | 334214 | 6300503 | 29a | 3j | 334057 | 6300591 | 29a |
| | | | | | | | |
| 4a | 334168 | 6300814 | 25 | 4f | 334011 | 6300956 | 25 |
| 4b | | | 25 | 4g | | | 25 |
| 4c | | | 25 | 4h | | | 25 |
| 4d | | | 29 | 4i | | | 29 |
| 4e | 334104 | 6300778 | 29 | 4j | 334999 | 6300965 | 29 |
| | | | | | | | |
| 5a | 334289 | 6300881 | 29a | (Only 1 line for #5) | | | |
| 5b | | | 29a | | | | |
| 5c | | | 29 | | | | |
| 5d | | | 26 | | | | |
| 5e | 334113 | 6300966 | 26 | | | | |

**Table A.3 Mammals and Reptiles Recorded in Project Site**

| Grid | Species | Name | Type |
|---|---|---|---|
| 1 | *Antechinus stuartii* | Brown Antechinus | Trap |
| 1 | *Antechinus swainsonii* (probable) | Dusky Antechinus | Hair |
| 1 | *Dasyurid* | Dasyurid | Hair |
| 1 | *Perameles nasuta* | Long-nosed Bandicoot | Trap |
| 1 | *Rattus fuscipes* | Bush Rat | Hair |
| 1 | *Rattus fuscipes* | Bush Rat | Trap |
| 1 | *Rattus fuscipes* (probable) | Bush Rat | Hair |
| 1 | *Rattus rattus* | Brown Rat | Hair |
| 1 | *Rattus sp.* | Rat | Hair |
| 1 | *Sminthopsis murina* | Common Planigale | Hair |
| 1 | *Sminthopsis murina* (probable) | Common Planigale | Hair |
| 1 | *Trichosurus sp.* | Brush-tailed Possum | Hair |
| 1 | *Wallabia bicolor* | Swamp Wallaby | Hair |
| 2 | *Antechinus sp.* | Antechinus | Hair |
| 2 | *Antechinus stuartii* (probable) | Brown Antechinus | Hair |
| 2 | *Perameles nasuta* | Long-nosed Bandicoot | Observed |
| 2 | *Peramelid* | Bandicoot | Hair |
| 2 | *Pseudocheirus peregrinus* | Ringtail Possum | Observed |
| 2 | *Rattus fuscipes* | Bush Rat | Hair |
| 2 | *Rattus fuscipes* | Bush Rat | Trap |
| 2 | *Rattus sp.* | Rat | Hair |
| 2 | *Sminthopsis murina* | Common Planigale | Hair |
| 2 | *Sminthopsis murina* | Common Planigale | Hair |
| 2 | *Varanus varius* | Lace Monitor | Trap |
| 2 | *Wallabia bicolor* | Swamp Wallaby | Observed |
| 3 | *Antechinus sp.* | Antechinus | Hair |
| 3 | *Antechinus stuartii* | Brown Antechinus | Trap |
| 3 | *Peramelid* | Bandicoot | Hair |
| 3 | *Rattus fuscipes* | Bush Rat | Trap |
| 3 | *Rattus fuscipes* (probable) | Bush Rat | Hair |
| 3 | *Rattus rattus* | Brown Rat | Hair |
| 3 | *Rattus sp.* | Rat | Hair |
| 3 | *Sminthopsis murina* | Common Planigale | Hair |
| 4 | *Antechinus stuartii* | Brown Antechinus | Trap |
| 4 | *Eulamprus quoyii* | Eastern Water Skink | Trap |
| 4 | *Mus domesticus* | House Mouse | Hair |
| 4 | *Petaurus breviceps* | Sugar Glider | Call |
| 4 | *Rattus fuscipes* | Bush Rat | Hair |
| 4 | *Rattus fuscipes* | Bush Rat | Trap |
| 4 | *Sminthopsis murina* | Common Planigale | Hair |
| 4 | *Sminthopsis murina* | Common Planigale | Hair |
| 4 | *Trichosurus caninus* (possible) | Mountain Brushtail Possum | Hair |
| 4 | *Vulpes vulpes* | Fox | Hair |
| 5 | *Pseudocheirus peregrinus* | Ringtail Possum | Observed |
| 5 | *Trichosurus vulpecula* | Common Brush-tailed Possum | Hair |
| 5 | *Trichosurus vulpecula* | Common Brush-tailed Possum | Hair |
| - | *Rhinolophus megaphyllus* | Eastern Horseshoe Bat | AnaBat |
| - | *Chalinolobus gouldii* (probable) | Gould's Wattled Bat | AnaBat |
| - | *Vespadelus* sp. | Forest Bat | AnaBat |

## Table A.4 Bird Survey Results



| TON | Common Name | *Scientific Name* | Abundance | Heath | Woodland Forest | Riparian | Cleared Grass |
|---|---|---|---|---|---|---|---|
| 32 | Bar-shouldered Dove | *Geopelia humeralis* | A | | X | | |
| 221 | Brown Goshawk | *Accipiter fasciatus* | A | | X | | |
| 254 | Rainbow Lorikeet | *Trichoglossus haematodus* | A | | X | | |
| 265 | **Glossy Black-Cockatoo** | ***Calyptorhynchus lathami*** | **3** | | **X** | **X** | |
| 282 | Crimson Rosella | *Platycercus elegans* | B | | X | | X |
| 322 | Laughing Kookaburra | *Dacelo novaeguineae* | A | | X | X | |
| 326 | Sacred Kingfisher | *Todiramphus sanctus* | A | | X | | |
| 334 | White-throated Needletail | *Hirundapus caudacutus* | C | X | X | X | X |
| 347 | Common Koel | *Eudynamis scolopacea* | A | | X | | |
| 349 | Pheasant Coucal | *Centropus phasianinus* | A | | X | | X |
| 357 | Welcome Swallow | *Hirundo neoxena* | A | | | | X |
| 361 | Grey Fantail | *Rhipidura fuliginosa* | B | X | X | X | |
| 392 | Eastern Yellow Robin | *Eopsaltria australis* | B | X | X | X | |
| 398 | Golden Whistler | *Pachycephala pectoralis* | A | X | | X | |
| 401 | Rufous Whistler | *Pachycephala rufiventris* | B | X | X | | |
| 408 | Grey Shrike-thrush | *Colluricincla harmonica* | A | X | X | X | |
| 415 | Magpie-lark | *Grallina cyanoleuca* | A | | | | X |
| 421 | Eastern Whipbird | *Psophodes olivaceus* | A | X | | X | |
| 424 | Black-faced Cuckoo-shrike | *Coracina novaehollandiae* | A | | X | X | |
| 429 | Cicadabird | *Coracina tenuirostris* | A | | X | | |
| 470 | Striated Thornbill | *Acanthiza lineata* | B | | X | X | |
| 475 | Brown Thornbill | *Acanthiza pusilla* | B | X | X | X | |
| 488 | White-browed Scrubwren | *Sericornis frontalis* | B | X | X | X | X |
| 494 | Large-billed Scrubwren | *Sericornis magnirostris* | A | | | X | |
| 498 | Chestnut-rumped Heathwren | *Hylacola pyrrhopygia* | A | X | | | |
| 525 | Golden-headed Cisticola | *Cisticola exilis* | A | | | | X |
| 529 | Superb Fairy-wren | *Malurus cyaneus* | B | | X | | X |
| 536 | Variegated Fairy-wren | *Malurus lamberti* | B | X | X | X | |
| 549 | Varied Sittella | *Daphoenositta chrysoptera* | A | | X | X | |
| 558 | White-throated Treecreeper | *Cormobates leucophaeus* | A | | X | | |
| 564 | Mistletoebird | *Dicaeum hirundinaceum* | A | | X | X | |
| 565 | Spotted Pardalote | *Pardalotus punctatus* | A | | X | | |
| 574 | Silvereye | *Zosterops lateralis* | B | X | X | X | |
| 583 | Brown-headed Honeyeater | *Melithreptus brevirostris* | A | | X | X | |
| 591 | Eastern Spinebill | *Acanthorhynchus tenuirostris* | B | X | X | X | |
| 605 | Lewin's Honeyeater | *Meliphaga lewinii* | A | | | X | |
| 614 | Yellow-faced Honeyeater | *Lichenostomus chrysops* | A | X | X | X | |
| 617 | White-eared Honeyeater | *Lichenostomus leucotis* | A | X | | | |
| 631 | New Holland Honeyeater | *Phylidonyris novaehollandiae* | C | X | X | X | |

## Table A.4 Bird Survey Results



| TON | Common Name | *Scientific Name* | Abundance | Heath | Woodland Forest | Riparian | Cleared Grass |
|---|---|---|---|---|---|---|---|
| 632 | White-cheeked Honeyeater | *Phylidonyris nigra* | A | | X | | |
| 634 | Noisy Miner | *Manorina melanocephala* | A | | X | | |
| 637 | Little Wattlebird | *Anthochaera chrysoptera* | B | X | X | X | |
| 645 | Noisy Friarbird | *Philemon corniculatus* | A | | X | X | |
| 662 | Red-browed Finch | *Neochmia temporalis* | A | X | | X | |
| 671 | Olive-backed Oriole | *Oriolus sagittatus* | A | | X | | |
| 679 | Satin Bowerbird | *Ptilonorhynchus violaceus* | A | | | X | |
| 694 | Pied Currawong | *Strepera graculina* | A | | X | X | |
| 702 | Grey Butcherbird | *Cracticus torquatus* | A | | X | | X |
| 705 | Australian Magpie | *Gymnorhina tibicen* | A | | | X | X |
| 930 | Australian Raven | *Corvus coronoides* | A | | X | | X |
| 990 | Red-whiskered Bulbul | *Pynonotus jocosus* | A | | X | | |

## Table A.5 Frog Survey Results



| Site | Easting | Northing | Description | Species Present | Threatened Species Habitat |
|---|---|---|---|---|---|
| A | 333614 | 6300809 | Small boggy area, near end of northern track. Area dominated by *Glychenia* and *Gahnia.* | | |
| B | 333945 | 6300783 | Wet sandstone outcrop. Northern track. Dominated by ferns, *Glychenia* | | Red-crowned Toadlet |
| C | 333992 | 6300648 | Northern track crossing of Creek A, above waterfall. | | Red-crowned Toadlet |
| D | 333887 | 6300634 | Creek A below waterfall. | Red-crowned Toadlets *Pseudophryne australis* | Red-crowned Toadlet |
| E | 334012 | 6300655 | Creek A above road crossing | Red-crowned Toadlets *Pseudophryne australis* | Red-crowned Toadlet |
| F | 334235 | 6300792 | *Eleocharis* Pond, Northern bore track | Eastern Dwarf Tree Frog *Litoria fallax* | |
| G | 334259 | 6300747 | *Gahnia* wetland, top of Creek A. | Perons Tree Frog *Litoria peronii,* Bleating Tree Frog *Litoria dentata* | Giant Burrowing Frog |
| H | 334108 | 6300509 | Northern side of Tea Tree Swamp | | Giant Burrowing Frog |
| I | 334132 | 6300413 | Southern side of Tea Tree Swamp | | Giant Burrowing Frog |
| J | 334119 | 6300401 | *Glychenia* ditch off Creek B | | Red-crowned Toadlet |
| K | 334129 | 6300345 | Top end of Creek B | | |
| L | 333946 | 6300454 | Lower tea Tree Swamp | | Giant Burrowing Frog |
| M | 334512 | 6300848 | Creek A, under power lines | Bleating Tree Frog *Litoria dentata,* *Striped Marsh Frog Limnodynastes peronii* | |

## Table A.5 Frog Survey Results



| Site | Easting | Northing | Description | Species Present | Threatened Species Habitat |
|---|---|---|---|---|---|
| N | 334287 | 6300255 | Creek B , under power lines | | |
| O | 334645 | 6300603 | Abandoned Quarry Pond and Sedge area | Perons Tree Frog *Litoria peronii,* *Broad-palmed Frog Litoria latopalmata,* *Eastern Dwarf Tree Frog Litoria fallax,* *Striped Marsh Frog Limnodynastes peronii* | |
| P | 333768 | 6300541 | Creek C below junction of Creeks A and B | Leaf Green Tree Frog *Litoria phyllochroa* | |

## Table A.6 Freshwater Macroinvertebrates

| Order | Family | Abundance | SIGNAL Grades |
|---|---|---|---|
| Diptera | Chironomidae: | | |
| | - Tanypodinae (sub-family) | 3 | 4 |
| | - Chironominae (sub family) | 6 | 3 |
| | - Orthocladiinae (sub family) | 1 | 4 |
| Hemiptera | Notonectidae | 12 | 1 |
| | Hydrometridae | 3 | 3 |
| | Mesoveliidae | 2 | 2 |
| | Veliidae | 1 | 3 |
| Tricoptera | Odontoceridae | 1 | 7 |
| | Leptoceridae | 2 | 6 |
| Odonata | Sylestidae | 4 | 7 |
| Megaloptera | Corydalidae | 1 | 7 |
| Aphipoda | - | 1 | 3 |
| Arachnida | - | 5 | - |
| | | | |
| Summary | Taxa Totals | Total Abundance | Average SIGNAL Grading |
| 7 Orders | 9 Families | 42 | 4.16667* |
| * Moderate Pollution (Chessman, 1995) | | | |

# Appendix B

## Flora Survey Results

(No. of pages excluding this page = 6)

## Table B.1 Plants Recorded by Cumberland Ecology



| Group | Species | Community: | E26 | E26 | E26 | E29 | E25 | E29 | E25 | E29 | E26 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Quadrat: | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| **Trees** | | | | | | | | | | | |
| Casuarinaceae | *Allocasuarina littoralis* | Black She-oak | | | 1 | 1 | | | | | |
| | *A. torulosa* | Forest Oak | | | | | adj | | | | |
| Cunoniaceae | *Callicoma serratifolia* | Callicoma | | | | | adj | | 3 | | |
| | *Ceratopetalum gummiferum* | Christmas Bush | | | | | | 2 | 3 | 2 | |
| Epacridaceae | *Trochocarpa laurina* | Tree Heath | | | | | adj | | | | |
| Myrtaceae | *Angophora costata* | Smooth-barked Apple | 2 | 5 | 1 | | 1 | 5 | 5 | 5 | |
| | *Corymbia gummifera* | Red Bloodwood | 5 | 2 | 2 | 1 | | 2 | | 1 | |
| | *Eucalyptus haemastoma* | Scribbly Gum | | | 5 | 1 | 3 | | | 5 | |
| | *E. piperita* | Sydney Peppermint | | | | | 6 | 5 | 5 | 5 | |
| | *E. punctata* | Grey Gum | 1 | 5 | 1 | | | | | 1 | |
| | *E. sparsifolia* | a stringybark | 1 | 1 | 1 | 1 | | | | 1 | |
| | *Syncarpia glomulifera* | Turpentine | | | | | | | adj | | |
| Proteaceae | *Banksia serrata* | Old Man Banksia | | 2 | | | | 2 | 2 | 2 | |
| **Shrubs** | | | | | | | | | | | |
| Apiaceae | *Platysace lanceolata* | | | | | | | | 1 | | |
| | *P. linearis* | | | 2 | 1 | 1 | 1 | | 1 | 1 | |
| Araliaceae | *Polyscias sambucifolius* | Elderberry Panax | | | | | 2 | | | | |
| Dilleniaceae | *Hibbertia bracteata* | | 3 | | 1 | | | 2 | 3 | 1 | |
| | *H. . empetrifolia* | | | | | 1 | | | | | |
| | *H. linearis* | | 3 | 3 | | | | | | | |
| | *H. procumbens* | | | | | 1 | | | | | |
| Elaeocarpaceae | *Elaeocarpus reticulatus* | Blueberry Ash | | | | | | | 1 | | |
| Epacridaceae | *Brachyloma daphnoides* | | 2 | 2 | | | | | | | |
| | *Drachophyllum secundum* | | | | | | | 1 | | | |
| | *Epacris longiflora* | | | | | | | 2 | | | |
| | *E. obtusa* | | | | | | | | | | 2 |
| | *E. pulchella* | | | | 2 | | | | | | |
| | *Leucopogon esquamatus* | | | | 1 | | | | | | |
| | *L. microphyllus* | | | 1 | 2 | | | | | | |
| | *Woollsia pungens* | | | | | | | 2 | | | |
| Euphorbiaceae | *Amperea xiphoclada* | | | | | | | 2 | | | |
| | *Glochidion ferdinandi* | Cheese Tree | | | | | 2 | | | | |
| | *Phyllanthus hirtellus* | | 1 | | | | | | | | |
| | *Micrantheum ericoides* | | | 1 | | | | | | | |
| | *Ricinocarpus pinifolius* | Wedding Bush | | | | | | 3 | | 2 | |
| Fabaceae | *Bossiaea heterophylla* | | 1 | | 2 | | | | | 2 | |
| | *B. scolopendria* | | 2 | 2 | | 1 | | | | 2 | |
| | *Dillwynia floribunda* | | 3 | 3 | 1 | | | 3 | | | |

**Table B.1 Plants Recorded by Cumberland Ecology (Cont'd)**



| Group | Species | Community: | E26 | E26 | E26 | E29 | E25 | E29 | E25 | E29 | E26 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Quadrat: | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| | *Gompholobium latifolia* | | | | | | | 1 | | | |
| | *G. virgata* | | 2 | | 1 | | | | | 1 | |
| | *Hovea linearis* | | 1 | | | | | | | 1 | |
| | *Phyllota philicoides* | | 2 | | 1 | | | 3 | | | |
| | *Pultenaea daphnoides* | | | | | | | | 3 | | |
| | *P. elliptica* | | 3 | 2 | 2 | | | | | 2 | |
| | *P. ?polifolia* | | | | 1 | | | | | | |
| | *P. rosmarinifolius* | | 1 | | | 1 | | | | | |
| | *Aotus ericoides* | | | | | | | | | | 2 |
| | *Acacia linifolia* | Flax Wattle | | 2 | | | 2 | 2 | | 2 | |
| | *A. myrtifolia* | Myrtle-leaved Wattle | | | 1 | | | | | 1 | |
| | *A. oxycedrus* | | 2 | 4 | | 1 | 2 | 2 | | 2 | 1 |
| | *A. suaveolens* | Sweet-scented Wattle | 1 | 3 | 1 | 2 | 2 | 2 | | 2 | |
| | *A. terminalis* | Sunshine Wattle | | | | | 1 | 1 | 1 | | |
| | *A. ulicifolia* | Prickly Moses | 1 | | | | 2 | 1 | | 1 | |
| Lamiaceae | *Prostanthera linearis* | | | | | | | 1 | 3 | | |
| Myrtaceae | *Angophora hispida* | Dwarf Apple | | | adj | 2 | | | | | |
| | *Baeckea brevifolia* | | 1 | | 2? | | | | | | |
| | *Callistemon pinifolius* | | 1 | 2 | | | | | | | |
| | *Darwinia glaucophylla* | | 2 | | | 2 | | | | | |
| | *Kunzea capitata* | | 3 | 3 | 3 | 4 | | | | | |
| | *Leptospermum juniperinum* | Prickly-leaved Tea Tree | | | | | | | | 2 | 3 |
| | *Leptospermum polygalifolium* | Yellow Tea Tree | | 3 | 2 | 2 | 6 | 2 | 5 | | |
| | *L. . trinervium* | Paperbark Tea Tree | 5 | 5 | 3 | 2 | | 2 | | | |
| Proteaceae | *Banksia ericifolia* | Heath Banksia | 2 | 2 | 1 | 7 | 2 | 2 | 2 | 3 | |
| | *B. oblonga* | | | 1 | 1 | 1 | | | | | |
| | *B. robur* | Swamp Banksia | | | | | | | | | 3 |
| | *B. spinulosa* | Hairpin Banksia | | | 1 | | | 2 | | | |
| | *Conospermum longifolium* | | | | 3 | | | 2 | | 3 | |
| | *Grevillea buxifolia* | Grey Spiderflower | 2 | 2 | | | | | | | |
| | *G. diffusa* | | | 1 | 3 | 2 | 2 | | | | |
| | *G. mucronulata* | | 1 | | | | | | | | |
| | *G. sericea* | Pink Spiderflower | | | | | | | | | |
| | *Hakea dactyloides* | | | | | 1 | 1 | | | | |
| | *Hakea laurina* | | | | | | | | | 1 | |
| | *H. . teretifolia* | Dagger Hakea | 2 | 3 | 3 | 2 | | 1 | 1 | 3 | |
| | *Isopogon anemonifolius* | Drumsticks | 2 | | | | | | | | |
| | *Lambertia formosa* | Mountain Devil | 2 | | 3 | 2 | 1 | 2 | | 3 | |
| | *Persoonia levis* | Broad-leaved Geebung | | | 1 | 1 | | 1 | | 1 | |
| | *P. linearis* | Narrow-leaved Geebung | | | | | 2 | | | | |

**Table B.1 Plants Recorded by Cumberland Ecology (Cont'd)**



| Group | Species | Community: | E26 | E26 | E26 | E29 | E25 | E29 | E25 | E29 | E26 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Quadrat:** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| | *Petrophile pulchella* | Conesticks | 2 | 2 | 5 | 3 | | | | | |
| | *P. ?sessilis* | | | | | | | 1 | | 2 | |
| | *Xylomelum pyriforme* | Woody Pear | | | | | | | | 1 | |
| Rhamnaceae | *Pomaderris intermedia* | | | | | | adj | | | | |
| Rutaceae | *Eriostemon australasius* | | | | | | | | | | |
| | *E. buxifolia ssp obovatus* | | 1 | | | | | 1 | | | |
| | *Boronia floribunda* | | 1 | | | 1 | | 2 | | 2 | |
| | *B. ledifolia* | | 2 | 2 | | | | | | | |
| Santalaceae | *Leptomeria acida* | | | | | | | | | 1 | |
| Sapindaceae | *Dodonaea multijuga* | | | 2 | | | | | | | |
| Thymeliaceae | *Pimelea linifolia* | Common Riceflower | | | 1 | | | | | | |
| Tremandraceae | *Tetratheca ericifolia* | | | | 1 | | | | | | |
| | *T. thymifolia* | | | | | | | | | 1 | |
| Xanthorrhoeaceae | *Xanthorrhoea* sp. | a grasstree | 2 | 2 | 2 | 2 | 1 | | 2 | | |
| **Herbs - Ferns** | | | | | | | | | | | |
| Adiantaceae | *Adiantum aethiopicum* | Common Maidenhair Fern | | | | | 2 | | | | |
| Blechnaceae | *Blechnum nudum* | | | | | | adj | | | | |
| Dennstaedtiaceae | *Hypolepis muelleri* | Harsh Ground Fern | | | | | 2 | | | | |
| | *Pteridium esculentum* | Bracken Fern | | 1 | | | 4 | 3 | 2 | 2 | |
| Gleicheniaceae | *Gleichenia dicarpa* | Pouched Coral Fern | | | | | | | 2 | | 6 |
| | *G. microphylla* | | | | | | | | | | adj |
| | *Sticherus flabellatus* | Umbrella Fern | | | | | | | 3 | | |
| Linsaeaceae | *Lindsaea linearis* | Screw Fern | | | | 2 | | | | | |
| Osmundaceae | *Todea barbara* | King Fern | | | | | | | 1 | | |
| Selaginellaceae | *Sellaginella uliginosa* | | | | | 2 | | 2 | | 3 | |
| **Herbs - Dicots** | | | | | | | | | | | |
| Apiaceae | *Actinotus minor* | Lesser Flannel Flower | 2 | 2 | 4 | 3 | | 2 | | 3 | |
| | *Xanthosia pilosa* | | | | | | | 1 | 2 | 1 | |
| | *X. tridentata* | | | | | | | | 1 | | |
| Goodeniaceae | *Dampieria stricta* | | | 2 | | 1 | | 1 | | | |
| | *Goodenia bellidifolius* | | 2 | | | | | | | | |
| | *Scaevola ramosissima* | | | | | | | 1 | | | |
| Loganiaceae | *Mitrasacme polymorpha* | | | | | | | 2 | | | |
| Rutaceae | *Pomax umbellata* | | | | | | | 1 | | | |
| Stackhousiaceae | *Stackhousia viminea* | | | | | 1 | | | | | |
| Stylidiaceae | *Stylidium gramineum* | a Trigger Plant | | | | | | 2 | | | |
| | *S. lineare* | a Trigger Plant | | | 3 | 3 | | | | | |

## Table B.1 Plants Recorded by Cumberland Ecology (Cont'd)



| Group | Species | Community: | E26 | E26 | E26 | E29 | E25 | E29 | E25 | E29 | E26 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Quadrat:** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Herbs - Monocots | | | | | | | | | | | |
| Agavaceae | *Doryanthes excelsa* | Gymea Lily | | 2 | | | | 3 | 2 | | |
| Anthericaceae | *Caesia parviflora* | | 1 | | | | | | | | |
| Cyperaceae | *Caustis flexuosa* | Curly Sedge | 1 | | 1 | | | | | | |
| | *C. recurvata* | | | | | | | 3 | | | |
| | *Cyathochaeta diandra* | | 2 | 2 | 2 | 2 | 2 | 3 | | 2 | |
| | *Gahnia clarkei* | | | | | | 2 | | | | 6 |
| | *G. sieberiana* | | | | | | | | 3 | | |
| | *Lepidosperma concavum* | | 3 | | | | | | | | |
| | *L. laterale* | Broad Sword-sedge | | | | 2 | | | | | |
| | *L. .* sp | | | 1 | 1 | | | | | | |
| | *Ptilothrix deusta* | | | | | 2 | | | | | |
| | *Schoenus imberbis* | | 3 | 3 | | | | | | | |
| Iridaceae | *Patersonia glabrata* | a Purple Flag | | | | | | 2 | | | |
| | *P. sericea* | a Purple Flag | 3 | | 4 | 2 | | | | | |
| Lomandraceae | *Lomandra glauca* | | 4 | 3 | | | | | | | |
| | *L. longifolia* | Spiny-headed Mat-rush | | 2 | | | | | 2 | | |
| | *L. obliqua* | Fishbone Mat-rush | 1 | | | | | 2 | | 2 | |
| Orchidaceae | *orchid sp* | | | | | 1 | | | | | |
| Phormiaceae | *Dianella prunina* | | 2 | 1 | 1 | 1 | | 1 | | 1 | |
| Poaceae | *Anisopogon avenaceous* | | 3 | 1 | 2 | 2 | | 3 | | 3 | |
| | *Entolasia stricta* | Wiry Panic | 2 | 4 | 2 | 2 | 3 | | | 4 | |
| | *Imperata cylindrica* var *major* | Blady Grass | | | | | 4 | | | | |
| | *Poa* sp. | | | | 2 | | | | | | |
| | *Themeda australis* | Kangaroo Grass | | | 1 | | | | | | |
| | *poaceae* | | | 2 | | | | | | | |
| Restionaceae | *Empodisma minor* | | | | | | 3 | | 2 | | |
| | *Lepyrodia scariosa* | Scale Rush | 1 | 4 | | 5 | | | | | |
| | *Restio ?fimbriatus* | | | | | | 2 | | | | |
| Xyridaceae | *Xyris gracilis* ssp *gracilis* | | | | | 2 | | | | | |
| **Vines** | | | | | | | | | | | |
| Asclepiadaceae | *Marsdenia suaveolens* | | | | | | | | 1 | | |
| Fabaceae | *Hardenbergia violcea* | Purple Coral Pea | | | | | 1 | 1 | | | |
| Lauraceae | *Cassytha pubescens* | Devils Twine | 2 | | 2 | 2 | | 1 | | 1 | |
| Pittosporaceae | *Billardiera scandens* | Common Appleberry | | | | | | | 1 | 1 | |
| Vitaceae | *Cissus hypoglauca* | Five-leaved Water Vine | | | | 1 | | | | | |
| Smilaceae | *Smilax glyciphylla* | Sarsaparilla | | | | | | 1 | 1 | | |

**Key:**
*1 = rare* *2 = occasional* *3 = common* *4 = very common but less than 5%* *5 = 5-25%* *6 = 26-50%*
*7 = 51-75%* *adj = recorded adjacent to quadrat*

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**Table B.2 Likelihood of Threatened Species Recorded (TSC Act-listed) or Predicted to Occur (EPBC Act-listed) within the Gosford LGA Occurring on the Project Site**



| Scientific Name | Common Name | TSC Status | EPBC Status | Popran NP | Study Area | Project Site | Locality | Habitat | Habitat present in Project Site | Likelihood of occurrence |
|---|---|---|---|---|---|---|---|---|---|---|
| *Olearia cordata* | | V | V | N | N | N | N | Grows in dry open sclerophyll forest and open shrubland, on sandstone ridges. | Yes | Low |
| *Astrotricha crassifolia* | Thick-leaf Star-hair | V | V | N | N | N | N | Occurs on sandstone in dry sclerophyll woodlands near Patonga and the Woronora Plateau, with an outlying record near Glen Davis | Yes | Low |
| *Senecio spathulatus* | Coast Groundsel | E1 | | N | N | N | N | Grows on primary dunes. | No | Low |
| *Hibbertia procumbens* | Spreading Guinea Flower | E1 | | Y | Y | Y | Y | Usually occurs within *Banksia ericifolia - Angophora hispida - Allocasuarina distyla* scrub/heath on skeletal soils. | Yes | Known |
| *Tetratheca glandulosa* | | V | V | Y | Y | N | Y | Associated with shale-sandstone transition habitat where shale-cappings occur over sandstone. Occupies ridgetops, upper-slopes and to a lesser extent mid-slope sandstone benches. | Yes | Probable |
| *Tetratheca juncea* | Black-eyed Susan | V | V | N | N | N | N | Usually occurs in low open forest/woodland with mixed scrub and grassy ground cover but is also found in moist forest and heathland. | Yes | Possible |
| *Epacris purpurascens* var. *purpurascens* | | V | | N | N | N | N | Found in a range of habitat types, most of which have a strong shale soil influence. | No | Low |
| *Chamaesyce psammogeton* | Sand Spurge | E1 | | N | N | N | N | Found on the foredunes and headlands of the eastern coast from Jervis Bay to Queensland | No | Low |
| *Acacia bynoeana* | Bynoe's Wattle | E1 | V | N | N | N | N | Found in heath and woodland on sandy soils. Prefer open, sometimes slightly disturbed sites such as trail margins, edges of roadside spoil mounds and in recently burnt patches. | Yes | Possible |
| *Acacia pubescens* | Downy Wattle | V | V | N | N | N | N | Occurs on alluviums, shales and at the intergrade between shales and sandstones. Associated with gravelly soils. | No | Low |
| *Haloragodendron lucasii* | | E1 | E | N | N | N | N | Associated with dry sclerophyll forest. | Yes | Low |
| *Maundia triglochinoides* | | V | | N | N | N | N | Grows in swamps, creeks or shallow freshwater on heavy clay. | No | Low |
| *Prostanthera askania* | Tranquillity Mintbush | E1 | E | N | N | N | Y | Found in moist sclerophyll forests or warm temperate rainforest but occurs only adjacent to creeks or drainage lines on Narrabeen sandstone or its associated alluvial soils. | Yes | Possible |
| *Prostanthera junonis* | Somersby Mintbush | E1 | E | N | N | N | Y | The species is restricted to the Somersby Plateau. It occurs on both the Somersby and Sydney Town soil landscapes on gently undulating country over weathered Hawkesbury sandstone within open forest/low woodland/open scrub. It occurs in both disturbed and undisturbed sites. | Yes | Possible |
| *Callistemon linearifolius* | Netted Bottle Brush | V | | N | Y | Y | Y | Grows in dry sclerophyll forest on the coast and adjacent ranges. | Yes | Known |
| *Darwinia biflora* | | V | V | N | N | N | N | Occurs on the edges of weathered shale-capped ridges, where these intergrade with Hawkesbury Sandstone. | No | Low |
| *Darwinia glaucophylla* | | V | | Y | Y | Y | Y | Occurs in sandy heath, scrub and woodland and is associated with sandstone rock platforms or hanging swamps. | Yes | Known |
| *Eucalyptus camfieldii* | Heart-leaved Stringybark | V | V | N | N | N | Y | Poor coastal country in shallow sandy soils overlying Hawkesbury sandstone. Coastal heath mostly on exposed sandy ridges. | Yes | Possible |
| *Kunzea rupestris* | | V | V | N | N | N | N | Grows in shallow depressions on large flat sandstone rock outcrops. Characteristically found in short to tall shrubland or heathland. | Yes | Possible |
| *Melaleuca biconvexa* | Biconvex Paperbark | V | V | N | N | N | N | Generally grows in damp places, often near streams or low-lying areas on alluvial soils of low slopes or sheltered aspects. | No | Low |
| *Melaleuca deanei* | Deane's Paperbark | V | V | N | N | N | N | The species grows in heath on sandstone. Occurs in two distinct areas, in the Ku-ring-gai/Berowra and Holsworthy/Wedderburn areas respectively. There are also more isolated occurrences at Springwood (in the Blue Mountains), Wollemi National Park, Yalwal (west of Nowra) and Central Coast (Hawkesbury River) areas. | Yes | Possible |
| *Micromyrtus blakelyi* | | V | V | N | N | N | Y | Typically occurs within heathlands in shallow sandy soil in cracks and depressions of sandstone rock platforms. | Yes | Possible |
| *Syzygium paniculatum* | Magenta Lilly Pilly | V | V | N | N | N | N | Occurs on gravels, sands, silts and clays in riverside gallery rainforest and remnants of littoral rainforest. | Yes | Possible |

**Table B.2 Likelihood of Threatened Species Recorded (TSC Act-listed) or Predicted to Occur (EPBC Act-listed) within the Gosford LGA Occurring on the Project Site (Cont'd)**



| Scientific Name | Common Name | TSC Status | EPBC Status | Popran NP | Study Area | Project Site | Locality | Habitat | Habitat present in Project Site | Likelihood of occurrence |
|---|---|---|---|---|---|---|---|---|---|---|
| *Caladenia tessellata* | Thick Lip Spider Orchid | E1 | V | N | N | N | N | Generally found in grassy sclerophyll woodland on clay loam or sandy soils. | No | Low |
| *Cryptostylis hunteriana* | Leafless Tongue Orchid | V | V | N | N | N | N | Known from a range of habitats including swamp-heath and woodland. | Yes | Low |
| *Diuris bracteata* | | E1 | | N | N | N | N | Occurs in dry sclerophyll woodland | Yes | Possible |
| *Diuris praecox* | Rough Double Tail | V | V | N | N | N | N | Grows on hills and slopes of near-coastal districts in open forests which have a grassy to fairly dense understorey. | No | Low |
| *Rhizanthella slateri* | Eastern Australian Underground Orchid | V | E | N | N | N | N | Habitat requirements are poorly understood and no particular vegetation type has been associated with the species, although it is known to occur in sclerophyll forest. | Yes | Low |
| *Ancistrachne maidenii* | | V | | N | N | N | Y | Populations occur in distinct bands in areas associated with a transitional geology between Hawkesbury and Watagan soil landscapes. Grows in dry sclerophyll forest on sandstone-derived soils. | Yes | Possible |
| *Grevillea parviflora subsp parviflora* | | V | V | N | N | N | N | Grows in sandy or light clay soils over thin shales in a range of vegetation types from heath and shrubby woodland to open forest. | No | Low |
| *Grevillea shiressii* | | V | V | N | N | N | Y | Grows along creek banks in wet sclerophyll forest with a moist understorey in alluvial sandy or loamy soils. | Yes | Possible |
| *Persoonia hirsuta* | Hairy Geebung | E1 | E | N | N | N | N | Found in sandy soils in dry sclerophyll open forest, woodland and heath on sandstone. | Yes | Possible |
| *Baloskion longipes* | Dense Cord-rush | V | | N | N | N | N | Found in swamps or depressions in sandy alluvium or in swales in tall forest. | Yes | Low |
| *Lasiopetalum joyceae* | | V | V | N | N | N | N | Grows in heath on sandstone. | Yes | Possible |

# Appendix C

## Threatened Species Profiles

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## C.1 Callistemon linearifolius

### C.1.1 Discussion of conservation status

*Callistemon linearifolius* is listed as vulnerable on Schedule 2 of the TSC Act. It is not listed under the EPBC Act. It is mainly distributed throughout coastal areas of the Sydney Basin Bioregion, from Wollongong to Lake Macquarie, and inland to Kurri Kurri. Its northern limit is Nelson Bay in the NSW North Coast Bioregion (DEC (NSW), 2005y). There is a high risk of local extinction due to low population numbers. *Callistemon linearifolius* is not at the limit of its known distribution.

The key threatening processes that generally threaten *Callistemon linearifolius* are:

- Clearing of native vegetation which leads to a loss of plants and habitat; and
- Ecological consequences of high frequency fires.

No threat abatement plans relate to this species and no recovery plan has been prepared for this species. Thirteen priority actions have been identified to help recover this species, including:

- Developing and implementing a population and threat abatement monitoring program (High priority);
- Increasing the level of legislative protection for sites through land use planning mechanisms and conservation agreements (High priority);
- Liaise with landholders to facilitate the implementation of site-specific threat abatement measures (Medium priority);
- Collect seed for NSW seedbank (Medium priority); and
- Provide a map of known occurrences to the Rural Fire Service and seek inclusion of mitigative measures on Bush Fire Risk Management Plans, risk register and/or operation maps (Medium priority).

There are currently only 5-6 populations in the Sydney area, of the 22 populations recorded in the past. Three of these are reserved in Ku-ring-gai Chase National Park, Lion Island Nature Reserve, and Spectacle Island Nature Reserve. Further north it has been recorded from Yengo National Park, Popran National Park and Brisbane Water National Park.

### C.1.2 Discussion of local and regional abundance

There are currently only 5-6 populations in the Sydney area, of the 22 populations recorded in the past (DECC (NSW), 2007). There are 44 records of the species in the last 20 years in the Sydney Basin Bioregion, mainly around Sydney and Gosford, with additional populations near Kurri Kurri, Budgewoi and Wollongong (NSW Government, 2009).

### C.1.3 Discussion of other known local populations

*Callistemon linearifolius* has been recorded from 8 locations in the Gosford LGA. This species has been recorded on Lion Island Nature Reserve and in the Patonga area (Bell, 2004) and Brisbane Water National Park within Gosford LGA. Based on available records, the occurrence of this species on the subject site forms a disjunct local population.

### C.1.4 Discussion of habitat utilisation

This plant was recorded in small groups in four scattered locations on the Project Site. The NE record is of 10 plants, the records in the centre and in the SE are both of a single plant, and in the SW there are 13 plants spread over 3 close locations.

### C.1.5 Assessment of habitat

This species typically occurs sporadically within sandstone communities, and although not recorded within the adjacent Popran National Park, it is possible that it is represented there. This species has been recorded in E26 Exposed Hawkesbury Woodland on Lion Island Nature Reserve and in the Patonga area within Gosford LGA (Bell, 2004).

### C.1.6 Description of habitat values

E26 Exposed Hawkesbury Woodland occurs throughout the Project Site, and makes up approximately 38% of the total native vegetation (31.8ha out of 83.5ha).

### C.1.7 Extent of habitat removal

On the Project Site, *Callistemon linearifolius* was recorded in small groups in four scattered locations, of which only one (within Stage 5) would be cleared as part of the Project, resulting in the loss of a single plant. 24 remaining plants would not be directly impacted by the development. 13.2ha (42%) of known habitat would be cleared from the Project Site as a result of the Project.

### C.1.8 Consideration of corridors

Habitat within the Project Site is contiguous with Popran National Park, and fragmentation and isolation of habitat would not occur. Popran National Park is part of a large corridor linking Brisbane Water National Park and the Blue Mountains (Morgan, 2001). The Project Site provides native vegetation which is continuous with the vegetation of Popran National Park, and is therefore part of the local corridor system for flora and fauna.

## C.2 Hibbertia procumbens

### C.2.1 Discussion of conservation status

*Hibbertia procumbens* is listed as endangered on Schedule 2 of the TSC Act. It is not listed under the EPBC Act. It is known from several locations in the Central Coast area (Gosford and Wyong LGAs). The species occurs in Victoria and Tasmania, although investigation is required to verify that the disjunct NSW populations are the same species. It is susceptible to extinction in NSW from human-induced or random natural events, due to its very restricted distribution, small size and the limited genetic base of its total population. *Hibbertia procumbens* within the Project Site is at the limit of its known distribution.

The key threatening processes that generally threaten *Hibbertia procumbens* are:

- Clearing of native vegetation which leads to a loss of plants and habitat; and
- Ecological consequences of high frequency fires.

No threat abatement plans relate to this species and no recovery plan has been prepared for this species. Sixteen priority actions have been identified to help recover this species, including:

- Increasing the level of legislative protection for sites through land use planning mechanisms and conservation agreements (High priority);
- Public authorities undertaking road, trail or easement maintenance activities in habitat to implement measures to avoid impacting upon any populations (High priority);
- Determine if and/or where an ecological burn is required (High priority); and
- Negotiate with managers of freehold sites to prepare and implement site management plans that address threatening processes (Medium priority).

*Hibbertia procumbens* has been recorded in four conservation reserves: Yengo, Popran and Brisbane Water National Parks and the non-production Strickland State Forest (Bell and Driscoll 2005).

### C.2.2 Discussion of local and regional abundance

Within NSW, *Hibbertia procumbens* is known only on the Central Coast in the Gosford and Wyong LGAs (Bell and Driscoll, 2005). *Hibbertia procumbens* has been recorded from 22 locations in the Gosford LGA and 45 locations in the Sydney Basin Bioregion (NSW Government, 2009).

### C.2.3 Discussion of other known local populations

This species occurs in moderate densities in other areas of the Somersby Plateau (Bell and Driscoll, 2005). Recently a large population was recorded in Yengo National Park, and smaller populations are also known from Popran and Brisbane Water National Parks (Bell, 2004).

### C.2.4 Discussion of habitat utilisation

*Hibbertia procumbens* has been recorded throughout communities E26 Exposed Hawkesbury Woodland and E29 Hawkesbury Banksia-Scrub Woodland within the Project Site (196 records). This species was recorded throughout much of the Project Site, particularly where surveys were concentrated on higher sections of the Project Site. Concentrations of the species are found in the powerline easement, in the southeast corner (proposed Project Site East Offset Area) and along the southern edge of the Project Site adjoining Popran National Park.

### C.2.5 Assessment of habitat

Within Gosford LGA potential habitat exists for this species within all areas mapped as E29 Hawkesbury Banksia Scrub-Woodland, as well as areas adjacent to E54 Sandstone Hanging Swamps (Bell, 2004). This species is also likely to have habitat throughout E26 Exposed Hawkesbury Woodland. E26 and E29 are widespread in the Gosford, Central Coast and Sydney regions.

### C.2.6 Description of habitat values

*Hibbertia procumbens* has been recorded throughout communities E26 Exposed Hawkesbury Woodland and E29 Hawkesbury Banksia-Scrub Woodland within the Project Site. These communities cover approximately 55.6ha of the Project Site, and are common in the locality. Some areas of the Project Site show evidence of relatively recent fire.

### C.2.7 Extent of habitat removal

Clearing of the habitat supporting *Hibbertia procumbens* would impact the species within the Project Site. Approximately half of the recorded locations would be impacted by clearing for the two quarries, however other sites will not be impacted. These include the cleared area along the power line easement, along Creek B, in the southeast corner adjacent to Australian Wildlife Walkabout Park, the northwest section between the Stage 3 and 4 quarries, and along the access road to Popran National Park on the southern border of the Project Site. A total of 24.7ha (44%) of known habitat for this species would be cleared from the Project Site.

### C.2.8 Consideration of corridors

Habitat to be retained within the Project Site (along the southern and western boundaries) is contiguous with habitat within the adjacent Popran National Park, and therefore fragmentation and isolation of habitat would not occur. Popran National Park is part of a large corridor linking Brisbane Water National Park and the Blue Mountains (Morgan, 2001). The Project Site provides native vegetation which is continuous with the vegetation of Popran National Park, and is therefore part of the local corridor system for flora and fauna.

## C.3 Darwinia glaucophylla

### C.3.1 Discussion of conservation status

*Darwinia glaucophylla* is listed as vulnerable on Schedule 2 of the TSC Act. It is not listed under the EPBC Act. This species occurs entirely within the Gosford LGA of the Sydney Basin Bioregion

The key threatening processes that generally threaten *Darwinia glaucophylla* are:

- Clearing of native vegetation which leads to a loss of plants and fragmentation of habitat; and

- Ecological consequences of high frequency fires – this species is highly sensitive to too frequent and infrequent fire (recommended fire interval is 5-10 years).

No threat abatement plans relate to this species and no recovery plan has been prepared for this species. Fifteen priority actions have been identified to help recover this species, including:

- Determine if and/or where an ecological burn is required (High priority);
- Increasing protection for sites through land use planning mechanisms and conservation agreements (High priority);
- Prepare and implement a population monitoring program (High priority);
- Restrict and control access to sites, particularly access by off-road vehicles (High priority);
- Undertake sediment and erosion control works at priority sites (High priority);
- Undertake weed control, priority given to sites at urban interface (High priority); and
- Liaise with landholders to facilitate the implementation of site-specific threat abatement measures (Medium priority).

*Darwinia glaucophylla* has been recorded in several locations within Brisbane Water National Park and also in Popran National Park. *Darwinia glaucophylla* within the Project Site is at the limit of its known distribution.

### C.3.2 Discussion of local and regional abundance

*Darwinia glaucophylla* occurs entirely within the Gosford LGA, and is known from approximately 15 sites, several within or near Brisbane Water National Park and one within Popran National Park.

### C.3.3 Discussion of other known local populations

*Darwinia glaucophylla* occurs entirely within the Gosford LGA, and is known from approximately 15 sites, several within or near Brisbane Water National Park and one within Popran National Park (DEC (NSW), 2005e).

### C.3.4 Discussion of habitat utilisation

*Darwinia glaucophylla* has been recorded throughout communities E26 Exposed Hawkesbury Woodland and E29 Hawkesbury Banksia-Scrub Woodland within the Project Site (167 records). This species was recorded in seven general sections of the study area including: along the southern edge of the existing quarry; in the southern part of the proposed Stage 4 extraction area, in the powerline easement, part of which will be retained and part will be included in the Stage 4 extraction area; the northern part of the powerline easement in the

Project Site; the southeastern corner of the Project Site (proposed Project Site East Offset Area); within the proposed Stage 5 extraction area; and at the south western corner of the Project Site spreading into the proposed Glenworth Valley Offset Area and Popran National Park.

### C.3.5 Assessment of habitat

Darwinia glaucophylla occurs in sandy heath, scrub and woodlands often associated with sandstone rock platforms or near hanging swamps and friable sandstone shallow soils (DEC (NSW), 2005e). It is killed by fire, hence its preference for rocky environments (Benson and McDougall, 1998). Germination is from soil stored seed which requires heat to break seed dormancy. Germination is unlikely in the absence of fire.

### C.3.6 Description of habitat values

*Darwinia glaucophylla* has been recorded throughout communities E26 Exposed Hawkesbury Woodland and E29 Hawkesbury Banksia-Scrub Woodland within the Project Site. These communities cover approximately 55.6ha of the Project Site, and are common in the locality. Some areas of the Project Site show evidence of relatively recent fire.

### C.3.7 Extent of habitat removal

Approximately half of the recorded locations would be impacted by clearing for the two quarries, however other sites will not be impacted. These include the cleared area along the power line easement, along Creek B, in the southeast corner adjacent to Australian Wildlife Walkabout Park, the northwest section between the Stage 3 and 4 quarries, and along the access road to Popran National Park on the southern border of the Project Site, particularly the southwest corner. A total of 24.7ha (44%) of known habitat for this species would be cleared from the Project Site.

### C.3.8 Consideration of corridors

Habitat to be retained within the Project Site (in the southern and north-western portions) is contiguous with habitat within the adjacent Popran National Park, and fragmentation and isolation of habitat would not occur. Popran National Park is part of a large corridor linking Brisbane Water National Park and the Blue Mountains National Park (Morgan, 2001). The Project Site provides native vegetation which is continuous with the vegetation of Popran National Park, and is therefore part of the local corridor system for flora and fauna.

## C.4 Acacia bynoeana

### C.4.1 Discussion of conservation status

*Acacia bynoeana* is listed as endangered on Schedule 1 of the TSC Act. It is listed as vulnerable under the EPBC Act. The species is distributed from Morisset to the Southern Highlands and west to the Blue Mountains. The species is susceptible to local extinction from

catastrophic events because of its disjunct and small populations (DEC (NSW), 2005c). The Project Site is not at the limit of the known distribution for *Acacia bynoeana*.

The key threatening processes that generally threaten *Acacia bynoeana* are:

- Clearing of native vegetation which leads to a loss of plants and habitat;
- Weed invasion (exotic perennial grasses, exotic vines and scramblers, Lantana camara); and
- Ecological consequences of high frequency fires (DEC (NSW), 2005c).

No threat abatement plans relate to this species and no recovery plan has been prepared for this species. Thirteen priority actions have been identified to help recover this species, including:

- Liaise with private and public land managers to facilitate the preparation and implementation of management plans that address threatening processes (Medium priority);
- Incorporate appropriate fire regime into land management practices (Medium priority);
- Restrict access to sites where necessary (Medium priority);
- Undertake targeted bush regeneration works where required (Medium priority);
- Increase the level of legislation protection for sites through land use planning mechanisms and conservation agreements. Retain vegetative linkages between sites where possible (High priority) (DEC (NSW), 2005c).

There are 72 records of the species recorded from the Sydney Basin bioregion from the last 20 years, including populations reserved within Ku-ring-gai Chase National Park, Marra Marra National Park, Dharug National Park, Parr State Conservation Area, Yengo National Park, Blue Mountains National Park, Nattai National Park and Bargo State Conservation Area (NSW Government, 2009).

### C.4.2 Discussion of local and regional abundance

There are 2 records of *Acacia bynoeana* in the Gosford LGA from the last 20 years and 72 records from the Sydney Basin bioregion. There are no records from within the locality (NSW Government, 2009).

### C.4.3 Discussion of other known local populations

*Acacia bynoeana* has been recorded from 2 locations in the Gosford LGA, both near Wisemans Ferry Road near Mangrove Creek (NSW Government, 2009).

### C.4.4 Discussion of habitat utilisation

This species has not been recorded from the Project Site. Potential habitat exists in the woodland and heath communities on the Project Site.

### C.4.5 Assessment of habitat

This species occurs on sandy soils in heath and dry sclerophyll forest (DEC (NSW), 2005c). The species has not been recorded in Popran National Park but potential habitat for the species does occur there.

### C.4.6 Description of habitat values

Potential habitat for *Acacia bynoeana* occurs throughout the Project Site in the communities of E25 Hawkesbury Peppermint Apple Forest, E26 Exposed Hawkesbury Woodland, E26a Hawkesbury Rock Pavement Heath, and E29 Hawkesbury Banksia Scrub-Woodland. This is approximately 82% of the total native vegetation on the Project Site (68.5ha out of 83.5ha).

### C.4.7 Extent of habitat removal

*Acacia bynoeana* has not been recorded on the Project Site during any of the threatened flora surveys. Approximately 24.7ha (36%) of potential habitat will be cleared as a result of the Project.

### C.4.8 Consideration of corridors

Habitat within the Project Site is contiguous with Popran National Park, and fragmentation and isolation of habitat would not occur. Popran National Park is part of a large corridor linking Brisbane Water National Park and the Blue Mountains National Park (Morgan, 2001). The Project Site provides native vegetation which is continuous with the vegetation of Popran National Park, and is therefore part of the local corridor system for flora and fauna.

## C.5 Tetratheca glandulosa

### C.5.1 Discussion of conservation status

*Tetratheca glandulosa* is listed as vulnerable on Schedule 2 of the TSC Act and as vulnerable under the EPBC Act. It is distributed from Sampsons Pass in Yengo National Park to the north, West Pymble in Lane Cove National Park to the south, Ingleside to the east and East Kurrajong in Wollemi National Park to the west (DEC (NSW), 2005g1). *Tetratheca glandulosa* is not at the limit of its known distribution.

The key threatening processes that generally threaten *Tetratheca glandulosa* are:

- Clearing of native vegetation which leads to a loss of plants and habitat; and
- Ecological consequences of high frequency fires (DEC (NSW), 2005g1).

No threat abatement plans relate to this species and no recovery plan has been prepared for this species. Sixteen priority actions have been identified to help recover this species, including:

- Encourage community awareness and involvement in threat management works (High priority);
- Reserve Fire Management Strategy to include operational guidelines to protect this species from fire (High priority);
- Increasing the level of legislative protection for sites through land use planning mechanisms and conservation agreements (High priority);
- Undertake identified priority threat management works including weed control, restrict access, stormwater management works and slashing under powerlines (High priority); and
- Undertake works to maintain or improve habitat connectivity between and within populations (Medium priority) (DEC (NSW), 2005g1).

There are 529 records of *Tetratheca glandulosa* from the Sydney Basin bioregion from the last 20 years. The species has been recorded in Yengo, Popran, Dharug, Marra Marra, Ku-ring-gai Chase and Garigal National Parks, Parr State Conservation Area and Berowra Valley Regional Park (NSW Government, 2009).

### C.5.2 Discussion of local and regional abundance

There are 529 records of the species in the last 20 years in the Sydney Basin Bioregion, with approximately 150 populations. Strongholds south of the Hawkesbury River are in Berowra Valley Regional Park, Maroota-South Maroota area and Marra Marra National Park. Strongholds north of the Hawkesbury River are in Dharug National Park, the Mangrove Mountain – Central Mangrove Area and Ourimbah State Forest (NSW Government, 2009).

### C.5.3 Discussion of other known local populations

*Tetratheca glandulosa* has been recorded from 92 locations in the Gosford LGA. This species has been recorded nearby at Mt White and in Popran National Park, which is adjacent to the Project Site. Large populations also occur in Dharug National Park and in the Mangrove Mountain area (NSW Government, 2009).

### C.5.4 Discussion of habitat utilisation

This plant has not been recorded on the Project Site but has been recorded from Popran National Park, adjacent to the Project Site.

### C.5.5 Assessment of habitat

This species is associated with shale-cappings over sandstone and can occur in heath, scrub, woodland and open forest communities (DEC (NSW), 2005g1). *Tetratheca glandulosa* has been recorded in the adjacent Popran National Park but has not been recorded on the Project Site, although it is possible it is present there in woodland and scrub communities.

### C.5.6 Description of habitat values

E26 Exposed Hawkesbury Woodland, E25 Hawkesbury Peppermint Apple Forest, E26a Hawkesbury Rock Pavement Heath, E 29 Hawkesbury Banksia Scrub-Woodland, and E29a Hawkesbury Banksia Scrub Woodland (Scrub) occur throughout the Project Site, and make up approximately 97% of the total native vegetation (80.9ha out of 83.5ha).

### C.5.7 Extent of habitat removal

*Tetratheca glandulosa* has not been recorded on the Project Site. Approximately 33.3ha (41%) of potential habitat would be cleared from the Project Site as a result of the project.

### C.5.8 Consideration of corridors

Habitat within the Project Site is contiguous with Popran National Park, and fragmentation and isolation of habitat would not occur. Popran National Park is part of a large corridor linking Brisbane Water National Park and the Blue Mountains (Morgan, 2001). The Project Site provides native vegetation which is continuous with the vegetation of Popran National Park, and is therefore part of the local corridor system for flora and fauna.

## C.6 Prostanthera junonis

### C.6.1 Discussion of conservation status

*Prostanthera junonis* is listed as endangered on Schedule 1 of the TSC Act. It is listed as endangered under the EPBC Act. It has a distribution restricted to the Somersby Plateau with records extending between Central Mangrove and Kariong to the east of the Project Site. An outlying record occurs on the edge of Mooney Mooney Creek near where it meets the Hawkesbury (NSW Government, 2009). The Project Site lies between this outlying record and the main distribution of the species. The species is at risk of extinction because of its restricted distribution.

The key threatening processes that generally threaten *Prostanthera junonis* are:

- Clearing of native vegetation which leads to a loss of plants and habitat;
- Weed invasion (exotic vines and scramblers, Lantana, exotic perennial grasses);
- Susceptibility to infection by Phytophthora cinnamomi; and
- Ecological consequences of high frequency fires (DEC (NSW), 2005c1).

No threat abatement plans relate to this species. A recovery plan has been prepared for *Prostanthera junonis* with the overall objective to identify policies and programs which protect and conserve *P. junonis* and which reduce the risk of extinction of the species. Specific objectives relevant to the Project include:

- Ensure populations are not destroyed by habitat loss, ensure security of lands that support populations; and

- Minimise long term decline through implementation of appropriate threat and habitat management practices (DEC (NSW), 2005c1).

Twenty priority actions have been identified to help recover this species, including:

- Prepare and implement site-specific management plans for all populations outside of the reserve system (Medium priority); and
- Undertake weed control activities as appropriate using approved bush regeneration methods (Medium priority) (DEC (NSW), 2005c1).

When the Recovery Plan for *P. junonis* was prepared, the species was known from 9 populations, eight of which were located within a 10km by 7km spread on the Somersby Plateau. There are currently 396 records for the species, mainly concentrated in the aforementioned distribution but there are also several outlying populations. At least two populations are conserved within Brisbane Waters National Park (NSW Government, 2009).

### C.6.2 Discussion of local and regional abundance

There are currently 396 records for the species, with the majority of these occurring in the east of the Somersby Plateau from Central Mangrove to Kariong. Outlying populations occur near where Mooney Mooney Creek meets the Hawkesbury River and records have been lodged with the Royal Botanic Gardens for the species at Mona Vale (NSW Government, 2009).

### C.6.3 Discussion of other known local populations

*Prostanthera junonis* has not been recorded from the Project Site. Other populations within the locality occur further east, generally on the eastern edge of the Somersby Plateau, east of Mooney Mooney Creek.

### C.6.4 Discussion of habitat utilisation

This species has not been recorded on the Project Site.

### C.6.5 Assessment of habitat

This species occurs on weathered sandstone within open forest, low woodland or open scrub (DEC (NSW), 2005c1). It could potentially occur in E25 Hawkesbury Peppermint Apple Forest, E26 Exposed Hawkesbury Woodland, E26a Hawkesbury Rock Pavement Heath, E29 Hawkesbury Banksia Scrub-Woodland and E29a Hawkesbury Banksia Scrub-Woodland (Scrub). The species has not been recorded in Popran National Park.

### C.6.6 Description of habitat values

E25 Hawkesbury Peppermint Apple Forest, E26 Exposed Hawkesbury Woodland, E26a Hawkesbury Rock Pavement Heath, E29 Hawkesbury Banksia Scrub-Woodland and E29a

Hawkesbury Banksia Scrub-Woodland (Scrub) occur throughout the Project Site and make up approximately 97% of the total native vegetation (80.9ha out of 83.5ha).

### C.6.7 Extent of habitat removal

*Prostanthera junonis* has not been recorded on the Project Site. Approximately 33.3ha (41%) of potential habitat would be cleared from the Project Site as a result of the project.

### C.6.8 Consideration of corridors

Habitat within the Project Site is contiguous with Popran National Park, and fragmentation and isolation of habitat would not occur. Popran National Park is part of a large corridor linking Brisbane Water National Park and the Blue Mountains (Morgan, 2001). The Project Site provides native vegetation which is continuous with the vegetation of Popran National Park, and is therefore part of the local corridor system for flora and fauna.

## C.7 Eucalyptus camfieldii

### C.7.1 Discussion of conservation status

*Eucalyptus camfieldii* is listed as vulnerable on Schedule 2 of the TSC Act. It is also listed as vulnerable under the EPBC Act. It is distributed in a narrow band from the Raymond Terrace area to Waterfall. There is a high risk of inbreeding due to low and isolated population numbers (DEC (NSW), 2005d). *Eucalyptus camfieldii* is not at the limit of its known distribution.

The key threatening processes that generally threaten *Eucalyptus camfieldii* are:

- Clearing of native vegetation which leads to a loss of plants and habitat;
- Weed invasion (exotic vines and scramblers, exotic perennial grasses, Lantana); and
- Ecological consequences of high frequency fires (DEC (NSW), 2005d).

No threat abatement plans relate to this species and no recovery plan has been prepared for this species. Fifteen priority actions have been identified to help recover this species, including:

- Liaise with landholders to facilitate the implementation of site-specific threat abatement measures (High priority);
- Implement appropriate fire regimes using suitable methods for this species (Medium priority);
- Control access at sites with high visitation and disturbance (Medium priority);
- Prepare and implement site-specific plans of management (High priority); and
- Seek to increase the level of legislative protection for sites through land use planning mechanisms and conservation agreements (High priority) (DEC (NSW), 2005d).

There are 186 records from the Sydney Basin bioregion. Several populations are reserved within the Mangrove Creek Dam Water Supply Reserve, Wyong State Forest, Popran National Park, Brisbane Waters National Park and further south in Ku-ring-gai Chase National Park, Berowra Valley Regional Park, Sydney Harbour National Park (at North Head), Royal National Park and Heathcote National Park (NSW Government, 2009).

### C.7.2 Discussion of local and regional abundance

There are fourteen records of *Eucalyptus camfieldii* in the Gosford LGA from the last 20 years. There are 186 records from the Sydney Basin bioregion. The species occurs in small, disjunct populations throughout its distribution (NSW Government, 2009).

### C.7.3 Discussion of other known local populations

There are 186 records for the species, the majority of which are from the Sydney Basin Bioregion. Several disjunct populations occur within the Gosford LGA including at Point Clare, Popran National Park and the northern section of Brisbane Waters National Park (NSW Government, 2009).

### C.7.4 Discussion of habitat utilisation

*Eucalyptus camfieldii* has not been recorded on the Project Site. It has been recorded from the northern portion of Popran National Park, not from the section adjacent to the Project Site.

### C.7.5 Assessment of habitat

This species occurs in shallow sandy soils on sandstone in coastal heath and low open woodland (DEC (NSW), 2005d). It could potentially occur in E26 Exposed Hawkesbury Woodland, E26a Hawkesbury Rock Pavement Heath, E29 Hawkesbury Banksia Scrub-Woodland and E29a Hawkesbury Banksia Scrub-Woodland (Scrub). The species has not been recorded in the section of Popran National Park adjacent to the Project Site.

### C.7.6 Description of habitat values

E26 Exposed Hawkesbury Woodland, E26a Hawkesbury Rock Pavement Heath, E29 Hawkesbury Banksia Scrub-Woodland and E29a Hawkesbury Banksia Scrub-Woodland (Scrub) occur throughout the Project Site, and make up approximately 83% of the total native vegetation (69.4ha out of 83.5ha).

### C.7.7 Extent of habitat removal

*Eucalyptus camfieldii* does not occur on the Project Site. Approximately 33.3ha (48%) of potential habitat would be cleared from the Project Site as a result of the project.

### C.7.8 Consideration of corridors

Habitat within the Project Site is contiguous with Popran National Park, and fragmentation and isolation of habitat would not occur. Popran National Park is part of a large corridor linking Brisbane Water National Park and the Blue Mountains National Park (Morgan, 2001). The Project Site provides native vegetation which is continuous with the vegetation of Popran National Park, and is therefore part of the local corridor system for flora and fauna.

## C.8 Kunzea rupestris

### C.8.1 Discussion of conservation status

*Kunzea rupestris* is listed as vulnerable on Schedule 2 of the TSC Act. It is also listed as vulnerable under the EPBC Act. It has a restricted distribution, mainly distributed in the Maroota – Sackville – Glenorie area. It is known from only 20 sites (NSW Government, 2009). The northern most records are from Dharug National Park.

The key threatening processes that generally threaten *Kunzea rupestris* are:

- Clearing of native vegetation which leads to a loss of plants and habitat;
- Weed invasion (exotic perennial grasses, exotic vines and scramblers, Lantana); and
- Ecological consequences of high frequency fires (DEC (NSW), 2005q).

No threat abatement plans relate to this species and no recovery plan has been prepared for this species. Thirteen priority actions have been identified to help recover this species, including:

- Negotiate with sand mining companies to reduce threats posed by mining activities (High priority); and
- Negotiate with private landholders to increase protection of sites through land use planning mechanisms or conservation agreements for sites on private land (Medium priority) (DEC (NSW), 2005q).

There are currently only 46 records from the Sydney Basin bioregion from the last 20 years. The species is conserved within Dharug National Park, Ku-ring-gai Chase National Park and Marra Marra National Park (NSW Government, 2009).

### C.8.2 Discussion of local and regional abundance

There are 46 records of *Kunzea rupestris* from the Sydney Basin bioregion from the last 20 years. The main populations are distributed around the Maroota – Sackville – Glenorie area with populations at Maroota, South Maroota and Sackville North. There are two records from the Gosford LGA within the last 20 years, both from Dharug National Park (NSW Government, 2009).

### C.8.3 Discussion of other known local populations

The species has not been recorded on the Project Site. The closest populations are those that have been recorded from Dharug National Park. These are the only records for the species north of the Hawkesbury River.

### C.8.4 Discussion of habitat utilisation

*Kunzea rupestris* has not been recorded from the Project Site.

### C.8.5 Assessment of habitat

This species grows in shallow depressions on large flat sandstone outcrops in short to tall shrubland or heathland (DEC (NSW), 2005q). Potential habitat occurs for the species in E26 Exposed Hawkesbury Woodland, E26a Hawkesbury Rock Pavement Heath, E29 Hawkesbury Banksia Scrub-Woodland and E29a Hawkesbury Banksia Scrub-Woodland (Scrub). The species has not been recorded in Popran National Park.

### C.8.6 Description of habitat values

E26 Exposed Hawkesbury Woodland, E26a Hawkesbury Rock Pavement Heath, E29 Hawkesbury Banksia Scrub-Woodland and E29a Hawkesbury Banksia Scrub-Woodland (Scrub) occur throughout the Project Site, and make up approximately 83% of the total native vegetation (69.4ha out of 83.5ha).

### C.8.7 Extent of habitat removal

*Kunzea rupestris* does not occur on the Project Site. Approximately 33.3ha (48%) of potential habitat would be cleared from the Project Site as a result of the project.

### C.8.8 Consideration of corridors

Habitat within the Project Site is contiguous with Popran National Park, and fragmentation and isolation of habitat would not occur. Popran National Park is part of a large corridor linking Brisbane Water National Park and the Blue Mountains (Morgan, 2001). The Project Site provides native vegetation which is continuous with the vegetation of Popran National Park, and is therefore part of the local corridor system for flora and fauna.

## C.9 Melaleuca deanei

### C.9.1 Discussion of conservation status

*Melaleuca deanei* is listed as vulnerable on Schedule 2 of the TSC Act. It is also listed as vulnerable under the EPBC Act. Its main distribution is in the Ku-ring-gai/Berowra and

Holsworthy/Wedderburn areas but occurs as far north as St Albans, as far south as Colymea State Conservation Area and west as Springwood and Bundanoon. There is a high risk of local extinction due to low population numbers (DEC (NSW), 2005f).

The key threatening processes that generally threaten *Melaleuca deanei* are:

- Clearing of native vegetation which leads to a loss of plants and habitat;
- Weed invasion (exotic vines and scramblers, exotic perennial grasses, Lantana); and
- Ecological consequences of high frequency fires (DEC (NSW), 2005f).

No threat abatement plans relate to this species and no recovery plan has been prepared for this species. Sixteen priority actions have been identified to help recover this species, including:

- Liaise with private and public land managers to facilitate the preparation and implementation of management plans that address threatening processes (Medium priority);
- Incorporate appropriate fire regime into land management practices (Medium priority);
- Restrict vehicular and pedestrian access to sites, where necessary (Medium priority);
- Undertake targeted bush regeneration works, where required (Medium priority); and
- Seek to increase the level of legislative protection for sites through land-use planning mechanisms and conservation agreements. Retain or, where lost, re-establish vegetative linkages between sites where possible (High priority) (DEC (NSW), 2005f).

There are 82 records of *Melaleuca deanei* from the Sydney Basin bioregion in the last 20 years. Many of these are within conservation reserves including Yengo National Park, Parr State Conservation Area, Marra Marra National Park, Ku-ring-gai Chase National Park, Garigal National Park, Lane Cove National Park, Heathcote National Park and Royal National Park. Berowra Valley Regional Park is a strong hold for the species (NSW Government, 2009).

### C.9.2 Discussion of local and regional abundance

There are currently 82 records for the species from the Sydney Basin bioregion from the last 20 years. The main populations occur in the Ku-ring-gai/Berowra and Holsworthy/Wedderburn areas. There is one record of the species in the Gosford LGA from the last 20 years, at Horsfield Bay (NSW Government, 2009).

### C.9.3 Discussion of other known local populations

*Melaleuca deanei* has been recorded at one location in the Gosford LGA in the last 20 years, at Horsfield Bay (NSW Government, 2009). The species has not been recorded on the Project Site or in the adjacent Popran National Park.

### C.9.4 Discussion of habitat utilisation

*Melaleuca deanei* has not been recorded from the Project Site.

### C.9.5 Assessment of habitat

This species has not been recorded on the Project Site. Potential habitat occurs in E26a Hawkesbury Rock Pavement Heath, E29 Hawkesbury Banksia Scrub-Woodland and E29a Hawkesbury Banksia Scrub-Woodland (Scrub). This species has not been recorded in Popran National Park.

### C.9.6 Description of habitat values

E26a Hawkesbury Rock Pavement Heath, E29 Hawkesbury Banksia Scrub-Woodland and E29a Hawkesbury Banksia Scrub-Woodland (Scrub) occur throughout the Project Site, and make up approximately 45% of the total native vegetation (37.6ha out of 83.5ha).

### C.9.7 Extent of habitat removal

*Melaleuca deanei* does not occur on the Project Site. Approximately 20.1ha (53%) of potential habitat would be cleared from the Project Site as a result of the project.

### C.9.8 Consideration of corridors

Habitat within the Project Site is contiguous with Popran National Park, and fragmentation and isolation of habitat would not occur. Popran National Park is part of a large corridor linking Brisbane Water National Park and the Blue Mountains (Morgan, 2001). The Project Site provides native vegetation which is continuous with the vegetation of Popran National Park, and is therefore part of the local corridor system for flora and fauna.

## C.10 Micromyrtus blakelyi

### C.10.1 Discussion of conservation status

*Micromyrtus blakelyi* is listed as vulnerable on Schedule 2 of the TSC Act. It is also listed as vulnerable under the EPBC Act. It is mainly distributed in the Baulkham Hills and Hornsby LGAs with the northern limit north of Maroota and the southern limit at Cowan (DEC (NSW), 2005x). There is one record from north of the Hawkesbury River near Mt White (NSW Government, 2009).

The key threatening processes that generally threaten *Micromyrtus blakelyi* are:

- Clearing of native vegetation which leads to a loss of plants and habitat;
- Weed invasion (exotic vines and scramblers, exotic perennial grasses, Lantana); and

- Ecological consequences of high frequency fires (DEC (NSW), 2005x).

No threat abatement plans relate to this species and no recovery plan has been prepared for this species. Seven priority actions have been identified to help recover this species, none of which are relevant to the Project (DEC (NSW), 2005x).

There are currently 45 records of *Micromyrtus blakelyi* from the Sydney Basin bioregion from the last 20 years. Many records are conserved within Marra Marra National Park with some in Muogamarra Nature Reserve (NSW Government, 2009).

### C.10.2 Discussion of local and regional abundance

The majority of records for this species occur south of the Hawkesbury in the region from Maroota to Cowan. There is one record from north of the Hawkesbury River near Mt White (NSW Government, 2009). The species has not been recorded on the Project Site or within Popran National Park.

### C.10.3 Discussion of other known local populations

*Micromyrtus blakelyi* has not been recorded on the Project Site or the adjacent Popran National Park. The species has been recorded once at Mt White (NSW Government, 2009).

### C.10.4 Discussion of habitat utilisation

*Micromyrtus blakelyi* has not been recorded from the Project Site.

### C.10.5 Assessment of habitat

This species occurs in shallow sandy soils in cracks and depressions on sandstone rock platforms (DEC (NSW), 2005x). It could potentially occur in E26 Exposed Hawkesbury Woodland, E26a Hawkesbury Rock Pavement Heath, E29 Hawkesbury Banksia Scrub-Woodland and E29a Hawkesbury Banksia Scrub-Woodland (Scrub). The species has not been recorded in the section of Popran National Park adjacent to the Project Site.

### C.10.6 Description of habitat values

E26 Exposed Hawkesbury Woodland, E26a Hawkesbury Rock Pavement Heath, E29 Hawkesbury Banksia Scrub-Woodland and E29a Hawkesbury Banksia Scrub-Woodland (Scrub) occur throughout the Project Site, and make up approximately 83% of the total vegetation (69.4ha out of 83.5ha).

### C.10.7 Extent of habitat removal

*Micromyrtus blakelyi* does not occur on the Project Site. Approximately 33.3ha (48%) of potential habitat would be cleared from the Project Site as a result of the project.

### C.10.8 Consideration of corridors

Habitat within the Project Site is contiguous with Popran National Park, and fragmentation and isolation of habitat would not occur. Popran National Park is part of a large corridor linking Brisbane Water National Park and the Blue Mountains (Morgan, 2001). The Project Site provides native vegetation which is continuous with the vegetation of Popran National Park, and is therefore part of the local corridor system for flora and fauna.

## C.11 Diuris bracteata

### C.11.1 Discussion of conservation status

*Diuris bracteata* is listed as endangered on Schedule 1 of the TSC Act. It is not listed under the EPBC Act. Original records for this species were from the Gladesville area and it was once thought to be extinct. The species is now known from only a few locations at Kulnura, Peats Ridge, near Kariong and Duffys Forest. There is a high risk of local extinction due to low population numbers and its restricted distribution (DEC (NSW), 2005g).

Roadside populations of *Diuris braceteata* are under threat from earthworks, herbicide spraying, slashing/mowing and illegal collection (DEC (NSW), 2005g).

No threat abatement plans relate to this species and no recovery plan has been prepared for this species. No priority actions have been identified for this species but it generally requires protection of the known roadside populations (DEC (NSW), 2005g).

There 12 records of this species from the Sydney Basin bioregion from the last 20 years (NSW Government, 2009). It has not been recorded from any conservation reserves.

### C.11.2 Discussion of local and regional abundance

There are currently only 12 records from the Sydney Basin bioregion, the majority of which are from the Gosford LGA (NSW Government, 2009).

### C.11.3 Discussion of other known local populations

*Diuris bracteata* has not been recorded on the Project Site or the adjacent Popran National Park. The species has been recorded at Kulnura and Peats Ridge (NSW Government, 2009).

### C.11.4 Discussion of habitat utilisation

*Diuris bracteata* has not been recorded from the Project Site.

### C.11.5 Assessment of habitat

This species has been recorded from dry scerophyll woodland (DEC (NSW), 2005g) but has not been recorded on the Project Site or Popran National Park. Potential habitat occurs in E26 Exposed Hawkesbury Woodland and E29 Hawkesbury Banksia Scrub-Woodland.

### C.11.6 Description of habitat values

E26 Exposed Hawkesbury Woodland and E29 Hawkesbury Banksia Scrub – Woodland occur throughout the Project Site, and make up approximately 67% of the total native vegetation (55.6ha out of 83.5ha).

### C.11.7 Extent of habitat removal

*Diuris bracteata* does not occur on the Project Site. Approximately 24.7ha (44%) of potential habitat would be cleared from the Project Site as a result of the project.

### C.11.8 Consideration of corridors

Habitat within the Project Site is contiguous with Popran National Park, and fragmentation and isolation of habitat would not occur. Popran National Park is part of a large corridor linking Brisbane Water National Park and the Blue Mountains National Park (Morgan, 2001). The Project Site provides native vegetation which is continuous with the vegetation of Popran National Park, and is therefore part of the local corridor system for flora and fauna.

## C.12 Ancistrachne maidenii

### C.12.1 Discussion of conservation status

*Ancistrachne maidenii* is listed as vulnerable on Schedule 2 of the TSC Act. It is not listed under the EPBC Act. It has a narrow distribution in the St Albans – Mt White – Maroota – Berowra area but has also been found at Shannon Creek near Grafton. There is a high risk of extinction due to low population numbers (DEC (NSW), 2005a).

The key threatening processes that generally threaten *Ancistrachne maidenii* are:

- Clearing of native vegetation which leads to a loss of plants and habitat;
- Weed invasion (exotic vines and scramblers, exotic perennial grasses, Lantana); and
- Ecological consequences of high frequency fires (DEC (NSW), 2005a).

No threat abatement plans relate to this species and no recovery plan has been prepared for this species. Five priority actions have been identified to help recover this species, including:

- Ensure staff undertaking track and roadside maintenance activities are aware of species and its habitat and habitat requirements (Medium priority) (DEC (NSW), 2005a).

There are 33 records from the Sydney Basin bioregion from the last 20 years of *Ancistrachne maidenii.* Several populations have been recorded from Dharug National Park, one from Parr State Conservation Area, several from Yengo National Park and one near Calga. Populations south of the Hawkesbury River occur at near Wisemans Ferry, Muogamarra Nature Reserve, Marra Marra National Park and Berowra Valley Regional Park (NSW Government, 2009).

### C.12.2 Discussion of local and regional abundance

There are 33 records of the species from the Sydney Basin bioregion from the last 20 years. There are 9 records from the Gosford LGA from the last 20 years, the majority of which are within Dharug National Park, with other records occurring near the edge of Brisbane Waters National Park (NSW Government, 2009).

### C.12.3 Discussion of other known local populations

*Ancistrachne maidenii* has not been recorded on the Project Site or the adjacent Popran National Park. The species has been recorded once to the east of Calga.

### C.12.4 Discussion of habitat utilisation

*Ancistrachne maidenii* has not been recorded from the Project Site.

### C.12.5 Assessment of habitat

This species occurs in distinct bands between the Hawkesbury and Watagan soil landscapes in dry sclerophyll forests (DEC (NSW), 2005a). Potential habitat occurs within the E25 Hawkesbury Peppermint Apple Forest, Exposed Hawkesbury Woodland and E29 Hawkesbury Banksia Scrub – Woodland. The species has not been recorded from Popran National Park or on the Project Site.

### C.12.6 Description of habitat values

E25 Hawkesbury Peppermint Apple Forest, Exposed Hawkesbury Woodland and E29 Hawkesbury Banksia Scrub – Woodland occur throughout the Project Site and represent approximately 42% of the total native vegetation (35.3ha out of 83.5ha).

### C.12.7 Extent of habitat removal

*Ancistrachne maidenii* does not occur on the Project Site. Approximately 11.6ha (32.9%) of potential habitat would be cleared from the Project Site as a result of the project.

### C.12.8 Consideration of corridors

Habitat within the Project Site is contiguous with Popran National Park, and fragmentation and isolation of habitat would not occur. Popran National Park is part of a large corridor linking Brisbane Water National Park and the Blue Mountains (Morgan, 2001). The Project Site provides native vegetation which is continuous with the vegetation of Popran National Park, and is therefore part of the local corridor system for flora and fauna.

## C.13 Grevillea shiresii

### C.13.1 Discussion of conservation status

*Grevillea shiressii* is listed as vulnerable on Schedule 2 of the TSC Act. It is also listed as vulnerable under the EPBC Act. It is known from only two populations: one along Mooney Mooney Creek and one along Mullet Creek (NSW Government, 2009). There is a high risk of local extinction due to low population numbers (DEC (NSW), 2005n).

The key threatening processes that generally threaten *Grevillea shiressii* are:

- Clearing of native vegetation which leads to a loss of plants and habitat; and
- Ecological consequences of high frequency fires (DEC (NSW), 2005n).

No threat abatement plans relate to this species and no recovery plan has been prepared for this species. Five priority actions have been identified to help recover this species, including:

- Reserve fire management strategy include operational guidelines to protect this species from fire (Medium priority) (DEC (NSW), 2005n).

There are currently only 2 known populations of the species in the Gosford area. There are 34 records of the species in total, with more populations recorded on the past. The two known populations are conserved within Brisbane Waters National Park (NSW Government, 2009).

### C.13.2 Discussion of local and regional abundance

There are currently only 2 known populations, both from within the Gosford LGA. These are in the tributaries of Mooney Mooney Creek and Mullet Creek (NSW Government, 2009).

### C.13.3 Discussion of other known local populations

*Grevillea shiressii* has been recorded from 2 locations in the Gosford LGA with a total of 7 records from the last 20 years. These locations are at Mooney Mooney Creek and Mullet Creek. The species has not been recorded on the Project Site or within Popran National Park (NSW Government, 2009).

### C.13.4 Discussion of habitat utilisation

Grevillea shiresii has not been recorded from the Project Site.

### C.13.5 Assessment of habitat

This species grows along creek banks in wet sclerophyll forest on alluvial sandy or loamy soils (DEC (NSW), 2005n). Potential habitat occurs within the E2 Sandstone Ranges Gully Rainforest community on the Project Site. It has not been recorded on the Project Site or from within Popran National Park.

### C.13.6 Description of habitat values

E2 Sandstone Ranges Gully Rainforest occurs in a narrow band along Creek C in the western part of the Project Site and within the proposed Glenworth Valley Offset Area. It represents approximately 0.005% of the total native vegetation (0.5ha out of 83.5ha).

### C.13.7 Extent of habitat removal

*Grevillea shiresii* does not occur on the Project Site. No potential habitat would be cleared from the Project Site as a result of the project.

### C.13.8 Consideration of corridors

Habitat within the Project Site is contiguous with Popran National Park, and fragmentation and isolation of habitat would not occur. Popran National Park is part of a large corridor linking Brisbane Water National Park and the Blue Mountains (Morgan, 2001). The Project Site provides native vegetation which is continuous with the vegetation of Popran National Park, and is therefore part of the local corridor system for flora and fauna.

## C.14 Persoonia hirsuta

### C.14.1 Discussion of conservation status

*Persoonia hirsuta* is listed as endangered on Schedule 1 of the TSC Act. It is also listed as endangered under the EPBC Act. This species has been split into two subspecies: *Persoonia hirsuta* subsp. *hirsuta* and *Persoonia hirsuta* subsp. *evoluta*. The subspecies *hirsuta* is recorded from the coastal area of Sydney from Gosford to Berowra, Manly to Royal National Park (DEC (NSW), 2005p).

The key threatening processes that generally threaten *Persoonia hirsuta* are:

- Clearing of native vegetation which leads to a loss of plants and habitat;
- Proliferation of the feral honey bee *Apis mellifera* as it does not pollinate Persoonia species adequately; and
- Ecological consequences of high frequency fires (DEC (NSW), 2005p).

No threat abatement plans relate to this species and no recovery plan has been prepared for this species. Twenty-one priority actions have been identified to help recover this species, including:

- Advise and liaise with private land managers to facilitate the preparation and implementation of site management plans that address threatening processes (High Priority);
- Incorporate best knowledge regarding appropriate fire regime into land management practices (High priority);
- Reserve Fire Management Strategy to include operational guidelines to protect this species from fire (Medium priority);
- Develop and implement site-awareness and protection procedures for use by land owners/managers and public utilities and their contractors when undertaking road, trail, or easement maintenance (High priority);
- Restrict vehicular and pedestrian access to sites, where necessary (High priority);
- Undertake targeted bush regeneration works, where required (High priority);
- Seek to increase the level of legislative protection for sites through land-use planning mechanisms and conservation agreements (Medium priority); and
- Retain or re-establish vegetation and fauna movement linkages between sites (Medium priority) (DEC (NSW), 2005p).

There have been 394 records of *Persoonia hirsuta* from the Sydney Basin bioregion from the last 20 years. These are from Yengo National Park, Parr State Conservation Area, around South Maroota, Wollemi National Park, Ku-ring-gai Chase National Park and many records are from the western side of the Hornsby Plateau near where it meets the Cumberland Plain (NSW Government, 2009).

### C.14.2 Discussion of local and regional abundance

There are 394 records of *Persoonia hirsuta* from the Sydney Basin bioregion from the last 20 years. There is only one record of the species from the Gosford LGA during that period, from Dharug National Park (NSW Government, 2009).

### C.14.3 Discussion of other known local populations

*Persoonia hirsuta* has not been recorded on the Project Site or the adjacent Popran National Park. The species has been recorded once from Dharug National Park (NSW Government, 2009).

### C.14.4 Discussion of habitat utilisation

Persoonia hirsuta has not been recorded from the Project Site.

### C.14.5 Assessment of habitat

This species occurs on sandy soils in dry sclerophyll open forest, woodland and heath on sandstone (DEC (NSW), 2005p). Potential habitat occurs on the Project Site within E25

Hawkesbury Peppermint Apple Forest, E26 Exposed Hawkesbury Woodland, E26a Hawkesbury Rock Pavement Heath, E29 Hawkesbury Banksia Scrub Woodland and E29a Hawkesbury Banksia Scrub-Woodland (Scrub). *Persoonia hirsuta* has not been recorded from the Project Site or from Popran National Park.

### C.14.6 Description of habitat values

E25 Hawkesbury Peppermint Apple Forest, E26 Exposed Hawkesbury Woodland, E26a Hawkesbury Rock Pavement Heath, E29 Hawkesbury Banksia Scrub Woodland and E29a Hawkesbury Banksia Scrub-Woodland (Scrub) occur throughout the Project Site and represent approximately 83% of the total native vegetation (69.4ha out of 83.5ha).

### C.14.7 Extent of habitat removal

*Persoonia hirsuta* does not occur on the Project Site. Approximately 33.3ha (48%) of potential habitat would be cleared from the Project Site as a result of the project.

### C.14.8 Consideration of corridors

Habitat within the Project Site is contiguous with Popran National Park, and fragmentation and isolation of habitat would not occur. Popran National Park is part of a large corridor linking Brisbane Water National Park and the Blue Mountains National Park (Morgan, 2001). The Project Site provides native vegetation which is continuous with the vegetation of Popran National Park, and is therefore part of the local corridor system for flora and fauna.

## C.15 Lasiopetalum joyceae

### C.15.1 Discussion of conservation status

*Lasiopetalum joyceae* is listed as vulnerable on Schedule 1 of the TSC Act. It is also listed as vulnerable under the EPBC Act. Its main distribution is south of the Hawkesbury River between Berrilee and Duffys Forest. There is a high risk of local extinction due to low population numbers (DEC (NSW), 2005t).

The key threatening processes that generally threaten *Lasiopetalum joyceae* are:

- Clearing of native vegetation which leads to a loss of plants and habitat; and
- Ecological consequences of high frequency fires (DEC (NSW), 2005t).

No threat abatement plans relate to this species and no recovery plan has been prepared for this species. Nine priority actions have been identified to help recover this species, including:

- Ensure agencies undertaking fire trail or easement maintenance activities can identify the species and are aware of its habitat (High priority) (DEC (NSW), 2005t).

There have been 100 records of *Lasiopetalum joyceae* from the Sydney Basin bioregion from the last 20 years. These are from Yengo National Park, Parr State Conservation Area and one from the Mangrove Creek Water Supply Reserve, with records south of the Hawkesbury River

occurring in Berowra Valley Regional Park, Marra Marra National Park and Ku-ring-gai Chase National Park (NSW Government, 2009).

### C.15.2 Discussion of local and regional abundance

There are 100 records of *Lasiopetalum joyceae* from the Sydney Basin bioregion from the last 20 years. There is only one record of the species from the Gosford LGA during that period, from Mangrove Creek Water Supply Reserve (NSW Government, 2009).

### C.15.3 Discussion of other known local populations

*Lasiopetalum joyceae* has not been recorded on the Project Site or the adjacent Popran National Park. The species has been recorded once from the Mangrove Creek Water Supply Reserve.

### C.15.4 Discussion of habitat utilisation

*Lasiopetalum joyceae* has not been recorded from the Project Site.

### C.15.5 Assessment of habitat

This species occurs in heath on sandstone (DEC (NSW), 2005t). Potential habitat occurs on the Project Site within E26a Hawkesbury Rock Pavement Heath and E29a Hawkesbury Banksia Scrub-Woodland (Scrub). *Lasiopetalum joyceae* has not been recorded from the Project Site or from Popran National Park.

### C.15.6 Description of habitat values

E26a Hawkesbury Rock Pavement Heath and E29a Hawkesbury Banksia Scrub-Woodland (Scrub) occur throughout the Project Site and represent approximately 17% of the total vegetation (13.8ha out of 83.5ha).

### C.15.7 Extent of habitat removal

*Lasiopetalum joyceae* does not occur on the Project Site. Approximately 8.6ha (62%) of potential habitat would be cleared from the Project Site as a result of the project.

### C.15.8 Consideration of corridors

Habitat within the Project Site is contiguous with Popran National Park, and fragmentation and isolation of habitat would not occur. Popran National Park is part of a large corridor linking Brisbane Water National Park and the Blue Mountains National Park (Morgan, 2001). The

Project Site provides native vegetation which is continuous with the vegetation of Popran National Park, and is therefore part of the local corridor system for flora and fauna.

## C.16 Glossy Black Cockatoo

### C.16.1 Discussion of conservation status

The Glossy Black Cockatoo is listed as vulnerable on Schedule 2 of the TSC Act. It is not listed under the EPBC Act. The species occurs along the east coast of Australia from Rockhampton in Queensland to western Victoria with isolated populations on King and Kangaroo Islands (NSW NPWS, 1999). The Glossy Black Cockatoo is not at the limit of its known distribution.

The key threatening processes that generally threaten the Glossy Black Cockatoo are:

- Clearing of native vegetation which leads to a loss of foraging and nesting habitat;
- Competition from feral honeybees which leads to a loss of nesting habitat;
- Ecological consequences of high frequency fires as this leads to habitat fragmentation, loss of foraging and loss of nesting resources; and
- Loss of hollow-bearing trees as this leads to a loss of nesting habitat (DEC(NSW), 2005l).

No threat abatement plans relate to this species and no recovery plan has been prepared for this species. Nine priority actions have been developed to help recover this species, including:

- Identify and map key breeding and foraging habitat (High priority);
- Encourage the restoration of foraging habitat that has been cleared or degraded by previous impacts (Medium priority); and
- Provide incentives for landholders to fence and manage key sites (Medium priority) (DEC(NSW), 2005l).

The Glossy Black Cockatoo has been recorded in Brisbane Water National Park, Popran National Park, Dharug National Park.

### C.16.2 Discussion of local and regional abundance

The Glossy Black Cockatoo has been recorded from 289 locations in the Gosford LGA and 1469 locations in the Sydney Basin Bioregion (NSW Government, 2009).

### C.16.3 Discussion of other known local populations

It is unknown how many populations occur in the locality due to the distribution of records, which are scattered throughout the locality (see **Figure 4.1**). It is likely however, that individuals from more than one population interbreed and disperse through the locality.

### C.16.4 Discussion of habitat utilisation

Three individuals have been observed on the Project Site, feeding among *Allocasuarina littoralis* and drinking from one of the creeks. The species needs an abundant food source to maintain a population and it is likely that a population or part thereof uses the Project Site as part of a wider foraging range. This family group may also nest on the Project Site.

### C.16.5 Assessment of habitat

The Glossy Black Cockatoo is a specialised feeder, only eating seeds of trees from the genera *Casuarina* and *Allocasuarina* (DEC(NSW), 2005l). Its distribution reflects the distribution of these plant genera. The species also requires large tree hollows for nesting (NSW NPWS, 1999). The Glossy Black Cockatoo is usually observed in family parties of no more than 10 birds (NSW NPWS, 1999).

### C.16.6 Description of habitat values

The Project Site provides foraging and potential nesting habitat. Foraging habitat occurs across much of the Study Area but the best quality foraging is found in communities E25, E26, E26a, and E29 where Allocasuarinas form an abundant understorey. Nesting habitat is present as many of the trees on the Project Site are likely to have formed large hollows. There are approximately 68.5ha of potential foraging habitat on the Project Site. This habitat is in generally good condition across the Project Site, with few weed infestations. Similar habitat is distributed throughout the locality.

### C.16.7 Extent of habitat removal

Up to 24.7ha of the 68.5ha of foraging habitat available for this species on the Project Site would be cleared (approximately 36%). Potential nesting hollows will also be lost from the Project Site. Extensive areas of similar habitat exist in the locality, of which some is protected in the adjacent Popran National Park.

### C.16.8 Consideration of corridors

Due to the Glossy Black Cockatoo being highly mobile (NSW NPWS, 1999), it is not considered that continuous vegetation is required for dispersal between habitat areas. Broad corridors occur in the locality through Popran, Brisbane Water and Dharug National Parks and across the region. Vegetation on the Project Site makes up part of a corridor between these National Parks in the locality and although the width of the corridor would be reduced, it is not likely that the Project would hinder movement of the species.

## C.17 Gang-gang Cockatoo

### C.17.1 Discussion of conservation status

The Gang-gang Cockatoo is listed as vulnerable on Schedule 2 of the TSC Act. It is not listed under the EPBC Act. The species occurs from southern Victoria through south and central-eastern NSW (DEC (NSW), 2005j). The Gang-gang Cockatoo is not at the limit of its known distribution.

The key threatening processes that generally threaten the Gang-gang Cockatoo are:

- Clearing of native vegetation which leads to a loss of foraging and nesting habitat;
- Competition from feral honeybees which leads to a loss of nesting habitat;
- Ecological consequences of high frequency fires as this leads to habitat fragmentation, loss of foraging and loss of nesting resources;
- Loss of hollow-bearing trees as this leads to a loss of nesting habitat;
- Climate change which may alter the nature and extent of cool temperate habitat; and
- The spread of Psittacine circoviral disease (PCD) (DEC (NSW), 2005j).

No threat abatement plans relate to this species and no recovery plan has been prepared for this species. Eleven priority actions have been developed to help recover this species, including:

- Increase landholder and public awareness of status, threats and priority actions (Low priority); and
- Negotiate management agreements and covenants over important areas of habitat (Medium priority) (DEC (NSW), 2005j).

The Gang-gang Cockatoo has been recorded in Popran National Park and Dharug National Park.

### C.17.2 Discussion of local and regional abundance

The Gang-gang Cockatoo has been recorded from 59 locations in the Gosford LGA and 1131 locations in the Sydney Basin Bioregion (NSW Government, 2009).

### C.17.3 Discussion of other known local populations

It is unknown how many populations occur in the locality due to the distribution of records, which are scattered throughout the locality (see **Figure 4.1**). It is likely however, that individuals from more than one population interbreed and disperse through the locality.

### C.17.4 Discussion of habitat utilisation

No Gang-gang Cockatoos have been observed on the Project Site, and the occurrence of this species on the Project Site is unlikely. The Project Site does not provide significant habitat for this species.

### C.17.5 Assessment of habitat

The Gang-gang Cockatoo is an altitudinal migrant, occurring in tall mountain forests and woodlands during summer, and in drier, more open forest and woodland at lower altitudes during winter. Gang-gang Cockatoos favour old-growth forest communities as forage and nesting habitat (DEC (NSW), 2005j).

### C.17.6 Description of habitat values

The Project Site provides potential winter foraging habitat. Foraging habitat occurs across much of the Study Area but the best quality foraging is found where Eucalyptus and Acacia trees are plentiful. Nesting occurs in summer, in tall mountain forests, so the Project Site is not likely to provide significant nesting habitat for the Gang-gang Cockatoo. There is approximately 80ha of potential foraging habitat for the species on the Project Site. This habitat is in generally good condition across the Project Site, with few weed infestations. Similar habitat is distributed throughout the locality.

### C.17.7 Extent of habitat removal

Up to 33.3ha of the 80ha of potential foraging habitat available for this species on the Project Site would be cleared (approximately 42%). Extensive areas of similar habitat exist in the locality, of which some is protected in the adjacent Popran National Park. Removal of significant nesting habitat for the Gang-gang Cockatoo within the Project Site is unlikely.

### C.17.8 Consideration of corridors

Due to the Gang-gang Cockatoo being highly mobile (DEC (NSW), 2005j), it is not considered that continuous vegetation is required for dispersal between habitat areas. Broad corridors occur in the locality through Popran, Brisbane Water and Dharug National Parks and across the region. Vegetation on the Project Site makes up part of a corridor between these National Parks in the locality and although the width of the corridor would be reduced, it is not likely that the Project would hinder movement of the species.

## C.18 Powerful Owl

### C.18.1 Discussion of conservation status

The Powerful Owl (Ninox strenua) is listed as vulnerable on Schedule 2 of the TSC Act (NSW Scientific Committee, 2004d). Powerful Owls occur along the south-eastern coast of Australia, from southern Queensland to eastern South Australia (DEC (NSW), 2005z). The Project Site is not near the limit of this species distribution.

The Powerful Owl is at threat from the following:

- Destruction of suitable forest and woodland habitat;
- Forest management practices that reduce availability of food or that result in the loss of old trees and large tree-hollows;
- High-frequency burning; and
- Disturbances during the breeding period, such as clearing, logging or burning.

A recovery plan has been written for large forest owls which includes the Powerful Owl. Objectives include (DEC (NSW), 2006b):

- Protecting habitat off-reserves and in State Forests;
- Minimising impacts of development activities;
- Modelling and mapping owl habitat;
- Monitoring trends in owl populations;
- Assessing management of forestry activities;
- Increasing knowledge of biology and ecology; and
- Increasing community awareness.

Management actions suggested by the DECC include protecting nest sites, retaining riparian areas, and preserving hollow-bearing trees. Twenty-one priority actions have been developed to help recover this species, including:

- Use records of concurrence and licence conditions to develop a set of prescriptive guidelines that may be used to mitigate the impacts of developments on the Powerful Owl outside conservation reserves and State forests (Medium priority); and
- Encourage private landholders to undertake management options to conserve and/or actively manage forest owl habitat (Medium priority).

The Powerful Owl has been recorded in Brisbane Water National Park, Popran National Park

### C.18.2 Discussion of local and regional abundance

The Powerful Owl has been recorded from 79 locations in the Gosford LGA and 860 locations in the Sydney Basin Bioregion (NSW Government, 2009).

### C.18.3 Discussion of other known local populations

There are a number of records of Powerful Owls from the Somersby Plateau as well as to the west in Dharug National Park (NSW Government, 2009), Although no specific information exists on the local population, a Powerful Owl was recorded by Countrywide Ecological Service from nearby in Popran National Park. This is likely to be part of a broadly distributed population which exists in the northern part of the Sydney Basin Bioregion.

### C.18.4 Discussion of habitat utilisation

No Powerful Owls were recorded on the Project Site, however an individual has been recorded responding to call playback from nearby in Popran National Park (Countrywide Ecological Service 2004). Powerful Owls have large home ranges (DEC (NSW), 2005z) and the Project Site is likely to form part of the home range of this owl.

### C.18.5 Assessment of habitat

Powerful Owls breed and hunt in open or closed sclerophyll forest or woodlands and occasionally hunt in open habitats (DEC (NSW), 2005z). They feed on larger arboreal marsupials, megachiropteran bats, and other fauna captured in trees.

Pairs of Powerful Owls are believed to have high fidelity to a small number of hollow-bearing nest trees and would defend a large home range of 400-1450 ha. The Powerful Owl requires large areas of forest or woodland habitat but can occur in fragmented landscapes as well. This species occurs mainly in tall moist eucalypt forest and woodland although its preferred habitat is densely forested gullies with adjacent more open forest containing old growth trees with hollows. They roost by day in dense vegetation, commonly along drainage lines, but require tree hollows for nesting (DEC (NSW), 2005z).

### C.18.6 Description of habitat values

A number of large stags and trees with large hollows exist on the Project Site, which could provide nesting opportunities for this species. Arboreal mammals (such as Ring-tailed Possums and Sugar Gliders) utilising the Study Area provide potential prey for Powerful Owls. Approximately 104.5ha of foraging habitat exists on the Project Site. Large expanses of potential foraging and roosting habitat are present throughout the National Parks in the locality. The condition of habitat in the locality is good, due to much of it being in conservation reserves. The potential habitat on the subject site is not a significant area of known habitat for the species and a proportion of this habitat would be retained and conserved on site.

### C.18.7 Extent of habitat removal

Clearing would only impact on up to 45.7ha of habitat. This is a small proportion of the home range for this species, and is likely to be low quality habitat compared to habitat that is available in the area. Clearing would include removal of potential roosting and nesting sites, as well as foraging habitat.

### C.18.8 Consideration of corridors

Due to the Powerful Owl being highly mobile (DEC (NSW), 2005z), it is not considered that continuous vegetation is required for dispersal between habitat areas. Broad corridors occur in the locality through Popran, Brisbane Water and Dharug National Parks and across the region. Vegetation on the Project Site makes up part of a corridor between these National Parks in the locality and although the width of the corridor would be reduced, it is not likely that the Project would hinder movement of the species.

## C.19 Masked Owl

### C.19.1 Discussion of conservation status

The Masked Owl (*Tyto novaehollandiae*) is listed as vulnerable on Schedule 2 of the TSC Act. It is not listed under the EPBC Act. Masked Owls occur along the eastern, northern and western coast of Australia. In NSW this species occurs from the coast (where it is most abundant) inland to the western plains (DEC (NSW), 2005w). The Project Site is not near the limit of the distribution of this species.

The Masked Owl is at threat from the following:

- Loss of hollow-bearing trees and recruitment hollow-bearing trees;
- Clearing for grazing, agriculture, forestry or development;
- Grazing and burning affecting habitat of prey;
- Secondary poisoning from rodenticide; and
- Vehicle strike. (DEC (NSW), 2005w)

A recovery plan has been written for large forest owls which includes the Masked Owl. Objectives include (DEC (NSW), 2006b):

- Protecting habitat off-reserves and in State Forests;
- Minimising impacts of development activities;
- Modelling and mapping owl habitat;
- Monitoring trends in owl populations;
- Assessing management of forestry activities;

- Increasing knowledge of biology and ecology; and
- Increasing community awareness.

Management actions suggested by the DECC include protecting nest sites, retaining riparian areas, and preserving hollow-bearing trees. Twenty one priority actions have been developed to help recover this species, including:

- Encourage private landholders to undertake management options to conserve and/or actively manage forest owl habitat (Medium priority);
- Use records of concurrence and licence conditions to develop a set of prescriptive guidelines that may be used to mitigate the impacts of developments on the Masked Owl outside conservation reserves and State forests (Medium priority);
- Monitor and report on effectiveness of concurrence and licence conditions previously applied to reduce impacts of development on Masked Owls and their habitats, by recording conditions, picking case studies and checking owl presence post development (Medium priority) (DEC (NSW), 2005w).

The Masked Owl has been recorded in Brisbane Water National Park, Dharug National Park, Yengo National Park, Ku-ring-gai Chase National Park, Berowra Valley Regional Park, Marra Marra National Park and Blue Mountains National Park (NSW Government, 2009).

### C.19.2 Discussion of local and regional abundance

There have been 31 records of the Masked Owl from the Gosford LGA in the last 20 years and 285 records from the last 20 years in the Sydney Basin Bioregion (NSW Government, 2009).

### C.19.3 Discussion of other known local populations

There are a number of records of Masked Owls from the Mooney Mooney Creek and Mount White Area as well as to the west in Dharug National Park (NSW Government, 2009). Although no specific information exists on the local population, the Masked Owls recorded in the locality are likely to be part of a broadly distributed population which exists in the northern part of the Sydney Basin Bioregion.

### C.19.4 Discussion of habitat utilisation

No Masked Owls were recorded on the Project Site. Masked Owls have large home ranges (DEC (NSW), 2005w) and the Project Site is likely to form part of the home range of this owl.

### C.19.5 Assessment of habitat

Masked Owls roost and breed in moist eucalypt forested gullies, nesting in large tree hollows or occasionally caves and hunt within and at the forest edge. They feed on small arboreal and ground-dwelling mammals, particularly rats (DEC (NSW), 2005w).

Pairs of Masked Owls hunt within a large home range of 500-1000 ha. The Masked Owl requires large areas of forest or woodland habitat but can occur in fragmented landscapes as well.

but they require tree hollows for nesting (DEC (NSW), 2005w).

### C.19.6 Description of habitat values

A number of large stags and trees with large hollows exist on the Project Site, which could provide nesting opportunities for this species. Arboreal mammals (such as Ring-tailed Possums and Sugar Gliders) and ground-dwelling mammals (such as Bush Rats and Antechinus) utilising the Study Area provide potential prey for Masked Owls. Approximately 104.5ha of foraging habitat exists on the Project Site. Large expanses of potential foraging and roosting habitat are present throughout the National Parks in the locality. The condition of habitat in the locality is good, due to much of it being in conservation reserves. The potential habitat on the subject site is not a significant area of known habitat for the species and a proportion of this habitat would be retained and conserved on site.

### C.19.7 Extent of habitat removal

Clearing would only impact on up to 45.7ha of potential habitat. This is a small proportion of the home range for this species, and is likely to be low quality habitat compared to habitat that is available in the area (i.e. downstream). Clearing would include removal of potential roosting and nesting sites, as well as foraging habitat.

### C.19.8 Consideration of corridors

Due to the Masked Owl being highly mobile, it is not considered that continuous vegetation is required for dispersal between habitat areas. Broad corridors occur in the locality through Popran, Brisbane Water and Dharug National Parks and across the region. Vegetation on the Project Site makes up part of a corridor between these National Parks in the locality and although the width of the corridor would be reduced, it is not likely that the Project would hinder movements of the species.

## C.20 Barking Owl

### C.20.1 Discussion of conservation status

The Barking Owl (*Ninox connivens*) is listed as vulnerable on Schedule 2 of the TSC Act. It is not listed under the EPBC Act. Barking Owls occur throughout Australia except for the central arid areas and Tasmania. In NSW this species occurs most frequently on the western slopes and plains. It is uncommon on the coast and escarpment areas (DEC (NSW), 2005b). The Project Site is not near the limit of the distribution of this species.

The Barking Owl is at threat from the following:

- Loss of hollow-bearing trees and recruitment hollow-bearing trees, and loss of dead wood;
- Clearing for grazing, agriculture, forestry or development;
- Inappropriate forestry practices changing the structure of habitat and removing old growth trees; and
- Grazing and burning affecting habitat of prey (DEC (NSW), 2005b).

A recovery plan has been written for the Barking Owl. Objectives include:

- Increasing knowledge of biology, ecology and management;
- Increase education, awareness and involvement in conservation;
- Undertake threat abatement and mitigation;
- Gain efficiencies through links with other conservation plans and groups; and
- Provide organisational support (NSW NPWS, 2003a).

Management actions suggested by the DECC include protecting retaining riparian and forest habitats, hazard reduction burning in mosaic patterns and preserving hollow-bearing and dead trees. Seventeen priority actions have been developed to help recover this species, including:

- Negotiate with individual land managers to achieve appropriate measures to protect all known Barking Owl nest sites in NSW. Protection will need to address threats such as human disturbance, collision with wires, secondary poisoning from chemicals (Medium priority);
- Incorporate the consideration of Barking Owl habitat and potential habitat as a high priority in the assessment of property for reserve establishment (High priority); and
- Establish formal conservation arrangements for properties with Barking Owls, which can be used to protect wildlife habitat (Low priority) (DEC (NSW), 2005b).

The Barking Owl has been recorded in Yengo National Park, Dharug National Park, Brisbane Water National Park, Ku-ring-gai Chase National Park, Berowra Valley Regional Park, Blue Mountains National Park, Wollemi National Park, Nattai National Park and Yerranderie State Conservation Area (NSW Government, 2009).

### C.20.2 Discussion of local and regional abundance

There have been 37 records of the Barking Owl from the Gosford LGA in the last 20 years and 140 records from the last 20 years in the Sydney Basin Bioregion (NSW Government, 2009).

### C.20.3 Discussion of other known local populations

The Barking Owl has been recorded sporadically throughout the Gosford LGA with records from Dharug National Park near Mangrove Creek, at Mangrove Mountain and one record from Strickland State Forest. The species has been more frequently recorded close to the coast and around Brisbane Water including Bouddi National Park and Brisbane Water National Park (NSW Government, 2009).

### C.20.4 Discussion of habitat utilisation

No Barking Owls were recorded on the Project Site. Barking Owls have large home ranges and the Project Site may form part of the home range of this species.

### C.20.5 Assessment of habitat

Barking Owls occur in eucalypt woodland, open forest and swamp woodland, especially along watercourses. They roost in dense foliage along creeklines and feed mainly on invertebrates but birds and small mammals are important part of the diet during breeding (DEC (NSW), 2005b).

Barking Owls have a home range of 30 to 200ha that they use year round. Hollows of large, old eucalypts are used for nests (DEC (NSW), 2005b).

### C.20.6 Description of habitat values

A number of large stags and trees with large hollows exist on the Project Site, which could provide nesting opportunities for this species. Arboreal mammals (such as Ring-tailed Possums and Sugar Gliders) and ground-dwelling mammals (such as Bush Rats and Antechinus) utilising the study area provide potential prey for Barking Owls. Approximately 104.5ha of foraging habitat exists on the Project Site. Large expanses of potential foraging and roosting habitat are present throughout the National Parks in the locality and will be retained in the Offset Areas. The condition of habitat in the locality is good, due to much of it being in conservation reserves. The potential habitat on the Project Site is not a significant area of known habitat for the species and a proportion of this habitat would be retained and conserved within the Offset Areas.

### C.20.7 Extent of habitat removal

Clearing would only impact on up to 45.7ha of potential habitat. This is a small proportion of the home range for this species, and is likely to be low quality habitat compared to habitat that is available in the area. Clearing would include removal of potential roosting and nesting sites, as well as foraging habitat.

### C.20.8 Consideration of corridors

Due to the Barking Owl being highly mobile, it is not considered that continuous vegetation is required for dispersal between habitat areas. Broad corridors occur in the locality through Popran, Brisbane Water and Dharug National Parks and across the region. Vegetation on the Project Site makes up part of a corridor between these National Parks in the locality and although the width of the corridor would be reduced, it is not likely that the Project would hinder movements of the species.

## C.21 Yellow-bellied Sheath-tailed Bat

### C.21.1 Discussion of conservation status

The Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*) is listed as vulnerable on Schedule 2 of the TSC Act. It is not listed under the EPBC Act. They occur across eastern and northern Australia. In NSW this species occurs from the coast (where it is most abundant) inland to the North-western Slopes (DEC (NSW), 2005i1). The Project Site is not near the limit of the distribution of this species.

The Yellow-bellied Sheathtail-bat is at threat from the following:

- Loss of hollow-bearing trees and recruitment hollow-bearing trees;
- Clearing for grazing, agriculture, forestry or development;
- Disturbance to roosting and summer breeding sites; and
- Pesticides and herbicides may reduce the availability of insects, or result in the accumulation of toxic residues in individuals' fat stores (DEC (NSW), 2005i1).

No threat abatement plans relate to this species and no recovery plan has been prepared for this species. Twenty priority actions have been developed to help recover this species, including:

- Ensure the largest hollow bearing trees (including dead trees and paddock trees) are given highest priority for retention in PVP assessments and or other land assessment tools (High priority);
- Promote the conservation of these High Conservation Value (HCV) private land areas using measures such as incentive funding to landholders, off-setting and biobanking, acquisition for reserve establishment or other means (High priority); and
- Identify areas of private land that contain high densities of large, hollow-bearing trees as areas of high conservation value planning instruments and land management negotiations e.g. LEP, CAPs, PVPs (High priority) (DEC (NSW), 2005i1).

The Yellow-bellied Sheathtail-bat has been recorded in Bouddi National Park, and they are known to occur in Yengo National Park, Ourimbah State Forest, Blue Mountains National Park and Holsworthy Military Area in the Sydney Basin Bioregion (NSW Government, 2009).

### C.21.2 Discussion of local and regional abundance

There have been 5 records of the Yellow-bellied Sheathtail-bat from the Gosford LGA in the last 20 years and 52 records from the last 20 years in the Sydney Basin Bioregion (NSW Government, 2009).

### C.21.3 Discussion of other known local populations

There are few records of Yellow-bellied Sheathtail-bat from the local area, one of which is from Bouddi National Park to the south-east of the Project Site. Although no specific information exists on the local population, the few Yellow-bellied Sheathtail-bats recorded in the locality are likely to be part of a broadly distributed population which exists in the northern part of the Sydney Basin Bioregion.

### C.21.4 Discussion of habitat utilisation

No Yellow-bellied Sheathtail-bats were recorded on the Project Site. They forage over large areas and the Project Site is likely to form part of the broader foraging area for this species.

### C.21.5 Assessment of habitat

Yellow-bellied Sheathtail-bats occur in a variety of habitats, from wet and dry sclerophyll forest and open woodland. They are insectivorous and forage high in the canopy. Animals roost singly or in groups of up to six, in tree hollows and buildings; in treeless areas they are known to utilise mammal burrows (Churchill, 1998).

Yellow-bellied Sheathtail-bats forage in most habitats across a very wide range, with and without trees and appear to defend an aerial territory. Although unconfirmed, it is thought that they may migrate to southern Australia in late summer and autumn (Churchill, 1998).

### C.21.6 Description of habitat values

A number of large stags and trees with large hollows exist on the Project Site, which could provide roosting opportunities for this species. Areas of vegetation, such as the Sandstone Hanging Swamp in the “Glenworth Valley” Offset Area provide particularly high quality foraging habitat due to an abundance of insect life. Approximately 83.5ha of potential foraging habitat exists on the Project Site. Large expanses of potential foraging and roosting habitat are present throughout the National Parks in the locality. The condition of habitat in the locality is good, due to much of it being in conservation reserves. The potential habitat on the subject

site is not a significant area of known habitat for the species and a proportion of this habitat would be retained and conserved on site.

### C.21.7 Extent of habitat removal

Clearing would only impact on up to 34.7ha of potential habitat for this species. This is a very small proportion of the home range of the species, and is likely to be low quality habitat compared to habitat that is available in the area (i.e. downstream). Clearing would include removal of potential roosting and foraging habitat.

### C.21.8 Consideration of corridors

Due to the Yellow-bellied Sheathtail-bat being highly mobile, it is not considered that continuous vegetation is required for dispersal between habitat areas. Broad corridors occur in the locality through Popran, Brisbane Water and Dharug National Parks and across the region. Vegetation on the Project Site makes up part of a corridor between these National Parks in the locality and although the width of the corridor would be reduced, it is not likely that the Project would hinder movements of the species.

## C.22 Eastern Freetail-bat

### C.22.1 Discussion of conservation status

The Eastern Freetail-bat (*Mormopterus norfolkensis*) is listed as vulnerable on Schedule 2 of the TSC Act. It is not listed under the EPBC Act. The species occurs along the east coast from south Queensland to southern NSW. The Project Site is not near the limit of the distribution of this species.

The Eastern Freetail-bat is at threat from the following:

- Loss of hollow-bearing trees and recruitment hollow-bearing trees; and
- Clearing for grazing, agriculture, forestry or development.

No threat abatement plans relate to this species and no recovery plan has been prepared for this species. Eighteen priority actions have been developed to help recover this species, including:

- Ensure the largest hollow bearing trees, inc. dead trees and paddock trees, are given highest priority for retention in PVP assessments. Offsets should include remnants in high productivity (High priority);
- Identify areas of private land that contain high densities of large hollow-bearing trees as areas of high conservation value planning instruments and land management negotiations e.g. LEP, CAPs, PVPs (High priority); and

- Promote the conservation of these private land areas using measures such as incentive funding to landholders, off-setting and biobanking, acquisition for reserve establishment or other means (High priority).

The Eastern Freetail-bat has been recorded from Yengo National Park, Olney State Forest, Parr State Conservation Area, Wollemi National Park, Dharug National Park, Bouddi National Park, Brisbane Water National Park, Marra Marra National Park, Cattai National Park, Scheyville National Park, Gulguer Nature Reserve, Mulgoa Nature Reserve, Blue Mountains National Park and Dharawal State Conservation Area in the Sydney Basin Bioregion (NSW Government, 2009).

### C.22.2 Discussion of local and regional abundance

There have been 17 records of the Eastern Freetail-bat from the Gosford LGA in the last 20 years and 357 records from the last 20 years in the Sydney Basin Bioregion (NSW Government, 2009).

### C.22.3 Discussion of other known local populations

There are a number of records of the Eastern Freetail-bat from the Gosford LGA, from near Popran National Park, Point Clare to the east, and Somersby and Peats Ridge to the north of the Project Site (NSW Government, 2009). Although no specific information exists on the local population, those recorded in the locality are likely to be part of a broadly distributed population which exists in the northern part of the Sydney Basin Bioregion.

### C.22.4 Discussion of habitat utilisation

No Eastern Freetail-bats were recorded on the Project Site. They forage over large areas and the Project Site is likely to form part of the broader foraging area for this species.

### C.22.5 Assessment of habitat

Eastern Freetail-bats occur in dry sclerophyll forest and woodland east of the Great Dividing Range. They roost mainly in tree hollows but will also roost under bark or in man-made structures. Little is known about their diet, although it is likely that they are insectivorous (Churchill, 1998, DEC (NSW), 2005h).

### C.22.6 Description of habitat values

A number of large stags and trees with large hollows exist on the Project Site, which could provide roosting opportunities for this species. Areas of vegetation, such as the Sandstone Hanging Swamp in the “Glenworth Valley” Offset Area provide particularly high quality foraging habitat due to an abundance of insect life. Approximately 83.5ha of potential foraging habitat exists on the Project Site. Large expanses of potential foraging and roosting habitat are

present throughout the National Parks in the locality. The condition of habitat in the locality is good, due to much of it being in conservation reserves. The potential habitat on the Project Site is not a significant area of known habitat for the species and a proportion of this habitat would be retained and conserved in the Offset Areas.

### C.22.7 Extent of habitat removal

Clearing would only impact on up to 34.7ha of potential habitat. This is a very small proportion of the home range for this species, and is likely to be low quality habitat compared to habitat that is available in the Offset Areas. Clearing would include removal of potential roosting and foraging habitat.

### C.22.8 Consideration of corridors

Due to the Eastern Freetail-bat being highly mobile, it is not considered that continuous vegetation is required for dispersal between habitat areas. Broad corridors occur in the locality through Popran, Brisbane Water and Dharug National Parks and across the region. Vegetation on the Project Site makes up part of a corridor between these National Parks in the locality and although the width of the corridor would be reduced, it is not likely that the Project would hinder movements of the species.

## C.23 Little Bentwing-bat

### C.23.1 Discussion of conservation status

The Little Bentwing-bat (*Miniopterus australis*) is listed as vulnerable on Schedule 2 of the TSC Act. It is not listed under the EPBC Act. They occur on coastal north-eastern NSW and eastern Queensland (DEC (NSW), 2005u). The Project Site is not near the limit of the distribution of this species.

The Little Bentwing-bat is at threat from the following:

- Destruction of caves that provide seasonal or potential roosting sites; and
- Clearing for grazing, agriculture, forestry or development (DEC (NSW), 2005u).

No threat abatement plans relate to this species and no recovery plan has been prepared for this species. Twenty-five priority actions have been developed to help recover this species, including:

- Protect significant roosts and forest habitat within 10 km of roosts in PVP assessments (offsets should include nearby remnants in high productivity) and other environmental planning instruments (Medium priority); and
- Promote the conservation of these significant roost areas using measures such as incentive funding to landholders, offsetting and biobanking, acquisition for reserve establishment or other means (Low priority) (DEC (NSW), 2005u).

The Little Bentwing-bat has been recorded in Brisbane Water National Park and Bouddi National Park in the Gosford LGA. They are known to occur in Newnes State Forest, Wollemi National Park, Lake Macquarie State Conservation Area and Olney State Forest in the Sydney Basin Bioregion (NSW Government, 2009).

### C.23.2 Discussion of local and regional abundance

There have been 34 records of the Little Bentwing-bat from the Gosford LGA in the last 20 years and 190 records from the last 20 years in the Sydney Basin Bioregion (NSW Government, 2009).

### C.23.3 Discussion of other known local populations

There are a number records of Little Bentwing-bats from the local area, one of which is from Brisbane Water National Park, and further to the east of the Project Site around Bouddi NP and Gosford (NSW Government, 2009). Although no specific information exists on the local population, those recorded in the locality are likely to be part of a broadly distributed population which exists in the northern part of the Sydney Basin Bioregion.

### C.23.4 Discussion of habitat utilisation

No Little Bentwing-bats were recorded on the Project Site. They forage over large areas and the Project Site is likely to form part of the broader foraging area for this species. The Project Site does not provide suitable breeding habitat for this species as they require deep caves.

### C.23.5 Assessment of habitat

Little Bentwing-bats occur in moist eucalypt forest, rainforest or dense coastal banksia scrub. They roost in caves, tunnels and sometimes tree hollows during the day, and at night forage for small insects beneath the canopy of densely vegetated habitats. Roost sites can be shared with other micro-bat species such as the Common Bentwing-bat and, in winter, the two species may form mixed clusters (DEC (NSW), 2005u).

In NSW the largest maternity colony is in close association with a large maternity colony of Common Bentwing-bats (*M. schreibersii*) and appears to depend on the large colony to provide the high temperatures needed to rear the young (DEC (NSW), 2005u).

### C.23.6 Description of habitat values

No known maternity sites or caves occur on the Project Site, although sandstone outcrops may provide suitable habitat in the study area. Areas of vegetation, such as the Sandstone Hanging Swamp in the “Glenworth Valley” Offset Area provide particularly high quality foraging habitat due to an abundance of insect life. Approximately 83.5ha of potential foraging habitat

exists on the Project Site. Large expanses of potential foraging and roosting habitat are present throughout the National Parks in the locality. The condition of habitat in the locality is good, due to much of it being in conservation reserves. The potential habitat on the Project Site is not a significant area of known habitat for the species and a proportion of this habitat would be retained and conserved within the Offset Areas.

### C.23.7 Extent of habitat removal

Clearing would only impact on up to 34.7ha of potential foraging habitat. This is likely to represent a small proportion of the home range for this species. Clearing would include removal of potential foraging habitat but would not affect roosting habitat.

### C.23.8 Consideration of corridors

Due to the Little Bentwing-bat being highly mobile, it is not considered that continuous vegetation is required for dispersal between habitat areas. Broad corridors occur in the locality through Popran, Brisbane Water and Dharug National Parks and across the region. Vegetation on the Project Site makes up part of a corridor between these National Parks in the locality and although the width of the corridor would be reduced, it is not likely that the Project would hinder movements of the species.

## C.24 Large-eared Pied Bat

### C.24.1 Discussion of conservation status

The Large-eared Pied Bat (*Chalinolobus dwyeri*) is listed as vulnerable on Schedule 2 of the TSC Act and as vulnerable under the EPBC Act. The species occurs along coastal north-eastern NSW and in eastern Queensland (DEC (NSW), 2005r). The Project Site is not near the limit of the distribution of this species.

The Large-eared Pied Bat is at threat from the following:

- Clearing and isolation of forest near roost habitat for development, agriculture, through forestry and fire;
- Damage to roost and maternity caves through mining and recreational caving; and
- Use of pesticides (DEC (NSW), 2005u).

No threat abatement plans relate to this species and no recovery plan has been prepared for this species. Twenty-five priority actions have been developed to help recover this species, including:

- Ensure protection of caves and overhangs in area of suitable geology when undertaking PVP assessments (offsets should include nearby remnants in high productivity) or other land assessment tools (High priority) (DEC (NSW), 2005u).

The Large-eared Pied Bat has been recorded in Yengo National Park, Wollemi National Park, Newnes State Forest, Watagans National Park, Olney State Forest, Bouddi National Park, Scheyville National Park, Blue Mountains National Park, Mulgoa Nature Reserve and Royal National Park in the Sydney Basin bioregion (NSW Government, 2009).

### C.24.2 Discussion of local and regional abundance

There have been 5 records of the Large-eared Pied Bat from the Gosford LGA in the last 20 years and 289 records from the last 20 years in the Sydney Basin Bioregion (NSW Government, 2009).

### C.24.3 Discussion of other known local populations

There are few records of Large-eared Pied Bats from the Gosford LGA, with three records from around Central Mangrove and McPherson State Forest, one from Bouddi National Park and one near Gosford (NSW Government, 2009). Although no specific information exists on the local population, those recorded in the locality are likely to be part of a broadly distributed population which exists in the northern part of the Sydney Basin Bioregion.

### C.24.4 Discussion of habitat utilisation

No Large-eared Pied Bats were recorded on the Project Site. They forage over large areas and the Project Site is likely to form part of the broader foraging area for this species. The Project Site may provide some suitable breeding habitat for this species as they used domed sandstone caves as maternity roosts. This type of habitat is more typical of the Offset Areas than the proposed extraction areas.

### C.24.5 Assessment of habitat

Large-eared Pied Bats occur in well-timbered areas containing gullies They roost in domed sandstone caves, crevices in cliffs and disused mines. The species is likely to forage for insects beneath the forest canopy. The species has high fidelity to roost sites and females raise young in maternity colonies in caves (DEC (NSW), 2005u).

### C.24.6 Description of habitat values

No known maternity sites or caves occur on the Project Site, although sandstone outcrops may provide suitable habitat in the study area. The species is most likely to occur in the taller forest along the gully of Creek C on the Project Site, which will be conserved as part of the Offset Areas. Approximately 83.5ha of potential foraging habitat exists on the Project Site. Large expanses of potential foraging and roosting habitat are present throughout the National Parks in the locality. The condition of habitat in the locality is good, due to much of it being in conservation reserves. The potential habitat on the Project Site is not a significant area of

known habitat for the species and a proportion of this habitat would be retained and conserved within the Offset Areas.

### C.24.7 Extent of habitat removal

Clearing would only impact on up to 34.7ha of potential habitat. This is likely to represent a small proportion of the home range for this species. Clearing would include removal of potential roosting and foraging habitat.

### C.24.8 Consideration of corridors

Due to the Large-eared Pied Bat being highly mobile, it is not considered that continuous vegetation is required for dispersal between habitat areas. Broad corridors occur in the locality through Popran, Brisbane Water and Dharug National Parks and across the region. Vegetation on the Project Site makes up part of a corridor between these National Parks in the locality and although the width of the corridor would be reduced, it is not likely that the Project would hinder movements of the species.

## C.25 Large-footed Myotis

### C.25.1 Discussion of conservation status

The Large-footed Myotis (*Myotis macropus*) is listed as vulnerable on Schedule 2 of the TSC Act. It is not listed under the EPBC Act. The species occurs in a coastal band from north-western Australia, across the top end and down the east coast through to western Victoria (DEC (NSW), 2005s). The Project Site is not near the limit of the distribution of this species.

The Large-footed Myotis is at threat from the following:

- Reduction in stream foraging resources and surrounding habitat;
- Loss of or disturbance to roost sites; and
- Use of pesticides in and around foraging habitat (DEC (NSW), 2005s).

No threat abatement plans relate to this species and no recovery plan has been prepared for this species. Fifteen priority actions have been developed to help recover this species, including:

- Ensure the largest hollow bearing trees in riparian zones are given highest priority for retention in PVP assessments or other land clearing assessment tools (Low priority); and
- Encourage recovery of natural hydrological regimes, including retention and rehabilitation of riparian vegetation (Medium priority) (DEC (NSW), 2005s).

The Large-footed Myotis has been recorded in Wollemi National Park, Yengo National Park, Blue Mountains National Park, Olney State Forest, Munmorah State Conservation Area, MacPherson State Forest, Ourimbah State Forest, Popran National Park, Brisbane Water National Park, Dharug National Park, Scheyville National Park, Castlereach Nature Reserve, Blue Mountains National Park and Royal National Park in the Sydney Basin bioregion (NSW Government, 2009).

### C.25.2 Discussion of local and regional abundance

There have been 43 records of the Large-footed Myotis from the Gosford LGA in the last 20 years and 969 records from the last 20 years in the Sydney Basin Bioregion (NSW Government, 2009).

### C.25.3 Discussion of other known local populations

There are many records of Large-footed Myotis scattered throughout the Gosford LGA, including one at the Mangrove Creek Dam, one in Dharug National Park near the Hawkesbury River, several around Brisbane Water likely to have been recorded from surrounding creeks, and from Avoca Lagoon (NSW Government, 2009). Although no specific information exists on the local population, those recorded in the locality are likely to be part of a broadly distributed population which exists in the northern part of the Sydney Basin Bioregion.

### C.25.4 Discussion of habitat utilisation

There was a possible record of the Large-footed Myotis from the eastern side of the Project Site; however, as this part of the Project Site is the highest, it is less likely to be used by the species as it forages over water. The species is more likely to forage over the lower lying creeks. Potential roosting habitat is provided on the Project Site in hollow-bearing trees.

### C.25.5 Assessment of habitat

The Large-footed Myotis roosts close to water in caves, mine shafts, hollow-bearing trees, storm water channels, buildings and in dense foliage. They forage over streams and pools, raking their feet across the surface to catch insects and small fish (DEC (NSW), 2005s).

### C.25.6 Description of habitat values

The Large-footed Myotis is most likely to use the creeks on the Project Site for foraging compared with the drier, heath areas. Potential roosting habitat is available in the hollow-bearing trees on the Project Site, although the species usually roosts near water, therefore the hollow-bearing trees closer to the creeks are those most likely to be used by the Large-footed Myotis. Minimal potential habitat exists on the Project Site, restricted to areas surrounding pools in creeks. Large expanses of potential foraging and roosting habitat are present throughout the National Parks in the locality. The condition of habitat in the locality is good,

due to much of it being in conservation reserves. The potential habitat on the Project Site is not a significant area of known habitat for the species and a proportion of this habitat would be retained and conserved within the Offset Areas.

### C.25.7 Extent of habitat removal

Clearing would only impact on any pools that occur within Creek A. This is likely to represent a small proportion of the home range for this species. Clearing would include removal of potential roosting habitat.

### C.25.8 Consideration of corridors

Due to the Large-footed Myotis being highly mobile, it is not considered that continuous vegetation is required for dispersal between habitat areas. Broad corridors occur in the locality through Popran, Brisbane Water and Dharug National Parks and across the region. Vegetation on the Project Site makes up part of a corridor between these National Parks in the locality and although the width of the corridor would be reduced, it is not likely that the Project would hinder movement of the species.

## C.26 Greater Broad-nosed Bat

### C.26.1 Discussion of conservation status

The Greater Broad-nosed Bat (*Scoteanax rueppellii*) is listed as vulnerable on Schedule 2 of the TSC Act. It is not listed under the EPBC Act. The species occurs along the east coast of Australia from the Atherton Tablelands in Queensland to north-eastern Victoria up to altitudes of 500m (DEC (NSW), 2005m). The Project Site is not near the limit of the distribution of this species.

The Greater Broad-nosed Bat is at threat from the following:

- Disturbance to roosting and breeding sites;
- Clearing of foraging habitats;
- Loss of hollow-bearing trees;
- Use of pesticides and herbicides; and
- Changes to water regimes affecting insect availability (DEC (NSW), 2005m).

No threat abatement plans relate to this species and no recovery plan has been prepared for this species. Eighteen priority actions have been developed to help recover this species, including:

- Ensure largest hollow bearing trees, inc. dead trees and paddock trees are given highest priority for retention in PVP assessments (offsets should include remnants in high productivity) and/or other land assessment tools (High priority);

- Promote the conservation of these HCV private land areas using measures such as incentive funding to landholders, off-setting and biobanking, acquisition for reserve establishment or other means (High priority); and
- Identify areas of private land that contain high densities of large, hollow-bearing trees as areas of high conservation value in planning instruments and land management negotiations e.g. LEP, CAPs, PVPs (High priority) (DEC (NSW), 2005m).

The Greater Broad-nosed Bat has been recorded from Yengo National Park, Wollemi National Park, Blue Mountains National Park, Royal National Park, Wyrrabalong National Park, Munmorah State Conservation Area, Olney State Forest, MacPherson State Forest, Dharug National Park, Brisbane Water National Park, Bouddi National Park, Castlereagh Nature Reserve, Cattai National Park, Scheyville National Park, Mulgoa Nature Reserve and Kemps Creek Nature Reserve in the Sydney Basin Bioregion (NSW Government, 2009).

### C.26.2 Discussion of local and regional abundance

There have been 19 records of the Greater Broad-nosed Bat from the Gosford LGA in the last 20 years and 321 records from the last 20 years in the Sydney Basin Bioregion (NSW Government, 2009).

### C.26.3 Discussion of other known local populations

There are a number of records of the Greater Broad-nosed Bat from the Gosford LGA, from near Popran National Park, Kariong, Dharug National Park, McPherson State Forest and in rural residential areas east of Gosford (NSW Government, 2009). Although no specific information exists on the local population, those recorded in the locality are likely to be part of a broadly distributed population which exists in the northern part of the Sydney Basin Bioregion.

### C.26.4 Discussion of habitat utilisation

No Greater Broad-nosed Bats were recorded on the Project Site. They forage over large areas and the Project Site is likely to form part of the broader foraging area for this species.

### C.26.5 Assessment of habitat

The Greater Broad-nosed Bat is most commonly found in tall, wet forest but also occurs in woodland, dry eucalypt forest and rainforest. It roosts in tree hollows but has also been recorded roosting in buildings. Females give birth and raise young at maternity sites in suitable trees, where they exclude males (DEC (NSW), 2005m).

### C.26.6 Description of habitat values

A number of large stags and trees with large hollows exist on the Project Site, which could provide roosting opportunities for this species. Areas of vegetation, such as the Sandstone Hanging Swamp in the "Glenworth Valley" Offset Area provide particularly high quality foraging habitat due to an abundance of insect life. Approximately 83.5ha of potential foraging habitat exists on the Project Site. Large expanses of potential foraging and roosting habitat are present throughout the National Parks in the locality. The condition of habitat in the locality is good, due to much of it being in conservation reserves. The potential habitat on the Project Site is not a significant area of known habitat for the species and a proportion of this habitat would be retained and conserved in the Offset Areas.

### C.26.7 Extent of habitat removal

Clearing would only impact on up to 34.7ha of potential habitat. This is a very small proportion of the home range for this species, and is likely to be low quality habitat compared to habitat that is available in the Offset Areas. Clearing would include removal of potential roosting and foraging habitat.

### C.26.8 Consideration of corridors

Due to the Greater Broad-nosed Bat being highly mobile, it is not considered that continuous vegetation is required for dispersal between habitat areas. Broad corridors occur in the locality through Popran, Brisbane Water and Dharug National Parks and across the region. Vegetation on the Project Site makes up part of a corridor between these National Parks in the locality and although the width of the corridor would be reduced, it is not likely that the Project would hinder movements of the species.

## C.27 Grey-headed Flying-fox

### C.27.1 Discussion of conservation status

The Grey-headed Flying-fox (*Pteropus poliocephalus*) is listed as vulnerable on Schedule 2 of the TSC Act and as vulnerable under the EPBC Act. The species occurs in a 200km wide coastal strip from Bundaberg in Queensland to Melbourne in Victoria (DEC (NSW), 2005o). The Project Site is not near the limit of the distribution of this species.

The Grey-headed Flying-fox is at threat from the following:

- Disturbance to roosting sites;
- Clearing of foraging habitats;
- Unregulated shooting; and
- Electrocution on powerlines (DEC (NSW), 2005o).

No threat abatement plans relate to this species and no recovery plan has been prepared for this species. Thirty-one priority actions have been developed to help recover this species, including:

- Protect and enhance priority foraging habitat for Grey-headed Flying-foxes, for example through management plans, local environmental plans and development assessments, and through volunteer conservation programs for privately owned land (Low priority); and
- Increase the extent and viability of foraging habitat for Grey-headed Flying-foxes that is productive during winter and spring (generally times of food shortage), including habitat restoration/rehabilitation works (High priority) (DEC (NSW), 2005o).

The Grey-headed Flying-fox has been recorded from Yengo National Park, Lower Hunter Regional Park, Awaba State Forest, Lake Macquarie State Conservation Area, Munmorah State Conservation Area, Wyrrabalong National Park, Brisbane Water National Park, Popran National Park, Dharug National Park, Strickland State Forest, Ku-ring-gai Chase National Park, Muogamarra National Park, Cattai National Park, Scheyville National Park, Wollemi National Park, Berowra Valley Regional Park, Garigal National Park, Lane Cove National Park, Blue Mountains National Park, Towra Point Nature Reserve, Georges River National Park, Royal National Park and Heathcote National Park in the Sydney Basin Bioregion (NSW Government, 2009).

### C.27.2 Discussion of local and regional abundance

There have been 2024 records of the Grey-headed Flying-fox from the Gosford LGA in the last 20 years and 4096 records from the last 20 years in the Sydney Basin Bioregion (NSW Government, 2009).

### C.27.3 Discussion of other known local populations

There are many records of the Grey-headed Flying-fox from the Gosford LGA, from Mangrove Mountain, Dharug and Popran National Parks and many records from around Gosford including Brisbane Water National Park, urban and rural residential areas (NSW Government, 2009). Grey-headed Flying-foxes roost in specific camps. The animals that have been observed in the northern part of the study area are likely to roost in the camp near Mangrove Mountain and do not roost on the Project Site but use it for foraging as part of a much larger range.

### C.27.4 Discussion of habitat utilisation

The Grey-headed Flying-fox was recorded during studies conducted to the north of the Project Site but was not recorded on the Project Site. They forage over large areas and the Project Site is likely to form part of the broader foraging area for this species.

### C.27.5 Assessment of habitat

The Grey-headed Flying-fox roosts, mates and rears young in camps with high site fidelity, with camps established in gullies with dense vegetation. It forages in subtropical and temperate rainforest, tall sclerophyll forest and woodland, heaths, swamps, urban gardens and orchards (DEC (NSW), 2005o).

### C.27.6 Description of habitat values

The Grey-headed Flying-fox is not known to roost on the Project Site and therefore would only use the study area for foraging. The species may forage across the entire Project Site and the Glenworth Valley Offset, with the exception of cleared areas. Large expanses of potential foraging and roosting habitat are present throughout the National Parks in the locality. The condition of habitat in the locality is good, due to much of it being in conservation reserves. The potential habitat on the Project Site is not a significant area of known habitat for the species and a proportion of this habitat would be retained and conserved in the Offset Areas.

### C.27.7 Extent of habitat removal

Clearing would only impact on up to 34.7ha of potential habitat. This is a very small proportion of the home range for this species and represents foraging habitat only.

### C.27.8 Consideration of corridors

Due to the Grey-headed Flying-fox being highly mobile, it is not considered that continuous vegetation is required for dispersal between habitat areas. Broad corridors occur in the locality through Popran, Brisbane Water and Dharug National Parks and across the region. Vegetation on the Project Site makes up part of a corridor between these National Parks in the locality and although the width of the corridor would be reduced, it is not likely that the Project would hinder movements of the species.

## C.28 Eastern Pygmy Possum

### C.28.1 Discussion of conservation status

The Eastern Pygmy Possum (*Cercartetus nanus*) is listed as vulnerable on Schedule 2 of the TSC Act. It is not listed under the EPBC Act. The species is distributed from southern Queensland to eastern South Australia. In NSW it occurs as far west as the western slopes (DEC (NSW), 2005i).

The Eastern Pygmy Possum is at threat from the following:

- Loss and fragmentation of habitat for agriculture, forestry and urban development;
- Changing fire regimes affecting abundance of flowering shrubs;

- Overgrazing by stock and rabbits affecting diversity of flowering shrubs;
- Predation by cats, dogs and foxes; and
- Loss of nest sites due to removal of firewood (DEC (NSW), 2005i).

No threat abatement plans relate to this species and no recovery plan has been prepared for this species. Seven priority actions have been developed to help recover this species, including:

- Encourage and support land managers to undertake management actions that benefit the species (Medium priority); and
- Reserve fire management strategies to include operational guidelines to protect this species from fire; with fire frequency of >10 years (Medium priority) (DEC (NSW), 2005i).

The Eastern Pygmy Possum has been recorded from Wollemi National Park, Yengo National Park, Blue Mountains National Park, Royal National Park, Heathcote National Park, Dharawal State Conservation Area, Garigal National Park, Ku-ring-gai Chase National Park, Berowra Valley Regional Park, Marra Marra National Park, Muogamarra Nature Reserve, Olney State Forest, Munmorah State Conservation Area, McPherson State Forest, Strickland State Forest and Brisbane Water National Park in the Sydney Basin Bioregion (NSW Government, 2009).

### C.28.2 Discussion of local and regional abundance

There have been 57 records of the Eastern Pygmy Possum from the Gosford LGA in the last 20 years and 248 records from the last 20 years in the Sydney Basin Bioregion (NSW Government, 2009).

### C.28.3 Discussion of other known local populations

There are many records of the Eastern Pygmy Possum from the Gosford LGA, from Mangrove Creek Water Supply Reserve, several from McPhersons State Forest, around Peats Ridge, Calga and Kariong, and many records from around Gosford including Brisbane Water National Park and rural residential areas. The Eastern Pygmy Possum recorded on the Project Site is likely to be part of a population that uses heath areas from the Calga – Peats Ridge area (NSW Government, 2009).

### C.28.4 Discussion of habitat utilisation

The Eastern Pygmy Possum was recorded along Creek A on the Project Site, near the southern edge of the Stage 4 extraction area. Heath and woodland are the preferred habitats of the species on the Central Coast but the individual observed during spotlighting surveys was in open forest.

### C.28.5 Assessment of habitat

The Eastern Pygmy Possum prefers woodlands and heaths in most parts of its range in NSW except the north east where it is more common in rainforest. The species also occurs in sclerophyll forest. It feeds on nectar and pollen collected from flowering shrubs and eucalypts. The species shelters in tree hollows, rotten stumps, holes in the ground, abandoned birds nests and Ringtail Possum dreys, and in thickets of vegetation (DEC (NSW), 2005i).

### C.28.6 Description of habitat values

The Eastern Pygmy Possum was recorded in open forest on the Project Site but is highly likely to occur throughout the heath and woodland communities where abundant flowering shrubs including *Banksia* and *Acacia* species occur. The species may forage across the entire Project Site and the Glenworth Valley Offset, with the exception of cleared areas. Large expanses of potential foraging and sheltering habitat are present throughout the National Parks in the locality. The condition of habitat in the locality is good, due to much of it being in conservation reserves. The potential habitat on the Project Site represents a large area of habitat for the species and a proportion of this habitat would be retained and conserved in the Offset Areas.

### C.28.7 Extent of habitat removal

Clearing would only impact on up to 34.7ha of known and potential habitat. This represents both foraging and sheltering habitat.

### C.28.8 Consideration of corridors

The Eastern Pygmy Possum is small, relies on movement on the ground to disperse and it is considered that continuous vegetation is required for dispersal between habitat areas. Broad corridors occur in the locality through Popran, Brisbane Water and Dharug National Parks and across the region. Vegetation on the Project Site makes up part of a corridor between these National Parks in the locality and although the width of the corridor would be reduced, it is not likely that the Project would isolate this species.

## C.29 Spotted-tailed Quoll

### C.29.1 Discussion of conservation status

The Spotted-tailed Quoll (*Dasyurus maculatus*) is listed as vulnerable on Schedule 2 of the TSC Act and as endangered under the EPBC Act. The species occurs in coastal NSW, eastern Victoria, north-eastern Queensland and in Tasmania (DEC (NSW), 2005d1).

The Spotted-tailed Quoll is at threat from the following:

- Loss, fragmentation and degradation of habitat;
- Accidental poisoning in fox and dog baiting programs; and
- Competition with cats and foxes (DEC (NSW), 2005d1).

No recovery plan has been prepared for this species. The Fox Threat Abatement Plan is relevant to this species: the Spotted-tailed Quoll is a medium priority species affected by foxes. The Project is not inconsistent with the objectives on this threat abatement plan. Thirty-two priority actions have been developed to help recover this species, including:

- Reserve Fire management Strategy(s) include operational guidelines that protect rocky outcrops and riparian zones within areas of known habitat (High priority) (DEC (NSW), 2005d1).

The Spotted-tailed Quoll has been recorded from Yengo National Park, Dharug National Park, Olney State Forest, MacPherson State Forest, Wyrrabalong National Park, Popran National Park, Brisbane Water National Park, Ku-ring-gai Chase National Park, Cattai National Park, Blue Mountains National Park, Wollemi National Park, Nattai National Park and Royal National Park in the Sydney Basin Bioregion (NSW Government, 2009).

### C.29.2 Discussion of local and regional abundance

There have been 87 records of the Spotted-tailed Quoll from the Gosford LGA in the last 20 years and 704 records from the last 20 years in the Sydney Basin Bioregion (NSW Government, 2009).

### C.29.3 Discussion of other known local populations

There are many records of the Spotted-tailed Quoll from the Gosford LGA, including from Dharug National Park along the Hawkesbury River, in the Kulnura – Mangrove Mountain area extending to the northern section of Popran National Park, Mt White and the southern part of Popran National Park, Brisbane Water National Park and in coastal areas east of Gosford including Bouddi National Park (NSW Government, 2009). The species has not been recorded from the Project Site but potential habitat does occur there.

### C.29.4 Discussion of habitat utilisation

No Spotted-tailed Quolls were recorded on the Project Site. They forage over large areas and the Project Site is likely to form part of the broader foraging area for this species.

### C.29.5 Assessment of habitat

The Spotted-tailed Quoll occurs in a range of habitats including rainforest, open forest, woodland, coastal heath and inland riparian forest. The species dens in tree hollows, fallen logs, small caves, rock crevices, boulder fields and rocky cliff faces (DEC (NSW), 2005d1).

### C.29.6 Description of habitat values

A number of large stags and trees with large hollows exist on the Project Site, which could provide denning opportunities for this species, as could the sandstone outcropping where shallow caves are formed. Approximately 83.5ha of potential foraging habitat exists on the Project Site with all vegetation communities providing potential foraging habitat. Large expanses of potential foraging and roosting habitat are present throughout the National Parks in the locality. The condition of habitat in the locality is good, due to much of it being in conservation reserves. The potential habitat on the Project Site is not a significant area of known habitat for the species and a proportion of this habitat would be retained and conserved in the Offset Areas.

### C.29.7 Extent of habitat removal

Clearing would only impact on up to 34.7ha of potential habitat. This represents both foraging and sheltering habitat.

### C.29.8 Consideration of corridors

The Spotted-tailed Quoll moves along the ground but contiguous vegetation is not necessarily required for dispersal between habitat areas. Broad corridors occur in the locality through Popran, Brisbane Water and Dharug National Parks and across the region. Vegetation on the Project Site makes up part of a corridor between these National Parks in the locality and although the width of the corridor would be reduced, it is not likely that the Project would isolate this species.

## C.30 Yellow-bellied Glider

### C.30.1 Discussion of conservation status

The Yellow-bellied Glider (*Petaurus australis*) is listed as vulnerable on Schedule 2 of the TSC Act. It is not listed under the EPBC Act. The species occurs from southern Queensland to Victoria from the coast to the western slopes (DEC (NSW), 2005h1).

The Yellow-bellied Glider is at threat from the following:

- Loss and fragmentation of habitat;
- Loss of hollow-bearing trees; and
- Loss of feed trees (DEC (NSW), 2005h1).

There are no threat abatement plans relevant to this species. A recovery plan has been prepared for this species and include the objectives:

- To encourage and assist in improving the protection and management of the Yellow-bellied Glider and its habitat; and

- To increase community awareness of the Yellow-bellied Glider and encourage community involvement in its conservation (NSW NPWS, 2003b).

Fourteen priority actions have been developed to help recover this species, including:

- Consider species in reserve management and planning to protect and enhance habitat and connection corridors (High priority) (DEC (NSW), 2005h1).

The Yellow-bellied Glider has been recorded from Yengo National Park, Wollemi National Park, Blue Mountains National Park, Olney State Forest, Wyong State Forest, Ourimbah State Forest, MacPherson State Forest, Popran National Park, Bouddi National Park, Dharug National Park, Parr State Conservation Area, Cattai National Park, Castlereach Nature Reserve, Lane Cove National Park and Nattai National Park in the Sydney Basin Bioregion (NSW Government, 2009).

### C.30.2 Discussion of local and regional abundance

There have been 100 records of the Yellow-bellied Glider from the Gosford LGA in the last 20 years and 1915 records from the last 20 years in the Sydney Basin Bioregion (NSW Government, 2009).

### C.30.3 Discussion of other known local populations

There are many records of the Yellow-bellied Glider from the Gosford LGA, particularly in the western parts including the Mangrove Creek Water Supply Reserve, McPherson State Forest and Dharug National Park, the northern section of Popran National Park and in the eastern parts of the LGA east of Gosford including Bouddi National Park (NSW Government, 2009). The species has not been recorded from the Project Site but potential habitat does occur there.

### C.30.4 Discussion of habitat utilisation

No Yellow-bellied Gliders were recorded on the Project Site. They forage over large areas and the Project Site is likely to form part of the broader foraging area for this species.

### C.30.5 Assessment of habitat

The Yellow-bellied Glider occurs in tall, mature eucalypt forest in high rainfall areas with nutrient rich soils. The species dens in the hollows of large trees (DEC (NSW), 2005h1).

### C.30.6 Description of habitat values

The area of the Project Site that this species is most likely to use is the gully surrounding Creek C where the forest is taller, including the communities: Hawkesbury Peppermint Apple

Forest, Sandstone Ranges Gully Rainforest and Dharug Footslopes Apple Redgum Forest in the Glenworth Offset Area. It is not likely to use the shorter heath and woodland communities that predominate throughout the proposed extraction areas. Large expanses of potential foraging and roosting habitat are present throughout the National Parks in the locality. The condition of habitat in the locality is good, due to much of it being in conservation reserves. The potential habitat on the Project Site is not a significant area of known habitat for the species and all of the potential habitat for this species would be retained and conserved in the Offset Areas.

### C.30.7 Extent of habitat removal

Clearing would not impact on any potential habitat for this species. Potential habitat for the species will be retained within the Offset Areas.

### C.30.8 Consideration of corridors

As the Yellow-bellied Glider is relatively mobile, but is considered to require tree connectivity for dispersal between habitat areas. Broad corridors occur in the locality through Popran, Brisbane Water and Dharug National Parks and across the region. Vegetation on the Project Site makes up part of a corridor between these National Parks in the locality and although the width of the corridor would be reduced, it is not likely that the Project would hinder movements of the species.

## C.31 Squirrel Glider

### C.31.1 Discussion of conservation status

The Squirrel Glider (*Petaurus norfolcensis*) is listed as vulnerable on Schedule 2 of the TSC Act. It is not listed under the EPBC Act. The species occurs in eastern Australia from northern Queensland to western Victoria (DEC (NSW), 2005e1).

The Squirrel Glider is at threat from the following:

- Loss and fragmentation of habitat;
- Loss of hollow-bearing trees;
- Loss of flowering understorey and midstorey shrubs in forests; and
- Individuals getting caught in barbed wire while gliding (DEC (NSW), 2005e1).

No threat abatement plans relate to this species and no recovery plan has been prepared for this species. Thirty-one priority actions have been developed to help recover this species, including:

- Ensure the largest hollow bearing trees (including dead trees) are given highest priority for retention in PVP assessments and other environmental planning instruments, or other land assessment tools (Medium priority) (DEC (NSW), 2005e1).

The Squirrel Glider has been recorded from Yengo National Park, Munmorah State Conservation Area, Olney State Forest, Wyong State Forest, Wyrrabalong National Park, Popran National Park, Brisbane Water National Park, Bouddi National Park, Dharug National Park, Wollemi National Park, Ku-ring-gai Chase National Park, Blue Mountains National Park and Nattai National Park in the Sydney Basin Bioregion (NSW Government, 2009).

### C.31.2 Discussion of local and regional abundance

There have been 17 records of the Squirrel Glider from the Gosford LGA in the last 20 years and 556 records from the last 20 years in the Sydney Basin Bioregion (NSW Government, 2009).

### C.31.3 Discussion of other known local populations

There are many records of the Squirrel Glider from the Gosford LGA, with a few records in the western part of the LGA from Kulnura, Dharug National Park and the northern section of Popran National Park. Most records are from the eastern part of the LGA from around Gosford, Niagara Park, Kariong, Erina, Brisbane Water National Park and Bouddi National Park (NSW Government, 2009). The species has not been recorded from the Project Site but potential habitat does occur there.

### C.31.4 Discussion of habitat utilisation

No Squirrel Gliders were recorded on the Project Site. Potential foraging and denning habitat is present throughout the native vegetation on the Project Site.

### C.31.5 Assessment of habitat

The Squirrel Glider inhabits mature or old growth species, particularly Blackbutt – Bloodwood forest in coastal areas. It prefers mixed-species stands with a shrubby or Acacia midstorey. The species nests and shelters in tree hollows and feed on Acacia gum, eucalypt sap, nectar, honeydew, manna, insects and pollen (DEC (NSW), 2005e1).

### C.31.6 Description of habitat values

Much of the Project Site provides potential habitat for the Squirrel Glider, with potential nesting habitat being provided in the treed vegetation communities. Large expanses of potential foraging and roosting habitat are present throughout the National Parks in the locality. The condition of habitat in the locality is good, due to much of it being in conservation reserves. The potential habitat on the Project Site is not a significant area of known habitat for the species and all of the potential habitat for this species would be retained and conserved in the Offset Areas.

### C.31.7 Extent of habitat removal

Clearing would only impact on up to 33.3ha of potential habitat. This represents both foraging and sheltering habitat.

### C.31.8 Consideration of corridors

The Squirrel Glider is relatively mobile, but is considered to require tree connectivity for dispersal between habitat areas. Broad corridors occur in the locality through Popran, Brisbane Water and Dharug National Parks and across the region. Vegetation on the Project Site makes up part of a corridor between these National Parks in the locality and although the width of the corridor would be reduced, it is not likely that the Project would hinder movements of the species.

## C.32 Long-nosed Potoroo

### C.32.1 Discussion of conservation status

The Long-nosed Potoroo (*Potorous tridactylus*) is listed as vulnerable on Schedule 2 of the TSC Act and as vulnerable under the EPBC Act. The species occurs along the south east coast of Australia from Queensland to eastern Victoria and Tasmania (DEC (NSW), 2005v). It occurs east of the Great Dividing Range in NSW.

The Long-nosed Potoroo is at threat from the following:

- Loss and fragmentation of habitat from clearing for residential and agricultural development;
- Predation by foxes, cats and dogs;
- Frequent fires and grazing by stock reducing the density and diversity of understorey and vegetation; and
- Logging regimes and other disturbances reducing availability and abundance of food resources (DEC (NSW), 2005v).

No recovery plan has been prepared for this species. The Fox Threat Abatement Plan is relevant to this species. The Project is not inconsistent with the objectives of this plan.

Nineteen priority actions have been developed to help recover this species, including:

- Encourage private landholders to exclude livestock from key habitat to reduce the impact of grazing, trampling and the spread of weeds (Medium priority);
- Encourage private landholders to protect known and potential Long-nosed Potoroo habitat from inappropriate fire regimes (Medium priority);
- Undertake control burn using a mosaic pattern to ensure adequate vegetation cover (Low priority);

- Control weeds, particularly those that affect the understorey layer, in Long-nosed Potoroo habitat (Low priority);
- Seek formal protection of all remaining areas of known habitat under voluntary conservation agreements, joint management agreements or as critical habitat (Low priority);
- Increase habitat via revegetation work and/or establishing corridors to link multiple patches of suitable habitat to expand the effective area of habitat (Low priority); and
- Prevent the spread of Phytophthora sp (Low priority) (DEC (NSW), 2005v).

The Long-nosed Potoroo has been recorded from Heaton State Forest, Olney State Forest and Wambina Nature Reserve in the Sydney Basin Bioregion (NSW Government, 2009).

### C.32.2 Discussion of local and regional abundance

There have been 7 records of the Long-nosed Potoroo from the Gosford LGA in the last 20 years and 118 records from the last 20 years in the Sydney Basin Bioregion (NSW Government, 2009).

### C.32.3 Discussion of other known local populations

There are few records of the Long-nosed Potoroo from the Gosford LGA, with records from near Mangrove Mountain, Point Clare, Narara and east of Gosford (NSW Government, 2009). The species has not been recorded from the Project Site but potential habitat does occur there.

### C.32.4 Discussion of habitat utilisation

No Long-nosed Potoroos were recorded on the Project Site. Potential habitat is provided throughout the native vegetation on the Project Site.

### C.32.5 Assessment of habitat

The Long-nosed Potoroo occurs in coastal heaths, dry and wet sclerophyll forests. It requires dense understorey with occasional open areas such as grass trees, sedges, ferns, heath or low shrubs. The species feeds on hypogeous (underground fruiting) fungi, roots, tubers and insects, and shelters in dense vegetation (DEC (NSW), 2005v).

### C.32.6 Description of habitat values

Much of the Project Site provides potential habitat for the Long-nosed Potoroo. Large expanses of potential habitat are present throughout the National Parks in the locality. The

condition of habitat in the locality is good, due to much of it being in conservation reserves. The potential habitat on the Project Site is not a significant area of known habitat for the species and all of the potential habitat for this species would be retained and conserved in the Offset Areas.

### C.32.7 Extent of habitat removal

Clearing would only impact on up to 34.7ha of potential habitat. This represents both foraging and sheltering habitat.

### C.32.8 Consideration of corridors

The Long-nosed Potoroo is considered to require vegetation cover to disperse between habitat areas. Broad corridors occur in the locality through Popran, Brisbane Water and Dharug National Parks and across the region. Vegetation on the Project Site makes up part of a corridor between these National Parks in the locality and although the width of the corridor would be reduced, it is not likely that the Project would hinder movements of the species.

## C.33 Red-crowned Toadlet

### C.33.1 Discussion of conservation status

The Red-crowned Toadlet is listed as vulnerable under the TSC Act. This species is confined to the Sydney Basin, from Pokolbin in the north, Mt Victoria in the west and Nowra to the south (NSW NPWS, 2001d). The Project Site is not at the limit of distribution for this species.
The Red-crowned Toadlet is threatened by the following key threatening processes:

- Bushrock removal as this would reduce shelter sites. This process would only impact on the species if bushrock is collected illegally from habitat areas that are to be retained;
- Clearing of native vegetation as this would remove potential dispersal habitat across the subject site;
- Ecological consequences of high frequency fires as frequent fires can destroy individuals and make habitat unsuitable; and
- Alteration to the natural flow regimes of rivers, streams, floodplains & wetlands as changes to water quality such as pollution and siltation has the potential to make habitat unsuitable for the species and changes to flow rates can affect suitability of habitat for breeding (DEC (NSW), 2005a1).

The Project may also exacerbate the following processes, further impacting on the species:

- Infection of frogs by Amphibian Chytrid Fungus causing the disease chytridiomycosis (key threatening process) as it has the potential to be fatal to all frog species. The Red-crowned Toadlet appears to be less susceptible to the disease as it does not breed in streams. The Project is not likely to affect the susceptibility of the species to the chytrid fungus (DEC (NSW), 2005a1).

No recovery plans have been drafted or finalised for this species (NSW NPWS, 2001d)) (NSW NPWS, 2001d). Fourteen priority actions have been developed to help recover this species, including:

- Develop best practice management strategies that buffer and protect important headwater/ridge-top breeding sites from changes to water flow, flow regimes and water quality changes (High priority);
- Prepare guide to creating, rehabilitating or augmenting habitat for the species; this might include provision of rock/log groundcover, diversion of water, provision of breeding sites and material (High priority);
- Develop preferred mitigation measures to minimize impact of wildlife and/or suppression operations (Medium priority); and
- Develop a guide to fire-trail, track and road construction and maintenance that includes details of microhabitat manipulation likely to be beneficial to the species (Medium priority) (DEC (NSW), 2005a1).

The Red-crowned Toadlet has been recorded in Brisbane Water National Park, Popran National Park, Dharug National Park, Yengo National Park and Bouddi National Park, as well as national parks within the Sydney area (NSW Government, 2009).

### C.33.2 Discussion of local and regional abundance

The species is limited to the Sydney Basin Bioregion and the northern margin of the South Eastern Highlands Bioregion, with its known distribution extending from Pokolbin State Forest and Wollemi National Park in the north, to the Nowra district in the south and Mt Victoria in the west (NSW NPWS, 2001b). The Red-crowned Toadlet has been recorded from 196 locations in the Gosford LGA and 989 locations in the Sydney Basin Bioregion (NSW Government, 2009).

### C.33.3 Discussion of other known local populations

No specific information exists regarding populations of Red-crowned Toadlets on the Somersby Plateau. There are records of this species along the ridge between Calga and Mt White (NSW Government, 2009), which are likely to form the local population. These species do not disperse great distances, so the local subpopulation is likely to be restricted to the Project Site and the adjacent Popran National Park.

### C.33.4 Discussion of habitat utilisation

Red-crowned Toadlets were recorded in five areas of which three (C, D and E) are associated with the upper section of Creek A. The creek passes through areas of stepped sandstone that are overlain in several sections by a thick bed of sand. Creek A does not appear to be a permanent creek but the banks retain moisture for long periods, as evidenced by the growth of Coral Fern (*Glychenia sieberi*), Swamp Rose (*Bauera ruboides*) and Saw-sedge (*Gahnia sp*).

It is possible that habitat for this species extends northwards from Creek A, towards the sandstone exposures nearby. Habitat for Red-crowned Toadlets appears to be lacking on the southern (drier) side of the central valley, with only one potential habitat area (J) identified along Creek B. An additional record of the species was made among sandstone overhangs away from the ephemeral creeks, in the northern section of the Project Site. It is likely that more individuals occur on the Project Site, on and off the subject site but the species is cryptic and can be difficult to detect. The individuals detected on the Project Site are likely to be residents as Red-crowned Toadlets do not disperse more than tens of metres (NSW NPWS, 2001b).

The Project is likely to affect Red-crowned Toadlets along Creek A as the quarry would remove a large portion of this ephemeral drainage line. Creek B would be retained, however with quarries on either side the water levels are likely to be reduced in this creek.

The Project is not likely to affect the viability of the species in the locality. The population in the Study Area and surrounding bushland areas would remain viable. Habitat is contiguous between these areas and other parts of the locality and as such other populations in the locality are not reliant on the habitat in the Study Area for viability.

### C.33.5 Assessment of habitat

The Red-crowned Toadlet generally occurs on the escarpment areas and plateaus of Triassic sandstones in the Sydney Basin, usually within 100m of the ridge top. The species utilises moist microhabitats rather than permanent water, such as under bushrock, logs on soil, thick ground litter and horizontal rock crevices along the ground. The Toadlets are usually found along permanently moist soaks in ephemeral feeder creeks. The species generally occurs in open woodland or heath communities that have a low, open tree cover with a xeromorphic (drought tolerant) understorey (NSW NPWS, 2001b). It tends to be found in disjunct locations where suitable microhabitats occur.

This pattern is likely to occur throughout the locality and region. The distribution of the species is contained within the Sydney Basin Bioregion and the northern margin of the South Eastern Highlands Bioregion. Ridge top and upper slope habitats are often disturbed by development. However, there are also many national parks within the Sydney Basin Bioregion and the Red-crowned Toadlet is known to occur in several of these including Blue Mountains, Bouddi, Brisbane Water, Dharug, Garigal, Heathcote, Ku-ring-gai Chase, Lane Cove, Marramarra, Popran, Royal, Sydney Harbour, Wollemi and Yengo National Parks, Barren Grounds, Muogamarra and Nattai Nature Reserves, Berowra Valley Regional Park, and Dharawal and Parr State Recreation Area (NSW NPWS, 2001b).

### C.33.6 Description of habitat values

On the Project Site, the Red-crowned Toadlet uses ephemeral drainage lines which are feeder creeks to the creek running west from the Project Site. Red-crowned Toadlets have been detected in association with the two smaller ephemeral creeks on the Project Site. These drainage lines contain a series of sandstone ledges with shallow sandy soil which retain some moisture and tall ground cover plants which provide shelter and feeding habitat (White, 2005).

It is unknown how much habitat is used on the Project Site as either breeding or dispersal habitat as it is difficult to determine the range through which individuals might move (NSW NPWS, 2001b).

There is much sandstone outcropping on the Project Site, containing shelters in the form of crevices. There is also loose bushrock on the Project Site under which the species could shelter and there is dense ground vegetation across most areas of the Project Site in all communities. These areas would provide shelter and foraging habitat for Red-crowned Toadlets and would be ideal for the species to use in dispersing across the Project Site.

### C.33.7 Extent of habitat removal

Up to 0.11ha (approximately 5%) of known habitat would be removed as a result of the Project, as well as up to 1.77ha (approximately 87%) of potential habitat.

### C.33.8 Discussion of corridors

Corridors or dispersal habitat for the Red-crowned Toadlet would be maintained on the Project Site. If the dispersal corridor through the subject site proves unsuccessful, there would still be opportunities for Red-crowned Toadlets to disperse around other areas of the Project Site, allowing them to move to the north and south along the ridge. The Project Site provides habitat which is continuous with Popran National Park, and is therefore part of the local corridor system for flora and fauna. Popran National Park is part of a large corridor linking Brisbane Water National Park and the Blue Mountains National Park (NSW NPWS, 2001c).

## C.34 Giant Burrowing Frog

### C.34.1 Discussion of conservation status

The Giant Burrowing Frog is listed as vulnerable under the TSC Act. This species occurs from the NSW Central Coast to eastern Victoria, but is most common on the Sydney Sandstone (DEC (NSW), 2005k). The Project Site is not at the limit of distribution for this species.

The Giant Burrowing Frog is threatened by the following processes:

- Bushrock removal (key threatening process) as this would reduce shelter sites. This process would only impact on the species if bushrock is collected illegally from habitat areas that are to be retained;
- Clearing of native vegetation (key threatening process) as this would remove potential dispersal habitat across the subject site;
- Ecological consequences of high frequency fires (key threatening process) as frequent fires can destroy individuals and make habitat unsuitable; and
- Alteration to the natural flow regimes of rivers, streams, floodplains & wetlands (key threatening process) as changes to water quality such as pollution and siltation has the potential to make habitat unsuitable for the species and changes to flow rates can affect suitability of habitat for breeding (DEC (NSW), 2005k).

The Project may also exacerbate the following processes, further impacting on the species:

- Infection of frogs by Amphibian Chytrid Fungus causing the disease chytridiomycosis (key threatening process) as it has the potential to be fatal to all frog species. The Giant Burrowing Frog appears to be less susceptible to the disease as it does not exclusively breed in streams. The Project is not likely to affect the susceptibility of the species to the chytrid fungus (DEC (NSW), 2005k).

No recovery plans have been drafted or finalised for this species (NSW NPWS, 2001a) Twenty-four priority actions have been developed to help recover this species, including:

- Develop best practice guidelines for road/drain construction and maintenance within reserves, forests and utility access easements (High priority);
- Develop interim minimum fire frequency recommendations based on best available knowledge (High priority);
- Ensure that appropriate erosion, sedimentation and water quality control measures are applied around known locations (Medium priority); and
- Develop guidelines for construction of microhabitat features as components of land management best practice (Medium priority) (DEC (NSW), 2005k).

The Giant Burrowing Frog has been recorded in Brisbane Water National Park, Popran National Park and Yengo National Park (NSW Government, 2009).

### C.34.2 Discussion of local and regional abundance

The Great Burrowing Frog has been recorded from 159 locations in the Gosford LGA and 457 locations in the Sydney Basin Bioregion in the last 20 years, including Popran, Brisbane Water, Dharug and Yengo National Parks (NSW Government, 2009).

### C.34.3 Discussion of other known local populations

No specific information exists regarding populations of Great Burrowing Frogs on the Somersby Plateau. There are records of this species in the southern section of the adjacent portion of Popran National Park, on the eastern side of the Calga Interchange, and to the south-west of the Project Site (see **Figure 4.1**).

### C.34.4 Discussion of habitat utilisation

No Giant Burrowing Frogs have been detected on the Project Site, however habitat for this species exists, of which a large area would be retained.

### C.34.5 Assessment of habitat

The Giant Burrowing shows a preference for sandstone ridge top habitat and broader upland valleys. In these locations the frog is associated with small headwater creek lines and along slow flowing to intermittent creeklines. The species often spends significant periods of time underground during unfavourable conditions. Limited observations on this species suggest an ability to range widely, frequently being observed on roads at considerable distance from suitable riparian breeding, or other moist habitat (DEC (NSW), 2005k).

### C.34.6 Description of habitat values

Potential habitat for the Giant Burrowing Frog is also on the Project Site and appears confined between the 170m and 190 m contours between creeks A and B (Figure 2). This area has a hanging swamp nested in deep sand. Above the 190 m contour, the sandstone layer does not seem to retain ground moisture; similarly below the 180 m contour, the sandstone is not deeply weathered and appears unsuitable. This zone contains two discrete hanging swamp ecosystems, one being dominated by Tea Trees (*Leptospermum* sp), and the other by Saw-sedges (*Gahnia* sp). These swamps do not appear to retain open water and breeding may not be possible in this area. If Giant Burrowing Frogs are present, then breeding is most likely to occur in pools in the upper parts of Creek A, although no tadpoles of this species were found there.

### C.34.7 Extent of habitat removal

Up to 3.23ha (approximately 44%) of potential habitat for this species would be removed as a result of the Project.

### C.34.8 Consideration of corridors

Corridors are being maintained on the Project Site, particularly along Creeks B and C, which would enable this species to move around. The Project Site provides habitat which is continuous with Popran National Park, and is therefore part of the local corridor system for flora and fauna. Popran National Park is part of a large corridor linking Brisbane Water National Park and the Blue Mountains National Park (Morgan, 2001).

## C.35 Rosenberg's Goanna

### C.35.1 Discussion of conservation status

Rosenberg's Goanna is listed as vulnerable under the TSC Act. In NSW this species occurs from the Central Coast and Wollemi National Park in the north to Cooma and Khancoban in the south. It also occurs in South Australia and Western Australia (DEC (NSW), 2005b1). The Project Site is near the northern limit of distribution for this species.

Rosenberg's Goanna is threatened by the following processes:

- Removal of habitat elements such as termite mounds and fallen timber (key threatening process);
- Clearing of native vegetation (key threatening process) as this would remove potential dispersal habitat across the subject site; and
- Predation by cats and dogs (DEC (NSW), 2005b1).

No recovery plans have been drafted or finalised for this species (NSW NPWS, 2001d, DEC (NSW), 2005b1). Nine priority actions have been developed to help recover this species, including:

- Identify key habitats or areas for protection and enhanced management on private lands through management agreements and incentives (High priority);
- Provide map of known occurrences to the Rural Fire Service and seek protection of rocky outcrops and riparian zones on Bush Fire Risk Management Plans, risk register and/or operation maps (Medium priority); and
- Implement management strategies that reduce the prevalence of bush rock removal, including surveillance (Medium priority) (DEC (NSW), 2005b1).

Rosenberg's Goanna has been recorded in Dharug National Park and Ku-ring-gai Chase National Park.

### C.35.2 Discussion of local and regional abundance

The Rosenberg's Goanna has been recorded from 9 locations in the Gosford LGA and 141 locations in the Sydney Basin Bioregion in the last 20 years (NSW Government, 2009).

### C.35.3 Discussion of other known local populations

Recorded locations within the LGA are mainly along the Hawkesbury River, as well as one north-east of Gosford (NSW Government, 2009). There is no information on the local population associated with the Study area.

### C.35.4 Discussion of habitat utilisation

This species has not been recorded on the Project Site, but has been recorded in the Study Area.

### C.35.5 Assessment of habitat

This species relies on termite mounds for laying its eggs, and shelter in hollow logs, rock crevices and burrows (DEC (NSW), 2005b1). Home range for this species is approximately 20ha (King and Green 1999).

### C.35.6 Description of habitat values

Foraging habitat for this species exists across the Project Site. Rock crevices and fallen logs provide shelter for this species. Woodland and heath dominate the vegetation on the Project Site, and the sandy soils provide habitat for termites, whose nests are a critical habitat component for this species (DEC (NSW), 2005b1).

### C.35.7 Extent of habitat removal

Up to 33.3ha of potential habitat for this species would be cleared from the Project Site, which is approximately 48% of the available habitat on the Project Site. Extensive similar habitat exists in the locality, including habitat which is protected in Popran National Park.

### C.35.8 Consideration of corridors

The Project Site is located adjacent to Popran National Park which is part of a large corridor linking Brisbane Water National Park and the Blue Mountains (Morgan, 2001). The Project Site provides native vegetation which is continuous with the vegetation of Popran National Park, and is therefore part of the local corridor system for flora and fauna.

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# Appendix D

## Assessments of Significance

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## D1 Callistemon linearifolius

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

*Callistemon linearifolius* has been recorded from 8 locations in the Gosford LGA and 44 locations in the Sydney Basin Bioregion in the last 20 years (all on the Central Coast) (DEC (NSW), 2005y). On the Project Site, this species was recorded in four locations, of which only one would be cleared as part of the Project, resulting in the loss of one known plant. 24 plants spread over the remaining locations would not be directly impacted by the Project. These plants form a disjunct population, as other records in the LGA are further to the east, around Gosford. No targeted surveys for this species have been carried out in the adjacent Popran National Park, however, it is likely that it occurs there. The Project is not likely to have an adverse affect on this species such that the population on the subject site is placed at risk of extinction.

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

There are no endangered populations of *Hibbertia procumbens* listed for the area under Schedule 1 Part 2 of the *Threatened Species Conservation Act* 1995.

**(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:**
- **(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
- **(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,**

Not applicable.

**(d) in relation to the habitat of a threatened species, population or ecological community:**
- **(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- **(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- **(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,**

On the Project Site, *Callistemon linearifolius* was recorded in small groups in four scattered locations, of which only one (within Stage 5) would be cleared as part of the Project, resulting in the loss of a single plant. The 24 remaining plants would not be directly impacted by the development. 13.2ha (42%) of known habitat would be cleared from the Project Site as a result of the Project.

Habitat within the Project Site is contiguous with Popran National Park, and fragmentation and isolation of habitat would not occur. Popran National Park is part of a large corridor linking Brisbane Water National Park and the Blue Mountains (Morgan, 2001). The Project Site provides native vegetation which is continuous with the vegetation of Popran National Park, and is therefore part of the local corridor system for flora and fauna.

*Callistemon linearifolius* occurs in vegetation communities on the Project Site which are common in the sandstone plateaus at Calga and surrounding areas. While a sizable area of habitat would be removed from the Project Site, approximately 17,200ha of similar habitat are present within Gosford LGA. Habitat is protected in Brisbane Water National Park (Bell, 1998), (Bell, 2004), and potential habitat exists in Dharug and Yengo National Parks (Clarke and Benson, 1986, Bell et al., 1993). Habitat within the Project Site is contiguous with Popran National Park, and fragmentation and isolation of habitat would not occur.

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

No critical habitat for this species has currently been listed in the critical habitat registry by the Director-General of the DECC.

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

No recovery plan has been prepared for this species. No threat abatement plans are relevant to this species. DECC has identified 13 priority actions to help recover the *Callistemon linearifolius* in New South Wales. These include:

- Seek to increase the level of legislative protection for sites through land-use planning mechanisms and conservation agreements;
- Liaise with landholders to facilitate the implementation of site-specific threat abatement measures;
- Conduct management-related ecological research, particularly into fire response;
- Undertake population viability analysis particularly for those small populations with a high risk of local extinction; and
- Collect seed for NSW Seedbank.

A number of these priority actions could be carried out on the Project Site or adjacent land.

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

*Callistemon linearifolius* is threatened by or the Project would further impact the species through the following processes:

- Clearing of native vegetation as this will clear habitat for this species. Habitat will be retained on the Project Site, and the species can be replanted as part of the rehabilitation program; and

- Ecological consequences of high frequency fires as fire can destroy individual plants and habitats for plants. There will be no need for regular burning, and as such the frequency of fire on the Project Site is unlikely to increase.

**Conclusion**
The Project is not likely to have a significant impact on this species.

## D2 Hibbertia procumbens

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

Clearing of the habitat supporting *Hibbertia procumbens* would impact the species within the Project Site. Approximately half of the recorded locations would be impacted by clearing for the two quarries, however other sites will not be impacted. These include the cleared area along the power line easement, along Creek B, in the southeast corner adjacent to Australian Wildlife Walkabout Park, the northwest section between the Stage 3 and 4 quarries, and along the access road to Popran National Park on the southern border of the Project Site. A total of 24.7ha (44%) of known habitat for this species would be cleared from the Project Site.

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

There are no endangered populations of *Hibbertia procumbens* listed for the area under Schedule 1 Part 2 of the *Threatened Species Conservation Act* 1995.

**c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:**
**i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
**ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,**

Not applicable.

**d) in relation to the habitat of a threatened species, population or ecological community:**
**i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
**ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
**iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,**

Clearing of the habitat supporting *Hibbertia procumbens* would impact the species within the Project Site. Less than half of the recorded locations would be impacted by clearing for the two extraction stages, however, other sites will not be impacted. These include the cleared area along the power line easement, along Creek B, in the southeast corner adjacent to

Australian Wildlife Walkabout Park, the northwest section between the Stage 3 and 4 quarries, and along the access road to Popran National Park on the southern border of the Project Site. A total of 24.7ha (44%) of known habitat for this species would be cleared from the Project Site.

Habitat to be retained within the Project Site (along the southern and western boundaries) is contiguous with habitat within the adjacent Popran National Park, and fragmentation and isolation of habitat would not occur. Popran National Park is part of a large corridor linking Brisbane Water National Park and the Blue Mountains National Park (Morgan, 2001). The Project Site provides native vegetation which is continuous with the vegetation of Popran National Park, and is therefore part of the local corridor system for flora and fauna.

Within Gosford LGA potential habitat exists for this species within all areas mapped as E29 Hawkesbury Banksia Scrub-Woodland, as well as areas adjacent to E54 Sandstone Hanging Swamps (Bell, 2004). This species is also likely to have habitat throughout E26 Exposed Hawkesbury Woodland. E26 and E29 are widespread in the Gosford, Central Coast and Sydney regions.

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

No critical habitat for this endangered species has currently been listed in the critical habitat registry by the Director-General of the DECC.

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

No recovery plan has been prepared for this species. No threat abatement plans are relevant to this species. DECC has identified 16 priority actions to help recover *Hibbertia procumbens* in New South Wales. These include:

- Seek to increase the level of legislative protection for sites on freehold land through land-use planning mechanisms and conservation agreements;
- Negotiate with the managers of freehold sites to prepare and implement site management plans that address threatening processes;
- Encourage research Projects on the ecological requirements of the species and its response to disturbance;
- Restrict access to sites, where necessary; and
- Undertake targeted bush regeneration works, where required.

A number of these priority actions could be carried out on the Project Site or adjacent land.

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

*Hibbertia procumbens* is threatened by or the Project would further impact the species through the following processes:

- Clearing of native vegetation as this will clear habitat for this species. Habitat will be retained on the Project Site, and the species can be replanted as part of the rehabilitation program; and
- Ecological consequences of high frequency fires as fire can destroy individual plants and habitats for plants. There will be no need for regular burning, and as such the frequency of fire on the Project Site is unlikely to increase.

**Conclusion**
The Project is not likely to have a significant impact on this species.

## D3 Darwinia glaucophylla

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

*Darwinia glaucophylla* has been recorded from 28 locations in the Gosford LGA. This species is only known from this LGA. Several sites are within Brisbane Water National Park and one is known from Popran National Park. This species was recorded across the higher elevations of the Project Site (where clearing for the Project is to take place), and into the adjacent Popran National Park. It is killed by fire, hence its preference for rocky environments (Benson and McDougall, 1998). In the absence of sufficient data for the adjacent Popran National Park, it is possible that a significant impact may be felt on a local population of this species, however, the viability of the species as a whole is not at risk as a result of the Project.

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

There are no endangered populations of *Darwinia glaucophylla* listed for the area under Schedule 1 Part 2 of the *Threatened Species Conservation Act* 1995.

**c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:**
**i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
**ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,**

Not applicable.

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

**i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
**ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
**iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,**

Approximately half of the recorded locations would be impacted by clearing for the two extraction areas, however other sites will not be impacted. These include the cleared area along the power line easement, along Creek B, in the southeast corner adjacent to Australian Wildlife Walkabout Park, the northwest section between the Stage 3 and 4 quarries, and along the access road to Popran National Park on the southern border of the Project Site, particularly the southwest corner. A total of 24.7ha (44%) of known habitat for this species would be cleared from the Project Site.

Habitat to be retained within the Project Site (in the southern and north-western portions) is contiguous with habitat within the adjacent Popran National Park, and fragmentation and isolation of habitat would not occur.

*Darwinia glaucophylla* has been recorded throughout communities E26 Exposed Hawkesbury Woodland and E29 Hawkesbury Banksia-Scrub Woodland within the Project Site. These communities cover approximately 55.6ha of the Project Site. The communities within which this species occurs in the Project Site are common in the locality. Some areas of the Project Site show evidence of relatively recent fire.

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

No critical habitat for this species has currently been listed in the critical habitat registry by the Director-General of the DECC.

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

No recovery plan has been prepared for this species. No threat abatement plans are relevant to this species. DECC has identified 15 priority actions to help recover *Darwinia glaucophylla* in New South Wales. These include:

- Increase protection of sites through land-use planning mechanisms and conservation agreements;
- Prepare and implement a population monitoring program;
- Restrict and control access to sites, particularly access by off-road vehicles;
- Undertake sediment and erosion control works at priority sites; and
- Undertake weed control, priority given to sites at urban interface

A number of these priority actions could be carried out on the Project Site or adjacent land.

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

*Darwinia glaucophylla* is threatened by or the Project would further impact the species through the following processes:

- Clearing of native vegetation as this will clear habitat for this species. Habitat will be retained on the Project Site, and the species can be replanted as part of the rehabilitation program; and
- Ecological consequences of high frequency fires as fire can destroy individual plants and habitats for plants. There will be no need for regular burning, and as such the frequency of fire on the Project Site is unlikely to increase. This species is killed by fire, hence its preference for rocky environments (Benson and McDougall 1998). Germination is from soil stored seed which requires heat to break seed dormancy. Germination is unlikely in the absence of fire.

**Conclusion**
The Project is not likely to have a significant impact on this species.

## D4 Acacia bynoeana

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

*Acacia bynoeana* has been recorded from 2 locations in the Gosford LGA, both near Wiseman's Ferry Road at Mangrove Creek. These occur within Dharug National Park (NSW Government, 2009). This species has not been recorded on the Project Site. Potential habitat for the species occurs on the Project Site and within the proposed offset areas. The Project is not likely to have an adverse effect on the life cycle of this species such that a local population is likely to be placed at risk of extinction.

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

There are no endangered populations of *Acacia bynoeana* listed for under Schedule 1 Part 2 of the *Threatened Species Conservation Act* 1995.

**c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:**
**i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
**ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,**

Not applicable.

**d) in relation to the habitat of a threatened species, population or ecological community:**
- **i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- **ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- **iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,**

*Acacia bynoeana* has not been recorded on the Project Site during any of the threatened flora surveys. Approximately 24.7ha (36%) of potential habitat will be cleared as a result of the Project.

Habitat to be retained within the Project Site (in the southern and north-western portions) is contiguous with habitat within the adjacent Popran National Park, and fragmentation and isolation of habitat would not occur.

The potential habitat to be removed is not likely to be important for the long term survival of the species because it has not been recorded on the project site. Large areas of potential habitat will be conserved within the proposed offset area.

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

No critical habitat for this species has currently been listed in the critical habitat registry by the Director-General of the DECC.

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

No threat abatement plans relate to this species and no recovery plan has been prepared for this species. Thirteen priority actions have been identified to help recover this species, including:

- Liaise with private and public land managers to facilitate the preparation and implementation of management plans that address threatening processes (Medium priority);
- Incorporate appropriate fire regime into land management practices (Medium priority);
- Restrict access to sites where necessary (Medium priority);
- Undertake targeted bush regeneration works where required (Medium priority); and
- Increase the level of legislative protection for sites through land use planning mechanisms and conservation agreements. Retain vegetative linkages between sites where possible (High priority).

A number of these priority actions could be carried out on the Project Site or adjacent land.

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

*Acacia bynoeana* is threatened by or the Project would further impact the species through the following processes:

- Clearing of native vegetation as this will clear potential habitat for this species. This process will not significantly affect this species as potential habitat will be retained on the Project Site;
- Weed invasion but this will be managed through the implementation of the Threatened Species and Habitat Management Plan; and
- Ecological consequences of high frequency fires as fire can destroy individual plants and habitats for plants. There will be no need for regular burning, and as such the frequency of fire on the Project Site is unlikely to increase.

**Conclusion**
The Project is not likely to have a significant impact on this species.

## D5 Tetratheca glandulosa

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

*Tetratheca glandulosa* has been recorded from 92 locations in Gosford LGA. This species has been recorded nearby at Mt White and in Popran National Park (NSW Government, 2009), which is adjacent to the Project Site. Large populations also occur in Dharug National Park and in the Mangrove Mountain area. This species has not been recorded on the Project Site. Potential habitat for the species occurs on the Project Site and within the proposed offset areas. The Project is not likely to have an adverse effect on the life cycle of this species such that a local population is likely to be placed at risk of extinction.

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

There are no endangered populations of *Tetratheca glandulosa* listed for under Schedule 1 Part 2 of the *Threatened Species Conservation Act* 1995.

**c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:**
**i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
**ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,**

Not applicable.

**d) in relation to the habitat of a threatened species, population or ecological community:**
- **i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- **ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- **iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,**

*Tetratheca glandulosa* has not been recorded on the Project Site. Approximately 33.3ha (41%) of potential habitat would be cleared from the Project Site as a result of the project.

Habitat to be retained within the Project Site (in the southern and north-western portions) is contiguous with habitat within the adjacent Popran National Park, and fragmentation and isolation of habitat would not occur.

The potential habitat to be removed is not likely to be important for the long term survival of the species because it has not been recorded on the project site. Large areas of potential habitat will be conserved within the proposed offset area and known habitat occurs within Popran National Park.

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

No critical habitat for this species has currently been listed in the critical habitat registry by the Director-General of the DECC.

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

No threat abatement plans relate to this species and no recovery plan has been prepared for this species. Sixteen priority actions have been identified to help recover this species, including:

- Encourage community awareness and involvement in threat management works (High priority);
- Reserve Fire Management Strategy to include operational guidelines to protect this species from fire (High priority);
- Increasing the level of legislative protection for sites through land use planning mechanisms and conservation agreements (High priority);
- Undertake identified priority threat management works including weed control, restrict access, stormwater management works and slashing under powerlines (High priority); and
- Undertake works to maintain or improve habitat connectivity between and within populations (Medium priority).

A number of these priority actions could be carried out on the Project Site or adjacent land.

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

*Tetratheca glandulosa* is threatened by or the Project would further impact the species through the following processes:

- Clearing of native vegetation as this will clear potential habitat for this species. This process will not significantly affect this species as potential habitat will be retained on the Project Site;
- Weed invasion but this will be managed through the implementation of the Threatened Species and Habitat Management Plan; and
- Ecological consequences of high frequency fires as fire can destroy individual plants and habitats for plants. There will be no need for regular burning, and as such the frequency of fire on the Project Site is unlikely to increase.

**Conclusion**
The Project is not likely to have a significant impact on this species.

## D6 Prostanthera junonis

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

*Prostanthera junonis* has not been recorded from the Project Site. Other populations within the locality occur further east, generally on the eastern edge of the Somersby Plateau, east of Mooney Mooney Creek (NSW Government, 2009). This species has not been recorded on the Project Site. Potential habitat for the species occurs on the Project Site and within the proposed offset areas. The Project is not likely to have an adverse effect on the life cycle of this species such that a local population is likely to be placed at risk of extinction.

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

There are no endangered populations of *Prostanthera junonis* listed for under Schedule 1 Part 2 of the *Threatened Species Conservation Act* 1995.

**c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:**
**i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
**ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,**

Not applicable.

**d) in relation to the habitat of a threatened species, population or ecological community:**
- **i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- **ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- **iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,**

*Prostanthera junonis* has not been recorded on the Project Site. Approximately 33.3ha (41%) of potential habitat would be cleared from the Project Site as a result of the project.

Potential habitat to be retained within the Project Site (in the southern and north-western portions) is contiguous with habitat within the adjacent Popran National Park, and fragmentation and isolation of habitat would not occur.

The potential habitat to be removed is not likely to be important for the long term survival of the species because it has not been recorded on the project site. Large areas of potential habitat will be conserved within the proposed offset area.

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

No critical habitat for this species has currently been listed in the critical habitat registry by the Director-General of the DECC.

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

No threat abatement plans relate to this species. A recovery plan has been prepared for *Prostanthera junonis* with the overall objective to identify policies and programs which protect and conserve *P. junonis* and which reduce the risk of extinction of the species. Specific objectives relevant to the Project include:
- Ensure populations are not destroyed by habitat loss, ensure security of lands that support populations; and
- Minimise long term decline through implementation of appropriate threat and habitat management practices.

Twenty priority actions have been identified to help recover this species, including:
- Prepare and implement site-specific management plans for all populations outside of the reserve system (Medium priority); and
- Undertake weed control activities as appropriate using approved bush regeneration methods (Medium priority).

A number of these priority actions could be carried out on the Project Site or adjacent land.

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

*Prostanthera junonis* is threatened by or the Project would further impact the species through the following processes:

- Clearing of native vegetation as this will clear potential habitat for this species. This process will not significantly affect this species as potential habitat will be retained on the Project Site;
- Weed invasion but this will be managed through the implementation of the Threatened Species and Habitat Management Plan; and
- Ecological consequences of high frequency fires as fire can destroy individual plants and habitats for plants. There will be no need for regular burning, and as such the frequency of fire on the Project Site is unlikely to increase.

**Conclusion**
The Project is not likely to have a significant impact on this species.

## D7 Eucalyptus camfieldii

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

Several disjunct populations occur within the Gosford LGA including at Point Clare, Popran National Park and the northern section of Brisbane Waters National Park. This species has not been recorded on the Project Site. Potential habitat for the species occurs on the Project Site and within the proposed offset areas. The Project is not likely to have an adverse effect on the life cycle of this species such that a local population is likely to be placed at risk of extinction.

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

There are no endangered populations of *Eucalyptus camfieldii* listed for under Schedule 1 Part 2 of the *Threatened Species Conservation Act* 1995.

**c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:**
**i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
**ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,**

Not applicable.

**d) in relation to the habitat of a threatened species, population or ecological community:**
**i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**

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

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

*Eucalyptus camfieldii* does not occur on the Project Site. Approximately 33.3ha (48%) of potential habitat would be cleared from the Project Site as a result of the project.

Potential habitat to be retained within the Project Site (in the southern and north-western portions) is contiguous with habitat within the adjacent Popran National Park, and fragmentation and isolation of habitat would not occur.

The potential habitat to be removed is not likely to be important for the long term survival of the species because it has not been recorded on the project site. Large areas of potential habitat will be conserved within the proposed offset area.

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

No critical habitat for this species has currently been listed in the critical habitat registry by the Director-General of the DECC.

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

No threat abatement plans relate to this species and no recovery plan has been prepared for this species. Fifteen priority actions have been identified to help recover this species, including:

- Liaise with landholders to facilitate the implementation of site-specific threat abatement measures (High priority);
- Implement appropriate fire regimes using suitable methods for this species (Medium priority);
- Control access at sites with high visitation and disturbance (Medium priority);
- Prepare and implement site-specific plans of management (High priority); and
- Seek to increase the level of legislative protection for sites through land use planning mechanisms and conservation agreements (High priority).

A number of these priority actions could be carried out on the Project Site or adjacent land.

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

*Eucalyptus camfieldii* is threatened by or the Project would further impact the species through the following processes:

- Clearing of native vegetation as this will clear potential habitat for this species. This process will not significantly affect this species as potential habitat will be retained on the Project Site;

- Weed invasion but this will be managed through the implementation of the Threatened Species and Habitat Management Plan; and
- Ecological consequences of high frequency fires as fire can destroy individual plants and habitats for plants. There will be no need for regular burning, and as such the frequency of fire on the Project Site is unlikely to increase.

**Conclusion**
The Project is not likely to have a significant impact on this species.

## D8 Kunzea rupestris

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

The species has not been recorded on the Project Site. The closest populations have been recorded from Dharug National Park. These are the only records for the species north of the Hawkesbury River (NSW Government, 2009). Potential habitat for the species occurs on the Project Site and within the proposed offset areas. The Project is not likely to have an adverse effect on the life cycle of this species such that a local population is likely to be placed at risk of extinction.

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

There are no endangered populations of *Kunzea rupestris* listed for under Schedule 1 Part 2 of the *Threatened Species Conservation Act* 1995.

**c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:**
**i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
**ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,**

Not applicable.

**d) in relation to the habitat of a threatened species, population or ecological community:**
**i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
**ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
**iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,**

*Kunzea rupestris* does not occur on the Project Site. Approximately 33.3ha (48%) of potential habitat would be cleared from the Project Site as a result of the project.

Habitat to be retained within the Project Site (in the southern and north-western portions) is contiguous with habitat within the adjacent Popran National Park, and fragmentation and isolation of habitat would not occur.

The potential habitat to be removed is not likely to be important for the long term survival of the species because it has not been recorded on the project site. Large areas of potential habitat will be conserved within the proposed offset area.

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

No critical habitat for this species has currently been listed in the critical habitat registry by the Director-General of the DECC.

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

No threat abatement plans relate to this species and no recovery plan has been prepared for this species. Thirteen priority actions have been identified to help recover this species, including:

- Negotiate with sand mining companies to reduce threats posed by mining activities (High priority); and
- Negotiate with private landholders to increase protection of sites through land use planning mechanisms or conservation agreements for sites on private land (Medium priority)

A number of these priority actions could be carried out on the Project Site or adjacent land.

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

*Kunzea rupestris* is threatened by or the Project would further impact the species through the following processes:

- Clearing of native vegetation as this will clear potential habitat for this species. This process will not significantly affect this species as potential habitat will be retained on the Project Site;
- Weed invasion but this will be managed through the implementation of the Threatened Species and Habitat Management Plan; and
- Ecological consequences of high frequency fires as fire can destroy individual plants and habitats for plants. There will be no need for regular burning, and as such the frequency of fire on the Project Site is unlikely to increase.

**Conclusion**
The Project is not likely to have a significant impact on this species.

## D9 Melaleuca deanei

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

*Melaleuca deanei* has been recorded at one location in the Gosford LGA in the last 20 years, at Horsfield Bay (NSW Government, 2009). The species has not been recorded on the Project Site or in the adjacent Popran National Park. Potential habitat for the species occurs on the Project Site and within the proposed offset areas. The Project is not likely to have an adverse effect on the life cycle of this species such that a local population is likely to be placed at risk of extinction.

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

There are no endangered populations of *Melaleuca deanei* listed for under Schedule 1 Part 2 of the *Threatened Species Conservation Act* 1995.

**c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:**
- **i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
- **ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,**

Not applicable.

**d) in relation to the habitat of a threatened species, population or ecological community:**
- **i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- **ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- **iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,**

*Melaleuca deanei* does not occur on the Project Site. Approximately 20.1ha (53%) of potential habitat would be cleared from the Project Site as a result of the project.

Habitat to be retained within the Project Site (in the southern and north-western portions) is contiguous with habitat within the adjacent Popran National Park, and fragmentation and isolation of habitat would not occur.

The potential habitat to be removed is not likely to be important for the long term survival of the species because it has not been recorded on the project site. Large areas of potential habitat will be conserved within the proposed offset area.

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

No critical habitat for this species has currently been listed in the critical habitat registry by the Director-General of the DECC.

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

No threat abatement plans relate to this species and no recovery plan has been prepared for this species. Sixteen priority actions have been identified to help recover this species, including:

- Liaise with private and public land managers to facilitate the preparation and implementation of management plans that address threatening processes (Medium priority);
- Incorporate appropriate fire regime into land management practices (Medium priority);
- Restrict vehicular and pedestrian access to sites, where necessary (Medium priority);
- Undertake targeted bush regeneration works, where required (Medium priority); and
- Seek to increase the level of legislative protection for sites through land-use planning mechanisms and conservation agreements. Retain or, where lost, re-establish vegetative linkages between sites where possible (High priority).

A number of these priority actions could be carried out on the Project Site or adjacent land.

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

*Melaleuca deanei* is threatened by or the Project would further impact the species through the following processes:

- Clearing of native vegetation as this will clear potential habitat for this species. This process will not significantly affect this species as potential habitat will be retained on the Project Site;
- Weed invasion but this will be managed through the implementation of the Threatened Species and Habitat Management Plan; and
- Ecological consequences of high frequency fires as fire can destroy individual plants and habitats for plants. There will be no need for regular burning, and as such the frequency of fire on the Project Site is unlikely to increase.

**Conclusion**
The Project is not likely to have a significant impact on this species.

## D10 Micromyrtus blakelyi

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

The majority of records for this species occur south of the Hawkesbury in the region from Maroota to Cowan. There is one record from north of the Hawkesbury River near Mt White (NSW Government, 2009). The species has not been recorded on the Project Site or within Popran National Park. Potential habitat for the species occurs on the Project Site and within the proposed offset areas. The Project is not likely to have an adverse effect on the life cycle of this species such that a local population is likely to be placed at risk of extinction.

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

There are no endangered populations of *Micromyrtus blakelyi* listed for under Schedule 1 Part 2 of the *Threatened Species Conservation Act* 1995.

**c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:**
- **i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
- **ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,**

Not applicable.

**d) in relation to the habitat of a threatened species, population or ecological community:**
- **i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- **ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- **iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,**

*Micromyrtus blakelyi* does not occur on the Project Site. Approximately 33.3ha (48%) of potential habitat would be cleared from the Project Site as a result of the project.

Habitat to be retained within the Project Site (in the southern and north-western portions) is contiguous with habitat within the adjacent Popran National Park, and fragmentation and isolation of habitat would not occur.

The potential habitat to be removed is not likely to be important for the long term survival of the species because it has not been recorded on the project site. Large areas of potential habitat will be conserved within the proposed offset area.

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

No critical habitat for this species has currently been listed in the critical habitat registry by the Director-General of the DECC.

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

No threat abatement plans relate to this species and no recovery plan has been prepared for this species. Seven priority actions have been identified to help recover this species, none of which are relevant to the Project.

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

*Micromyrtus blakelyi* is threatened by or the Project would further impact the species through the following processes:

- Clearing of native vegetation as this will clear potential habitat for this species. This process will not significantly affect this species as potential habitat will be retained on the Project Site;
- Weed invasion but this will be managed through the implementation of the Threatened Species and Habitat Management Plan; and
- Ecological consequences of high frequency fires as fire can destroy individual plants and habitats for plants. There will be no need for regular burning, and as such the frequency of fire on the Project Site is unlikely to increase.

**Conclusion**
The Project is not likely to have a significant impact on this species.

## D11 Diuris bracteata

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

*Diuris bracteata* has not been recorded on the Project Site or the adjacent Popran National Park. The species has been recorded at Kulnura and Peats Ridge. (NSW Government, 2009) This species has not been recorded on the Project Site. Potential habitat for the species occurs on the Project Site and within the proposed offset areas. The Project is not likely to have an adverse effect on the life cycle of this species such that a local population is likely to be placed at risk of extinction.

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

There are no endangered populations of *Diuris bracteata* listed for under Schedule 1 Part 2 of the *Threatened Species Conservation Act* 1995.

**c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:**
- **i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
- **ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,**

Not applicable.

**d) in relation to the habitat of a threatened species, population or ecological community:**
- **i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- **ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- **iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,**

*Diuris bracteata* does not occur on the Project Site. Approximately 24.7ha (44%) of potential habitat would be cleared from the Project Site as a result of the project.

Habitat to be retained within the Project Site (in the southern and north-western portions) is contiguous with habitat within the adjacent Popran National Park, and fragmentation and isolation of habitat would not occur.

The potential habitat to be removed is not likely to be important for the long term survival of the species because it has not been recorded on the project site. Large areas of potential habitat will be conserved within the proposed offset area.

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

No critical habitat for this species has currently been listed in the critical habitat registry by the Director-General of the DECC.

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

No threat abatement plans relate to this species and no recovery plan has been prepared for this species. No priority actions have been identified for this species but it generally requires protection of the known roadside populations.

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

*Diuris bracteata* is threatened by or the Project would further impact the species through the following processes:

- Clearing of native vegetation as this will clear potential habitat for this species. This process will not significantly affect this species as potential habitat will be retained on the Project Site;
- Weed invasion but this will be managed through the implementation of the Threatened Species and Habitat Management Plan; and
- Ecological consequences of high frequency fires as fire can destroy individual plants and habitats for plants. There will be no need for regular burning, and as such the frequency of fire on the Project Site is unlikely to increase.

**Conclusion**
The Project is not likely to have a significant impact on this species.

## D12 Ancistrachne maidenii

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

*Ancistrachne maidenii* has not been recorded on the Project Site or the adjacent Popran National Park (NSW Government, 2009). The species has been recorded once to the east of Calga. This species has not been recorded on the Project Site. Potential habitat for the species occurs on the Project Site and within the proposed offset areas. The Project is not likely to have an adverse effect on the life cycle of this species such that a local population is likely to be placed at risk of extinction.

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

There are no endangered populations of *Ancistrachne maidenii* listed for under Schedule 1 Part 2 of the *Threatened Species Conservation Act* 1995.

**c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:**
**i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
**ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,**

Not applicable.

**d) in relation to the habitat of a threatened species, population or ecological community:**
**i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
**ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**

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

*Ancistrachne maidenii* does not occur on the Project Site. Approximately 11.6ha (32.9%) of potential habitat would be cleared from the Project Site as a result of the project.

Habitat to be retained within the Project Site (in the southern and north-western portions) is contiguous with habitat within the adjacent Popran National Park, and fragmentation and isolation of habitat would not occur.

The potential habitat to be removed is not likely to be important for the long term survival of the species because it has not been recorded on the project site. Large areas of potential habitat will be conserved within the proposed offset area.

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

No critical habitat for this species has currently been listed in the critical habitat registry by the Director-General of the DECC.

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

No threat abatement plans relate to this species and no recovery plan has been prepared for this species. Five priority actions have been identified to help recover this species, including:

- Ensure staff undertaking track and roadside maintenance activities are aware of species and its habitat and habitat requirements (Medium priority).

This priority action could be carried out on the Project Site or adjacent land.

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

*Ancistrachne maidenii* is threatened by or the Project would further impact the species through the following processes:

- Clearing of native vegetation as this will clear potential habitat for this species. This process will not significantly affect this species as potential habitat will be retained on the Project Site;
- Weed invasion but this will be managed through the implementation of the Threatened Species and Habitat Management Plan; and
- Ecological consequences of high frequency fires as fire can destroy individual plants and habitats for plants. There will be no need for regular burning, and as such the frequency of fire on the Project Site is unlikely to increase.

**Conclusion**
The Project is not likely to have a significant impact on this species.

## D13 Grevillea shiresii

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

*Grevillea shiressii* has been recorded from 2 locations in the Gosford LGA with a total of 7 records from the last 20 years. These locations are at Mooney Mooney Creek and Mullet Creek (NSW Government, 2009). The species has not been recorded on the Project Site or within Popran National Park.

This species has not been recorded on the Project Site. Potential habitat for the species occurs on the Project Site and within the proposed offset areas. The Project is not likely to have an adverse effect on the life cycle of this species such that a local population is likely to be placed at risk of extinction.

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

There are no endangered populations of *Grevillea shiresii* listed for under Schedule 1 Part 2 of the *Threatened Species Conservation Act* 1995.

**c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:**
- **i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
- **ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,**

Not applicable.

**d) in relation to the habitat of a threatened species, population or ecological community:**
- **i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- **ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- **iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,**

*Grevillea shiresii* does not occur on the Project Site. No potential habitat would be cleared from the Project Site as a result of the project.

Habitat to be retained within the Project Site (in the southern and north-western portions) is contiguous with habitat within the adjacent Popran National Park, and fragmentation and isolation of habitat would not occur.

The potential habitat to be removed is not likely to be important for the long term survival of the species because it has not been recorded on the project site. Large areas of potential habitat will be conserved within the proposed offset area.

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

No critical habitat for this species has currently been listed in the critical habitat registry by the Director-General of the DECC.

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

No threat abatement plans relate to this species and no recovery plan has been prepared for this species. Five priority actions have been identified to help recover this species, including:

- Reserve fire management strategy include operational guidelines to protect this species from fire (Medium priority).

This priority action could be carried out on the Project Site or adjacent land.

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

*Grevillea shiresii* is threatened by or the Project would further impact the species through the following processes:

- Clearing of native vegetation as this will clear potential habitat for this species. This process will not significantly affect this species as potential habitat will be retained on the Project Site;
- Weed invasion but this will be managed through the implementation of the Threatened Species and Habitat Management Plan; and
- Ecological consequences of high frequency fires as fire can destroy individual plants and habitats for plants. There will be no need for regular burning, and as such the frequency of fire on the Project Site is unlikely to increase.

**Conclusion**
The Project is not likely to have a significant impact on this species.

## D14 Persoonia hirsuta

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

*Persoonia hirsuta* has not been recorded on the Project Site or the adjacent Popran National Park. The species has been recorded once from Dharug National Park (NSW Government, 2009). This species has not been recorded on the Project Site. Potential habitat for the species occurs on the Project Site and within the proposed offset areas. The Project is not

likely to have an adverse effect on the life cycle of this species such that a local population is likely to be placed at risk of extinction.

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

There are no endangered populations of *Persoonia hirsuta* listed for under Schedule 1 Part 2 of the *Threatened Species Conservation Act* 1995.

**c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:**
- **i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
- **ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,**

Not applicable.

**d) in relation to the habitat of a threatened species, population or ecological community:**
- **i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- **ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- **iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,**

*Persoonia hirsuta* does not occur on the Project Site. Approximately 33.3ha (48%) of potential habitat would be cleared from the Project Site as a result of the project.

Habitat to be retained within the Project Site (in the southern and north-western portions) is contiguous with habitat within the adjacent Popran National Park, and fragmentation and isolation of habitat would not occur.

The potential habitat to be removed is not likely to be important for the long term survival of the species because it has not been recorded on the project site. Large areas of potential habitat will be conserved within the proposed offset area.

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

No critical habitat for this species has currently been listed in the critical habitat registry by the Director-General of the DECC.

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

No threat abatement plans relate to this species and no recovery plan has been prepared for this species. Twenty-one priority actions have been identified to help recover this species, including:

- Advise and liaise with private land managers to facilitate the preparation and implementation of site management plans that address threatening processes (High Priority);
- Incorporate best knowledge regarding appropriate fire regime into land management practices (High priority);
- Reserve Fire Management Strategy to include operational guidelines to protect this species from fire (Medium priority);
- Develop and implement site-awareness and protection procedures for use by land owners/managers and public utilities and their contractors when undertaking road, trail, or easement maintenance (High priority);
- Restrict vehicular and pedestrian access to sites, where necessary (High priority);
- Undertake targeted bush regeneration works, where required (High priority);
- Seek to increase the level of legislative protection for sites through land-use planning mechanisms and conservation agreements (Medium priority); and
- Retain or re-establish vegetation and fauna movement linkages between sites (Medium priority).

A number of these priority actions could be carried out on the Project Site or adjacent land.

- **whether the action proposed constitutes or is part of a key threatening process or is** Clearing of native vegetation as this will clear potential habitat for this species. This process will not significantly affect this species as potential habitat will be retained on the Project Site;
- Weed invasion but this will be managed through the implementation of the Threatened Species and Habitat Management Plan; and
- Ecological consequences of high frequency fires as fire can destroy individual plants and habitats for plants. There will be no need for regular burning, and as such the frequency of fire on the Project Site is unlikely to increase.

**g) likely to result in the operation of, or increase the impact of, a key threatening process.**

*Persoonia hirsuta* is threatened by or the Project would further impact the species through the following processes:

**Conclusion**
The Project is not likely to have a significant impact on this species.

## D15 Lasiopetalum joyceae

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

*Lasiopetalum joyceae* has not been recorded on the Project Site or the adjacent Popran National Park. The species has been recorded once from the Mangrove Creek Water Supply

Reserve (NSW Government, 2009). Potential habitat for the species occurs on the Project Site and within the proposed offset areas. The Project is not likely to have an adverse effect on the life cycle of this species such that a local population is likely to be placed at risk of extinction.

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

There are no endangered populations of *Lasiopetalum joyceae* listed for under Schedule 1 Part 2 of the *Threatened Species Conservation Act* 1995.

**c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:**
- **i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
- **ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,**

Not applicable.

**d) in relation to the habitat of a threatened species, population or ecological community:**
- **i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- **ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- **iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,**

*Lasiopetalum joyceae* does not occur on the Project Site. Approximately 8.6ha (62%) of potential habitat would be cleared from the Project Site as a result of the project.

Habitat to be retained within the Project Site (in the southern and north-western portions) is contiguous with habitat within the adjacent Popran National Park, and fragmentation and isolation of habitat would not occur.

The potential habitat to be removed is not likely to be important for the long term survival of the species because it has not been recorded on the project site. Large areas of potential habitat will be conserved within the proposed offset area.

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

No critical habitat for this species has currently been listed in the critical habitat registry by the Director-General of the DECC.

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

No threat abatement plans relate to this species and no recovery plan has been prepared for this species. Nine priority actions have been identified to help recover this species, including:

- Ensure agencies undertaking fire trail or easement maintenance activities can identify the species and are aware of its habitat (High priority).

This priority action could be carried out on the Project Site or adjacent land.

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

*Lasiopetalum joyceae* is threatened by or the Project would further impact the species through the following processes:

- Clearing of native vegetation as this will clear potential habitat for this species. This process will not significantly affect this species as potential habitat will be retained on the Project Site;
- Weed invasion but this will be managed through the implementation of the Threatened Species and Habitat Management Plan; and
- Ecological consequences of high frequency fires as fire can destroy individual plants and habitats for plants. There will be no need for regular burning, and as such the frequency of fire on the Project Site is unlikely to increase.

**Conclusion**
The Project is not likely to have a significant impact on this species.

## D16 Glossy Black-cockatoo

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

One family group (three birds) has been recorded utilising the Project Site, and also may be nesting on the Project Site. Hollow-bearing trees and Allocasuarinas will be retained on the Project Site. Clearing for the Project may interrupt the life cycle of this family group, however a population is likely to continue in the locality, and would not be placed at risk of extinction.

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

There are no endangered populations of Glossy Black-cockatoos listed for the area under Schedule 1 Part 2 of the *Threatened Species Conservation Act* 1995.

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

**i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
**ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,**

Not applicable.

**d) in relation to the habitat of a threatened species, population or ecological community:**
**i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
**ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
**iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,**

Up to 24.7ha of the 68.5ha of foraging habitat available for this species on the Project Site would be cleared (approximately 36%). Potential nesting hollows will also be lost from the Project Site. Extensive areas of similar habitat exist in the locality, of which some is protected in the adjacent Popran National Park.

Due to the Glossy Black Cockatoo being highly mobile, it is not considered that continuous vegetation is required for dispersal between habitat areas. Broad corridors occur in the locality through Popran, Brisbane Water and Dharug National Parks and across the region. Vegetation on the Project Site makes up part of a corridor between these National Parks in the locality and although the width of the corridor would be reduced, it is not likely that the Project would hinder movements of the species.

The Glossy Black-cockatoo inhabits forests on sites with low soil nutrient status, reflecting the distribution of key *Allocasuarina* spp (Tanton 1994). One of the main threats to this species is logging of nest trees within the proximity of food resources. Feeding habitat and potential nesting habitat would be cleared as a result of the Project, however approximately 20,000ha of similar habitat is present in the Gosford LGA. Habitat to be retained within the Project Site is contiguous with habitat within the adjacent Popran National Park, and fragmentation and isolation of habitat would not occur. Replanting areas with Casuarina trees and promotion of their growth and development during the rehabilitation stage would replace some of the foraging habitat lost.

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

No critical habitat for this species has currently been listed in the critical habitat registry by the Director-General of the DECC.

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

No recovery plan for this species has been prepared by the NSW National Parks and Wildlife Service to date. The threat abatement plan for predation by the red fox is relevant to this

species. The Project is not inconsistent with these objectives, which focus on fox control programs. DECC has identified nine priority actions to help recover the Netted Bottle Brush in New South Wales. These include:

- Encourage the restoration of foraging habitat that has been cleared or degraded by previous impacts;
- Assist landholders who wish to enter into voluntary conservation agreements at key sites; and
- Continue existing monitoring programs (e.g. Goonoo population) and encourage other community groups to develop a monitoring program of local populations.

A number of these priority actions could be carried out on the Project Site or adjacent land.

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

The Glossy Black Cockatoo is threatened by or the Project would further impact the species through the following processes.

- Clearing of native vegetation as this will clear foraging habitat. However, potential nesting and further potential foraging habitat will be retained on the Project Site.
- Competition from feral honeybees as they can form hives in tree hollows that also form potential nesting habitat for the Glossy Black Cockatoo. The Project is not likely to exacerbate this process.
- Ecological consequences of high frequency fires as fire can destroy tree hollows that form potential nesting habitat. There will be no need for regular burning, and as such the frequency of fire on the Project Site is unlikely to increase.
- Infection by Psittacine circoviral (beak and feather) disease affecting endangered psittacine species and populations as it can leave Glossy Black Cockatoos prone to other infections. However, the Project will not exacerbate the likelihood of this disease infecting a local population.
- Predation by the European red fox as fledglings can become prey items for foxes. Foxes already exist on the Project Site and are not likely to be increased in number by the Project.
- The removal of dead wood and dead trees, and loss of hollow-bearing trees, as dead trees are often hollow and contain potential nesting habitat. Hollow-bearing trees would be removed as a result of the Project, however many will also be retained on the Project Site.

**Conclusion**
The Project is not likely to have a significant impact on this species.

## D17 Gang-gang Cockatoo

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

It is unknown how many populations occur in the locality due to the distribution of records, which are scattered throughout the locality. It is likely however, that individuals from more than one population interbreed and disperse through the locality. Potential habitat will be retained on the Project Site, however a population is likely to continue in the locality, and would not be placed at risk of extinction.

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

There are no endangered populations of Gang-gang Cockatoos listed for the area under Schedule 1 Part 2 of the *Threatened Species Conservation Act* 1995.

**c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:**
- **i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
- **ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,**

Not applicable.

**d) in relation to the habitat of a threatened species, population or ecological community:**
- **i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- **ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- **iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,**

Up to 33.3ha of the 80ha of potential foraging habitat available for this species on the Project Site would be cleared (approximately 42%). Extensive areas of similar habitat exist in the locality, of which some is protected in the adjacent Popran National Park. It is unlikely that there will be removal of significant nesting habitat for the Gang-gang Cockatoo within the Project Site.

Due to the Gang-gang Cockatoo being highly mobile, it is not considered that continuous vegetation is required for dispersal between habitat areas. Broad corridors occur in the locality through Popran, Brisbane Water and Dharug National Parks and across the region. Vegetation on the Project Site makes up part of a corridor between these National Parks in the

locality and although the width of the corridor would be reduced, it is not likely that the Project would hinder movements of the species.

The potential habitat to be removed is not likely to be important for the long term survival of the species because it has not been recorded on the project site. Large areas of potential habitat will be conserved within the proposed offset area.

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

No critical habitat for this species has currently been listed in the critical habitat registry by the Director-General of the DECC.

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

No threat abatement plans relate to this species and no recovery plan has been prepared for this species. Eleven priority actions have been developed to help recover this species, including:

- Increase landholder and public awareness of status, threats and priority actions (Low priority); and
- Negotiate management agreements and covenants over important areas of habitat (Medium priority).

A number of these priority actions could be carried out on the Project Site or adjacent land.

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

The Gang-gang Cockatoo is threatened by or the Project would further impact the species through the following processes.

- Clearing of native vegetation as this will clear foraging habitat. However, potential nesting and further potential foraging habitat will be retained on the Project Site.
- Competition from feral honeybees as they can form hives in tree hollows that also form potential nesting habitat for the Glossy Black Cockatoo. The Project is not likely to exacerbate this process.
- Ecological consequences of high frequency fires as fire can destroy tree hollows that form potential nesting habitat. There will be no need for regular burning, and as such the frequency of fire on the Project Site is unlikely to increase.
- Infection by Psittacine circoviral (beak and feather) disease affecting endangered psittacine species and populations as it can leave Glossy Black Cockatoos prone to other infections. However, the Project will not exacerbate the likelihood of this disease infecting a local population.
- The removal of dead wood and dead trees, and loss of hollow-bearing trees, as dead trees are often hollow and contain potential nesting habitat. Hollow-bearing trees

would be removed as a result of the Project, however many will also be retained on the Project Site.

**Conclusion**
The Project is not likely to have a significant impact on this species.

## D18 Powerful Owl

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

The Powerful Owl has been recorded from the adjacent to the Study Area. The species is likely to use the Project Site for foraging but may also nest on the Project Site as there are large tree hollows present in which the owls could nest. Given the large home range of the species (pairs maintain and hunt throughout a home range that may be over 1000 ha), the presence of suitable adjacent habitat and its ability to adapt to disturbance within its home range, it is unlikely that the viability of the local population will be adversely affected by the Project.

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

There are no endangered populations of the Powerful Owl listed for the area under Schedule 1 Part 2 of the *Threatened Species Conservation Act* 1995.

**c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:**
- **i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
- **ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,**

Not applicable.

**d) in relation to the habitat of a threatened species, population or ecological community:**
- **i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- **ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- **iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,**

Clearing would only impact on up to 45.7ha of habitat. This is a small proportion of the home range for this species, and is likely to be low quality habitat compared to habitat that is

available in the area (i.e. downstream). Clearing would include removal of potential roosting and nesting sites, as well as foraging habitat.

Due to the Powerful Owl being highly mobile, it is not considered that continuous vegetation is required for dispersal between habitat areas. Broad corridors occur in the locality through Popran, Brisbane Water and Dharug National Parks and across the region. Vegetation on the Project Site makes up part of a corridor between these National Parks in the locality and although the width of the corridor would be reduced, it is not likely that the Project would hinder movements of the species. The Project is not likely to fragment or isolate any areas of habitat for this species as it is highly mobile. The species is capable of flying over developed areas.

The Powerful Owl inhabits a range of vegetation types, from woodland and open sclerophyll forest to tall open wet forest and rainforest. The species hunts in open or closed sclerophyll forest or woodlands and occasionally hunts in open habitats, with the main prey being Ring-tailed Possums, gliders and small birds (DEC (NSW), 2005e). The Project Site affords foraging habitat for the species as well as potential roosting and nesting habitat. The area of habitat to be retained on the Project Site may also be used for foraging and nesting. As the Powerful Owl is highly mobile, it is likely to use a much broader area of habitat, including large areas of Popran and Brisbane Water National Parks. Therefore the land affected by the Project is not important habitat for the species.

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

No critical habitat for this species has currently been listed in the critical habitat registry by the Director-General of the DECC.

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

A draft recovery plan for the Large Forest Owls has been prepared and is relevant to the Powerful Owl. The overall objective of this plan is *"to ensure that the three species persist in the wild in NSW in each region where they presently occur."* Specific objectives relevant to the Project include:

*Objective 1: To minimise further loss and fragmentation of habitat outside conservation reserves and State Forests by protection and management of significant owl habitat (including individual nests).*

*Objective 2: To minimise the impacts of development activities on large forest owls and their habitats outside conservation reserves and State Forests.*

Although the Project would remove some potential foraging habitat for the species, potential foraging and nesting habitat would be retained on the Project Site. The Project Site is on the outskirts of a large tract of native vegetation, and as such large areas of habitat will remain in the locality.

The threat abatement plan for predation by the red fox is relevant to this species. The Project is not inconsistent with these objectives, which focus on fox control programs.

DECC has identified 21 priority actions to assist with the recovery of this species in New South Wales. These include:

- Encourage private landholders to undertake management options to conserve and/or actively manage forest owl habitat;
- Use records of concurrence and licence conditions to develop a set of prescriptive guidelines that may be used to mitigate the impacts of developments on the Powerful Owl outside conservation reserves and State forests; and
- Develop a sampling methodology stratified across different land tenures and disturbance histories, as well as a set of standardised regional monitoring protocols.

A number of these priority actions could be carried out on the Project Site or adjacent land.

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

The Powerful Owl is threatened by or the Project would further impact the species through the following processes:

- Clearing of native vegetation as this will clear potential foraging habitat. However, potential nesting and further potential foraging habitat will be retained on the Project Site.
- Competition from feral honeybees as they can form hives in tree hollows that also form potential nesting habitat for the Powerful Owl. The Project is not likely to exacerbate this process.
- Ecological consequences of high frequency fires as fire can destroy tree hollows that form potential nesting habitat. There will be no need for regular burning, and as such the frequency of fire on the Project Site is unlikely to increase.
- Predation by the European red fox as fledglings can become prey items for foxes. Foxes already exist on the Project Site and are not likely to be increased in number by the Project.
- The removal of dead wood and dead trees as dead trees are often hollow and contain potential nesting habitat. Hollow trees and stags would be removed as a result of the Project, but no dead trees or trees with hollows would be removed outside the Subject Area.

**Conclusion**
The Project is not likely to have a significant impact on this species.

## D.19 Masked Owl

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

The Masked Owl has not been recorded in the Study Area. Records in the locality (NSW Government, 2009) indicate that the species is likely to use the Project Site for foraging and may also nest on the Project Site as there are large tree hollows present in which the owls could nest. Given the large home range of the species (pairs maintain and hunt throughout a home range that may be over 1000 ha), the presence of suitable adjacent habitat and its ability to adapt to disturbance within its home range, it is unlikely that the viability of the local population will be adversely affected by the Project.

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

There are no endangered populations of the Masked Owl listed for the area under Schedule 1 Part 2 of the *Threatened Species Conservation Act* 1995.

**c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:**
- **i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
- **ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,**

Not applicable.

**d) in relation to the habitat of a threatened species, population or ecological community:**
- **i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- **ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- **iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,**

Clearing would only impact on up to 45.7ha of potential habitat. This is a small proportion of the home range for this species, and is likely to be low quality habitat compared to habitat that is available in the area (i.e. downstream). Clearing would include removal of potential roosting and nesting sites, as well as foraging habitat.

Due to the Masked Owl being highly mobile, it is not considered that continuous vegetation is required for dispersal between habitat areas. Broad corridors occur in the locality through Popran, Brisbane Water and Dharug National Parks and across the region. Vegetation on the Project Site makes up part of a corridor between these National Parks in the locality and although the width of the corridor would be reduced, it is not likely that the Project would hinder movements of the species. The Project is not likely to fragment or isolate any areas of habitat for this species as it is highly mobile. The species is capable of flying over developed areas.

The Masked Owl inhabits a range of vegetation types, from woodland and open sclerophyll forest to tall open wet forest and rainforest. The species hunts in open or closed sclerophyll

forest or woodlands and occasionally hunts in open habitats, with the main prey being Ring-tailed Possums, gliders and small birds (DEC (NSW), 2005e). The Project Site affords foraging habitat for the species as well as potential roosting and nesting habitat. The area of habitat to be retained on the Project Site may also be used for foraging and nesting. As the Masked Owl is highly mobile, it is likely to use a much broader area of habitat, including large areas of Popran and Brisbane Water National Parks. Therefore the land affected by the Project is not important habitat for the species.

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

No critical habitat for this species has currently been listed in the critical habitat registry by the Director-General of the DECC.

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

A draft recovery plan for the Large Forest Owls has been prepared and is relevant to the Masked Owl. The overall objective of this plan is *"to ensure that the three species persist in the wild in NSW in each region where they presently occur."* Specific objectives relevant to the Project include:

*Objective 1: To minimise further loss and fragmentation of habitat outside conservation reserves and State Forests by protection and management of significant owl habitat (including individual nests).*

*Objective 2: To minimise the impacts of development activities on large forest owls and their habitats outside conservation reserves and State Forests.*

Although the Project would remove some potential foraging habitat for the species, potential foraging and nesting habitat would be retained on the Project Site. The Project Site is on the outskirts of a large tract of native vegetation, and as such large areas of habitat will remain in the locality.

The threat abatement plan for predation by the red fox is relevant to this species. The Project is not inconsistent with these objectives, which focus on fox control programs.

DECC has identified 21 priority actions to assist with the recovery of this species in New South Wales. These include:

- Encourage private landholders to undertake management options to conserve and/or actively manage forest owl habitat;
- Use records of concurrence and licence conditions to develop a set of prescriptive guidelines that may be used to mitigate the impacts of developments on the Masked Owl outside conservation reserves and State forests; and
- Develop a sampling methodology stratified across different land tenures and disturbance histories, as well as a set of standardised regional monitoring protocols.

A number of these priority actions could be carried out on the Project Site or adjacent land.

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

The Masked Owl is threatened by or the Project would further impact the species through the following processes:

- Clearing of native vegetation as this will clear potential foraging habitat. However, potential nesting and further potential foraging habitat will be retained on the Project Site.
- Competition from feral honeybees as they can form hives in tree hollows that also form potential nesting habitat for the Masked Owl. The Project is not likely to exacerbate this process.
- Ecological consequences of high frequency fires as fire can destroy tree hollows that form potential nesting habitat. There will be no need for regular burning, and as such the frequency of fire on the Project Site is unlikely to increase.
- Predation by the European red fox as fledglings can become prey items for foxes. Foxes already exist on the Project Site and are not likely to be increased in number by the Project.
- The removal of dead wood and dead trees as dead trees are often hollow and contain potential nesting habitat. Hollow trees and stags would be removed as a result of the Project, but no dead trees or trees with hollows would be removed outside the Subject Area.

**Conclusion**
The Project is not likely to have a significant impact on this species.

## D.20 Barking Owl

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

No Barking Owls were recorded on the Project Site. Barking Owls have large home ranges and the Project Site may form part of the home range of this species. The Barking Owl has been recorded sporadically throughout the Gosford LGA with records from Dharug National Park near Mangrove Creek, at Mangrove Mountain and one record from Strickland State Forest. The species has been more frequently recorded close to the coast and around Brisbane Water including Bouddi National Park and Brisbane Water National Park.

Records in the locality (NSW Government, 2009) indicate that the species is likely to use the Project Site for foraging but may also nest on the Project Site as there are large tree hollows present in which the owls could nest. Given the large home range of the species (pairs maintain and hunt throughout a home range that may be over 1000 ha), the presence of suitable adjacent habitat and its ability to adapt to disturbance within its home range, it is unlikely that the viability of the local population will be adversely affected by the Project.

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

There are no endangered populations of the Masked Owl listed for the area under Schedule 1 Part 2 of the *Threatened Species Conservation Act* 1995.

**c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:**
- **i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
- **ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,**

Not applicable.

**d) in relation to the habitat of a threatened species, population or ecological community:**
- **i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- **ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- **iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,**

Clearing would only impact on up to 45.7ha of potential habitat. This is a small proportion of the home range for this species, and is likely to be low quality habitat compared to habitat that is available in the area (i.e. downstream). Clearing would include removal of potential roosting and nesting sites, as well as foraging habitat.

Due to the Barking Owl being highly mobile (DEC (NSW), 2005z), it is not considered that continuous vegetation is required for dispersal between habitat areas. Broad corridors occur in the locality through Popran, Brisbane Water and Dharug National Parks and across the region. Vegetation on the Project Site makes up part of a corridor between these National Parks in the locality and although the width of the corridor would be reduced, it is not likely that the Project would hinder movements of the species.

Barking Owls occur in eucalypt woodland, open forest and swamp woodland, especially along watercourses. They roost in dense foliage along creeklines and feed mainly on invertebrates but birds and small mammals are important part of the diet during breeding. Hollows of large, old eucalypts are used for nests. Barking Owls have a home range of 30 to 200ha that they use year round. Therefore the land affected by the Project is not important habitat for the species.

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

No critical habitat for this species has currently been listed in the critical habitat registry by the Director-General of the DECC.

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

A draft recovery plan for the Large Forest Owls has been prepared and is relevant to the Masked Owl. The overall objective of this plan is *"to ensure that the three species persist in the wild in NSW in each region where they presently occur."* Specific objectives relevant to the Project include:

*Objective 1: To minimise further loss and fragmentation of habitat outside conservation reserves and State Forests by protection and management of significant owl habitat (including individual nests).*

*Objective 2: To minimise the impacts of development activities on large forest owls and their habitats outside conservation reserves and State Forests.*

Although the Project would remove some potential foraging habitat for the species, potential foraging and nesting habitat would be retained on the Project Site. The Project Site is on the outskirts of a large tract of native vegetation, and as such large areas of habitat will remain in the locality.

The threat abatement plan for predation by the red fox is relevant to this species. The Project is not inconsistent with these objectives, which focus on fox control programs.

Management actions suggested by the DECC include protecting retaining riparian and forest habitats, hazard reduction burning in mosaic patterns and preserving hollow-bearing and dead trees. Seventeen priority actions have been developed to help recover this species, including:

- Negotiate with individual land managers to achieve appropriate measures to protect all known Barking Owl nest sites in NSW. Protection will need to address threats such as human disturbance, collision with wires, secondary poisoning from chemicals (Medium priority);
- Incorporate the consideration of Barking Owl habitat and potential habitat as a high priority in the assessment of property for reserve establishment (High priority); and
- Establish formal conservation arrangements for properties with Barking Owls, which can be used to protect wildlife habitat (Low priority).

A number of these priority actions could be carried out on the Project Site or adjacent land.

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

The Barking Owl is at threat from the following:

- Loss of hollow-bearing trees and recruitment hollow-bearing trees, and loss of dead wood;
- Clearing for grazing, agriculture, forestry or development;

- Inappropriate forestry practices changing the structure of habitat and removing old growth trees; and
- Grazing and burning affecting habitat of prey.

**Conclusion**
The Project is not likely to have a significant impact on this species.

## D21 Yellow-bellied Sheathtail-bat

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

No Yellow-bellied Sheathtail-bats were recorded on the Project Site. They forage over large areas and the Project Site is likely to form part of the broader foraging area for this species.

There are few records of Yellow-bellied Sheathtail-bat from the local area, one of which is from Bouddi National Park to the south-east of the Project Site. Although no specific information exists on the local population, the few Yellow-bellied Sheathtail-bats recorded in the locality are likely to be part of a broadly distributed population which exists in the northern part of the Sydney Basin Bioregion.

Given the mobility of this species and large areas over which they forage, it is unlikely that the viability of the local population will be adversely affected by the Project.

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

There are no endangered populations of the Masked Owl listed for the area under Schedule 1 Part 2 of the *Threatened Species Conservation Act* 1995.

**c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:**
**i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
**ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,**

Not applicable.

**d) in relation to the habitat of a threatened species, population or ecological community:**
**i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
**ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**

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

Clearing would only impact on up to 34.7ha of potential habitat for this species. This is a very small proportion of the home range of the species, and is likely to be low quality habitat compared to habitat that is available in the area (i.e. downstream). Clearing would include removal of potential roosting and foraging habitat.

Habitat within the Project Site is contiguous with Popran National Park, and fragmentation and isolation of habitat would not occur. Popran National Park is part of a large corridor linking Brisbane Water National Park and the Blue Mountains (Morgan, 2001). The Project Site provides native vegetation which is continuous with the vegetation of Popran National Park, and is therefore part of the local corridor system for flora and fauna.

Yellow-bellied Sheathtail-bats occur in a variety of habitats, from wet and dry sclerophyll forest and open woodland. They are insectivorous and forage high in the canopy. Animals roost singly or in groups of up to six, in tree hollows and buildings; in treeless areas they are known to utilise mammal burrows (Churchill, 1998). Therefore the land affected by the Project is not likely to be important habitat for the species.

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

No critical habitat for this species has currently been listed in the critical habitat registry by the Director-General of the DECC.

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

No recovery plan or threat abatement plan specific to this species have been prepared or drafted to date.

Management actions suggested by the DECC include protecting retaining forest habitats and preserving hollow-bearing and dead trees. Twenty priority actions have been developed to help recover this species, including:

- Ensure the largest hollow bearing trees (including dead trees and paddock trees) are given highest priority for retention in PVP assessments and or other land assessment tools (High priority);
- Promote the conservation of these HCV private land areas using measures such as incentive funding to landholders, off-setting and biobanking, acquisition for reserve establishment or other means (High priority); and
- Identify areas of private land that contain high densities of large, hollow-bearing trees as areas of high conservation value planning instruments and land management negotiations e.g. LEP, CAPs, PVPs (High priority).

A number of these priority actions could be carried out on the Project Site or adjacent land.

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

The Yellow-bellied Sheathtail-bat is at threat from the following:

- Loss of hollow-bearing trees and recruitment hollow-bearing trees;
- Clearing for grazing, agriculture, forestry or development;
- Disturbance to roosting and summer breeding sites; and
- Pesticides and herbicides may reduce the availability of insects, or result in the accumulation of toxic residues in individuals' fat stores.

**Conclusion**
The Project is not likely to have a significant impact on this species.

## D22 Eastern Freetail-bat

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

No Eastern Freetail-bats were recorded on the Project Site. They forage over large areas and the Project Site is likely to form part of the broader foraging area for this species.

There are a number of records of the Eastern Freetail-bat from the Gosford LGA, from near Popran National Park, Point Clare to the east, and Somersby and Peats Ridge to the north of the Project Site. Although no specific information exists on the local population, those recorded in the locality are likely to be part of a broadly distributed population which exists in the northern part of the Sydney Basin Bioregion.

Given the mobility of this species and large areas over which they forage, it is unlikely that the viability of the local population will be adversely affected by the Project.

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

There are no endangered populations of the Eastern Freetail-bat listed for the area under Schedule 1 Part 2 of the *Threatened Species Conservation Act* 1995.

**c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:**
**i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
**ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,**

Not applicable.

**d) in relation to the habitat of a threatened species, population or ecological community:**
- **i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- **ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- **iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,**

Clearing would only impact on up to 34.7ha of potential habitat. This is a very small proportion of the home range for this species, and is likely to be low quality habitat compared to habitat that is available in the Offset Areas (i.e. downstream). Clearing would include removal of potential roosting and foraging habitat.

Habitat within the Project Site is contiguous with Popran National Park, and fragmentation and isolation of habitat would not occur. Popran National Park is part of a large corridor linking Brisbane Water National Park and the Blue Mountains (Morgan, 2001). The Project Site provides native vegetation which is continuous with the vegetation of Popran National Park, and is therefore part of the local corridor system for flora and fauna.

Eastern Freetail-bats occur in dry sclerophyll forest and woodland east of the Great Dividing Range. They roost mainly in tree hollows but will also roost under bark or in man-made structures. Little is known about their diet, although it is likely that they are insectivorous (Churchill, 1998, DEC (NSW), 2005h).

Due to the large areas of potential habitat available to this species in the locality, the land affected by the Project is not likely to be important habitat for the species.

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

No critical habitat for this species has currently been listed in the critical habitat registry by the Director-General of the DECC.

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

No recovery plan or threat abatement plan specific to this species have been prepared or drafted to date.

Management actions suggested by the DECC include protecting retaining forest habitats and preserving hollow-bearing and dead trees. Eighteen priority actions have been developed to help recover this species, including:

- Ensure the largest hollow bearing trees, inc. dead trees and paddock trees, are given highest priority for retention in PVP assessments. Offsets should include remnants in high productivity (High priority);

- Identify areas of private land that contain high densities of large hollow-bearing trees as areas of high conservation value planning instruments and land management negotiations e.g. LEP, CAPs, PVPs (High priority); and
- Promote the conservation of these private land areas using measures such as incentive funding to landholders, off-setting and biobanking, acquisition for reserve establishment or other means (High priority).

A number of these priority actions could be carried out on the Project Site or adjacent land.

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

The Eastern Freetail-bat is at threat from the following:

- Loss of hollow-bearing trees and recruitment hollow-bearing trees; and
- Clearing for grazing, agriculture, forestry or development.

**Conclusion**
The Project is not likely to have a significant impact on this species.

## D23 Little Bentwing-bat

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

No Little Bentwing-bats were recorded on the Project Site. They forage over large areas and the Project Site is likely to form part of the broader foraging area for this species. The Project Site does not provide suitable breeding habitat for this species as they require deep caves.

There are a number of records of Little Bentwing-bats from the local area, one of which is from Brisbane Water National Park, and further to the east of the Project Site around Bouddi NP and Gosford (NSW Government, 2009). Although no specific information exists on the local population, those recorded in the locality are likely to be part of a broadly distributed population which exists in the northern part of the Sydney Basin Bioregion.

Given the mobility of this species and large areas over which they forage, it is unlikely that the viability of the local population will be adversely affected by the Project.

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

There are no endangered populations of the Little Bentwing-bat listed for the area under Schedule 1 Part 2 of the *Threatened Species Conservation Act* 1995.

**c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:**
- **i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
- **ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,**

Not applicable.

**d) in relation to the habitat of a threatened species, population or ecological community:**
- **i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- **ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- **iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,**

Clearing would only impact on up to 34.7ha of potential foraging habitat. This is likely to represent a small proportion of the home range for this species. Clearing would include removal of potential foraging habitat but would not affect roosting habitat.

Due to the Little Bentwing-bat being highly mobile, it is not considered that continuous vegetation is required for dispersal between habitat areas. Broad corridors occur in the locality through Popran, Brisbane Water and Dharug National Parks and across the region. Vegetation on the Project Site makes up part of a corridor between these National Parks in the locality and although the width of the corridor would be reduced, it is not likely that the Project would hinder movements of the species.

Little Bentwing-bats occur in moist eucalypt forest, rainforest or dense coastal banksia scrub. They roost in caves, tunnels and sometimes tree hollows during the day, and at night forage for small insects beneath the canopy of densely vegetated habitats. Roost sites can be shared with other micro-bat species such as the Common Bentwing-bat and, in winter, the two species may form mixed clusters.

In NSW the largest maternity colony is in close association with a large maternity colony of Common Bentwing-bats (*M. schreibersii*) and appears to depend on the large colony to provide the high temperatures needed to rear the young.

Due to the lack of suitable caves for breeding and the large areas of potential foraging habitat available to this species in the locality, the land affected by the Project is not likely to be important habitat for the species.

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

No critical habitat for this species has currently been listed in the critical habitat registry by the Director-General of the DECC.

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

No threat abatement plans relate to this species and no recovery plan has been prepared for this species. Twenty-five priority actions have been developed to help recover this species, including:

- Protect significant roosts and forest habitat within 10 km of roosts in PVP assessments (offsets should include nearby remnants in high productivity) and other environmental planning instruments (Medium priority); and
- Promote the conservation of these significant roost areas using measures such as incentive funding to landholders, offsetting and biobanking, acquisition for reserve establishment or other means (Low priority).

A number of these priority actions could be carried out on the Project Site or adjacent land.

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

The Little Bentwing-bat is at threat from the following:

- Destruction of caves that provide seasonal or potential roosting sites; and
- Clearing for grazing, agriculture, forestry or development.

**Conclusion**
The Project is not likely to have a significant impact on this species.

## D24 Large-eared Pied Bat

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

No Large-eared Pied Bats were recorded on the Project Site. They forage over large areas and the Project Site is likely to form part of the broader foraging area for this species. The Project Site may provide some suitable breeding habitat for this species as they used domed sandstone caves as maternity roosts. This type of habitat is more typical of the Offset Areas than the proposed extraction areas.

There are few records of Large-eared Pied Bats from the Gosford LGA, with three records from around Central Mangrove and McPherson State Forest, one from Bouddi National Park and one near Gosford. Although no specific information exists on the local population, those recorded in the locality are likely to be part of a broadly distributed population which exists in the northern part of the Sydney Basin Bioregion.

Given the mobility of this species and large areas over which they forage, it is unlikely that the viability of the local population will be adversely affected by the Project.

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

There are no endangered populations of the Large-eared Pied Bat listed for the area under Schedule 1 Part 2 of the *Threatened Species Conservation Act* 1995.

**c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:**
- **i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
- **ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,**

Not applicable.

**d) in relation to the habitat of a threatened species, population or ecological community:**
- **i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- **ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- **iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,**

Clearing would only impact on up to 34.7ha of potential habitat. This is likely to represent a small proportion of the home range for this species. Clearing would include removal of potential roosting and foraging habitat.

Due to the Large-eared Pied Bat being highly mobile, it is not considered that continuous vegetation is required for dispersal between habitat areas. Broad corridors occur in the locality through Popran, Brisbane Water and Dharug National Parks and across the region. Vegetation on the Project Site makes up part of a corridor between these National Parks in the locality and although the width of the corridor would be reduced, it is not likely that the Project would hinder movements of the species.

Large-eared Pied Bats occur in well-timbered areas containing gullies. They roost in domed sandstone caves, crevices in cliffs and disused mines. The species is likely to forage for insects beneath the forest canopy. The species has high fidelity to roost sites and females raise young in maternity colonies in caves.

Due to the lack of suitable caves for breeding and the large areas of potential foraging habitat available to this species in the locality, the land affected by the Project is not likely to be important habitat for the species.

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

No critical habitat for this species has currently been listed in the critical habitat registry by the Director-General of the DECC.

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

No threat abatement plans relate to this species and no recovery plan has been prepared for this species. Twenty-five priority actions have been developed to help recover this species, including:

- Ensure protection of caves and overhangs in area of suitable geology when undertaking PVP assessments (offsets should include nearby remnants in high productivity) or other land assessment tools (High priority).

A number of these priority actions could be carried out on the Project Site or adjacent land.

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

The Large-eared Pied Bat is at threat from the following:

- Clearing and isolation of forest near roost habitat for development, agriculture, through forestry and fire;
- Damage to roost and maternity caves through mining and recreational caving; and
- Use of pesticides.

**Conclusion**
The Project is not likely to have a significant impact on this species.

## D25 Large-footed Myotis

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

There was a possible record on the Large-footed Myotis from the eastern side of the Project Site, however, as this part of the Project Site is the highest, it is less likely to be used by the species as it forages over water. The species is more likely to forage over the low lying creeks. Potential roosting habitat is provided on the Project Site in hollow-bearing trees.

There are many records of the Large-footed Myotis scattered throughout the Gosford LGA, including one at the Mangrove Creek Dam, one in Dharug National Park near the Hawkesbury River, several around Brisbane Water likely to have been recorded from surrounding creeks,

and from Avoca Lagoon. Although no specific information exists on the local population, those recorded in the locality are likely to be part of a broadly distributed population which exists in the northern part of the Sydney Basin Bioregion.

Given the mobility of this species and large areas over which they forage, it is unlikely that the viability of the local population will be adversely affected by the Project.

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

There are no endangered populations of the Large-footed Myotis listed for the area under Schedule 1 Part 2 of the *Threatened Species Conservation Act* 1995.

**c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:**
- **i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
- **ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,**

Not applicable.

**d) in relation to the habitat of a threatened species, population or ecological community:**
- **i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- **ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- **iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,**

Clearing would only impact on any pools that occur within Creek A. This is likely to represent a small proportion of the home range for this species. Clearing would include removal of potential roosting habitat.

Due to the Large-footed Myotis being highly mobile, it is not considered that continuous vegetation is required for dispersal between habitat areas. Broad corridors occur in the locality through Popran, Brisbane Water and Dharug National Parks and across the region. Vegetation on the Project Site makes up part of a corridor between these National Parks in the locality and although the width of the corridor would be reduced, it is not likely that the Project would hinder movements of the species.

The Large-footed Myotis roosts close to water in caves, mine shafts, hollow-bearing trees, storm water channels, buildings and in dense foliage. They forage over streams and pools, raking their feet across the surface to catch insects and small fish.

The Large-footed Myotis is most likely to use the creeks on the Project Site for foraging compared with the drier, heath areas. Potential roosting habitat is available in the hollow-

bearing trees on the Project Site, although the species usually roosts near water, therefore the hollow-bearing trees closer to the creeks are those most likely to be used by the Large-footed Myotis. Therefore, the land affected by the Project is not likely to be important habitat for the species.

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

No critical habitat for this species has currently been listed in the critical habitat registry by the Director-General of the DECC.

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

No threat abatement plans relate to this species and no recovery plan has been prepared for this species. Fifteen priority actions have been developed to help recover this species, including:

- Ensure the largest hollow bearing trees in riparian zones are given highest priority for retention in PVP assessments or other land clearing assessment tools (Low priority); and
- Encourage recovery of natural hydrological regimes, including retention and rehabilitation of riparian vegetation (Medium priority).

A number of these priority actions could be carried out on the Project Site or adjacent land.

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

The Large-footed Myotis is at threat from the following:

- Reduction in stream foraging resources and surrounding habitat;
- Loss of or disturbance to roost sites; and
- Use of pesticides in and around foraging habitat.

**Conclusion**
The Project is not likely to have a significant impact on this species.

## D26 Greater Broad-nosed Bat

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

No Greater Broad-nosed Bats were recorded on the Project Site. They forage over large areas and the Project Site is likely to form part of the broader foraging area for this species.

There are a number of records of the Greater Broad-nosed Bat from the Gosford LGA, from near Popran National Park, Kariong, Dharug National Park, McPherson State Forest and in rural residential areas east of Gosford. Although no specific information exists on the local population, those recorded in the locality are likely to be part of a broadly distributed population which exists in the northern part of the Sydney Basin Bioregion.

Given the mobility of this species and large areas over which they forage, it is unlikely that the viability of the local population will be adversely affected by the Project.

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

There are no endangered populations of the Greater Broad-nosed Bat listed for the area under Schedule 1 Part 2 of the *Threatened Species Conservation Act* 1995.

**c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:**
- **i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
- **ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,**

Not applicable.

**d) in relation to the habitat of a threatened species, population or ecological community:**
- **i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- **ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- **iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,**

Clearing would only impact on up to 34.7ha of potential habitat. This is a very small proportion of the home range for this species, and is likely to be low quality habitat compared to habitat that is available in the Offset Areas (i.e. downstream). Clearing would include removal of potential roosting and foraging habitat.

Due to the Greater Broad-nosed Bat being highly mobile, it is not considered that continuous vegetation is required for dispersal between habitat areas. Broad corridors occur in the locality through Popran, Brisbane Water and Dharug National Parks and across the region. Vegetation on the Project Site makes up part of a corridor between these National Parks in the locality and although the width of the corridor would be reduced, it is not likely that the Project would hinder movements of the species.

The Greater Broad-nosed Bat is most commonly found in tall, wet forest but also occurs in woodland, dry eucalypt forest and rainforest. It roosts in tree hollows but has also been

recorded roosting in buildings. Females give birth and raise young at maternity sites in suitable trees.

The majority of vegetation removed by the Project is dry woodland and heath, which is a less suitable habitat type for the Greater Broad-nosed Bat. Due to the large areas of potential habitat available to this species in the locality, the land affected by the Project is not likely to be important habitat for the species.

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

No critical habitat for this species has currently been listed in the critical habitat registry by the Director-General of the DECC.

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

No threat abatement plans relate to this species and no recovery plan has been prepared for this species. Eighteen priority actions have been developed to help recover this species, including:

- Ensure largest hollow bearing trees, inc. dead trees and paddock trees are given highest priority for retention in PVP assessments (offsets should include remnants in high productivity) and/or other land assessment tools (High priority);
- Promote the conservation of these HCV private land areas using measures such as incentive funding to landholders, off-setting and biobanking, acquisition for reserve establishment or other means (High priority); and
- Identify areas of private land that contain high densities of large, hollow-bearing trees as areas of high conservation value in planning instruments and land management negotiations e.g. LEP, CAPs, PVPs (High priority).

A number of these priority actions could be carried out on the Project Site or adjacent land.

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

The Greater Broad-nosed Bat is at threat from the following:

- Disturbance to roosting and breeding sites;
- Clearing of foraging habitats;
- Loss of hollow-bearing trees;
- Use of pesticides and herbicides; and
- Changes to water regimes affecting insect availability.

**Conclusion**
The Project is not likely to have a significant impact on this species.

## D27 Grey-headed Flying-fox

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

The Grey-headed Flying-fox was recorded during studies conducted to the north of the Project Site but was not recorded on the Project Site. They forage over large areas and the Project Site is likely to form part of the broader foraging area for this species.

There are many records of the Grey-headed Flying-fox from the Gosford LGA, from Mangrove Mountain, Dharug and Popran National Parks and many records from around Gosford including Brisbane Water National Park, urban and rural residential areas. Grey-headed Flying-foxes roost in specific camps. The animals that have been observed in the northern part of the study area are likely to roost in the camp near Mangrove Mountain and do not roost on the Project Site but use it for foraging as part of a much larger range.

Given the mobility of this species and large areas over which they forage, it is unlikely that the viability of the local population will be adversely affected by the Project.

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

There are no endangered populations of the Grey-headed Flying-fox listed for the area under Schedule 1 Part 2 of the *Threatened Species Conservation Act* 1995.

**c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:**
- **i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
- **ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,**

Not applicable.

**d) in relation to the habitat of a threatened species, population or ecological community:**
- **i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- **ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- **iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,**

Clearing would only impact on up to 34.7ha of potential habitat. This is a very small proportion of the home range for this species and represents foraging habitat only.

Due to the Grey-headed Flying-fox being highly mobile, it is not considered that continuous vegetation is required for dispersal between habitat areas. Broad corridors occur in the locality through Popran, Brisbane Water and Dharug National Parks and across the region. Vegetation on the Project Site makes up part of a corridor between these National Parks in the locality and although the width of the corridor would be reduced, it is not likely that the Project would hinder movements of the species.

The Grey-headed Flying-fox roosts, mates and rears young in camps with high site fidelity, with camps established in gullies with dense vegetation. It forages in subtropical and temperate rainforest, tall sclerophyll forest and woodland, heaths, swamps, urban gardens and orchards.

No known maternity camps exist on or adjacent to the Project Site. Foraging habitat is abundant in the locality, therefore the land affected by the Project is not likely to be important habitat for the species.

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

No critical habitat for this species has currently been listed in the critical habitat registry by the Director-General of the DECC.

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

No threat abatement plans relate to this species and no recovery plan has been prepared for this species. Thirty-one priority actions have been developed to help recover this species, including:

- Protect and enhance priority foraging habitat for Grey-headed Flying-foxes, for example through management plans, local environmental plans and development assessments, and through volunteer conservation programs for privately owned land (Low priority); and
- Increase the extent and viability of foraging habitat for Grey-headed Flying-foxes that is productive during winter and spring (generally times of food shortage), including habitat restoration/rehabilitation works (High priority).

A number of these priority actions could be carried out on the Project Site or adjacent land.

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

The Grey-headed Flying-fox is at threat from the following:

- Disturbance to roosting sites;
- Clearing of foraging habitats;
- Unregulated shooting; and

- Electrocution on powerlines.

**Conclusion**
The Project is not likely to have a significant impact on this species.

## D28 Eastern Pygmy Possum

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

There are many records of the Eastern Pygmy Possum from the Gosford LGA, from Mangrove Creek Water Supply Reserve, several from McPhersons State Forest, around Peats Ridge, Calga and Kariong, and many records from around Gosford including Brisbane Water National Park and rural residential areas. The Eastern Pygmy Possum recorded on the Project Site is likely to be part of a metapopulation that uses heath areas from the Calga – Peats Ridge area. Clearing for the Project may interrupt the life cycle of this family group, however a population is likely to continue in the locality, and would not be placed at risk of extinction.

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

There are no endangered populations of the Eastern Pygmy Possum listed for the area under Schedule 1 Part 2 of the *Threatened Species Conservation Act* 1995.

**c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:**
**i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
**ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,**

Not applicable.

**d) in relation to the habitat of a threatened species, population or ecological community:**
**i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
**ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
**iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,**

Clearing would only impact on up to 34.7ha of known and potential habitat. This represents both foraging and sheltering habitat.

The Eastern Pygmy Possum is small, relies on movement on the ground to disperse and it is considered that continuous vegetation is required for dispersal between habitat areas. Broad corridors occur in the locality through Popran, Brisbane Water and Dharug National Parks and across the region. Vegetation on the Project Site makes up part of a corridor between these National Parks in the locality and although the width of the corridor would be reduced, it is not likely that the Project would isolate this species.

The Eastern Pygmy Possum was recorded on a part of the Project Site occurring close to the Stage 4 extraction area but that will be retained in the Offset Areas. The species may use habitat across the majority of the Project Site including offset and extraction areas and although a large area of potential habitat will be cleared for the species, habitat will be retained and conserved in the Offset Areas, which is likely to ensure the long-term survival of the species in the study area.

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

No critical habitat for this species has currently been listed in the critical habitat registry by the Director-General of the DECC.

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

No threat abatement plans relate to this species and no recovery plan has been prepared for this species. Seven priority actions have been developed to help recover this species, including:

- Encourage and support land managers to undertake management actions that benefit the species (Medium priority); and
- Reserve fire management strategies to include operational guidelines to protect this species from fire; with fire frequency of >10 years (Medium priority).

A number of these priority actions could be carried out on the Project Site or adjacent land.

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

The Eastern Pygmy Possum is threatened by or the Project would further impact the species through the following processes.

- Clearing of native vegetation as this will clear foraging habitat. However, potential foraging habitat will be retained on the Project Site;
- Ecological consequences of high frequency fires as this can diminish the abundance of flowering shrubs used by this species for foraging. There will be no need for regular burning, and as such the frequency of fire on the Project Site is unlikely to increase;
- Predation by the European red fox as individuals can become prey items for foxes. Foxes already exist on the Project Site and are not likely to be increased in number by the Project;

- Predation by feral cats as individuals can become prey items for cats. It is unknown as to whether feral cats exist on the Project Site but numbers are not likely to be increased as a result of the Project;
- Grazing by feral rabbits as this can affect the diversity of flowering shrubs. It is unlikely that the presence of rabbits will increase in the Offset Areas as a result of the Project;
- The removal of dead wood and dead trees, as the removal of wood on the ground can reduce potential nest sites. Dead wood would be removed as a result of the Project, however all dead wood will be retained in the Offset Areas.

**Conclusion**
The Project is not likely to have a significant impact on this species.

## D29 Spotted-tailed Quoll

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

There are many records of the Spotted-tailed Quoll from the Gosford LGA, including from Dharug National Park along the Hawkesbury River, in the Kulnura – Mangrove Mountain area extending to the northern section of Popran National Park, Mt White and the southern part of Popran National Park, Brisbane Water National Park and in coastal areas east of Gosford including Bouddi National Park. The species has not been recorded on the Project Site but potential habitat does occur there. Potential habitat will be retained on the Project Site, however, a population is likely to continue in the locality, and would not be placed at risk of extinction.

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

There are no endangered populations of the Spotted-tailed Quoll listed for the area under Schedule 1 Part 2 of the *Threatened Species Conservation Act* 1995.

**c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:**
**i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
**ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,**

Not applicable.

**d) in relation to the habitat of a threatened species, population or ecological community:**
**i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**

**ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
**iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,**

Clearing would only impact on up to 34.7ha of potential habitat. This represents both foraging and sheltering habitat.

The Spotted-tailed Quoll moves along the ground but contiguous vegetation is not necessarily required for dispersal between habitat areas. Broad corridors occur in the locality through Popran, Brisbane Water and Dharug National Parks and across the region. Vegetation on the Project Site makes up part of a corridor between these National Parks in the locality and although the width of the corridor would be reduced, it is not likely that the Project would isolate this species.

The Spotted-tailed Quoll has not been recorded on the Project Site. The species may use habitat across the majority of the Project Site including offset and extraction areas and although a large area of potential habitat will be cleared for the species, habitat will be retained and conserved in the Offset Areas, which is likely to ensure the long-term survival of the species in the study area.

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

No critical habitat for this species has currently been listed in the critical habitat registry by the Director-General of the DECC.

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

No recovery plan has been prepared for this species. The Fox Threat Abatement Plan is relevant to this species: the Spotted-tailed Quoll is a medium priority species affected by foxes. The Project is not inconsistent with the objectives on this threat abatement plan. Thirty-two priority actions have been developed to help recover this species, including:

- Reserve Fire management Strategy(s) include operational guidelines that protect rocky outcrops and riparian zones within areas of known habitat (High priority).

This priority action could be carried out on the Project Site or adjacent land.

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

The Spotted-tailed Quoll is threatened by or the Project would further impact the species through the following processes.

- Clearing of native vegetation as this will clear foraging habitat. However, potential habitat will be retained on the Project Site;

- Competition from feral honeybees as they can form hives in tree hollows that also form potential denning habitat for the Spotted-tailed Quoll. The Project is not likely to exacerbate this process.
- Competition with the European red fox for prey items. Foxes already exist on the Project Site and are not likely to be increased in number by the Project.
- The removal of dead wood and dead trees, and loss of hollow-bearing trees, as dead trees and logs are often hollow and contain potential denning habitat. Hollow-bearing trees would be removed as a result of the Project, however many will also be retained on the Project Site.

**Conclusion**
The Project is not likely to have a significant impact on this species.

## D30 Yellow-bellied Glider

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

There are many records of the Yellow-bellied Glider from the Gosford LGA, particularly in the western parts including the Mangrove Creek Water Supply Reserve, McPherson State Forest and Dharug National Park, the northern section of Popran National Park and in the eastern parts of the LGA east of Gosford including Bouddi National Park. The species has not been recorded on the Project Site but potential habitat does occur there. Potential habitat will be retained on the Project Site, however, a population is likely to continue in the locality, and would not be placed at risk of extinction.

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

There are no endangered populations of the Yellow-bellied Glider listed for the area under Schedule 1 Part 2 of the *Threatened Species Conservation Act* 1995.

**c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:**
**i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
**ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,**

Not applicable.

**d) in relation to the habitat of a threatened species, population or ecological community:**
**i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**

**ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
**iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,**

Clearing would not impact on none of the potential habitat for this species. Potential habitat for the species will be retained within the Offset Areas.

As the Yellow-bellied Glider is relatively mobile, but is considered to require tree connectivity for dispersal between habitat areas. Broad corridors occur in the locality through Popran, Brisbane Water and Dharug National Parks and across the region. Vegetation on the Project Site makes up part of a corridor between these National Parks in the locality and although the width of the corridor would be reduced, it is not likely that the Project would hinder movements of the species.

The Yellow-bellied Glider has not been recorded on the Project Site. The species may use habitat across the majority of the Project Site including offset and extraction areas but preferred habitat for the species will be retained and conserved in the Offset Areas, which is likely to ensure the long-term survival of the species in the study area.

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

No critical habitat for this species has currently been listed in the critical habitat registry by the Director-General of the DECC.

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

There are no threat abatement plans relevant to this species. A recovery plan has been prepared for this species and includes the objectives:

- To encourage and assist in improving the protection and management of the Yellow-bellied Glider and its habitat; and
- To increase community awareness of the Yellow-bellied Glider and encourage community involvement in its conservation.

Fourteen priority actions have been developed to help recover this species, including:

- Consider species in reserve management and planning to protect and enhance habitat and connection corridors (High priority).

This priority action could be carried out on the Project Site or adjacent land.

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

The Yellow-bellied Glider is threatened by or the Project would further impact the species through the following processes.

- Clearing of native vegetation as this will clear potential habitat. However, potential foraging and denning habitat will be retained on the Project Site;
- Competition from feral honeybees as they can form hives in tree hollows that also form potential denning habitat for the Yellow-bellied Glider. The Project is not likely to exacerbate this process.
- The removal of dead wood and dead trees, and loss of hollow-bearing trees, as dead trees are often hollow and contain potential denning habitat. Hollow-bearing trees would be removed as a result of the Project, however many will also be retained on the Project Site.

**Conclusion**
The Project is not likely to have a significant impact on this species.

## D31 Squirrel Glider

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

There are many records of the Squirrel Glider from the Gosford LGA, with a few records in the western part of the LGA from Kulnura, Dharug National Park and the northern section of Popran National Park. Most records are from the eastern part of the LGA from around Gosford, Niagara Park, Kariong, Erina, Brisbane Water National Park and Bouddi National Park. The species has not been recorded from the Project Site but potential habitat does occur there. Potential habitat will be retained on the Project Site, however a population is likely to continue in the locality, and would not be placed at risk of extinction.

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

There are no endangered populations of the Squirrel Glider listed for the area under Schedule 1 Part 2 of the *Threatened Species Conservation Act* 1995.

**c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:**
**i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
**ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,**

Not applicable.

**d) in relation to the habitat of a threatened species, population or ecological community:**
- **i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- **ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- **iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,**

Clearing would only impact on up to 33.3ha of potential habitat. This represents both foraging and sheltering habitat.

As the Squirrel Glider is relatively mobile, but is considered to require tree connectivity for dispersal between habitat areas. Broad corridors occur in the locality through Popran, Brisbane Water and Dharug National Parks and across the region. Vegetation on the Project Site makes up part of a corridor between these National Parks in the locality and although the width of the corridor would be reduced, it is not likely that the Project would hinder movements of the species.

The Squirrel Glider has not been recorded on the Project Site. The species may use habitat across the majority of the Project Site including offset and extraction areas and although a large area of potential habitat will be cleared for the species, habitat will be retained and conserved in the Offset Areas, which is likely to ensure the long-term survival of the species in the study area.

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

No critical habitat for this species has currently been listed in the critical habitat registry by the Director-General of the DECC.

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

No threat abatement plans relate to this species and no recovery plan has been prepared for this species. Thirty-one priority actions have been developed to help recover this species, including:

- Ensure the largest hollow bearing trees (including dead trees) are given highest priority for retention in PVP assessments and other environmental planning instruments, or other land assessment tools (Medium priority).

This priority action could be carried out on the Project Site or adjacent land.

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

The Squirrel Glider is threatened by or the Project would further impact the species through the following processes.

- Clearing of native vegetation as this will clear potential habitat. However, potential habitat will be retained on the Project Site;
- Competition from feral honeybees as they can form hives in tree hollows that also form potential denning habitat for the Squirrel Glider. The Project is not likely to exacerbate this process.
- The removal of dead wood and dead trees, and loss of hollow-bearing trees, as dead trees are often hollow and contain potential denning habitat. Hollow-bearing trees would be removed as a result of the Project, however many will also be retained on the Project Site.

**Conclusion**
The Project is not likely to have a significant impact on this species.

## D32 Long-nosed Potoroo

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

There are few records of the Long-nosed Potoroo from the Gosford LGA, with records from near Mangrove Mountain, Point Clare, Narara and east of Gosford. The species has not been recorded from the Project Site but potential habitat does occur there and. will be retained. A population is likely to continue in the locality, and would not be placed at risk of extinction by the development.

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

There are no endangered populations of the Long-nosed Potoroo listed for the area under Schedule 1 Part 2 of the *Threatened Species Conservation Act* 1995.

**c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:**
**i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
**ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,**

Not applicable.

**d) in relation to the habitat of a threatened species, population or ecological community:**
**i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
**ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**

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

Clearing would only impact on up to 34.7ha of potential habitat. This represents both foraging and sheltering habitat.

The Long-nosed Potoroo is considered to require vegetation cover to disperse between habitat areas. Broad corridors occur in the locality through Popran, Brisbane Water and Dharug National Parks and across the region. Vegetation on the Project Site makes up part of a corridor between these National Parks in the locality and although the width of the corridor would be reduced, it is not likely that the Project would hinder movements of the species.

The Long-nosed Potoroo has not been recorded on the Project Site. The species may use habitat across the majority of the Project Site including offset and extraction areas and although a large area of potential habitat will be cleared for the species, habitat will be retained and conserved in the Offset Areas, which is likely to ensure the long-term survival of the species in the study area.

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

No critical habitat for this species has currently been listed in the critical habitat registry by the Director-General of the DECC.

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

No recovery plan has been prepared for this species. The Fox Threat Abatement Plan is relevant to this species. The Project is not inconsistent with the objectives of this plan.

Nineteen priority actions have been developed to help recover this species, including:

- Encourage private landholders to exclude livestock from key habitat to reduce the impact of grazing, trampling and the spread of weeds (Medium priority);
- Encourage private landholders to protect known and potential Long-nosed Potoroo habitat from inappropriate fire regimes (Medium priority);
- Undertake control burn using a mosaic pattern to ensure adequate vegetation cover (Low priority);
- Control weeds, particularly those that affect the understorey layer, in Long-nosed Potoroo habitat (Low priority);
- Seek formal protection of all remaining areas of known habitat under voluntary conservation agreements, joint management agreements or as critical habitat (Low priority);
- Increase habitat via revegetation work and/or establishing corridors to link multiple patches of suitable habitat to expand the effective area of habitat (Low priority); and
- Prevent the spread of Phytophthora sp (Low priority).

This priority action could be carried out on the Project Site or adjacent land.

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

The Long-nosed Potoroo is threatened by or the Project would further impact the species through the following processes.

- Clearing of native vegetation as this will clear potential habitat. However, potential habitat will be retained on the Project Site;
- Predation by the European red fox as individuals can become prey items for foxes. Foxes already exist on the Project Site and are not likely to be increased in number by the Project;
- Ecological consequences of high frequency fires as this can diminish the dense understorey vegetation used for sheltering. There will be no need for regular burning, and as such the frequency of fire on the Project Site is unlikely to increase;
- Predation by feral cats as individuals can become prey items for cats. It is unknown as to whether feral cats exist on the Project Site but numbers are not likely to be increased as a result of the Project; and
- The removal of dead wood and dead trees, as the removal of wood on the ground can reduce potential nest sites. Dead wood would be removed as a result of the Project, however all dead wood will be retained in the Offset Areas.

**Conclusion**
The Project is not likely to have a significant impact on this species.

## D33 Red-crowned Toadlet

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

Red-crowned Toadlets were recorded from four locations within the Project Site: two along Creek A, one along Creek B and another in a rock overhang away from the creeks. The size and extent of Red-crowned Toadlet populations are difficult to determine without intensive survey. The extensive surveys that have been conducted in the study area have only detected a few individuals, which may be part of one or several much larger populations. Assuming that dispersal is possible between all sites where Red-crowned Toadlets have been detected, it is possible that a large ranging population extends over the Project Site and into neighbouring bushland.

The population is likely to have been once part of a much larger population that extended throughout sandstone ridge top habitats before development occurred in the locality. Gene flow would have occurred throughout these sandstone habitats. The population on the Project Site occurs in a habitat which is well-represented throughout the locality and therefore it is likely to be similar in genetic construct to other populations in the locality.

Breeding is likely to occur along the ephemeral creeks which are present in the Project Site. Much of Creek A would be removed as a result of the Project, which would remove a significant area of known habitat for this species, however small patches of known habitat would be retained, as well as other potential areas for breeding. The population would remain viable as breeding habitat would be retained on the Project Site.

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

There are no endangered populations of the Red-Crowned Toadlet listed under Schedule 1 Part 2 of the *Threatened Species Conservation Act* 1995.

**c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:**
- **i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
- **ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,**

Not applicable.

**d) in relation to the habitat of a threatened species, population or ecological community:**
- **i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- **ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- **iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,**

A large area of potential habitat would be cleared as a result of the Stage 4 extraction stage, however, habitat would be retained on the Project Site, and much larger areas of habitat for this species exists throughout the Somersby Plateau and habitat is protected within the adjacent Popran National Park. No known habitat would be removed as a result of the Project, although up to 1.5ha (approximately 75%) of potential habitat will be removed.

While vegetation corridors are being maintained through the Project Site, movement of Red-crowned Toadlets is restricted to rock outcrops and damp areas. Creek B would be retained and Evans & Peck (2008) predicts the reduction in surface flows within the retained creeks of the Project Site would be (at worst 33%) and more likely less than 15%. There is much sandstone outcropping on the Project Site, containing shelters in the form of crevices. These areas would provide shelter and foraging habitat for Red-crowned Toadlets and would be ideal for the species to use in dispersing across the Project Site.

The Red-crowned Toadlet generally occurs on the sandstone escarpment areas and plateaus in the Sydney basin, usually within 100m of the ridge top. It utilises moist microhabitats and are usually found along permanently moist soaks in ephemeral feeder creeks (NSW NPWS, 2001d). Within the Project Site the species is found in isolated habitats along the two

ephemeral upper creeks. The habitat present on the Project Site is similar to large areas found throughout the Somersby Plateau.

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

No critical habitat for this species has currently been listed in the critical habitat registry by the Director-General of the DECC.

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

No recovery plan has been prepared for this species. No threat abatement plans are relevant to this species. DECC has identified 14 priority actions to help recover this species in NSW. These include:

- develop preferred mitigation measures to minimize impact of wildlife and/or suppression operations;
- develop best practice management strategies that buffer and protect important headwater/ridge top breeding sites from changes to water flow, flow regimes and water quality changes;
- prepare guide to creating, rehabilitating or augmenting habitat for the species; this might include provision of rock/log ground cover, diversion of water, provision of breeding/nesting sites and material; and
- monitor the various initiatives and trials of habitat manipulation for effectiveness.

A number of these priority actions could be carried out on the Project Site or adjacent land.

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

The Red-crowned Toadlet is threatened by or the Project would further impact the species through the following processes.

- Bushrock removal as this will reduce shelter sites. This process will only impact on the species if bushrock is collected illegally from habitat areas that are to be retained.
- Clearing of native vegetation as this will remove potential dispersal habitat across the Project Site. A corridor of sandstone outcropping and ground layer vegetation will be retained as a dispersal corridor through the Project Site between the Stage 4 and Stage 5 quarries.
- Ecological consequences of high frequency fires as frequent fires can destroy individuals and make habitat unsuitable. No hazard reduction burning is proposed for the Project Site and fire frequency is likely to remain low.
- Alteration to the natural flow regimes of rivers, streams, floodplains & wetlands as changes to water quality such as pollution and siltation has the potential to make habitat unsuitable for the species and changes to flow rates can affect suitability of

habitat for breeding. The Project is likely to affect Red-crowned Toadlets along Creek A as the Project would remove a large portion of this ephemeral drainage line. Creek B would be retained, however, some reduction in surface and base groundwater flows has been predicted by GeoTerra (Dawkins, 2009) and Evans & Peck (2008).

The Project may also exacerbate the following processes, further impacting on the species:

- Infection of frogs by Amphibian Chytrid Fungus causing the disease chytridiomycosis as it has the potential to be fatal to all frog species. The Red-crowned Toadlet appears to be less susceptible to the disease as it does not breed in streams. The Project is not likely to affect the susceptibility of the species to the chytrid fungus.

**Conclusion**
The Project is not likely to have a significant impact on this species.

## D34 Giant Burrowing Frog

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

The Giant Burrowing Frog has not been recorded on the Project Site, but has been recorded in the Study Area. Potential habitat for the Giant Burrowing Frog occurs on the Project Site and appears confined between the 170m and 190 m contours between Creeks A and B (Figure 2). This area has a hanging swamp nested in deep sand. Above the 190 m contour, the sandstone layer does not seem to retain ground moisture; similarly below the 180 m contour, the sandstone is not deeply weathered and appears unsuitable. This zone contains two discrete hanging swamp ecosystems, one being dominated by Tea Trees (*Leptospermum* sp), and the other by Saw-sedges (*Gahnia* sp). These swamps do not appear to retain open water and breeding may not be possible in this area. If Giant Burrowing Frogs are present, then breeding is most likely to occur in pools in the upper parts of Creek A, although no tadpoles of this species were found there.

Up to 3.23ha (approximately 44%) of potential habitat for this species would be removed as a result of the Project. Extensive similar habitat exists in the locality, including habitat which is protected in Popran National Park. Patches of potential habitat on the Project Site would be retained, as well as other potential areas for breeding. The population would remain viable as breeding habitat would be retained on the Project Site.

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

There are no endangered populations of Giant Burrowing Frogs listed for the area under Schedule 1 Part 2 of the *Threatened Species Conservation Act* 1995.

**c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:**
- **i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
- **ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,**

Not applicable.

**d) in relation to the habitat of a threatened species, population or ecological community:**
- **i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- **ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- **iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,**

Up to 3.23ha (approximately 44%) of potential habitat for this species would be removed as a result of the Project.

Corridors are being maintained on the Project Site, particularly along Creeks B and C, which would enable this species to move around. The Project Site provides habitat which is continuous with Popran National Park, and is therefore part of the local corridor system for flora and fauna. Popran National Park is part of a large corridor linking Brisbane Water National Park and the Blue Mountains National Park (Morgan, 2001). No areas of habitat will become isolated or fragmented as part of the proposed development.

Extensive similar habitat exists in the locality, including habitat which is protected in Popran National Park. Therefore the habitat to be removed on the Project Site is not considered to be important for the long term survival of this species in the locality.

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

No critical habitat for this species has currently been listed in the critical habitat registry by the Director-General of the DECC.

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

No recovery plan has been prepared for this species. No threat abatement plans are relevant to this species. DECC has identified 24 priority actions to help recover this species in NSW. These include:

- develop best practice guidelines for road/drain construction and maintenance within reserves, forests and utility access easements;

- ensure that appropriate erosion, sedimentation and water quality control measures are applied around known locations;
- develop guidelines for construction of microhabitat features as components of land management best practice; and
- investigate performance of supplementary habitat design and construction in trial locations.

A number of these priority actions could be carried out on the Project Site or adjacent land.

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

The Giant Burrowing Frog is threatened by or the Project would further impact the species through the following processes:

- Clearing of native vegetation as this will remove potential dispersal habitat across the Project Site A corridor of sandstone outcropping and ground layer vegetation will be retained as a dispersal corridor through the Project Site between the Stage 4 and Stage 5 extraction area;
- Ecological consequences of high frequency fires as frequent fires can destroy individuals and make habitat unsuitable. No hazard reduction burning is proposed for the Project Site and fire frequency is likely to remain low; and
- Alteration to the natural flow regimes of rivers, streams, floodplains & wetlands as changes to water quality such as pollution and siltation has the potential to make habitat unsuitable for the species and changes to flow rates can affect suitability of habitat for breeding. The Project would affect Giant Burrowing Frogs along Creek A if they occur on the Project Site as the quarry would remove a large portion of this ephemeral drainage line. Creek B would be retained, however with quarries on either side the water levels are likely to be reduced in this creek.

The Project may also exacerbate the following processes, further impacting on the species.

- Infection of frogs by Amphibian Chytrid Fungus causing the disease chytridiomycosis as it has the potential to be fatal to all frog species. The Giant Burrowing Frog appears to be less susceptible to the disease as it does not breed in streams. The Project is not likely to affect the susceptibility of the species to the chytrid fungus.

**Conclusion**
The Project is not likely to have a significant impact on this species.

## D35 Rosenberg's Goanna

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

This species has not been recorded on the Project Site, but has been recorded in the Study Area. This species relies on termite mounds for laying its eggs, and shelters in hollow logs, rock crevices and burrows (DEC (NSW), 2005b1). The home range for this species is approximately 20ha (King and Green 1999). Foraging and nesting habitat would be retained on the Project Site. In the absence of sufficient data for the adjacent Popran National Park, it is possible that a significant impact may be felt on a local population of this species, however the viability of the species as a whole is not at risk as a result of the Project.

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

There are no endangered populations of Rosenberg's Goanna listed for the area under Schedule 1 Part 2 of the *Threatened Species Conservation Act* 1995.

**c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:**
- **i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
- **ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,**

Not applicable.

**d) in relation to the habitat of a threatened species, population or ecological community:**
- **i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- **ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- **iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,**

Up to 33.3ha of potential habitat for this species would be cleared from the Project Site, which is approximately 48 of the available habitat on the Project Site. Extensive similar habitat exists in the locality, including habitat which is protected in Popran National Park.

The Project Site is located adjacent to Popran National Park which is part of a large corridor linking Brisbane Water National Park and the Blue Mountains (Morgan, 2001). The Project Site provides native vegetation which is continuous with the vegetation of Popran National Park, and is therefore part of the local corridor system for flora and fauna. While there will be fragmentation of potential habitat on the Project Site, this will not be isolated from adjacent habitat areas.

Rosenberg's Goanna relies on termite mounds for laying its eggs, and shelter in hollow logs, rock crevices and burrows (DEC (NSW), 2005b1). Home range for this species is variable, averaging approximately 20ha (King and Green, 1999). Foraging and nesting habitat would be retained on the Project Site. Similar habitat exists throughout the adjacent Popran National Park, and habitat would not be isolated as a result of the Project.

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

No critical habitat for this species has currently been listed in the critical habitat registry by the Director-General of the DECC.

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

No recovery plan has been prepared for this species. No threat abatement plans are relevant to this species. DECC has identified nine priority actions to help recover this species in NSW. These include:

- identify key habitats or areas for protection and enhanced management on private land through management agreements and incentives;
- undertake investigations into general biology and ecology of the species, particularly movement patterns and tree use, rock crevice use and termitaria use; and
- develop habitat identification, management and enhancement guidelines.

A number of these priority actions could be carried out on the Project Site or adjacent land.

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

Rosenberg's Goanna is threatened by or the Project would further impact the species through the following processes.

- Clearing of native vegetation as this will clear foraging habitat. Potential foraging habitat will be retained on the Project Site.
- Predation by the European red fox as young goannas can become prey items for foxes. Foxes already exist on the Project Site and are not likely to be increased in number by the Project.
- The removal of dead wood and dead trees as dead wood is often hollow and contain potential den habitat. Some dead wood would be removed as a result of the Project, however much will also be retained on the Project Site.

**Conclusion**
The Project is not likely to have a significant impact on this species.

# Appendix E

## Tree Hollow Plot Data

(No. of pages excluding this page = 2)

| Species | Scientific Name | Dbh (cm) | Height (m) | # Hollows | Approx hollow size | Comments |
|---|---|---|---|---|---|---|
| **Plot 1** | | | | | | |
| Grey Gum | *Eucalyptus punctata* | 40 | 10 | 3 | <5cm | |
| Grey Gum | *Eucalyptus punctata* | 35 | 12 | 1 | <5cm | |
| Scribbly Gum | *Eucalyptus racemosa* | 55 | 15 | 2 | <5cm | |
| Scribbly Gum | *Eucalyptus racemosa* | 55 | 8 | 1 | <5cm | |
| Scribbly Gum | *Eucalyptus racemosa* | 80 | 20 | 3<br>2 | >20cm<br>5-20cm | |
| Scribbly Gum | *Eucalyptus racemosa* | 25 | 8 | 0 | | |
| Scribbly Gum | *Eucalyptus racemosa* | 20 | 10 | 0 | | |
| Scribbly Gum | *Eucalyptus racemosa* | 60 | 15 | 1<br>1 | 10cm<br><5cm | Scratches |
| Scribbly Gum | *Eucalyptus racemosa* | 35 | 10 | 0 | | |
| Scribbly Gum | *Eucalyptus racemosa* | 70 | 10 | 1<br>1 | <5cm<br>>20cm | Basal hollow |
| Scribbly Gum | *Eucalyptus racemosa* | 35 | 8 | 0 | | |
| Scribbly Gum | *Eucalyptus racemosa* | 10 | 8 | 0 | | |
| Stringybark | *Eucalyptus sparsifolia* | 50 | 8 | 1 | 15cm | Basal hollow |
| Grey Gum | *Eucalyptus punctata* | 55 | 15 | 1 | 10-15cm | |
| Scribbly Gum | *Eucalyptus racemosa* | 70 | 8 | 1 | 15cm | Basal hollow |
| Scribbly Gum | *Eucalyptus racemosa* | 45 | 10 | 2 | 20cm | nest in hollow |
| Scribbly Gum | *Eucalyptus racemosa* | 60 | 8 | 1 | 20cm | |
| Scribbly Gum | *Eucalyptus racemosa* | 80 | 10 | 1 | 5-10cm | |
| Stringybark | *Eucalyptus sparsifolia* | 40 | 12 | 1 | 5cm | |
| Scribbly Gum | *Eucalyptus racemosa* | 80 | 10 | 1<br>1 | 10cm<br>5cm | |
| Scribbly Gum | *Eucalyptus racemosa* | 30 | 8 | 1<br>1 | 10cm<br>5cm | |
| Scribbly Gum | *Eucalyptus racemosa* | 80 | 12 | 3 | 5-10cm | |
| Scribbly Gum | *Eucalyptus racemosa* | 20 | 8 | 1 | 10cm | Basal hollow |
| Scribbly Gum | *Eucalyptus racemosa* | 80 | 11 | 1<br>1<br>1 | 15cm<br>20cm<br>20cm | 3 entrances<br><br>Basal hollow |
| **Total hollows** | | | | **35** | | |
| | | | | | | |
| **Plot 2** | | | | | | |
| Smooth-barked Apple | *Angophora costata* | 30 | 12 | 2 | <5cm | |
| Smooth-barked | *Angophora* | 30 | 8 | 4 | <5cm | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Apple | *costata* | | | | | |
| Smooth-barked Apple | *Angophora costata* | 45 | 12 | 1<br>1 | 10-15cm<br>5-10cm | |
| Smooth-barked Apple | *Angophora costata* | 30 | 10 | 1 | 15cm | |
| Stag | | 45 | 12 | 1<br>1<br>2 | >20cm<br>15cm<br><5cm | |
| Smooth-barked Apple | *Angophora costata* | 45 | 15 | 2 | 10cm | |
| Scribbly Gum | *Eucalyptus haemastoma* | 70 | 9 | 1 | <5cm | |
| Stag | | 65 | 7 | 2 | >20cm | |
| Smooth-barked Apple | *Angophora costata* | 45 | 15 | 1 | >20cm | |
| Smooth-barked Apple | *Angophora costata* | 35 | 12 | 1 | <5cm | |
| Grey Gum | *Eucalyptus punctata* | 20 | 8 | 0 | | |
| Grey Gum | *Eucalyptus punctata* | 70 | 12 | 2 | <5cm | |
| Smooth-barked Apple | *Angophora costata* | 40 | 15 | 1 | <5cm | |
| Smooth-barked Apple | *Angophora costata* | 50 | 8 | 3 | 5-15cm | |
| Smooth-barked Apple | *Angophora costata* | 25 | 8 | 1 | 5cm | |
| Bloodwood | *Corymbia gummifera* | 65 | 18 | 2 | 15-20cm | |
| Stag | | 25 | 7 | 2 | 10-15cm | |
| Smooth-barked Apple | *Angophora costata* | 30 | 15 | 1 | <5cm | |
| Bloodwood | *Corymbia gummifera* | 35 | 15 | 1 | 5-10cm | |
| Grey Gum | *Eucalyptus punctata* | 20 | 8 | 0 | | |
| **Total hollows** | | | | **33** | | |
| | | | | | | |
| **Recorded incidentally** | | | | | | |
| Smooth-barked Apple | *Angophora costata* | 110 | 25 | 3 | >15cm | |
| Smooth-barked Apple | *Angophora costata* | 100 | 25 | 1<br>3 | >50cm<br>5-10cm | Trunk |
| Scribbly Gum | *Eucalyptus haemastoma* | 150 | 20 | 3<br>2 | >30cm<br><5cm | |
| Bloodwood | *Corymbia gummifera* | 110 | 22 | 5<br>2 | >20cm<br><5cm | |

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