Gerringong upgrade
Princes Highway
Review of Environmental Factors
APPENDIX E - FLORA AND FAUNA ASSESSMENT
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Project Manager |

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Executive summary

Biosis Research Pty Ltd was commissioned by AECOM on behalf of the NSW Roads and Traffic Authority (RTA) to carry out a terrestrial ecological assessment of the Gerringong upgrade from Mount Pleasant to Toolijooa Road (the proposal) which forms part of the RTA’s Princes Highway upgrade program between Gerringong and Bomaderry.

The aim of the assessment is to identify issues of conservation significance associated with the proposed upgrade. The specific objectives are to:

a) Gather existing information regarding terrestrial flora and fauna within and surrounding the study area, focussing on threatened species, populations and ecological communities.

b) Examine the nature, extent and condition of fauna habitats and vegetation associations within the study area, through a combination of desktop and field studies.

c) Identify areas supporting vegetation associations that are, or are likely to be, of conservation significance, or support resources that may be utilised by species or populations of conservation significance.

d) Assess the potential occurrence of flora and fauna species or populations of conservation significance, in particular, threatened species and populations.

e) Identify areas that may be of importance as habitat corridors.

f) Assess the potential impacts of the proposed highway upgrade on threatened species and populations (including their habitats) and endangered ecological communities.

The terrestrial ecological field investigations of the proposed upgrade were conducted during February 2007, November 2008 and May 2009. Surveys were carried out using a combination of habitat-based assessment, trapping, anabat recording, spotlighting and targeted sampling techniques. The study area consists of the area of earthworks for the proposed road (subject site), and a buffer of approximately 50 m on either side of the subject site to account for potential indirect impacts.

Endangered ecological communities (EEC)

Two plant communities were recorded in the study area: estuarine saltmarsh and subtropical dry rainforest. Estuarine saltmarsh is part of the coastal saltmarsh EEC listed in the Threatened Species Conservation Act 1995 which occurs in the NSW North Coast, Sydney Basin and South East Corner Bioregions. Subtropical dry rainforest is included within the Illawarra Subtropical Rainforest EEC which is confined to the Sydney Basin Bioregion. Impact assessments were carried out for each of these EECs and it was determined that the proposed upgrade is unlikely to have a significant impact upon either of the ecological communities.

Flora

A total of 12 plant species listed on the Threatened Species Conservation Act 1995 and/or the Environment Protection and Biodiversity Conservation Act 1999, or their habitat, have been previously recorded within a 10 km radius of the study area. A further 19 plant species listed on the Threatened Species Conservation Act are known or predicted to occur in the Illawarra subregion of the Southern Rivers Catchment Management Area. No threatened plant species were recorded in the study area, however, based on the proximity of previous records and the presence of identified habitat preferences, potential habitat may exist within the study area for 10 threatened plant species including Cynanchum elegans, Daphnandra sp. ‘Illawarra’ Distichlis distichophylla, Irenepharsus trypherus, Senna acclinis, Solanum celatum, Syzygium paniculatum, W lsonia backhousei, W lsonia rotundifolia and Zieria granulata. Impact assessments were carried out for each of these threatened plant species and it was determined that the proposed upgrade is unlikely to have a significant impact upon any of these species.
Fauna

Fauna habitat within the study area ranges from predominantly cleared areas which have low to moderate habitat quality in terms of fauna habitat characteristics, to fragmented small patches of native vegetation, including important habitat features such as tree hollows, rocky shelters, riparian vegetation, fallen logs and feeding resources.

A total of 80 animal species listed on the Threatened Species Conservation Act 1995 and/or the Environment Protection and Biodiversity Conservation Act 1999, or their habitat, have been previously recorded within a 10 km radius of the study area. Two migratory species were recorded within the study area (Ardea ibis, Cattle Egret and Gallinago hardwickii, Latham’s Snipe) and an additional two migratory and one threatened species were recorded during the current surveys, just outside the study area. Based on the proximity of current and previous records and the presence of identified habitat preferences, potential habitat may exist within the study area for 44 threatened and 21 migratory animal species.

Impacts to the potential habitat of 38 threatened species were considered negligible and therefore, significance assessments were not conducted for these species. Impact assessments were carried out for the remaining six threatened animal species and concluded a significant impact by the proposed upgrade to be unlikely.

Impacts to the potential habitat of 35 threatened species were considered negligible and therefore, significance assessments were not conducted for these species. Impact assessments were carried out for the remaining six threatened animal species and concluded a significant impact by the proposed upgrade to be unlikely.

Impacts to the potential habitat of the 21 migratory species were considered negligible. Individuals of these species that may occur in the study area were not considered likely to be an ecologically significant proportion of the population. Further, potential habitat in the study area was not considered important for the migratory species. As such, no significance assessments under the Environmental Protection and Biodiversity Conservation Act were carried out for these species.

A Species Impact Statement and/or Referral to the Environment Minister is not recommended for any endangered ecological communities or threatened (or migratory) flora and fauna.

Wildlife corridors and connectivity

Within the study area roadside native vegetation is limited to small discontinuous segments of native and exotic vegetation cover and groundcover. The proposed upgrade is not likely to impact on any local or regional wildlife corridors due to the existing degree of clearing and fragmentation.

Mitigation

Impacts of the proposed upgrade are likely to come from a number of sources such as:

- Vegetation clearance / habitat loss.
- Edge effects.
- Mortality of individuals during both the construction and operations phases.
- Introduction and/or spread of weeds.
Early consideration of potential flora and fauna constraints in the initial route selection stage of the project has generally allowed important ecological features in the study area to be avoided (Gerringong to Bomaderry Princes Highway Upgrade, Preferred Option Report, RTA October 2008). Mitigation measures have been suggested to ameliorate potential impacts on terrestrial flora and fauna that could not have otherwise been avoided, including:

- Preparation of a vegetation management plan, prior to construction, detailing restoration, regeneration and rehabilitation of areas of native vegetation in the vicinity of the proposed upgrade.
- Monitoring and control of weed populations that establish on disturbed areas, with particular attention to eradication of noxious weeds. The monitoring and control should be undertaken by person experienced in weed management.
- Fencing and protection of EECs and potential habitat of threatened species that occur within the impact zone.
- Minimising disturbance wherever possible to stream banks and streambeds. This may be more easily achieved with bridge construction but would be unlikely where culverts are to be installed.
- Clearing of vegetation should follow the RTA requirements for fauna rescue on highway projects as updated from time to time. These guidelines are a dynamic document produced in consultation with the Department of Environment, Climate Change and Water (DECCW). They include procedures for clearing of non-habitat and habitat trees, the relocation of rescued fauna and the inclusion of wildlife specialists in the process.
1.0 Introduction

1.1 Background

The Roads and Traffic Authority of NSW (RTA) is proposing to upgrade the Princes Highway between Mount Pleasant and Toolijooa Road; the Gerringong upgrade (the proposal). The proposal is part of the RTA’s program to upgrade the Princes Highway between Gerringong and Bomaderry, providing increased road safety and traffic efficiency in the South Coast region.

This working paper presents an assessment of the potential environmental impacts on terrestrial ecology and supplements the Review of Environmental Factors for the proposal as required under Part 5 of the Environmental Planning and Assessment Act 1979.

1.2 Objectives of the report

Biosis Research Pty Ltd (Biosis Research) was engaged to investigate potential terrestrial flora and fauna issues in relation to the proposal. The terrestrial flora and fauna study involved two major components:

a) Preliminary investigations to assist the process of selecting a preferred route option (Biosis Research 2007).

b) Detailed investigations of the selected route (this report).

The overall objective of this report is to present the results of surveys and the assessment of potential impacts upon terrestrial flora and fauna values within Gerringong upgrade study area. The potential impacts are assessed in accordance with relevant state and federal threatened species legislation.

The specific objectives of this study are to:

a) Gather existing information regarding terrestrial flora and fauna within and surrounding the study area, focusing on threatened species, populations and ecological communities.

b) Examine the nature, extent and condition of fauna habitats and vegetation associations within the study area, through a combination of desktop and field studies.

c) Determine areas supporting vegetation associations that are, or are likely to be, of conservation significance, or support resources that may be utilised by species or populations of conservation significance.

d) Assess the potential occurrence of flora and fauna species or populations of conservation significance, in particular, threatened species and populations.

e) Determine areas that may be of importance as habitat corridors.

f) Assess the potential impacts of the proposed highway upgrade on threatened species and populations (including their habitats) and endangered ecological communities (EECs).
1.3 Legislative framework

NSW Environmental Planning and Assessment Act 1979

The NSW Environmental Planning and Assessment Act 1979 and Regulations 2000 provide the statutory context for environmental assessment of the project and ultimately planning approval. The current project is to be assessed under Part 5 and other relevant provisions of the Environmental Planning and Assessment Act.

One objective of the Act is to encourage the protection of the environment, including the protection and conservation of native animals and plants, including threatened species, populations and ecological communities and their habitats. A second objective is to encourage the principles of ecologically sustainable development, including the precautionary principle as defined under the Protection of the Environment Administration Act 1991.

Section 5A of the Environmental Planning and Assessment Act, and Section 94 of the Threatened Species Conservation Act 1995 (as amended by the Threatened Species Conservation Amendment Act 2002), lists seven factors (seven part test or assessment of significance) which are used to assess the likely impact of a development on threatened species, populations (including their habitats) or endangered ecological communities. If it is found that a significant impact is expected for any threatened species, populations or ecological communities a species impact statement is required (see below).

Threatened Species Conservation Act 1995 (NSW)

The Threatened Species Conservation Act 1995 protects all threatened plants and animals native to NSW (with the exception of fish and marine plants). It provides for the identification, conservation and recovery of threatened species and their populations and communities. It also aims to reduce the threats faced by those species.

If a planned development or activity would have an impact on a threatened species, population or ecological community this must be taken into account in the development approval process. If the impact is likely to be significant, a species impact statement must be prepared and the Director General of the Department of Environment, Climate Change and Water (DECCW) must agree to the development approval. In some cases, the Minister for the Environment would also need to be consulted.

Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth)

The Environment Protection and Biodiversity Conservation Act 1999 is a Commonwealth mechanism that requires proposed actions to be assessed in terms of their potential impact upon “Matters of National Environmental Significance”. “Matters of National Environmental Significance” currently listed under the Act are:

- World Heritage properties.
- Natural heritage places.
- Wetlands of international importance.
- Threatened species and ecological communities.
- Migratory species.
- Commonwealth marine areas.
- Nuclear actions (including uranium mining).
Where a potential impact on a “Matters of National Environmental Significance” is likely to occur as a result of a proposed action, the significance of that impact must be assessed. Guideline criterions for determining whether an impact is significant are provided under the Act. Where a proposed action would, or is likely to, have a significant impact on a “Matters of National Environmental Significance”, a Referral to the Commonwealth Environment Minister must be prepared. The purpose of the Referral is to determine whether a proposed action requires approval and/or controls under the Environment Protection and Biodiversity Conservation Act 1999.

1.4 Study area

1.4.1 Definitions

New South Wales threatened species legislation applies particular definitions to the site of a proposed development and the area likely to be impacted by a proposed development. In addition, the present NSW and Commonwealth Government approach to biodiversity conservation recognises a system of “bioregions” and “subregions”. In order to provide clarity of reporting and consistency with current legislation and policy, the following definitions apply throughout this document:

Proposed upgrade - proposed upgrade of the Princes Highway between Mount Pleasant and Toolijooa Road on the NSW South Coast (Gerringong upgrade).

Subject site – the area to be directly affected by the proposed upgrade (ie the development “footprint”).

Study area – the subject site and any additional areas which are likely to be affected by the proposed upgrade, either directly or indirectly. In the case of the proposed upgrade, the study area includes the subject site (construction envelope) and a 50 m buffer to account for any indirect impacts.

Locality - for the purposes of this report, the “locality” is defined as the area within a five kilometre radius of the perimeter of the study area.

Region - the region and sub-region in which the proposed upgrade would be located, as defined by the Interim Biogeographic Regionalisation of Australia. The Interim Biogeographic Regionalisation of Australia is based on Thackway and Cresswell (1995) and Morgan and Terry (1992) and periodically updated by Parks Australia. IBRA Version 6.1 (DEH204a, b) was current at the time of this study. The proposed upgrade is located in the Sydney Basin Bioregion.

Threatened biota - threatened species, populations and ecological communities, or their potential habitats, as listed under the Threatened Species Conservation Act or Environment Protection and Biodiversity Conservation Act.

1.4.2 Location and extent

The proposal is located along an approximately 7.4 km route that commences in the north at Mount Pleasant lookout and terminates in the south at Toolijooa Road, west of Gerringong (Figure 1.1). The proposed upgrade passes through the Kiama Local Government Area.

The study area is defined by the extent of direct and indirect impacts on flora and fauna that are likely to occur as a result of the proposed upgrade. Potential impacts on flora and fauna may occur during the construction and/or the subsequent operation of the proposed upgrade. Direct impacts are likely to be limited to the development footprint, which covers the road upgrade footprint. Areas that may be indirectly affected by the proposed upgrade include adjoining flora and fauna habitats within 50 m of either side of the proposed upgrade (see Section 4.1.3 for more information).
The study area is surrounded by cleared agricultural land, with some small scattered patches of native vegetation also occurring. Conservation reserves that occur locally include Seven Mile Beach National Park, Barren Grounds Nature Reserve, Jerrara Dam Reserve and Saddleback Mountain Reserve.

The study area mainly comprises the existing road reserve and privately owned rural and rural residential properties, collectively supporting houses, cleared paddocks and dams. Small patches of native vegetation and isolated remnant trees are scattered throughout the majority cleared agricultural landscape. The main agricultural land-use in the study area is cattle grazing.

The study area encompasses the foothills of the escarpment slopes north of Berry and the floodplains to the north and west of Gerringong. The proposed upgrade crosses a number of small artificial drainages with the two named waterways being Ooaree Creek and the Crooked River. The proposed upgrade would cross each of these drainages at the location of the existing Princes Highway crossings.

1.4.3 Description

The preferred option for the proposal has been selected as that which best meets the project objectives applied across the program of projects for the Princes Highway upgrade between Gerringong and Bomaderry and which performs well across a combination of the technical input gathered through investigations carried out to date (including a review of studies from previous investigations into the upgrade), community feedback and the findings of the value management process.

The proposal would include the following key features:

- Construction of 7.5 km of two lanes in each direction between Mount Pleasant and Toolijooa Road.
- Grade-separated interchange at Rose Valley Road incorporating four-way traffic access to and from Gerringong via a two-way service road and overbridge spanning the South Coast Railway at Fern Street.
- Grade-separated interchange at Belinda Street providing four-way, flood free traffic access to and from Gerringong and incorporating a two-way service road connecting to Willowvale Road.
- Bridge structure spanning a realigned Crooked River, incorporating Bailey’s Road and an existing cattle underpass.
- Northbound climbing lane between Rose Valley Road and the top of Mount Pleasant.
- Southbound climbing lane for approximately 800 m from Belinda Street on ramp.
- Property acquisition and the setting of corridor boundaries for the provision of future widening to six lanes (three in each direction).
- Extensive drainage structures maintaining cross drainage flow in the low lying area of Omega Flat.
- Incorporation of the provision for future widening now where the design is constrained by topography and alignment eg the ‘slot’ and bridge structure at the Rose Valley Road interchange.

Other design features would include areas of cuts and fills, possible redirection of minor tributaries (which would be confirmed during detailed design), less significant drainage culverts, soft soil treatments in the Omega Flat such as preloading and surcharging with wick drains to manage long-term settlement, local road and private road access treatments and cattle underpasses.

The proposal is expected to cost in the order of $230m and would be funded by the NSW State Government. Subject to funding, construction of the proposal is anticipated to commence in early 2011 and is expected to take up to two years to complete.
Figure 1.1: Overview of the study area
2.0 Methods

2.1 Approach

The location and extent of the study area is shown on Figure 1.1. The study involved three key stages: a desktop examination; field surveys; and impact assessment reporting. The desktop study involved gathering and reviewing existing information regarding the flora and fauna of the study area. Field surveys were undertaken for the purpose of ground-truthing information obtained during the desktop examination and to gather additional data from parts of the study area selected for further investigation. The combined information from field and desktop studies was then used to assess the impacts of the upgrade on terrestrial flora and fauna values within the study area.

2.2 Desktop study

Existing information regarding the flora and fauna of the study area was obtained from a range of sources, including: databases; aerial photographs and maps; previous studies carried out in the vicinity of the study area; and consultation with experts, government agencies, land owners and land managers, local volunteer organisations and natural heritage clubs. A list of documents cited in this report is located Chapter 7.0.

Database records were obtained for the study area, land within a 10 km radius of the study area and the Illawarra subregion of the Southern Rivers Catchment Management Authority region. Database searches included:

a) Records of threatened flora and fauna species listed on the schedules of the NSW Threatened Species Conservation Act 1995 within a 10 km radius of the study area obtained from the NSW Department of Environment Climate Change and Water (DECCW) Atlas of NSW Wildlife in August 2009.

b) Records of Matters of National Environmental Significance listed under the provisions of the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (within a 10 km radius of the study area obtained from the Commonwealth Department of the Environment Heritage Water and the Arts (DEHWA) Protected Matters Database in August 2009.


e) Records of threatened flora and fauna species listed on the Threatened Species Conservation Act known or predicted to occur within the Illawarra sub-region of the Southern Rivers Catchment Management Authority, obtained from the DECCW online Threatened Species Profile Database in February 2010.

Spatial information from previous studies carried out in the vicinity of the study area that was examined included:

f) Aerial photographs of the study area and surrounds, sourced by AECOM.

g) Topographic and orthophoto maps (Department of Lands 1:25,000 maps of Gerroa and Kiama).

h) Cadastral information, sourced by AECOM.

i) Native Vegetation Map Report Series. No. 4 (DEC 2005t).

k) Kiama Municipal Council Local Environment Plan.

l) Illawarra Regional Environment Plan.

m) The Natural Vegetation in the Municipality of Kiama New South W ales (Mills 2006).

n) Threatened fauna of the Shoalhaven (NPWS and Shoalhaven Catchment Management Committee 2000).

o) Mammal Survey of Seven Mile Beach National Park and Comerong Island Nature Reserve on the South Coast of New South W ales (Murphy 1998).

p) Bats of the Illawarra Region (Robinson 1985).

Additional data or information was provided by Mark Tozer, Ann Goeth, NANA, the Berry & District Historical Society Inc., Kerry W ithers, Dr Arthur W hite and Gary Daly.

2.3 Site selection

Sites within the study area were selected for field investigation following roadside reconnaissance and an examination of aerial photographs, topographic maps, existing vegetation maps and threatened species records. Survey sites within the study area included locations containing strands of native vegetation and riparian vegetation along creeks and farm dams. Survey effort previously conducted outside the area of potential direct and indirect impacts is included for contextual purposes.

Seasonal surveys along the entire upgrade route were conducted January 2007, November 2008 and May 2009. The location of survey sites is shown on Figure 1.1 with survey types shown in Figure 2.1 and Figure 2.2. It should be noted that survey effort for the entire Gerringong to Bomaderry upgrade was more intensive in areas identified as being of higher conservation significance (Biosis Research 2007). O n this basis, survey effort within the proposal study area was limited due the highly disturbed, agricultural nature of this portion of the study area.

Site selection and survey effort was also influenced by site access limitations, as some land owners could not be contacted, were unwilling to allow access or unwilling to allow sufficient access for detailed surveys.

2.4 Flora surveys

2.4.1 Survey techniques

Flora surveys were conducted by two botanists over a total of four days during three split survey periods conducted in February 2007; November 2008; and May 2009. Survey effort specific to the proposal are provided in Section 2.4.5. Surveys involved targeted searches for threatened plant species using random meander techniques and ground-truthing of the plant communities mapped by DECCW (DEC 2005t) using plot-based surveys. An assessment of plant community condition was conducted at all survey sites.

Surveys were conducted in accordance with the draft DECCW publication, Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities (DEC 2004). Survey effort was most rigorous within areas identified as known or potential habitat for threatened plant species and areas identified as EECs. A description of each of the survey methods is provided below.
2.4.2 Targeted searches

Targeted searches for threatened plant species involved random meander transects as described by Cropper (1993), carried out in selected areas of known or potential habitat. Random meander transects were undertaken by two botanists traversing each site. The locations of random meander transects are shown on Figure 2.1.

During the random meander surveys, an inventory of all observed plant species was recorded at each site (Appendix A). Where threatened plants were detected, the number of individuals present was counted and the extent and geographic location of each population recorded using a hand-held non-differential Global Positioning Systems (GPS). Where plant species could not be identified in the field, a representative sample was collected and preserved for later identification by the Royal Botanic Gardens, Sydney Herbarium.

2.4.3 Plot based surveys (quadrats)

In order to comprehensively describe the structure and floristics of each sampled plant community, plot-based surveys were used. Plot-based surveys also provided a concentrated search area for the detection of inconspicuous plant species that may be present at a particular site. The structure and floristics exhibited by each plant community present in the study area was sampled using one or more 400 m² quadrats (20 m x 20 m). A modified Braun-Blanquet cover abundance scale (Moore 1955) was assigned to each of the species collected within any one quadrat. For this assessment a seven-division cover abundance scale was used (Table 2.1).

<table>
<thead>
<tr>
<th>Cover abundance score</th>
<th>Cover abundance estimate (% cover of any species within each quadrat)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Less than five per cent - three or less individuals</td>
</tr>
<tr>
<td>2</td>
<td>Less than five per cent - more than three individuals but sparsely scattered consistent throughout plot</td>
</tr>
<tr>
<td>3</td>
<td>Less than five per cent - many individuals throughout plot and any number less than five per cent cover abundance</td>
</tr>
<tr>
<td>4</td>
<td>Species covers between five per cent and 25 per cent of the plot</td>
</tr>
<tr>
<td>5</td>
<td>Species covers between 25 per cent and 50 per cent of the plot</td>
</tr>
<tr>
<td></td>
<td>Species covers between 50 per cent and 75 per cent of the plot</td>
</tr>
<tr>
<td></td>
<td>Species covers between 75 per cent and 100 per cent of the plot</td>
</tr>
</tbody>
</table>

Survey data were compared with existing vegetation maps of the study area (DEC 2005t) in order to confirm the identification and extent of plant communities, particularly those that correspond to EECs. Any inconsistencies identified in the DECC vegetation mapping were checked using the results of both random meander transects and plot-based surveys.

2.4.4 Condition assessments

Habitat condition assessments collected data regarding the plant communities present at each survey site, including the dominant species within each stratum, the degree of cover and the relative quality or condition of the plant community. The condition of the vegetation was assessed according to the degree to which it resembled relatively natural, undisturbed vegetation using the following criteria:

a) Species composition (species richness, extent of weed invasion).

b) Structure (representation of each of the original layers of vegetation).
Plant community condition was categorised as follows:

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

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

**Poor:** containing a low number of indigenous species; high level of weed invasion; weeds occurring in dense patches or scattered throughout; one or more of the original layers of vegetation highly modified; one or more original vegetation layers (ground, shrub, canopy etc) modified or missing.

**Unnatural landscape:** highly modified landscape containing few or no indigenous species; exotic species dominant; original native vegetation layers removed; natural soil profile disturbed; unable to be regenerated to natural condition; high input intervention required to revegetate.
Figure 2.1: Location of flora survey effort
2.4.5 Flora survey effort

The details of the flora survey effort for the proposal are shown in Table 2.2 and Table 2.3. Time invested in each survey technique is based on on-site person hours and does not include travel between locations or plant specimen identification conducted post survey.

Table 2.2: Flora survey details – targeted searches and habitat condition assessments

<table>
<thead>
<tr>
<th>Task</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aim: to determine presence of threatened plant species and assess habitat condition</td>
<td></td>
</tr>
<tr>
<td>Targeted subject species</td>
<td>All species listed in Table 3.2</td>
</tr>
<tr>
<td>Survey technique</td>
<td>Random meander transects</td>
</tr>
<tr>
<td>Time invested in survey technique</td>
<td>24 person hours</td>
</tr>
<tr>
<td>Survey point or transect marked on a map</td>
<td>See Figure 2.2</td>
</tr>
<tr>
<td>Size, orientation and dimensions of quadrat or length of transect for each survey technique</td>
<td>Targeted searches (random meanders) carried out within the study area. This included two persons walking in parallel lines approximately 20 m apart and traversing the sample site.</td>
</tr>
<tr>
<td>Survey start times and finish times</td>
<td>Between 8am 6pm each day</td>
</tr>
</tbody>
</table>

Table 2.3 Flora survey details – plot-based sampling

<table>
<thead>
<tr>
<th>Task</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aim: to describe structure and floristics of each plant community, identify endangered ecological communities and search for inconspicuous plant species</td>
<td></td>
</tr>
<tr>
<td>Targeted subject species</td>
<td>All plant species and communities</td>
</tr>
<tr>
<td>Survey technique</td>
<td>Quadrats</td>
</tr>
<tr>
<td>Time invested survey technique</td>
<td>Six person hours</td>
</tr>
<tr>
<td>Description of site location</td>
<td>Stratified within each of the different plant communities.</td>
</tr>
<tr>
<td>Survey point marked on a map</td>
<td>See Figure 2.2</td>
</tr>
<tr>
<td>Size, orientation and dimensions of quadrat or length of transect for each survey technique</td>
<td>Three quadrats each measuring 20 m x 20 m or 30 m x 10 m (400 m²)</td>
</tr>
<tr>
<td>Survey start times and finish times</td>
<td>8.30am to 4.30pm per day</td>
</tr>
</tbody>
</table>

2.5 Fauna surveys

The locations of fauna survey sites are shown in Figure 2.2. Targeted surveys were conducted as described below.

2.5.1 Diurnal bird survey

Diurnal bird surveys were carried out in patches of native vegetation occurring within the study area (Sites 1, 2 and 3). Surveys involved one or two zoologists traversing forest or wetland patches or scanning an area from a fixed point with binoculars. Birds were identified by direct observation or by call.
2.5.2 **Spotlighting**
Spotlighting for nocturnal mammals and birds was carried out within the saltmarsh wetland of Site 2. Spotlighting was undertaken by two zoologists traversing the site on foot and examining the vegetation using hand-held 50 watt spotlights.

2.5.3 **Call playback**
Nocturnal call playback was used at Site 2 to survey for the Green and Golden Bell Frog (*Litoria aurea*). Following an initial listening period of five minutes, a recorded call of the Green and Golden Bell Frog was played through a 10W TOA megaphone for a period of three minutes. This was followed by a three minute listening period and spotlighting (using hand-held 50 watt spotlights).

2.5.4 **Nocturnal frog survey**
In addition to call playback, frogs were surveyed by spotlight searches and aural surveys, which were conducted at night within two hours of dusk. A nocturnal frog survey was conducted along a water channel within Site 2. Following an initial listening period of five minutes, two zoologists surveyed the channel for 15 minutes using hand-held 50 watt spotlights.

2.5.5 **Incidental observations**
Both indirect and direct evidence of fauna was recorded and used to identify species presence. Direct evidence of animal species included actual sightings or identification of the species by calls (eg birds, frogs and some nocturnal mammals). Indirect evidence of animal species included remains (eg skin), scats, diggings or burrows and feeding scars.

Incidental animal observations were recorded each day over the entire length of the study area.

2.5.6 **Mammal trapping**
No mammal trapping was conducted for the proposal due to the lack of potential habitat. Mammal trapping (eg Elliott, Cage and Harp).

2.5.7 **Reptile survey**
Habitat for threatened reptile species does not occur within the study area and no systematic searches for reptiles were carried out as part of this study. Reptiles were recorded by opportunistic identification when observed during other surveys or by occasional hand searches under rocks or fallen timber where suitable habitat was present.

2.5.8 **Fauna habitat assessment**
Fauna habitats within the study area were assessed on the presence of one or more of the following features:

- Vegetation cover.
- Size range and abundance of tree hollows.
- Rock outcrops, overhangs or crevices.
- Freestanding water bodies, ephemeral drainage or seepage areas.
- Disturbances, including weed invasion, clearing, rubbish dumping or fire.
- Potential foraging, nesting or roosting resources.
- Connectivity to off-site habitats.
- Surrounding habitat.
The three categories used to evaluate habitat value were Good, Moderate or Poor, as detailed below:

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

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

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

Other habitat features, such as the value of the study area as a habitat corridor, the presence of remnant communities or unusual ecological plant community structures were also used to assess habitat quality.
Figure 2.2: Fauna survey effort
2.6 Fauna survey effort

Table 2.4 shows the total survey effort (excluding incidental observations) conducted for the proposal. The locations of fauna survey sites are shown in Figure 2.2.

<table>
<thead>
<tr>
<th>Survey techniques</th>
<th>No. of sites (surveys)</th>
<th>Total transect length (metres)</th>
<th>Total person hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diurnal bird survey</td>
<td>3 (4)</td>
<td>566</td>
<td>3.5</td>
</tr>
<tr>
<td>Spotting (mammals and birds)</td>
<td>1 (2)</td>
<td>1378</td>
<td>1.5</td>
</tr>
<tr>
<td>Frog call playback</td>
<td>1 (1)</td>
<td>n/a</td>
<td>0.19</td>
</tr>
<tr>
<td>Nocturnal frog survey</td>
<td>1 (1)</td>
<td>50</td>
<td>0.5</td>
</tr>
<tr>
<td>Habitat assessment</td>
<td>2 (2)</td>
<td>n/a</td>
<td>n/a</td>
</tr>
</tbody>
</table>

2.7 Taxonomy

The plant taxonomy (classification) used in this report follows the most recent Flora of New South Wales (Harden 1990; Harden 1992; Harden 1993; Harden 2002). All doubtful species names were verified with the on-line Australian Plant Name Index (Australian National Botanic Gardens 2007). In the text of this report plants are referred to by their scientific names only. Plant common names where available have been included in threatened species tables and the complete flora list in Appendix A.

Names of vertebrates follow the Census of Australian Vertebrates maintained by the Department of the Environment, Water, Heritage and the Arts (DEWHA 2007). In the body of this report vertebrates are referred to by both their common and scientific names when first mentioned. Subsequent references to these species cite the common name only. Common and scientific names are included in the Appendix B.

2.8 Limitations

Some plant species that occur in the local area are annuals (completing their life cycle within a single season) and are present only in the seed bank for much of the year. While seasonal surveys were undertaken, some species do not appear or flower consistently each season or from one year to the next. Other plant species are perennial, but are inconspicuous unless flowering or in fruit. Furthermore, some animal species are only detectable at certain times of the year. Therefore, despite seasonal surveys it is likely that some species that are present on the site were not detected. Despite these limitations, the assessment of impact is based on the presence or absence of suitable habitat for threatened flora and fauna, and as such, species are taken into account during the assessment even though they may not have been detected during the survey.

Other limitations to the field investigations included site access. While the majority of land owners able to be contacted assisted the field investigations and the study was able to apply recognised sampling techniques to most of the habitat types present within the study area, surveys of some sites were limited by various constraints. These included limitations imposed by land owners on survey techniques or survey times and duration or, in some cases, a refusal of access. Based on an assessment of aerial photography and road side reconnaissance, areas subject to access constraints were determined to be of low conservation significance and therefore, refusal of access to parts of the study area was not a major limitation.
3.0 Results

A list of the flora and fauna recorded during the surveys within the Gerringong upgrade portion of the study area is provided in Appendix A and Appendix B respectively.

3.1 Geology and soils

The study area encompasses the foothills of the escarpment slopes south of Gerringong and the floodplains associated with the Crooked River and Ooaree Creek. The hilly areas to the south of the study area at Toolijooa, and in and around the townships of Gerringong and Gerroa, are underlain by Budgong Sandstone, Blow Hole Latite and the Berry Formation (Hazelton 1992). These soil landscapes are associated with rock outcrops and boulders on ridges and steeper slopes (Hazelton 1992). The floodplains in the study area are underlain by alluvium derived mainly from sandstone and shale and are described as active floodplains (Hazelton 1992). An area adjoining the Princes Highway to the north of Gerringong is underlain by Quaternary Marine Sands (Hazelton 1992).

The majority of the study area supports cleared agricultural land, cattle grazing being the main agricultural activity of the region. Vegetation generally occurs in the study area as scattered patches on ridge tops and steep slopes at Mount Pleasant; and as thin strips of riparian vegetation along the banks of the Crooked River and associated wetland and tributaries.

3.2 Plant communities

3.2.1 Vegetation mapping

The following section provides descriptions of each plant community recorded within the study area as well as a discussion of their conservation status, location and extent. Existing vegetation mapping (DEC 2005t) provided the background and assisted with the planning of field sampling and subsequent analysis; however, occasional inconsistencies with the Department of Environment, Climate Change and Water (DECCW) maps arose in the type and extent of vegetation within the study area. Plant communities as mapped by DECCW (DEC 2005t) have been amended following ground-truthing during the surveys. All amendments to DECCW mapping are identified within the text in Section 3.2.2 and illustrated in Figure 3.1.

A description of the condition of plant communities and fauna habitats present within the study area is provided in Section 3.3.
Figure 3.1: Vegetation mapping of the study area (DEC 2005)

Legend

- Eucalypt woodland
- Coastal sand forest
- Coastal warm temperate rainforest
- Bawarraburra gully woodland
- Bawarraburra inland swamp woodland
- Uluru scrub
- Subtropical complex rainforest
- Subtropical dry rainforest
- Temperate coastal rainforest
- Warm temperate layered forest
- Coastal Sand Geasp Forest
- Eucalypt Fringe Forest
- Phytophile Swamp Forest
- SEEP 14 woodland

Survey areas:
- Subject Site
- Study Area
3.2.2 Identification of plant communities

The majority of the study area is covered by cleared areas and grazed paddocks that contain little native vegetation and have not been mapped or described as a native plant community. Native plant communities that do occur within the study area have been named in accordance with the plant community descriptions provided by DECCW (DEC 2005t) as part of the NSW native vegetation mapping program. Plant communities conforming to listed endangered ecological communities (EECs) were sampled and identified according to their floristic composition and compared to the DECCW profiles and relevant scientific committee determinations. The area of each native plant community occurring within the subject site, study area and locality is shown in Table 3.1 and has been applied as an estimate of the likely extent of potential habitat for threatened biota within each impact assessment (see Appendix C and Appendix D). The conservation status of each community according to the Environment Protection and Biodiversity Conservation Act 1999 and the Threatened Species Conservation Act 1995 is also shown in Table 3.1.

Twenty-two plant communities have been mapped as occurring within the locality (five kilometre radius of the study area) (Table 2.4). Sixteen of these plant communities are likely to form part of an endangered ecological community as listed on the Threatened Species Conservation Act including: coastal freshwater lagoon, estuarine saltmarsh, coastal sand forest, coastal sand swamp forest, coastal warm temperate rainforest, estuarine fringe forest, estuarine mangrove forest, floodplain swamp forest, headland grassland, Illawarra lowland swamp woodland, littoral thicket, riverbank forest, South Coast grassy woodland, subtropical complex rainforest, subtropical dry rainforest and temperate littoral rainforest. No plant communities occurring within the locality form part of an EEC as listed under the Environment Protection and Biodiversity Conservation Act.

Four plant communities were recorded during surveys of the study area and surrounds. A brief description of vegetation is provided below. For contextual information, vegetation occurring downstream and outside of the study area at Crooked River (see Site 2 – estuarine fringe forest) has also been provided. Information is also provided on cleared land and paddocks as these can provide habitat for fauna species.

**Subtropical dry rainforest**

Subtropical dry rainforest is a low closed forest characterised by a dense tree canopy, prominent small tree / shrub layer and a sparse groundcover (DEC 2005q). This community is distributed on the lowlands between Mount Keira and Nowra, with a southern occurrence near Milton (DEC 2005t). Within the study area this community is represented by a single fragment near Mount Pleasant (Site 1) (see Figure 1.1 and Figure 3.1). Subtropical dry rainforest is included within the EEC, Illawarra subtropical rainforest in the Sydney Basin Bioregion.

Dominant species include *Baloghia inophylla*, *Ficus* spp, *Streblus brunonianus* and *Pittosporum undulatum* in the canopy, with a shrub layer including *Maclura cochinchinensis*, *Notelaea venosa*, *Cassine australis* and *Pittosporum multiflorum*. Dominant climbers found in this community include *Gelonoplesium cymosum* and *Pandorea pandorana*. The groundcover is dominated by *Oplismenus imbecillis*, *Arthropteris tenella* and *Doodia aspera*. 
Estuarine saltmarsh

Estuarine saltmarsh is a succulent herbfield or sedgeland occurring on estuarine mudflats that are exposed to tidal inundation (DEC 2005t). This community is known to occur at coastal NSW locations including Botany Bay, Jervis Bay and the Shoalhaven, Clyde and Deua estuaries. Within the study area, this community is confined to Site 2 (Figure 1.1) immediately east of Fern Street in the north of Gerringong. It should be noted that the DECCW (DEC 2005t) mapping identified this portion of the study area incorrectly as coastal sand forest, which is typically a eucalypt forest community and does not occur as such in the study area. Further areas of estuarine saltmarsh within the locality are likely to occur within the tidal zone at Werri Lagoon (north-east of Site 2) and Crooked River (Site 3) in association with estuarine fringe forest as described below. The vegetation between Fern Street and the Princes Highway immediately west of Site 2 is subject to impeded drainage from historic road and rail construction and is considered an artificial wetland.

Plant species identified during the field survey were consistent with the diagnostic plant species described for this community (DEC 2005t). Dominant native species included a groundlayer of Juncus krausii, Sarcocornia quinqueflora and Triglochin striata. Estuarine saltmarsh is a part of the EEC, coastal saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions.

Estuarine fringe forest

Estuarine fringe forest is a low forest with a non-eucalypt canopy, open understorey and continuous groundcover tolerant of saline conditions (DEC 2005t). Its distribution is confined to the high tide mark on the margins of tidal estuaries and rivers at elevations less than five metres. This community occurs along the Hawkesbury, Georges, Hacking, Shoalhaven, Clyde and Moruya rivers and near the tidal mouths of St Georges Basin and Lake Illawarra. Within the study area, this community is confined to narrow strips of remnant and regrowth vegetation along the upper reaches of the Crooked River (Site 3) and Werri Lagoon (north-east of Site 2), well outside the area of potential direct and indirect impacts relating to the proposed upgrade.

Plant species identified during the field survey were consistent with the diagnostic plant species described for this community (DEC 2005t). Dominant species included a canopy of Casuarina glauca with an understorey of Melaleuca stypheloides, Myoporum acuminatum and ground layer including Atriplex cinerea, A. prostrata, Juncus krausii, Sarcocornia quinqueflora and Suaeda australis. Estuarine fringe forest is a part of the EEC, swamp oak floodplain forest of the NSW North Coast, Sydney Basin and South East Corner Bioregions.

Cleared land and paddocks

Cleared paddocks dominate the foothills, slopes and floodplains throughout the study area. The majority of the cleared land and paddock areas are considered an unnatural landscape, with limited or no capacity for regeneration to a native plant community.

The cleared land and paddocks are typically comprised of grasslands dominated by exotic pasture species, including Bromus catharticus, Holcus lanatus, Pennisetum clandestinum, Ehrharta erecta and Paspalum spp. Introduced annual and perennial herbs and shrubs are also a typical feature of this community, including: Rumex crispus, Sida rhombifolia, Ageratina riparia, Senecio madagascariensis, Plantago lanceolata and Trifolium repens. Large patches of woody weeds including Lantana camara and Salix babylonica are present along the cleared and disturbed drainage lines such as the upper reaches of the Crooked River.

Scattered trees occur in varying densities across the landscape and include a range of remnant native trees and exotic plantings. Some of the older trees are likely to provide habitat (such as tree hollows or perch sites) for native animals and, as such, are an important feature within an otherwise denuded landscape.
Table 3.1: Plant communities of the subject site, study area and locality

<table>
<thead>
<tr>
<th>Plant community (DEC 2005t)</th>
<th>Conservation status</th>
<th>Equivalent EEC</th>
<th>Area within subject site (ha)</th>
<th>Area within study area (ha)</th>
<th>Area within locality (Ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TSC Act</td>
<td>EPBC Act</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coastal foredune scrub</td>
<td>-</td>
<td>-</td>
<td>N/A</td>
<td>N/A</td>
<td>9.63</td>
</tr>
<tr>
<td>Coastal freshwater lagoon</td>
<td>V</td>
<td>-</td>
<td>Freshwater wetlands on coastal floodplains</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Estuarine saltmarsh</td>
<td>V</td>
<td>-</td>
<td>Coastal saltmarsh</td>
<td>0.002</td>
<td>0.93</td>
</tr>
<tr>
<td>Coastal sand forest</td>
<td>V</td>
<td>-</td>
<td>Bangalay sand forest</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Coastal sand swamp forest</td>
<td>V</td>
<td>-</td>
<td>Swamp sclerophyll forest</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Coastal warm temperate rainforest</td>
<td>V</td>
<td>-</td>
<td>Illawarra subtropical rainforest</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Escarpment foothills wet forest</td>
<td>V</td>
<td>-</td>
<td>N/A</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Estuarine fringe forest</td>
<td>V</td>
<td>-</td>
<td>Swamp oak floodplain forest</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Estuarine mangrove forest</td>
<td>V</td>
<td>-</td>
<td>N/A</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Floodplain swamp forest</td>
<td>V</td>
<td>-</td>
<td>Swamp oak floodplain forest</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Headland grassland</td>
<td>V</td>
<td>-</td>
<td>Themeda grassland on seaciffs and coastal headlands</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Illawarra gully wet forest</td>
<td>-</td>
<td>-</td>
<td>--</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Illawarra lowland swamp woodland</td>
<td>V</td>
<td>-</td>
<td>Illawarra lowlands grassy woodland</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Intermediate temperate rainforest</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Littoral thicket</td>
<td>V</td>
<td>-</td>
<td>Bangalay sand forest</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Riverbank forest</td>
<td>V</td>
<td>-</td>
<td>River-flat eucalypt forest</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Shoalhaven sandstone forest</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>South Coast grassy woodland</td>
<td>V</td>
<td>-</td>
<td>Illawarra lowlands grassy woodland</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

1. Area of each plant community applied as an estimate of the likely extent of potential habitat for threatened biota within impact assessments (see Appendix C and Appendix D)

2. Vegetation map unit amended from coastal sand forest to estuarine saltmarsh based on field surveys.
<table>
<thead>
<tr>
<th>Plant community (DEC 2005t)</th>
<th>Conservation status</th>
<th>Equivalent EEC</th>
<th>Area within subject site (ha)</th>
<th>Area within study area (ha)</th>
<th>Area within locality (Ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subtropical complex rainforest</td>
<td>V</td>
<td>Illawarra subtropical rainforest</td>
<td>-</td>
<td>-</td>
<td>1013.26</td>
</tr>
<tr>
<td>Subtropical dry rainforest</td>
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<td>Illawarra subtropical rainforest</td>
<td>0.009</td>
<td>0.63</td>
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<tr>
<td>Temperate littoral rainforest</td>
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<td>-</td>
<td>-</td>
<td>5.93</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>928.77</td>
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<tr>
<td>Totals (ha)</td>
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<td></td>
<td>0.01</td>
<td>1.55</td>
<td>2679.09</td>
</tr>
</tbody>
</table>
3.3 Flora and fauna habitats

3.3.1 Mount Pleasant (Site 1)

Native vegetation in the study area at Mount Pleasant is confined to an isolated remnant located on a steep slope immediately south-east of the Princes Highway. Vegetation at this site is represented by subtropical dry rainforest. Ongoing disturbances such as grazing and a high degree of weed invasion continue to threaten the integrity of flora and fauna habitat at this location.

Vegetation condition at Site 1 is highly variable and ranges from poor along the disturbed edges to good with distance into core forest areas. The condition of vegetation was considered poor along edges where large infestations of Lantana camara are present and have displaced most native species. These edges were considered to have little or no capacity for the regeneration of natural vegetation without significant resources allocated to weed control and revegetation. Disturbances identified on site included grazing, erosion and runoff. Patches of Lantana camara and Tradescantia fluminensis were also dispersed within the remnants, especially where disturbances have created gaps in the remnant canopy.

The core areas of remnant vegetation at the sites contained subtropical dry rainforest, often in good condition with all structural layers intact and a high diversity of native species present.

The condition of fauna habitats at Site 1 were considered to be in moderate condition. Despite existing disturbances, a variety of feeding and sheltering resources were observed. A large proportion of surface rock and outcropping is present. Such rock outcrops are likely to provide shelter for a variety of mammals including Rattus fuscipes, bush rat and Antechinus stuartii, brown antechinus. Hollow-bearing trees were scarce and none were observed within the subject site; however those present within the remainder of the study area may provide nesting and roosting habitat for various birds, bats and small mammals. Flowering and fruiting trees such as Livistona australis, Ficus spp. and Acmena smithii are present and are likely to provide important feeding resources for a range of insects and nectivorous and frugivorous vertebrates. An ephemeral drainage line is present and provides an intermittent water source for fauna.

3.3.2 Fern Street, Gerringong (Site 2)

Native vegetation in the study area adjacent to Fern Street (Site 2), Gerringong includes estuarine saltmarsh to the east and an artificial wetland to the west. This area forms part of a floodplain known as Omega Flat. A constructed canal traverses this portion of the study area from east to west, before draining into Werri Lagoon. The area east of Fern Street is subject to periodic tidal inundation associated with Werri Lagoon and the constructed drainages connected to the lagoon. Ongoing disturbances such as grazing and weed invasion continue to threaten the integrity of flora and fauna habitat at this location.

Vegetation condition at Site 2 is highly variable and ranges from poor along the Fern Street edge to good with distance from the edge into core areas. Vegetation along the edges has been subject to significant clearance and disturbances resulting from the existing road and track construction in addition to the installation of underground services. Salt tolerant weed species such as Cotula coronopifolia and Pennisetum clandestinum dominate the disturbed edges.

Vegetation within the artificial wetland, west of Fern Street is dominated by large stands of Phragmites australis and a variety of weed species. While Phragmites australis in this area shares similar characteristics with the EEC, freshwater wetlands on coastal floodplains, artificial wetlands are not included as part of this EEC. Potential impacts to patches of Phragmites australis in this area are likely to be confined to the narrow drainage ditch located between the existing rail line and Princes Highway.
The condition of fauna habitats at Site 2 were considered to range from poor along the Fern Street edge to good with distance from the edge into core areas. The emergent sedges and grasses provide known and potential nesting and shelter habitat for a range of birds, particularly waterbirds (including threatened and migratory species). The constructed canal occurring within the study area and other parts of the saltmarsh also provides foraging habitat for birds and microchiropteran bats. While the canal is lined with dense sedges and surrounded by unshaded areas of grass, the waters are infested with Gambusia holbrooki, a known threat to the Green and Golden Bell Frog. The canal is considered unlikely to provide potential breeding habitat for the Green and Golden Bell Frog. However, the species may use it as a movement or dispersal corridor from time to time.

3.3.3 Crooked River (Site 3)

Based on roadside reconnaissance, vegetation located adjacent to the existing Princes Highway at the Crooked River crossing is cleared and disturbed, dominated by weeds including Foeniculum vulgare, Lantana camara and Salix babylonica. This area is considered to be in poor condition and is no longer representative of a native plant community.

Surveys were conducted downstream of Crooked River at Site 3, outside of the area of potential direct and indirect impacts from the selected route and are included for contextual information. The majority of native vegetation at Site 3 has been previously cleared for grazing lands and rail infrastructure. Native vegetation is now confined to a narrow strip of regrowth extending an average of less than 10 m from the water edge. In recent years fence installation has restricted grazing along the water edge, allowing some regeneration of native vegetation. Vegetation surveyed at this site was identified as estuarine fringe forest (DEC 2005t) and is the only recorded occurrence of this community in the study area. Isolated paddock trees indicate that this community may have graded into floodplain swamp forest, which has long since been cleared for grazing.

Due to past and ongoing disturbances the vegetation across Site 3 was assessed as being in poor condition. The natural vegetation layers are no longer intact and a high percentage of weed cover is present. Outside of the fenced edge, the ground layer is dominated by exotic pasture species such as Stenotaphrum secundatum and Pennisetum clandestinum. These cleared and grazed areas were considered to have little or no capacity for natural regeneration. Nevertheless, the plant species within the fenced area were predominantly salt tolerant native ground layer species. Long-term disturbance has altered the structure of this community and the natural vegetation strata or layers are no longer intact. The canopy of Casuarina glauca is largely represented by immature regrowth with a few mature individuals scattered across the site.

The condition of fauna habitats at Site 3 were considered to be in poor condition. Typical fauna roosting and or shelter sites such as hollow-bearing trees, hollow logs, and dense undergrowth are largely absent. Despite this, the tidal flats of the Crooked River and its tributaries are considered to provide feeding resources and potential waterbird habitat.
### 3.4 Plant species

A total of 110 vascular plant species were recorded in the study area, comprising 83 (75 per cent) locally indigenous species and 27 (25 per cent) exotic weed species. A list of plant species recorded is provided in Appendix A.

Two common exotic species recorded in the study area are listed as noxious weeds in the Kiama Local Government Area: *Lantana camara* (Class 4) and *Salix babylonica* (Class 5). The legal requirements of these noxious weed classes include:

- **a)** Class 4 - The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority.
- **b)** Class 5 - The requirements in the *Noxious Weeds Act* 1993 for a notifiable weed must be complied with.

Given that survey effort was focussed within areas of native vegetation, it is considered highly likely that further noxious weed species would occur within cleared and disturbed portions of the study area.

#### 3.4.1 Significant flora

A total of 12 plant species listed on the *Threatened Species Conservation Act* 1997 and/or the *Environment Protection and Biodiversity Conservation Act* 1999, or their habitat have been previously recorded within a 10 km radius of the study area (see Figure 3.2 and Table 3.2). An additional 19 species listed on the Threatened Species Conservation Act, known or predicted to occur within the Illawarra sub-region of the Southern Rivers Catchment Management Area, have also been considered (Table 3.2).

No threatened plant species were recorded in the study area during survey. However, due to the proximity of previous records and or the presence of identified habitat preferences, potential habitat may exist within the study area for 10 threatened plant species including; *Cynanchum elegans*, *Daphnandra sp.* ‘Illawarra’ *Distichlis distichophylla*, *Irenepharsus trypherus*, *Senna acclinis*, *Solanum celatum*, *Syzygium paniculatum*, *W ilsonia backhousei*, *W ilsonia rotundifolia* and *Zieria granulata*. These species have been considered further in Chapter 4.0 (impact assessment) of this report.
<table>
<thead>
<tr>
<th>Latin name / common name</th>
<th>EPBC Act</th>
<th>TSC Act (NSW)</th>
<th>Habitat</th>
<th>Potential habitat</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Acacia baueri</em> ssp. <em>aspera</em></td>
<td>V</td>
<td></td>
<td>Occurs in the Hawkesbury / Nepean, Southern Rivers, and Sydney Metropolitan Catchment Authority Regions. More specifically it occurs on the Kings Tableland in the central Blue Mountains and with sporadic occurrences on the Woronora Plateau in the Royal National Park, Mount Keira district and at W edderburn. May also occur on the escarpment / Woronora Plateau in the Flat Rock Junction and Stanwell Tops area of the Illawarra (DEC 2005a). Occurs in low, damp heathlands, often on exposed rocky outcrops over a wide range of climatic and topographical conditions (Ollerenshaw 1979), in wet heath (Harden 1991) and in drier open forest (Duretto, 2003) on low nutrient, poorly drained peaty soils on sandstone or granite (Benson and McDougall 2001).</td>
<td>No</td>
</tr>
</tbody>
</table>
| *Arthropteris palisotii*  
Lesser Creeping Fern | E1 | | Found in rainforest where it usually grows on tree trunks (1990). North-eastern NSW and also in Queensland. This species may be extinct in NSW, however, a single records exists for the Illawarra escarpment from 1993. | Yes Potential habitat considered within subtropical dry rainforest |
| *Boronia deanei*  
Deane's Boronia | V | V | Occurs in Hawkesbury / Nepean and Southern Rivers Catchments. There are scattered populations of Deane's Boronia between the far south-east of NSW and the Blue Mountains (DEC 2005d). The species grows on the margins of high altitude swamps (O llerenshaw 1979), in wet heath (Harden 1991) and in drier open forest (Duretto, 2003) on low nutrient, poorly drained peaty soils on sandstone or granite (Benson and McDougall 2001). | No |
<p>| <em>Callistemon linearifolius</em> | V | | Occurs chiefly from Georges River to the Hawkesbury River where it grows in dry sclerophyll forest (Harden 2002), open forest, scrubland (Fairley and Moore 2000) or woodland on sandstone. Found in damp places, usually in gullies (Robinson 1994). Flowers in spring. | No |</p>
<table>
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<tr>
<th>Latin name / common name</th>
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<th>Habitat</th>
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<tbody>
<tr>
<td><em>Calomnion complanatum</em></td>
<td>E1</td>
<td></td>
<td>A small moss that grows almost exclusively on the trunks of tree ferns, most commonly <em>Dicksonia antarctica</em> although it has also been found on <em>Cyathea</em> spp. in other states. Calomnion complanatum grows only on the trunks of tree ferns in moist gullies of mountainous areas with relatively high rainfall. The species has been recorded from only three locations in NSW: Cambewarra Mountain (in 1903), Rocky Creek Canyon on the Newnes Plateau (in 1990), and two sites at Mount Wilson, Zircon Creek (in 2001) and Waterfall Reserve (in both 2001 and 2007) (DEC 2005e).</td>
<td>No Although subtropical dry rainforest may represent potential habitat for this species, it is considered extremely unlikely to occur given that it has not been recorded in the region since 1903, despite extensive searches (NSW Scientific Committee 2008a). No tree ferns were recorded in the study area.</td>
</tr>
<tr>
<td><em>Chamaesyce psammogeton</em></td>
<td>E1</td>
<td></td>
<td>Found sparsely along the coast from south of Jervis Bay to Queensland, in the following catchment regions – Hunter / Central Rivers, Hawkesbury / Nepean, Northern Rivers, Southern Rivers, Sydney Metropolitan. Populations have been recorded in Wamberal Lagoon Nature Reserve, Myall Lakes National Park and Bundjalung National Park. Grows on fore-dunes and exposed headlands, often with <em>Spinifex sericeus</em>. Flowering occurs in summer, with plant growth occurring in spring and summer (DEC 2005f). Likes disturbed edges of tracks leading through foredunes (N. Smith pers. Comm.).</td>
<td>No</td>
</tr>
<tr>
<td>Latin name / common name</td>
<td>EPBC Act</td>
<td>TSC Act (NSW)</td>
<td>Habitat</td>
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<tr>
<td><em>Chorizema parviflorum</em></td>
<td>EP</td>
<td></td>
<td>Heath and sclerophyll woodland and forest on heavy soils (Harden 2002). The endangered population has been recorded from between Austinmer and Albion Park in the local government areas of Wollongong and Shellharbour. All known sites (excluding the site at Austinmer) occupy woodland or forest dominated by Forest Red Gum (<em>Eucalyptus tereticornis</em>) and/or Woollybutt (<em>E. longifolia</em>). At Austinmer, the species is recorded from a coastal headland. (DEC 2005g).</td>
<td>No</td>
</tr>
<tr>
<td><em>Cryptostylis hunteriana</em></td>
<td>V</td>
<td>V</td>
<td>This species typically grows in swamp-heath on sandy soils chiefly in coastal districts (Harden 1993) but has also been recorded on steep bare hillsides (Bishop 1996). This species does not appear to have well defined habitat preferences and is known from a range of communities, including swamp-heath and woodland. The larger populations typically occur in woodland dominated by <em>Eucalyptus sclerophylla</em>, <em>E. sieberi</em>, <em>Corymbia gummifera</em> and <em>Allocasuarina littoralis</em>; appears to prefer open areas in the understorey of this community and is often found in association with <em>Cryptostylis subulata</em> (DEC 2005i).</td>
<td>No</td>
</tr>
<tr>
<td><em>Cynanchum elegans</em></td>
<td>E</td>
<td>E1</td>
<td>Restricted to eastern NSW where it is distributed from Brunswick Heads on the north coast to Gerroa in the Illawarra region. Catchment Management Regions include Hawkesbury / Nepean, Hunter / Central Rivers, Northern Rivers, Southern Rivers and Sydney Metropolitan (DEC 2005S). <em>Cynanchum elegans</em> usually occurs on the edge of dry rainforest vegetation. Other associated vegetation types include littoral rainforest, scrub, open forest and woodland (DEC 2005S). Flowering occurs between August and May, with a peak in November. Flower abundance on individual plants varies from sparse to prolific (DEC 2005S).</td>
<td>Yes</td>
</tr>
<tr>
<td><em>Daphnandra sp. Illawarra</em></td>
<td>E</td>
<td>E1</td>
<td>Occupies the rocky hillsides and gullies of the Illawarra lowlands, occasionally extending onto the upper escarpment slopes. Associated vegetation includes rainforest and moist eucalypt forest (DEC 2005k).</td>
<td>Yes</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Latin name / common name</th>
<th>EPBC Act</th>
<th>TSC Act (NSW)</th>
<th>Potential habitat</th>
<th>Habitat</th>
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</thead>
</table>
| *Distichlis distichophylla*  
Australian Saltgrass |          | E1            | Yes               | This grass is common in Victoria and Tasmania, and extends to South Australia and Western Australia. In Victoria it is found inland as well, but in its limited NSW range it grows only in coastal situations, except for one existing population at Lake Cargelligo. Scattered records are from the areas of Jervis Bay, Bermagui, W onboy, N arooma, Bodalla and N adgee N ature Reserve (at W omboyn). A coloniser of damp saline soils; found at the edges of salt marshes and on low dunes. |
| *Eucalyptus langleyi*  
Albatross Mallee | V        | V             | No                | The main occurrence of the Albatross Mallee is to the south-west of N owra as far as Y arramunmun C reek. It is also found to a limited extent north of the Shoalhaven River in the vicinity of Bomaderry Creek. Found in mallee shrubland on poorly-drained, shallow, sandy soils on sandstone. The species regenerates from rootstock after fire. (DEC 2005p) |
| *Genoplesium baueri*  
Bauer's Midge Orchid |          | V             | No                | This terrestrial orchid species grows in open sclerophyll forest or moss gardens on sandstone. Typically the habitat is a drier heathy forest (Harden 1993) (Bishop 1996). The species has been recorded from locations between N owra and Pittwater and may occur as far north as Port Stephens. About half the records were made before 1960 with most of the older records being from Sydney suburbs including A squith, C own, G ladesville, L ongueville and W ahroonga. No collections have been made from those sites in recent years. Flowers D ec. - M ar (DEC 2005q). |
| *Haloragis exalata ssp. exalata*  
W ingless Raspwort | V        | V             | No                | Square Raspwort is known from a few scattered locations in south-eastern NSW including the N epean River (near Sydney), Lake I Iawarra, the W allaga Lake - T ilba area and the G eehi Valley in Kosciuszko N ational Park. There are isolated records from northern NSW (Mount Kaputar N ational Park and T uggolo State Forest). It also occurs in Victoria. Square Raspwort occurs in damp places near watercourses. It regenerates only from seed. The species appears to be favoured by soil disturbance (DEC 2005t). |
<table>
<thead>
<tr>
<th>Latin name / common name</th>
<th>EPBC Act</th>
<th>TSC Act (NSW)</th>
<th>Habitat</th>
<th>Potential habitat</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Irenepharsus trypherus</em></td>
<td>E</td>
<td>E1</td>
<td>Occurs on coast and escarpment between Wollongong and the Shoalhaven River (Harden 1990). Typically inhabits steep rocky slopes near cliff lines and ridge tops. The species is less typically found growing out of rock crevices or on narrow benches along cliff lines. The vast majority of sites are recorded from the upper slopes of the ridge systems that extend south and east of the Illawarra escarpment, although the species has also been recorded from the deep sandstone gorges of the Shoalhaven River. Associated vegetation includes moist sclerophyll forest, Ironwood <em>Backhousia myrtifolia</em> thicket, and rainforest. (DEC 2005y)</td>
<td>Yes</td>
</tr>
<tr>
<td><em>Lespedeza juncea ssp. sericea</em></td>
<td>EP</td>
<td>Known from just one roadside population of approximately 200 plants. Located in a small strip of open forest dominated by <em>Eucalyptus tereticornis</em> (Forest Red Gum), <em>E. longifolia</em> (Woollybutt), and <em>Melaleuca decora</em> (White Feather Honeymyrtle), on Budgong Sandstone. Also originally recorded in <em>Pennisetum clandestinum</em> (Kikuyu) grassland directly across the road from this site. This grassland was subsequently cleared and the species has not regenerated (DEC 2005).</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td><em>Pimelea spicata</em></td>
<td>E</td>
<td>E1</td>
<td>Once widespread on the Cumberland Plain, <em>Pimelea spicata</em> occurs in two disjunct areas, the Cumberland Plain and the Illawarra. Catchment areas are Hawkesbury / Nepean, Southern Rivers, and Sydney Metropolitan Catchment (NPW S 2000). Typically known from well structured clay soils on the Cumberland Plain and in the Illawarra. In the coastal Illawarra it occurs in <em>Banksia integrifolia</em> open woodland with a more well developed shrub and grass understorey (NPW S 2004). This species is also known from highly disturbed areas including road verges, table drains, road embankments and ploughed paddocks (DEC 2005b). <em>Pimelea spicata</em> flowers sporadically throughout the year, with flowering likely to depend upon climatic conditions, particularly rainfall. Flowering times recorded for <em>P. spicata</em> vary. Rye (1990) noted flowering period as May - January; Benson and McDougall (2001) noted peak flowering period as March/ April (NPW S 2000).</td>
<td>No</td>
</tr>
<tr>
<td>Latin name / common name</td>
<td>EPBC Act</td>
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<td>Potential habitat</td>
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</tr>
<tr>
<td>Pomaderris adenata</td>
<td>E1</td>
<td></td>
<td>Ridgetop vegetation often with <em>Eucalyptus sieberi</em> and <em>Corymbia gummifera</em>. Occurs near the edge of the plateau behind the Illawarra escarpment. Known only from one site at Sublime Point, north of Wollongong (DEC 2005–)</td>
<td>No</td>
</tr>
<tr>
<td>Pomaderris</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pterostylis gibbosa</td>
<td>E</td>
<td>E1</td>
<td>Known from a small number of populations in the Hunter region, the Illawarra region and the Shoalhaven region. It is apparently extinct in western Sydney which is the area where it was first collected (1803) (DEC 2005€). All known populations grow in open forest or woodland, on flat or gently sloping land with poor drainage. In the Illawarra region, the species grows in woodland dominated by <em>Eucalyptus tereticornis</em>, <em>E. longifolia</em> and <em>Melaleuca decora</em>. Near Nowra, the species grows in an open forest of <em>Corymbia maculata</em>, <em>E. tereticornis</em> and <em>E. paniculata</em>. In the Hunter region, the species grows in open woodland dominated by <em>E. crebra</em>, Forest Red Gum and <em>Callitris endlicherii</em> (DEC 2005€).</td>
<td>No</td>
</tr>
<tr>
<td>Illawarra Greenhood</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pterostylis pulchella</td>
<td>V</td>
<td>V</td>
<td>The waterfall Greenhood is found only at Fitzroy Falls, Belmore Falls, upper Bundanoon Creek (Meryla) and Minnamurra Falls (DEC 2005€). Usually favours creek banks and mossy rocks very close to running water (Bishop 1996). Flowers appear from February to May (DEC 2005€).</td>
<td>No</td>
</tr>
<tr>
<td>Pretty Greenhood</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pultenaea aristata</td>
<td>V</td>
<td>V</td>
<td>Restricted to the Woronora Plateau, a small area between Helensburgh, south of Sydney, and Mount Keira above Wollongong. The species occurs in either dry sclerophyll woodland or wet heath on sandstone. Flowering has been recorded in winter and spring.</td>
<td>No</td>
</tr>
<tr>
<td>Prickly Bush-pea</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Senna acclinis</td>
<td>E1</td>
<td></td>
<td>Found in coastal districts and adjacent tablelands of NSW from the Illawarra in NSW to Queensland. Grows in or on the edges of subtropical and dry rainforest (DEC 2005€).</td>
<td>Yes</td>
</tr>
<tr>
<td>Rainforest Cassia</td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Latin name / common name</th>
<th>EPBC Act</th>
<th>TSC Act (NSW)</th>
<th>Habitat</th>
<th>Potential habitat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solanum celatum</td>
<td>E1</td>
<td></td>
<td>Restricted to an area from Wollongong to just south of Nowra, and west to Bungonia. Majority of records are prior to 1960 and the majority of populations are likely to have been lost to clearing. Grows in rainforest clearings, or in wet sclerophyll forests. Flowers August to October and produces fruit December to January. (DEC 2005…).</td>
<td>Yes Potential habitat considered to be associated with subtropical dry rainforest</td>
</tr>
<tr>
<td>Syzygium paniculatum</td>
<td>V</td>
<td>V</td>
<td>Subtropical and littoral rainforest on sandy soils or stabilised dunes near the sea (Harden 1991). Found only in NSW, in a narrow, linear coastal strip from Bulahdelah to Conjola State Forest. On the south coast <em>Syzygium paniculatum</em> occurs on grey soils over sandstone, restricted mainly to remnant stands of littoral (coastal) rainforest. On the central coast this species occurs on gravels, sands, silts and clays in riverside gallery rainforests and remnant littoral rainforest communities. (DEC 2005‡).</td>
<td>Yes Potential habitat considered to be associated with subtropical dry rainforest</td>
</tr>
<tr>
<td>Thelymitra sp. Kangaloon</td>
<td>Z</td>
<td></td>
<td>Thelymitra sp. Kangaloon is a terrestrial orchid endemic to New South Wales, and is known from three locations near Robertson in the Southern Highlands. The swamp habitat in which the species occurs has an extent of occurrence of 300 km² and an area of occupancy of 10 km². The three swamps are Butlers Swamp, Stockyard Swamp and Wildes Meadow Swamp, and are all located above what is known as the Kangaloon aquifer. It flowers in late October and early November. The species grows amongst tall sedges and rushes in seasonally swampy sedgeland on grey silty clay loam at 600 m to 700 m above sea level. (Threatened Species Listing Advice, 2008 20176 /id).</td>
<td>No</td>
</tr>
<tr>
<td>Thesium australis Austral Toad-flax</td>
<td>V</td>
<td>V</td>
<td>Found in very small to large populations scattered across eastern NSW, along the coast, and from the Northern to Southern Tablelands. <em>Thesium australis</em> is a root parasite that takes water and some nutrient from other plants, especially Kangaroo Grass (DEC 2005†). It is often found in damp sites in association with <em>Themeda australis</em>, but also found on other grass species at inland sites (G. Leonard pers. obs.). Occurs on clay soils in grassy woodlands or coastal headlands. (James et al. 1999).</td>
<td>No</td>
</tr>
<tr>
<td>Latin name / common name</td>
<td>EPBC Act</td>
<td>TSC Act (NSW)</td>
<td>Habitat</td>
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<tr>
<td><em>Triplarina nowraensis</em></td>
<td>E</td>
<td>E1</td>
<td>There are five known populations of Nowra Heath Myrtle. Three of these form a cluster to the immediate west of Nowra. A fourth, much smaller population is found 18 km south-west of Nowra in the Boolijong Creek Valley. The fifth population is located north of the Shoalhaven River on the plateau above Bundanon. Nowra Heath Myrtle occurs on poorly drained, gently sloping sandstone shelves or along creek lines underlain by Nowra Sandstone. The sites are often either treeless or have a very open tree canopy due to the impeded drainage (DEC 2005).</td>
<td>No</td>
</tr>
<tr>
<td><em>Wilsonia backhousei</em></td>
<td>V</td>
<td></td>
<td>In NSW <em>Wilsonia backhousei</em> is found in the Southern Rivers and Sydney Metropolitan Catchment Area, specifically on the coast between Mimosa Rocks National Park and W amberal north of Sydney (Nelson's Lake, Potato Point, Sussex Inlet, W owly Gully, Parramatta River at Ermitton, Clowelly, Voyager Point, W ollongong and Royal N ational Park) (DEC 2005). This is a species of the margins of salt marshes and lakes, both coastal and inland, chiefly in the Sydney district, also common at Jervis Bay (Harden 1992). Flowering occurs in spring and summer (DEC 2005).</td>
<td>Yes, Potential habitat considered within estuarine saltmarsh</td>
</tr>
<tr>
<td><em>Wilsonia rotundifolia</em></td>
<td>E1</td>
<td></td>
<td>Occurs in the Sydney Metropolitan, Hawkesbury / Nepean, Murray and Southern Rivers Catchment Authority Regions. Is known from several sites in the Jervis Bay area, Royal National Park, near Deniliquin and in Lake George and Lake Bathurst (DEC 2005). Grows in mud in coastal salt marsh and inland saline lakes. It occurs in mid marsh, mixed with <em>Sporobolus virginicus</em> and <em>Sarcocornia quinqueflora</em>. Flowers mainly appear in spring and summer (DEC 2005).</td>
<td>Yes, Potential habitat considered within estuarine saltmarsh</td>
</tr>
<tr>
<td>Latin name / common name</td>
<td>EPBC Act</td>
<td>TSC Act (NSW)</td>
<td>Habitat</td>
<td>Potential habitat</td>
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</tr>
<tr>
<td><em>Zieria baeuerleni</em> Bomaderry Zieria</td>
<td>E</td>
<td>E1</td>
<td>The species occurs in only one location north-west of Nowra. The population occurs in a total of 43 colonies in six discrete clusters. These clusters are confined within a 0.5 km x 1.0 km area of the bushland, and are found on both sides of Bomaderry Creek. Bomaderry Zieria occurs on skeletal sandy loam overlaying sandstone, on a rocky plateau amongst sandstone boulders in either shrubby open forest, shrubby woodland or closed scrub (DEC 2005').</td>
<td>No</td>
</tr>
<tr>
<td><em>Zieria granulata</em> Hill Zieria</td>
<td>E</td>
<td>E1</td>
<td>Occurs in the Kiama district where it grows on dry rocky ridges in sclerophyll forest to rainforest margins (Harden 2002). The species primarily occupies the coastal lowlands between Oak Flats and Toolijooa, in the local government areas of Shellharbour and Kiama. The typical habitat is dry ridge tops and rocky outcrops on shallow volcanic soils. Less frequently found on the moist slopes of the Illawarra escarpment and in low-lying areas on Quaternary sediments. Associated vegetation includes <em>Melaleuca armillaris</em> scrub, <em>Eucalyptus tereticornis</em> woodland and rainforest margins, although the species has been recorded from a number of other vegetation types (DEC 2005').</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Source: DECCW Atlas of NSW Wildlife and Threatened Species Profile database, and the DEWHA Environment Protection and Biodiversity Conservation online database

Key: 1) Listed on the Environment Protection and Biodiversity Conservation Act as Endangered (E), Vulnerable (V) or Extinct (X)
2) Listed on the Threatened Species Conservation Act as Endangered (E1), Vulnerable (V) or Presumed Extinct (E4)
Figure 3.2: Threatened flora listed on the Threatened Species Conservation Act and the Environment Protection and Biodiversity Conservation Act that have been recorded within 10 km of the study area.
3.5 Animal species

A list of fauna recorded within the vicinity of the proposal is provided in Appendix B and includes 62 species of bird (including five introduced species), six mammals (including three introduced) and two frogs.

3.5.1 Significant fauna

A total of 80 threatened, migratory and/or preliminarily listed animal species or their habitat have been previously recorded within a 10 km radius of the study area (DECCW, Atlas of NSW Wildlife and DEWHA, Online Environment Protection and Biodiversity Conservation Database) (Table 3.3). An additional 16 species listed on the Threatened Species Conservation Act 1995, known or predicted to occur within the Illawarra sub-region of the Southern Rivers Catchment Management Area, have also been considered (Table 3.3). Of all these animal species, 71 are listed under the Act (including one as a preliminary determination) and 50 are listed under the Environment Protection and Biodiversity Conservation Act 1999 (16 threatened and 36 migratory). Seventy-five threatened and/or migratory species have been previously recorded within 10 km of the study area (Figure 3.3). Marine and pelagic species have been excluded.

Potential habitat for 60 species is considered present in the study area (Figure 3.3 and Table 3.3). Species with potential habitat have been considered further in Chapter 4.0 (impact assessment) of this report.

---

3 An individual species may be listed under one or both Acts and may be listed as threatened and/or migratory.
### Table 3.3: Terrestrial fauna listed on the Threatened Species Conservation Act and the Environment Protection and Biodiversity Conservation Act that may occur in the local area

<table>
<thead>
<tr>
<th>Latin and common name</th>
<th>EPBC Act¹</th>
<th>TSC Act²</th>
<th>Habitat</th>
<th>Potential habitat in the study area?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Amphibians</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Litoria aurea</em></td>
<td>V</td>
<td>E¹</td>
<td>Most existing locations for the species occur as small, coastal, or near coastal populations, with records occurring between south of Grafton and northern VIC (NSW Government 2009). The species is found in marshes, dams and stream sides, particularly those containing bulrushes or spikerushes. Preferred habitat contains water bodies that are unshaded, are free of predatory fish, have a grassy area nearby and have diurnal sheltering sites nearby such as vegetation or rocks (NPWS 1999; White and Pyke 1996), although the species has also been recorded from highly disturbed areas including disused industrial sites, brick pits, landfill areas and cleared land. Breeding usually occurs in summer. Tadpoles, which take approximately six weeks to develop, feed on algae and other vegetative matter. Adults eat insects as well as other frogs, including juveniles of their own species (DEC 2005s).</td>
<td>Yes, but limited. Previously recorded north of the study area at Beachside and south of the study area within Cooms and Coomonderry Swamps.</td>
</tr>
<tr>
<td>Littlejohn's Tree Frog</td>
<td>V</td>
<td>V</td>
<td>The species is distributed along the eastern slopes of the Great Dividing Range from Watagan State Forest near Wyong, south to Buchan in North Eastern Victoria. It is not known from coastal habitats (DEH 2005b). Occurs in wet and dry sclerophyll forests and heath communities associated with sandstone outcrops between 280 m and 1000 m (Barker et al. 1995). Littlejohn's Tree Frog prefers permanent and semi-permanent rock flowing streams, but individuals have also been collected from semi-permanent dams with some emergent vegetation (Barker et al. 1995). Forages both in the tree canopy and on the ground, and has been observed sheltering under rocks on high exposed ridges during summer. The species breeds in autumn but would also breed after heavy rainfall in spring and summer (NSW Scientific Committee 2000a). The species has been recorded calling in all seasons with variously reported peak calling periods (DEH 2005b). Eggs are laid in loose gelatinous masses attached to submerged twigs; eggs and tadpoles are most often recorded in slow-flowing pools that receive extended exposure to sunlight (DEW 2007).</td>
<td>No. Previously recorded north-west of the study area. Not a coastal species.</td>
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<td>Latin and common name</td>
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<td>TSC Act²</td>
<td>Habitat</td>
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<tr>
<td><strong>Amphibians</strong></td>
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<tr>
<td><em>Heleioporus australicus</em></td>
<td>V</td>
<td>V</td>
<td>Prefers hanging swamps on sandstone shelves adjacent to perennial non-flooding creeks (Daly 1996; Recsei 1996). Can also occur within shale outcrops within sandstone formations. Known from wet and dry forests and montane woodland in the southern part range (Daly 1996). Individuals can be found around sandy creek banks or foraging along ridge-tops during or directly after heavy rain. Males often call from burrows located in sandy banks next to water (Barker et al. 1995). Spends the majority of its time in non-breeding habitat 20 m to 250 m from breeding sites (Penman et al. 2008).</td>
<td>No. Not previously recorded within 10 km of study area.</td>
</tr>
<tr>
<td><em>Mixophyes balbus</em></td>
<td>V</td>
<td>E1</td>
<td>This species is usually associated with mountain streams, wet mountain forests and rainforests (Barker et al. 1995). It rarely moves very far from the banks of permanent forest streams, although it would forage on nearby forest floors. Eggs are deposited in leaf litter on the banks of streams and are washed into the water during heavy rains (Barker et al. 1995).</td>
<td>No. Not previously recorded within 10 km of study area.</td>
</tr>
<tr>
<td><em>Pseudophryne australis</em></td>
<td>-</td>
<td>V</td>
<td>Occurs on wetter ridge tops and upper slopes of sandstone formations on which the predominant vegetation is dry open forests and heaths. This species typically breeds within small ephemeral creeks characterised by a series of shallow pools that feed into larger semi-perennial streams (Thumm and Mahony 1997). Breeds all year round (Thumm and Mahoney 2002).</td>
<td>No. Not previously recorded within 10 km of study area.</td>
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<td><strong>Birds</strong></td>
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<tr>
<td><em>Circus assimilis</em></td>
<td>-</td>
<td>V</td>
<td>Open and wooded country with grassland nearby for hunting. Habitat types include open grasslands, spinifex, open shrublands, saltbush, very open woodlands, crops and similar low vegetation. More common in drier inland areas, nomadic part migratory and dispersive, movements linked to abundance of prey species. Nest in open or remnant woodland (Marchant and Higgins 1993). Unlike other harriers nests in trees.</td>
<td>Yes. Previously recorded north and north-west of the study area.</td>
</tr>
<tr>
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<tr>
<td><em>Haliaeetus leucogaster</em></td>
<td>M</td>
<td>-</td>
<td>A migratory species that is generally sedentary in Australia, although immatures and some adults are dispersive (Marchant and Higgins 1993). Found in terrestrial and coastal wetlands; favouring deep freshwater swamps, lakes and reservoirs; shallow coastal lagoons and saltmarshes. It hunts over open terrestrial habitats. Feeds on birds, reptiles, fish, mammals, crustaceans and carrion. Roosts and makes nest in trees (Marchant and Higgins 1993).</td>
<td>Yes. Previously recorded immediately east of the estuarine saltmarsh (Site 2) as well as north, south and west of the study area.</td>
</tr>
<tr>
<td><em>Hieraaetus morphnoides</em></td>
<td>-</td>
<td>V</td>
<td>Most abundant in lightly timbered areas with open areas nearby. Often recorded foraging in grasslands, crops, treeless dune fields, and recently logged areas. May nest in farmland, woodland and forest in tall trees (Marchant and Higgins 1993).</td>
<td>Yes. Recorded during 2007 surveys just south of the study area at Crooked River (Site 3). Previously recorded north and north-west of the study area.</td>
</tr>
<tr>
<td><em>Lophoictinia isura</em></td>
<td>-</td>
<td>V</td>
<td>Typically inhabits coastal forested and wooded lands of tropical and temperate Australia (Marchant and Higgins 1993). In NSW it is often associated with ridge and gully forests dominated by <em>Eucalyptus longifolia</em>, <em>Corymbia maculata</em>, <em>E. elata</em>, or <em>E. smithii</em> (NPWS 1999h). Individuals appear to occupy large hunting ranges of more than 100 km². They require large living trees for breeding, particularly near water with surrounding woodland / forest close by for foraging habitat. Nest sites are generally located along or near watercourses, in a tree fork or on large horizontal limbs (Marchant and Higgins 1993).</td>
<td>Yes. Previously recorded once, south of the study area at Coomonderry Swamp.</td>
</tr>
<tr>
<td><em>Pandion haliaetus</em></td>
<td>M</td>
<td>V</td>
<td>Found in coastal waters, inlets, estuaries and offshore islands. Occasionally found 100 km inland along larger rivers (Pizzey and Knight 1997). It is water-dependent, hunting for fish in clear, open water. The O sprey occurs in terrestrial wetlands, coastal lands and offshore islands. It is a predominantly coastal species, generally using marine cliffs as nesting and roosting sites. Nests can also be made high up in dead trees or in dead crowns of live trees, usually within one kilometre of the sea (Marchant and Higgins 1993).</td>
<td>Yes. Previously recorded once, south-west of study area at Seven Mile Beach National Park.</td>
</tr>
<tr>
<td><em>Oxyura australis</em></td>
<td>-</td>
<td>V</td>
<td>Almost wholly aquatic, preferring deep water in large, permanent wetlands with an abundant aquatic flora (Marchant and Higgins 1990).</td>
<td>Yes, but limited. Not previously recorded within 10 km of study area.</td>
</tr>
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<tr>
<td><em>Stictonetta naevosa</em></td>
<td>-</td>
<td>V</td>
<td>The Freckled Duck breeds in permanent fresh swamps that are heavily vegetated. Found in fresh or salty permanent open lakes, especially during drought. Often seen in groups on fallen trees and sand spits (Simpson and Day 1996).</td>
<td>Yes, but limited. Previously recorded once, north of the study area.</td>
</tr>
<tr>
<td><em>Apus pacificus</em></td>
<td>M</td>
<td>-</td>
<td>Almost exclusively aerial (foraging). The Fork-tailed Swift breeds in Asia but migrates to Australia from September to April (Higgins 1999). Individuals or flocks can be observed hawking for insects at varying heights from only a few metres from the ground and up to 300 m high (Boehm 1944).</td>
<td>No. May fly high over the study area.</td>
</tr>
<tr>
<td><em>Hirundapus caudacutus</em></td>
<td>M</td>
<td>-</td>
<td>An aerial species found in feeding concentrations over cities, hilltops and timbered ranges. Breeds in Asia (Pizzey and Knight 1997).</td>
<td>No. May fly high over the study area.</td>
</tr>
<tr>
<td><em>Ardea alba</em></td>
<td>M</td>
<td>-</td>
<td>Terrestrial wetlands, estuarine and littoral habitats and moist grasslands. Inland, prefer permanent waterbodies on floodplains; shallows of deep permanent lakes (either open or vegetated), semi-permanent swamps with tall emergent vegetation and herb dominated seasonal swamps with abundant aquatic flora. Also regularly use saline habitats including mangrove forests, estuarine mudflats, saltmarshes, bare salt pans, shallows of salt lakes, salt fields and offshore reefs. Breeding requires wetlands with fringing trees in which to build nests including mangrove forest, freshwater lakes or swamps and rivers (Marchant and Higgins 1990).</td>
<td>Yes. Previously recorded within estuarine saltmarsh (Site 2) as well as north, south and west of the study area.</td>
</tr>
<tr>
<td><em>Ardea ibis</em></td>
<td>M</td>
<td>-</td>
<td>Occurs in tropical and temperate grasslands, wooded lands and terrestrial wetlands (Marchant and Higgins 1990).</td>
<td>Yes. Recorded during current surveys. Also previously recorded within estuarine saltmarsh (Site 2) as well as north, south and west of the study area.</td>
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| Latin and common name | EPBC Act? | TSC Act? | Habitat | Potential habitat in the study area?
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<tr>
<td><strong>Birds</strong></td>
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</table>
| *Botaurus poiciloptilus*  
Australasian Bittern | -         | V        | Inhabits terrestrial and estuarine wetlands, generally where there is permanent water. Prefers wetlands with dense vegetation including rushes and reeds (NPWS 1999a). | Yes. Previously recorded immediately east of the estuarine saltmarsh (Site 2) in Werri Lagoon as well as north, north-west and south of the study area (including within Coomonderry Swamp). |
| *Ixobrychus flavicollis*  
Black Bittern | -         | V        | Usually found on coastal plains below 200 m. Often found along timbered watercourses, in wetlands with fringing trees and shrub vegetation. The sites where they occur are characterised by dense waterside vegetation (NPWS 1999b). | Yes. Previously recorded south of the study area at Black Head and to the south-west in Berry. |
| *Egretta sacra*  
Eastern Reef Egret | M         | -        | Widely distributed throughout a range of maritime littoral and estuarine habitats on mainland, islands and atolls. Prefers rocky shorelines. Roosts within close proximity to water, on dead or living trees, sand spits, banks, and artificial structures, such as wharfs (Marchant and Higgins 1990). | Yes. Previously recorded south of the study area at Crooked River and Black Head. |
| *Artamus superciliosus*  
White-browed Woodswallow | -         | PD (V)   | Mainly inhabits open eucalypt, sheoak and acacia woodland; forest; riparian zones; and, grasslands with few or no trees and sparsely scattered shrubs (including farmland) (Higgins et al. 2006). In NSW the species is widespread on the inland slopes of the Great Divide and western plains; occurs more sparsely east of the Great Divide (Higgins et al. 2006). The species eats arthropods, including insects that swarm above vegetation, plus some nectar and small native fruits (NSW Scientific Committee 2009b). Would nest in a tree fork, tree crevice, foliage, vine, stump or artificial structure (NSW Scientific Committee 2009b). | Yes. Previously recorded once, south of the study area at Seven Mile Beach National Park. |
| *Burhinus grallarius*  
Bush Stone-curlew | -         | E1       | Lightly timbered open forest and woodland, or partly cleared farmland with remnants of woodland, with a ground cover of short sparse grass and few or no shrubs where fallen branches and leaf litter are present (Marchant and Higgins 1993). | Yes, but species presence unlikely. Previously recorded once, north of the study area at Minnamurra River. |
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<tbody>
<tr>
<td><em>Esacus neglectus</em> Beach Stone-curlew</td>
<td>-</td>
<td>C1</td>
<td>Occurs on open, undisturbed beaches, islands, reefs and estuarine intertidal sand and mudflats (Marchant and Higgins 1993).</td>
<td>No. Not previously recorded within 10 km of study area.</td>
</tr>
<tr>
<td><em>Callocephalon fimbriatum</em> Gang-gang Cockatoo</td>
<td>-</td>
<td>V</td>
<td>In summer, occupies tall montane forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests (Higgins 1999). Also occur in subalpine Snow Gum woodland and occasionally in temperate or regenerating forest (Forshaw and Cooper 1981). In winter, occurs at lower altitudes in drier, more open eucalypt forests and woodlands, particularly in box-ironbark assemblages, or in dry forest in coastal areas (Shields and Crome 1992). It requires tree hollows in which to breed (Gibbons and Linenmayer 1997).</td>
<td>Yes. Previously recorded immediately east of the estuarine saltmarsh (Site 2) as well as north-west, west and south-west of the study area.</td>
</tr>
<tr>
<td><em>Calyptorhynchus lathami</em> Glossy Black-cockatoo</td>
<td>-</td>
<td>V</td>
<td>Inhabits forest with low nutrients, characteristically with key Allocasuarina species. Tends to prefer drier forest types (NPWS 1999c). Often confined to remnant patches in hills and gullies. Breed in tree hollows stumps or limbs, either living or dead (Higgins 1999).</td>
<td>Yes. Previously recorded once, south of the study area.</td>
</tr>
<tr>
<td><em>Charadrius bicinctus</em> Double-banded Plover</td>
<td>M</td>
<td>-</td>
<td>Tidal mudflats, beaches, exposed reefs, salt marshes, freshwater wetlands, inland salt lakes, short grass on golf courses, airfields (Morcombe 2003).</td>
<td>Yes. Previously recorded south of the study area at Seven Mile Beach National Park and Coomonderry Swamp.</td>
</tr>
<tr>
<td><em>Charadrius leschenaultia</em> Greater Sand Plover</td>
<td>M</td>
<td>V</td>
<td>Entirely coastal in NSW, foraging on intertidal sand and mudflats in estuaries and roosting during high tide on sandy beaches or rocky shores. Individuals have been recorded on inshore reefs, rock platforms, small rocky islands and sand cays on coral reefs, within Australia. Occasional sightings have also occurred on near-coast saltlakes, brackish swamps, shallow freshwater wetlands and grassed paddocks (NPWS 1999d).</td>
<td>Yes. Previously recorded once, south of the study area at Seven Mile Beach National Park.</td>
</tr>
<tr>
<td><em>Charadrius mongolus</em> Lesser Sand Plover</td>
<td>M</td>
<td>V</td>
<td>In Australia, the species is known to favour coastal environs including beaches, mudflats and mangroves. Within NSW, individuals have been observed on intertidal sand and mudflats in estuaries or roosting on sandy beaches or rocky shores at high tide (NPWS 1999f).</td>
<td>Yes. Previously recorded once, south of the study area at Coomonderry Swamp.</td>
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<tr>
<td><em>Pluvialis fulva</em>&lt;br&gt;Pacific Golden Plover</td>
<td>M</td>
<td>-</td>
<td>Migratory species that visits estuaries mudflats, saltmarshes and ocean shores as well as paddocks, grasslands and swamps near the coast (Pizzey and Knight 1997).</td>
<td>Yes. Previously recorded once, south of the study area at Coomonderry Swamp.</td>
</tr>
<tr>
<td><em>Thinornis rubricollis</em>&lt;br&gt;Hooded Plover</td>
<td>-</td>
<td>C1</td>
<td>Prefers sandy ocean beaches, especially those that are broad and flat (Marchant and Higgins 1993).</td>
<td>No. Not previously recorded within 10 km of study area.</td>
</tr>
<tr>
<td><em>Ephippiorhynchus asiaticus</em>&lt;br&gt;Black-necked Stork</td>
<td>-</td>
<td>E1</td>
<td>Found in swamps, mangroves and mudflats. Can also occur in dry floodplains and irrigated lands and occasionally forages in open grassy woodland. Nests in live or dead trees usually near water (Pizzey and Knight 1997).</td>
<td>Yes. Previously recorded south of the study area at Crooked River and Coomonderry Swamp (records over 30 years old).</td>
</tr>
<tr>
<td><em>Ptilinopus regina</em>&lt;br&gt;Rose-crowned Fruit-dove</td>
<td>-</td>
<td>V</td>
<td>Occurs in tall tropical and subtropical, evergreen or semi-deciduous rainforest, especially with dense growth of vines. Prefers large patches of rainforest, but sometimes occurs in remnant patches surrounded by suboptimal habitat including farmlands (Higgins and Davies 1996).</td>
<td>Yes, but limited. Not previously recorded within 10 km of study area.</td>
</tr>
<tr>
<td><em>Ptilinopus superbus</em>&lt;br&gt;Superb Fruit-Dove</td>
<td>-</td>
<td>V</td>
<td>Mostly closed forests, including monsoon rainforests and mesophyll vine forests (Higgins and Davies 1996).</td>
<td>Yes, but limited. Not previously recorded within 10 km of study area.</td>
</tr>
<tr>
<td><em>Cuculus saturatus</em>&lt;br&gt;Oriental Cuckoo</td>
<td>M</td>
<td>-</td>
<td>Canopy or shrub layer of monsoon rainforest, vine thickets, wet sclerophyll forest, or open casuarina, acacia or eucalyptus woodland (Higgins 1999).</td>
<td>Yes. Previously recorded once, north-west of the study area.</td>
</tr>
<tr>
<td><em>Monarcha melanopsis</em>&lt;br&gt;Black-faced Monarch</td>
<td>M</td>
<td>-</td>
<td>A migratory species found during the breeding season in damp gullies in temperate rainforests. Disperses after breeding into more open woodland (Pizzey and Knight 1997).</td>
<td>Yes. Recorded during current surveys within other sections of the Princes Highway upgrade. Also, previously recorded north, south and west of the study area.</td>
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<tr>
<td>Monacha trivirgatus Spectacled Monarch</td>
<td>M</td>
<td>-</td>
<td>Found in darker parts of mountain and lowland rainforest, adjacent to thickly wooded gullies (Pizzey and Knight 1997).</td>
<td>Yes. Previously recorded once, north-west of the study area.</td>
</tr>
<tr>
<td>Myiagra cyanoleuca Satin Flycatcher</td>
<td>M</td>
<td>-</td>
<td>Migratory species that occurs in coastal forests, woodlands and scrubs during migration. Breeds in heavily vegetated gullies (Pizzey and Knight 1997).</td>
<td>Yes. Previously recorded south of the study area.</td>
</tr>
<tr>
<td>Rhipidura rufifrons Rufous Fantail</td>
<td>M</td>
<td>-</td>
<td>Migratory species that prefers dense, moist undergrowth of tropical rainforests and scrubs. During migration it can stray into gardens and more open areas (Pizzey and Knight 1997).</td>
<td>Yes. Recorded during current surveys within other sections of the Princes Highway upgrade. Also, previously recorded immediately east of the estuarine saltmarsh (Site 2) as well as north, west and south of the study area.</td>
</tr>
<tr>
<td>Haematopus fuliginosus Sooty Oyster catcher</td>
<td>-</td>
<td>V</td>
<td>Found on undisturbed tidal rocks on ocean shores and islands. Occasionally found on sandspits and mudflats (Pizzey and Knight 1997).</td>
<td>No. Previously recorded north and south of the study area.</td>
</tr>
<tr>
<td>Haematopus longirostris Pied Oyster catcher</td>
<td>-</td>
<td>V</td>
<td>An intertidal forager found on undisturbed sandy beaches and spits, tidal mudflats and estuaries. Occasionally found in paddocks near the coast (Pizzey and Knight 1997).</td>
<td>Yes. Previously recorded within the estuarine saltmarsh (Site 2) as well as south of the study area at Seven Mile Beach National Park and Coomonderry Swamp.</td>
</tr>
<tr>
<td>Irediparra gallinacea Comb-crested Jacana</td>
<td>-</td>
<td>V</td>
<td>Occurs in freshwater wetlands, lagoons, Billabongs, swamps, lakes, rivers and reservoirs, generally with abundant floating aquatic vegetation (Marchant and Higgins 1993).</td>
<td>No. Not previously recorded within 10 km of study area.</td>
</tr>
<tr>
<td>Anous stolidus Common Noddy</td>
<td>M</td>
<td>-</td>
<td>Habitat is tropical and subtropical seas, cays, reefs, buoys and piles (Pizzey and Knight 1997).</td>
<td>No. Previously recorded once, south of the study area at Black Head.</td>
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<td><strong>Birds</strong></td>
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<tr>
<td><em>Sterna albifrons</em></td>
<td>M</td>
<td>E1</td>
<td>Found in sheltered coastal environments including lagoons, estuaries, river mouths and deltas, lakes, bays, harbours and inlets (Higgins and Davies 1996).</td>
<td>No. Previously recorded north, south and south-west of the study area.</td>
</tr>
<tr>
<td>Little Tern</td>
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<tr>
<td><em>Sterna caspia</em></td>
<td>M</td>
<td>-</td>
<td>Usually coastal, with a preference for sheltered estuaries, inlets, bays, harbours, lagoons with muddy or sandy shores. Keeps close inshore, not out beyond reef line. Also extends well inland on fresh or salt lakes, temporary floodwaters, large rivers, reservoirs, sewage ponds (Morcombe 2003).</td>
<td>Yes. Previously recorded within the estuarine saltmarsh (Site 2) as well as south of the study area at Seven Mile Beach National Park and Coomonderry Swamp.</td>
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<tr>
<td>Caspian Tern</td>
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<tr>
<td><em>Anthochaera Phrygia</em></td>
<td>E</td>
<td>E1</td>
<td>A semi-nomadic species occurring in temperate eucalypt woodlands and open forests. Most records are from box-ironbark eucalypt forest associations and wet lowland coastal forests (NPWS 1999f; Pizzey and Knight 1997). Key eucalypt species include Mugga Ironbark, Yellow Box, Blakely’s Red Gum, White Box and Swamp Mahogany. Also utilises: <em>E. microcarpa</em>, <em>E. punctata</em>, <em>E. polyanthemos</em>, <em>E. mollucana</em>, <em>Corymbia robusta</em>, <em>E. caleyi</em>, <em>Corymbia maculata</em>, <em>E. mckieana</em>, <em>E. macrocarphyna</em>, <em>E. laeopinea</em> and <em>Angophora floribunda</em>. Nectar and fruit from the mistletoes <em>A. miqueli</em>, <em>A. pendula</em>, <em>A. cambagei</em> are also eaten during the breeding season (DEC 2005•). Regent Honeyeaters usually nest in horizontal branches or forks in tall mature eucalypts and Sheoaks. Also nest in mistletoe haustoria. An open cup-shaped nest is constructed of bark, grass, twigs and wool by the female (DEC 2005•).</td>
<td>Yes, but limited. Previously recorded south-west of the study area at Seven Mile Beach National Park.</td>
</tr>
<tr>
<td>Regent Honeyeater</td>
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<tr>
<td><em>Merops ornatus</em></td>
<td>M</td>
<td>-</td>
<td>Usually occurs in open or lightly timbered areas, often near water. Nest in embankments, including banks of creeks and rivers, in sand dunes, in quarries and in roadside cuttings. Breeding occurs from November to January. It has complex migratory movements in Australia. NSW populations migrate north for winter (Higgins 1999).</td>
<td>Yes. Previously recorded once, south-west of the study area at Seven Mile Beach National Park.</td>
</tr>
<tr>
<td>Rainbow Bee-eater</td>
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<td></td>
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<tr>
<td>Latin and common name</td>
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<tr>
<td><strong>Acrocephalus stentoreus</strong>&lt;br&gt;Clamorous Reed-Warbler</td>
<td>M</td>
<td>-</td>
<td>This species lives singly or in pairs usually in wetlands with reeds. It feeds on insects (Blakers et al. 1984).</td>
<td>Yes. Previously recorded immediately east of the estuarine saltmarsh (Site 2) as well as north, north-west, south and south-west of the study area.</td>
</tr>
<tr>
<td><strong>Daphoenositta chrysoptera</strong>&lt;br&gt;Varied Sittella</td>
<td>-</td>
<td>PD (V)</td>
<td>A sedentary species which inhabits a wide variety of dry eucalypt forests and woodlands, usually with either shrubby understorey or grassy ground cover or both, in all climatic zones of Australia. Usually inhabit areas with rough-barked trees, such as stringybarks or ironbarks, but also in paperbarks or mature Eucalypts (Higgins and Peter 2002). The Varied Sittella feeds on arthropods gleaned from bark, small branches and twigs. It builds a cup-shaped nest of plant fibres and cobweb in an upright tree fork high in the living tree canopy, and often re-uses the same fork or tree in successive years (NSW Scientific Committee 2009a).</td>
<td>Yes, but limited. Previously recorded north-west, west and south-west of the study area.</td>
</tr>
<tr>
<td><strong>Pachycephala olivacea</strong>&lt;br&gt;Olive Whistler</td>
<td>-</td>
<td>V</td>
<td>Found in a range of habitats including alpine thickets, wetter rainforest / woodlands, riparian vegetation and heaths (Pizzey and Knight 1997).</td>
<td>Yes. Previously recorded north-west and south-west of the study area.</td>
</tr>
<tr>
<td><strong>Dasyornis brachypterus</strong>&lt;br&gt;Eastern Bristlebird</td>
<td>E</td>
<td>E1</td>
<td>Found in coastal woodlands, dense scrub and heathlands, particularly where it borders taller woodlands (Pizzey and Knight 1997).</td>
<td>No. Previously recorded north-west and west of the study area at Barren Grounds Nature Reserve.</td>
</tr>
<tr>
<td><strong>Stagonopleura guttata</strong>&lt;br&gt;Diamond Firetail</td>
<td>-</td>
<td>V</td>
<td>Found in a range of habitat types including open eucalypt forest, mallee and acacia scrubs (Pizzey and Knight 1997). Often occur in vegetation along watercourses (Higgins et al. 2006).</td>
<td>No. Not previously recorded within 10 km of study area.</td>
</tr>
<tr>
<td><strong>Petroica boodang</strong>&lt;br&gt;Scarlet Robin</td>
<td>-</td>
<td>V</td>
<td>The Scarlet Robin’s range includes all state capitals. Occurs in forests, woodlands; and heavier vegetation when breeding. During autumn and winter occurs in more open and cleared areas. It has dispersive or locally migratory seasonal movements. Is conspicuous in open and suburban habitats (Morcombe 2003).</td>
<td>Yes. Previously recorded once, north-west of the study area.</td>
</tr>
<tr>
<td>Latin and common name</td>
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<tr>
<td><strong>Birds</strong></td>
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<tr>
<td><em>Petroica phoenicea</em></td>
<td>-</td>
<td>V</td>
<td>Flame Robins are found in a broad coastal band from southern Queensland to just west of the South Australian border (Australian Museum 2009). The species is also found in Tasmania. The preferred habitat in summer includes eucalyptus forests and woodland, whilst in winter prefers open woodlands and farmlands. It is considered migratory. The Flame Robin breeds from about August to January (Morcombe 2003).</td>
<td>Yes. Previously recorded north and north-west of the study area.</td>
</tr>
<tr>
<td>Flame Robin</td>
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<tr>
<td><em>Petroica rodinogaster</em></td>
<td>-</td>
<td>V</td>
<td>Found in dense, dank forest / treefern gullies and disperses in autumn-winter to open forests, woodlands and scrublands (Pizzey and Knight 1997).</td>
<td>Yes. Not previously recorded within 10 km of study area.</td>
</tr>
<tr>
<td>Pink Robin</td>
<td></td>
<td></td>
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</tr>
<tr>
<td><em>Glossopsitta pusilla</em></td>
<td>-</td>
<td>V</td>
<td>Distributed in forests and woodlands from the coast to the western slopes of the Great Dividing Range in NSW, extending westwards to the vicinity of Albury, Parkes, Dubbo and Narrabri. Mostly occurs in dry, open eucalypt forests and woodlands. They feed primarily on nectar and pollen in the tree canopy. Nest hollows are located at heights of between two metres and 15 m, mostly in living, smooth-barked eucalypts. Most breeding records come from the western slopes (NSW Scientific Committee 2008b).</td>
<td>Yes. Previously recorded north, south and south-west of the study area.</td>
</tr>
<tr>
<td>Little Lorikeet</td>
<td></td>
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<tr>
<td><em>Lathamus discolor</em></td>
<td>E</td>
<td>E1</td>
<td>The Swift Parrot occurs in woodlands and forests of NSW from May to August, where it feeds on eucalypt nectar, pollen and associated insects (Forshaw and Cooper 1981). The Swift Parrot is dependent on flowering resources across a wide range of habitats in its wintering grounds in NSW (Shields and Crome 1992). This species is migratory, breeding in Tasmania and also nomadic, moving about in response to changing food availability (Pizzey and Knight 1997).</td>
<td>Yes, but unlikely to occur frequently in the local area. Previously recorded north-west and south of the study area.</td>
</tr>
<tr>
<td>Swift Parrot</td>
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<tr>
<td>Latin and common name</td>
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</tr>
<tr>
<td>Neophema chrysogaster  Orange-bellied Parrot</td>
<td>ZM</td>
<td>C1</td>
<td>A single breeding population of fewer than 200 individuals occurs in a narrow coastal strip of south-west Tasmania. Adult birds depart Tasmania for the mainland in February. The first adults begin leaving the mainland for Tasmania in September with the last birds having departed by November. It is a coastal species inhabiting saltmarshes, sedgeplains, coastal dunes, pastures, shrublands and moorlands, generally within 10 km of the coast (OBPRT 1998). Critical winter habitat for the species includes natural saltmarshes dominated by Sarcocornia quinqueflora (Beaded Glasswort) and Sclerostegia arbuscula (Shrubby Glasswort), as well as the associated grassy or weedy pastures (DECC 2007). Historical records indicate that the Orange-bellied Parrot was formerly more abundant and widespread in NSW than it is now, however the species’ distribution continues to extend into south-eastern NSW where suitable habitat is still available (DECC 2007).</td>
<td>Yes, but unlikely to occur frequently in the local area. Not previously recorded within 10 km of study area.</td>
</tr>
<tr>
<td>Neophema pulchella  Turquoise Parrot</td>
<td>-</td>
<td>V</td>
<td>Occurs in open woodlands and eucalypt forests with a ground cover of grasses and understorey of low shrubs (Morris 1980). Generally found in the foothills of the Great Divide, including steep rocky ridges and gullies (Higgins 1999). Nest in hollow-bearing trees, either dead or alive; also in hollows in tree stumps. Prefer to breed in open grassy forests and woodlands, and gullies that are moist (Higgins 1999).</td>
<td>Yes, but unlikely to occur frequently in the local area. Previously recorded north-west of the study area at Barren Grounds Nature Reserve.</td>
</tr>
<tr>
<td>Pezoporus wallicus wallicus  Eastern Ground Parrot</td>
<td>-</td>
<td>V</td>
<td>Mainly found in heathland, sedgeland or buttongrass plains providing medium to dense cover (Higgins 1999).</td>
<td>Yes, but unlikely to occur frequently in the local area. Previously recorded north-west of the study area at Barren Grounds Nature Reserve and once to the south at Seven Mile Beach National Park.</td>
</tr>
<tr>
<td>Latin and common name</td>
<td>EPBC Act¹</td>
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<tr>
<td><em>Rostratula australis</em> Australian Painted Snipe</td>
<td>VM</td>
<td>E1</td>
<td>Usually found in shallow inland wetlands including farm dams, lakes, rice crops, swamps and waterlogged grassland. They prefer freshwater wetlands, ephemeral or permanent, although they have been recorded in brackish waters (Marchant and Higgins 1993).</td>
<td>Yes. Not previously recorded within 10 km of the study area.</td>
</tr>
<tr>
<td><em>Actitis hypoleucos</em> Common Sandpiper</td>
<td>M</td>
<td>-</td>
<td>Inhabits a wide range of coastal and inland wetlands, often with muddy or rocky margins. Also known to occur at estuaries, billabongs, dams, pools and lakes, often associated with mangroves (Higgins and Davies 1996).</td>
<td>No. Previously recorded immediately east of the estuarine saltmarsh (Site 2) at Werri Beach as well as north of the study area.</td>
</tr>
<tr>
<td><em>Arenaria interpres</em> Ruddy Turnstone</td>
<td>M</td>
<td>-</td>
<td>Inhabits tidal reefs, sandy beaches mudflats and exposed or shallow seaweed beds (Pizzey and Knight 1997).</td>
<td>No. Previously recorded south of the study area at Black Head and Seven Mile Beach National Park.</td>
</tr>
<tr>
<td><em>Calidris acuminata</em> Sharp-tailed Sandpiper</td>
<td>M</td>
<td>-</td>
<td>Inland waters, coastal (Simpson and Day 1996).</td>
<td>No. Previously recorded once, south of the study area at Seven Mile Beach National Park.</td>
</tr>
<tr>
<td><em>Calidris alba</em> Sanderling</td>
<td>M</td>
<td>V</td>
<td>Occurs on the coast mostly on open sand beaches exposed to open sea-swells (Higgins and Davies 1996).</td>
<td>No. Previously recorded south and south-west of the study area at Seven Mile Beach National Park and Coomonderry Swamp.</td>
</tr>
<tr>
<td><em>Calidris ruficollis</em> Red-necked Stint</td>
<td>M</td>
<td>-</td>
<td>Inhabits mainly coastal environments; saltmarshes, tidal mudflats, saline and freshwater wetlands, sandy or shelly beaches and sewage ponds (Higgins and Davies 1996).</td>
<td>Yes. Previously recorded south and south-west of the study area at Seven Mile Beach National Park and Coomonderry Swamp.</td>
</tr>
<tr>
<td>Latin and common name</td>
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<tr>
<td>Calidris tenuirostris Great Knot</td>
<td>Mv</td>
<td></td>
<td>Mainly found on intertidal mudflats, sandflats and sandy beaches (Higgins and Davies 1996).</td>
<td>No. Previously recorded once, south-west of the study area within Coomonderry Swamp.</td>
</tr>
<tr>
<td>Gallinago hardwickii Latham’s Snipe</td>
<td>M</td>
<td>-</td>
<td>Typically found on wet soft ground or shallow water with good cover of tussocks. Often found in wet paddocks, seepage areas below dams (Pizzey and Knight 1997).</td>
<td>Yes. Recorded during the current surveys Site 2). Also previously recorded east of the estuarine saltmarsh (Site 2), north, north-west and south of the study area.</td>
</tr>
<tr>
<td>Limicola falcinellus Broad-billed Sandpiper</td>
<td>M V</td>
<td></td>
<td>Occurs in sheltered parts of coasts, such as estuaries, harbours, embayments and lagoons, which have shell or sandbanks nearby (Higgins and Davies 1996).</td>
<td>No. Not previously recorded within 10 km of study area.</td>
</tr>
<tr>
<td>Limosa lapponica Bar-tailed Godwit</td>
<td>M</td>
<td>-</td>
<td>Coastal species usually inhabiting intertidal sandflats, spits and banks. Less frequently found in mudflats, estuaries, coastal lagoons and harbours (Higgins and Davies 1996).</td>
<td>No. Previously recorded south and south-west of the study area at Seven Mile Beach and Coomonderry Swamp.</td>
</tr>
<tr>
<td>Limosa limosa Black-tailed Godwit</td>
<td>M</td>
<td>V</td>
<td>Mainly coastal, usually in sheltered bays, estuaries and lagoons with large intertidal mudflats or sandflats (Higgins and Davies 1996).</td>
<td>No. Previously recorded once, south-west of the study area at Coomonderry Swamp.</td>
</tr>
<tr>
<td>Numenius madagascariensis Eastern Curlew</td>
<td>M</td>
<td>-</td>
<td>Occurs in sheltered coasts, especially estuaries, embayments, harbours, inlets and coastal lagoons with large intertidal mudflats or sandflats often with beds of seagrass (Higgins and Davies 1996).</td>
<td>No. Previously recorded immediately east of the estuarine saltmarsh (Site 2) at Werri Beach as well as south and south-west of the study area.</td>
</tr>
<tr>
<td>Latin and common name</td>
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<tr>
<td><strong>Birds</strong></td>
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<tr>
<td><em>Numenius phaeopus</em></td>
<td>M</td>
<td>-</td>
<td>Occurs in intertidal mudflats of sheltered coasts (Higgins and Davies 1996). Also in estuaries, mangroves, coral clays and exposed reefs. Roosts in trees and mangroves (Pizzey and Knight 1997).</td>
<td>No. Previously recorded once, south of the study area near Crooked River.</td>
</tr>
<tr>
<td>Whimbrel</td>
<td></td>
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<tr>
<td><em>Xenus cinereus</em></td>
<td>M</td>
<td>V</td>
<td>Mainly found on saline intertidal mudflats in sheltered estuaries, embayments, harbours and lagoons (Higgins and Davies 1996).</td>
<td>No. Not previously recorded within 10 km of study area.</td>
</tr>
<tr>
<td>Terek Sandpiper</td>
<td></td>
<td></td>
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<tr>
<td><em>Ninox connivens</em></td>
<td>-</td>
<td>V</td>
<td>Generally found in open forests, woodlands, swamp woodlands and dense scrub. Can also be found in the foothills and timber along watercourses in otherwise open country (Pizzey and Knight 1997). Territories range from 30 ha to 200 ha (DEC 2005c).</td>
<td>Yes. Previously recorded once, east of the study area at Werri Beach.</td>
</tr>
<tr>
<td>Barking Owl</td>
<td></td>
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<tr>
<td><em>Ninox strenua</em></td>
<td>-</td>
<td>V</td>
<td>Occupies wet and dry eucalypt forests and rainforests. Can occupy both unlogged and lightly logged forests as well as undisturbed forests where it usually roosts on the limbs of dense trees in gully areas (Debus and Chafer 1994b; Debus and Chafer 1994a). Large mature trees with hollows at least 0.5 m deep are required for nesting (Garnett 1992). Tree hollows are particularly important for the Powerful Owl because a large proportion of the diet is made up of hollow-dependent arboreal marsupials (Gibbons and Lindenmayer 1997). Nest trees for this species are usually emergent with a diameter at breast height of at least 100 cm (Gibbons and Lindenmayer 1997). Has a large home range of between 450 and 1450 ha (DEC 2005c).</td>
<td>Yes. Recorded during current surveys within another section of the Princes Highway upgrade. Also previously recorded east, north-west and south of the study area.</td>
</tr>
<tr>
<td>Powerful Owl</td>
<td></td>
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<tr>
<td><em>Tyto novaehollandiae</em></td>
<td>-</td>
<td>V</td>
<td>Inhabits a diverse range of wooded habitats that provide tall or dense mature trees with hollows suitable for nesting and roosting (Higgins 1999). Mostly recorded in open forest and woodlands adjacent to cleared lands. Nest in hollows, in trunks and in near vertical spouts or large trees, usually living but sometimes dead (Higgins 1999). Nest hollows are usually located within dense forests or woodlands (Gibbons and Lindenmayer 1997). Masked Owls prey upon hollow-dependent arboreal marsupials, but terrestrial mammals make up the largest proportion of the diet (Gibbons and Lindenmayer 1997; Higgins 1999). Has a large home range of between 500 ha and 1000 ha (DEC 2005c).</td>
<td>Yes. Previously recorded once, south-west of the study area at Seven Mile Beach National Park.</td>
</tr>
<tr>
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<td><strong>Birds</strong></td>
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<tr>
<td><em>Tyto tenebricosa</em> Sooty Owl</td>
<td>-</td>
<td>V</td>
<td>Often found in tall old-growth forests, including temperate and subtropical rainforests. In NSW mostly found on escarpments with a mean altitude &lt;500 m. Nests and roosts in hollows of tall emergent trees, mainly eucalypts (Higgins 1999) often located in gullies (Gibbons and Lindenmayer 1997). Nests have been located in trees 125 cm to 161 cm in diameter (Gibbons and Lindenmayer 1997).</td>
<td>Yes. Previously recorded north-west of the study area including at Barren Grounds Nature Reserve.</td>
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<td><strong>Mammals</strong></td>
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<tr>
<td><em>Cercartetus nanus</em> Eastern Pygmy-possum</td>
<td>-</td>
<td>V</td>
<td>Patchily distributed from the coast to the Great Dividing Range, and as far as Pillaga, Dubbo, Parkes and W agga W agga on the western slopes. Inhabits rainforest through to sclerophyll forest and tree heath. Banksias and myrtaceous shrubs and trees are a favoured food source. Soft fruits are eaten when flowers are unavailable and it also feeds on insects (DEC 2005; Ward and Turner 2008). Would often nest in tree hollows, but can also construct its own nest (Turner and Ward 1995). Because of its small size it is able to utilise a range of hollow sizes including very small hollows (Gibbons and Lindenmayer 1997). Individuals would use a number of different hollows and an individual has been recorded using up to nine nest sites within a 0.5 ha area over a five month period (Ward 1990). It is mainly solitary, and each individual uses several nests. Home ranges of males are generally less than 0.75 ha, and those of females are smaller (Ward and Turner 2008).</td>
<td>No. Not previously recorded within 10 km of study area and connectivity inadequate.</td>
</tr>
<tr>
<td>Latin and common name</td>
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<tr>
<td><strong>Mammals</strong></td>
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<tr>
<td><em>Dasyurus maculatus</em></td>
<td>E</td>
<td>V</td>
<td>Occurs along the east coast of Australia and the Great Divide Range (Belcher <em>et al.</em> 2008). Uses a range of habitats including sclerophyll forests and woodlands, coastal heathlands and rainforests (Dickman and Read 1992). Occasional sightings have been made in open country, grazing lands, rocky outcrops and other treeless areas (NPWS 1999k). Habitat requirements include suitable den sites, including hollow logs, rock crevices and caves, an abundance of food and an area of intact vegetation in which to forage (Edgar and Belcher 1995). Seventy per cent of the diet is medium-sized mammals, and also feeds on invertebrates, reptiles and birds. Individuals require large areas of relatively intact vegetation through which to forage (NPWS 1999h). The home range of a female is between 180 ha and 1000 ha, while males have larger home ranges of between 2000 ha and 5000 ha. Breeding occurs from May to August (Belcher <em>et al.</em> 2008).</td>
<td>Yes. Previously recorded immediately east of the study area at Werri Gully and a tributary of Werri Lagoon, immediately south of the study area at a tributary of Crooked River, as well as north, north-west and west of the study area.</td>
</tr>
<tr>
<td><em>Sminthopsis leucopus</em></td>
<td>-</td>
<td>V</td>
<td>The White-footed Dunnart is found in a range of different habitats across its distribution, including coastal dune vegetation, coastal forest, tussock grassland and sedgeland, heathland, woodland and forest. They shelter in bark nests in hollows under standing or fallen timber, burrows in the ground, piles of logging debris, large grass clumps such as provided by Grass Trees Xanthorrhoea sp. and Macrozamias and rock crevices (DEC 2005).</td>
<td>No. Not previously recorded within 10 km of study area.</td>
</tr>
<tr>
<td><em>Saccolaimus flaviventris</em></td>
<td>-</td>
<td>V</td>
<td>Found throughout NSW. They have been reported from southern Australia between January and April. Reported from a wide range of habitats throughout eastern and northern Australia, including wet and dry sclerophyll forest, open woodland, acacia shrubland, mallee, grasslands and desert. They roost in tree hollows in colonies of up to 30 (but more usually two to six) and have also been observed roosting in animal burrows, abandoned Sugar Glider nests, cracks in dry clay, hanging from buildings and under slabs of rock. It is high-flying, making it difficult to detect. It forages above the canopy of eucalypt forests, but comes lower to the ground in mallee or open country (Churchill 2008; Richard 2008).</td>
<td>Yes. Recorded during 2007 surveys west of the study area. Also previously recorded south-west of the study area.</td>
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<tr>
<td>Latin and common name</td>
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<tr>
<td><strong>Mammals</strong></td>
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<tr>
<td>Petrogale penicillata</td>
<td>V</td>
<td>E1</td>
<td>Occurs along the Great Dividing Range south to the Shoalhaven, and also occurs in the Warrumbungles and Mt Kaputar. Habitats range from rainforest to open woodland. It is found in areas with numerous ledges, caves and crevices, particularly where these have a northerly aspect. Individuals defend a specific rock shelter, emerging in the evening to forage on grasses and forbs, as well as browse in drier months. Home sizes range from two hectares to 30 ha (Eldridge and Close 1995).</td>
<td>No. Not previously recorded within 10 km of study area.</td>
</tr>
<tr>
<td>Mormopterus norfolkensis</td>
<td>-</td>
<td>V</td>
<td>Distribution extends east of the Great Dividing Range from southern Queensland to south of Sydney. Most records are from dry eucalypt forests and woodland. Individuals tend to forage in natural and artificial openings in forests, although it has also been caught foraging low over a rocky river within rainforest and wet sclerophyll forest habitats. The species generally roosts in hollow spouts of large mature eucalypts (including paddock trees), although individuals have been recorded roosting in the roof of a hut, in wall cavities, and under metal caps of telegraph poles. Foraging generally occurs within a few kilometres of roosting sites (Churchill 2008; Hoye et al. 2008).</td>
<td>Yes. Recorded during current surveys west of the study area. Also previously recorded south-west of the study area.</td>
</tr>
<tr>
<td>Isoodon obesulus obesulus</td>
<td>E</td>
<td>E1</td>
<td>Prefers sandy soils with scrubby vegetation and/or areas with low ground cover that are burnt from time to time (Braithwaite 1995). A mosaic of post fire vegetation is important for this species (Maxwell et al. 1996).</td>
<td>No. Not previously recorded within 10 km of study area.</td>
</tr>
<tr>
<td>Petaurus australis</td>
<td>-</td>
<td>V</td>
<td>Restricted to tall native forests in regions of high rainfall along the coast of NSW. Preferred habitats are productive, tall open sclerophyll forests where mature trees provide shelter and nesting hollows. Critical elements of habitat include sap-site trees, winter flowering eucalypts, mature trees suitable for den sites and a mosaic of different forest types (NPWS 1999)). Live in family groups of two to six individuals which commonly share a number of tree hollows. Family groups are territorial with exclusive home ranges of 30 ha to 60 ha. Very large expanses of forest (&gt;15,000 ha) are required to conserve viable populations (Goldingay 2008).</td>
<td>No. Previously recorded once, north-west of the study area at Foxground.</td>
</tr>
<tr>
<td>Latin and common name</td>
<td>EPBC Act</td>
<td>TSC Act</td>
<td>Habitat</td>
<td>Potential habitat in the study area?</td>
</tr>
<tr>
<td>-------------------------</td>
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<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>------------------------------------------------------</td>
</tr>
<tr>
<td>Petaurus norfolcensis</td>
<td>-</td>
<td>V</td>
<td>Sparsely distributed along the east coast and immediate inland areas as far west as Coonabarabran (DEC 1999) in the northern part of the state and as far west as Tocumwal along the southern border of the state. Generally occurs in dry sclerophyll forests and woodlands but is absent from dense coastal ranges in the southern part of its range. Require abundant hollow bearing trees and a mix of eucalypts, banksias and acacias (Van der Ree and Suckling 2008). Within a suitable vegetation community at least one species should flower heavily in winter and one species of eucalypt should be smooth barked (Menkhorst et al. 1988). They live in family groups of two to 10 individuals and maintain home ranges between 0.65 ha and 10.5 ha, varying according to habitat quality and food resource availability (Quin 1995; Goldingay and Jackson 2004). Family groups occupy multiple hollows over time (Van der Ree and Suckling 2008).</td>
<td>No. Not previously recorded within 10 km of study area.</td>
</tr>
<tr>
<td>Phascolarctos cinereus</td>
<td>-</td>
<td>V</td>
<td>In NSW the Koala mainly occurs on the central and north coasts with some populations in the western region (DEC 2005z). Koalas feed almost exclusively on eucalypt foliage, and their preferences vary regionally (Martin et al. 2008). Primary feed trees include Eucalyptus robusta, E. tereticornis, E. punctata, E. haemostoma and E. signata (DoP 1995). They are solitary with varying home ranges. In high quality habitat home ranges may be one to two hectares and overlap, while in semi-arid country they are usually discrete and around 100 ha (Martin et al. 2008).</td>
<td>No. Previously recorded north, north-west and south-west of the study area.</td>
</tr>
<tr>
<td>Potorous tridactylus</td>
<td>V</td>
<td>V</td>
<td>Occurs from Queensland to Victoria, normally within 50 km of the coast (Claridge et al. 2007). Inhabits coastal heath and wet and dry sclerophyll forests. Generally found in areas with rainfall greater than 760 mm. Requires relatively thick ground cover where the soil is light and sandy. Known to eat fungi, arthropods, fleshy fruit, seeds and plant tissue. It is solitary and sedentary, buts tends to aggregate in small groups. It has two breeding seasons, one in late winter-early spring and the other in late summer (Johnston 2008). This species appears to benefit from a lack of recent disturbance Claridge et al. 2007).</td>
<td>No. Previously recorded north-west and south-west of the study area.</td>
</tr>
<tr>
<td>Latin and common name</td>
<td>EPBC Act</td>
<td>TSC Act</td>
<td>Habitat</td>
<td>Potential habitat in the study area?</td>
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<tr>
<td><strong>Mammals</strong></td>
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</tr>
<tr>
<td><em>Pteropus poliocephalus</em>&lt;br&gt;Grey-headed Flying-fox</td>
<td>V</td>
<td>V</td>
<td>Occurs along the NSW coast, extending further inland in the north. This species is a canopy-feeding frugivore and nectarivore of rainforests, open forests, woodlands, melaleuca swamps and banksia woodlands. Roosts in large colonies (camps), commonly in dense riparian vegetation. Bats commute daily to foraging areas, usually within 15 km of the day roost (Tidemann 1995) although some individuals may travel up to 70 km (Augee and Ford 1999).&lt;br&gt;Yes. Recorded during current surveys west of the study area. Also previously recorded north, south and south-west of the study area. Known camp site within Coomonderry Swamp.</td>
<td></td>
</tr>
<tr>
<td><em>Chalinolobus dwyeri</em>&lt;br&gt;Large-eared Pied Bat</td>
<td>V</td>
<td>V</td>
<td>Occurs from the Queensland border to Ulladulla, with largest numbers from the sandstone escarpment country in the Sydney Basin and Hunter Valley (van dyck and Strahan 2008). Primarily found in dry sclerophyll forests and woodlands, but also found in rainforest fringes and subalpine woodlands (Churchill 2008; Hoye and Schulz 2008). Forages on small, flying insects below the forest canopy. Roosts in colonies of between three and 80 in caves, Fairy Martin nests and mines, and beneath rock overhangs, but usually less than 10 individuals. Likely that it hibernates during the cooler months (Churchill 2008). The only known existing maternity roost is in a sandstone cave near Coonabarabran (Pennay 2008).&lt;br&gt;Yes. Recorded once during 2007 surveys west of the current study area. No other records within 10 km.</td>
<td></td>
</tr>
<tr>
<td><em>Falsistrellus tasmaniensis</em>&lt;br&gt;Eastern False Pipistrelle</td>
<td>-</td>
<td>V</td>
<td>Distribution extending east of the Great Dividing Range throughout the coastal regions of NSW, from the Queensland border to the Victorian border. Prefers wet sclerophyll and coastal mallee, preferring wet forests with a dense understorey but being found in open forests at lower altitudes (Churchill 2008). Roosts in tree hollows and sometimes in buildings and caves, in colonies of between three and 80. Often change roosts every night. Has a large foraging range, up to 136 ha (Churchill 2008; Law et al. 2008). Records show movements of up to 12 km between roosting and foraging sites (Menkhorst and Lumsden 1995).&lt;br&gt;Yes. Recorded during 2007 and 2008 surveys west of the current study area. Also previously recorded north and south of the study area.</td>
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<tr>
<td>Latin and common name</td>
<td>EPBC Act</td>
<td>TSC Act</td>
<td>Habitat</td>
<td>Potential habitat in the study area?</td>
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<tr>
<td><strong>Mammals</strong></td>
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<tr>
<td>Kerivoula papuensis</td>
<td>-</td>
<td>V</td>
<td>Occurs in a narrow band down the coast from Cape York to Eden, in moist, closed forest that receives high rainfall (Law and Chidel 2004). Important habitat features includes forest ecotones, streams and an abundance of vines (van dyck and Strahan 2008). Primarily feeds on web-building spiders. Most nightly movements occur within two kilometres of the roost. Roosts in the nests of Yellow-throated Scrubwren and Brown Gerygone, as well as in tree hollows, foliage and roofs of houses (van dyck and Strahan 2008).</td>
<td>No. Not previously recorded within 10 km of study area.</td>
</tr>
<tr>
<td>Miniopterus</td>
<td>V</td>
<td>V</td>
<td>Occurs from Victoria to Queensland, on both sides of the Great Dividing Range. Forms large maternity roosts (up to 100,000 individuals) in caves and mines in spring and summer. Individuals may fly several hundred kilometres to their wintering sites, where they roost in caves, culverts, buildings, and bridges. They occur in a broad range of habitats including rainforest, wet and dry sclerophyll forest, paperbark forest and open grasslands. Has a fast, direct flight and forages for flying insects (particularly moths) above the tree canopy and along waterways (Churchill 2008; Hoye and Hall 2008).</td>
<td>Yes. Recorded during 2007 surveys west of current study area. Also previously recorded north-east, north-west and south of the study area.</td>
</tr>
<tr>
<td>schreibersii</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>oceanensis</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Eastern Bentwing-bat</td>
<td></td>
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<tr>
<td>Myotis macropus</td>
<td>-</td>
<td>V</td>
<td>Scattered, mainly coastal distribution extending to South Australia along the Murray River. Roosts in caves, mines or tunnels, under bridges, in buildings, tree hollows, and even in dense foliage. Colonies occur close to water bodies, ranging from rainforest streams to large lakes and reservoirs. They catch aquatic insects and small fish with their large hind claws, and also catch flying insects (Richards et al. 2008).</td>
<td>Yes. Recorded during 2007 and 2008 surveys west of the current study area. Also previously recorded south-west of study area.</td>
</tr>
<tr>
<td>Large-footed Myotis</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Scoteanax rueppellii</td>
<td>-</td>
<td>V</td>
<td>Occurs along the Great Dividing Range, up to 1200 m and in coastal areas. Occurs in woodland and rainforest, but prefers open habitats or natural or human-made openings in wetter forests. Often hunts along creeks or river corridors. Flies slowly and directly at a height of 30 m or so to catch beetles and other large, flying insects. Also known to eat other bats and spiders. Roosts in hollow tree trunks and branches (Churchill, 2008; Richards et al, 2008).</td>
<td>Yes. Recorded during 2007 and 2008 surveys west of the current study area. Also previously recorded south-west of study area.</td>
</tr>
<tr>
<td>Greater Broad-nosed</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bat</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Latin and common name</td>
<td>EPBC Act¹</td>
<td>TSC Act²</td>
<td>Habitat</td>
<td>Potential habitat in the study area?</td>
</tr>
<tr>
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</tr>
<tr>
<td><strong>Reptiles</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Hoplocephalus bungaroides</em> Broad-headed Snake</td>
<td>V</td>
<td>E1</td>
<td>Mainly occurs in association with communities occurring on Triassic sandstone within the Sydney Basin. Typically found among exposed sandstone outcrops with vegetation types ranging from woodland to heath. Within these habitats they generally use rock crevices and exfoliating rock during the cooler months and tree hollows during summer (Webb 1996; Webb and Shine 1998).</td>
<td>No. Not previously recorded within 10 km of study area.</td>
</tr>
<tr>
<td><em>Varanus rosenbergi</em> Rosenberg's Goanna</td>
<td>-</td>
<td>V</td>
<td>This species is a Hawkesbury / Narrabeen sandstone outcrop specialist (Wellington and Wells 1985). Occurs in coastal heaths, humid woodlands and both wet and dry sclerophyll forests (Cogger 1992). Termite mounds are a critical habitat component (DEC 2005f).</td>
<td>No. Not previously recorded within 10 km of study area.</td>
</tr>
</tbody>
</table>

Key:  
1) Listed on the Environment Protection and Biodiversity Conservation Act as Endangered (E), Critically Endangered (Z), Vulnerable (V) or covered under migratory provisions (M) of the Act  
2) Listed on the Threatened Species Conservation Act as Endangered (E1), Critically Endangered (C1), Vulnerable (V) or as a Preliminary Determination as Vulnerable (PD(V))
Figure 3.3: Threatened and migratory fauna listed on the Threatened Species Conservation Act and the Environment Protection and Biodiversity Conservation Act that have been recorded within 10 km of the study area
3.6 Endangered populations

Part 2 of Schedule 1 of the Threatened Species Conservation Act lists endangered populations of flora and fauna. There are no endangered fauna or flora populations listed that occur within the study area.

One endangered population has been listed to the north of the study area; the plant species *Chorizema parviflorum* in the Wollongong and Shellharbour local government areas. The closest known location of this species to the study area occurs approximately 18 km to the north. The species grows in heath and sclerophyll woodland and forest on heavy soils (Harden 2002). All known sites (excluding the site at Austinmer) occupy woodland or forest dominated by *Eucalyptus tereticornis* and/or *E. longifolia* (DEC 2005d). It is unlikely that potential habitat for the species occurs within the study area, given that the known associate species were not recorded.

3.7 Critical habitat

Critical habitat can be declared under both the Environment Protection and Biodiversity Conservation Act and the Threatened Species Conservation Act. Under the Environment Protection and Biodiversity Conservation Act, it is an offence for a person to take an action that the person knows would significantly damage the critical habitat of a listed threatened species. Under the Threatened Species Conservation Act, the declaration of critical habitat serves primarily as a guide for planning under Part 3 of the Environment Planning and Assessment Act and a trigger which ensures a rigorous environmental assessment of all activities and development proposed upgrades and any other action that has the potential to damage the species or its habitat (NPWS 2002b).

No areas of critical habitat for flora or fauna have been declared within or near the study area under either the Environment Protection and Biodiversity Conservation Act or Threatened Species Conservation Act.

3.8 Corridors

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

Vegetation cover in a corridor may not always be continuous. Corridors may include smaller remnants, wetlands, roadside vegetation, groups of trees, and even individual trees. Corridors may be broken, or fragmented, by currently degraded or cleared areas but still contribute to landscape connectivity.

Discontinuous corridors can provide important stepping-stone links (Scotts et al. 2000).

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

- Structural connectivity. This is the mappable spatial continuity of the corridor. This can include the distance over which the corridor extends, the width, the number of gaps and the presence of habitat nodes.
Functional connectivity. This is a measure of the ability of a species to move between two habitats. The functional connectivity of a corridor depends not only on its spatial continuity, but also on factors such as behaviour of the species, the scale of the species' movements, and its response to the width and quality of habitat in the corridor (Bennett 1990).

The major habitat corridors within the Illawarra region occur to the south, west and north of the study area and incorporate a number of national parks, nature reserves and state forests. To the west of the study area, Morton National Park provides a wildlife corridor from Fitzroy Falls in the north to the Budawang National Park west of Ulladulla in the south. North of the study area, land managed by the Sydney Catchment Authority provides a wildlife corridor from the Southern Highlands to the Royal National Park.

These two main wildlife corridors are separated along the Illawarra Highway. However, habitat linkages between the two corridors occur via Budderoo National Park, Macquarie Pass National Park, Barren Grounds Nature Reserve and the Cambewarra Range Nature Reserve. The Illawarra Regional Environmental Plan No. 1 identifies a regional wildlife corridor linking Saddleback Mountain and Barren Grounds Nature Reserve (south-west of Kiama) with Morton National Park. This regional wildlife corridor extends along the western side of the study area and incorporates well-vegetated land in the foothills of the escarpment in the areas of Foxground and Broughton Village.

With the exception of the regional wildlife corridor well to the west of the study area, no habitat corridors are considered to occur within the vicinity of the proposal.

Vegetation along creeks and some road reserves within the study area would also provide limited value as local corridors for some species. Scattered riparian vegetation along the upper reaches of the Crooked River at the crossing of the existing Princes Highway provides little or no linkages to local fauna habitats. Although the surrounding vegetation matrix consists primarily of cleared lands for agriculture and the quality of riparian vegetation along this section is poor to non-existent, the creek still provides a level of connectivity. Currently the existing Princes Highway and the South Coast Railway Line form potential barriers in the corridor, although both have bridges over the Crooked River. The South Coast Railway Line is not considered a major fauna barrier due to the infrequency of rail traffic. The current proposed upgrade would not impact upon the existing level of connectivity at the Crooked River crossing.

As noted above, vegetation within roadside reserves is often an important element within a regional corridor network (Bennett, 1991). Animals can use road reserves as habitat in which to live as well as movement corridors facilitating local movements, dispersal and migration (Bennett 1990). Within highly modified landscapes, remnant patches and strips of vegetation within road reserves are often the only remaining vegetation links. A number of studies have indicated the importance of such roadside vegetation (Breckwoldt, 1990; Middleton, 1980). Within the study area native roadside vegetation was limited to small discontinuous segments of native and exotic tree cover and groundcover within a matrix of introduced grasses and weeds. Isolated, small patches of vegetation in the study area are unconnected and therefore provided limited value for native wildlife.
4.0 Impact assessment

This section details the types of impacts that may result as a consequence of the construction and operation of a road, with specific reference to the Princes Highway between Mount Pleasant and Toolijooa Road. However, many of these impacts can be mitigated, greatly reducing or eliminating the impacts.

4.1 Potential impacts

Potential impacts resulting from roads on terrestrial ecological values include the following:

- Vegetation clearance and habitat loss.
- Increased fragmentation.
- Edge effects.
- Increased mortality.
- Weed invasion.

Each of these potential impacts is discussed below.

4.1.1 Vegetation clearance / habitat loss

Impacts of vegetation clearing can result in the loss of plant species and fauna habitat features that occur in the area. In the study area this would include nesting habitat and roosting hollows (although the potential for tree hollows in the study area is limited), as well as feeding and shelter resources.

Vegetation clearing is likely to be minimal and involve removal of vegetation that is already disturbed. While these areas provide a range of food and shelter for vertebrate and invertebrate fauna, the small areas to be cleared would not significantly impact fauna habitats in the study area.

Table 4.1 shows the area of each plant community recorded in the subject site and study area that would be impacted by the proposed upgrade. Overall, only two small fragmented patches of native vegetation would be impacted by the proposed upgrade, with only the edges of these patches being directly impacted. No new edges would be created by the proposed upgrade. The impacts of this vegetation clearing on threatened species habitat are discussed in Section 4.4 and Section 4.5.

<table>
<thead>
<tr>
<th>Plant community</th>
<th>Impacted area (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estuarine Saltmarsh</td>
<td>0.002</td>
</tr>
<tr>
<td>Subtropical Dry Rainforest</td>
<td>0.009</td>
</tr>
<tr>
<td>Total</td>
<td>0.01</td>
</tr>
</tbody>
</table>
4.1.2 Fragmentation

Habitat fragmentation is the division of a single area of habitat into two or more smaller areas, with a new habitat type occurring in the area between the fragments. This new dividing habitat type is often artificial and inhospitable to the fauna species remaining within the fragments (MacNally 1999) and can provide suitable conditions for weed species to establish, which may outcompete native plant species. Although the newly created habitat would be used by some species, they are usually generalist species and are often considered aggressive (eg Noisy Miners (Loyn et al. 1983)), further decreasing population levels of the species remaining in the fragments. In addition to the loss of total habitat area, the process of fragmentation can impact on the species within the newly created fragments in a number of ways (eg barrier effects, genetic isolation and edge effects). The degree to which these potential impacts affect the flora and fauna within the newly created fragments depends on a number of variables including distance between fragments, local environmental conditions, the species present and mitigation measures (see Chapter 5). Some of the potential impacts are summarised below:

**Barrier effects**

Barrier effects occur where particular species are either unable or are unwilling to move between suitable areas of fragmented habitat. This could result in either a complete halt to movement or a reduced level of movement between fragments. Roads through areas of native vegetation can act as barriers, with barrier effects greater for some species than others (Goosem 2002). Species most vulnerable to barrier effects include rare species (even a small reduction in movements can reduce genetic continuity within the population hence reducing the effective population size), smaller ground-dwelling species and species with low mobility. Species least vulnerable to barrier effects tend to be those that are highly mobile (eg birds), although even these species can vary in their response to barriers.

**Genetic isolation**

Genetic isolation occurs where individuals from a population within one fragment are unable to interbreed with individuals from populations in adjoining fragments. Genetic isolation can lead to inbreeding and genetic drift problems for populations isolated within a fragment.

**Edge effects**

A zone of changed environmental conditions (ie altered light levels, wind speed, temperature) occurs along the edges of habitat fragments. This may lead to lower cover of native species due to exposure to the elements and an increased weed cover.

The study area has been highly disturbed and contains small isolated patches of native vegetation. The proposed upgrade generally follows the path of the existing Princes Highway, thereby minimising further fragmentation of habitats and barrier effects. The proposed upgrade is unlikely to increase the impact of fragmentation on threatened species and endangered ecological communities (EECs) in the local area given the high degree of fragmentation in the existing landscape.

**Corridors and connectivity**

As discussed in Section 3.8, the proposal is not likely to impact on any local or regional wildlife corridors due to the existing degree of clearing and fragmentation.

Limited connectivity is afforded by cleared and disturbed drainage lines including Ooaree Creek and the Crooked River. Currently the existing Princes Highway and the South Coast Railway Line have bridge crossings over these drainage lines. The proposed upgrade would not impact upon the existing level of connectivity at these crossings.
**Edge effects**

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

Biosis Research (2000) noted that there are limitations to edge effect studies, with a study by Murcia (1995) noting that it is unrealistic to expect all variables to vary equally with distance from the edge. As edge effects varied between community types and abiotic effects were the most consistent indicator of edge effects (measuring less than or equal to 50 m in most studies), Biosis Research (2000) concluded that average edge effects generally occur up to 50 m away from the road edge.

Specifically, edge effects associated with roads can include the degradation of adjacent habitat through:

- Changes in microclimate (eg temperature, wind, light humidity).
- Changes in hydrology (ie surface and sub-surface water flows).
- Changes in floristics (ie species composition and abundance).
- Alteration to the pattern and frequency of fire.
- Invasion by exotic plant and animal species.
- Increase in sedimentation.
- Increase in tree death (eg dieback, impact on root zone).
- Increase in rubbish and water pollution.
- Improved access for predators (Bali 2000).

Edge effects may not affect both sides of the road equally and may be greater if they are downslope, downwind or surrounded by more suitable habitat (Biosis Research 2000).

Using the estimate of edge effects of 50 m proposed by Biosis Research (2000), the construction footprint was buffered by 50 m to calculate new edge effects from the proposed upgrade. It was calculated that the proposed upgrade would directly impact 0.01 ha of native vegetation (see Table 4.1). An additional 1.55 ha of non-native vegetation would also be impacted by new edge effects. However, the proposed upgrade would not create any new edges in plant communities and habitats in the study area, as the impacted patches are small and isolated, and already impacted by edge effects due to their small size and edge to area ratio. No DECCW estates, crown land or State forests would be impacted by edge effects from the proposed upgrade.

### 4.1.3 Mortality

Fauna injury or death can occur as a result of highway construction and operation in two ways:

- **During the break-out phase of construction (when all vegetation is removed to expose a natural earth substrate).** Habitat clearance may result in the injury or death of resident or visiting fauna. Some species can more readily evade injury by flying (birds) or ‘running’ away (eg the larger mammals). Many species, however, are unlikely to move quickly enough to avoid being caught. For example, many nocturnal species (possums, gliders, bats) shelter during the day and smaller ground-dwelling species, such as lizards and snakes, are unable to move rapidly and over large distances.
**Road kills.** Mortality due to road kill during operation has the potential to affect local fauna species at the sub-population level. In general, rates of road kill mortality are likely to be directly proportional to the distance of native vegetation / fauna habitat crossed by the highway (Forman and Sperling 2002). However, other factors such as the design of the road (e.g., raised or not, presence of walls and fences, fauna underpasses) also influence road kill mortality. Generally, the effects of road kill mortality on sub-populations cannot be accurately predicted without more detailed demographic data than is available for species in the local area.

The RTA has policies and guidelines in place to manage the risk of fauna mortality during construction (see Chapter 5.0).

### 4.1.4 Weeds

Weed invasion can be a significant problem along the edges of habitat fragments. Along these boundaries there are changes in the environment (edge effects) including, altered light levels, wind speed, temperature, humidity and runoff. These altered conditions allow the colonisation and growth of weeds which would themselves result in further environmental changes that promote the colonisation and growth of weed species within the area. Due to these environmental changes, weeds may be able to outcompete native plant species and (at worst) could result in the loss of the native plant community in that area. Given the small size, isolation and poor condition of vegetation that would be impacted, the proposed upgrade is not likely to increase the impact of weed invasion in the study area. However, mitigation measures are recommended to reduce the likelihood of increased weed invasion in the impacted patches (see Chapter 5.0).

### 4.2 Cumulative impacts

The proposal occurs in a highly development landscape, dominated by rural development. Consequently, much of the native vegetation of the local area has been cleared and the remaining remnants are small, isolated and fragmented. Due to its location within a highly developed landscape, the proposed upgrade is one of many developments impacting biodiversity in the local area. The cumulative impacts of the Gerringong upgrade, in conjunction with the other proposed projects that form part of the RTA’s Princes Highway upgrade program between Gerringong and Bomaderry, would be considered as part of the environmental assessments for those projects as they are developed further.

### 4.3 Potential impacts on endangered ecological communities (EECs)

Two plant communities have been recorded in the study area (Table 3.1); subtropical dry rainforest and estuarine saltmarsh.

Subtropical dry rainforest is attributable to the EEC, Illawarra subtropical rainforest in the Sydney Basin bioregion as listed under the *NSW Threatened Species Conservation Act 1995*. The proposed upgrade would result in impacts to approximately 0.009 ha of this community. According to the vegetation mapping a total of 11007.5 ha of this EEC occurs within the locality (from 8.62 ha coastal warm temperate rainforest, 1013.26 ha subtropical complex rainforest and 78.87 ha subtropical dry rainforest) (Table 3.1).

Estuarine saltmarsh corresponds to the EEC, coastal saltmarsh in the NSW north coast, Sydney Basin and south-east corner bioregions as listed under the Threatened Species Conservation Act. The proposed upgrade would result in impacts to approximately 0.002 ha of this community. Based on the extent of this community identified during field surveys and the DECC vegetation mapping (DEC 2005t), approximately 19.76 ha of this EEC occurs within the locality (Table 3.1).
On this basis, assessments of significance under Section 5A of the Environment Planning and Assessment Act 1979, and Section 94 of the Threatened Species Conservation Act (as amended by the Threatened Species Conservation Amendment Act 2002) have been carried out for each EEC (see Appendix C). The results of these assessments concluded that a significant impact on the EEC’s, Illawarra subtropical rainforest and coastal saltmarsh would not result from the proposed upgrade.

Impacts on these EECs are considered to be negligible, on the basis that:

- The magnitude of impacts on each community resulting from the proposed upgrade is very small.
- The proposed upgrade would not result in the fragmentation or isolation of any patches of these communities in the study area.
- The areas subject to direct impacts is along existing edges of each community where vegetation is largely in poor condition.
- Mitigation measures would be implemented to minimise the potential indirect impacts on each community.

Mitigation measures have been included in this report in order to minimise the impacts of the proposed upgrade on each EEC.

4.4 Potential impacts on threatened plant species

No threatened plant species were recorded in the study area. However, of the 12 threatened plant species considered in Table 3.2, six species (Cynanchum elegans, Daphnandra sp. 'Illawarra', Irenephurus trypherus, Solanum celatum, Syzygium paniculatum and Zieria granulata) are considered to have potential habitat within the study area.

On this basis, assessments of significance under Section 5A of the Environment Planning and Assessment Act, and Section 94 of the Threatened Species Conservation Act (as amended by the Threatened Species Conservation Amendment Act) have been carried out for each of the six plant species with potential habitat in the study area (see Appendix C). Five (Cynanchum elegans, Daphnandra sp. 'Illawarra', Irenephurus trypherus, Syzygium paniculatum and Zieria granulata) of the six threatened plants species are also listed under the Environment Protection and Biodiversity Conservation Act 1999 have been assessed against the relevant significant impact criteria (see Appendix D) in accordance with the DEWHA publication; EPBC Act Policy Statement 1.1 Significant Impact Guidelines: Matters of National Environmental Significance (DEH 2005).

Key threatening processes

The following Key Threatening Processes, as listed under the TSC Act, are relevant to the proposal with potential to impact on threatened plant species or their potential habitat in the study area:

- Clearing of native vegetation - approximately 0.01 ha of potential habitat would be cleared for the proposal.
- Infection of native plants by Phytophthora cinnamomi - there is potential for construction vehicles to spread Phytophthora cinnamomi if they have come into contact with the soil pathogen. As a precaution, vehicles should be washed down prior to use on site.
- Invasion of native plant communities by exotic perennial grasses - given the presence of existing perennial grasses within the study area, there is potential for construction vehicles to spread seed of these invasive species into the subject site. As a precaution, vehicles should be washed down prior to use on site.
Invasion, establishment and spread of *Lantana camara* - *Lantana camara* is an existing threat to the native plant communities in and surrounding the study area. The proposal would involve vegetation disturbance which could lead to further spread of *Lantana camara*.

Invasion and establishment of exotic vines and scramblers - coastal saltmarsh is specifically listed as an ecological community impacted by this key threatening process. Exotic vines and scramblers are present in vicinity of the study area. These invasive species have the potential to invade disturbed areas resulting from the proposal.

The impact assessments concluded that the proposed upgrade would have a minimal impact on threatened plant species or their potential habitat in the locality based on the following:

- No individuals were recorded in the study area despite targeted surveys, including for those that are considered relatively conspicuous.
- The area of potential habitat in the locality compared to that impacted within the study area is considered small.
- Impacts resulting from the proposed upgrade are largely contained to areas that are already cleared and disturbed and include existing road infrastructure.
- The proposed upgrade would not result in the isolation or fragmentation of potential habitat.
- The proposed upgrade is unlikely to interfere with the pollination and dispersal of native plant species.
- The proposed upgrade is unlikely to interfere with the existing fire regimes of the study area.
- Native vegetation would be allowed to regenerate within the easement post construction (within the limits of transmission line safety clearance requirements).

A species impact statement and/or a Referral to the Federal Environment Minister are not considered necessary for any threatened plant species.

### 4.5 Potential impacts on fauna

#### 4.5.1 Potential impacts on fauna habitats

The potential impacts of the proposed upgrade on fauna habitats are likely to be minimal, however, would involve the removal of a small amount of rainforest (0.009 ha) and saltmarsh (0.002 ha) as well as some isolated roadside trees (of which few contain hollows). Ongoing disturbances such as grazing and a high degree of weed invasion continue to threaten the integrity of fauna habitats within the subject site.

#### 4.5.2 Potential impacts on threatened fauna

Where there is potential habitat (foraging or breeding resources) for threatened species in the study area, further consideration must be given to the potential impact of the proposed upgrade on these species. The proposed upgrade may impact on threatened species by causing any of the following:

- Death or injury of individuals.
- Loss or disturbance of limiting foraging resources.
- Loss or disturbance of limiting breeding resources.

Limiting resources are specialised habitat components that species are dependent on for their ongoing survival. Such limiting resources are predominantly associated with specialised breeding habitats (such as tree hollows or suitable nest / maternity roost sites) that occur at low densities, with high levels of competition from a range of species. However, for some species, limiting resources include specialised foraging habitats that have a restricted distribution (e.g. koalas feeding only on specific tree species).
Key threatening processes
The following Key Threatening Processes, as listed under the TSC Act, are relevant to the proposal with potential to impact on threatened fauna species or their potential habitat in the study area:

- Clearing of Native Vegetation - the proposal would involve clearing of 0.01 ha of native vegetation.
- Invasion, establishment and spread of Lantana camara – Lantana camara is an existing threat to the native plant communities in and surrounding the study area. The proposal would involve vegetation disturbance which could lead to further spread of Lantana camara.
- Loss of Hollow-bearing Trees – a minimal number of hollow-bearing trees may be removed by the proposal.
- Removal of Dead Wood and Dead Trees – a minimal amount of dead wood and dead trees expected to be removed from previously disturbed areas and grazed paddocks.

Threatened Species Conservation Act assessments of significance
No threatened species have been recorded within the study area. The Little Eagle, listed on the Threatened Species Conservation Act as vulnerable, was recorded just south of the study area at Site 3 (Crooked River). Potential habitat for 44 threatened animal species listed (or preliminarily listed) on the Act is considered present within the study area.

Table 4.2 summarises the possible impacts from the proposed upgrade on the 44 Threatened Species Conservation Act listed threatened fauna with potential habitat in the study area, and determines the need for Seven Part Tests (Threatened Species Conservation Act). Based on the nature of the proposed upgrade (see Section 1.4), database interrogation, literature review regarding the ecology of each species, and information gathered during field surveys within the study area, 38 of these species are considered as unlikely to be subject to negative impacts resulting from the proposed upgrade. Accordingly, no Seven Part Tests have been prepared for these species.

Seven Part Tests have been prepared for the remaining six species: Rose-crowned Fruit-dove, Superb Fruit-dove, Yellow-bellied Sheathtail Bat, Eastern Freetail Bat, Eastern False Pipistrelle and Greater Broad-nosed Bat (see Appendix C). The assessments concluded that the proposed upgrade is unlikely to have a significant impact on these species. A species impact statement is not considered necessary.
Table 4.2: Potential impact and Seven Part Test requirements for threatened fauna listed on the Threatened Species Conservation Act with potential habitat in the study area

<table>
<thead>
<tr>
<th>Common name</th>
<th>EPBC Act</th>
<th>TSC Act</th>
<th>Potential impacts on threatened species</th>
<th>Impact assessment required?</th>
<th>Reasoning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green and Golden Bell Frog</td>
<td>V E1</td>
<td>Unlikely</td>
<td>Loss or disturbance of limiting foraging resources? No  Loss or disturbance of limiting breeding resources? No</td>
<td>No</td>
<td>Found in marshes, dams and stream sides, particularly those containing bulrushes or spikerushes. Can also occur in highly disturbed areas including industrial sites (NPWS 1999d; White and Pyke 1996). The Green and Golden Bell Frog has been recorded to the north and south of the subject site. Constructed canals occurring within the saltmarsh are not considered to provide potential breeding habitat for this species given the presence of predatory Gambusia holbrooki. However, the species may occur within the canals on occasion if dispersing throughout the landscape. Notwithstanding this, the proposed upgrade is unlikely to fragment any areas of potential habitat. The loss of a small area of saltmarsh and temporary disturbance (during road / bridge construction) to the canal is not likely to impact this species. No Seven Part Test is provided.</td>
</tr>
<tr>
<td>Spotted Harrier</td>
<td>- PD(V)</td>
<td>Unlikely</td>
<td>Loss or disturbance of limiting foraging resources? No  Loss or disturbance of limiting breeding resources? No</td>
<td>No</td>
<td>The species occurs in open and wooded country with grassland nearby for hunting. It is more common in drier inland areas. Nest in trees (Marchant and Higgins 1993). Previously recorded north and north-west of the study area. Loss of a small area of rainforest and saltmarsh is not likely to impact this species. No Seven Part Test is provided.</td>
</tr>
<tr>
<td>Common name</td>
<td>EPBC Act</td>
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<td>Potential impacts on threatened species</td>
<td>Impact assessment required?</td>
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<tr>
<td>Little Eagle</td>
<td>-</td>
<td>PD(V)</td>
<td>Unlikely</td>
<td>No</td>
<td>Most abundant in lightly timbered areas with open areas nearby, including farmland. May nest in farmland, woodland and forest in tall trees (Marchant and Higgins 1993). Recorded during surveys just south of the study area, and previously to the north and north-west of the study area. Loss of a small area of rainforest and saltmarsh is not likely to impact this species. No Seven Part Test is provided.</td>
</tr>
<tr>
<td>Square-tailed Kite</td>
<td>-</td>
<td>V</td>
<td>Unlikely</td>
<td>No</td>
<td>Typically inhabits coastal forested and wooded lands of tropical and temperate Australia. They require large living trees for breeding (Marchant and Higgins 1993). Previously recorded once, south of the study area at Coomonderry Swamp. Loss of a small area of rainforest and saltmarsh is not likely to impact this species. No Seven Part Test is provided.</td>
</tr>
<tr>
<td>O sprey</td>
<td>-</td>
<td>V</td>
<td>Unlikely</td>
<td>No</td>
<td>The O sprey occurs in terrestrial wetlands, coastal lands and offshore islands, catching fish for prey. It generally uses marine cliffs as nesting and roosting sites. Nests can also be made high up in trees (Marchant and Higgins 1993). Previously recorded once, south-west of study area at Seven Mile Beach National Park. Loss of a small area of rainforest and saltmarsh is not likely to impact this species. No Seven Part Test is provided.</td>
</tr>
<tr>
<td>Blue-billed Duck</td>
<td>-</td>
<td>V</td>
<td>Unlikely</td>
<td>No</td>
<td>The Blue-billed Duck is almost wholly aquatic, preferring deep water in large, permanent wetlands with an abundant aquatic flora (Marchant and Higgins 1990). Not previously recorded within 10 km of study area. Loss of a small area of saltmarsh is not likely to impact this species. No Seven Part Test is provided.</td>
</tr>
<tr>
<td>Common name</td>
<td>EPBC Act</td>
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<td>Potential impacts on threatened species</td>
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<tr>
<td>Freckled Duck</td>
<td>-</td>
<td>V</td>
<td>Unlikely</td>
<td>The Freckled Duck breeds in permanent fresh swamps that are heavily vegetated (Simpson and Day 1996). Previously recorded once, north of the study area. Loss of a small area of saltmarsh is not likely to impact this species. No Seven Part Test is provided.</td>
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</tr>
<tr>
<td>Australasian Bittern</td>
<td>-</td>
<td>V</td>
<td>Unlikely</td>
<td>Inhabits terrestrial and estuarine wetlands, preferring wetlands with dense vegetation including rushes and reeds (NPWS 1999a). Previously recorded immediately east of the estuarine saltmarsh (Site 2) in Werrin Lagoon as well as north, north-west and south of the study area (including within Coomonderry Swamp). Loss of a small area of saltmarsh is not likely to impact this species. No Seven Part Test is provided.</td>
<td></td>
</tr>
<tr>
<td>Black Bittern</td>
<td>-</td>
<td>V</td>
<td>Unlikely</td>
<td>Found along timbered watercourses, in wetlands with fringing trees and shrub vegetation. The sites where they occur are characterised by dense waterside vegetation (NPWS 1999b). Previously recorded south of the study area at Black Head and south-east of the study area at Berrry. Limited potential habitat occurs within the study area in the form of creeklines and wetlands where dense fringing and emergent vegetation occurs. However, no limiting resources would be removed and habitat connectivity would not be impacted. No Seven Part Test is provided.</td>
<td></td>
</tr>
<tr>
<td>White-browed Woodswallow</td>
<td>-</td>
<td>PD(V)</td>
<td>Unlikely</td>
<td>Inhabits a variety of habitats, including open eucalypt, sheoak and acacia woodland; forest; riparian zones; and, grasslands with few or no trees and sparsely scattered shrubs (including farmland) (Higgins et al. 2006). Previously recorded once, south of the study area at Seven Mile Beach National Park. Loss of a small area of rainforest is not likely to impact this species. No Seven Part Test is provided.</td>
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<tr>
<td>Common name</td>
<td>EPBC Act</td>
<td>TSC Act</td>
<td>Potential impacts on threatened species</td>
<td>Impact assessment required?</td>
<td>Reasoning</td>
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<tr>
<td>Bush Stone-curlew</td>
<td>-</td>
<td>E1</td>
<td>Unlikely</td>
<td>No</td>
<td>Loss of a small area of rainforest is not likely to impact this species. No Seven Part Test is provided.</td>
</tr>
<tr>
<td>Gang-gang Cockatoo</td>
<td>-</td>
<td>V</td>
<td>Unlikely</td>
<td>No</td>
<td>Loss of a small area of rainforest is not likely to impact this species. No Seven Part Test is provided.</td>
</tr>
<tr>
<td>Glossy Black Cockatoo</td>
<td>-</td>
<td>V</td>
<td>Unlikely</td>
<td>No</td>
<td>Loss of a small area of rainforest is not likely to impact this species. No Seven Part Test is provided.</td>
</tr>
<tr>
<td>Greater Sand Plover</td>
<td>-</td>
<td>V</td>
<td>Unlikely</td>
<td>No</td>
<td>Loss of a small area of saltmarsh is not likely to impact this species. No Seven Part Test is provided.</td>
</tr>
<tr>
<td>Common name</td>
<td>EPBC Act</td>
<td>TSC Act</td>
<td>Potential Impacts on threatened species</td>
<td>Impact assessment required?</td>
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<tr>
<td>Lesser Sand Plover</td>
<td>-</td>
<td>V</td>
<td>Unlikely</td>
<td>No</td>
<td>Loss or disturbance of limiting foraging resources? No Loss or disturbance of limiting breeding resources? No Reasoning Favours coastal environs including beaches, mudflats and mangroves. Roost on sandy beaches or rocky shores at high tide (NPWS 1999e). Previously recorded once, south of the study area at Coomonderry Swamp. Loss of a small area of saltmarsh is not likely to impact this species. No Seven Part Test is provided.</td>
</tr>
<tr>
<td>Black-necked Stork</td>
<td>-</td>
<td>E1</td>
<td>Unlikely</td>
<td>No</td>
<td>Loss or disturbance of limiting foraging resources? No Loss or disturbance of limiting breeding resources? No Reasoning Found in swamps, mangroves and mudflats. Can also occur in dry floodplains and irrigated lands and occasionally forages in open grassy woodland. Nests in live or dead trees usually near water (Pizzey and Knight 1997). Previously recorded south of the study area at Crooked River and Coomonderry Swamp (records over 30 years old). Loss of a small area of saltmarsh is not likely to impact this species. No Seven Part Test is provided.</td>
</tr>
<tr>
<td>Rose-crowned Fruit-dove</td>
<td>-</td>
<td>V</td>
<td>Unlikely</td>
<td>Yes</td>
<td>Loss or disturbance of limiting foraging resources? Yes Reasoning Occur in rainforests (Higgins and Davies 1996) and forage on fruit-bearing trees such as those present in the study area (Site 1). Not previously recorded within 10 km of study area. Although loss of a small area of rainforest is not likely to significantly impact these species, a Seven Part Test is provided given the loss of a favoured potential foraging resource.</td>
</tr>
<tr>
<td>Superb Fruit-dove</td>
<td>-</td>
<td>V</td>
<td>Unlikely</td>
<td>No</td>
<td>Loss or disturbance of limiting foraging resources? No Reasoning An intertidal forager found on undisturbed sandy beaches and spits, tidal mudflats and estuaries. Occasionally found in paddocks near the coast (Pizzey and Knight 1997). Previously recorded within the estuarine saltmarsh (Site 2) as well as south of the study area at Seven Mile Beach National Park and Coomonderry Swamp. Loss of a small area of saltmarsh is not likely to impact this species. No Seven Part Test is provided.</td>
</tr>
<tr>
<td>Pied Oystercatcher</td>
<td>-</td>
<td>V</td>
<td>Unlikely</td>
<td>No</td>
<td>Loss or disturbance of limiting foraging resources? No Reasoning An intertidal forager found on undisturbed sandy beaches and spits, tidal mudflats and estuaries. Occasionally found in paddocks near the coast (Pizzey and Knight 1997). Previously recorded within the estuarine saltmarsh (Site 2) as well as south of the study area at Seven Mile Beach National Park and Coomonderry Swamp. Loss of a small area of saltmarsh is not likely to impact this species. No Seven Part Test is provided.</td>
</tr>
<tr>
<td>Common name</td>
<td>EPBC Act</td>
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<td>Potential Impacts on threatened species</td>
<td>Impact assessment required?</td>
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<tr>
<td>Regent Honeyeater</td>
<td>E</td>
<td>E1</td>
<td>Individual death or injury?</td>
<td>No</td>
<td>A semi-nomadic species occurring in temperate eucalypt woodlands and open forests. Most records are from box-ironbark eucalypt forest associations and wet lowland coastal forests (NPWS 1999f; Pizzey and Knight 1997). Previously recorded south-west of the study area at Seven Mile Beach National Park. Loss of a small area of rainforest is not likely to impact this species. No Seven Part Test is provided.</td>
</tr>
<tr>
<td>Varied Sittella</td>
<td>-</td>
<td>PD(V)</td>
<td>Loss or disturbance of limiting foraging resources?</td>
<td>No</td>
<td>Inhabit a wide variety of dry eucalypt forests and woodlands (Higgins and Peter 2002). Previously recorded north-west, west and south-west of the study area. Loss of a small area of rainforest is not likely to impact this species. No Seven Part Test is provided.</td>
</tr>
<tr>
<td>Olive Whistler</td>
<td>-</td>
<td>V</td>
<td>Loss or disturbance of limiting breeding resources?</td>
<td>No</td>
<td>Found in a range of habitats including alpine thickets, wetter rainforest / woodlands, riparian vegetation and heaths (Pizzey and Knight 1997). Previously recorded north-west and south-west of the study area. Loss of a small area of rainforest is not likely to impact this species. No Seven Part Test is provided.</td>
</tr>
<tr>
<td>Scarlet Robin</td>
<td>-</td>
<td>PD(V)</td>
<td>Loss or disturbance of limiting breeding resources?</td>
<td>No</td>
<td>Occurs in forests, woodlands and heavier vegetation when breeding. During autumn and winter occurs in more open and cleared areas (Morcombe 2003). Previously recorded once, north-west of the study area. Loss of a small area of rainforest is not likely to impact this species. No Seven Part Test is provided.</td>
</tr>
<tr>
<td>Flame Robin</td>
<td>-</td>
<td>PD(V)</td>
<td>Loss or disturbance of limiting breeding resources?</td>
<td>No</td>
<td>The preferred habitat in summer includes eucalyptus forests and woodland, whilst in winter prefers open woodlands and farmlands (Morcombe 2003). Previously recorded north and north-west of the study area. Loss of a small area of rainforest is not likely to impact this species. No Seven Part Test is provided.</td>
</tr>
<tr>
<td>Common name</td>
<td>EPBC Act</td>
<td>TSC Act</td>
<td>Potential Impacts on threatened species</td>
<td>Impact assessment required?</td>
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<tr>
<td>Pink Robin</td>
<td></td>
<td>V</td>
<td>Unlikely</td>
<td>No</td>
<td>Found in dense, dank forest / treefern gullies and disperses in autumn-winter to open forests, woodlands and scrublands (Pizzey and Knight 1997). Not previously recorded within 10 km of study area. Loss of a small area of rainforest is not likely to impact this species. No Seven Part Test is provided.</td>
</tr>
<tr>
<td>Little Lorikeet</td>
<td></td>
<td>V</td>
<td>Unlikely</td>
<td>No</td>
<td>Mostly occurs in dry, open eucalypt forests and woodlands. Nest in hollows, particularly in <em>Eucalyptus viminalis</em>, <em>E. blakelyi</em> and <em>E. dealbata</em> (NSW Scientific Committee 2008). Previously recorded north, south and south-west of the study area. While some tree hollows may be removed, none of the preferred nest tree species occur in the study area. Loss of a small area of rainforest is not likely to impact this species. No Seven Part Test is provided.</td>
</tr>
<tr>
<td>Swift Parrot</td>
<td>E</td>
<td>E1</td>
<td>Unlikely</td>
<td>No</td>
<td>The Swift Parrot occurs in woodlands and forests of NSW from May to August, where it feeds on eucalypt nectar, pollen and associated insects (Forshaw and Cooper 1981). Breeds in Tasmania (Pizzey and Knight 1997). Previously recorded north-west and south of the study area. Loss of a small area of rainforest is not likely to impact this species. No Seven Part Test is provided.</td>
</tr>
<tr>
<td>Orange-bellied Parrot</td>
<td>ZM</td>
<td>C1</td>
<td>Unlikely</td>
<td>No</td>
<td>A coastal species inhabiting saltmarshes, sedgeplains, coastal dunes, pastures, shrublands and moorlands, generally within 10 km of the coast. Breeds in Tasmania (OBPRT 1998). Not previously recorded within 10 km of the study area. Loss of a small area of saltmarsh is not likely to impact this species. No Seven Part Test is provided.</td>
</tr>
<tr>
<td>Common name</td>
<td>EPBC Act</td>
<td>TSC Act</td>
<td>Potential Impacts on threatened species</td>
<td>Impact assessment required?</td>
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<tr>
<td>Turquoise Parrot</td>
<td>-</td>
<td>V</td>
<td>Unlikely</td>
<td>No</td>
<td>Occurs in open woodlands and eucalypt forests with a ground cover of grasses and understorey of low shrubs (Morris 1980). Previously recorded north-west of the study area at Barren Grounds Nature Reserve. Loss of a small area of rainforest and roadside trees is not likely to impact this species. No Seven Part Test is provided.</td>
</tr>
<tr>
<td>Eastern Ground Parrot</td>
<td>-</td>
<td>V</td>
<td>Unlikely</td>
<td>No</td>
<td>Mainly found in heathland, sedgeland or buttongrass plains providing medium to dense cover (Higgins 1999). Previously recorded north-west of the study area at Barren Grounds Nature Reserve and once to the south at Seven Mile Beach National Park. Loss of a small area of saltmarsh is not likely to impact this species. No Seven Part Test is provided.</td>
</tr>
<tr>
<td>Australian Painted Snipe</td>
<td>V</td>
<td>E1</td>
<td>Unlikely</td>
<td>No</td>
<td>Prefers freshwater wetlands, ephemeral or permanent, although they have been recorded in brackish waters (Marchant and Higgins 1993). Not previously recorded within 10 km of the study area. Loss of a small area of saltmarsh is not likely to impact this species. No Seven Part Test is provided.</td>
</tr>
<tr>
<td>Common name</td>
<td>EPBC Act</td>
<td>TSC Act</td>
<td>Potential Impacts on threatened species</td>
<td>Impact assessment required?</td>
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<tr>
<td>Barking Owl</td>
<td>-</td>
<td>V</td>
<td>Unlikely</td>
<td>No</td>
<td>Inhabit a range of wooded habitats, including rainforest (Higgins 1999). Previously recorded in the locality. Forage over large home ranges for ground-dwelling and/or arboreal mammals. However, the foraging habitat within the study area is not considered to be limiting for these mobile species. These owls breed in tree hollows with the Barking Owl preferring <em>Eucalyptus camaldulensis</em>, <em>E. albans</em>, <em>E. polyanthemos</em> and <em>E. blakelyi</em>; the Powerful Owl preferring large hollows in large trees at least 150 years old; the Masked Owl preferring large tree hollows in moist eucalypt forested gullies; and, the Sooty Owl preferring large tree hollows in rainforest. No tree hollows would be removed from the rainforest and no other suitable nesting hollows occur within the subject site. No Seven Part Tests are provided for these species.</td>
</tr>
<tr>
<td>Powerful Owl</td>
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<tr>
<td>Masked Owl</td>
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<tr>
<td>Sooty Owl</td>
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<tr>
<td>Spotted-tailed Quoll</td>
<td>E</td>
<td>V</td>
<td>Unlikely</td>
<td>No</td>
<td>Uses a range of habitats including sclerophyll forests and woodlands, coastal heathlands and rainforests (Dickman and Read 1992). Habitat requirements include suitable den sites, including hollow logs, rock crevices and caves, an abundance of food and an area of intact vegetation in which to forage (Edgar and Belcher 1995). Previously recorded immediately east of the study area at Werri Gully and a tributary of Werri Lagoon, immediately south of the study area at a tributary of Crooked River, as well as north, north-west and west of the study area. No hollow-bearing trees within the rainforest would be removed. Loss of a small area of rainforest is not likely to impact this species. No Seven Part Test is provided.</td>
</tr>
<tr>
<td>Common name</td>
<td>EPBC Act</td>
<td>TSC Act</td>
<td>Potential Impacts on threatened species</td>
<td>Impact assessment required?</td>
<td>Reasoning</td>
</tr>
<tr>
<td>------------------------------------</td>
<td>----------</td>
<td>---------</td>
<td>----------------------------------------</td>
<td>----------------------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Grey-headed Flying-fox</td>
<td>V</td>
<td>V</td>
<td>Unlikely</td>
<td>No</td>
<td>No 7 Part Test is provided. This species is a canopy-feeding frugivore and nectarivore of rainforests, open forests, woodlands, melaleuca swamps and banksia woodlands. Roosts in large colonies (camps), commonly in dense riparian vegetation (Tidemann 1995). Recorded during current surveys west of the study area. Also previously recorded north, south and south-west of the study area. Known camp site within Coomonderry Swamp. Loss of a small area of rainforest is not likely to impact this species.</td>
</tr>
<tr>
<td>Large-footed Myotis</td>
<td>-</td>
<td>V</td>
<td>Unlikely</td>
<td>No</td>
<td>No 7 Part Test is provided. Forms maternity roosts in caves and mines. Also roost in culverts, buildings, and bridges. They occur in a broad range of habitats including rainforest, wet and dry sclerophyll forest, paperbark forest and open grasslands (Churchill 2008). Recorded during current surveys and previously. Loss of a small area of rainforest is not likely to impact these species.</td>
</tr>
<tr>
<td>Large-eared Pied Bat</td>
<td>V</td>
<td>V</td>
<td>Unlikely</td>
<td>No</td>
<td>No 7 Part Test is provided. This species roosts in caves, Fairy Martin nests and mines, and beneath rock overhangs. Primarily found in dry sclerophyll forests and woodlands, but also found in rainforest fringes and subalpine woodlands (Churchill 2008; Hoye and Schulz 2008). Recorded once during 2007 surveys west of the current study area. No other records within 10 km. Loss of a small area of rainforest is not likely to impact this species.</td>
</tr>
<tr>
<td>Common name</td>
<td>EPBC Act</td>
<td>TSC Act</td>
<td>Potential Impacts on threatened species</td>
<td>Impact assessment required?</td>
<td>Reasoning</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>----------</td>
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<td>-----------------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Yellow-bellied Sheathtail Bat</td>
<td></td>
<td>V</td>
<td>Unlikely</td>
<td>No</td>
<td>Yes, these species primarily roost and breed within tree hollows. All five microbats forage aerially for insects and may fly through the study areas hunting for moths, beetles, weevils, etc. However, the foraging habitat within the study area is not considered to be limiting for these mobile species. These species have been recorded during current surveys and/or previously. No tree hollows would be removed from the rainforest however a small number of isolated, roadside tree hollows may be lost. A Seven Part Test is provided for these species.</td>
</tr>
<tr>
<td>Eastern Freetail Bat</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eastern False Pipistrelle</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Greater Broad-nosed Bat</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Environment Protection and Biodiversity Conservation Act assessments of significance

Four species listed as Endangered or Critically Endangered under the Environment Protection and Biodiversity Conservation Act have potential habitat in the study area: Spotted-tailed Quoll, Swift Parrot, Orange-bellied Parrot and Regent Honeyeater. As shown above (Table 4.2), no limiting breeding habitat or foraging habitat is expected to be impacted for these species. The proposal is unlikely to have a significant impact on these species as there is a low possibility that it would:

- Lead to a long-term decrease in the size of a population.
- Reduce the area of occupancy of the species.
- Fragment an existing population into two or more populations.
- Adversely affect habitat critical to the survival of a species.
- Disrupt the breeding cycle of a population.
- Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.
- Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species’ habitat.
- Introduce disease that may cause the species to decline.
- Interfere with the recovery of the species.

As such, no assessments have been carried out for these species, in accordance with the Significant Impact Criteria (DEH 2006).

Four species listed as Vulnerable under the Environment Protection and Biodiversity Conservation Act that have potential habitat in the study area include the Large-eared Pied-Bat, Grey-headed Flying-fox, Australian Painted Snipe and Green and Golden Bell Frog. As shown above (Table 4.2), no limiting breeding habitat or foraging habitat is expected to be impacted for these species. These species are not considered important populations as they are not likely to be key source populations either for breeding or dispersal; populations that are necessary for maintaining genetic diversity; and/or populations that are near the limit of the species range. In addition, the proposal is not likely to:

- Adversely affect habitat critical to the survival of any of these species.
- Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that any of these species is likely to decline.
- Result in invasive species that are harmful to any of these vulnerable species becoming established in the vulnerable species’ habitat.
- Introduce disease that may cause any of these species to decline.
- Interfere substantially with the recovery of any of these species.

As such, no assessments have been carried out for these species, in accordance with the Significant Impact Criteria (DEH 2006).

A Referral to the Federal Environment Minister is not considered necessary for any Environment Protection and Biodiversity Conservation Act listed threatened species.

4.5.3 Potential impacts on migratory fauna

The list of migratory species under the Environment Protection and Biodiversity Conservation Act is a compilation of species listed under four international conventions: China-Australia Migratory Bird Agreement (CAMBA), Japan-Australia Migratory Bird Agreement (JAMBA), Republic of Korea-Australia Migratory Bird Agreement (RO KAMBA), and the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention).
Twenty-nine migratory species have been previously recorded in the locality, two of which (Latham’s Snipe and Cattle Egret), were recorded during the current surveys. Twenty-one migratory species were considered to have potential habitat in the study area (see Table 3.3). The potential impacts of the proposal on fauna habitats are likely to be minimal, however, would involve the removal of a small amount of rainforest (0.009 ha) and saltmarsh (0.002 ha) as well as some isolated roadside trees. Including edge effects, less than one hectare of each of these communities would be impacted by the proposal.

Migratory waders are the most common migratory species recorded in the locality. While the Crooked River Estuary in particular is used on occasion or regularly by these species, individuals of these species that have been or may be recorded in the study area are not considered likely to be an ecologically significant proportion of their populations. Similarly, individuals of other migratory birds that have been or may be recorded in the study area are not considered likely to be an ecologically significant proportion of their populations. Potential habitat in the study area is not considered important for the migratory species listed in Table 3.3. Only edge-effected areas of rainforest and saltmarsh would be removed by the proposal and indirect impacts are not expected to extend greater than 50 m from the subject site. Given the minimal impact expected on the potential habitat for these species in the study area, no assessments have been carried out for these species, in accordance with the Significant Impact Criteria (DEH 2006).

A Referral to the Federal Environment Minister is not considered necessary for any Environment Protection and Biodiversity Conservation Act listed migratory species.
5.0 Mitigation

The key policy principle of the RTA’s road development and impact on habitat amelioration measures is that “in principle, the planning and construction of roads should, in order of consideration endeavour to:

1) Avoid impacts on habitat though the planning process.
2) Minimise impacts on habitat through the planning process.
3) Mitigate impacts on habitat, through the use of a range of amelioration measures” (RTA 2001).

Where possible important ecological features identified in the local area have been avoided. The proposed upgrade has been designed, where possible, to minimise impacts on habitat. Where sensitive items such as significant vegetation are located, the construction footprint incorporating the road footprint and construction access requirements has been reduced to minimise impacts. Further mitigation measures are discussed below.

5.1.1 Vegetation clearing / habitat loss

In order to mitigate some of the impacts of vegetation clearing and habitat loss it is recommended that:

- Vegetation clearing would be restricted to those areas where it is necessary.
- Where clearing does occur, the area would be fenced with highly visible temporary fencing to ensure that clearing does not extend beyond the area necessary.
- Vegetation within the road reserve and adjacent to areas of vegetation clearing would be managed to reduce invasion of noxious weed species, this may include controlling weeds at their point of source (ie the area of clearing).
- A vegetation management plan would be prepared prior to construction, detailing measures to minimise impacts to areas of conservation significance. The vegetation management plan would also detail appropriate management for the potential habitat of threatened plant species adjacent to the proposed upgrade. Appropriate management detailed within the vegetation management plan may include fencing the habitat, signage and educating contractors of the presence of habitats, its significance and no-go zones. The vegetation management plan would be integrated with the landscape plan for the project and be developed during the detailed design.

5.1.2 Edge effects

Mitigation measures related to edge effects relate generally to reducing impacts outside of the direct development zone, controlling possible impacts at their source within the road reserve and reducing the hardness of the edge between the extent of earthworks and native vegetation. Measures that are relevant to the current upgrade of the Princes Highway include:

- Minimising disturbance to habitat adjacent to construction (eg the use of visible temporary fencing).
- Minimising disturbance wherever possible to stream banks and streambeds. This may be more easily achieved with some bridges, but would be impossible in the case of culverts.
- Siting all ancillary building and works in cleared or otherwise disturbed areas away from waterways and other sensitive areas.
- Avoiding stockpiling materials on adjacent vegetation.
- Managing general construction activities to appropriately store waste material and/or contaminants away from adjacent habitats.
- Implementing soil erosion and sedimentation control measures.
- Implementing a weed management strategy within the road reserve, to be incorporated into the vegetation management plan.
Prominent local landscape species would be used for revegetation in accordance with the landscaping plan to be developed during detailed design.

**Corridors and connectivity**

Wildlife corridors and connectivity are not a prominent feature of the study area.

**Fauna crossings**

Underpasses can be either constructed solely for the purpose of fauna movements or can be modified from existing structures such as box culverts (AMBS 2002) and bridges. Suitability of the structures as fauna underpasses would depend on a number of factors including:

- The regional continuity of habitat in the area.
- Habitat directly on either side of the structure.
- The dimensions of the structure (width, height and length).
- The species in the local area.

Structures such as exclusion fences can also increase the effectiveness of underpasses.

Within the proposed upgrade the following points were considered when deciding on the need and suitability of fauna crossing structures:

- The size and location of vegetation patches on both sides of the proposed highway and their suitability as fauna habitat. Local and regional wildlife corridors are located outside of the study area, however, local connectivity between small patches of vegetation can also be important in maintaining local populations.
- Species that are likely to need or use fauna crossing structures at that point.
- Current and, where possible, future land-use on either side of the proposed highway and other potential barriers.
- The feasibility of constructing a fauna crossing structure at that point due to engineering constraints.

A number of drainage structures (e.g., box culverts) and bridges would be included in the upgraded highway section and some of these may serve as fauna underpasses.

Potential corridors in the study area are confined to exotic riparian vegetation, which generally provides a discontinuous strip of vegetative cover through an otherwise cleared landscape. Therefore, the greatest opportunity for maintaining or improving connectivity across the proposal is through the design of bridges and box culverts over creeks and rivers, so that they provide sufficient dry passage and/or clearance (both height and the space between the embankments and the watercourse) for fauna to move through or under the upgrade. Watercourse crossings that would enable unrestricted movement of fauna include at Ooaree Creek and Crooked River. It should be noted that these creeks have little connecting vegetation, and therefore, limited fauna are likely to be present within their vicinity.
5.1.3 Mortality

A number of recommendations should be implemented to reduce the risk of mortality.

Prior to and during construction:
- Minimise clearance and disturbance of fauna habitat, particularly hollow-bearing trees and other habitat features where fauna may be sheltering. Although this may be difficult to achieve in areas where earthworks are to proceed, it should be particularly noted within the road reserve where temporary sites such as stockpiles may be placed.
- Clearing of vegetation should follow the RTA requirements for fauna rescue on highway projects as updated from time to time. These guidelines are a dynamic document produced in consultation with the DECCW. They include procedures for clearing of non-habitat and habitat trees, the relocation of rescued fauna and the inclusion of wildlife specialists in the process.

To reduce the risk of roadkill once the highway is operational:
- Design barriers to prevent access to the highway by animals eg possums, wallabies. This should however not reduce connectivity in the area and should be related to fauna crossings structures.
- Avoid vegetation overhanging barriers that may encourage fauna crossing into the road reserve.
- Carefully consider location and type of plant species for the verges and median strip so that they do not attract fauna species.

5.1.4 Weeds

A number of recommendations should be implemented to reduce the impact of weed invasion on native plant communities:
- Restrict the area of native vegetation disturbed during construction works.
- Restrict stockpiling to areas already cleared of vegetation.
- Control drainage that may contain weed seeds or high levels of nutrients.
- Monitor and control weed populations that establish on disturbed areas, with particular attention to eradication of noxious weeds. Weed invasions should be monitored and controlled by person experienced in weed management.
- Weed management strategies should be incorporated into the vegetation management plan, detailing necessary weed control works, particularly in areas where the weeds may impact on threatened species and/or their habitats.
6.0 Conclusion

This report assesses the ecological significance of threatened plant and animal species, endangered populations and endangered ecological communities (EECs) that occur, or have the potential to occur, within the area affected by the proposed upgrade, in accordance with the Environment Planning and Assessment Act 1979, the Threatened Species Conservation Act 1995 and the Environment Protection and Biodiversity Conservation Act 1999.

Two EECs were recorded in the study area and would be impacted by the proposal. Approximately 0.002 ha of the EEC, coastal saltmarsh would be impacted by the proposal. A further 0.009 ha of the EEC, Illawarra subtropical rainforest would be impacted by the proposal. Both EECs were considered to be in variable condition ranging from moderate to good (core areas of relatively intact native vegetation) to poor (patch edges) within the study area. Impact assessments were undertaken for each EEC and concluded the proposal was unlikely to have a significant impact.

No threatened plant species were recorded in the study area, however, potential habitat exists for 10 threatened plant species: Cynanchum elegans, Daphnandra sp. 'Illawarra', Distichlis distichophylla, Ireneophysus trypherus, Senna acclinis, Solanum celatum, Syzygium paniculatum, Wilsonia backhousei, Wilsonia rotundifolia and Zieria granulata. Impact assessments were undertaken for each threatened plant species and concluded the proposal was unlikely to have a significant impact.

No threatened and two migratory animal species were recorded within the study area. However, potential habitat exists for 44 threatened and 21 migratory animal species. Impact assessments were undertaken for six threatened animal species that may be impacted by the proposed upgrade including Rose-crowned Fruit-dove, Superb Fruit-dove, Yellow-bellied Sheathtail Bat, Eastern Freetail Bat, Eastern False Pipistrelle and Greater Broad-nosed Bat; the results of which concluded that the proposal was unlikely to have a significant impact on a local population these species.

A Species Impact Statement (Threatened Species Conservation Act) and/or a Referral (Environment Protection and Biodiversity Conservation Act) are not considered necessary for any threatened or migratory flora or fauna as a result of the proposed upgrade. Recommendations to minimise impacts of the proposed upgrade on local flora and fauna are detailed in Chapter 5.0.
7.0 References


DEH (2005a) 'EPBC Act - Principal Significant Impact Guidelines 1.1 Matters of National Environmental Significance.' Department of the Environment and Heritage, Canberra.

DEH (2005b). Litoria littlejohni in Species Profile,


Hazelton P (1992) 'Soil landscapes of the Kiama 1:100 000 sheet.' Department of Conservation and Land Management (incorporating the Soil Conservation Service of NSW, Sydney.


James T et al. (1999) 'Rare Bushland Plants of Western Sydney.' Royal Botanical Gardens, Sydney.


NPWS (2002b) 'Native Vegetation of the Illawarra Escarpment and Coastal Plain.' NPWS, Hurstville.


NPWS and Shoalhaven Catchment Management Committee (2000) 'Threatened fauna of the Shoalhaven:'.


NSW Scientific Committee (2000a) 'Final determination to list *Litoria littlejohnii* (Littlejohn's Tree Frog) as a Vulnerable species under the TSC Act.' NSW Scientific Committee, Hurstville.


Quin DG (1995) Population ecology of the Squirrel Glider (Petaurus norfolcensis) and the Sugar Glider (P. breviceps) (Marsupialia: Petauridae) at Limeburners Creek, on the central North Coast of New South W ales. W ildlife Research 22, 471-505.


Appendix A   Flora results
# Appendix A Flora results

Plant species recorded in the Gerringong upgrade study area:

<table>
<thead>
<tr>
<th>Scientific name</th>
<th>Common name</th>
<th>Quadrats</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Acmena smithii</em></td>
<td>Lilly Pilly</td>
<td>1</td>
<td>+</td>
</tr>
<tr>
<td><em>Adiantum hispidulum var. hispidulum</em></td>
<td>Rough Maidenhair</td>
<td>2</td>
<td>+</td>
</tr>
<tr>
<td><em>Ageratina riparia</em></td>
<td>Mistflower</td>
<td>1</td>
<td>+</td>
</tr>
<tr>
<td><em>Alectryon subcinereus</em></td>
<td>Wild Quince</td>
<td>2</td>
<td>+</td>
</tr>
<tr>
<td><em>Aplium prostratum var. prostratum</em></td>
<td>Sea Celery</td>
<td>2</td>
<td>+</td>
</tr>
<tr>
<td><em>Arthropteris tenella</em></td>
<td>Arthropteris</td>
<td>2</td>
<td>+</td>
</tr>
<tr>
<td><em>Asplenium australasicum</em></td>
<td>Asplenium</td>
<td>2</td>
<td>+</td>
</tr>
<tr>
<td><em>Asplenium flabellifolium</em></td>
<td>Necklace Fern</td>
<td>1</td>
<td>+</td>
</tr>
<tr>
<td><em>Aster subulatus</em></td>
<td>Wild Aster</td>
<td>*1</td>
<td>+</td>
</tr>
<tr>
<td><em>Atriplex cinerea</em></td>
<td>Grey Saltbush</td>
<td>1</td>
<td>+</td>
</tr>
<tr>
<td><em>Atriplex prostrata</em></td>
<td>Hastate Orache</td>
<td>*2</td>
<td>+</td>
</tr>
<tr>
<td><em>Atriplex semibaccata</em></td>
<td>Creeping Saltbush</td>
<td>1</td>
<td>+</td>
</tr>
<tr>
<td><em>Atriplex sp.</em></td>
<td>Atriplex</td>
<td>1</td>
<td>+</td>
</tr>
<tr>
<td><em>Baloghia inophylla</em></td>
<td>Brush Bloodwood</td>
<td>6</td>
<td>+</td>
</tr>
<tr>
<td><em>Blechnum cartilagineum</em></td>
<td>Gristle Fern</td>
<td>1</td>
<td>+</td>
</tr>
<tr>
<td><em>Brachychiton acerifolius</em></td>
<td>Illawarra Flame Tree</td>
<td>1</td>
<td>+</td>
</tr>
<tr>
<td><em>Bromus catharticus</em></td>
<td>Prairie Grass</td>
<td>*1</td>
<td>+</td>
</tr>
<tr>
<td><em>Callistemon salignus</em></td>
<td>Wouldow Bottlebrush</td>
<td>1</td>
<td>+</td>
</tr>
<tr>
<td><em>Calystegia silvatica</em></td>
<td>Greater Bindweed</td>
<td>*1</td>
<td>+</td>
</tr>
<tr>
<td><em>Carex appressa</em></td>
<td>Tall Sedge</td>
<td>1</td>
<td>+</td>
</tr>
<tr>
<td><em>Carronia multisepalea</em></td>
<td>Carronia</td>
<td>1</td>
<td>+</td>
</tr>
<tr>
<td><em>Cassine australis var. australis</em></td>
<td>Red Olive-berry</td>
<td>2</td>
<td>+</td>
</tr>
<tr>
<td><em>Casuarina glauca</em></td>
<td>Swamp Oak</td>
<td>1</td>
<td>+</td>
</tr>
<tr>
<td><em>Christella dentata</em></td>
<td>Binung</td>
<td>2</td>
<td>+</td>
</tr>
<tr>
<td><em>Cissus antarctica</em></td>
<td>Watter Vine</td>
<td>1</td>
<td>+</td>
</tr>
<tr>
<td><em>Cotula coronopifolia</em></td>
<td>Watter Buttons</td>
<td>*3</td>
<td>+</td>
</tr>
<tr>
<td><em>Croton verreauxii</em></td>
<td>Native Cascarilla</td>
<td>1</td>
<td>+</td>
</tr>
<tr>
<td><em>Cryptocarya glaucescens</em></td>
<td>Jackwood</td>
<td>1</td>
<td>+</td>
</tr>
<tr>
<td><em>Cynodon dactylon</em></td>
<td>Common Couch</td>
<td>1</td>
<td>+</td>
</tr>
<tr>
<td><em>Cyperus eragrostis</em></td>
<td>Umbrella Sedge</td>
<td>*1</td>
<td>+</td>
</tr>
<tr>
<td><em>Dendrocnide excelsa</em></td>
<td>Giant Stinging Tree</td>
<td>1</td>
<td>+</td>
</tr>
<tr>
<td><em>Diospyros australis</em></td>
<td>Black Plum</td>
<td>1</td>
<td>+</td>
</tr>
<tr>
<td><em>Diploglottis australis</em></td>
<td>Native Tamarind</td>
<td>1</td>
<td>+</td>
</tr>
<tr>
<td><em>Doodia aspera</em></td>
<td>Prickly Rasp Fern</td>
<td>1</td>
<td>+</td>
</tr>
<tr>
<td><em>Ehrharta erecta</em></td>
<td>Panic Veldtgrass</td>
<td>*1</td>
<td>+</td>
</tr>
<tr>
<td><em>Endiandra sieberi</em></td>
<td>Hard Corkwood</td>
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<td>+</td>
</tr>
<tr>
<td><em>Eucalyptus amplifolia subsp. amplifolia</em></td>
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<td>+</td>
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<tr>
<td><em>Eucalyptus botryoides</em></td>
<td>Bangalay</td>
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<td>+</td>
</tr>
<tr>
<td>Scientific name</td>
<td>Common name</td>
<td>Quadrats</td>
<td>Weed</td>
</tr>
<tr>
<td>-----------------------------------------------------</td>
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</tr>
<tr>
<td><em>Ficus macrophylla subsp. macrophylla</em></td>
<td>Moreton Bay Fig</td>
<td></td>
<td></td>
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<tr>
<td><em>Ficus obliqua var. obliqua</em></td>
<td>Small Leaved Fig</td>
<td></td>
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<tr>
<td><em>Ficus rubiginosa</em></td>
<td>Port Jackson Fig</td>
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<td>Fig</td>
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<td><em>Foeniculum vulgare</em></td>
<td>Fennel</td>
<td></td>
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<td><em>Geitonoplesium cymosum</em></td>
<td>Scrambling Lily</td>
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<td><em>Geranium homeanum</em></td>
<td>Northern Cranesbill</td>
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<tr>
<td><em>Glycine clandestina</em></td>
<td>Twining Glycerine</td>
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<td><em>Guioa semiglaucia</em></td>
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<tr>
<td><em>Gymnostachys anceps</em></td>
<td>Settler's Flax</td>
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<td><em>Hedychium gardnerianum</em></td>
<td>Ginger Lily</td>
<td>*</td>
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<td><em>Holcus lanatus</em></td>
<td>Yorkshire Fog</td>
<td>*</td>
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<td><em>Isolepis producta</em></td>
<td>Nutty Club-sedge</td>
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<td><em>Juncus kraussii subsp. australiensis</em></td>
<td>Sea Rush</td>
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<td><em>Juncus sp.</em></td>
<td>Juncus</td>
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</tr>
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* Denotes weed species
A Denotes opportunistic records of all plant species
Cover abundance scores:

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<th>Other attributes</th>
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<td>1</td>
<td>&lt;5%</td>
<td>Three or less individuals of all species</td>
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<tr>
<td>2</td>
<td>&lt;5%</td>
<td>More than three individuals of a species</td>
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<tr>
<td>3</td>
<td>&lt;5%</td>
<td>Species common throughout plot</td>
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<td>4</td>
<td>5% - 25%</td>
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<tr>
<td>5</td>
<td>25% - 50%</td>
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<tr>
<td>6</td>
<td>50% - 75%</td>
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<tr>
<td>7</td>
<td>75% - 100%</td>
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Appendix B  Fauna results
### Appendix B  Fauna results

Animal species recorded in the Gerringong upgrade survey area:

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<td><em>Phalacrocorax carbo</em></td>
<td>Great Cormorant</td>
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<tr>
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<td><em>Phalacrocorax sulcicristis</em></td>
<td>Little Black Cormorant</td>
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<td>Rallidae</td>
<td><em>Porphyrio porphyrio</em></td>
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</tr>
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<td>Latin name</td>
<td>Common name</td>
<td>EPBC Act</td>
<td>TSC Act</td>
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<td>Australian White Ibis</td>
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<td>Zosterops lateralis</td>
<td>Silvereye</td>
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<td>Lepus capensis</td>
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<td>Molossidae</td>
<td>Tadarida australis</td>
<td>White-striped Freetail Bat</td>
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<tr>
<td>Vombatidae</td>
<td>Vombatus ursinus</td>
<td>Common Wombat</td>
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</table>

**Key:**
- **Act listing:** M = Migratory, PD (V) = Preliminary Determination as Vulnerable, U = Unprotected / Introduced
- **Observation type:** W = heard, O = seen, I = indirect evidence (eg scats)
Appendix C Threatened Species Conservation Act
assessments of significance
Appendix C Threatened Species Conservation Act assessments of significance

C-1 Flora

*Arthropteris palisotii*, Lesser creeping fern

*Arthropteris palisotii* is listed as Endangered on the *Threatened Species Conservation Act 1995*. *A. palisotii* is a fern occurring in rainforest, mainly on trees.

According to the NSW Flora Online entry for this *Arthropteris palisotii* (Wilson P.G. 2010), this species only occurs in the North Coast botanical subdivision of NSW. However there is a record of this species (dated 1993) in the Department of Environment, Climate Change and Water (DECCW) wildlife Atlas database located on Mount Brisbane in the Illawarra Escarpment State Recreation Area, north-west of Wollongong.

Vegetation communities mapped in the vicinity of the Mount Brisbane record of *A. palisotii* include coastal warm temperate rainforest, subtropical complex rainforest and warm temperate layered forest (Tozer et al. 2006).

The closest record of *A. palisotii* is approximately 34 km north of the study area.

*Arthropteris palisotii* was not recorded in the study area; however potential habitat does exist within the study area. Potential habitat for *A. palisotii* is considered to include rainforests. These potential habitats include: coastal warm temperate rainforest, intermediate temperate rainforest, subtropical complex rainforest, subtropical dry rainforest, and temperate littoral rainforest. These vegetation communities occur as scattered patches throughout the locality and cover an area of approximately 1171.05 ha.

Approximately 0.009 ha of potential habitat for *Arthropteris palisotii* would be directly impacted as part of the proposed upgrade with further potential indirect impacts to an additional 0.64 ha.

**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 published information regarding the lifecycle of *Arthropteris palisotii* was found. However, the species is known to spread via long creeping rhizomes. Based on the reproduction of other *Arthropteris* species, this species is also likely to reproduce via spores which are normally dispersed via wind or water.

The proposed upgrade would not involve the direct removal of any individuals of *Arthropteris palisotii*, as the species was not recorded in the study area. It is considered unlikely that the proposed upgrade would disrupt the lifecycle of this species.

**In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.**

Not applicable.

**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.

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

(i) the extent to which the 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.

*Arthropteris palisotii* has not been recorded in the study area, however potential habitat for the species occurs within subtropical dry rainforest in the study area with further potential habitat in the locality occurring within coastal warm temperate rainforest, intermediate temperate rainforest, subtropical complex rainforest, subtropical dry rainforest, and temperate littoral rainforest. Vegetation mapping (DEC 2005)) indicates approximately 1171.05 ha of these potential habitats occur within the locality (five kilometre radius of the study area).

The potential habitat for this species within the study area is in moderate to poor condition, due to the dominance of exotic species in the understorey, altered community structure and existing fragmentation.

Approximately 0.009 ha of potential habitat for *Arthropteris palisotii* would be directly impacted by the proposed development. The area of potential habitat for *Arthropteris palisotii* that would be removed as part of the proposed development equates to 0.00076 per cent of the extent of similar potential habitats mapped in the locality.

Areas of potential habitat for *A. palisotii* that would be impacted by the proposed upgrade are part of an already fragmented and cleared landscape. The proposed upgrade would impact upon the edge of an existing patch of potential habitat and would not increase fragmentation or isolation.

Given that the species has not been recorded in the study area; the small area of potential habitat to be impacted in relation to that in the locality; potential habitat in the study area is not considered to be vital for the long-term survival of the species in the locality.

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

Under the Threatened Species Conservation Act, the Director General maintains a Register of critical habitat. To date, no critical habitat has been declared for *Arthropteris palisotii*.

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

To date, no recovery plan has been prepared for *Arthropteris palisotii*. The threatened species profile for *A. palisotii* refers to five priority actions to assist in recovery of the species (DEC 2005b). Those relevant to the proposed upgrade include:

- Ensure the species is considered in statutory plans relevant to its distribution.
- Protect areas of known habitat from land clearing.
The proposed upgrade and associated mitigation measures are not inconsistent with the above listed recovery actions.

Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The following Key Threatening Processes relevant to the proposed upgrade may impact on potential habitat for *Arthropteris palisotii*:

- Clearing of native vegetation - approximately 0.009 ha of potential habitat for *Arthropteris palisotii* would be cleared for the proposed upgrade.
- Infection of native plants by *Phytophthora cinnamomi* - there is potential for construction vehicles to spread *Phytophthora cinnamomi* if they have come into contact with the soil pathogen. As a precaution, vehicles should be washed down prior to use on site.
- Invasion of native plant communities by exotic perennial grasses - given the presence of existing perennial grasses within the study area, there is potential for construction vehicles to spread seed of these invasive species into the subject site. As a precaution, vehicles should be washed down prior to use on site.
- Invasion, establishment and spread of *Lantana camara* - *Lantana camara* was recorded growing underneath the existing power line easement within the subject site. To prevent further spread of this invasive species, cleared *Lantana camara* should be disposed of off-site at an appropriate waste disposal facility.

The proposed upgrade may increase the potential operation of these Key Threatening Processes in relation to the potential habitat of *Arthropteris palisotii* in the study area.

**Conclusion**

In determining the nature and magnitude of impacts on the potential habitat of *Arthropteris palisotii*, the proposed upgrade is considered unlikely to have a significant impact as:

- The species was not recorded during the field surveys of the study area.
- A relatively small disturbed area of potential habitat would be directly impacted.
- The proposed upgrade would not result in fragmentation or isolation of potential habitat.

However, the proposed upgrade has the potential to increase the operation of key threatening processes in the potential habitat of this species. On this basis, mitigation measures included in Chapter 5.0 of this report should be implemented in order to minimise potential indirect impacts resulting from the proposed upgrade.
**Cynanchum elegans**

*Cynanchum elegans* is listed as Endangered under the Threatened Species Conservation Act.

*Cynanchum elegans* is a climber or twiner with a highly variable form and white tubular flowers (DEC 2005). Mature stems have a fissured corky bark and can grow to 10 m long and 3.5 cm thick (DEC 2005). The leaves are paired (or rarely in threes), ovate to broadly ovate in shape (DEC 2005). The species is known to occur on the edge of dry rainforest vegetation (DEC 2005).

*Cynanchum elegans* was not recorded in the study area; however potential habitat does exist within the study area. Potential habitat for *Cynanchum elegans* exists in subtropical complex rainforest. These include vegetation communities: coastal warm temperate rainforest, intermediate temperate rainforest, subtropical complex rainforest, subtropical dry rainforest and temperate littoral rainforest. These vegetation communities occur as scattered patches throughout the locality.

Approximately 0.009 ha of potential habitat for *Cynanchum elegans* would be cleared as part of the proposed development with further potential indirect impacts to an additional 0.64 ha of potential habitat.

In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The following is known about the lifecycle of *Cynanchum elegans* (DEC 2005):

- Flowering occurs between August and May, with a peak in November.
- Flower abundance on individual plants varies from sparse to prolific.
- The fruit can take up to six months to mature.
- Seed production is variable and unreliable. Seeds are wind dispersed.
- Plants are capable of suckering from rootstock in response to occasional slashing or grazing.
- The fire response of the species is unknown.

The following disturbances are thought to impact on the lifecycle of *Cynanchum elegans* (NPWS 2002a):

- Loss of individuals – the proposed development is not likely to result in the loss of any individuals of *Cynanchum elegans*.
- Fragmentation of habitat – the habitat for the species in the study area is already fragmented by cleared and disturbed land. The proposed development impacts upon existing edges of potential habitat and would not increase fragmentation of potential habitat for the species.
- Modification of habitat – the potential habitat for *Cynanchum elegans* in the study area is already modified due to the ongoing impacts from edge effects (eg weeds) and disturbances such as grazing. The proposed development may result in an increase in the intensity of some existing impacts.
- Damage to the soil seed bank – the proposed development is likely to require the removal of some soil, which may have an impact on the soils seed bank of the species. However, the species is not known to occur in the study area, with the closest known recording of the species approximately three kilometres to the west and north of the study area.
- Altered fire regime – the proposed development is not likely to alter the fire regime of the local area.
Cynanchum elegans was not recorded in the study area, however the species has previously been recorded approximately three kilometres to the north and east of the study area. Potential habitat for the species occurs in the subtropical dry rainforest in the study area. Since no individuals have been recorded in the study area, it is unlikely that the proposed development would have an adverse effect on the lifecycle of the species such that a viable population of the species would be placed at risk of extinction.

In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

Not applicable.

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.

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

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

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

The species has not been recorded in the study area, however potential habitat for the species occurs within subtropical dry rainforest in the study area with further potential habitat in the locality as occurring within coastal warm temperate rainforest, intermediate temperate rainforest, subtropical complex rainforest and temperate littoral rainforest. Vegetation mapping (DEC 2005t) indicates approximately 1,171.5 ha of these potential habitats occur within the locality (five kilometre radius of the study area).

The potential habitat for this species within the study area is in moderate to poor condition, due to the dominance of exotic species in the understorey, altered community structure and existing fragmentation.

Approximately 0.009 ha of potential habitat for Cynanchum elegans would be directly impacted by the proposed development. The area of potential habitat for Cynanchum elegans that would be removed as part of the proposed development equates to 0.00076 per cent of the extent of these plant communities in the locality.

Potential habitat for Cynanchum elegans that would be impacted by the proposed upgrade, are part of an already fragmented and cleared landscape. The proposed upgrade would impact upon the edge of an existing patch of potential habitat and would not increase fragmentation or isolation.

Given that the species has not been recorded in the study area; the small area of potential habitat directly impacted in relation to that in the locality area; potential habitat in the study area is not considered to be vital for the long-term survival of the species in the locality.
Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Under the Threatened Species Conservation Act, the Director General maintains a Register of Critical Habitat. To date, no critical habitat has been declared for *Cynanchum elegans*.

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

To date, no recovery plans have been prepared for *Cynanchum elegans*. The threatened species profile for *Cynanchum elegans* refers to nine priority actions to assist in recovery of the species (DEC 2005v). Those relevant to the proposed development include (DEC 2005):

- Consider off-site impacts in the assessment of nearby developments.
- Install fencing to exclude livestock and machinery, and control access where required.
- Protect areas of known and potential habitat from clearing and further fragmentation.
- Restore degraded habitat using bush regeneration techniques.
- Mark sites and potential habitat onto maps used for planning maintenance work.
- Map known sites and conduct searches of potential habitat for new sites.

The proposed upgrade and associated mitigation measures are not inconsistent with the above listed recovery actions.

Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The following Key Threatening Processes, as listed under the *Threatened Species Conservation Act*, are relevant to the proposed development and may impact on *Cynanchum elegans*:

- ‘Clearing of native vegetation’ - The proposed development would result in the clearing of approximately 0.009 ha of potential habitat for *Cynanchum elegans*.
- ‘Invasion of native plant communities by exotic perennial grasses’ - exotic perennial grasses such as *Pennisetum clandestinum* currently occur in proximity of the study area. These exotic grasses have the potential to spread further into the adjoining bushland after disturbance associated with the proposed development.
- ‘Invasion, establishment and spread of *Lantana camara*’ - *Lantana camara* is an existing threat to the native plant communities in and surrounding the study area. The proposed upgrade would involve vegetation disturbance which could lead to further spread of *Lantana camara*.

Conclusion

The nearest known record of *Cynanchum elegans* occurs within three kilometres of the study area; however, it was not recorded during the field surveys for this assessment. Potential habitat for this species that would be removed by the proposed upgrade represents a relatively small area that is already subject to existing edge effects and disturbances. For these reasons it is considered unlikely that the proposed development would have a significant impact on this species.
**Daphnandra sp. ‘Illawarra**

*Daphnandra* sp. ‘Illawarra’ is listed as Endangered on the Threatened Species Conservation Act.

*Daphnandra* sp. ‘Illawarra’ is a rainforest tree growing to 20 m tall, with coarsely toothed opposite leaves and small, pale, greenish white flowers (DEC 2005h). This species is known to occupy the rocky hillsides and gullies of the Illawarra lowlands, occasionally extending onto the upper escarpment slopes and is associated with rainforest and moist eucalypt forest (DEC 2005h).

*Daphnandra* sp. ‘Illawarra’ was not recorded in the study area; however potential habitat does exist within the study area within subtropical dry rainforest and wet sclerophyll forests. These include the vegetation communities: coastal warm temperate rainforest, escarpment foothills wet forest, Illawarra gully wet forest, intermediate temperate rainforest, subtropical complex rainforest, subtropical dry rainforest, and temperate littoral rainforest. These vegetation communities occur as scattered patches throughout the locality covering approximately 1,279.2 ha.

The proposed upgrade would impact on approximately 0.009 ha of potential habitat for *Daphnandra* sp. ‘Illawarra’ in the subject site with potential indirect impacts to a further 0.64 ha.

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 following is known about the lifecycle of *Daphnandra* sp. ‘Illawarra’ (DEC 2005h):

- Flowers briefly in September and early October with fruits taking 10 to 12 months to mature.
- Capable of vegetative reproduction from stems (coppicing) and rhizomes (suckering).
- Low levels of seed production are suspected, with stems at most sites appearing to only produce ‘pseudo-fruit’ which lack seeds. The predominant means of reproduction appears to be asexual (DEC 2005g).
- The species is possibly killed by fire.

*Daphnandra* sp. ‘Illawarra’ was not recorded in the study area. There are two previous recordings of the species approximately seven kilometres to the south-east of the study area (Figure 3.2). Potential habitat for the species does, however, exist within the rainforest and wet forest plant communities in the study area. Since no individuals were recorded in the study area, it is unlikely that the proposed upgrade would have an adverse effect on the lifecycle of the species such that a viable population of the species would be placed at risk of extinction.

In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

Not applicable.

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

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

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

The species has not been recorded in the study area, however potential habitat for the species occurs within subtropical dry rainforest with further potential habitat in the locality (five kilometre radius) including coastal warm temperate rainforest, escarpment foothills wet forest, Illawarra gully wet forest, intermediate temperate rainforest, subtropical complex rainforest, subtropical dry rainforest, and temperate littoral rainforest. Vegetation mapping (DEC 2005t) indicates approximately 1,279.2 ha of these potential habitats occur within the locality.

The potential habitat for this species within the study area is in moderate to poor condition, due to the existing disturbances (grazing and road construction).

Approximately 0.64 ha of potential habitat for *Daphnandra* sp. ‘Illawarra’ would be impacted (directly and indirectly) by the proposed upgrade. The area of potential habitat that would be removed as part of the proposed upgrade equates to 0.00076 per cent of the extent of potential habitat for the species in the locality.

Potential habitat for *Daphnandra* sp. ‘Illawarra’ that would be impacted by the proposed upgrade, are part of an already fragmented and cleared landscape. The proposed upgrade would impact upon the edge of an existing patch of potential habitat and would not increase fragmentation or isolation.

Given that the species has not been recorded in the study area, the small area of potential habitat directly impacted in relation to that in the locality area, potential habitat in the study area is not considered to be vital for the long-term survival of the species in the locality.

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

Under the Threatened Species Conservation Act, the Director General maintains a Register of Critical Habitat. To date, no critical habitat has been declared for *Daphnandra* sp. ‘Illawarra’.

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

A recovery plan has been prepared for *Daphnandra* sp. ‘Illawarra’ (DEC 2005g). The objectives of the recovery plan are:

- To prevent the loss of sites through land-use change.
- To identify and manage the threats operating at sites that contain the species.
- To provide the community with information that assists in conserving the species.
- To raise awareness of the species and involve the community in the recovery program.
- To establish the extent of the current distribution of the species.
- To promote research that would assist with the management of the species.
- To maintain an ex-situ seed collection for the species.

The proposed upgrade is not inconsistent with the above listed objectives.
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 following key threatening processes, as listed under the Threatened Species Conservation Act, are relevant to the proposed upgrade and may impact on the species:

- ‘Clearing of native vegetation’ - The proposed upgrade would result in the clearing of approximately 0.64 ha of potential habitat for *Daphnandra* sp. ‘Illawarra’.
- ‘Invasion of native plant communities by exotic perennial grasses’ - exotic perennial grasses, such as *Pennisetum clandestinum* and *Ehrharta erecta*, currently subject area. These exotic grasses have the potential to spread further into the adjoining bushland after disturbance associated with the proposed upgrade.
- Infection of native plants by *Phytophthora cinnamomi* - there is potential for construction vehicles to spread *Phytophthora cinnamomi* if they have come into contact with the soil pathogen. As a precaution, vehicles should be washed down prior to use on site.
- ‘Invasion, establishment and spread of *Lantana camara*’ - *Lantana camara* is an existing threat to the native plant communities in and surrounding the study area. The proposed upgrade would involve vegetation disturbance which could lead to further spread of *Lantana camara*.

**Conclusion**

*Daphnandra* sp. ‘Illawarra’ is known to occur within 10 km of the study area and has potential habitat in the study area. In determining the nature and magnitude of impacts on the potential habitat of *Daphnandra* sp. ‘Illawarra’, the proposed upgrade is considered unlikely to have a significant impact as:

- The species was not recorded during the field surveys of the study area.
- A relatively small disturbed area of potential habitat would be directly impacted.
- The proposed upgrade would not result in fragmentation or isolation of the potential habitat.

However, the proposed upgrade has the potential to increase the operation of key threatening processes in the potential habitat of this species. On this basis, mitigation measures included in Chapter 5.0 of this report should be implemented in order to minimise potential indirect impacts resulting from the proposed upgrade.
**Distichlis distichophylla, Australian Saltgrass**

*Distichlis distichophylla* is listed as an Endangered Species on Part 1 of Schedule 1 of the Threatened Species Conservation Act.

*Distichlis distichophylla* is a spreading perennial grass, with distinctive foliage consisting of a row of thin stiff leaves to 50 mm on each side of the stem. It often grows alongside *Sporobolus virginicus*, a similar-looking grass, and is best-distinguished in summer when in flower or fruit (DEC 2005).

*Distichlis distichophylla* is a coloniser of damp saline soils and is found at the edges of saltmarsh and on low dunes (DEC 2005).

*Distichlis distichophylla* is widespread across Australia, occurring in Victoria, Tasmania, Western Australia and South Australia. Its range in NSW is limited to coastal situations, except for one population at Lake Cargelligo. Scattered records of this species are from Jervis Bay, Bermagui, Wombeyn, Narooma, Bodalla and Nadgee Nature Reserve (at Wombeyn) (DEC 2005).

*Distichlis distichophylla* was not recorded in the study area, nor was it recorded in the 10 km radius searches. According to the NSW Wildlife Atlas, the closest record of *D. distichophylla* is located approximately 24 km to the south of the study area. This record represents the northern known limit of occurrence for this species.

Potential habitat for the species occurs in the estuarine saltmarsh in the study area. The proposed upgrade would result in impacts to approximately 0.93 ha (from 0.002 ha direct and 0.93 ha indirect) of potential habitat for *D. distichophylla*. Further areas of potential habitat within the locality are likely to occur within the tidal zone at Werri Lagoon (north-east of Site 2) and Crooked River (Site 3) in association with estuarine fringe forest.

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 is little published information available concerning the life cycle of *Distichlis distichophylla*. According to the threatened species profile for *D. distichophylla* (DEC 2005), the species flowers and sets seed in late spring and summer.

Activities likely to impact on the lifecycle of the species are those that contribute to the following:

- **Loss of individuals** – *Distichlis distichophylla* is not known to occur in the study area, therefore the proposed development is not likely to result in a loss of individuals of the species.

- **Fragmentation of habitat** – the habitat for the species in the study area is already fragmented. The proposed upgrade impacts upon existing edges of potential habitat and would not increase fragmentation of potential habitat for the species.

- **Modification of habitat** – the potential habitat for *Distichlis distichophylla* in the study area is already modified due to the ongoing impacts from edge effects (e.g. weeds) and disturbances such as grazing. The proposed upgrade may result in an increase in the intensity of some existing impacts.

- **Damage to the soil seed bank** – the proposed upgrade is likely to require the removal of some soil, which may have an impact on the soil seed bank of the species. However, the species is not known to occur in the study area, nor in the locality.

- **Altered fire regimes** – the proposed upgrade is not likely to alter the fire regimes of the study area.
Distichlis distichophylla was not recorded in the study area, nor in the locality. Potential habitat for the species occurs in the estuarine saltmarsh in the study area. Since no individuals have been recorded in the study area, it is unlikely that the proposed upgrade would have an adverse effect on the lifecycle of the species such that a viable local population of the species (if one exists) would be placed at risk of extinction.

In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

Not applicable

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.

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

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

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

The local occurrence of potential habitat for Distichlis distichophylla within the study area is 19.6 ha. The proposed upgrade would result in clearing approximately 0.002 ha of D. distichophylla habitat within the study area. This equates to 0.001 per cent of the local occurrence of D. distichophylla habitat that would either be directly or indirectly impacted by the proposed upgrade within the study area.

The proposed upgrade impacts upon an existing edge along Fern Street and would not result in the fragmentation or isolation of any habitat for D. distichophylla in the study area or locality.

The extent of potential habitat in the study area is already subject to impacts resulting from clearing, soil disturbance and grazing. The majority of the area directly impacted by the proposed upgrade is in moderate to poor condition with significant weed infestation. Given that no individuals of D. distichophylla have been recorded in the study area, the area of potential habitat to be impacted is small, and that indirect impacts are likely to be negligible, the importance of the habitat to be impacted to the long-term survival of the species is considered to be low.

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

Under the Threatened Species Conservation Act, the Director General maintains a Register of critical habitat. To date, no critical habitat has been declared for Distichlis distichophylla.
Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

To date, no recovery plan for *Distichlis distichophylla* has been prepared. The threatened species profile for *D. distichophylla* refers to three strategies to assist in recovery of this species. None of the listed strategies are relevant to the proposed upgrade (DEC 2005).

The proposed upgrade and associated mitigation measures (see Chapter 5.0) are not inconsistent with listed priority actions, however, the clearing of a small area of potential habitat for *Distichlis distichophylla* would result from the proposed upgrade.

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 following Key Threatening Processes have been identified as threats to the EEC coastal saltmarsh (NSW Scientific Committee 2004a) and are therefore likely to constitute a threat to *Distichlis distichophylla*:

- Clearing of native vegetation – the proposed upgrade would result in the direct removal of approximately 0.002 ha of estuarine saltmarsh in the study area.
- Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands – The natural flow regime has already been altered with constructed canals. Existing hydrological regimes are subject to tidal influences emanating from Werri Lagoon to the east of the study area. These tidal influences are considered unlikely to be altered by the proposed upgrade.
- Invasion of native plant communities by exotic perennial grasses – exotic perennial grasses, such as *Pennisetum clandestinum* currently occur in the study area. These exotic grasses have the potential to spread further into the disturbed areas resulting from the proposed upgrade.
- High frequency fire – the proposed upgrade is not likely to alter the fire regime of the locality.

Other identified threats to *Distichlis distichophylla* include habitat damage by recreational vehicles, trampling by cattle, modified tidal flows, land reclamation, rubbish dumping and marine pollution (DEC 2005). The proposed upgrade is unlikely to result in or increase the impact of these threats.

Conclusion

*Distichlis distichophylla* has not been recorded within 10 km of the study area. In determining the nature and magnitude of impacts on the potential habitat of *Distichlis distichophylla*, the proposed upgrade is considered unlikely to have a significant impact as:

- The species was not recorded during the field surveys of the study area.
- A relatively small disturbed area of potential habitat would be directly impacted.
- The proposed upgrade would not result in fragmentation or isolation of the potential habitat.

However, the proposed upgrade has the potential to increase the operation of Key Threatening Processes in the potential habitat of this species. On this basis, mitigation measures included in Chapter 5.0 of this report should be implemented in order to minimise potential indirect impacts resulting from the proposed upgrade.
**Senna acclinis**

*Senna acclinis* is listed as Endangered under the Threatened Species Conservation Act.

*Senna acclinis* is a rainforest shrub which grows to three metres tall. *Senna acclinis* can easily be mistaken for introduced *Senna* species. The species is known to occur on the edge of dry rainforest vegetation (DEC 2005”).

*Senna acclinis* was not recorded in the study area; however potential habitat does exist within the study area. Potential habitat for *Senna acclinis* exists in rainforests. These include the following mapped vegetation communities: coastal warm temperate rainforest, intermediate temperate rainforest, subtropical complex rainforest, subtropical dry rainforest and temperate littoral rainforest. These vegetation communities occur as scattered patches throughout the locality.

Approximately 0.009 ha of potential habitat for *Senna acclinis* would be directly impacted as part of the proposed development with further potential indirect impacts to an additional 0.64 ha of potential habitat.

In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Little is known about the lifecycle of *Senna acclinis*:

- Flowering occurs in spring and summer.
- *Senna acclinis* is pollinated by an assemblage of native bees (Wouldiams 1998).
- The seeds are possibly dispersed by ants, but unlikely to be dispersed over large distances (Wouldiams 1998).

The following disturbances are thought to impact on the lifecycle of *Senna acclinis* (NPWS 2002a):

- Loss of individuals – the proposed upgrade is unlikely to result in the loss of any individuals of *Senna acclinis*
- Fragmentation of habitat – the habitat for the species in the study area is already fragmented by cleared and disturbed land. The proposed development impacts upon existing edges of potential habitat and would not increase fragmentation of potential habitat for the species.
- Modification of habitat – the potential habitat for *Senna acclinis* in the study area is already modified due to the ongoing impacts from edge effects (eg weeds) and disturbances such as grazing. The proposed upgrade may result in an increase in the intensity of some existing impacts.
- Damage to the soil seed bank – the proposed development is likely to require the removal of some soil, which may have an impact on the soils seed bank of the species. However, the species is not known to occur in the study area, with the closest known recording of the species approximately 39 km to the north of the study area.
- Altered fire regime – the proposed development is not likely to alter the fire regime of the local area.

*Senna acclinis* was not recorded in the study area, with the closest record occurring approximately 39 km to the north of the study area. Potential habitat for the species occurs in subtropical dry rainforest in the study area. Since no individuals have been recorded in the study area, it is unlikely that the proposed development would have an adverse effect on the lifecycle of the species such that a viable population of the species would be placed at risk of extinction.
In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

Not applicable.

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.

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

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

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

The species has not been recorded in the study area, however potential habitat for the species occurs within subtropical dry rainforest in the study area with further potential habitat in the locality occurring within coastal warm temperate rainforest, intermediate temperate rainforest, subtropical complex rainforest and temperate littoral rainforest. Vegetation mapping (DEC 2005) indicates approximately 1,171.05 ha of these potential habitats occur within the locality (five kilometre radius of the study area).

The potential habitat for this species within the study area is in moderate to poor condition, due to the dominance of exotic species in the understorey, altered community structure and existing fragmentation.

Approximately 0.009 ha of potential habitat for Senna acclinis would be directly impacted by the proposed development. The area of potential habitat for Senna acclinis that would be removed as part of the proposed development equates to 0.00076 per cent of the extent of these plant communities in the locality.

Potential habitat for Senna acclinis that would be disturbed as part of the proposed upgrade is part of an already fragmented and cleared landscape. The proposed upgrade would impact upon the edge of an existing patch of potential habitat and would not increase fragmentation or isolation.

Given that the species has not been recorded in the study area; the small area of potential habitat directly impacted in relation to that in the locality; potential habitat in the study area is not considered to be vital for the long-term survival of the species in the locality.
Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Under the Threatened Species Conservation Act, the Director General maintains a Register of Critical Habitat. To date, no critical habitat has been declared for *Senna acclinis*.

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

To date, no recovery plans have been prepared for *Senna acclinis*. The threatened species profile for *Senna acclinis* refers to eight priority actions to assist in recovery of the species (DEC 2005). Those relevant to the proposed upgrade include:

- Consider off-site impacts in the assessment of nearby developments.
- Install fencing to exclude livestock and machinery, and control access where required.
- Protect areas of known and potential habitat from clearing and further fragmentation.
- Restore degraded habitat using bush regeneration techniques.
- Mark sites and potential habitat onto maps used for planning maintenance work.
- Map known sites and conduct searches of potential habitat for new sites.
- Ensure the correct identification of weed *Senna* during weed control and removal.

The proposed upgrade and associated mitigation measures are not inconsistent with the above listed recovery actions.

Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The following Key Threatening Processes, as listed under the Threatened Species Conservation Act, are relevant to the proposed upgrade and may impact on the potential habitat of *Senna acclinis*:

- ‘Clearing of native vegetation’ - The proposed development would result in the clearing of approximately 0.009 ha of potential habitat for *Senna acclinis*.
- ‘Invasion of native plant communities by exotic perennial grasses’ - exotic perennial grasses such as *Pennisetum clandestinum* currently occur in proximity of the study area. These exotic grasses have the potential to spread further into the adjoining bushland after disturbance associated with the proposed upgrade.
- ‘Invasion, establishment and spread of *Lantana camara*’ - *Lantana camara* is an existing threat to the native plant communities in and surrounding the study area. The proposed upgrade would involve vegetation disturbance which could lead to further spread of *Lantana camara*.

Conclusion

*Senna acclinis* was not recorded during field surveys, and the nearest known record of the species occurs 39 km to the north of the study area. Potential habitat for this species does exist in the rainforest community present in the study area. The proposed upgrade would require the removal of a relatively small area of potential habitat, which is already subject to existing edge effects and disturbances. For these reasons it is considered unlikely that the proposed development would have a significant impact on this species.
**Solanum celatum**

*Solanum celatum* is listed as Endangered on the Threatened Species Conservation Act. *Solanum celatum* is an erect shrub one metre to 2.5 m high (Plantnet Online Database). This species grows on hills and slopes in eucalypt woodland; in rainforest clearings, or in wet sclerophyll forests (DEC 2005c). It is also commonly found after fire or disturbance.

*Solanum celatum* was not recorded in the study area; however potential habitat does exist within the study area. Potential habitat for *Solanum celatum* is considered to include subtropical dry rainforest and wet sclerophyll forests. These potential habitats include: coastal warm temperate rainforest, escarpment foothills wet forest, Illawarra gully wet forest, intermediate temperate rainforest, subtropical complex rainforest, subtropical dry rainforest, and temperate littoral rainforest. These vegetation communities occur as scattered patches throughout the locality and cover an area of approximately 1279.1 ha.

Approximately 0.009 ha of potential habitat for *Solanum celatum* would be directly impacted as part of the proposed upgrade with further potential indirect impacts to an additional 0.64 ha.

**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 following is known about the lifecycle of *Solanum celatum* (DEC 2005x):

- Flowers August to October and produces fruit December to January.
- Fire sensitive obligate seeder, with adult plants killed by fire and recruitment occurring from a soil stored seed bank - The proposed upgrade would not alter the fire frequency of the study area.

The closest known record of the species occurs approximately seven kilometres to the north of the study area (Figure 3.1). The proposed upgrade would not involve the direct removal of any individuals of *Solanum celatum*, as the species was not recorded in the study area. It is considered unlikely that the proposed upgrade would disrupt the lifecycle of this species.

**In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.**

Not applicable.

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

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

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

The species has not been recorded in the study area, however potential habitat for the species occurs within subtropical dry rainforest in the study area with further potential habitat in the locality occurring within coastal warm temperate rainforest, escarpment foothills wet forest, Illawarra gully wet forest, intermediate temperate rainforest, subtropical complex rainforest, subtropical dry rainforest, and temperate littoral rainforest. Vegetation mapping (DEC 2005t) indicates approximately 1,279.2 ha of these potential habitats occur within the locality (five kilometre radius of the study area).

The potential habitat for this species within the study area is in moderate to poor condition, due to the dominance of exotic species in the understorey, altered community structure and existing fragmentation.

Approximately 0.009 ha of potential habitat for Solanum celatum would be directly impacted by the proposed development. The area of potential habitat for Solanum celatum that would be removed as part of the proposed development equates to 0.00076 per cent of the extent of similar potential habitats mapped in the locality.

Potential habitat for Solanum celatum that would be impacted by the proposed upgrade, are part of an already fragmented and cleared landscape. The proposed upgrade would impact upon the edge of an existing patch of potential habitat and would not increase fragmentation or isolation.

Given that the species has not been recorded in the study area; the small area of potential habitat to be impacted in relation to that in the locality; potential habitat in the study area is not considered to be vital for the long-term survival of the species in the locality.

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

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

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

To date, no recovery plans have been prepared for Solanum celatum. The threatened species profile for Solanum celatum refers to nine priority actions to assist in recovery of the species (DEC 2005v). Those relevant to the proposed upgrade include (DEC 2005):

- Consider off-site impacts in the assessment of nearby developments.
- Install fencing to exclude livestock and machinery, and control access where required.
- Protect areas of known and potential habitat from clearing and further fragmentation.
- Restore degraded habitat using bush regeneration techniques.
- Mark sites and potential habitat onto maps used for planning maintenance work.
- Map known sites and conduct searches of potential habitat for new sites.
The proposed upgrade and associated mitigation measures are not inconsistent with the above listed recovery actions.

Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

Key threatening processes listed on the Threatened Species Conservation Act relevant to the proposed upgrade that may impact on potential habitat for *Solanum celatum* include:

- Clearing of native vegetation - approximately 0.64 ha of potential habitat for *Solanum celatum* would be cleared for the proposed upgrade.
- Infection of native plants by *Phytophthora cinnamomi* - there is potential for construction vehicles to spread *Phytophthora cinnamomi* if they have come into contact with the soil pathogen. As a precaution, vehicles should be washed down prior to use on site.
- Invasion of native plant communities by exotic perennial grasses - given the presence of existing perennial grasses within the study area, there is potential for construction vehicles to spread seed of these invasive species into the subject site. As a precaution, vehicles should be washed down prior to use on site.
- Invasion, establishment and spread of *Lantana camara* - *Lantana camara* was recorded growing underneath the existing power line easement within the subject site. To prevent further spread of this invasive species, cleared *Lantana camara* should be bagged and disposed of off-site at an appropriate waste disposal facility.

The proposed upgrade may increase the potential operation of these key threatening processes in relation to the potential habitat of *Solanum celatum* in the study area.

**Conclusion:**

In determining the nature and magnitude of impacts on the potential habitat of *Solanum celatum*, the proposed upgrade is considered unlikely to have a significant impact as:

- The species was not recorded during the field surveys of the study area.
- A relatively small disturbed area of potential habitat would be directly impacted.
- The proposed upgrade would not result in fragmentation or isolation of the potential habitat.

However, the proposed upgrade has the potential to increase the operation of key threatening processes in the potential habitat of this species. On this basis, mitigation measures included in Chapter 5.0 of this report should be implemented in order to minimise potential indirect impacts resulting from the proposed upgrade.
**Syzygium paniculatum**

*Syzygium paniculatum* is listed as a Vulnerable species on Schedule 2 of the New South Wales Threatened Species Conservation Act. This species is also listed as a nationally vulnerable species under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.

*Syzygium paniculatum* is a small to medium tree, growing between three metres to eight metres in height, depending on location. The species occurs mainly in littoral rainforest in the South Coast, Central Coast and North Coast Botanical Divisions.

*Syzygium paniculatum* was not recorded in the study area; however potential habitat does exist within the study area. Potential habitat for *Syzygium paniculatum* exists in subtropical dry rainforest. Potential habitats mapped in the locality include: coastal warm temperate rainforest, escarpment foothills wet forest, Illawarra gully wet forest, intermediate temperate rainforest, subtropical complex rainforest, subtropical dry rainforest, and temperate littoral rainforest. These vegetation communities occur as scattered patches throughout the locality and cover an area of approximately 1279.1 ha.

Approximately 0.009 ha of potential habitat for *Syzygium paniculatum* would be directly impacted as part of the proposed upgrade with further potential indirect impacts to an additional 0.64 ha of potential habitat.

In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The following is known about the lifecycle of *Syzygium paniculatum* (DEC 2005z):

- *Syzygium paniculatum* is summer flowering (November-February), with the fruits maturing in May.
- Small native mammals (e.g. possums) and birds presumably forage on the fleshy fruits and may also play a role in seed dispersal.
- The plant has a generalised pollination strategy, exhibiting the ability to rely on both self pollination and outcrossing breeding systems.
- As a rainforest species, it is likely that *Syzygium paniculatum* has not evolved to cope with frequent fire.

Activities likely to effect on the lifecycle of the species are those that contribute to the following:

**Loss of individuals** - *Syzygium paniculatum* is not known to occur in the study area, therefore the proposed development is not likely to result in a loss of individuals of the species.

- Fragmentation of habitat - the habitat for the species in the study area is already fragmented by cleared and disturbed land. The proposed development impacts upon existing edges of potential habitat and would not increase fragmentation of potential habitat for the species.
- Modification of habitat - the potential habitat for *Syzygium paniculatum* in the study area is already modified due to the ongoing impacts from edge effects (e.g. weeds) and disturbances such as grazing. The proposed development may result in an increase in the intensity of some existing impacts.
- Damage to the soil seed bank - the proposed development is likely to require the removal of some soil, which may have an impact on the soils seed bank of the species. However, the species is not known to occur in the study area, nor in the locality.
- Altered fire regimes - the proposed upgrade is not likely to alter the fire regimes of the study area.
Syzygium paniculatum was not recorded in the study area, nor in the locality. Potential habitat for the species occurs in the subtropical dry rainforest in the study area. Since no individuals have been recorded in the study area, it is unlikely that the proposed upgrade would have an adverse effect on the lifecycle of the species such that a viable local population of the species (if one exists) would be placed at risk of extinction.

In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

Not applicable.

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.

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

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

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

The species has not been recorded in the study area, however potential habitat for the species occurs within subtropical dry rainforest in the study area with further potential habitat in the locality occurring within coastal warm temperate rainforest, escarpment foothills wet forest, Illawarra gully wet forest, intermediate temperate rainforest, subtropical complex rainforest, subtropical dry rainforest, and temperate littoral rainforest. Vegetation mapping (DEC 2005t) indicates approximately 1,171.5 ha of these potential habitats occur within the locality (five kilometre radius of the study area).

The potential habitat for this species within the study area is in moderate to poor condition, due to the dominance of exotic species in the understorey, altered community structure and existing fragmentation.

Approximately 0.009 ha of potential habitat for Syzygium paniculatum would be directly impacted by the proposed development. The area of potential habitat for Syzygium paniculatum that would be removed as part of the proposed development equates to 0.00076 per cent of the extent of similar potential habitats mapped in the locality.

Potential habitat for Syzygium paniculatum that would be impacted by the proposed upgrade, are part of an already fragmented and cleared landscape. The proposed upgrade would impact upon the edge of an existing patch of potential habitat and would not increase fragmentation or isolation.

Given that the species has not been recorded in the study area; the small area of potential habitat to be impacted in relation to that in the locality; potential habitat in the study area is not considered to be vital for the long-term survival of the species in the locality.
Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Part 3 of the Threatened Species Conservation Act outlines the procedures involved in declaring critical habitat. Critical habitat refers only to those areas of land listed in the Register of critical habitat as kept by the Director General of DECCW and Department of Primary Industries. No critical habitat has been declared for *Syzygium paniculatum*.

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

To date, no recovery plans have been prepared for *Syzygium paniculatum*. The threatened species profile for *Syzygium paniculatum* refers to nine priority actions to assist in recovery of the species (DEC 2005v). Those considered relevant to the proposed development include:

- Consider off-site impacts in the assessment of nearby developments.
- Install fencing to exclude livestock and machinery, and control access where required.
- Protect areas of known and potential habitat from clearing and further fragmentation.
- Restore degraded habitat using bush regeneration techniques.
- Mark sites and potential habitat onto maps used for planning maintenance work.
- Map known sites and conduct searches of potential habitat for new sites.

The proposed upgrade and associated mitigation measures are not inconsistent with the above listed recovery actions.

Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The following key threatening processes, as listed under the Threatened Species Conservation Act, are relevant to the proposed upgrade and may impact on the potential habitat of *Syzygium paniculatum*:

- ‘Clearing of native vegetation’ - The proposed upgrade would result in the clearing of approximately 0.009 ha of potential habitat for *Syzygium paniculatum*.
- ‘Invasion of native plant communities by exotic perennial grasses’ - exotic perennial grasses such as *Pennisetum clandestinum* and *Ehrharta erecta* currently occur in proximity of the study area. These exotic grasses have the potential to spread further into the adjoining bushland after disturbance associated with the proposed upgrade.
- Infection of native plants by *Phytophthora cinnamomi* - there is potential for construction vehicles to spread *Phytophthora cinnamomi* if they have come into contact with the soil pathogen. As a precaution, vehicles should be washed down prior to use on site.
- ‘Invasion, establishment and spread of *Lantana camara*’ - *Lantana camara* is an existing threat to the native plant communities in and surrounding the study area. The proposed upgrade would involve vegetation disturbance which could lead to further spread of *Lantana camara*.
Conclusion

*Syzygium paniculatum* has not been recorded within 10 km of the study area. In determining the nature and magnitude of impacts on the potential habitat of *Syzygium paniculatum*, the proposed upgrade is considered unlikely to have a significant impact as:

- The species was not recorded during the field surveys of the study area.
- A relatively small disturbed area of potential habitat would be directly impacted.
- The proposed upgrade would not result in fragmentation or isolation of the potential habitat.

However, the proposed upgrade has the potential to increase the operation of key threatening processes in the potential habitat of this species. On this basis, mitigation measures included in Chapter 5.0 of this report should be implemented in order to minimise potential indirect impacts resulting from the proposed upgrade.
**Wilsonia backhousei, Narrow-leafed Wilsonia**

*Wilsonia backhousei* is listed as a Vulnerable species on Schedule 2 of the Threatened Species Conservation Act.

*Wilsonia backhousei* is a perennial, sprawling, matted shrub less than 15 cm tall with narrow, stalkless succulent leaves and single white stalkless flowers (DEC 2005). It often occurs as pure, or nearly pure, stands. At most sites, stands are limited in extent to a few tens of metres square; the most extensive stands occur around Jervis Bay (NSW Scientific Committee 2000c).

*Wilsonia backhousei* occurs in coastal areas between Wamberal and Mimosa Rocks in NSW. This species is found in all southern states (DEC 2005). Habitat for *W. backhousei* exists in saltmarsh on the tidal flats of rivers and on sea cliff tops (Benson and McDougall 1995). It is a species of the margins of salt marshes and lakes (DEC 2005).

*Wilsonia backhousei* was not recorded in the study area, nor has it been recorded within 10 km of the study area. According to the NSW Wildlife Atlas, the closest record of *W. backhousei* is located approximately 25 km south of the study area.

Potential habitat for *W. backhousei* exists in the estuarine saltmarsh in the study area. The proposed upgrade would result in impacts to approximately 0.93 ha (from 0.002 ha direct and 0.93 ha indirect) of potential habitat for *W. backhousei*. Further areas of potential habitat within the locality are likely to occur within the tidal zone at Werri Lagoon (north-east of Site 2) and Crooked River (Site 3) in association with estuarine fringe forest.

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 following is known about the lifecycle of *Wilsonia backhousei* (DEC 2005):

- Flowering occurs from October to December.
- The fruit is an indehiscent capsule with one to two seeds, maturing in December.

Activities likely to impact on the lifecycle of the species are those that contribute to the following:

- Loss of individuals – *Wilsonia backhousei* is not known to occur in the study area, therefore the proposed development is not likely to result in a loss of individuals of the species.
- Fragmentation of habitat – the habitat for the species in the study area is already fragmented by cleared and disturbed land. The proposed development impacts upon existing edges of potential habitat and would not increase fragmentation of potential habitat for the species.
- Modification of habitat – the potential habitat for *Wilsonia backhousei* in the study area is already modified due to the ongoing impacts from edge effects (eg weeds) and disturbances such as grazing. The proposed development may result in an increase in the intensity of some existing impacts.
- Damage to the soil seed bank – the proposed development is likely to require the removal of some soil, which may have an impact on the soil seed bank of the species. However, the species is not known to occur in the study area, nor in the locality.
- Altered fire regimes – the proposed upgrade is not likely to alter the fire regimes of the study area.
*Wilsonia backhousei* was not recorded in the study area, nor in the locality. Potential habitat for the species occurs in the estuarine saltmarsh in the study area. As no individuals have been recorded in the study area, it is unlikely that the proposed upgrade would have an adverse effect on the lifecycle of the species such that a viable local population of the species (if one exists) would be placed at risk of extinction.

In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

Not applicable.

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.

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

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

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

The local occurrence of potential habitat for *Wilsonia backhousei* within the study area is 19.6 ha. The proposed upgrade would result in clearing approximately 0.002 ha of *W. backhousei* habitat within the study area. This equates to 0.001 per cent of the local occurrence of *W. backhousei* habitat that would either be directly or indirectly impacted by the proposed upgrade within the study area.

The proposed upgrade impacts upon an existing edge along Fern Street and would not result in the further fragmentation or isolation of any habitat for *W. backhousei* in the study area or locality.

The extent of potential habitat in the study area is already subject to impacts resulting from clearing, soil disturbance and grazing. The majority of the area directly impacted by the proposed upgrade is in moderate to poor condition with significant weed infestation. Given that no individuals of *W. backhousei* have been recorded in the study area, the area of potential habitat to be impacted is small, and that indirect impacts are likely to be negligible, the importance of the habitat to be impacted to the long-term survival of the species is considered to be low.

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

Under the Threatened Species Conservation Act, the Director General maintains a Register of critical habitat. To date, no critical habitat has been declared for *Wilsonia backhousei*. 
Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

To date, no recovery plan for *Wilsonia backhousei* has been prepared. The threatened species profile for *W. backhousei* refers to five strategies to assist in recovery of this species. Only one of these strategies is broadly relevant to the proposed upgrade (DEC 2005):

- Ensure that this species is considered in proposals affecting saline riparian areas.

Potential impacts on *W. backhousei* are considered in this assessment of significance. The proposed upgrade and associated mitigation measures (see Chapter 5.0) are consistent with the above listed priority actions, however, the clearing of a small area of potential habitat for *W. backhousei* would result from the proposed upgrade.

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 following key threatening processes have been identified as threats to the EEC coastal saltmarsh (NSW Scientific Committee 2004a) and are therefore likely to constitute a threat to *Wilsonia backhousei*:

- Clearing of native vegetation – the proposed upgrade would result in the direct removal of approximately 0.002 ha of estuarine saltmarsh in the study area.
- Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands – The natural flow regime has already been altered with constructed canals. Existing hydrological regimes are subject to tidal influences emanating from Werri Lagoon to the east of the study area. These tidal influences are considered unlikely to be altered by the proposed upgrade.
- Invasion of native plant communities by exotic perennial grasses – exotic perennial grasses, such as *Pennisetum clandestinum* currently occur in the study area. These exotic grasses have the potential to spread further into the disturbed areas resulting from the proposed upgrade.
- High frequency fire – the proposed upgrade is not likely to alter the fire regime of the locality.

Other identified threats to *Wilsonia backhousei* are trampling by stock, damage by four wheel drive vehicles and rubbish dumping (DEC 2005). The proposed upgrade is unlikely to result in or increase the impact of these threats.

Conclusion

*Wilsonia backhousei* has not been recorded within 10 km of the study area. In determining the nature and magnitude of impacts on the potential habitat of *Wilsonia backhousei*, the proposed upgrade is considered unlikely to have a significant impact as:

- The species was not recorded during the field surveys of the study area.
- A relatively small disturbed area of potential habitat would be directly impacted.
- The proposed upgrade would not result in fragmentation or isolation of potential habitat for this species.

However, the proposed upgrade has the potential to increase the operation of key threatening processes in the potential habitat of this species. On this basis, mitigation measures included in Chapter 5.0 of this report should be implemented in order to minimise potential indirect impacts resulting from the proposed upgrade.
**Wilsonia rotundifolia** Round-leafed *W. ilsonia*

*W. ilsonia rotundifolia* is listed as an Endangered Species on Part 1 of Schedule 1 of the Threatened Species Conservation Act.

*W. ilsonia rotundifolia* is a hairy, prostrate, perennial subshrub with succulent leaves and woody stems (DEC 2005+). *W. rotundifolia* is salt tolerant and is found in coastal saltmarshes and inland saline sites. It occurs in mid marsh, mixed with *Sporobolus virginicus* and *Sarcocornia quinqueflora* (NSW Scientific Committee 2000d).

*W. ilsonia rotundifolia* was not recorded in the study area, nor was it recorded in the 10 km radius searches. According to the NSW Wildlife Atlas records, the closest record of *W. rotundifolia* is located approximately 24 km south of the study area.

Potential habitat for *W. rotundifolia* exists in the estuarine saltmarsh in the study area. The proposed upgrade would result in impacts to approximately 0.93 ha (from 0.002 ha direct and 0.93 ha indirect) of potential habitat for *W. rotundifolia*. Further areas of potential habitat within the locality are likely to occur within the tidal zone at Werri Lagoon (north-east of Site 2) and Crooked River (Site 3) in association with estuarine fringe forest.

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 is very little published information on the lifecycle of *W. ilsonia rotundifolia*. According to the threatened species profile for this species (DEC 2005+):

- Flowers appear mainly in spring and summer.
- The fruit is an oval capsule containing one black seed.

Activities likely to impact on the lifecycle of the species are those that contribute to the following:

- Loss of individuals – *W. ilsonia rotundifolia* is not known to occur in the study area, therefore the proposed development is not likely to result in a loss of individuals of the species.
- Fragmentation of habitat – the habitat for the species in the study area is already fragmented by cleared and disturbed land. The proposed development impacts upon existing edges of potential habitat and would not increase fragmentation of potential habitat for the species.
- Modification of habitat – the potential habitat for *W. ilsonia rotundifolia* in the study area is already modified due to the ongoing impacts from edge effects (eg weeds) and disturbances such as grazing. The proposed upgrade may result in an increase in the intensity of some existing impacts.
- Damage to the soil seed bank – the proposed upgrade is likely to require the removal of some soil, which may have an impact on the soil seed bank of the species. However, the species is not known to occur in the study area, nor in the locality.
- Altered fire regimes – the proposed upgrade is not likely to alter the fire regimes of the study area.

*W. ilsonia rotundifolia* was not recorded in the study area, nor in the locality. Potential habitat for the species occurs in the estuarine saltmarsh in the study area. As no individuals have been recorded in the study area, it is unlikely that the proposed upgrade would have an adverse effect on the lifecycle of the species such that a viable local population of the species (if one exists) would be placed at risk of extinction.
In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

Not applicable.

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.

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

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

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

The local occurrence of potential habitat for *Wilsonia rotundifolia* within the study area is 19.6 ha. The proposed upgrade would result in clearing approximately 0.002 ha of *W. rotundifolia* habitat within the study area. This equates to 0.001 per cent of the local occurrence of *W. rotundifolia* habitat that would either be directly or indirectly impacted by the proposed upgrade within the study area.

The proposed upgrade impacts upon an existing edge along Fern Street and would not result in the fragmentation or isolation of any habitat for *W. rotundifolia* in the study area or locality.

The extent of potential habitat in the study area is already subject to impacts resulting from clearing, soil disturbance and grazing. The majority of the area directly impacted by the proposed upgrade is in moderate to poor condition with significant weed infestation. Given that no individuals of *W. rotundifolia* have been recorded in the study area; the area of potential habitat to be impacted is small; and, that indirect impacts are likely to be negligible, the importance of the habitat to be impacted to the long-term survival of the species is considered to be low.

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

Under the Threatened Species Conservation Act, the Director General maintains a Register of critical habitat. To date, no critical habitat has been declared for *W. rotundifolia*.

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

To date, no recovery plan for *W. rotundifolia* has been prepared. The threatened species profile for *W. rotundifolia* refers to five strategies to assist in recovery of this species. None of the listed strategies are relevant to the proposed upgrade (DEC 2005†).
The proposed upgrade and associated mitigation measures (see Chapter 5.0) are not inconsistent with listed priority actions, however, the clearing of a small area of potential habitat for W. rotundifolia would result from the proposed upgrade.

**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 following key threatening processes have been identified as threats to the EEC coastal saltmarsh (NSW Scientific Committee 2004a) and are therefore likely to constitute a threat to *Wilsonia rotundifolia*:

- Clearing of native vegetation – the proposed upgrade would result in the direct removal of approximately 0.002 ha of estuarine saltmarsh in the study area.
- Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands – The natural flow regime have already been altered with constructed canals. Existing hydrological regimes are subject to tidal influences emanating from Werri Lagoon to the east of the study area. These tidal influences are considered unlikely to be altered by the proposed upgrade.
- Invasion of native plant communities by exotic perennial grasses – exotic perennial grasses, such as *Pennisetum clandestinum* currently occur in the study area. These exotic grasses have the potential to spread further into the disturbed areas resulting from the proposed upgrade.
- High frequency fire – the proposed upgrade is not likely to alter the fire regime of the locality.

Other identified threats to *Wilsonia rotundifolia* include off-road vehicles, changes in tidal behaviour and grazing and trampling by stock (DEC 2005•). The proposed upgrade is unlikely to result in or increase the impact of these threats.

**Conclusion**

*Wilsonia rotundifolia* has not been recorded within 10 km of the study area. In determining the nature and magnitude of impacts on the potential habitat of *Wilsonia rotundifolia*, the proposed upgrade is considered unlikely to have a significant impact as:

- The species was not recorded during the field surveys of the study area.
- A relatively small disturbed area of potential habitat would be directly impacted.
- The proposed upgrade would not result in fragmentation or isolation of potential habitat.

However, the proposed upgrade has the potential to increase the operation of key threatening processes in the potential habitat of this species. On this basis, mitigation measures included in Chapter 5.0 of this report should be implemented in order to minimise potential indirect impacts resulting from the proposed upgrade.
Zieria granulata

*Zieria granulata* is listed as endangered on the Threatened Species Conservation Act.

This species is a tall bushy shrub that grows to six metres. The typical habitat is dry ridge tops and rocky outcrops on shallow volcanic soils, usually on Bombo Latite. Less frequently found on the moist slopes of the Illawarra escarpment and in low-lying areas on Quaternary sediments (DEC 2005). The species is restricted to the Illawarra region. The species primarily occupies the coastal lowlands between Oak Flats and Toolioo, in the local government areas of Shellharbour and Kiama.

*Zieria granulata* was not recorded in the study area; however potential habitat is considered to occur within subtropical dry rainforest and wet sclerophyll forest within the locality. These potential habitats include: coastal warm temperate rainforest, escarpment foothills wet forest, Illawarra gully wet forest, intermediate temperate rainforest, subtropical complex rainforest, subtropical dry rainforest, and temperate littoral rainforest. These vegetation communities occur as scattered patches throughout the locality and cover an area of approximately 1279.2 ha.

Approximately 0.009 ha of potential habitat for *Zieria granulata* would be cleared as part of the proposed upgrade with further potential indirect impacts to an additional 0.64 ha of potential habitat.

In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The following is known about the lifecycle of *Zieria granulata* (DEC 2005):

- Flowering occurs between early spring and summer.
- Seed dispersal is initially through forcible ejection from the mature fruit, and it is suspected that secondary dispersal by ants also occurs.
- Response to fire not known.

*Zieria granulata* was not recorded in the study area. There have been numerous recordings of the species to the north and west of the study area. The closest recording was approximately one kilometre to the north of the study area (Figure 3.2). Potential habitat for the species does, however, exist within or associated with rainforest communities in the study area. Since no individuals were recorded in the study area, it is unlikely that the proposed upgrade would have an adverse effect on the lifecycle of the species such that a viable population of the species would be placed at risk of extinction.

In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

Not applicable.

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

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

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

The species has not been recorded in the study area, however potential habitat for the species occurs within subtropical dry rainforest in the study area with further potential habitat in the locality as occurring within coastal warm temperate rainforest, escarpment foothills wet forest, Illawarra gully wet forest, Intermediate temperate rainforest, subtropical complex rainforest, subtropical dry rainforest, and temperate littoral rainforest. Vegetation mapping (DEC 2005t) indicates approximately 1,279.2 ha of these potential habitats occur within the locality (five kilometre radius of the study area).

Potential habitat for *Zieria granulata* that would be impacted by the proposed upgrade, are part of an already fragmented and cleared landscape. The proposed upgrade would impact upon the edge of an existing patch of potential habitat and would not increase fragmentation or isolation.

Approximately 0.009 ha of potential habitat for *Zieria granulata* would be directly impacted by the proposed upgrade. The area of potential habitat for *Zieria granulata* that would be removed as part of the proposed upgrade equates to 0.00076 per cent of the extent of these plant communities in the locality.

Potential habitat for *Zieria granulata* that would be disturbed as part of the proposed upgrade, occurs in the rainforest communities towards the north of the development footprint. These rainforest plant communities are fragmented by cleared and grazing land. The proposed upgrade would widen the existing cleared land, thus increase fragmentation. However it is unlikely to result in the isolation of areas of potential habitat for this species.

Given that the species has not been recorded in the study area; the small area of potential habitat directly impacted in relation to that in the locality area; potential habitat in the study area is not considered to be vital for the long-term survival of the species in the locality.

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

Under the Threatened Species Conservation Act, the Director General maintains a Register of Critical Habitat. To date, no critical habitat has been declared for *Zieria granulata*.

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

A recovery plan has been prepared for *Zieria granulata* (DEC 2005g). The objectives of the recovery plan are (DEC 2005g):

- To prevent the loss of sites through land-use change.
- To identify and manage the threats operating at sites that contain the species.
- To provide the community with information that assists in conserving the species.
- To raise awareness of the species and involve the community in the recovery program.
- To establish the extent of the current distribution of the species.
- To promote research that would assist with the management of the species.
To maintain an ex-situ seed collection for the species.

Given that this species was not recorded in the study area, the proposed upgrade is not considered to be inconsistent with the above listed recovery plan objectives.

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 following key threatening processes, as listed under the Threatened Species Conservation Act, are relevant to the proposed upgrade and may impact on *Zieria granulata*:

- ‘Clearing of native vegetation’ - The proposed upgrade would result in the clearing of approximately 0.009 ha of potential habitat for *Zieria granulata*.
- Infection of native plants by *Phytophthora cinnamomi* - there is potential for construction vehicles to spread *Phytophthora cinnamomi* if they have come into contact with the soil pathogen. As a precaution, vehicles should be washed down prior to use on site.
- Invasion of native plant communities by exotic perennial grasses - given the presence of existing perennial grasses within the study area, there is potential for construction vehicles to spread seed of these invasive species into the subject site. As a precaution, vehicles should be washed down prior to use on site.
- Invasion, establishment and spread of *Lantana camara* - *Lantana camara* was recorded growing underneath the existing power line easement within the subject site. To prevent further spread of this invasive species, cleared *Lantana camara* should be bagged and disposed of off-site at an appropriate waste disposal facility.

The proposed upgrade may increase the potential operation of these key threatening processes in relation to the potential habitat of *Zieria granulata* in the study area.

**Conclusion**

In determining the nature and magnitude of impacts on the potential habitat of *Zieria granulata*, the proposed upgrade is considered unlikely to have a significant impact as:

- The species was not recorded during the field surveys of the study area.
- A relatively small disturbed area of potential habitat would be directly impacted.
- The proposed upgrade would not result in fragmentation or isolation of the potential habitat.

However, the proposed upgrade has the potential to increase the operation of key threatening processes in the potential habitat of this species. On this basis, mitigation measures included in Chapter 5.0 of this report should be implemented in order to minimise potential indirect impacts resulting from the proposed upgrade.
Irenepharsus trypherus

*Irenepharsus trypherus* is listed as Endangered on the Threatened Species Conservation Act.

*Irenepharsus trypherus* is a hairless annual or short-lived perennial herb that grows to 250 cm. It has a spreading to erect habit and is often multi-stemmed. The species typically inhabits steep rocky slopes near cliff lines and ridge tops. The species is less typically found growing out of rock crevices or on narrow benches along cliff lines. The vast majority of sites are recorded from the upper slopes of the ridge systems that extend south and east of the Illawarra escarpment, although the species has also been recorded from the deep sandstone gorges of the Shoalhaven River (DEC 2005q).

*Irenepharsus trypherus* was not recorded in the study area; however potential habitat does exist within the study area. Potential habitat for *Irenepharsus trypherus* is considered to include subtropical dry rainforest and wet sclerophyll forests. These include vegetation communities: coastal warm temperate rainforest, escarpment foothills wet forest, Illawarra gully wet forest, intermediate temperate rainforest, subtropical complex rainforest, subtropical dry rainforest, and temperate littoral rainforest. These vegetation communities occur as scattered patches throughout the locality and cover an area of approximately 1279.1 ha.

Approximately 0.009 ha of potential habitat for *Irenepharsus trypherus* would be directly impacted as part of the proposed upgrade with further potential indirect impacts to an additional 0.64 ha.

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 following is known about the lifecycle of *Irenepharsus trypherus* (DEC 2005q):

- Mature plants are capable of reshooting from dry or desiccated stems following light grazing, trampling, or drought.
- The species is thought to be a prolific seeder, with disturbance and light levels influencing germination.
- Fire response of this species, is unknown.

Activities likely to effect on the lifecycle of the species are those that contribute to the following (DEC 2005g):

- Loss of individuals – *Irenepharsus trypherus* is not known to occur in the study area, therefore the proposed upgrade is not likely to result the loss of individuals of the species.
- Fragmentation of habitat – the potential habitat for *Irenepharsus trypherus* would not be fragmented as a result of the proposed upgrade.
- Modification of habitat – the potential habitat for *Irenepharsus trypherus* in the study area is already modified due to the ongoing impacts from edge effects (eg weeds) and disturbances such as grazing. The proposed development may result in an increase in the intensity of some existing impacts.
- Damage to the soil seed bank – the proposed upgrade may involve the removal of some soil. This may lead damage the soil seed bank of the subject site.
- Altered fire regimes – the proposed upgrade is not likely to alter the fire frequency of the locality.

On the basis of the above, the proposed upgrade is considered unlikely to have an adverse effect on the lifecycle of the species such that a viable local population (if one exists) of the species would be placed at risk of extinction.
In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

Not applicable.

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.

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

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

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

The species has not been recorded in the study area, however potential habitat for the species occurs within subtropical dry rainforest in the study area with further potential habitat in the locality occurring within coastal warm temperate rainforest, escarpment foothills wet forest, Illawarra gully wet forest, intermediate temperate rainforest, subtropical complex rainforest, subtropical dry rainforest, and temperate littoral rainforest. Vegetation mapping (DEC 2005t) indicates approximately 1,171.5 ha of these potential habitats occur within the locality (five kilometres radius of the study area).

The potential habitat for this species within the study area is in moderate to poor condition, due to the dominance of exotic species in the understorey, altered community structure and existing fragmentation.

Approximately 0.009 ha of potential habitat for *Irenepharsus trypherus* would be directly impacted by the proposed development. The area of potential habitat for *Irenepharsus trypherus* that would be removed as part of the proposed development equates to 0.00076 per cent of the extent of similar potential habitats mapped in the locality.

Potential habitat for *Irenepharsus trypherus* that would be impacted by the proposed upgrade, are part of an already fragmented and cleared landscape. The proposed upgrade would impact upon the edge of an existing patch of potential habitat and would not increase fragmentation or isolation.

Given that the species has not been recorded in the study area; the small area of potential habitat to be impacted in relation to that in the locality; potential habitat in the study area is not considered to be vital for the long-term survival of the species in the locality.

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

Under the Threatened Species Conservation Act, the Director General maintains a register of critical habitat. To date, no critical habitat has been declared for *Irenepharsus trypherus*. 
Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

A recovery plan has been prepared for *Irenepharsus trypherus*. The objectives of the recovery plan are (DEC 2005a):

- To prevent the loss of sites through land-use change.
- To identify and manage the threats operating at sites that contain the species.
- To provide the community with information that assists in conserving the species.
- To raise awareness of the species and involve the community in the recovery program.
- To establish the extent of the current distribution of the species.
- To promote research that would assist with the management of the species.
- To maintain an ex-situ seed collection for the species.

The proposed upgrade is not considered to be inconsistent with the above listed recovery plan objectives.

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 following key threatening processes, as listed under the Threatened Species Conservation Act, are relevant to the proposed upgrade and may impact on the species:

- 'Clearing of native vegetation'- The proposed upgrade would result in the clearing of approximately 0.009 ha of potential habitat for *Syzygium paniculatum*.
- 'Invasion of native plant communities by exotic perennial grasses' – exotic perennial grasses such as *Pennisetum clandestinum* and *Ehrharta erecta* currently occur in proximity of the study area. These exotic grasses have the potential to spread further into the adjoining bushland after disturbance associated with the proposed upgrade.
- Infection of native plants by *Phytophthora cinnamomi* – there is potential for construction vehicles to spread *Phytophthora cinnamomi* if they have come into contact with the soil pathogen. As a precaution, vehicles should be washed down prior to use on site.
- 'Invasion, establishment and spread of *Lantana camara* - *Lantana camara* is an existing threat to the native plant communities in and surrounding the study area. The proposed upgrade would involve vegetation disturbance which could lead to further spread of *Lantana camara*.

Conclusion

*Irenepharsus trypherus* has not been recorded within 10 km of the study area. In determining the nature and magnitude of impacts on the potential habitat of *Irenepharsus trypherus*, the proposed upgrade is considered unlikely to have a significant impact as:

- The species was not recorded during the field surveys of the study area.
- A relatively small disturbed area of potential habitat would be directly impacted.
- The proposed upgrade would not result in fragmentation or isolation of the potential habitat.

However, the proposed upgrade has the potential to increase the operation of key threatening processes in the potential habitat of this species. On this basis, mitigation measures included in Chapter 5.0 of this report should be implemented in order to minimise potential indirect impacts resulting from the proposed upgrade.
Illawarra subtropical rainforest (ISR)

Illawarra subtropical rainforest is listed as an EEC in Part 3 of Schedule 1 of the Threatened Species Conservation Act.

Subtropical dry rainforest occurring in the study area is included within the EEC, Illawarra subtropical rainforest in the Sydney Basin Bioregion. Subtropical dry rainforest is a low closed forest characterised by a dense tree canopy, prominent small tree / shrub layer and a sparse groundcover (DEC 2005q). This community is distributed on the lowlands between Mount Keira and Nowra, with a southern occurrence near Milton (DEC 2005q).

The proposed development would result in impacts to approximately 0.64 ha (from 0.009 ha direct and 0.63 ha indirect) of this EEC. Other plant communities occurring within the locality are also included as part of this EEC including coastal warm temperate rainforest and subtropical complex rainforest. The total area of Illawarra subtropical rainforest mapped (DEC 2005t) within the locality is 1100.8 ha.

In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Not applicable.

In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

Not applicable.

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.

Illawarra subtropical rainforest has been recorded from the local government areas of Wollongong, Shellharbour, Shoalhaven and Kiama, but may occur elsewhere in the Sydney Basin Bioregion (DEC 2005o). The main occurrences of Illawarra subtropical rainforest are located between Albion Park and Gerringong and on the Berkeley Hills north of Lake Illawarra (DEC 2005m). Outlying occurrences extend south to the Shoalhaven River and west into the Kangaroo Valley (DEC 2005p). The community generally occurs on the coastal plain and escarpment foothills, rarely extending onto the upper escarpment slopes (NSW Scientific Committee 2002). Illawarra subtropical rainforest occurs in the study area as a single fragment near Mount Pleasant (Site 1) (Figure 1.1 and Figure 3.1).

The proposed upgrade would result in direct impacts to approximately 0.009 ha with a further 0.63 ha subject to potential indirect impacts. The patch of Illawarra subtropical rainforest that would be directly impacted as a result of the proposed works is in moderate to poor condition, being already highly modified through disturbances such as weed invasion, grazing, fragmentation and edge effects. Given the presence of ongoing disturbances, without significant resources allocated to its rehabilitation it is likely that the patch would further degrade with time.

The proposed upgrade is unlikely to adversely affect the extent or composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.
In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which the 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.

NSW National Parks and Wildlife Service (NPWS 2002b) have mapped approximately 1100.8 ha of Illawarra subtropical rainforest within the locality (five kilometres radius of the study area). The Illawarra subtropical rainforest within the study area is in variable condition, ranging from poor near the existing roadside edges, to good in core forested areas. The area that would be impacted by the proposed upgrade equates to approximately 0.06 per cent of the local distribution of this EEC in the locality.

The proposed upgrade impacts upon an existing edge along the existing Princes Highway and would not result in the fragmentation or isolation of any Illawarra subtropical rainforest in the study area or locality.

Given the condition and small area of this EEC which would be removed, this patch of vegetation is not considered to be vital for the long-term survival of the EEC in the locality.

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

Under the Threatened Species Conservation Act, the Director General maintains a Register of Critical Habitat. To date, no critical habitat has been declared for Illawarra subtropical rainforest.

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

A recovery plan for Illawarra subtropical rainforest has not been prepared to date. The threatened species profile for Illawarra subtropical rainforest refers to 17 priority actions to assist in recovery of the EEC. Those considered relevant to the proposed upgrade include (DEC 2005m):

- Install fencing and signage to exclude livestock and machinery, and prevent rubbish dumping.
- Implement weed control programs.
- Protect remnants from clearing and further fragmentation.
- Restore degraded habitat using bush regeneration techniques.

The proposed upgrade and associated mitigation measures are not inconsistent with the priority actions that relate to the recovery of the EEC.

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 following key threatening processes, as listed under the Threatened Species Conservation Act, are relevant to the proposed development and may impact on Illawarra subtropical rainforest:

- ‘Clearing of native vegetation’ - The proposed development would involve clearing of approximately 0.009 ha of Illawarra subtropical rainforest.
- ‘Invasion of native plant communities by exotic perennial grasses’ – exotic perennial grasses, such as *Pennisetum clandestinum* currently occur in the study area. These exotic grasses have the potential to spread further into the disturbed areas resulting from the proposed upgrade.
Invasion, establishment and spread of *Lantana camara* - *Lantana camara* is an existing threat to the native plant communities in and surrounding the study area, including Illawarra subtropical rainforest. *Lantana camara* has the potential to spread further into disturbed areas as a result of the proposed upgrade.

The proposed upgrade has the potential to increase the operation of the above listed key threatening processes.

**Conclusion**

In determining the nature and magnitude of the impact on this EEC the proposed upgrade is unlikely to have a significant impacts as:

- A relatively small disturbed area would be directly impacted.
- The proposed upgrade would not result in fragmentation or isolation of the EEC.
- The proposed upgrade is unlikely to adversely affect the extent or composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

However, the proposed upgrade has the potential to increase the operation of key threatening processes. On this basis, mitigation measures included in Chapter 5.0 of this report should be implemented in order to minimise potential indirect impacts resulting from the proposed upgrade.
Coastal saltmarsh

Coastal saltmarsh is listed as an Endangered Ecological Community in Part 3 of Schedule 1 of the Threatened Species Conservation Act.

Coastal saltmarsh occurs in the intertidal zone on the shores of estuaries and lagoons that are permanently or intermittently open to the sea (DEC 2005e). This community is known to occur at coastal NSW locations including Botany Bay, Jervis Bay and the Shoalhaven, Clyde and Deua estuaries. Within the study area, coastal salt marsh is represented as estuarine saltmarsh, which is a component of the EEC. This community is confined to Site 2 (Figure 1.1) immediately east of Fern Street in the north of Gerringong.

The proposed upgrade would result in impacts to approximately 0.93 ha (from 0.002 ha direct and 0.93 ha indirect) of this EEC. Further areas of estuarine saltmarsh within the locality are likely to occur within the tidal zone at Werri Lagoon (north-east of Site 2) and Crooked River (Site 3) in association with estuarine fringe forest.

In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Not applicable.

In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

Not applicable.

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.

The vegetation in the study area occurs within a largely cleared rural area currently utilised for grazing. Based on amended vegetation mapping (DEC 2005t) approximately 19.76 ha of Coastal saltmarsh (estuarine saltmarsh) occurs within a five kilometre radius of the study area. The proposed upgrade would result in direct impacts to approximately 0.002 ha of Coastal saltmarsh. This equates to 0.001 per cent of the local occurrence of Coastal saltmarsh that impacted by the proposed upgrade within the study area.

Given the open nature of this plant community, indirect impacts are considered unlikely to extend 50 m beyond the development footprint. Existing hydrological regimes are subject to tidal influences emanating from Werri Lagoon to the east of the study area. These tidal influences are considered unlikely to be altered by the proposed upgrade. It is considered unlikely that this extent of impact would place the local occurrence of Coastal saltmarsh at risk of extinction.

Given the small area of Coastal saltmarsh that would be impacted, it is considered unlikely that the proposed upgrade would adversely modify the composition of the EEC such that its local occurrence would be placed at risk of extinction.
In relation to the habitat of a threatened species, population or ecological community:

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

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

The local occurrence of Coastal saltmarsh habitat within the study area is 19.6 ha. The proposed upgrade would result in clearing approximately 0.002 ha of Coastal saltmarsh habitat within the study area. This equates to 0.001 per cent of the local occurrence of Coastal saltmarsh habitat that would either be directly or indirectly impacted by the proposed upgrade within the study area.

The proposed upgrade impacts upon an existing edge along the existing Fern Street and would not result in the fragmentation or isolation of any coastal saltmarsh in the study area or locality.

The extent of this community in the study area is already subject to impacts resulting from clearing, soil disturbance and grazing. The majority of the area directly impacted by the proposed upgrade is in moderate to poor condition with significant weed infestation. Due to the small area to be impacted and the negligible indirect impacts, the importance of the habitat to be impacted, to the long-term survival of the community as a whole, is considered to be low.

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

Under the Threatened Species Conservation Act, the Director General maintains a Register of critical habitat. To date, no critical habitat has been declared for coastal saltmarsh.

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

To date, no recovery plan for coastal saltmarsh has not been prepared. The threatened species profile for coastal saltmarsh refers to eight strategies to assist in recovery of the EEC. Those relevant to the proposed upgrade include (DEC 2005e):

- Install fencing and signage to exclude livestock and machinery, and prevent rubbish dumping.
- Implement weed control programs.
- Protect remnants from clearing and further fragmentation.
- Restore degraded habitat using bush regeneration techniques.

The proposed upgrade and associated mitigation measures (see Chapter 5.0) are largely consistent with the above listed priority actions, however, the clearing of a small area of coastal saltmarsh would result from the proposed upgrade.

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 following key threatening processes listed by the Threatened Species Conservation Act may threaten coastal saltmarsh (NSW Scientific Committee 2004a):

- Clearing of native vegetation - the proposed upgrade would result in the direct removal of approximately 0.002 ha of coastal saltmarsh in the study area.
- Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands – The natural flow regime has already been altered with constructed canals. Existing hydrological regimes are subject to tidal influences emanating from Werri Lagoon to the east of the study area. These tidal influences are considered unlikely to be altered by the proposed upgrade.

- Invasion of native plant communities by exotic perennial grasses’ – exotic perennial grasses, such as *Pennisetum clandestinum* currently occur in the study area. These exotic grasses have the potential to spread further into the disturbed areas resulting from the proposed upgrade.

- High frequency fire – the proposed upgrade is not likely to alter the fire regime of the locality.

- Invasion and establishment of exotic vines and scramblers – coastal saltmarsh is specifically listed as an ecological community impacted by this key threatening process (NSW Scientific Committee 2006a). Exotic vines and scramblers are present in vicinity of the study area. These invasive species have the potential to invade disturbed areas resulting from the proposed upgrade.

**Conclusion**

In determining the nature and magnitude of the impact on this EEC the proposed upgrade is unlikely to have a significant impacts as:

- A relatively small disturbed area would be directly impacted.
- The proposed upgrade would not result in fragmentation or isolation of the EEC.
- The proposed upgrade is unlikely to adversely affect the extent or composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

However, the proposed upgrade has the potential to increase the operation of key threatening processes. On this basis, mitigation measures included in Chapter 5.0 of this report should be implemented in order to minimise potential indirect impacts resulting from the proposed upgrade.
C-2 Fauna

Rose-crowned Fruit-dove (Ptilinopus regina)

The Rose-crowned Fruit-dove is listed as Vulnerable under Schedule 2 of the Threatened Species Conservation Act.

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 Rose-crowned Fruit-dove occurs in rainforest and similar closed forests where it forages on fleshy fruits from a variety of trees. It prefers large expanses of undisturbed forest, but can be found in very small remnants. It has also been recorded near wetlands and Melaleuca forest. It has also been recorded feeding in isolated fruit trees and sometimes in gardens (Higgins and Davies 1996). They are also known to use stands of Camphor laurel as a source of food (DEC 2005w).

The Rose-crowned Fruit-dove nests in dense rainforest, but also in the Eucalyptus or Melaleuca ecotone with rainforest, and in mangroves. It is considered partially nomadic, following the fruiting patterns of trees within a local area (Higgins and Davies 1996).

The Rose-crowned Fruit-dove was not recorded during the current surveys and no records occur within the locality. However potential habitat for this species does occur within the subtropical dry rainforest in the northern section of the study area. The proposed upgrade is likely to clear approximately 0.009 ha of subtropical dry rainforest habitat for this species, with a further 0.63 ha likely to be indirectly impacted. The habitat to be impacted occurs along the roadside and has been subjected to disturbance and is considered to be in poor condition. As such, this habitat is likely to provide only marginal foraging resources for the Rose-crowned Fruit-dove. Given this species is mobile and the small area of foraging habitat to be removed, it is not likely to alter the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

An Endangered Population is a population listed under Part 2 of Schedule 1 of the Threatened Species Conservation Act and is defined as a population that, in the opinion of the NSW Scientific Committee, is facing a very high risk of extinction in NSW. A population is not eligible to be listed as an Endangered Population if it is a population of a species already listed in Schedule 1 or 1A (ie already listed as an Endangered or Critically Endangered species).

There are currently no endangered populations listed for the Rose-crowned Fruit-dove in NSW.

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

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

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

The Rose-crowned Fruit-Dove was not recorded during the current surveys and has not been previously recorded in the locality. Impacts to the Rose-crowned Fruit-dove would involve the removal or modification of approximately 0.64 ha of marginal foraging habitat (0.009 ha direct impacts and 0.63 ha of indirect impacts). These impacts equate to 0.8 per cent of the occurrence of subtropical dry rainforest within the locality.

Subtropical dry rainforest habitat within the study area is part of a heavily fragmented landscape and is dissected by agricultural, road and electricity easements. No new edges would be created by the proposed upgrade as only the existing edges of the rainforest would be removed. Given this and the high mobility of the fruit-dove (considered partially nomadic, following the fruiting patterns of trees within a local area (Higgins and Davies 1996), the proposed upgrade would not result in habitat fragmentation or isolation for this species.

Potential habitat to be removed /modified occurs along the roadside edge and has been subjected to edge disturbances, and as such is considered to be in poor condition. A local population of Rose-crowned Fruit-dove would be unlikely to rely on the disturbed rainforest within the subject site for ongoing survival. The potential habitat to be removed is considered to be of low importance to the long-term survival of the Rose-crowned Fruit-dove in the locality.

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

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations or ecological communities. Under the Threatened Species Conservation Act, the Director General maintains a register of critical habitat. To date, no critical habitat has been declared for the Rose-crowned Fruit-dove.

Whether the action proposed is consistent with the objectives or actions of a Recovery Plan or Threat Abatement Plan.

To date, no recovery plan or threat abatement plan has been written for the Rose-crowned Fruit-dove. However, the DECCW has listed 19 Priority Actions and a number of recovery strategies to help recover the Rose-crowned Fruit-dove in NSW; those relevant to the proposed upgrade include:

- Liaise with relevant landholders and managers to protect, rehabilitate, enlarge and reconnect habitat. Raise awareness of weed threats and need for compensatory plantings.
- Retain forested corridors that link north-south and east-west migration routes.
- Encourage and initiate weed control programs.
- Protect known and potential food trees.
The proposed upgrade would involve clearing of potential marginal habitat for the Rose-crowned Fruit-dove. The proposed upgrade also has the potential to increase weed invasion. As such, the proposed upgrade is not entirely consistent with the objectives outlined by the DECCW (in the absence of a recovery plan).

A number of recommendations (see Chapter 5.0) have been made to mitigate weed infestation within the study area.

**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 Rose-crowned Fruit-dove is threatened by the clearing and fragmentation of low to mid-elevation rainforest, logging and road construction in moist eucalypt forest with well-developed rainforest understorey, burning of remnant rainforest habitat, invasion of habitat by introduced weed species, and removal of *Camphor laurel* food source without appropriate mitigation measures (DEC 2005w).

The Rose-crowned Fruit-dove is threatened by the following key threatening processes as listed under Schedule 3 of the Threatened Species Conservation Act:

- **Clearing of Native Vegetation (NSW Scientific Committee 2001)** - the proposed upgrade would involve clearing of 0.009 ha of native vegetation that is potential habitat for the Rose-crowned Fruit-dove.
- **Ecological Consequences of High Frequency Fires (NSW Scientific Committee 2000)** - the proposed upgrade is not likely to alter the fire frequency within areas that are potential habitat for the Rose-crowned Fruit-dove.
- **Invasion of Native Plant Communities by Lantana (NSW Scientific Committee 2006)** - the proposed upgrade has the potential to increase invasion by lantana along any new disturbed edges created.

**Conclusion**

The proposed upgrade would have the following impacts on the Rose-crowned Fruit-dove:

- Approximately 0.64 ha of marginal foraging habitat for this species would be modified and/or removed.
- Increase in the impact of two key threatening processes.

The proposed upgrade is considered **unlikely** to result in a significant impact on a local population of the Rose-crowned Fruit-dove as:

- Breeding habitat is unlikely to be removed.
- Potential foraging habitat to be removed is in poor condition.
- No individuals of this species have been recorded in the locality.
- The proposed upgrade would not have an adverse effect on critical habitat (directly or indirectly).
- The habitat to be impacted by the proposed upgrade is not considered to be important for the long-term survival of the species in the locality.

Based on the above assessment, a species impact statement is not considered necessary.
**Superb Fruit-dove (Ptilinopus superbus)**

The Superb Fruit-dove is listed as Vulnerable under Schedule 2 of the Threatened Species Conservation Act.

_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 Superb Fruit-dove occurs in rainforest and similar closed forests where it forages on fleshy fruits from a variety of trees (including introduced species), vines and palms. It may also forage in eucalypt or acacia woodland where fruit-bearing trees are found (DEC 2005Y), and has been recorded in shrubby regrowth, often where infestations of _Lantana camara_ occur (Higgins and Davies 1996).

The Superb Fruit-dove breeding habits are poorly known, but it has been recorded using horizontal forks of shrubs or small trees and vine thickets for nesting (Higgins and Davies 1996). It has been recorded nesting in wet sclerophyll forest or rainforest near foraging habitat (DEC 2005Y).

The Superb Fruit-dove is highly mobile but its movements are poorly known. There are no records of the Superb Fruit-dove in the locality. Potential habitat for this species occurs within the subtropical dry rainforest in the northern section of the study area. The proposed upgrade is likely to clear approximately 0.009 ha of subtropical dry rainforest habitat for this species, with a further 0.63 ha likely to be indirectly impacted. The habitat to be impacted occurs along the roadside and has been subjected to disturbance and is considered to be in poor condition. As such, this habitat is likely to provide only marginal foraging resources for the Rose-crowned Fruit-dove. Given this species is mobile and the small area of foraging habitat to be removed, it is not likely to alter the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

_In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction._

An Endangered Population is a population listed under Part 2 of Schedule 1 of the Threatened Species Conservation Act and is defined as a population that, in the opinion of the NSW Scientific Committee, is facing a very high risk of extinction in NSW. A population is not eligible to be listed as an Endangered Population if it is a population of a species already listed in Schedule 1 or 1A (ie already listed as an Endangered or Critically Endangered species).

There are currently no endangered populations listed for the Superb Fruit-dove in NSW.

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

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

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

The Superb Fruit-dove was not recorded during the current surveys and has not been previously recorded in the locality. Impacts to the Superb Fruit-dove would involve the removal or modification of approximately 0.64 ha of marginal foraging habitat (0.009 ha direct impacts and 0.63 ha of indirect impacts). These impacts equate to 0.8 per cent of the occurrence of subtropical dry rainforest within the locality.

Subtropical dry rainforest habitat within the study area is part of a heavily fragmented landscape and is dissected by agricultural, road and electricity easements. No new edges would be created by the proposed upgrade as only the existing edges of the rainforest would be removed. Given this and the high mobility of the fruit-dove, the proposed upgrade would not result in habitat fragmentation or isolation for this species.

Potential habitat to be removed / modified occurs along the roadside edge and has been subjected to edge disturbances, and as such is considered to be in poor condition. A local population of Superb Fruit-dove would be unlikely to rely on the disturbed rainforest within the subject site for ongoing survival. The potential habitat to be removed is considered to be of low importance to the long-term survival of the Superb Fruit-dove in the locality.

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

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations or ecological communities. Under the Threatened Species Conservation Act, the Director General maintains a register of critical habitat. To date, no critical habitat has been declared for the Superb Fruit-dove.

Whether the action proposed is consistent with the objectives or actions of a Recovery Plan or Threat Abatement Plan.

To date, no recovery plan or threat abatement plan has been written for the Superb Fruit-dove. The DECCW however, has listed 16 Priority Actions and a number of recovery strategies to help recover the Superb Fruit-dove in NSW; those relevant to the proposed upgrade include:

- Liaise with relevant landholders and managers to protect, rehabilitate, enlarge and reconnect habitat. Raise awareness of weed threats and need for compensatory plantings.
- Retain and protect rainforest remnants.

The proposed upgrade would involve clearing of potential marginal habitat for the Superb Fruit-dove. The proposed upgrade also has the potential to increase weed invasion. As such, the proposed upgrade is not entirely consistent with the objectives outlined by the DECCW (in the absence of a recovery plan).

A number of recommendations (see Chapter 5.0) have been made to mitigate weed infestation within the study area.
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 Superb Fruit-dove is threatened by the clearing and degradation of rainforest remnants (DEC 2005Y).

The Superb Fruit-dove is threatened by the following key threatening processes as listed under Schedule 3 of the Threatened Species Conservation Act:

- Clearing of Native Vegetation (NSW Scientific Committee 2001) - the proposed upgrade would involve clearing of 0.009 ha of native vegetation that is potential habitat for the Superb Fruit-dove.
- Ecological Consequences of High Frequency Fires (NSW Scientific Committee 2000) - the proposed upgrade is not likely to alter the fire frequency within areas that are potential habitat for the Superb Fruit-dove.

Conclusion

The proposed upgrade would have the following impacts on the Superb Fruit-dove:

- Approximately 0.64 ha of marginal foraging habitat for this species would be modified and/or removed.
- Increase in the impact of one key threatening process.

The proposed upgrade is considered unlikely to result in a significant impact on a local population of the Superb Fruit-dove as:

- Breeding habitat is not likely to be removed.
- Potential foraging habitat to be removed is marginal and in poor condition.
- No individuals of this species have been recorded in the locality.
- The proposed upgrade would not have an adverse effect on critical habitat (directly or indirectly).
- The habitat to be impacted by the proposed upgrade is not considered to be important for the long-term survival of the species in the locality.

Based on the above assessment, an species impact statement is not considered necessary.
Yellow-bellied Sheathtail Bat (*Saccolaimus flaviventris*), Eastern Freetail Bat (*Mormopterus norfolkensis*), Eastern False Pipistrelle (*Falsistrellus tasmaniensis*) and Greater Broad-nosed Bat (*Scoteanax rueppellii*)

The Yellow-bellied Sheathtail Bat, Eastern Freetail Bat, Eastern False Pipistrelle and Greater Broad-nosed Bat are listed as Vulnerable under Schedule 2 of the Threatened Species Conservation Act.

These four species have been considered together for this assessment based on their similar habitat requirements (ie tree hollow-dependant).

Note: a taxonomic revision of Australian molossids has lead to a change of the Eastern Freetail Bat’s scientific name from *Mormopterus norfolkensis* to *Micronomus norfolkensis* (Churchill 2008) however, as the Census of Australian Vertebrates and the DECCW are yet to adopt the name change, *Mormopterus norfolkensis* is used in this report.

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 Yellow-bellied Sheathtail Bat, Eastern Freetail Bat, Eastern False Pipistrelle and Greater Broad-nosed Bat are known to be tree-hollow dependent (Churchill 2008). The Greater Broad-nosed Bat and Eastern Freetail Bat tend to forage along gaps and edges of forests and bushland patches (Churchill 2008), whereas the Eastern False Pipistrelle and Yellow-bellied Sheathtail Bat are faster fliers with greater manoeuvrability. The Eastern False Pipistrelle forages below or within the forest canopy while the Yellow-bellied Sheathtail Bat forages above the canopy (Churchill 2008).

The study area provides potential breeding habitat for these four microbats in the form of hollow-bearing trees. Few hollow-bearing trees occur within the predominantly cleared subject site and no tree hollows would be removed from the rainforest. These microbats are likely to forage aerially for insects within the study area, however, the study area is not considered to provide limiting foraging resources.

All four microbats have been previously recorded within the locality. These species have not been recorded within the study area however no targeted surveys were conducted within the study area due to the lack of habitat. The closest record to the study area is of the Eastern False Pipistrelle and occurs approximately 1.7 km west of Mount Pleasant, recorded in 1999.

The proposed upgrade is unlikely to impact the foraging behaviour of the four microbats as no limiting foraging resources occur on site. Potential breeding habitat, tree hollows, would be removed by the proposed upgrade.

Given that few tree hollows would be removed, that other tree hollows within and surrounding the study area would be retained, the low condition of the potential habitat to be removed (ie isolated roadside trees), and the high mobility of these species, it is considered unlikely that the proposed upgrade would have an adverse effect on the life cycle of the Yellow-bellied Sheathtail Bat, Eastern Freetail Bat, Eastern False Pipistrelle or Greater Broad-nosed Bat such that a viable local population of these species is likely to be placed at risk of extinction.
In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

An Endangered Population is a population listed under Part 2 of Schedule 1 of the Threatened Species Conservation Act and is defined as a population that, in the opinion of the NSW Scientific Committee, is facing a very high risk of extinction in NSW in the near future. A population is not eligible to be listed as an Endangered Population if it is a population of a species already listed in Schedule 1 or 1A (i.e., already listed as an Endangered or Critically Endangered species).

There are currently no Endangered Populations listed for the Yellow-bellied Sheathtail Bat, Eastern Freetail Bat, Eastern False Pipistrelle or Greater Broad-nosed Bat in NSW.

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 to threatened species.

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

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

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

The proposed upgrade would result in the removal of approximately 0.009 ha of subtropical dry rainforest and 0.002 ha of estuarine saltmarsh (which consists largely of non-limiting foraging habitat). A further 0.63 and 0.93 ha of rainforest and saltmarsh would be indirectly impacted, respectively. These impacts equate to 0.8 per cent of the occurrence of subtropical dry rainforest and 4.7 per cent of the occurrence of estuarine saltmarsh within the locality. In addition, a small number of isolated roadside hollow-bearing trees (unmapped) would be removed.

No new edges would be created by the proposed upgrade as only the existing edges of the rainforest and saltmarsh would be removed. Given this and the high mobility of the microbats, the proposed upgrade would not result in habitat fragmentation or isolation for these species.

The area of potential habitat to be removed by the proposed upgrade is small, does not provide limiting foraging resources and provides only minimal breeding resources (e.g., few hollow-bearing trees). A local population of these microbat species would be unlikely to rely on the few isolated tree hollows within the subject site for ongoing survival. The potential habitat to be removed is disturbed (e.g., cleared, edge-effected) and is considered to be of low importance to the long-term survival of the Yellow-bellied Sheathtail Bat, Eastern Freetail Bat, Eastern False Pipistrelle and Greater Broad-nosed Bat in the locality.
W hether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations or ecological communities. Under the Threatened Species Conservation Act, the Director General maintains a register of critical habitat. To date, no critical habitat has been declared for the Yellow-bellied Sheathtail Bat, Eastern Freetail Bat, Eastern False Pipistrelle or Greater Broad-nosed Bat.

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

There is currently no recovery plan or threat abatement plan for these microbats. DECCW, however, has listed 20, 18, 16 and 19 Priority Actions and recovery strategies, to help recover the Yellow-bellied Sheathtail Bat, Eastern Freetail Bat, Eastern False Pipistrelle and Greater Broad-nosed Bat, respectively. Those relevant to the proposed upgrade include:

- Retain hollow-bearing trees and provide for hollow tree recruitment.
- Ensure the largest hollow-bearing trees, including dead trees and paddock trees, are given highest priority for retention in PVP assessments.
- Retain foraging habitat.
- Conduct searches for the species in suitable habitat in proposed development areas.
- Assess the site’s importance to the species’ survival, including linkages provided between ecological resources across the broader landscape.

No known or significant roost sites would be removed by the proposed upgrade however a small number of roadside hollow-bearing trees (potential roosting / breeding habitat) would be removed. The proposed upgrade would involve clearing of native vegetation which constitutes foraging habitat for the four microbats. As such, the proposed upgrade is not entirely consistent with the objectives outlined by DECCW (in the absence of a recovery plan).

W hether 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.

Threats to the Yellow-bellied Sheathtail Bat include: disturbance to roosting and summer breeding sites; foraging habitats being cleared for residential and agricultural developments, including clearing by residents within rural subdivisions; loss of hollow-bearing trees; clearing and fragmentation of forest and woodland habitat; and, use of pesticides and herbicides (which may reduce the availability of insects, or result in the accumulation of toxic residues in individuals fat stores) (DEC 2005~).

The main threats to the Eastern Freetail Bat include: loss of hollow-bearing trees, loss of foraging habitat and application of pesticides in or adjacent to foraging areas (DEC 2005i).

Threats to the Eastern False Pipistrelle include: disturbance to winter roosting and breeding sites; loss of trees for foraging and hollow-bearing trees for roosting; and, application of pesticides in or adjacent to foraging areas (DEC 2005i).

The main threats to the Greater Broad-nosed Bat include: disturbance to roosting and summer breeding sites; foraging habitats being cleared for residential and agricultural developments, including clearing by residents within rural subdivisions; loss of hollow-bearing trees; the use of pesticides and herbicides (may reduce the availability of insects or result in the accumulation of toxic residues in individuals fat stores); and, changes to water regimes (which are likely to impact food resources) (DEC 2005k).
The Yellow-bellied Sheathtail Bat, Eastern Freetail Bat, Eastern False Pipistrelle and Greater Broad-nosed Bat are threatened by the following key threatening processes as listed under Schedule 3 of the Threatened Species Conservation Act:

- Clearing of Native Vegetation (NSW Scientific Committee 2001) - the proposed upgrade would involve clearing of 0.01 ha of native vegetation that provides general foraging habitat for the four microbat species.
- Loss of Hollow-bearing Trees (NSW Scientific Committee 2007) - the proposed upgrade would involve the removal of a small number of hollow-bearing trees, which could provide roosting and limited breeding opportunities for the four microbats.
- Removal of Dead Wood and Dead Trees (NSW Scientific Committee 2003) - some dead wood and dead trees may be removed by the proposed upgrade.

**Conclusion**

The proposed upgrade would have the following impacts on the Yellow-bellied Sheathtail Bat, Eastern Freetail Bat, Eastern False Pipistrelle and Greater Broad-nosed Bat:

- Approximately 0.01 ha of potential foraging habitat would be cleared.
- Approximately 1.56 ha of potential foraging habitat would be indirectly impacted.
- The loss of a small number of isolated, roadside hollow-bearing trees.
- The operation of three key threatening processes.

The proposed upgrade is considered **unlikely** to result in a significant impact on a local population of Yellow-bellied Sheathtail Bat, Eastern Freetail Bat, Eastern False Pipistrelle or Greater Broad-nosed Bat, as:

- No limiting foraging resources would be removed.
- Only a small number of disturbed potential roosting / breeding sites would be removed.
- Potential habitat would not be fragmented or isolated.
- Approximately 99.2 per cent ha of rainforest and 95.3 per cent of saltmarsh would be retained within the locality.
- The proposed upgrade would not have an adverse effect on critical habitat (directly or indirectly).
- The habitat to be impacted by the proposed upgrade is considered to be of low importance for the long-term survival of these species in the locality.

Based on the above assessment, an species impact statement is not considered necessary.
Appendix D  Environment Protection and Biodiversity Conservation Act significant impact criteria
Appendix D  Environment Protection and Biodiversity Conservation Act significant impact criteria

**Cynanchum elegans**

*Cynanchum elegans* is listed as a nationally endangered species under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.

Potential habitat in the study area for this species is considered to be within the subtropical dry rainforest vegetation community.

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

Within the study area, no individuals of *Cynanchum elegans* were recorded. Potential habitat exists in the subtropical dry rainforest. Only 0.64 ha of the community would be impacted by the proposed development. Due to the small size of the area of the impacted, and no records of the species in the study area, the relative importance of habitat within the study area for the long-term survival of the species is considered low. In addition to this, more suitable potential habitat in the Locality equates to 1,171.1 ha, and this would not be impacted by the proposal. It is therefore considered unlikely that the proposal would lead to a long-term decrease of a population of the species.

**Is the action likely to reduce the area of occupancy of a population?**

This species was not recorded within the study area. Approximately 1,171.1 ha of potential habitat for *Cynanchum elegans* exists within the locality. The proposed upgrade would involve the removal of 0.64 ha of potential habitat in the study area. On this basis, the area to be impacted by the proposed upgrade equates to 0.00076 per cent of similar potential habitats in the locality. This is not considered likely to reduce the area of occupancy of a population.

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

Potential habitat for *Cynanchum elegans* that would be impacted by the proposed upgrade includes subtropical rainforest. This community is part of an already fragmented and cleared landscape. The proposed upgrade would impact upon the edge of an existing patch of potential habitat and would not increase fragmentation or isolation.

Given that the species has not been recorded in the study area; the small area of potential habitat directly impacted in relation to that in the locality area; potential habitat in the study area is likely to fragment an existing population.

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

The Commonwealth Environment Minister may identify and list habitat critical to the survival of a listed threatened species or ecological community. Details of this identified habitat are recorded in the Register of Critical Habitat. To date no areas of critical habitat has been listed for *Cynanchum elegans*.

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

*Cynanchum elegans* was not recorded in the study area. The closest known record of the species is approximately three kilometres to the west and north of the study area. Potential habitat for the species in the locality includes coastal warm temperate rainforest, intermediate temperate rainforest, subtropical complex rainforest, subtropical dry rainforest and temperate littoral rainforest vegetation communities. These vegetation communities occur as scattered patches throughout the locality. Since no individuals have been recorded in the study area, the proposal is unlikely to disrupt the breeding cycle of a population.
Is the action likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

This species was not recorded within the study area, however, potential habitat within subtropical dry rainforest is present. The proposal would involve the loss of 0.009 ha of potential habitat, all of which is considered potential habitat for Cynanchum elegans. A further 0.64 ha of potential habitat may be indirectly impacted by the proposal. Approximately 1,171.1 ha of further potential habitats for Cynanchum elegans exists within the locality (five kilometre radius). Given the availability of a large areas of potential habitat in the locality, compared to the area to be impacted by the proposal, it is considered unlikely that the proposal would modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

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

The proposed upgrade may increase the threat of weed invasion particularly given the presence of exotic perennial grasses along existing disturbed edges in the study area.

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

The removal of approximately 0.64 ha of potential habitat is not likely to introduce disease that may cause the species to decline. As a precaution, construction/earth moving vehicles should be washed down prior to use on site, this would help prevent the infection of native plants by the fungus, Phytophthora cinnamomi.

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

No Recovery Plan as published by DEWHA is available for Cynanchum elegans. The threatened species profile for Cynanchum elegans refers to nine priority actions to assist in recovery of the species (DEC 2005). Those relevant to the proposal include:

- Consider off-site impacts in the assessment of nearby developments.
- Install fencing to exclude livestock and machinery, and control access where required.
- Protect areas of known and potential habitat from clearing and further fragmentation.
- Restore degraded habitat using bush regeneration techniques.
- Mark sites and potential habitat onto maps used for planning maintenance work.
- Map known sites and conduct searches of potential habitat for new sites.

With the exception of the removal of a small area of potential habitat, the proposed upgrade is not inconsistent with the priority actions that relate to the recovery of Cynanchum elegans.

Conclusion

Based on the above assessment, Cynanchum elegans is unlikely to be significantly impacted by the proposal and, as such, a referral under the provisions of the Environment Protection and Biodiversity Conservation Act is not recommended for this species.
**Daphnandra sp. ‘Illawarra**

*Daphnandra* sp. ‘Illawarra’ is listed as a nationally endangered species under the Commonwealth Environment Protection and Biodiversity Conservation Act.

Potential habitat in the study area for this species is considered to be within the subtropical dry rainforest vegetation community.

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

Within the study area, no individuals of *Daphnandra* sp. ‘Illawarra’ were recorded. Potential habitat exists in the subtropical dry rainforest. Only 0.64 ha of the community would be impacted by the proposed upgrade. Due to the small size of the area of the impacted, and no records of the species in the study area, the relative importance of habitat within the study area for the long-term survival of the species is considered low. In addition to this, more suitable potential habitat in the Locality equates to 1,279.2 ha, and this would not be impacted by the proposal. It is therefore considered unlikely that the proposal would lead to a long-term decrease of a population of the species.

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

This species was not recorded within the study area. Approximately 1,279.2 ha of potential habitat for *Daphnandra* sp. ‘Illawarra’ exists within the locality. The proposed upgrade would involve the removal of 0.64 ha of potential habitat in the study area. On this basis, the area to be impacted by the proposed upgrade equates to 0.00076 per cent of similar potential habitats in the locality. The proposed upgrade therefore is not considered likely to reduce the area of occupancy of a population.

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

Potential habitat for *Daphnandra* sp. ‘Illawarra’ that would be impacted by the proposed upgrade includes subtropical dry rainforest. This community is part of an already fragmented and cleared landscape. The proposed upgrade would impact upon the edge of an existing patch of potential habitat and would not increase fragmentation or isolation.

Given that the species has not been recorded in the study area; the small area of potential habitat directly impacted in relation to that in the locality area; potential habitat in the study area is likely to fragment an existing population.

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

The Commonwealth Environment Minister may identify and list habitat critical to the survival of a listed threatened species or ecological community. Details of this identified habitat are recorded in the Register of Critical Habitat. To date no areas of critical habitat has been listed for *Daphnandra* sp. ‘Illawarra’.

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

*Daphnandra* sp. ‘Illawarra’ was not recorded in the study area. It is known to be recorded within 10 km of the study area. There are two previous recordings of the species approximately seven kilometres to the south-east of the study area.

Potential habitat for the species occurs in the coastal warm temperate rainforest, intermediate temperate rainforest, subtropical complex rainforest, subtropical dry rainforest and temperate littoral rainforest vegetation communities. These vegetation communities occur as scattered patches throughout the locality.

Since no individuals have been recorded in the study area, the small area of potential habitat directly impacted in relation to that in the locality area; the proposed upgrade is unlikely to disrupt the breeding cycle of a population.
Is the action likely to modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

This species was not recorded within the study area, however, potential habitat within subtropical dry rainforest is present. The proposal would involve the loss of 0.009 ha of potential habitat, all of which is considered potential habitat for *Daphnandra* sp. ‘Illawarra’. A further 0.64 ha of potential habitat may be indirectly impacted by the proposal. Approximately 1.279.4 ha of further potential habitats for *Daphnandra* sp. ‘Illawarra’ exists within the locality (five kilometre radius). Given the availability of a large areas of potential habitat in the locality, compared to the area to be impacted by the proposal, it is considered unlikely that the proposal would modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

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

The proposed development may increase the threat of weed invasion particularly given the presence of exotic perennial grasses along existing disturbed edges in the study area.

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

The direct removal of approximately 0.64 ha of potential habitat is not likely to introduce disease that may cause the species to decline. As a precaution, construction / earth moving vehicles should be washed down prior to use on site this would help prevent the infection of native plants by the fungus, *Phytophthora cinnamomi*.

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

A Recovery Plan has been published by DEW HA regarding *Daphnandra* sp. ‘Illawarra’. The threatened species profile for *Daphnandra* sp. ‘Illawarra’ refers to nine priority actions to assist in recovery of the species (DEC 2005v). Those relevant to the proposed development include (DEC 2005v):

- Consider off-site impacts in the assessment of nearby developments.
- Install fencing to exclude livestock and machinery, and control access where required.
- Protect areas of known and potential habitat from clearing and further fragmentation.
- Restore degraded habitat using bush regeneration techniques.
- Mark sites and potential habitat onto maps used for planning maintenance work.
- Map known sites and conduct searches of potential habitat for new sites.

The proposed upgrade and associated mitigation measures are not inconsistent with the above listed recovery actions.

With the exception of the removal of a small area of potential habitat, the proposal is not inconsistent with the priority actions that relate to the recovery of *Daphnandra* sp. ‘Illawarra’

**Conclusion**

Based on the above assessment, *Daphnandra* sp. ‘Illawarra’ is unlikely to be significantly impacted by the proposal and, as such, a referral under the provisions of the Environment Protection and Biodiversity Conservation Act is not recommended for this species.
**Irenepharsus trypherus**

*Irenepharsus trypherus* is listed as a nationally endangered species under the Commonwealth Environment Protection and Biodiversity Conservation Act.

Potential habitat in the study area for this species is considered to be within the subtropical dry rainforest vegetation community.

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

Within the study area, no individuals of *Irenepharsus trypherus* were recorded. Potential habitat exists in the subtropical dry rainforest. Only 0.64 ha of the community would be impacted by the proposed upgrade. Due to the small size of the area of the impacted, and no records of the species in the study area, the relative importance of habitat within the study area for the long-term survival of the species is considered low. In addition to this, more suitable potential habitat in the Locality equates to 1,279.2 ha, and this would not be impacted by the proposal. It is therefore considered unlikely that the proposal would lead to a long-term decrease of a population of the species.

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

This species was not recorded within the study area. Approximately 1,279.2 ha of potential habitat for *Irenepharsus tryphera* exists within the locality. The proposed upgrade would involve the removal of 0.64 ha of potential habitat in the study area. On this basis, the area to be impacted by the proposed upgrade equates to 0.00076 per cent of similar potential habitats in the locality. The proposed upgrade therefore is not considered likely to reduce the area of occupancy of a population.

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

Potential habitat for *Irenepharsus tryphera* that would be impacted by the proposed upgrade includes subtropical dry rainforest. This community is part of an already fragmented and cleared landscape. The proposed upgrade would impact upon the edge of an existing patch of potential habitat and would not increase fragmentation or isolation.

Given that the species has not been recorded in the study area; the small area of potential habitat directly impacted in relation to that in the locality area; potential habitat in the study area is likely to fragment an existing population.

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

The Commonwealth Environment Minister may identify and list habitat critical to the survival of a listed threatened species or ecological community. Details of this identified habitat are recorded in the Register of Critical Habitat. To date no areas of critical habitat has been listed for *Irenepharsus trypherus*.

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

*Irenepharsus trypherus* was not recorded in the study area, nor within a 10 km radius of the study area.

Potential habitat for the species occurs in the coastal warm temperate rainforest, escarpment foothills wet forest, Illawarra gully wet forest, intermediate temperate rainforest, subtropical complex rainforest, subtropical dry rainforest, and temperate littoral rainforest vegetation communities. These vegetation communities occur as scattered patches throughout the locality.

Since no individuals have been recorded in the study area, the small area of potential habitat directly impacted in relation to that in the locality area; the proposed upgrade is unlikely to disrupt the breeding cycle of a population.
Is the action likely to modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

This species was not recorded within the study area, however potential habitat within subtropical dry rainforest is present. The proposal would involve the loss of 0.009 ha of potential habitat, all of which is considered potential habitat for *Irenepharsus trypherus*. A further 0.64 ha of potential habitat may be indirectly impacted by the proposal. Approximately 1.279.4 ha of further potential habitats for *Irenepharsus trypherus* exists within the locality (five kilometre radius). Given the availability of a large areas of potential habitat in the locality, compared to the area to be impacted by the proposal, it is considered unlikely that the proposal would modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

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

The proposed development may increase the threat of weed invasion particularly given the presence of exotic perennial grasses along existing disturbed edges in the study area.

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

The direct removal of approximately 0.64 ha of potential habitat is not likely to introduce disease that may cause the species to decline. As a precaution, construction/earth moving vehicles should be washed down prior to use on site, this would help prevent the infection of native plants by the fungus, *Phytophthora cinnamomi*.

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

A Recovery Plan published by DEWHA is available for *Irenepharsus trypheru*. The threatened species profile for *Irenepharsus trypheru* refers to nine priority actions to assist in recovery of the species (DEC 2005v). Those relevant to the proposal include (DEC 2005):

- Consider off-site impacts in the assessment of nearby developments.
- Install fencing to exclude livestock and machinery, and control access where required.
- Protect areas of known and potential habitat from clearing and further fragmentation.
- Restore degraded habitat using bush regeneration techniques.
- Mark sites and potential habitat onto maps used for planning maintenance work.
- Map known sites and conduct searches of potential habitat for new sites.

The proposed upgrade and associated mitigation measures are not inconsistent with the above listed recovery actions.

With the exception of the removal of a small area of potential habitat, the proposal is not inconsistent with the priority actions that relate to the recovery of *Irenepharsus trypheru*.

Conclusion

Based on the above assessment, *Irenepharsus trypheru* is unlikely to be significantly impacted by the proposal and, as such, a referral under the provisions of the Environment Protection and Biodiversity Conservation Act is not recommended for this species.
**Syzygium paniculatum**

*Syzygium paniculatum* is listed as a nationally vulnerable species under the Commonwealth Environment Protection and Biodiversity Conservation Act.

Potential habitat in the study area for this species is considered to be within the subtropical dry rainforest vegetation community.

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

Within the study area, no individuals of *Syzygium paniculatum* were recorded. Potential habitat exists in the subtropical dry rainforest. Only 0.64 ha of the community would be impacted by the proposed upgrade. Due to the small size of the area of the impacted, and no records of the species in the study area, the relative importance of habitat within the study area for the long-term survival of the species is considered low. In addition to this, more suitable potential habitat in the locality equates to 1,279.2 ha, and this would not be impacted by the proposal. It is therefore considered unlikely that the proposal would lead to a long-term decrease of an important population of the species.

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

This species was not recorded within the study area. Approximately 1,279.2 ha of potential habitat for *Syzygium paniculatum* exists within the locality. The proposed upgrade would involve the removal of 0.64 ha of potential habitat in the study area. On this basis, the area to be impacted by the proposed upgrade equates to 0.00076 per cent of similar potential habitats in the locality. The proposed upgrade therefore is not considered likely to reduce the area of occupancy of an important population.

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

Potential habitat for *Syzygium paniculatum* that would be impacted by the proposed upgrade includes subtropical dry rainforest. This community is part of an already fragmented and cleared landscape. The proposed upgrade would impact upon the edge of an existing patch of potential habitat and would not increase fragmentation or isolation.

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

The Commonwealth Environment Minister may identify and list habitat critical to the survival of a listed threatened species or ecological community. Details of this identified habitat are recorded in the Register of Critical Habitat. To date no areas of critical habitat has been listed for *Syzygium paniculatum*.

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

*Syzygium paniculatum* was not recorded in the study area, nor within the locality. Potential habitat for the species occurs in the coastal warm temperate rainforest, intermediate temperate rainforest, subtropical complex rainforest, subtropical dry rainforest and temperate littoral rainforest vegetation communities. These vegetation communities occur as scattered patches throughout the locality.

Since no individuals have been recorded in the study area, the small area of potential habitat directly impacted in relation to that in the locality area; the proposed upgrade is unlikely to disrupt the breeding cycle of an important population.
**Is the action likely to modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?**

This species was not recorded within the study area, however, potential habitat within subtropical dry rainforest is present. The proposal would involve the loss of 0.009 ha of potential habitat, all of which is considered potential habitat for *Syzygium paniculatum*. A further 0.64 ha of potential habitat may be indirectly impacted by the proposal. Approximately 1.279.4 ha of further potential habitats for *Syzygium paniculatum* exists within the locality (five kilometre radius). Given the availability of a large areas of potential habitat in the locality, compared to the area to be impacted by the proposal, it is considered unlikely that the proposal would modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

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

The proposed development may increase the threat of weed invasion particularly given the presence of exotic perennial grasses along existing disturbed edges in the study area.

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

The direct removal of approximately 0.64 ha of potential habitat is not likely to introduce disease that may cause the species to decline. As a precaution, construction / earth moving vehicles should be washed down prior to use on site. This would help prevent the infection of native plants by the fungus, *Phytophthora cinnamomi*.

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

No Recovery Plan as published by DEWHA is available for *Syzygium paniculatum*. The threatened species profile for *Syzygium paniculatum* refers to nine priority actions to assist in recovery of the species (DEC 2005v). Those relevant to the proposal include (DEC 2005):

To date, no recovery plans have been prepared for *Syzygium paniculatum*. The threatened species profile for *Syzygium paniculatum* refers to nine priority actions to assist in recovery of the species (DEC 2005v). Those considered relevant to the proposed development include:

- Consider off-site impacts in the assessment of nearby developments.
- Install fencing to exclude livestock and machinery, and control access where required.
- Protect areas of known and potential habitat from clearing and further fragmentation.
- Restore degraded habitat using bush regeneration techniques.
- Mark sites and potential habitat onto maps used for planning maintenance work.
- Map known sites and conduct searches of potential habitat for new sites.

The proposed upgrade and associated mitigation measures are not inconsistent with the above listed recovery actions.

**Conclusion**

Based on the above assessment, *Syzygium paniculatum* is unlikely to be significantly impacted by the proposal and, as such, a referral under the provisions of the Environment Protection and Biodiversity Conservation Act is not recommended for this species.
**Zieria granulata**

*Zieria granulata* is listed as a nationally vulnerable species under the Commonwealth Environment Protection and Biodiversity Conservation Act.

Potential habitat in the study area for this species is considered to be within the subtropical dry rainforest vegetation community.

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

Within the study area, no individuals of *Zieria granulata* were recorded. Potential habitat exists in the subtropical dry rainforest. Only 0.64 ha of the community would be impacted by the proposed upgrade. Due to the small size of the area of the impacted, and no records of the species in the study area, the relative importance of habitat within the study area for the long-term survival of the species is considered low. In addition to this, more suitable potential habitat in the Locality equates to 1,279.2 ha, and this would not be impacted by the proposal. It is therefore considered unlikely that the proposal would lead to a long-term decrease of an important population of the species.

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

This species was not recorded within the study area. Approximately 1,279.2 ha of potential habitat for *Zieria granulata* exists within the Locality. The proposed upgrade would involve the removal of 0.64 ha of potential habitat in the study area. On this basis, the area to be impacted by the proposed upgrade equates to 0.00076 per cent of similar potential habitats in the Locality. The proposed upgrade therefore is not considered likely to reduce the area of occupancy of an important population.

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

Potential habitat for *Zieria granulata* that would be impacted by the proposed upgrade includes subtropical dry rainforest. This community is part of an already fragmented and cleared landscape. The proposed upgrade would impact upon the edge of an existing patch of potential habitat and would not increase fragmentation or isolation.

Given that the species has not been recorded in the study area; the small area of potential habitat directly impacted in relation to that in the Locality area; potential habitat in the study area is likely to fragment an existing important population.

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

The Commonwealth Environment Minister may identify and list habitat critical to the survival of a listed threatened species or ecological community. Details of this identified habitat are recorded in the Register of Critical Habitat. To date no areas of critical habitat has been listed for *Zieria granulata*.

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

*Zieria granulata* was not recorded in the study area. It is known to be recorded within 10 km of the study area. There are two previous recordings of the species approximately seven kilometres to the south-east of the study area.

Potential habitat for the species occurs in the coastal warm temperate rainforest, intermediate temperate rainforest, subtropical complex rainforest, subtropical dry rainforest and temperate littoral rainforest vegetation communities. These vegetation communities occur as scattered patches throughout the Locality.

Since no individuals have been recorded in the study area, the small area of potential habitat directly impacted in relation to that in the Locality area; the proposed upgrade is unlikely to disrupt the breeding cycle of an important population.
Is the action likely to modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

This species was not recorded within the study area, however, potential habitat within subtropical dry rainforest is present. The proposal would involve the loss of 0.009 ha of potential habitat, all of which is considered potential habitat for *Zieria granulata*. A further 0.64 ha of potential habitat may be indirectly impacted by the proposal. Approximately 1,279.4 ha of further potential habitats for *Zieria granulata* exists within the locality (five kilometre radius). Given the availability of a large areas of potential habitat in the locality, compared to the area to be impacted by the proposal, it is considered unlikely that the proposal would modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

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

The proposed development may increase the threat of weed invasion particularly given the presence of exotic perennial grasses along existing disturbed edges in the study area.

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

The direct removal of approximately 0.64 ha of potential habitat is not likely to introduce disease that may cause the species to decline. As a precaution, construction / earth moving vehicles should be washed down prior to use on site, this would help prevent the infection of native plants by the fungus, *Phytophthora cinnamomi*.

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

To date, a Recovery Plans have been prepared for *Zieria granulata*. Priority actions considered relevant to the proposed development include:

The objectives of the recovery plan are (DEC 2005g):

- To prevent the loss of sites through land-use change.
- To identify and manage the threats operating at sites that contain the species.
- To provide the community with information that assists in conserving the species.
- To raise awareness of the species and involve the community in the recovery program.
- To establish the extent of the current distribution of the species.
- To promote research that would assist with the management of the species.
- To maintain an ex-situ seed collection for the species.

The proposed upgrade and associated mitigation measures are not inconsistent with the above listed recovery actions.

Conclusion

Based on the above assessment, *Zieria granulata* is unlikely to be significantly impacted by the proposal and, as such, a referral under the provisions of the Environment Protection and Biodiversity Conservation Act is not recommended for this species.