Appendix K - Part A

SKM (2013) Biodiversity Assessment
Upgrade of the Princes Highway, Dignams Creek

BIODIVERSITY ASSESSMENT
Final
# Document history and status

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# Glossary of terms and abbreviations

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<th>Meaning</th>
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<tbody>
<tr>
<td>ANZECC</td>
<td>Australian and New Zealand Environment Conservation Council</td>
</tr>
<tr>
<td>AHD</td>
<td>Australian height datum</td>
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<tr>
<td>CMA</td>
<td>Catchment Management Authority</td>
</tr>
<tr>
<td>CEMP</td>
<td>Construction Environmental Management Plan</td>
</tr>
<tr>
<td>Construction footprint</td>
<td>Refers to the area of bridge replacement and includes any ancillary locations or drainage structures.</td>
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<tr>
<td>CSIRO</td>
<td>Commonwealth Science and Industrial Research Organisation</td>
</tr>
<tr>
<td>DBH</td>
<td>Diameter at breast height</td>
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<tr>
<td>DEC</td>
<td>Department of Environment and Conservation</td>
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<td>DECC</td>
<td>Department of Environment and Climate Change</td>
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<td>DECCW</td>
<td>Department of Environment, Climate Change and Water</td>
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<td>DPI</td>
<td>Department of Primary Industries</td>
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<tr>
<td>EIA</td>
<td>Environmental Impact Assessment</td>
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<tr>
<td>DSEWPaC</td>
<td>Commonwealth Department of Sustainability, Environment, Water, Population and Communities</td>
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<td>EIS</td>
<td>Environmental Impact Statement</td>
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<td>EP&amp;A Act</td>
<td>Environmental Planning and Assessment Act 1979</td>
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<td>EPBC Act</td>
<td>Environment Protection and Biodiversity Conservation Act 1999</td>
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<td>FM Act</td>
<td>Fisheries Management Act 1994</td>
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<tr>
<td>GPS</td>
<td>Global positioning system</td>
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<tr>
<td>HBT</td>
<td>Hollow bearing trees</td>
</tr>
<tr>
<td>Km</td>
<td>Kilometre</td>
</tr>
<tr>
<td>m</td>
<td>Metre</td>
</tr>
<tr>
<td>m²</td>
<td>Metres squared</td>
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<tr>
<td>NES</td>
<td>National Environmental Significance</td>
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<td>NPWS</td>
<td>National Parks and Wildlife Service (now included under OEH)</td>
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<td>NSW</td>
<td>New South Wales</td>
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<tr>
<td>OEH</td>
<td>Office of Environment and Heritage</td>
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<tr>
<td>Riparian</td>
<td>Transition zone between land and watercourse</td>
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<td>REF</td>
<td>Review of Environmental Factors</td>
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<td>RMS</td>
<td>Roads Maritime Service NSW</td>
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<td>Roads Traffic Authority NSW (now known as the RMS)</td>
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### Term

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<td>SEPP</td>
<td>State Environmental Planning Policy</td>
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<tr>
<td>SIS</td>
<td>Species impact Statement</td>
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<tr>
<td>SKM</td>
<td>Sinclair Knight Merz</td>
</tr>
<tr>
<td>Study area</td>
<td>Encompasses the construction footprint and any adjoining or adjacent habitat where potential indirect impacts may occur.</td>
</tr>
<tr>
<td>Study region</td>
<td>The broader bioregional context defined by Thackway and Creswell (1995) as the Sydney Bioregion and occurs within a 10 kilometre radius of the construction footprint.</td>
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<tr>
<td>Subject site</td>
<td>The immediate design footprint of the proposal.</td>
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<tr>
<td>TEC</td>
<td>Threatened Ecological Communities</td>
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<td>TSC Act</td>
<td>Threatened Species Conservation Act 1995</td>
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Executive summary

Background

Roads and Maritime Services (RMS) propose to realign around 3.7 kilometres of the existing Princes Highway at Dignams Creek on the South Coast of New South Wales (NSW). The proposal is located between Narooma and Cobargo in the Eurobodalla and Bega Local Government Areas (LGAs). The proposal includes the section of the Princes Highway about 1.5 kilometres north of the intersection of Dignams Creek Road to around 2.2 kilometres south of the intersection. The proposal has been split into two stages in order to obtain construction funding for the proposal and to provide a plan for future works. Stage 2 is a long term plan and is unlikely to be constructed for some time. Key features of the proposal would include the construction of a two lane highway comprised of one northbound and one south bound lane; a new intersection at Dignams Creek Road; a new bridge over Dignams Creek which would replace the existing bridge, and the upgrade of an existing southbound overtaking lane. The proposal would also result in sections of the original highway to the south of Dignams Creek Road being removed and revegetated.

This report details the methods and results of a biodiversity assessment prepared to identify the extent and potential magnitude of ecological impacts associated with the proposal. The report addresses the requirements for assessment of significance under the NSW Environmental Planning and Assessment Act 1979 (EP&A Act) and the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).

Existing Environment

The study area supports a variety of land uses. The southern section of the proposal passes through areas of land classified for conservation use and is comprised of Kooraban and Gulaga National Parks. Kooraban National Park is located to the west and Gulaga National Park is located to the east of the existing Princes Highway. Land use surrounding the northern section of the proposal includes:

- Rural residential properties.
- Agricultural lands, used predominantly for cattle grazing and occasionally for cropping. This land supports scattered remnant trees.
- Patches of remnant forest used for forestry.
- Strips of riparian vegetation along Dignams Creek and Blind Creek.
A total of five separate vegetation community types were identified comprising:

- Map Unit 1: Silvertop Ash - Stringybark Dry Open Forest.
- Map Unit 2: White Stringybark Forest.
- Map Unit 3: Bangalay/Blue Gum Sheltered Forest.
- Map Unit 4: River Peppermint - Rough-barked Apple moist shrubby forest.
- Map Unit 5: Riparian Forest.

Map unit 1 comprises a dry open forest habitat located across ridges, upper slopes and low hills, while the remaining remnant habitats comprise wet sclerophyll forests chiefly in lower slopes, and sheltered gullies. The riparian forest community is consistent with the final determination of the state-listed Threatened Ecological Community (TEC) River Flat Eucalypt Forest.

A total of 330 flora species were recorded within the study area, of these 49 species of introduced flora were identified, representing approximately 15 per cent of the total species.

A total of 49 bird species, 17 mammal species including two introduced species, two frog species and five reptile species were recorded in the study area from a combination of all surveys including NGH (2010) and surveys completed by Sinclair Knight Merz (SKM) for this assessment. A total of 122 individuals from seven species of fish and aquatic reptiles were collected from the two aquatic survey sites sampled in Dignams Creek.

Hollow trees in the study area occur in moderate abundance, comprising small to medium sized hollows suitable for larger arboreal mammals, as well as a range of bird species, herpetofauna and microbats. Trees supporting larger trunk hollows suitable for large forest owls were not observed in the study area and are considered to be low in abundance.

Threatened fauna species recorded in the study area comprise Eastern False Pipistrelle (*Falsistrellus tasmaniensis*), Greater Broad-nosed Bat (*Scoteanax rueppellii*), Eastern Bentwing-Bat (*Miniopterus schreibersii oceanensis*), Eastern Freetail-Bat (*Mormopterus australis*), Gang-Gang Cockatoo (*Callocephalon fimbriatum*), Glossy Black-cockatoo (*Calyptorhynchus lathami*) and Yellow-bellied Glider (*Petaurus australis*). Several other threatened fauna are predicted to occur including the Koala (*Phascolarctos cinereus*).
A population of the vulnerable species Square Raspwort (*Haloragis exaltata subsp. exaltata*) listed under the TSC Act and EPBC Act was identified within riparian vegetation along Dignams Creek.

**Potential impacts**

Potential biodiversity impacts to accommodate the proposal comprise:

- The removal of around 20 hectares of remnant vegetation a portion of which currently occurs in areas identified as Kooraban National Park but which have undergone revocation by the *National Parks and Wildlife Amendment (Adjustment of Areas) Bill 2012*. As such 18.3 hectares of the Kooraban National Park impacted by the proposal would be transferred to RMS for the purposes of road reserve for this proposal. The proposal would include a land and biodiversity offset package negotiated between RMS and OEH.

- This remnant vegetation provides habitat for several threatened fauna species confirmed to occur in the study area or considered highly likely to occur based on the presence of local records and the suitability of the habitat.

- Removal of approximately 0.2 hectares of the Threatened Ecological Community River-Flat Eucalypt Forest of Coastal Floodplain listed as endangered under the TSC Act.

- Impact on a portion of a population of the vulnerable listed species Square Raspwort (*Haloragis exaltata subsp. exaltata*) (listed under the TSC Act and EPBC Act) from the construction of the new bridge over Dignams Creek.

- Potential increasing of the barrier effect of the Princes Highway within an important wildlife corridor connecting the two national parks and the broader east-west landscape.

- The proposal would remove about 19.9 hectares of habitat considered critical to the survival of Koalas based on Commonwealth guidelines (DSEWPaC 2012). This is considered a minor loss of habitat in this locality given the presence of over 6,000 hectares of habitat containing Koala feed trees across these two national parks. Additionally, the proposal includes two dedicated fauna underpasses with fauna furniture and two combined drainage culvert/fauna underpass that would provide alternate crossing locations for Koalas. This would improve the poor connectivity that currently exists between the national parks, and is considered a positive outcome for improving fauna connectivity. The assessment concluded that the proposal is unlikely to have a significant impact on the Koala.
Avoidance and mitigation

Avoidance of impacts has been a major part of the planning strategy for the proposal to limit the potential impacts to native vegetation and habitat with particular emphasis on avoiding the known locations of Yellow-bellied Glider sap feed trees and hollow-bearing trees in general. Further focus has been on recognising the significance of an important east-west corridor connecting the two national parks and providing broad landscape connectivity. To provide for fauna connectivity the proposal would incorporate two dedicated fauna underpasses with fauna furniture, two combined drainage culvert/fauna underpasses, one canopy rope bridge at the southern end of the proposal and a new bridge over Dignams Creek at the northern end of the proposal which allows fauna passage on both sides of the creek. Where impacts cannot be avoided, mitigation measures are planned and a number of these have been recommended in this assessment. The proposed mitigation measures specified are consistent with the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA 2011). This would include among others pre-clearing surveys to confirm the appropriate management measures to minimise impacts to biodiversity, such as salvage and reuse of bushrock, hollow trees and woody debris. Other mitigation measures include the establishment of exclusion zones, staged habitat removal, weed management, pest and pathogen management and a wildlife connectivity strategy.

A biodiversity offset strategy has been developed to compensate for the proposed impacts from the proposal. A potential offset location has been identified in lands adjoining Gulaga National Park and surrounding Dignams Creek. Further assessment and negotiation with OEH and RMS would be required to establish an appropriate biodiversity offset and strategic revegetation would accompany this biodiversity offset strategy.

Significance assessments and conclusions

Provided the mitigation measures detailed in Chapter 5 are adequately implemented, the proposal is unlikely to have a significant impact on any threatened species or ecological communities listed under the TSC Act, therefore a Species Impact Statement for is not required. Further to this, no significant impacts on a matter of national environmental significance under the EPBC Act have been identified. However, an EBPC Act referral will be made to the Federal Minister of DSEWPaC as the proposal may potentially impact upon an important population of Koala, and habitat being impacted is considered critical to the survival of Koalas based on Commonwealth guidelines (DSEWPaC 2012). If the proposal is determined to be a controlled action, the approval of the Australian Government Minister for the Environment is required.
1. Introduction

1.1. Background and description

Roads and Maritime Services (RMS) propose to realign around 3.7 kilometres of the existing Princes Highway at Dignams Creek on the South Coast of New South Wales (NSW). The proposal is located between Narooma and Cobargo in the Eurobodalla and Bega Local Government Areas (LGAs). The proposal includes the section of the Princes Highway about 1.5 kilometres north of the intersection of Dignams Creek Road to around 2.2 kilometres south of the intersection. The proposal (refer to Figure 1-1) has been split into two stages in order to obtain construction funding for the proposal and to provide a plan for future works. Stage 2 is a long term plan and is unlikely to be constructed for some time.

Key features of Stage 1 of the proposal would include:

- Realigning about two kilometres of single carriageway starting about 1.5 kilometres north of the Dignams Creek Road intersection and extending to about 600 metres south of the Dignams Creek Road and Princes Highway intersection. The section would be constructed as a single carriageway with 3.5 metre wide lanes and three metre shoulders in each direction.
- Removal of four tight sub-standard curves along the existing Princes Highway.
- Construction of a new single carriageway bridge over Dignams Creek about 91 metres in length.
- Relocating the Princes Highway and Dignams Creek intersection about 100 metres north-west.
- Realigning around 200 metres of the most eastern section of Dignams Creek Road.
- Tie ins to the existing Princes Highway alignment.
- Provision of around 1.4 kilometres of road safety treatments along the existing Princes Highway alignment at the southern end of the proposal.
- Provision of one dedicated fauna underpass and one combined drainage culvert/fauna underpass.
- Relocating two private property access roads and formalising and consolidating one national park access point.
- Part of the existing Princes Highway alignment and Dignams Creek Bridge would be retained for private use.
Key features Stage 2 of the proposal would include:

- Realigning about 1.5 kilometres of single carriageway commencing about 600 metres south of Dignams Creek Road and extending to the southern end of the proposal. The section would be constructed as a single carriageway with 3.5 metre wide lanes and three metre shoulders in each direction.
- Removal of six sub-standard curves along the existing Princes Highway.
- Tie ins to stage 1 and the existing Princes Highway alignment.
- Provision of one dedicated fauna underpass, one combined drainage culvert/fauna underpass and one rope canopy bridge.
- Relocating access roads for Kooraban National Park and Gulaga National Park.
- Removal of the existing Princes Highway between Dignams Creek Road and the access road to Gulaga National Park.

The following general features would be included for both stages of the proposal:

- Installation of operational water quality controls including:
  - Five biofiltration basins.
  - A water quality basin.
  - Two constructed wetlands.
  - Biofiltration/vegetated swales.
- Installation of four retaining walls.
- Provision of ancillary facilities such as temporary sedimentation basins, compound and stockpile sites, and access tracks.
- Removal, rehabilitation and revegetation of 0.6 kilometres of the redundant sections of the Princes Highway.
- Relocation of overhead utilities to accommodate the proposal.

Construction of the proposal would proceed following determination of the Review of Environmental Factors (REF), obtaining other approvals as required, completion of the detailed design and the securing of funding from government sources. The construction period for Stage 1, would have duration of between 18 and 24 months. Stage 1 of the proposal has a strategic estimate of about $40 million. Whilst Stage 2 is a long term plan which is unlikely to be built for some time, the strategic cost estimate for Stage 2 costs is around $20 million (2013 dollars). The construction period for Stage 2 will be defined during detailed design.
1.2. Study area

The proposal is located at Dignams Creek on the Princes Highway around 25 kilometres south of Narooma and 50 kilometres north of Bega on the South Coast of New South Wales (NSW). The Princes Highway is the main coastal road connection between Sydney and Melbourne, and is known as Highway 1 on the national highway map. The northern end of the proposal traverses through areas of remnant forest that are privately owned before dropping in elevation to Dignams Creek where the surrounding area is cleared for pastures and crops. The southern end of the proposal rises up onto Dignams Hill and passes through forested conservation areas identified as Kooraban and Gulaga National Parks. Dignams Creek Sanctuary Zone of the Batemans Marine Park is present to the east of the study area along Dignams Creek and extends through to Wallaga Lake. Coastal wetlands identified under the State Environmental Planning Policy No 14 – Coastal Wetlands (SEPP 14) are present along the most eastern reaches of Dignams Creek (refer to Figure 1-2).

The following areas are discussed throughout the report, these are defined as:

- **Proposal footprint**: this area comprises the limits of the upgrade design with a 5 metre buffer to allow for a small contingency surrounding the proposal for construction activities.

- **Study area**: includes the proposal footprint and surrounding area, and for the purposes of this proposal comprises a 50 metre buffer surrounding the proposal.

- **Locality**: This area comprises a 10 kilometre radius surrounding the proposal footprint.

The study area is located in the South East Corner bioregion (Thackway and Cresswell 1995) and entirely within the Southern Rivers Catchment Management Area (CMA) (Far South Coast CMA sub-region). This region is important for biodiversity because it occurs in a transition area from the coast to the hinterland areas.

1.3. Scope of the biodiversity assessment

This report details the methods and results of a biodiversity field survey and assessment to identify the extent and magnitude of ecological impacts associated with the proposal. The report addresses the requirements for assessment of significance under the NSW Environmental Planning and Assessment Act 1979 (EP&A Act) and the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). Mitigation measures to ameliorate ecological impacts arising from the proposal are also provided.

Building on the existing ecological research and field data completed for the design development phase of the proposal, the biodiversity assessment provides updated research and additional field data to determine the presence and extent of terrestrial and aquatic flora.
and fauna species, populations, ecological communities and their habitats, migratory species or critical habitat in the study area and provide an assessment on the condition of the vegetation and habitats. The methodology was designed to provide specific focus on the further survey requirements recommended in the preliminary ecology assessment undertaken by NGH Environmental in 2010 with respect to undertaking systematic surveys for threatened flora and fauna which may be significantly affected by the proposal.

The aims of the biodiversity assessment are to:

- Describe the characteristics and ecological condition of the vegetation communities and habitats within the study area.
- Determine the occurrence, or likelihood of occurrence of threatened species, populations and communities listed under the Threatened Species Conservation 1995 (TSC Act), Fisheries Management Act 1994 (FM Act) and EPBC Act within the study area.
- Describe the potential impacts on biodiversity in the study area as a result of the proposal.
- Undertake significance assessments for threatened biodiversity that occur or have potential habitat within the study area.
- Propose further investigations and/or mitigation measures to mitigate impacts on the biodiversity values of the study area.
- Conduct a condition assessment using the biobanking assessment methodology to identify the condition of the vegetation and habitat to be impacted for use in determining future offset options.

1.4. Legislative context

The information presented in this report identifies the potential biodiversity impacts of the proposal in relation to the relevant State and Commonwealth environmental and threatened species legislation and policy. Relevant legislation and policy includes the:

- TSC Act.
- FM Act.
- State Environment Planning Policy No 44 - Koala Habitat Protection (SEPP 44).
- Commonwealth EPBC Act.
Upgrade of the Princes Highway, Dignams Creek - Biodiversity assessment

LEGEND
- Concept design
- Stage 1
- Stage 2
- Potential construction access track
- Private access track
- Temporary topsoil stockpile site
- Retaining wall (1-4)
- Compound site
- Fauna wildlife crossing structure (A-F)
- Operational water quality control
- Temporary sediment basin
- Construction footprint
- Dignams Creek and LGA boundary
- Major road
- Local road
- Track
- National Parks
  - Gulaga National Park
  - Kooraban National Park

DATA SOURCES
LPMA 2010
SKM 2011, 2013
RMS 2013

Figure 1-1 | The proposal
Figure 1-2 | Overview of the locality
Environmental Planning and Assessment Act 1979

Under Part 5 of the EP&A Act (section 111 and section 112), all proposals must include an assessment of threatened flora and fauna and their habitats that are likely to occur within the area of the activity or that may be indirectly affected by the construction and operation of an activity. The assessment has to address whether the proposed activity ‘is likely to have a significant effect’ on the threatened biodiversity identified, and a decision made on whether an Environmental Impact Statement (EIS) or Species Impact Statement (SIS) is required. In order to make this decision, a determining authority must consider the effect of an activity on:

- Threatened species, populations and ecological communities, and their habitats (listed under the TSC Act or FM Act) and whether there is likely to be a significant effect on these (as determined in section 5A of the EP&A Act).
- Critical habitat (listed under the TSC Act or FM Act).
- Any other protected fauna or protected native plants within the meaning of the NPW Act.

Section 5A of the EP&A Act outlines the seven factors that must be taken into account when deciding whether a proposal would be likely to have a significant impact on threatened species, populations or communities or their habitats (significance assessments).

NSW Threatened Species Conservation Act, 1995

The TSC Act identifies threatened species, populations and ecological communities, as listed under Schedules 1, 1A and 2 that are to be identified as potential subject species and therefore require a significance assessment under section 5A of the EP&A Act.

Fisheries Management Act, 1994

The FM Act establishes provisions for the identification, conservation and recovery of threatened fish, aquatic invertebrates and marine vegetation. This Act also covers the identification and management of key threatening processes which affect threatened species or could cause other species to become threatened.

The Minister for Fisheries would need to be notified of any proposed dredging (Part 7 Division 3 of the FM Act) or reclamation works associated with the proposed upgrade in accordance with Section 199 of the Act. A permit under Section 220(1) may also be required if the construction of culverts of the bridge over Dignams Creek blocks fish passage.

NSW Noxious Weeds Act 1993

The objectives of this NW Act are to reduce the negative impact of weeds on the economy, community and environment of NSW. This involves: establishing control mechanisms to prevent
the establishment of significant new weeds; prevent, eliminate or restrict the spread of particular significant weeds; effectively manage widespread significant weeds; and to provide for the monitoring of and reporting on the effectiveness of the management of weeds in NSW.

**State Environment Planning Policy No 44- Koala Habitat Protection**

SEPP 44 aims to encourage the ‘proper conservation and management of areas of natural vegetation that provide habitat for Koalas (*Phascolarctos cinereus*) to ensure a permanent free-living population over their present range and reverse the current trend of Koala population decline’.

Schedule 1 of SEPP 44 identifies areas of land that are classified as being ‘Core Koala Habitat’ or ‘Potential Koala Habitat’. ‘Core Koala Habitat’ is defined as an area of land with a resident population of Koalas, evidenced by attributes such as breeding females and recent sightings of and historical records of a population. ‘Potential Koala Habitat’ comprises areas of native vegetation where the trees of the types listed in Schedule 2 constitute at least 15 per cent of the total number of trees in the upper or lower strata of the tree component.

While SEPP 44 does not apply to projects that are being assessed under Part 5 of the EP&A Act, the Koala is however listed as vulnerable under the Commonwealth *EPBC Act* and in NSW under the TSC Act and hence targeted surveys were conducted for this species and further consideration given throughout the report on the impacts of the proposal.

**National Parks and Wildlife Act 1974**

The NPW Act is administered by the OEH and provides for the:

- Protection of flora and fauna, including threatened species listed under the TSC Act and protected flora and fauna listed under the NPW Act.
- Protection of Aboriginal sites or remains.
- Reservation of land for protection under the Act, including reservation of National Parks.

The *National Parks and Wildlife Amendment (Adjustment of Areas) Bill 2012* has been passed by the NSW Parliament which included the revocation of about 18.3 hectares of Kooraban National Park for the purposes of use as road reserve for the Dignams Creek project. The proposal would include a land and biodiversity offset package negotiated between RMS and OEH.

The harming of threatened species, populations and ecological communities is prohibited under section 118A of the Act. However, given that the proposal constitutes an activity by a determining authority under Part 5 of the EP&A Act, section 118A does not apply.
Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act protects the environment, particularly matters of national environmental significance (Matters of NES) and assessment of the environment on Commonwealth land. It streamlines the national environmental assessment and approvals process, protects Australian biodiversity and integrates management of important natural and cultural places. The EPBC Act identifies eight Matters of NES:

- World Heritage properties.
- National heritage places.
- Wetlands of international importance (Ramsar wetlands).
- Threatened species and ecological communities.
- Migratory species.
- Commonwealth marine areas.
- Nuclear actions (including uranium mining).
- Great Barrier Reef.

The EPBC Act is triggered by actions that would be likely to have a significant impact upon Matters of NES matters. Under the EPBC Act, such actions require approval from the Commonwealth Environment Minister and should be referred to the Commonwealth Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) for consideration. Actions deemed by DSEWPaC to require Commonwealth approval would be 'controlled actions' which require an environmental assessment.
2. Methodology

2.1. Personnel

Four separate ecological surveys were conducted in the study area during the development of the proposal and included targeted terrestrial and aquatic surveys and a survey to assess offsetting options of the proposal. Surveys were conducted over three seasons and included the following:

- Terrestrial flora and fauna surveys completed during the autumn (11-15 April 2011) and spring seasons (13-14 September 2011).
- Aquatic survey in Dignams Creek during spring season (7-9 November 2011).
- Flora and fauna surveys during the winter season (4-8 June 2012) which also included assessments of the property RMS has purchased for the offset investigations.

SKM ecologists are licensed to conduct field surveys under the NPW Act (Scientific Research Permit SL100044 and Fisheries Permit P06/0066.4) and hold ethical approval to conduct research by the Department of Primary Industries Animal Care and Ethics Committee (Animal Research Authority 09/1895). The qualifications and role of personnel involved in the field assessments are provided in Table 2-1.

Table 2-1: Qualifications and role of key personnel

<table>
<thead>
<tr>
<th>Personnel</th>
<th>Qualifications</th>
<th>Assessment tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Andrew Carty</td>
<td>BEnvSc; DipBushRegen; Accredited Biobanking Assessor</td>
<td>Biodiversity assessment report; flora and fauna surveys, vegetation mapping, Biobanking assessment</td>
</tr>
<tr>
<td>Chris Thomson</td>
<td>BAppSc; GradCertNatRes</td>
<td>Biodiversity assessment report, fauna surveys</td>
</tr>
<tr>
<td>Sarah Douglass</td>
<td>BSc; MEnvMgt</td>
<td>Biodiversity assessment report; aquatic surveys</td>
</tr>
<tr>
<td>Kate Byrnes</td>
<td>BSc</td>
<td>Biodiversity assessment report; aquatic surveys</td>
</tr>
<tr>
<td>Jonathan Carr</td>
<td>BEnvScMgt</td>
<td>Field assistant Biobanking assessment</td>
</tr>
</tbody>
</table>

2.2. Database search and literature review

A review of existing reports and government maintained databases was undertaken as the first stage of the investigation. The following information was reviewed:

The review focused on identifying and listing the threatened flora and fauna species, populations and ecological communities previously recorded from a 10 kilometre radius of the proposal. Following collation of database records and species and community profiles a ‘likelihood of occurrence’ assessment was prepared with reference to the broad habitats contained within the study area. This was further refined following field surveys and assessment of habitat present. The list of threatened species recorded from the locality is provided as Appendix E.

Previous ecological assessment and gap analysis

An ecological habitat investigation was conducted by NGH Environmental (2010). These authors conducted separate field surveys for the northern and southern section of the upgrade along the full length of the proposal and up to 300-400 metres east and west from the existing highway.

Surveys in the northern section involved detailed habitat assessment, field searches and the recording of signs of significant fauna. Survey techniques included diurnal bird census, amphibian and reptile searches, nocturnal call playback, microbat call detection and spotlighting. The survey in the southern section focused on threatened species habitat identification, the presence of key habitat resources and signs of threatened fauna species activity.

The review of the NGH (2010) work was conducted to scope an additional surveys required to complete a biodiversity assessment for the REF. The review concludes that the surveys were of sufficient effort and rigour to adequately identify habitat and species of conservation significance. However the surveys in the southern section only focused on threatened species habitat identification, the presence of key habitat resources and signs of threatened fauna species activity with limited targeted survey. To address this disparity the ecological surveys for
the REF included general and targeted surveys over the southern section to the same level of effort as conducted by NGH (2010) for the northern section.

Table 2-2 outlines threatened species recorded from the study area in the original proposal development surveys (NGH 2010), with notes on distribution and survey approach used in the REF to address any spatial gaps.

Table 2-2: Review of proposal development survey effort used to scope additional surveys for the REF.

<table>
<thead>
<tr>
<th>Species</th>
<th>NGH (2010) survey</th>
<th>REF survey approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glossy Black Cockatoo</td>
<td>Glossy Black Cockatoo was recorded in Kooraban National Park. Both Kooraban and Gulaga National Parks carry dense stands of post-logging or post-fire Allocasuarina regrowth of which is likely to provide feeding resources for the local Glossy black cockatoo population.</td>
<td>As the species has been confirmed in the study area, the survey focused on identifying the extent and condition of food resources (Allocasuarina foraging habitat). The data used to assist in assessing the impacts and devising appropriate mitigation measures during construction. Hollow-bearing trees surveyed in the proposal footprint and any trees with large hollows considered suitable as nesting nests identified.</td>
</tr>
<tr>
<td>(Calyptorhynchus lathami)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Long-nosed Potoroo</td>
<td>The Long-nosed Potoroo was tentatively identified from conical diggings that were recorded in the study area although these diggings may have been produced by the Long-nosed Bandicoot. Of the areas where diggings were identified, the northern portion of the study area has the greater chance of being Long-nosed Potoroo habitat.</td>
<td>The species has been tentatively identified and targeted surveys aimed to confirm presence. Trapping sites positioned in proximity to where diggings were reported in NGH (2010) and included the use of wire mesh cage traps and Elliot aluminium box traps set over four consecutive nights in a grid pattern. The trapping program was supplemented with a hair-tube survey at each site and spotlighting surveys in suitable habitat.</td>
</tr>
<tr>
<td>(Potorous tridactylus)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Koala (Phascolarctos cinereus)</td>
<td>Two small Koala populations occur within the vicinity of the study area, these being located in: The Bermagui/Murrah/Mumbulla forests to the south west of Bermagui, commencing approximately 10 km to the south. The Kooraban National Park, which borders the study area. This species may be facing regional extinction and has high conservation significance. The study area is likely to form part</td>
<td>Recent surveys have recorded the species in Kooraban National Park, and the study area may overlap with an individuals’ home range [C.Allen, pers.comm reported in NGH (2010)]. Systematic Koala surveys were conducted to the east and west of the highway to record the distribution of preferred and supplementary habitat up to 300-400 m from the highway based on dominant Eucalypt species and with reference to secondary and supplementary food tree species identified for the south coast region in the Koala Recovery Plan. Regularised scat searches conducted by placing a 500 m grid over the mapped habitat areas and systematically searching for scats</td>
</tr>
</tbody>
</table>
The data collected from the targeted surveys was used to inform the design of the upgrade in terms of identifying the most appropriate location for fauna crossing structures to be incorporated into the proposal to ensure habitat connectivity and facilitate movements of fauna, in particular the Koala.

2.3. Field survey

2.3.1. Vegetation and flora survey

A combination of aerial photographs, broad-scale vegetation mapping (Tozer et al. 2010), data from previous investigations (NGH Environmental 2010), and contour data was used to stratify the vegetation and habitats in the study area. The stratification of vegetation map units was based on a number of factors including the vegetation structure, dominant species and landscape position. The location and number of sampling sites used in the field survey was determined according to the extent of each vegetation type present to ensure adequate representation (refer to Figure 2-1).

The flora survey aimed to provide baseline data for the presence of threatened plant species, populations and vegetation communities to provide a basis for the prediction of impacts. It comprised the following steps:

A thorough review of the previous specialist reports, broad-scale vegetation mapping, other available literature and scientific databases to gain an appreciation of the diversity of flora that could potentially occur in the study area.
Figure 2-1 | Location of flora sampling methods
Stratified sampling techniques to classify and map vegetation communities, threatened species habitat and develop an inventory of flora species specific to each vegetation association.

Targeted searches for threatened flora species in areas of suitable habitat.

**Vegetation association classification and mapping**

Transect sampling was used to identify vegetation community types and boundaries. The number of transects sampled was proportional to the size of the stratification units identified with a minimum of two 100 metre transects sampled per 2-50 hectares of each stratification unit and three 100 metre transects sampled per 51-250 hectares of stratification unit in accordance with DEC (2004).

Digital mapping of vegetation communities was conducted using ArcGIS® software. A combination of field data, aerial photograph interpretation and biophysical data such as elevation and soil type were used to delineate community boundaries. Description of the vegetation communities was based on their structure and dominant canopy species (Specht 1981) and correlated with Keith (2004) and Tozer *et al.* (2010) and compared with final determinations for threatened ecological communities.

Following field identification the vegetation communities in the proposal area were matched to relevant Biometric vegetation types as reported in DECC (2009a) as well as broad-scale vegetation mapping for the region produced by Tozer *et al.* (2010).

**Plot sampling**

Standard quadrat based sampling was used in conjunction with general traverses of the study area, and in particular those areas associated with the proposal footprint. Quantitative data on plant species richness were collected from a series of 20 x 20 metre plots (400 m²) sampled within each vegetation association. The flora species within each plot were given a cover abundance score using a modified Braun-Blanquet cover scale (Braun-Blanquet 1965). Data collected within each plot included:

- Heights of structural layers (i.e. canopy, sub-canopy, shrub and groundcovers).
- The abundance/cover of each species and vegetation layer.
- Landscape features (e.g. slope, gully, and aspect).
- Soil features (e.g. soil type, rocks, organic matter).
- Geographical coordinates and a photographic record.
Transects and traverses

General traverses comprised random searches throughout targeted areas to develop a flora inventory and to complete searches for threatened species, as well as to opportunistically record the distribution of vegetation communities, important habitat attributes and any other factors that may be of interest. The location of all threatened species, vegetation community boundaries and any other ecological factors were recorded with a GPS.

2.3.2. Terrestrial fauna survey

As discussed in the gap analysis in Section 2.2, the terrestrial fauna survey aimed to build on the previous work by NGH (2010) by focusing on further assessment of the known threatened fauna species and identifying critical habitat resources such as feeding and sheltering habitat. The surveys included:

- Small mammal trapping and hair-tube survey targeting Long-nosed Potoroo.
- Koala survey based on identification of activity levels as per Philips and Callaghan 1995; 2011) using a Regularised Grid-based survey in consultation with OEH to provide data consistent with regional Koala surveys.
- Spotlighting and call playback survey targeting Koala and Yellow-bellied Glider.
- Survey of habitat trees and Glossy Black-cockatoo feeding resources in proximity to the alignment.
- Bat call recording and general searches for birds, reptiles and frogs.

Stratification and site selection

The different fauna habitats along the proposal are represented by moist forest with a dense mesic understorey, open forest with a sparsely vegetated understorey and creek and riparian habitats, in addition to modified farm land and cleared land. Where possible surveys were conducted across the different range of floristic types associated with these units. Aquatic habitats (creeks and wetlands) provided additional incidental data. This regime resulted in comprehensive sampling and habitat assessment across the study area.

Weather conditions

Details of temperature and rainfall conditions during field surveys are provided in Table 2-3. Conditions were generally dry and mild with cool overnight periods. The survey conditions were considered suitable for detection of the large majority of fauna groups and species expected in the study area, particularly threatened birds and mammals. However, the cooler temperatures and season would have adversely affected the detectability of reptiles and amphibians. The predicted presence of additional species from these fauna groups has been inferred from the
data collected during habitat assessments, the previous specialist studies and regional data (Atlas of NSW fauna).

**Table 2-3: Survey weather conditions**

<table>
<thead>
<tr>
<th>Dates</th>
<th>Mean temp (°C)</th>
<th>Rainfall (mm)</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min</td>
<td>Max</td>
<td></td>
</tr>
<tr>
<td>11-15 April 2011</td>
<td>5.0</td>
<td>18.0</td>
<td>0</td>
</tr>
<tr>
<td>13-14 September 2011</td>
<td>6.3</td>
<td>25.2</td>
<td>0.8</td>
</tr>
</tbody>
</table>

**General and targeted surveys**

The combination of mammal, bird and herpetofauna searches was conducted at one moist open forest (site 1) and three dry open forest sites (Sites 2-4) (refer to Figure 2-2). The moist forest site occurred in the northern section and represented the site where NGH (2010) previously recorded mammal diggings (i.e. patch 4). Previous comprehensive surveys had not been conducted in the southern section and hence the remaining three sites were positioned south of Dignams Creek Road.

**Mammal trapping**

Live-trapping targeting the Long-nosed Potoroo was conducted between the 11 and 15 April 2011. At each of the four sites a standardised plot arrangement (2 X 100 metre transects 50 metre apart) was delineated by 10 Elliott traps (type B, 45 x 15 x 12 cm, aluminium folding traps) spaced 10 metre apart and two cage trap (30 x 30 x 60 cm) placed at opposite ends of the plot. All traps were baited with universal peanut butter, rolled oats and honey bait and cage traps were also baited with tinned sardines to attract Spotted-tailed Quoll if present. Traps and cages were placed in or under cover wherever possible. Traps were open for a three-night period (96 hours) at each site and were checked each morning. Captured animals were measured, weighed, identified and released.

Total ground trapping effort equated to 120 Elliot trap nights and 24 cage trap nights over three nights consistent with the DEC (2004) survey guidelines. The species and location of mammal scats, scratches and other evidence of fauna presence when encountered were noted to provide locality records for native and exotic species.
Upgrade of the Princes Highway Dignams Creek - Biodiversity assessment

Figure 2-2 | Location of fauna sampling methods

DATA SOURCES
Imagery: LPMA 2010
Contextual Data: LPMA 2010
Project Data: SKM 2011

LEGEND
- Dignams Creek
- oLGA boundary
- Major road
- Local road
- Track
- National Parks
  - Gulaga National Park
  - Kooraban National Park
- Construction footprint
- Aquatic survey sites
- Koala plot sites

Survey Sites
Waypoint
- Bat call detector
- Call playback
- Site 1
- Site 2
- Site 3
- Site 4
- Stag Watching

Path: I:\ENVR\Projects\EN02937\Technical\GIS\Spatial_Directory\ArcGIS\Ecology\EN02937_Ecology_0003b_Fauna_sample_Fig2-2.mxd

Newcastle Spatial Team - Prepared by: AL
Checked by: VC
Hair-tubes were also employed to target Long-nosed Potoroo. Six hair-tubes were placed at each survey site for a total of three nights; the tubes were baited with rolled oats, honey and peanut butter.

**Spotlighting and call playback**

Spotlighting and dusk census for arboreal mammals was conducted at each of the four sites during the trapping periods. Spotlighting was foot-based and comprised a concentrated survey across the entire trapping grid and general survey through adjacent areas, utilising hand-held spotlights. Two observers conducted the survey for a minimum period of 30 minutes per site following dusk (around 1800-1900 hours). All fauna heard or observed were recorded to species level. Observations of fauna were aided by the use of binoculars. Counts were taken on the number of fauna heard and observed.

Stagwatching and spotlighting was also conducted at the southern end of the proposal after detection of a Yellow-bellied Glider sap tree. Total survey effort by spotlight was 6 hours.

Call playback of the threatened species Powerful Owl (*Ninox strenua*), Barking Owl (*Ninox connivens*), Masked Owl (*Tyto novaehollandiae*), Koala (*Phascolarctos cinereus*) and Yellow-bellied Glider (*Petaurus australis*) was conducted during spotlighting surveys at each of the four spotlight sites. Pre-recorded calls were broadcast via a portable MP3 player and megaphone for a period of five minutes for each species, followed by a five minute listening period. Spotlighting was conducted briefly between calls and then following completion of the call playback series for a period of 10 minutes. Quiet listening for dusk calls of species was also undertaken whilst conducting other field activities such as spotlight searches.

**Bat call recording and bridge inspection**

A stationary ultrasonic bat call detector (Anabat II, Titley Electronics) was used with a storage ZCAIM unit to record bat calls at sites 3 and 4. Calls were recorded continuously between 1800 and 0500 hours on each occasion for two nights. Calls were identified to genus or species level where possible using computer frequency analysis software (Analook v.4.0).

Spotlighting and listening for calls of megachiropteran bats (*Pteropus* spp.) was conducted during all spotlighting activities.

A diurnal and nocturnal search was conducted of the existing Dignams Creek bridge structure to assess the presence of roosting bats and potential for microchiropteran bats to roost under the bridge. Both searches included an investigation with a spotlight in all cracks and crevices of the structure and a hand-held bat detector was used for 1 hour after dusk on the 13 April 2011.
**Herpetofauna searches**

Both nocturnal and diurnal herpetological surveys were conducted at each of the four trap sites. Nocturnal herpetofauna was opportunistically identified during spotlighting surveys and included the survey of the margins of wet areas for active frogs and reptiles. Nocturnal surveys for frogs were conducted by two persons using spotlights and battery powered head torches to survey along drainage lines and soaks.

Frogs were identified by call, and/or capture. All active frogs were captured, where possible, identified and immediately released. At potentially suitable locations throughout the study area, a period of listening for the calls of frog species was undertaken, especially at dusk. The diurnal component of the reptile surveys consisted of hand searches for active and resting individuals under rocks, logs, bark, leaves and timber and artificial debris when encountered. Specific reptile census was conducted for 30 minutes at each site. Opportunistic observations were also recorded during the carrying out of other survey activities.

**Birds**

Surveys were conducted at each of the four trap sites involving line transects undertaken by a single observer moving along a fixed route and recording the birds seen and heard on either side of the route. Each transect was a fixed 200 metre long and 100 metre wide, generating a two hectares search area. The survey aimed to record all birds, seen or heard within 50 metres on either side of the transect, over a minimum period of 20 minutes. This survey effort was applied to each site.

Birds were also recorded opportunistically during all other site visits and field surveys along the proposal corridor. Binoculars were carried in the field at all times to assist in identification.

**Koala population assessment**

The method for assessing potential impacts of the proposal on the Koala was undertaken following the guidance of the interim Koala referral advice for proponents (DSEWPaC 2012). The document provides preliminary advice for consideration in assessing the impacts of an action on Koalas and the need to refer the action. In summary the approach used was to:

- Establish that a Koala population occurs in the study area from an NSW Atlas Wildlife database search and EPBC Act Protected Matters Search and background data and literature review.
- Gather adequate information on the characteristics of the Koala populations and the quality of potential habitat within the study area. This involved a Koala survey and habitat assessment in consultation with OEH (Chris Allen, OEH; pers comm.).
As recommended by the interim referral advice the Spot Assessment Technique (SAT) developed by Phillips and Callaghan (2011), was used to provide an indication of how much or frequently the area of habitat is being used by Koalas and identify the relative importance of the habitat. The survey used a *Regularised Grid-based Spot Assessment Technique* (RGBSAT) as per Phillips and Hopkins (2007) and Phillips and Callaghan (2011).

Two small Koala populations are known to occur within the vicinity of the study area, these being located in the Bermagui / Murrah / Mumbulla forests to the south west of Bermagui (Allen *et al* 2010), approximately 10 km to the south and parts of Kooraban National Park, within one kilometre of the study area, and the study area may overlap with an individuals’ home range [C.Allen, pers. comm reported in NGH (2010)]. Several larger Koala populations are also known from the wider Eden region which includes the current study area (Lunney *et al* 1997).

The field method used to record Koala activity levels in proximity to the road corridor was based on the *Regularised Grid-based Spot Assessment Technique* (RGBSAT) as per Phillips and Hopkins (2007) and Phillips and Callaghan (2011). Searches for Koala scats were conducted over a pre-determined grid pattern placed over the study area and extending up to 700 m from the existing road. The Spot Assessment Technique was conducted on each corner of the grid at 500 metre intervals resulting in searches at a total of 20 plots (refer to Figure 2-2) over 16 person hours.

At each of these sites the base of the closest 30 live trees over 150 millimetres in diameter at breast height (DBH) were searched for Koala faecal pellets out to a metre from the trunks. The species and DBH of each of the 30 trees were recorded.

The survey aimed to place pellet into two age classes on the basis of their general appearance, such that dry and faded pellets are classed as ‘old’, and pellets with patina (a shiny film of mucus) remaining were classed as ‘fresh’. Pellet longevity is generally considered to be in the order of 6 to 18 months, with drier conditions more conducive to pellet longevity (Worth 2001).

The proportion of trees with Koala pellets compared with the total number of trees assessed at each site (30 per site) is termed the site’s activity level (Phillips & Callaghan 2011). The activity level at each of the 20 sites was calculated.

**Habitat resource survey**

A systematic survey for habitat trees was conducted along the length of the proposal footprint up to 50 metres either side of the construction boundary. This involved a foot-based traverse of the proposal corridor and recording data on the number and location of habitat trees (i.e. trees with hollows, trees with feeding scars indicative of Yellow-bellied Glider use and Allocasuarina species with chewed cones present indicative of Glossy Black-cockatoo use).
Any extensive areas of diggings were recorded, due to the tentative identification of threatened Long-nosed Potoroo (NGH 2010). Where hollow-bearing trees were encountered further data was recorded for the geographical location using a GPS, the tree species and size (Diameter at Breast Height) and number and type of hollows present.

2.3.3. Vegetation and habitat condition assessment

A vegetation and habitat condition assessment was conducted using the Biobanking Assessment Methodology (DECCW 2008). The assessment aimed to provide a measure of habitat condition for each of the vegetation types impacted by the proposal and identify the floristic diversity, structure of the vegetation, the type and distribution of plant communities present as well as the density of fauna habitat features in the study area. Data collected in these condition assessment plots were used to calculate the credit points required by the proposal to offset the proposed impacts. Detailed description of the methods used in the Biobanking Assessment is provided in Appendix G.

2.3.4. Aquatic surveys

Fish surveys were conducted at two sites within Dignams Creek using both active (electrofishing) and passive (fyke and bait traps) fishing techniques, refer to Figure 2-2. The use of both sampling methodologies increases the probability of sampling a wider range of species and size classes. No surveys were conducted within Blind Creek as it is an ephemeral creek and dry at the time of the surveys. A description of each of the sampling methodologies employed is provided below. Backpack electrofishing was conducted using a Smith Root Electric Fishing Machine (LR24). The purpose of electrofishing is to apply a suitable electrical field to a given body of freshwater in order to attract and induce a temporary state of narcosis in fish within the immediate area. The most effective output for fish capture is within a voltage range adjustable from 100 V to 600 V dc. Electricity is provided from batteries and is transferred into the water, as a pulsed DC waveform, via a back-pack unit which is carried by the operator, with portable electrodes. At each survey site, one electrofishing transect was conducted consisting of 600 shots. Whilst undertaking electrofishing, all care was taken to avoid shocking non-target species including platypus, birds, snakes and other aquatic animals. All stunned specimens were dip netted and transferred to an aerated holding tank for recovery.

Fyke nets were used to trap mobile, large bodied fish. Between two to four fyke nets were set for a minimum of two hours. Large single-wing fyke nets with either a four metre leaders were set with the cod-end on one bank with the wing attached to the opposite bank. The cod-end of
each fyke was always suspended out of the water to avoid the mortality of captured air breathing vertebrates.

Bait traps were used to trap mobile, small bodied fish. At each site, 10 bait traps (unbaited) (45 × 25 × 25 cm) were set in shallow habitats for a minimum of two hours. Where possible, traps were set in stands of emergent vegetation, areas with submerged vegetation, or snag piles, as these areas are likely to have a greater diversity and abundance of small bodied fish.

**Macroinvertebrates**

Macroinvertebrates were sampled at two sites within Dignams Creek (one upstream and one downstream of the proposal) in accordance with the NSW AUSRIVAS protocol during the spring sampling period.

The AUSRIVAS sampling area at both sites was 100 metres. At both macroinvertebrate sampling sites, macroinvertebrates were collected from edge habitats. Edge habitats were defined as the creek bank in areas of little or no flow, including alcoves and backwaters, with abundant leaf litter, fine sediment deposits, macrophyte beds and overhanging bank vegetation (Turak et al. 2004). At Aquatic Site 1 a Riffle sample was also collected from the riffle habitat present. Riffle habitats were defined as areas of broken water with rapid current. Both Edge and Riffle samples were collected from 10 m of representative edge or riffle sub-habitats using a 0.25 millimetres mesh size kick net to dislodge macroinvertebrates, whilst noting physical habitat conditions of the sampled locations. Care was taken to ensure all sub-habitats within the site were represented within the sample.

Macroinvertebrate samples were live sorted in the field for a minimum of 40 minutes. If new taxa were collected between the 30 to 40 minute period, picking continued for 10 minutes. If no new taxa were found after the additional 10 minutes, sorting stopped. If new taxa were found, picking continued for a further 10 minutes. The maximum sorting time was 60 minutes. All picked animals were preserved in ethanol and transferred to the laboratory for identification. Specific care was taken to ensure cryptic, fast moving or micro-crustacean taxa were represented.

All macroinvertebrates were identified to the family level of taxonomic resolution, except for Chironomidae which was identified to Subfamily as required by the AUSRIVAS model.

**AUSRIVAS modelling**

The AUSRIVAS program uses mathematical models to compare observed macroinvertebrate taxa against a modelled reference condition. These comparisons provide a measure of biological impairment. Predictor variables (including physical habitat variables, latitude,
longitude, altitude, slope and distance from source) are used to model the predicted reference condition for each sampling site. Latitude, longitude, altitude, slope and distance from source were determined from 1:25,000 topographic maps. Physical habitat variables were qualitatively assessed or directly measured at each site.

The AUSRIVAS model software outputs specify the 'Observed' (macroinvertebrates collected during sampling) to 'Expected Ratios' (macroinvertebrates which are predicted to occur in reference conditions). Both measures relate to macroinvertebrates that have a predicted probability greater than 50 per cent of occurring at the site if it is in reference condition. The 'Observed' value is the number of these macroinvertebrate families that are actually collected at the site. Each observed family contributes a score of 1 to the 'Observed' value. The 'Expected' value is the sum of the probabilities for all taxa that are predicted to occur at that site with a probability greater than 50 per cent. Families that have a 50 per cent probability of occurring at the site contribute a score of 0.5 to the 'Expected' value, while families that have a 90 per cent probability of occurrence contribute a score of 0.9. An Observed to Expected ratio (O/E50 score) close to 1 indicates that the macroinvertebrate fauna are similar to those of the modelled reference condition. A ratio close to zero indicates severe impairment compared to reference condition. Based upon these O/E50 scores, a band ranking indicating the ecological health of the river can be assigned (refer to Table 2-4).

**Table 2-4 Key to O/E50 AUSRIVAS Scores and Bands**

<table>
<thead>
<tr>
<th>Band</th>
<th>Spring Edge O/E50</th>
<th>Band Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Band X</td>
<td>Infinite</td>
<td>Macroinvertebrate assemblage is more biologically diverse than reference sites</td>
</tr>
<tr>
<td>Band A</td>
<td>1.16</td>
<td>Site is in reference condition with most/all of the expected families found</td>
</tr>
<tr>
<td>Band B</td>
<td>0.83</td>
<td>Site is significantly impaired, indicating a potential impact either on water quality and/or habitat quality which has resulted in a loss of taxa</td>
</tr>
<tr>
<td>Band C</td>
<td>0.51</td>
<td>Site is severely impaired; indicating a loss of biodiversity due to substantial impacts on water and/or habitat quality</td>
</tr>
</tbody>
</table>
Band  | Spring Edge O/E50 Upper Band Limit | Band Description
---|---|---
Band D | 0.19 | Site is extremely impaired; few expected taxa remain, indicating extremely poor water and/or habitat quality resulting in a highly degraded waterway.

**Water quality**

Surface water quality parameters were measured at each aquatic survey site *in situ* using a calibrated Hydrolab water quality probe. Parameters measured include:

- **Turbidity (NTU)** – a measure of the 'muddiness' of the water. It provides an indication of the amount of suspended colloidal and particulate matter in the water and how much light can penetrate for important biochemical processes such as photosynthesis. Elevated levels of particulate matter can also impact on dissolved oxygen concentrations and pH;

- **Conductivity (mS.cm⁻¹)** – measures the amount of dissolved salts in the water and its ability to conduct an electrical current. It is important as some plant and animal species are salt sensitive whilst others require higher salt concentrations;

- **Total Dissolved Solids (ppm)** – the salt concentration of water, measured directly as dissolved salts;

- **Temperature (°C)** –measures the degree of hotness or coldness of water. It is a form of pollution and can impact on riverine biota and associated biological and chemical processes;

- **pH** – is a measure of acidity or alkalinity of water. Most freshwater and estuarine biota have a range of tolerances between 6.5 and 8; and

- **Dissolved Oxygen (% saturation and mg.L⁻¹)** – measures the amount of oxygen dissolved in water. Dissolved oxygen is vital for many forms of riverine and estuarine biota including native fish and is also vital for the functioning of healthy aquatic ecosystems.

Measurements were collected from 30 centimetres below the surface of the water. For each parameter, three replicate measurements were recorded approximately 10 metres apart from the access point to the site. Each parameter has been reported as the average (arithmetic mean) of the three measurements. Flow conditions at the time of sampling were also noted, such as rainfall in the preceding 24-48 hours from sampling.
Water quality data has been assessed against the Australia and New Zealand Environment and Conservation Council/ Agriculture and Resource Management Council of Australia and New Zealand (ANZECC/ARMCANZ) guidelines for the protection of aquatic ecosystems (ANZECC/ARMCANZ 2000).

Aquatic habitats

The distribution and types of aquatic habitats throughout Dignams Creek were recorded at five sites throughout the study area. Each aquatic habitat was described and mapped covering all wetland habitats, creeks and rivers, including their immediate riparian habitats, and swamps and marshes. Dignams Creek was also classified in accordance to standard NSW Fisheries guidelines *Fish Passage Requirements for Waterway Crossings* (Fairfull & Witheridge 2003) to determine waterways classification as per Table 2-5.

**Table 2-5** Fish habitat classification criteria for watercourses and recommended crossings types

<table>
<thead>
<tr>
<th>Classification</th>
<th>Characteristics of waterway type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 1 - Major fish habitat</td>
<td>Major permanently or intermittently flowing waterway (e.g. river or major creek), habitat of a threatened fish species.</td>
</tr>
<tr>
<td>Class 2 - Moderate fish habitat</td>
<td>Named permanent or intermittent stream, creek or waterway with clearly defined bed and banks and with semi-permanent to permanent waters in pools or in connected wetland areas. Marine or freshwater aquatic vegetation is present. Known fish habitat and/or fish observed inhabiting the area.</td>
</tr>
<tr>
<td>Class 3 - Minimal fish habitat</td>
<td>Named or unnamed waterway with intermittent flow and potential refuge, breeding or feeding areas for some aquatic fauna (e.g. fish, yabbies). Semi-permanent pools form within the waterway or adjacent wetlands after a rain event. Otherwise, any minor waterway that interconnects with wetlands or recognised aquatic habitats.</td>
</tr>
<tr>
<td>Class 4 – Unlikely fish habitat</td>
<td>Named or unnamed watercourse with intermittent flow during rain events only, little or no defined drainage channel, little or no free standing water or pools after rain event (e.g. dry gullies or shallow floodplain depression with no permanent wetland aquatic flora).</td>
</tr>
</tbody>
</table>

(Source: Fairfull & Witheridge, 2003)
Aquatic macrophytes

Any submerged or emergent aquatic water plants encountered at each aquatic habitat survey site were identified, to assist in the identification of any threatened flora, or noxious weed species. The description of aquatic macrophytes included submerged, floating and emergent macrophytes, macroscopic algae, as well as the presence of any introduced or pest plant species.

Aquatic flora was assessed along a 100 metres reach at each site, with the presence of native and exotic macrophytes recorded. Photographs of the aquatic habitat were taken at each site and species were identified in the field where practical.

2.4. Survey effort

A summary of the flora survey effort with respect to the number of quadrats and transects sampled per habitat type are summarised in Table 2-6.

Table 2-6 Flora survey effort per habitat stratification unit

<table>
<thead>
<tr>
<th>Habitat</th>
<th>Area in study area (ha)</th>
<th>Sampling effort</th>
</tr>
</thead>
<tbody>
<tr>
<td>Map Unit 1: Silvertop Ash - Stringybark Dry Open Forest</td>
<td>4.2</td>
<td></td>
</tr>
<tr>
<td>Map Unit 2: White Stringybark Forest</td>
<td>12.0</td>
<td></td>
</tr>
<tr>
<td>Map Unit 3: Bangalay/Blue Gum Sheltered Forest</td>
<td>3.5</td>
<td></td>
</tr>
<tr>
<td>Map Unit 4: River Peppermint - Rough-barked Apple moist shrubby forest</td>
<td>0.2</td>
<td></td>
</tr>
<tr>
<td>Map Unit 5: Riparian Forest</td>
<td>0.2</td>
<td></td>
</tr>
</tbody>
</table>

The total terrestrial and aquatic fauna survey effort is summarised in Table 2-7, this is exclusive of the additional fauna survey effort documented in NGH (2010).
Table 2-7 Summary of fauna survey effort for additional REF surveys

<table>
<thead>
<tr>
<th>Technique</th>
<th>Methodology</th>
<th>Survey effort</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small to medium-sized mammal</td>
<td>A standardised plot arrangement (2 X 100 metre transects 50 metre apart) was delineated by 10 Elliott traps (type B, 45 x 15 x 12 cm, aluminium folding traps) spaced 10 metre apart and two cage trap (30 x 30 x 60 cm) placed at opposite ends of the plot. All Elliott traps were baited with peanut butter, rolled oats and honey and cage traps were baited with tinned sardines. Traps and cages were placed in or under cover wherever possible.</td>
<td>Surveys were conducted at 4 sites over a 3 night period (96 hours). Total 144 trap nights.</td>
</tr>
<tr>
<td>trapping</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hair-tube survey</td>
<td>Hair-tubes were also employed to target Long-nosed Potoroo. Six hair-tubes were placed at each survey site for a total of three nights; the tubes were baited with rolled oats, honey and peanut butter.</td>
<td>Surveys were conducted at 4 sites with a total of 6 tubes at each site for 3 consecutive nights (72 trap nights)</td>
</tr>
<tr>
<td>Diurnal bird census</td>
<td>Bird census was conducted at each of the four trap sites involving a line transect surveyed by a single observer moving along a fixed route and recording the birds seen and heard on either side of the route. Each transect was a fixed 200 metre long and 100 metre wide, generating a two hectares search area. The survey aimed to record all birds, seen or heard within 50 metres either side of the transect, over a minimum period of 20 minutes. This survey effort was applied to each site.</td>
<td>Two bird census at each site equal to 2.4 person-hours</td>
</tr>
<tr>
<td>Amphibian searches</td>
<td>Amphibian habitat was centred on the dams and riparian areas of Dignams Creek and Blind Creek. Frogs were identified by calls and capture when encountered.</td>
<td>2 person-hours</td>
</tr>
<tr>
<td>Reptiles searches</td>
<td>Reptile surveys consisted of hand searches for active and resting individuals under rocks, logs, bark, leaves and timber and artificial debris. Time-based searches were conducted for 30 minutes at each of the four trap sites.</td>
<td>2 person-hours</td>
</tr>
</tbody>
</table>
### Technique | Methodology | Survey effort
--- | --- | ---
Spotlighting & dusk census for arboreal mammals was conducted at each of the four sites during the trapping periods. Spotlighting was foot-based and comprised a concentrated survey across the entire trapping grid and general survey through adjacent areas, utilising hand-held spotlights. Two observers conducted the survey for a minimum period of 30 minutes per site following dusk (around 1800-1900 hours). All fauna heard or observed were recorded to species level. Observations of fauna were aided by the use of binoculars. | 4 person-hours, comprising one hour at each of the trap sites

<table>
<thead>
<tr>
<th>Technique</th>
<th>Methodology</th>
<th>Survey effort</th>
</tr>
</thead>
</table>
| Nocturnal call playback | Call playback of the threatened species Powerful Owl (Ninox strenua), Barking Owl (Ninox connivens), Masked Owl (Tyto novaehollandiae), Koala (Phascolarctos cinereus) and Yellow-bellied Glider (Petaurus australis) was conducted during spotlighting surveys at each of the four spotlight sites. Pre-recorded calls were broadcast via a portable MP3 player and megaphone for a period of five minutes for each species, followed by a five minute listening period. Spotlighting was conducted briefly between calls and then following completion of the call playback series for a period of 10 minutes. Quiet listening for dusk calls of species was also undertaken whilst conducting other field activities such as spotlight searches. | Call playback was undertaken at four sites for a total of approximately 2 hours

<table>
<thead>
<tr>
<th>Technique</th>
<th>Methodology</th>
<th>Survey effort</th>
</tr>
</thead>
</table>
| Bat call recording | A stationary ultrasonic bat call detector (Anabat II, Titley Electronics) was used with a storage ZCAIM unit to record bat calls at sites 3 and 4. Calls were recorded continuously between 1800 and 0500 hours on each occasion for two nights. | 44 hours continuous recording, plus spotlighting survey beneath the Dignams Creek bridge structure

<table>
<thead>
<tr>
<th>Technique</th>
<th>Methodology</th>
<th>Survey effort</th>
</tr>
</thead>
</table>
| Scats, tracks and opportunistic records | The species and location of mammal scats, scratches and other evidence of fauna presence when encountered were noted to provide locality records for native and exotic species. | Opportunistic during all site survey times
2.5. Limitations

The list of flora and fauna species recorded from this study should not be seen to be fully comprehensive, but rather an indication of the species present at the time of the survey. A period of several seasons or years is often needed to identify all the species present in an area, especially as some species are only apparent at certain times of the year e.g. orchids or migratory birds and require specific weather conditions for optimum detection e.g. frogs. The conclusions of this report are therefore based upon available data and the field surveys and are therefore merely indicative of the environmental condition of the site at the time of the survey. It should be recognised that site conditions, including the presence of threatened species, can change with time. The address this limitation, the assessment has aimed to identify the
presence and suitability of the habitat for threatened species as discussed in the following section.

2.6. Threatened species assessment

Likelihood of occurrence

State and nationally listed threatened species identified from the background reviews were considered in terms of their likelihood to occur in the habitats present within the study area based on their identified habitat requirements. The results of this review are provided in Appendix E. The likelihood of occurrence was classified according to the criteria described in Table 2-8. The presence of all potentially occurring threatened species were targeted during the surveys with particular emphasis on those species with a high or moderate likelihood of occurrence. Species with a high or moderate likelihood of occurrence were subject to assessments of significance under the relevant legislation (TSC Act and/or EPBC Act).

Table 2-8 Likelihood of occurrence includes one or more of the following criteria

<table>
<thead>
<tr>
<th>Likelihood of Occurrence</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unlikely</td>
<td>Species highly restricted to certain geographical areas not within the proposal area. Specific habitat requirements are not present in the study area.</td>
</tr>
<tr>
<td>Low</td>
<td>Species not recorded during field surveys and fit one or more of the following criteria: Have not been recorded previously in the study area/surrounds and for which the study area is beyond the current distribution range. Use specific habitats or resources not present in the study area. Are a non-cryptic perennial flora species that were specifically targeted by surveys and not recorded.</td>
</tr>
<tr>
<td>Moderate</td>
<td>Species not recorded during the field surveys that fit one or more of the following criteria: Have infrequently been recorded previously in the study area/surrounds. Use specific habitats or resources present in the study area but in a poor or modified condition. Are unlikely to maintain sedentary populations, however may seasonally use resources within the study area opportunistically or during migration. Are cryptic flowering flora species that were not seasonally targeted by surveys and that have not been recorded.</td>
</tr>
<tr>
<td>High</td>
<td>Species recorded during the field surveys or species not recorded that fit one or more of the following criteria:</td>
</tr>
</tbody>
</table>
### Likelihood of Occurrence

<table>
<thead>
<tr>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Have frequently been recorded previously in the study area/surrounds</td>
</tr>
<tr>
<td>Use habitat types or resources that are present in the study area that are abundance and/or in good condition within the study area</td>
</tr>
<tr>
<td>Are known or likely to maintain resident populations surrounding the study area</td>
</tr>
<tr>
<td>Are known or likely to visit the site during regular seasonal movements or migration</td>
</tr>
</tbody>
</table>

### Significance assessments

Significance assessments were conducted for species, populations and communities that have been positively identified or that have a moderate or high potential to occur in the study area based on the above assessment criteria.

For threatened biodiversity listed under the TSC Act and or FM Act, the assessment addressed the threatened species assessment guidelines for assessment of significance as outlined under Section 5A of the EP&A Act, Section 94A of the TSC Act and Section 220ZZ of the FM Act. For threatened biodiversity listed under the EPBC Act a significance assessment have been completed in accordance with the *Matters of National Environmental Significance Significant Impact Guidelines 1.1* (Department of the Environment, Water, Heritage and the Arts 2009).

Species with similar taxonomy or ecological requirements have been assessed together, for example tree-roosting microchiropteran bats.
3. **Existing Environment**

3.1. **Landscape context**

The proposal is located in the South East Corner bioregion, with the study area entirely within the Southern Rivers Catchment Management Area (CMA) and within the Far South Coast CMA sub-region. This region is important for biodiversity in the catchment because it occurs in a transition area from the coast to the hinterland areas.

The study area is part of the catchment for Wallaga Lake and the tidal limit is a short distance downstream of the eastern boundary of the existing highway alignment. The presence of River Oak (*Casuarina cunninghamiana*) along Dignams Creek in the study area suggests there is no tidal influence within the proposal study area. Elevation in the study area varies from two to ten metres Australian Height Datum (AHD) along Dignams Creek and the surrounding floodplain and up to around 140 metres at the southern end of the proposal.

The study area is within the Bega Coastal Foothills landscape of the South East Corner Coastal Ranges. This landscape consists of low hills with a general slope toward the coast on bedrock of Ordovician quartzite, slate, chert, phyllite, with a general elevation 0 to 520 metres AHD, and local relief of 250 metres.

Other landscapes in the locality include the Mt Dromedary - Mumbulla Mountain of the South East Corner Coastal Ranges to the north of the study area, and Bega Granites of the South East Corner Granites to the south of the study area.

3.2. **Surrounding land use**

The study area supports a variety of land uses. The southern section of the proposal passes through areas of land classified for conservation use and is comprised of Kooraban and Gulaga National Parks. Kooraban National Park is located to the west and Gulaga National Park is located to the east of the existing Princes Highway. Land use surrounding the northern section of the proposal includes:

- Rural residential properties.
- Agricultural lands, used predominantly for cattle grazing and occasionally for cropping. This land supports scattered remnant trees.
- Patches of remnant forest used for forestry.
- Strips of riparian vegetation along Dignams Creek and Blind Creek.
3.3. Vegetation communities and habitat

The vegetation communities in the study area represent a complex of a number of types which intergrade with each other. Distinct boundaries between the communities were difficult to ascertain in the field, and therefore topography and aspect were used as an indicator of community boundaries coupled with species composition field data. This is further confounded by previous disturbances from logging and fire which has altered species composition and vegetation structure.

The vegetation communities were classified in accordance with Biometric Vegetation Types as defined in DECC (2008a), these are described in Table 3-1 including the legal status and cleared estimate as defined by DECC (2008a) and the approximate area of intact vegetation in the study area (within 50 m of the proposal footprint). A total of five separate vegetation community types were identified comprising:

- Map Unit 1: Silvertop Ash - Stringybark Dry Open Forest.
- Map Unit 2: White Stringybark Forest.
- Map Unit 3: Bangalay/Blue Gum Sheltered Forest.
- Map Unit 4: River Peppermint - Rough-barked Apple moist shrubby forest.
- Map Unit 5: Riparian Forest.

A summary of the vegetation community descriptions and corresponding fauna habitat types is provided in Table 3-1 and detailed descriptions of the vegetation communities are provided in Appendix A. The distribution of these communities in the study area is displayed in Figure 3-1.

A comprehensive list of the flora species present within the study area has been included as Appendix B.
Table 3-1 Vegetation and fauna habitat types in the study area

<table>
<thead>
<tr>
<th>Map Unit</th>
<th>Biometric Vegetation Type</th>
<th>Description</th>
<th>Status (TSC Act)</th>
<th>Cleared estimate</th>
<th>Fauna habitat type and characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Map Unit 1: Silvertop Ash - Stringybark Dry Open Forest</td>
<td>Silvertop Ash - Blue-leaved Stringybark - Woollybutt shrubby open forest on coastal foothills central South East Corner</td>
<td>This community occurs on exposed ridges and slopes of the study area. This community is dominated by the tree species Silvertop Ash (<em>Eucalyptus sieberi</em>) and Blue-leaved Stringybark (<em>Eucalyptus agglomerata</em>) with several other canopy species generally occurring in lower abundance including White Stringybark (<em>Eucalyptus globoidea</em>), Rough-barked Apple (<em>Angophora floribunda</em>) and Mugga Ironbark (<em>Eucalyptus tricarpa</em>); however these species are co-dominant in some areas of this map unit. In places there is a sub-canopy of Black She-oak (<em>Allocasuarina littoralis</em>), in particular where there has been past disturbance from logging activities. The understorey is dominated by various shrubs and grasses. Dominant shrub species include Gorse Bitter-pea (<em>Daviesia ulicifolia</em>), Spiny Bossiaea (<em>Bossiaea obcordata</em>), Narrow-leaved Geebung (<em>Persoonia linearis</em>) and Shrubby Platysace (<em>Platysace lanceolata</em>). Dominant groundcover species include grasses Kangaroo Grass (<em>Themeda australis</em>), Threeawn Speargrass...</td>
<td>Not listed</td>
<td>5%</td>
<td>Dry open forest is largely restricted to upper slopes and ridges in the study area and comprises an open canopy with medium to tall trees dominated mainly by Silvertop Ash, and Stringybanks. Midstorey sparse and comprises scattered wattles (Acacia spp.) and other small trees. Understorey and ground cover also open and sparsely covered with grasses and graminoids. Logs and fallen trees are common, however hollow-bearing trees and dead habitat trees are very scarce. The habitat is suited to a range of small to medium-sized forest birds particularly those species represented in drier forest and woodland habitats compared to the moist...</td>
</tr>
<tr>
<td>Map Unit</td>
<td>Biometric Vegetation Type</td>
<td>Description</td>
<td>Status (TSC Act)</td>
<td>Cleared estimate</td>
<td>Fauna habitat type and characteristics</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>(Aristida vagans), Blady Grass (Imperata cylindrica) and Wiry Panic (Entolasia stricta), and forb species Pomax (Pomax umbellata), Many-flowered Mat-rush (Lomandra multiflora subsp. multiflora) and Blue Bottle-daisy (Lagenophora stipitata). Biobanking condition assessment plots in this community confirmed this community is in good condition with a score of 84 out of 100. This community supports a diversity of native flora species and good vegetation structure with no or very little exotic species cover, however overstorey regeneration was under benchmark. Hollow trees were observed and there is an abundance of fallen logs providing habitat for fauna. Previous disturbances are generally limited to selective logging throughout areas of this community.</td>
<td></td>
<td></td>
<td>gufly forests. Reptile diversity is also expected to be well developed, with a mix of cover and shelter and abundance of logs.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>This community occurs on less exposed slopes of the study area, in the areas in between the more exposed slopes of map unit 1 and sheltered gully areas of map unit 3. This community is dominated by White Stringybark (Eucalyptus globoidea), however canopy species from both Map Unit 1 and 3 are present in this community and are often co-dominant particularly Rough-barked Apple</td>
<td>Not listed</td>
<td>15%</td>
<td>Moist gully forest occupying steep gullies and natural drainage areas. Characterised by a complex well developed forest structural diversity and tall overstorey of various eucalypt species. Tall mid-storey (6-7 m) dominated by</td>
</tr>
<tr>
<td>Map Unit</td>
<td>Biometric Vegetation Type</td>
<td>Description</td>
<td>Status (TSC Act)</td>
<td>Cleared estimate#</td>
<td>Fauna habitat type and characteristics</td>
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<td>----------------------------------------</td>
</tr>
<tr>
<td>East Corner</td>
<td>(Angophora floribunda) and Yellow Stringybark (Eucalyptus muelleriana). In places there is an open to dense sub-canopy of Black She-oak (Allocasuarina littoralis), in particular where there has been past disturbance from logging activities. In areas Broad-leaved Hickory (Acacia falciformis), Sweet Pittosporum (Pittosporum undulatum) and Acacia irrorata also forms part of the subcanopy of this map unit. This understorey supports a mix of shrubs and groundcovers many of which occur in Map Unit 1 and 3. Dominant shrub species include Coffee Bush (Breyinia oblongifolia), Wild Yellow Jasmine (Pittosporum revolutum), Narrow-leaved Geebung (Persoonia linearis), Leucopogon lanceolatus var. lanceolatus, Shrubby Platysace (Platysace lanceolata) and Rough Guinea Flower (Hibbertia aspera). Dominant groundcovers include Weeping Grass (Microlaena stipoides), Bordered Panic (Entolasia marginata), Stinking Pennywort (Hydrocotyle laxiflora) and Kidney Weed (Dichondra repens). Biobanking condition assessment plots in intact areas of this community confirmed this community...</td>
<td></td>
<td></td>
<td>Acacia spp., with abundant nectar and fruit resources. The understorey is also tall and very dense dominated by bracken ferns and in combination with the abundance of fallen trees and logs provides high quality shelter and breeding habitat for a range of small to medium sized ground-dwelling mammals such as bandicoots and rodents. The high structural and floristic diversity is suited to a high diversity of fauna species in particular birds, mammals and reptiles. There are limited opportunities for frogs due to lack of permanent water.</td>
<td></td>
</tr>
</tbody>
</table>
### Biometric Vegetation Type

<table>
<thead>
<tr>
<th>Map Unit</th>
<th>Description</th>
<th>Status (TSC Act)</th>
<th>Cleared estimate#</th>
<th>Fauna habitat type and characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>is in good condition with scores ranging from 71 to 97 out of 100. This community supports a diversity of native flora species and good vegetation structure with no or very little exotic species cover and overstorey regeneration was observed. Hollow trees were observed and as well as fallen logs providing habitat for fauna. Previous disturbances are generally limited to selective logging throughout areas of this community. There are disturbed areas of this community in paddock areas with a low floral diversity and exotic-dominated groundcover with a fragmented canopy. Biobanking condition assessment these areas of this community are in low condition with a score of 12 out of 100.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Map Unit 3: Mountain Grey Gum - Yellow Stringybark moist shrubby open forest in gullies of the coastal ranges, northern South East</td>
<td>This map unit occurs in sheltered gullies and slopes of the study area. This community is dominated by a mix of canopy species with Bangalay/Blue Gum (<em>Eucalyptus botryoides x saligna</em>) being consistently present. Other dominant species comprise Yellow Stringybark (<em>Eucalyptus muelleriana</em>), Rough-barked Apple (<em>Angophora floribunda</em>), Monkey Gum (<em>Eucalyptus cypellocarpa</em>), White Stringybark (<em>Eucalyptus globoidea</em>) and River Peppermint</td>
<td>Not listed</td>
<td>5%</td>
<td>As per map unit 2</td>
</tr>
</tbody>
</table>
(Eucalyptus elata). Some areas of this community have an open sub-canopy of small tree species including Grey Myrtle (Backhousia myrtifolia), Sweet Pittosporum (Pittosporum undulatum), Scentless Rosewood (Synoum glandulosum) and Blueberry Ash (Elaeocarpus reticulatus).

The understorey is dominated by a mix of mesic shrubs and groundcovers. Dominant species include: shrubs such as Tree Violet (Melicytus dentatus), Hazel Pomaderris (Pomaderris aspera) and Cassinia trinervia; fern species such as Soft Bracken (Calochlaena dubia), Prickly Rasp-fern (Doodia aspera), Gristle Fern (Blechnum cartilagineum) and Rough Tree-fern (Cyathea australis); grasses and forbs such as Basket Grass (Oplismenus aemulus), Margined Panic (Entolasia marginata), Purple-sheathed Tussock-grass (Poa ensiformis), Stinking Pennywort (Hydrocotyle laxiflora) and Lilac Lily (Schelhammera undulata); and numerous vine species including Water Vine (Cissus antarctica), Common Milk Vine (Marsdenia rostrata) and Morinda (Morinda jasminoides).

Biobanking condition assessment plots in intact areas of this community confirmed this community
<table>
<thead>
<tr>
<th>Map Unit</th>
<th>Biometric Vegetation Type</th>
<th>Description</th>
<th>Status (TSC Act)</th>
<th>Cleared estimate#</th>
<th>Fauna habitat type and characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>is in good condition with scores ranging from of 77 to 82 out of 100. This community supports a diversity of native flora species and good vegetation structure with no or very little exotic species cover and there is limited overstorey regeneration. Hollow trees were observed and as well as fallen logs providing habitat for fauna. Previous disturbances are generally limited to selective logging throughout areas of this community.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Not listed</td>
<td>65%</td>
<td>As per map unit 2</td>
</tr>
<tr>
<td></td>
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<td>This map unit occurs on a steep sheltered slope above Dignams Creek at the north-eastern end of the study area. This community is dominated by River Peppermint (<em>Eucalyptus elata</em>) and Rough-barked Apple (<em>Angophora floribunda</em>). This community has a relatively dense subcanopy including Sweet Pittosporum (<em>Pittosporum undulatum</em>), Mock Olive (<em>Notelaea venosa</em>) and Brush Muttonwood (<em>Myrsine howittiana</em>). The majority of this community in the study area is in a low-moderate condition, being underscrubbed and used for cattle grazing. There is a relatively dense shrub layer in areas including Tree Violet (<em>Melicytus dentatus</em>), Tall Paper Daisy (<em>Ozothamnus diosmifolius</em>), Wild</td>
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<td>Biometric Vegetation Type</td>
<td>Description</td>
<td>Status (TSC Act)</td>
<td>Cleared estimate#</td>
<td>Fauna habitat type and characteristics</td>
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<td>Yellow Jasmine (Pittosporum revolutum) and Orange Thorn (Pittosporum multiflorum). The ground layer is relatively sparse due to shading from the dense subcanopy and shrub layers, including a diversity of shade tolerant species such as fern species such as Prickly Rasp-fern (Doodia aspera) and Gristle Fern (Blechnum cartilagineum), grasses and forbs such as Basket Grass (Oplismenus aemulus), Weeping Grass (Microlaena stipoides), Lilac Lily (Schelhammera undulata) and Ivy-leaf Violet (Viola hederacea). Biobanking condition assessment plots in intact areas of this community confirmed this community is in moderate condition with a score of 45 out of 100. This community has been subject to disturbances from agricultural activities including underscrubbing and grazing in areas adjacent to the Princes Highway resulting in lower flora diversity and a modified vegetation structure and no overstorey regeneration. There is still no or very little exotic species cover. Hollow trees were not observed in this community and there is a moderate abundance of fallen logs.</td>
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Upgrade of the Princes Highway, Dignams Creek – Biodiversity Assessment

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<th>Map Unit</th>
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<td>Map Unit 5:</td>
<td>River Peppermint</td>
<td>This community occurs as a thin edge-effected riparian strip along Dignams Creek and intact examples of this community are present along Blinds Creek. This community is dominated by River Oak (Casuarina cunninghamiana) along Dignams Creek and River Peppermint (Eucalyptus elata) on Blind Creek. Other canopy species present along Dignams Creek and Blind Creek include Bangalay/Blue Gum (Eucalyptus botryoides x saligna) and Rough-barked Apple (Angophora floribunda). Smaller tree species include White Sally Wattle (Acacia floribunda), Black Wattle (Acacia mearnsii), Cassinia trinerva and Brush Kurrajong (Commersonia fraseri). Dominant shrub species include Tree Violet (Melicytus dentatus), Twin-flower Tea-tree (Leptospermum emarginatum), the threatened Square Raspwort (Haloragis exaltata subsp. exaltata) and Fireweed Groundsel (Senecio linearifolius). Groundcovers include a diversity of flora species including: fern species such as Fishbone Water Fern (Blechnum nudum) and Maidenhair Fern (Adiantum aethiopicum); grasses and graminoids include Basket Grass (Oplismenus linearifolius). Riparian habitat comprises of narrow linear remnants of swamp oak with occasional wattles (Acacia spp.) and a predominant exotic understorey. Habitat trees are typically absent however some fallen trees and logs are scattered throughout. The habitat has connectivity along creek areas, although is generally fragmented from near-by forest habitats by surrounding cleared and grazed creek flats. The habitat has greatest value for birds, particularly wide-ranging species which would include the migratory listed Cattle Egret and a range of species tolerant of modified habitats. Common reptiles and frogs could be expected, such as the Eastern Water Dragon and Common...</td>
<td>Endangered (River-flat eucalypt forest on coastal floodplains)</td>
<td>50%</td>
<td>Riparian habitat comprises of narrow linear remnants of swamp oak with occasional wattles (Acacia spp.) and a predominant exotic understorey. Habitat trees are typically absent however some fallen trees and logs are scattered throughout. The habitat has connectivity along creek areas, although is generally fragmented from near-by forest habitats by surrounding cleared and grazed creek flats. The habitat has greatest value for birds, particularly wide-ranging species which would include the migratory listed Cattle Egret and a range of species tolerant of modified habitats. Common reptiles and frogs could be expected, such as the Eastern Water Dragon and Common...</td>
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<td><em>aemulus</em> and Mat Rush (<em>Lomandra longifolia</em>); and forb species such as <em>Austrocynoglossum latifolium</em>, Native Violet (<em>Viola hederacea</em>), Spotted Knotweed (<em>Persicaria decipiens</em>). There is a diversity exotic species present along Dignams Creek including common pasture plants such as White Clover (<em>Trifolium repens</em>) and Kikuyu (<em>Pennisetum clandestinum</em>), as well as common environmental weed species such as Wandering Dew (<em>Tradescantia fluminensis</em>), Rambling Dock (<em>Acetosa sagittata</em>) and Moth Vine (<em>Araujia sericifera</em>). Biobanking condition assessment plots in areas of this community surrounding Blind Creek confirmed this community is in moderate to good condition in this area with a score of 57 out of 100. This community supports a diversity of native flora species with a modified vegetation structure with no or very little exotic species cover and no overstorey regeneration. Hollow trees were not observed in this area and fallen logs are abundant. Previous disturbances are generally limited to selective logging throughout areas of this community and there is a telecommunications easement through Eastern Froglet. Habitat for mammals is limited, in particular arboreal species due to the lack of connectivity, feeding and shelter resources. The stream habitat is characterised by a fast flowing clear water moderately deep in parts and containing a series of pools and riffles over a course sandy substrate. Abundant woody debris is present and overhanging vegetation on banks providing habitat for a range of common fish species.</td>
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Areas of this community along Dignams Creek are highly disturbed from clearing and grazing supporting a diversity of weeds. These areas are considered to be in a moderate condition with a biobanking score of 45 out of 100.

# cleared estimate for the Biometric Vegetation Types database (DECC 2009a).
Figure 3-1 | Distribution of vegetation communities and fauna habitats
**Aquatic habitats**

The proposal is located approximately 6.2 kilometres upstream from the Dignams Creek Sanctuary zone which is part of the Batemans Marine Park (refer to Figure 3-2). A sanctuary zone provides the highest level of protection allowing activities that do not harm plants animals or habitats. Sanctuary zones do not allow recreational or commercial fishing activities, but does allow for guided tours, boating, surfing, snorkelling and diving.

Dignams Creek is identified as key fish habitat (NSW DPI) and contains a diversity of aquatic habitats including freshwater aquatic vegetation and numerous submerged woody snags, as such it was classified as Class 2 – Moderate fish habitat (Fairfull & Witheridge 2003).

Survey sites monitored during the Aquatic Ecology surveys is provided Figure 2-2.
Figure 3-2 | Waterways, wetlands and Dignams Creek Sanctuary Zone (Batemans Marine Park)