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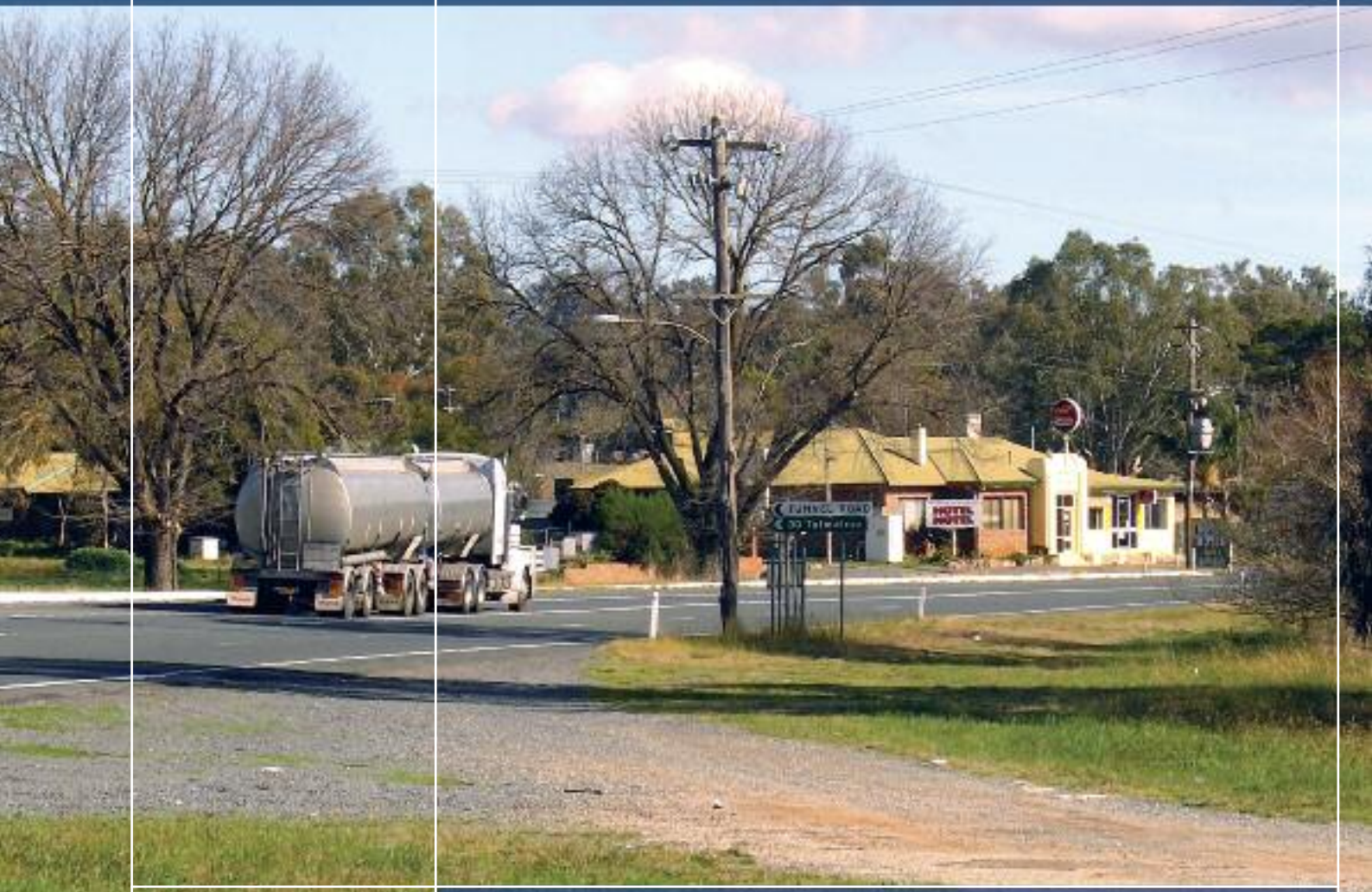

Hume Highway Upgrade

Woomargama bypass

Environmental Assessment
Technical Paper 1 – Flora and Fauna

September 2009

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Hume Highway Upgrade Woomargama Bypass - Ecology

September, 2009

NSW Roads and Traffic Authority

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Glossary

Biodiversity	The biological diversity of life is commonly regarded as being made up of the following three components: ▪ genetic diversity — the variety of genes (or units of heredity) in any population ▪ species diversity — the variety of species ▪ ecosystem diversity — the variety of communities or ecosystems.
Bioregion (region)	A bioregion defined in a national system of bioregionalisation. For this study this is the NSW South-western Slopes bioregion as defined in the Interim Biogeographic Regionalisation for Australia (Thackway & Cresswell 1995).
Brown Treecreeper	Refers to the eastern subspecies of Brown Treecreeper (*Climacteris picumnus victoriae*).
Critical Habitat	The whole or any part or parts of an area or areas of land comprising the habitat of an Endangered species, an Endangered population or an Endangered ecological community that is critical to the survival of the species, population or ecological community (Department of Environment and Conservation 2004). Critical habitat is listed under both the *Threatened Species Conservation Act 1995* and the *Environment Protection and Biodiversity Conservation Act 1999* and both the State (Department of Environment, Climate Change and Water) and Federal (Department of the Environment, Water, Heritage and the Arts) Directors-General maintain a register of this habitat. Capitalisation of the term 'Critical Habitat' in this report refers to the habitat listed specifically under the relevant State and Commonwealth legislation.
Department of Environment, Climate Change and Water	Broadly, the Department of Environment, Climate Change and Water works towards a healthy environment cared for and enjoyed by the whole NSW community; manages the state's natural resources, including biodiversity, soils and natural vegetation; manages natural and cultural heritage across the state's land and waters; acts to minimise the impacts of climate change; promotes sustainable consumption, resource use and waste management; regulates activities to protect the environment; and conducts biodiversity, plant, environmental and cultural heritage research to improve decision making. The Department of Environment, Climate Change and Water formed on 27 April 2007 incorporating the former NSW Department of Environment and Conservation in addition to some functions of the former Department of Natural Resources, Department of Energy, Utilities and Sustainability and The Greenhouse Office.
Department of Industry and Investment	The Department of Industry and Investment now incorporates the Department of Primary Industry.
Department of the Environment and Heritage	The former name for the Commonwealth Department of the Environment, Water, Heritage and the Arts.
Department of the Environment and Water Resources	The former name for the Commonwealth Department of the Environment, Water, Heritage and the Arts.
Department of the Environment, Water, Heritage and the Arts	The department develops and implements national policy, programs and legislation to protect and conserve Australia's natural environment and cultural heritage and administers the *Environment Protection and Biodiversity Conservation Act 1999*.The Commonwealth Department of the Environment, Water, Heritage and the Arts changed their name from the Department of the Environment and Water Resources in 2007, which was previously the Department of the Environment and Heritage.
Ecological community	An assemblage of species occupying a particular area.
Environmental weed	Any plant that is not native to a local area that has invaded native vegetation.
Habitat	An area or areas occupied, or periodically or occasionally occupied, by a species, population or ecological community, including any biotic or abiotic components.

Hooded Robin	Refers to the south-eastern form of the Hooded Robin (*Melanodryas cucullata cucullata*).
Key Threatening Processes	A process that threatens, or could threaten, the survival, abundance or evolutionary development of native species, populations or ecological communities (Department of Environment and Conservation 2004). Key threatening processes are listed under the *Threatened Species Conservation Act 1995,* the *Fisheries Management Act 1994* and the *Environment Protection and Biodiversity Conservation Act 1999.* Capitalisation of the term 'Key Threatening Processes' in this report refers to those processes listed specifically under the relevant State and Commonwealth legislation.
Likely	Taken to be a real chance or possibility (Department of Environment and Conservation 2004).
Local population	The population that occurs within the study area, unless the existence of contiguous or proximal occupied habitat and the movement of individuals or exchange of genetic material across the boundary can be demonstrated (as defined by NSW National Parks and Wildlife Service 1996).
Subject site	The area to be directly impacted by the construction and/ or operation of the Proposal, including a construction buffer to account for construction access (i.e. the extent of direct impacts).
Study area	The subject site and any additional areas that could potentially be affected by the Proposal either directly or indirectly, such as ancillary construction areas. This is taken to include a 200 metre buffer around the Proposal centreline.
Locality	The area within 10 kilometres of the Proposal centreline.
Migratory species	Species listed as Migratory under the *Environment Protection and Biodiversity Conservation Act 1999.* Capitalisation of the term 'Migratory' in this report refers to those species listed as Migratory under the *Environment Protection and Biodiversity Conservation Act 1999*.
Protected species	Those species defined as protected under the *National Parks and Wildlife Act 1974*. Includes all native animals, and all native plants listed on Schedule 13 of the *National Parks and Wildlife Act 1974*.
Recovery plan	A plan prepared under the *Threatened Species Conservation Act 1995* or the *Environment Protection and Biodiversity Conservation Act 1999* to assist the recovery of a Threatened species, population or ecological community.
Region	A bioregion defined in a national system of bioregionalisation. For this study this is the South-western Slopes bioregion as defined in the *Interim Biogeographic Regionalisation for Australia* (Thackway & Cresswell 1995).
Significant	Important, weighty or more than ordinary (as defined by NSW National Parks and Wildlife Service 1996).
Threatened biodiversity	Threatened species, populations or ecological communities, or their habitats as listed under either the *Threatened Species Conservation Act 1995* or the *Environment Protection and Biodiversity Conservation Act 1999*.
Threatened species, populations and ecological communities	Species, populations and ecological communities listed as Vulnerable, Endangered or Critically Endangered (collectively referred to as Threatened) under the *Threatened Species Conservation Act 1995*, *Fisheries Management Act 1994* or the *Environment Protection and Biodiversity Conservation Act 1999*. Capitalisation of the terms 'Threatened', 'Vulnerable', 'Endangered' or 'Critically Endangered' in this report refers listing under the relevant State and/or Commonwealth legislation.
Viable local population	A population that has the capacity to live, develop and reproduce under normal conditions, unless the contrary can be conclusively demonstrated through analysis of records and references (as defined by NSW National Parks and Wildlife Service 1996).

1. Introduction

This Technical Paper addresses the biological impacts associated with the proposed bypass of the township of Woomargama, part of the Hume Highway upgrade project (the Proposal).

The Technical Paper examines the terrestrial and aquatic flora and fauna assemblages and their habitats along the proposed bypass route and determines the biological impacts of the construction and operation of the Proposal. It summarises the proposed mitigation measures as well as the assessments of significance required under the *Environmental Planning and Assessment Act 1979* and the (Commonwealth) *Environment Protection and Biodiversity Conservation Act 1999*.

1.1 Overview

The Proposal includes the following key components:

- approximately nine kilometres of dual carriageway
- an at-grade intersection with the existing Hume Highway approximately 6.5 kilometres north of Woomargama village
- bridges over Sandy Creek
- six deep cuttings
- twin bridges over Mountain Creek
- an at-grade intersection with the existing Hume Highway approximately two kilometres south of Woomargama village
- an upgrade to the at-grade intersection at Fairbairn Road.

The Proposal would be undulating and form an elongated curved alignment. It would lie to the west of Woomargama village at a maximum distance of approximately three kilometres from the existing location of the Hume Highway (Figure 1-1).

At its northern extent, the Proposal would tie-in to the existing Hume Highway. The Proposal would continue south and gradually veer away, in a slight westerly direction, from the existing highway. At approximately 500 metres from the start of the project, a new at-grade intersection would be constructed. This intersection would tie-in the Proposal with the existing highway about 6.5 kilometres north of Woomargama village and would provide access to Woomargama village from the north.

The Proposal would include bridges over Sandy Creek. The project would continue in a westerly direction gradually ascending and traversing through the saddles of Mount McKenzie and would require three deep cuts on the ascent.

The Proposal would then gradually descend in a southerly direction and pass through two further cuts. Still descending the project would travel adjacent to a drainage line.

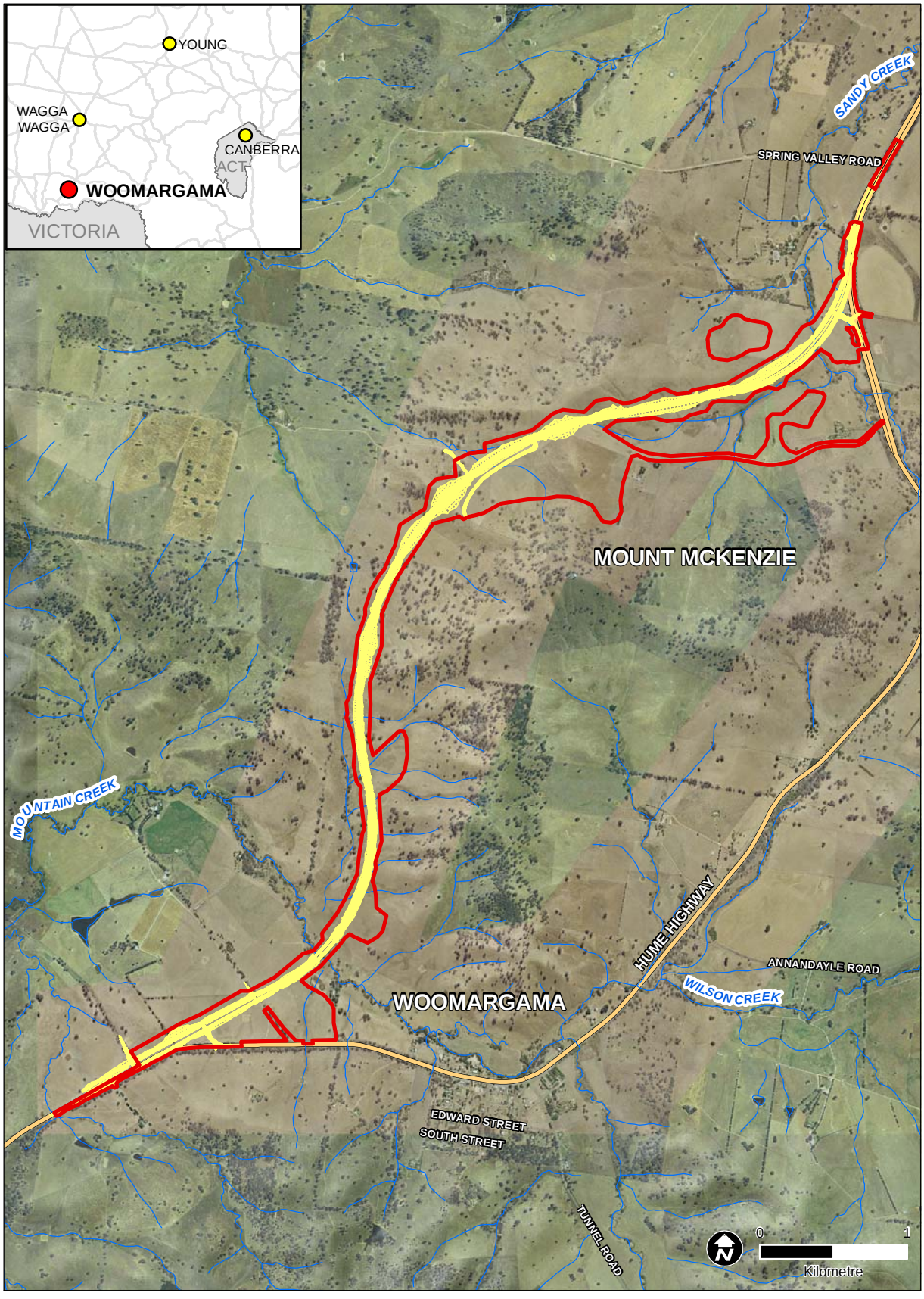

Figure 1-1 The Proposal

Twin bridges would be constructed to enable the crossing of Mountain Creek and its floodplain. The Proposal would continue travelling in a south-westerly direction.

A new at-grade intersection would be constructed approximately 900 metres south of Mountain Creek. This intersection would tie-in with the existing Hume Highway approximately two kilometres south of Woomargama village. This would provide access to the village from the south.

A final deep cut would then be required for the Proposal. The Proposal would include an upgrade of the intersection at Fairbairn Road. It would then tie-in to the new section of Hume Highway dual carriageway scheduled to be completed in December 2009.

1.2 Legislative context

The Proposal will be assessed under Part 3A of the *Environmental Planning and Assessment Act 197*9. Part 3A consolidates the assessment and approval regime for major projects under the *Environmental Planning and Assessment Act 1979*.

Further NSW legislation and planning policies relevant to the protection of biodiversity include:

- *Threatened Species Conservation Act 1995*
- *Fisheries Management Act 1994*
- *National Parks and Wildlife Act 1974*
- *Native Vegetation Act 2003*
- *Water Management Act 2000* and *Rivers and Foreshores Improvement Act 1948*.

Although licences and approvals may not be required under these or other state acts and policies, in addition to approval under Part 3A of the *Environmental Planning and Assessment Act 1979*, consideration has been given to their intent.

The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* applies to the Proposal.

1.3 Scope of the technical paper

The Director-General's environmental assessment requirements (2009) for the Woomargama bypass indicate that the assessment should consider flora and fauna, including but not limited to:

- Assessment of threatened terrestrial and aquatic species, populations, ecological communities and/or critical habitat, consistent with the *Threatened Species Assessment Guidelines* (DECC, 2007)[1], including details on the existing site conditions and quantity and likelihood of disturbance.

[1] Subsequent to the release of the Director-General's Requirements, the Department of Planning confirmed that the guidelines to be followed were, in fact, the Draft Guidelines for Threatened Species Assessment (Department of Environment and Conservation (2005a).

- Targeted surveys of threatened flora and fauna species, including White Box, Yellow Box, Blakely's Red Gum Woodland, hooded Robin, Brown Treecreeper and Squirrel Glider.
- Native vegetation loss; weed infestation; habitat fragmentation; impacts to wildlife corridors including riparian corridors; and impacts to groundwater dependent communities, riparian and aquatic habitat.

The draft *Guidelines for Threatened Species Assessment under Part 3A* (Department of Environment and Conservation 2005a) state that the objective of the assessment process under Part 3A is to provide information to enable decision-makers to ensure that developments deliver the following environmental outcomes:

1. Maintain or improve biodiversity values (i.e. there is no net impact on threatened species or native vegetation).
2. Conserve biological diversity and promote ecologically sustainable development.
3. Protect areas of high conservation value (including areas of Critical Habitat).
4. Prevent the extinction of Threatened species.
5. Protect the long-term viability of local populations of a species, population or ecological community.
6. Protect aspects of the environment that are Matters of National Environmental Significance.

With these objectives in mind, the aims of this Technical Paper are to:

- Determine and describe the characteristics and current condition of the vegetation communities and flora and fauna habitats within the study area.
- Determine the occurrence, or likelihood of occurrence, of Threatened species, populations and communities (biodiversity) listed under the *Threatened Species Conservation Act 1995, Fisheries Management Act 1994* and *Environment Protection and Biodiversity Conservation Act 1999* within the study area.
- Undertake significance assessments for Threatened biodiversity that occur or have potential habitat within the study area.
- Propose further investigations and/or amelioration measures to mitigate impacts on the ecological values of the study area.

The principles of Ecologically Sustainable Development (ESD) are also required to be considered in the assessment of the Proposal's impacts on this site's ecology. These principles are:

- The precautionary principle.
- Inter-generational equity.
- Conservation of biodiversity and ecological integrity.
- Improved valuation, pricing and incentive mechanisms.

The goal of ESD is to ensure that all development is ecologically sustainable in terms of environmental, social, and economic values. For ecological assessments these principles particularly relate to the conservation of biodiversity and amelioration of impacts of the Proposal on biodiversity within the site. The principles of ESD are included in legislation such as the *Threatened Species Conservation Act 1995* and the *Environment Protection and Biodiversity Conservation Act 1999.*

1.4 Structure of the technical paper

The structure and content of this Technical Paper is as follows:

- Chapter 2 details the desk-based and field methods used in surveying the environment as well as the assessment methods.
- Chapter 3 describes the study area and locality in terms of the existing environment, including vegetation communities, terrestrial flora and fauna and aquatic habitats and fauna, based on the results of the desk-based and previous field assessments.
- Chapter 4 describes the Threatened biodiversity and other species of conservation concern likely to occur within the study area based on those found within the Proposal locality and the nature of the habitats within the existing environment.
- Chapter 5 describes the potential impacts of the Proposal on the biological environment, including loss of vegetation and habitats and impacts on Threatened species.
- Chapter 6 describes mitigation measures recommended to be incorporated into the final design and construction program.
- Chapter 7 summarises the assessment of significance of the potential impacts following the requirements of the *Environmental Planning and Assessment Act 1979* (draft *Guidelines for Threatened Species Assessment under Part 3A* of the *Environmental Planning and Assessment Act 1979*) and the *Environment Protection and Biodiversity Conservation Act 1999*.
- Chapter 8 presents conclusions and recommendations.

2. Methods

This chapter details the desk-based and field methods used in surveying the environment as well as the assessment methods.

Due to restrictions of property access during the preparation of this assessment, detailed and targeted field survey has not been completed for this assessment. The information presented in this report is based largely on the surveys completed for the route option studies (nghenvironmental 2007) which included specific targeted surveys for threatened flora and fauna in the study area. As such a precautionary approach has been adopted for this assessment both in terms of the presence or otherwise of rare and threatened biodiversity and the impacts of the proposal.

2.1 Location

Location information for the study area is outlined in Table 2-1.

Table 2-1 Study area location

Location information	Study area
Bioregion	NSW South western slopes (Thackway & Cresswell 1995)
Local government area	Greater Hume Shire
Catchment Management Authority, subregion	Murray CMA, Upper Slopes sub-catchment
Mitchell landscapes	Tipperary Hills Granites
	Brokong Plains
	Wonga Hills and Plains

2.2 Nomenclature

Names of plants used in this document follow Harden (Harden 1992, 1993, 2000, 2002) with updates from PlantNet (Royal Botanic Gardens 2009). Scientific names are used in this report for species of plant. Scientific and common names are provided in plant lists in Appendix A and C.

Names of vertebrates used in this document follow the Census of Australian Vertebrates (CAVS) database maintained by the Department of the Environment, Water, Heritage and the Arts (Department of the Environment Water Heritage and the Arts 2008a) and as used in the Atlas of NSW Wildlife (Department of Environment and Climate Change 2008a). Common names are used in the report for species of animal. Scientific names are included in species lists found in Appendix B and D.

2.3 Literature and database review

Records of Threatened ecological communities, flora and fauna known, or predicted to occur, previously in the Proposal locality or region were obtained from various databases as detailed in Table 2-2.

The results of these database searches are presented in Appendix C and D. Further records of Threatened biodiversity were obtained from various literature sources that are cited throughout this document.

Table 2-2 Databases searched for records of Threatened species

Database	Search date	Area searched	Reference
Atlas of NSW Wildlife	01/06/09	10 kilometre buffer around subject site	Department of Environment, Climate Change and Water (2009a)
PlantNet Database	01/06/09	10 kilometre buffer around subject site	Royal Botanic Gardens (2009)
Threatened species, populations and ecological communities database	01/06/09	Murray Management Authority area, Upper Slopes sub-Catchment	Department of Environment, Climate Change and Water (2009c)
Bionet	01/06/09	10 kilometre buffer around subject site	Department of Environment, Climate Change and Water (2009b)
Protected Matters Search Tool	01/06/09	10 kilometre buffer around subject site	Department of the Environment Water Heritage and the Arts (2009)

Note: Database searches were completed in a radius (generally 10 km) around the following co-ordinates Easting: 522265. Northing: 6038272

2.4 Field surveys

2.4.1 Terrestrial flora and fauna

Terrestrial surveys of the study area were carried out between 17 and 21 December 2006 by nghenvironmental (2007).The preliminary surveys sought to assess the extent and condition of vegetation communities and potential flora and fauna habitat, with particular consideration given to species of conservation concern such as Threatened and Migratory species or locally significant species. Sites surveyed were associated with three broad route options (nghenvironmental 2007) and included surrounding areas potentially affected by the construction and operation of the Proposal (study area).

Survey effort and design considered the *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities* (*Working Draft*) (Department of Environment and Conservation 2004). Surveys included:

- Random Meaner surveys and traverses (Cropper 1993).
- Identification of Box-gum Woodland following the identification guidelines of White Box, Yellow Box, Blakely's Red Gum Woodland (NSW National Parks and Wildlife Service 2002a) and White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grasslands (Department of the Environment and Heritage 2006b).
- Vegetation condition assessment (condition scores adapted from (nghenvironmental 2007).

- Diurnal bird census.
- Nocturnal call playback.
- Trapping of arboreal and terrestrial mammals (Elliott traps).
- Amphibian nocturnal streamside searches.
- Reptile surveys.
- Foot-based spotlighting.
- Scat and animal sign searches.

The locations of surveys are shown in Figure 2-1 and the fauna survey effort is summarised in Table 2-3.

Table 2-3 Summary of fauna survey effort

Survey technique	Target species	Number of sites surveyed	Minimum survey effort
Diurnal bird census	All birds	7	4.6 hours
Nocturnal call playback	Powerful Owl, Masked Owl, Barking Owl, Bush Stone-curlew and Squirrel Glider	1	45 minutes
Elliot trapping	Arboreal and terrestrial mammals (Squirrel Glider & Yellow-footed Antechinus)	3	120 trap nights per site
Amphibian nocturnal streamside searches	All frogs	2	4 person hours
Foot based spotlighting	Nocturnal reptile, bird and mammal fauna	4	8 person hours
Scat and animal sign searches	All species	7	2.3 hours
Incidental sightings	All species	Across study area	

2.4.2 Aquatic surveys

Bio-Analysis carried out field surveys of Mountain Creek on 27 and 28 May 2009, with three sampling locations (WD, WB and WU) used to quantify the aquatic ecology of the creek. Mountain Creek flows from east to west through Woomargama with sampling location WB occurring closest in proximity to the proposed bridge crossing (approximately one kilometre to the south-east). Survey locations WU and WD were situated upstream and downstream respectively, of the bypass location (Figure 2-1).The experimental design for the aquatic survey was based on quantifying the aquatic assemblages at appropriate spatial scales within each of the three locations. Within each location, two randomly nested sites were sampled. Each site was separated by approximately 200 metres.

Within each site, three replicate measurements of physico-chemical water quality variables were recorded using a YEOKAL 611 submersible data logger. The variables included conductivity, dissolved oxygen, pH, temperature and turbidity.

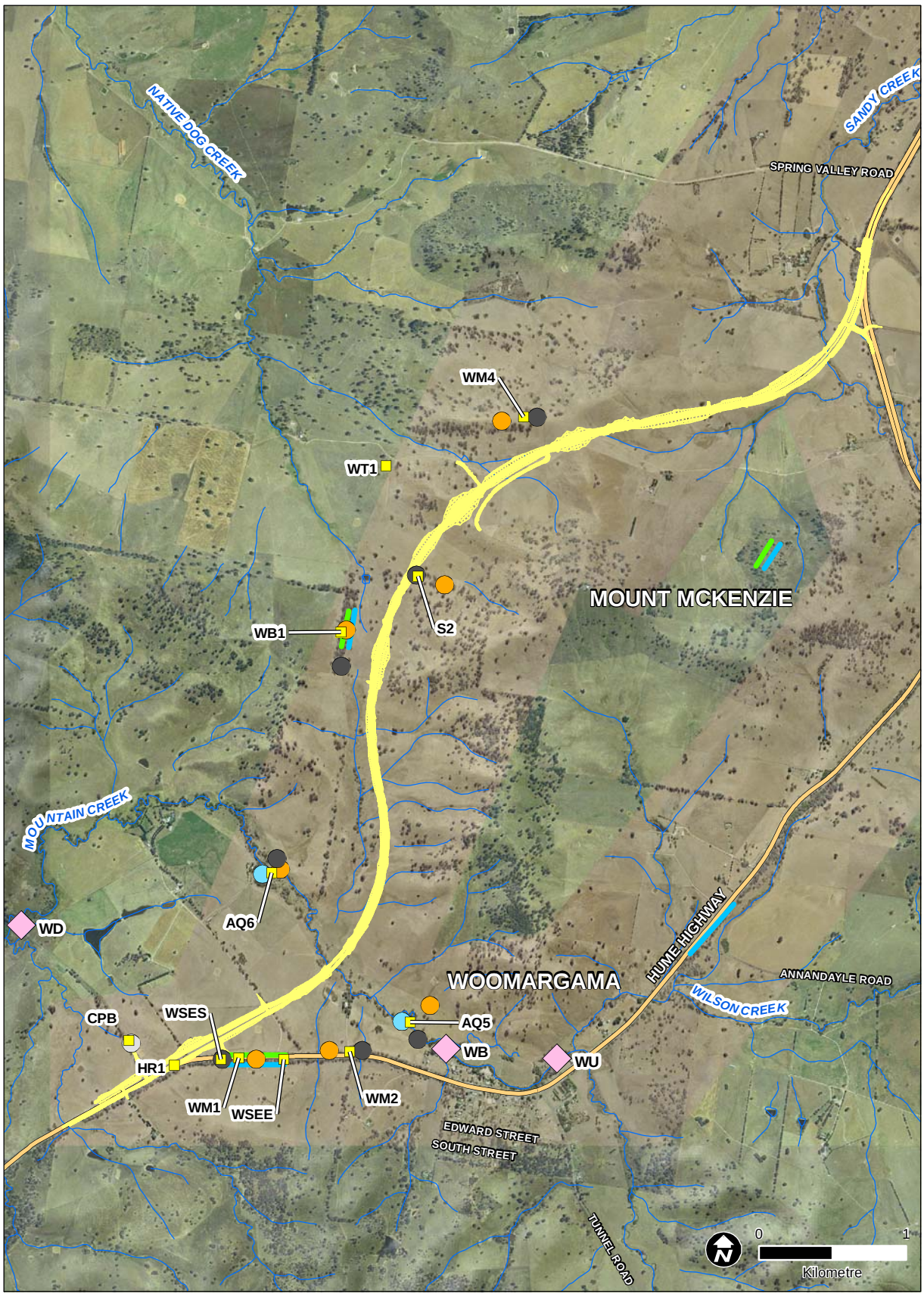

Figure 2-1 Location of Surveys

At each site, three replicate macroinvertebrate samples were collected using timed one minute sweeps of all habitats (edge, riffle, pools, etc.), using a 250 by 250 centimetre (250 micrometre) dip net. The contents of the net were placed into plastic trays filled with fresh water and the macroinvertebrates sorted and placed into pre-labelled plastic sample containers filled with 70% alcohol. The samples were identified to family level and counted in the laboratory using an ISSCO M400 stereomicroscope.

Within each site, three replicate samples of the assemblages of fish were collected using a Smith-Root 15C Electrofisher backpack unit. The electrofisher was used to stun the fish in open water and in submerged and emergent aquatic vegetation. Three minutes of electrofishing effort per replicate was used. All stunned fish were collected using a dip net and placed into plastic trays filled with water. In sites where deeper water occurred, additional sampling was done using nets and traps to sample the assemblages of fish. At least three replicates of each technique were used to quantify the fish assemblages at each site.

Fish were identified and counted in the trays and native species released back into the water once sampling at a site was completed. Exotic species such as carp and gold fish were euthanized using Animal Research Authority Care and Ethics Protocol 03/2445. All collections of fish were done in accordance with Section 37, of the NSW *Fisheries Management Act 1994*, using Scientific Collection Permit Number P03/0032(B)-5.0.

Aquatic analysis

Both univariate (ANOVA – GMAV) and multivariate (PRIMER) statistical routines were used to analyse the data. Analysis of variance (ANOVA) was used to test differences among locations and between sites for the total number of taxa (total richness) and the number of individuals (total abundance). Student Newman Kuels (SNK) tests were used to determine where differences were found in the ANOVA (Underwood 1981). Prior to analysis of variance, the data sets were examined for homogeneity of variances using Cochran's test (Winer 1971) and if necessary were transformed to stabilise the variances (Underwood 1981).

Multivariate statistical techniques were used to examine patterns in assemblages using the PRIMER software package (Plymouth Marine Laboratories, UK). Multivariate methods such as PRIMER allow comparisons of two (or more) samples based on the degree to which these samples share particular species, at comparable levels of abundance. A non-metric multidimensional scaling (nMDS) ordination was used to graphically illustrate relationships between samples for each assemblage. The significance of any apparent differences among sites was determined using ANOSIM (analysis of similarities). A SIMPER (similarity of percentages) procedure was used to examine the contribution of taxa to the similarities (or dissimilarities) among locations and sites (Clarke & Warwick 1994).

The SIGNAL biotic index (Chessman 2001, 2003) was used to assign average pollution sensitivity grades to each of the sites. An average SIGNAL value was calculated for each site by summing the sensitivity grades assigned to each macroinvertebrate family and dividing by the number of families at each site. SIGNAL values range from 1 (most tolerant to pollution) to 10 (most sensitive to pollution). Average SIGNAL values greater than 6 indicate clean water, whilst between 5 and 6 the water quality is doubtful or mildly polluted. SIGNAL values between 4 and 5 indicate moderate pollution, whilst a value less than 4 indicates severe pollution.

Additional information

Additional survey information was obtained from the following local studies:

- Technical Paper 1 — Hume Highway Duplication Biological Impacts Yarra Yarra to Holbrook and Woomargama to Mullengandra (Parsons Brinckerhoff 2007).
- Hume Highway Duplication Threatened Species (Squirrel Glider) Monitoring Final Report of Pre-clearing Surveys (August-November 2007) (van der Ree et al. 2008a).
- Hume Highway Duplication Threatened Species (Squirrel Glider) Monitoring Draft Report Autumn 2008 (van der Ree et al. 2008b).
- Hume Highway Duplication: Sturt Highway to Table Top Road Construction Woodland Bird Surveys (Ambrose 2008a, 2008b, 2008c).
- Threatened species monitoring program – Hume Highway duplication. Assessment of fish populations (Roberts 2008).
- Hume Highway Duplication. Threatened fish monitoring program Assessment of Fish Populations during Duplication: Survey 1 – November 2008 (Knight 2008).

2.5 Landscape context

Landscape context is the condition and nature of vegetation and habitats within and surrounding the study area. Many processes in a patch of vegetation are linked to processes in the surrounding landscape (Lindenmayer & Burgman 2005). The quality (including the long-term survival) of vegetation is dependent on a suite of factors that influence the patch or stand, including its position in the vegetated landscape (Todd 2003).

The assessment of landscape context was both qualitative and quantitative. The qualitative assessment included inspection of the following information within both the study area and the surrounding landscape, defined as 20 kilometres from the Proposal centre-line:

- Aerial photographs.
- Digital elevation model.
- Mitchell Landscapes (NSW National Parks and Wildlife Service 2002b).
- Forest ecosystem mapping for the Southern Comprehensive Regional Assessment (Thomas *et al.* 2000).

Using the Thomas et al. (2000) forest ecosystem mapping, the following quantitative assessment was undertaken using a geographic information system (GIS) (ArcView), following the methods proposed by Parkes et al. (2003). For the purpose of this assessment, a patch was defined as an area (remnant) of native vegetation with a defined physical boundary occurring in fragmented landscapes. A patch may occur across one or more land tenures and consist of one or more vegetation types. The following were assessed:

- **Patch size**: The size of remnant vegetation patches within the study area and within the wider landscape was measured, defined in this case as a distance of 20 kilometres from the study area. For this assessment, any patch intersecting the area of interest was counted. The sizes of vegetation remnants mapped in the study area as part of the current survey were also measured, although this mapping did not extend across the full landscape.

- **Neighbourhood**: The degree to which remnant vegetation is connected to other areas of native vegetation is likely to influence the regenerative capacity of the site, and therefore, its long-term viability (Cunningham 2000). The amount of cover within a locality can also strongly influence the species that occur in the landscape (Reid 2000). The proportion of native vegetation within a set distance of the footprint was measured: Distances were 100 metres, one kilometre, two kilometres and five kilometres from the footprint (refer Figure 2-2).
- **Distance to core area**: For the purposes of this assessment, a 'core area' was defined as a patch of native vegetation greater than 50 hectares. For this assessment, the Thomas et al (2000) mapping was combined with the vegetation mapping completed as part of this assessment. The distance was measured from the centroid of each remnant mapped within the study area to the nearest edge of a 'core area' (refer Figure 2-2).

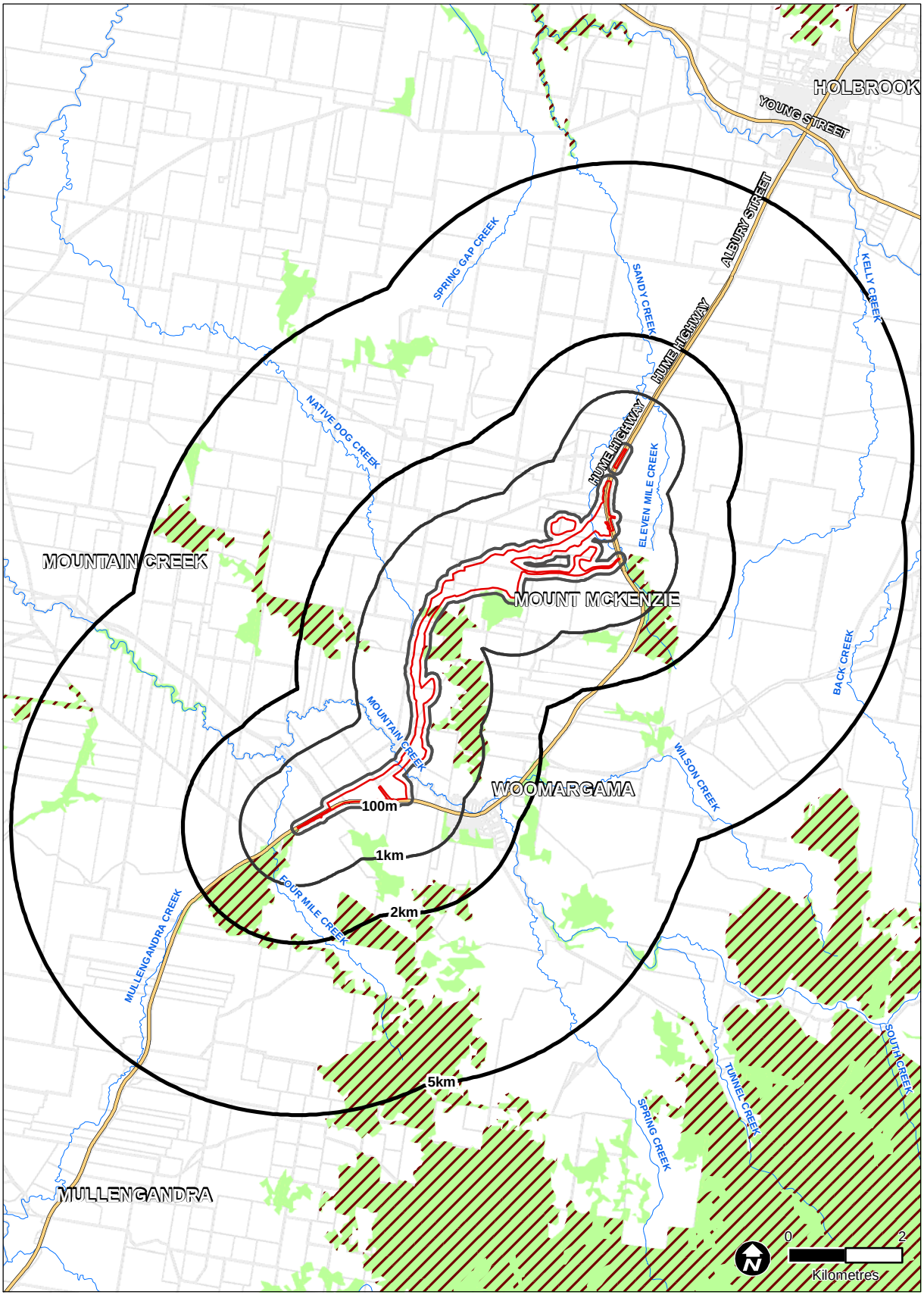

Figure 2-2 Landscape context methodology

2.6 Conservation significance

The conservation significance of native terrestrial flora, fauna and their habitats is generally categorised according to the hierarchy:

- National.
- State.
- Regional.
- Local.

Meaningful comparisons of significance or value at a variety of scales rely on widely accepted criteria (for example, International Union for the Conservation of Nature 2001). The following criteria were used to assign the biodiversity within the study area to an appropriate conservation significance category:

- **National:** Where part of the study area contained features listed as Matters of National Environmental Significance, it was considered to be of national significance. Matters dealt with under the *Environment Protection and Biodiversity Conservation Act 1999* include:
  - Important areas of habitat for migratory species covered under international agreements to which Australia is a signatory, such as the *China Australian Migratory Bird Agree*ment (CAMBA), *Japan Australian Migratory Bird Agreement* (JAMBA), *Republic of Korea Australian Migratory Bird Agree*ment (RoKAMBA) and the Bonn Convention.
  - Ramsar wetlands.
  - World Heritage properties that contain natural heritage considered to be of outstanding value to humanity, as listed under the Convention Concerning the Protection of the World Cultural and Natural Heritage.
  - Species populations or communities listed as Vulnerable, Endangered or Critically Endangered under the *Environment Protection and Biodiversity Conservation Act 1999*.

  This category also includes:
  - Species listed as threatened and rare in *Rare or Threatened Australian Plants* (Briggs & Leigh 1996).
  - Species listed as endangered, vulnerable or rare in *Australia in an Action Plan* published by the Department of the Environment, Water, Heritage and the Arts.
- **State:** State significance refers to habitat containing populations of plant or animal species, or vegetation or animal communities considered threatened in NSW, including species and communities listed pursuant to the *Threatened Species Conservation Act 1995* and the *Fisheries Management Act 1994.* This category also includes species of plant listed as 'poorly known' in Australia in *Rare or Threatened Australian Plants* (Briggs & Leigh 1996).

- **Regional:** There are no widely accepted criteria for regional significance in NSW. The State is divided into bioregions (Thackway & Cresswell 1995) and many of the listings of Endangered Ecological Communities under the *Threatened Species Conservation Act 1995* and the *Environment Protection and Biodiversity Conservation Act 1999* are based around these regions. Also, numerous published studies and vegetation mapping projects (e.g. Thomas *et al.* 2000) have indicated the importance of vegetation and species at various spatial scales. Within the region of the Proposal, the Southern Comprehensive Regional Assessment (National Parks and Wildlife Service 2000) has assigned regional significance for species of both plant and animal.
- **Local:** All remnant native vegetation and fauna habitat that does not fall into the categories above is considered to be of at least local significance as most of these areas have been reduced in extent since European settlement. The overall significance of a site on a local scale can consider factors such as the size of remnants, degree of intactness and connectivity.
- **Potentially significant:** Often the limitations of field methods, seasonal factors or time constraints make it impossible to confirm the presence of a significant species or population. However, the habitat of an area being investigated may closely match that used by a significant species in areas nearby where it is known to occur (Department of Environment and Conservation 2004). In these circumstances, the level of significance that would otherwise apply is qualified by the term 'potential'.

2.7 Likelihood of occurrence and assessment of impact significance

Significance assessments were completed for those Threatened species recorded or predicted to occur with a moderate or high likelihood. For this study, likelihood of occurrence is defined in Table 2-4.

Table 2-4 Likelihood of occurrence of threatened species

Likelihood	Description
Low	Species considered to have a **low likelihood of occurrence** include species not recorded during the field surveys that fit one or more of the following criteria: ▸ Have not been recorded previously in the study area and surrounds and for which the study area is beyond the current distribution range. ▸ Use specific habitat types or resources that are not present in the study area. ▸ Are considered locally extinct. ▸ Are a non-cryptic perennial flora species that were specifically targeted by surveys.
Moderate	Species considered to have a **moderate likelihood of occurrence** include 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 and surrounds. ▸ Use habitat types or resources that are present in the study area, although generally in a poor or modified condition. ▸ Are unlikely to maintain sedentary populations, however, may seasonally use resources within the study area opportunistically during variable seasons or migration. ▸ Are cryptic flowering flora species that were not seasonally targeted by surveys.
High	Species considered to have a **high likelihood of occurrence** include species recorded during the field surveys or species not recorded that fit one or more of the following criteria: ▸ Have frequently been recorded previously in the study area and surrounds. ▸ Use habitat types or resources that are present in the study area that are abundant and/or in good condition within the study area. ▸ Are known or likely to maintain resident populations surrounding the study area. ▸ Are known or likely to visit the site during regular seasonal movements or migration.

For species, populations and communities listed under the *Threatened Species Conservation Act 1995* and the *Fisheries Management Act 1994* that have a moderate or greater potential to occur in the study area, the significance of impacts was assessed based on the Department of Environment, Climate Change and Water's and Department of Industry and Investments' *Draft Guidelines for Threatened Species Assessment under Part 3A* (Department of Environment and Conservation 2005a). Under these guidelines, impacts are considered more significant if:

- Areas of high conservation value are affected.
- Individual animals and/or plants and/or sub-populations that are likely to be affected by a Proposal play an important role in maintaining the long-term viability of the species, population or ecological community.
- Habitat features that are likely to be affected by a Proposal play an important role in maintaining the long-term viability of the species, population or ecological community.

- The duration of the impacts would be long-term.
- The impacts would be permanent and irreversible (Department of Environment and Conservation 2005a).

For species listed under the *Environment Protection and Biodiversity Conservation Act 1999*, significance assessments were completed in accordance with the *EPBC Act Policy Statement 1.1 Significant Impact Guidelines* (Department of the Environment and Heritage 2006a).

Species listed under both the *Threatened Species Conservation Act 1995* and the *Environment Protection and Biodiversity Conservation Act 1999* were assessed using both assessment guidelines separately, although there is considerable overlap between the two assessment processes.

2.8 Limitations

This assessment is based largely on previous survey work completed in the local area. Much of this previous work was related to the current Proposal, or related projects, and specific targeted surveys were completed in the study area. However, detailed field surveys were not undertaken in the study area for the current assessment due to access limitations. As such a precautionary approach has been adopted for this assessment both in terms of the presence or otherwise of rare and threatened biodiversity and the impacts of the proposal.

A common limitation of ecological surveys is the short time period in which they are undertaken and the lack of seasonal sampling, which can lead to low capture rates or lack of detection of some species. For this reason, no sampling technique can totally eliminate the possibility that a species is present on a site. The conclusions in this report are based largely on data acquired for the site and environmental field surveys previously undertaken by nghenvironmental in December 2006 and are therefore, merely indicative of the environmental condition of the site at the time of those surveys, including the presence or otherwise of species. Also, it should be recognised that site conditions, including the presence of Threatened species, can change with time.