BIOSIS
RESEARCH

Proposed Rezoning
Maldon Employment Lands
Terrestrial and Aquatic Flora and Fauna Survey and Constraints Assessment

Report for Wollondilly Shire Council

August 2011

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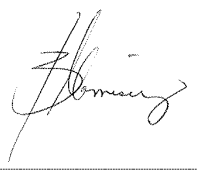
Draft	11/03/11	Brett Morrisey	
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ABBREVIATIONS

CAMBA	*China-Australia Migratory Bird Agreement*
Council	Wollondilly Shire Council
DI & I	Department of Industry and Investment
DIPNR	Department of Infrastructure, Planning and Natural Resources
DO	Dissolved Oxygen
DSEWPC	Department of Sustainability, Environment, Water, Population and Communities (formerly Department of the Environment, Water Heritage and the Arts)
EC	Electrical Conductivity
EEC	Endangered Ecological Community
EIS	Environmental Impact Statement
EP&A Act	*Environmental Planning and Assessment Act* 1979
EPBC Act	*Environment Protection and Biodiversity Conservation Act* 1999
EPI	Environmental Planning Instrument
FM Act	*Fisheries Management Act* 1994
GDE	Groundwater Dependent Ecosystem
HN-CMA	Hawkesbury Nepean – Catchment Management Authority
JAMBA	*Japan-Australia Migratory Bird Agreement*
KTP	Key Threatening Process
LEP	Local Environmental Plan
LGA	Local Government Area
Locality	10km radius of Study Area
NPWS	NSW National Parks and Wildlife Service (now part of OEH)
NW Act	*Noxious Weeds Act* 1993
OEH	Office of Environment and Heritage NSW Department of Environment, Climate Change and Water (formerly NSW Department of Environment Climate Change and Water)
RCMS	Riparian Corridor Management Study
Resilience	Resilience refers to the manifested recovery of a plant community, species or ecosystem following disturbance, as well as the potential of the plant community, species or ecosystem to recover after disturbance (Department of Infrastructure 2003; McDonald 1996).

ROKAMBA	*Republic of Korea-Australia Migratory Bird Agreement*
SCA	Sydney Catchment Authority
SREP 20	*Sydney Regional Environmental Plan No 20 - Hawkesbury-Nepean River (No 2—1997)*
sp.	species (singular)
spp.	species (plural)
ssp.	subspecies
SSTF	Shale Sandstone Transition Forest
Study Area	Area of direct impact and any areas subject to potential indirect impacts
Subject Site	Area of direct impact
TEC	Threatened Ecological Community
TSC Act	*Threatened Species Conservation Act* 1995
var.	variety
UGRSW	Upper George's River Sandstone Woodland
WLEP 1991	*Wollondilly Local Environmental Plan 1991*
WSC	Wollondilly Shire Council

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1.0 INTRODUCTION

Biosis Research Pty. Ltd. has been commissioned by Wollondilly Shire Council (WSC) to undertake terrestrial and aquatic flora and fauna assessments over nine parcels of land (the Subject Site) proposed for rezoning at Maldon. At the time of commissioning the Subject Site (Figures 1 and 2) was zoned Rural 1(a3) under the *Wollondilly Local Environmental Plan 1991* (WLEP 1991). Subsequent to this and following the exhibition and community and stakeholder consultation phases for the *Draft Wollondilly Local Environmental Plan 2009* the *Wollondilly Local Environmental Plan 2011* (WLEP) has been recently gazetted.

The proposed rezoning of the Subject Site (hereafter referred to as the 'proposal') to accommodate light industrial development and incorporate environmental protection zones will be provided for by the preparation of a Local Environmental Plan (LEP) amending the recently gazetted WLEP. Maps accompanying the WLEP identify the majority of the Subject Site is zoned RU2 Rural Landscape and E2 Environmental Conservation over a narrow sliver of the Nepean River along the southern boundary.

Following due process and in identifying key issues to be considered by the draft LEP for the Subject Site, WSC has engaged in Section 62 consultation with several state government agencies. Comments and suggestions from the Section 62 consultations have been considered in defining the scope of the current flora and fauna assessment. In proceeding with the rezoning proposal WSC has set a number of aims and objectives for the rezoning process with the following most relevant to biodiversity conservation and management:

- retention, protection and enhancement of riparian areas;
- retention, protection and enhancement of flora, fauna and habitats with ecological significance; and
- retention, protection and enhancement of natural and cultural assets identified as being of significance.

The terrestrial and aquatic flora and fauna assessments form part of a suite of studies that will identify opportunities and constraints for the preparation of the draft LEP specific to the rezoning proposal. The Subject Site spanning nine lots is generally bound by Picton Road Bridge over the Nepean River in the east, then along the southern side of Picton Road to Maldon Bridge Road with the Allied Mills land south of the Main Southern Railway to the Nepean River forming the majority of the western and southern boundaries. The Subject Site and Study Area (Figures 1 and 2) occur in a broader rural landscape setting with heavy industry including the Allied Mills grain and maize mill and Blue Circle cement works adjoining the Subject Site. Significant natural features of the Study Area are:

- the Nepean River with associated sandstone escarpments and contiguous cover of intact native vegetation; and

- Carriage Creek and tributaries with low sandstone scarps and areas of fully and partially intact native vegetation.

Other terrestrial and aquatic flora and fauna habitats of the Study Area and Subject Site are provided by farm dams, disturbed drainage lines with pools and soaks, structures such as road and rail tunnels and disused buildings, scattered paddock trees and large areas of closed grasslands.

A number of regional and Local Government Area (LGA) specific biodiversity studies have been prepared that incorporate the Study Area. In addition to the broad scale studies, flora and fauna surveys and desktop assessments have previously been carried out for both the Subject Site and Study Area. Most recently the *Rezoning Scoping Study 330 Picton Rd, Maldon* prepared by Parsons Brinkerhoff (2007) has considered biodiversity issues of the Subject Site and potential constraints of the proposed rezoning by desktop analysis. A terrestrial and aquatic flora and fauna survey and assessment was carried out by Ambrose (2004) to accompany the *Picton Flour Mill Environmental Impact Statement* (EIS) by Kellogg Brown and Root (2004) prepared for the construction of the Allied Mills grain and maize mill in the Study Area. Both cited documents are summarised in the following sections.

This report assesses the conservation significance of terrestrial and aquatic flora and fauna on the Subject Site and potential impacts of the proposal on threatened species, populations (and their habitats) or ecological communities that occur, or have the potential to occur in the Study Area in accordance with the requirements of the *Environmental Planning and Assessment Act* 1979 (EP&A Act), *Threatened Species Conservation Act* 1995 (TSC Act), *Fisheries Management Act* 1994 (FM Act) and *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act). For the purposes of this assessment, the following definitions are used:

- **Subject Site** - the area of direct impact associated with the proposal. In this case, this constitutes the combined nine lots proposed for rezoning from rural to light industrial. The Subject Site includes all areas that would potentially support development including commercial buildings, associated infrastructure, bushfire protection zones and areas of potential environmental management works (Figure 2).

- **Study Area** – the area of direct impact and any areas subject to potential indirect impacts. For this assessment, this area is considered to include a 200m buffer around the Subject Site (Figure 2).

- **Locality** – 10km area surrounding the Study Area.

1.1 Aims

The general aim of this project is to undertake a terrestrial and aquatic flora and fauna assessment of the Subject Site and Study Area and to determine the potential constraints of the proposed rezoning of the nine lots at Maldon on matters of conservation significance.

The specific aims of this assessment are to:

- conduct a literature review and database search for the Study Area;
- describe the terrestrial and aquatic flora and fauna of the Subject Site focusing on remnant vegetation, riparian zones and aquatic habitats either on or immediately adjoining the Subject Site;
- identify significant terrestrial and aquatic flora and fauna or their habitats on the Subject Site and in the Study Area, focusing on threatened species, populations and ecological communities listed under the schedules of the TSC, FM and/or EPBC Acts that are known or likely to occur within the Study Area;
- describe the condition of riparian and aquatic habitats and the riparian setback strategy and stream classification associated with riparian and aquatic habitats either on or immediately adjoining the Subject Site;
- provide a biodiversity constraints analysis consistent with WSC planning policy and WSC biodiversity management objectives; and
- describe the potential ecological impacts of the proposed rezoning and future land use.

2.0 METHODS

2.1 Desktop

The main documents reviewed in the preparation of this report are summarised in Section 3. Records of threatened species, populations and ecological communities were obtained from the NSW Office of Environment and Heritage (OEH) Atlas of NSW Wildlife from within a 10km radius of the Subject Site and these are mapped in Figures 4 (flora) and 5 (fauna). Records of other protected and unprotected fauna were also generated from the Atlas of NSW Wildlife and the DPI Fisheries Management Database to inform this assessment. Records of threatened species, populations and ecological communities listed under the EPBC Act were obtained from the Commonwealth Department of Sustainability, Environment, Water, Population and Communities (DSEWPC) Online EPBC Act Protected Matters Database from within a 10km radius of the Subject Site and these are not mapped herein. Database searches were conducted in December 2010 prior to field surveys.

2.2 Field Surveys

Terrestrial flora and fauna surveys were carried out across the Subject Site and immediate surrounds of the Study Area on the 8th and 20th December, 2010. The general condition of the Subject Site and Study Area was assessed and observations were made of plant communities, plant and animal species and flora and fauna habitats. Weather conditions were variable

during the site investigations. Weather conditions on the 8th of December were partly cloudy, warm to hot, with air temperature ranging from 22^0C to 29^0C and a light to moderate north-easterly breeze. Air temperature on the 20th of December was approximately 20^0C with clear skies and a light to moderate westerly breeze.

Aquatic habitat assessments were conducted across the Subject Site and immediate surrounds of the Study Area on the 8th and 9th December, 2010. Weather conditions were consistent with those experienced during the terrestrial flora and fauna surveys on the 8th December, 2010.

2.2.1 Flora Survey

The majority of the flora survey effort on the Subject Site was focused in areas of remnant or regrowth canopy. Formal survey techniques involved a combination of 20m*20m quadrats, transects and random meanders. Brief observations were made at spot locations in native vegetation to record dominant species in each major stratum.

Flora surveys included formulation of species inventories, ground-truthing existing plant community mapping and defining plant communities where these were not otherwise identified in the existing regional surveys.

Threatened flora species previously recorded in the Locality and with potential to occur on the Subject Site and immediate surrounds were targeted in the quadrat and random meander surveys. An inventory of native and exotic flora species was compiled (Appendix 1).

Flora habitat assessments focused on the potential for threatened flora species to occur on the Subject Site and the presence or absence of Threatened Ecological Communities (TEC's). Verification of the presence or absence of TEC's has referenced descriptions of the final determinations for TEC's known to occur within the Locality.

The general condition of the vegetation was assessed based on disturbance history, the degree of infestation by exotic species, structure and overall resilience.

2.2.2 Fauna Survey

The presence of fauna species on the Subject Site and in the Study Area was primarily determined through consideration of suitable habitats, with species of animal present on the site recorded opportunistically during the habitat assessment. Habitat assessments have been used in this assessment as a surrogate for intensive surveys (e.g. trapping, call playback). Consequently, it is assumed that threatened species are present if the habitat features necessary for completion of their life cycles are located in the Study Area.

A general fauna features traverse was undertaken throughout the Subject Site and parts of the Study Area. The objective of this traverse was to identify additional species and their habitats. During the traverse, opportunistic recordings of species were made through:

- direct sightings and observations of other signs and traces such as tracks and scats and aural recognition of calls;
- active searches by turning logs, rocks and other debris for general native fauna in locations of preferential habitat such as the Woodland and Riparian areas of the Study Area;
- searches for evidence of Koala's to inform a SEPP 44 assessment including searches for SEPP 44-listed feed trees, scats and scratches on trees;
- assessments of broad fauna habitat types and identification of fauna habitat features such as feed trees, hollows, rock outcrops and waterways; and
- identification of opportunities and constraints to minimise or ameliorate impacts on native fauna and their habitats in developing land use zoning and concept planning for residential development.

An inventory of native and exotic fauna species was compiled (Appendix 1).

2.2.3 Fauna Habitat Assessment

Fauna habitats were assessed by examining the following characteristics of the Study Area:

- structure and floristics of the canopy;
- understorey and ground cover vegetation;
- size range of hollows and fissures in trees;
- structure and composition of the litter layer;
- rock outcrops, overhangs and crevices;
- waterbodies and aquatic habitats;
- disturbances, including weed invasion, clearing, rubbish dumping or fire;
- potential foraging, nesting or roosting resources; and
- connectivity to off site habitats.

The following criteria were used to evaluate habitat values:

Good: good condition endemic vegetation supporting a full range of fauna habitat components (e.g. hollow-bearing trees, fallen timber, feeding and roosting resources) and habitat linkages to other remnant ecosystems in the landscape are intact.

Moderate: Some fauna habitat components are missing (for example, old-growth trees and fallen timber), although linkages with other remnant habitats in the landscape are usually intact, but sometimes degraded.

Poor: Many fauna habitat elements in low quality remnants have been lost, including old-growth trees (for example, due to past timber harvesting or land clearing) and fallen timber, and tree canopies are often highly fragmented. Habitat linkages with other remnant ecosystems in the landscape have usually been severely compromised by extensive clearing in the past.

2.2.4 Aquatic Habitat Assessment

HABSCORE Assessment

The assessment of aquatic habitats was undertaken using the HABSCORE assessment methodology. Barbour *et al* (1999) describes this methodology as follows: 'HABSCORE is a visually based habitat assessment that evaluates the structure of the surrounding physical habitat that influences the quality of the water resource and the condition of the resident aquatic community' (Barbour *et al.* 1999). At each survey site within the Study Area, an assessment of the waterway and its riparian condition was undertaken and classified based on the presence and condition of the following features:

- pool substrate characterisation;
- pool variability;
- channel flow status;
- bank vegetation (score for each bank);
- bank stability (score for each bank);
- width of riparian zone (score for each bank); and
- epifaunal substrate / available cover.

The aquatic habitat within the Study Area was described in terms of four category types (adapted from Barbour et al. (1999) and Fairfull and Witheridge (2003). The four categories used to evaluate habitat value were Optimal, Suboptimal, Marginal or Poor, as detailed below:

Optimal: watercourses that contain numerous large, permanent pools and generally have flow connectivity except during prolonged drought. They provide extensive and diverse aquatic habitat for aquatic flora and fauna.

Suboptimal: watercourses that contain some larger permanent and semi-permanent refuge pools, which would persist through prolonged drought but become greatly reduced in extent. These watercourses should support a relatively diverse array of aquatic biota including some

fish, freshwater crayfish and aquatic macroinvertebrates. There may also be some aquatic plant species present.

Marginal: watercourses that contain some small semi-permanent refuge pools which are unlikely to persist through prolonged drought. Flow connectivity would only occur during and following significant rainfall. These pools may provide habitat for some aquatic species including aquatic macroinvertebrates and freshwater crayfish.

Poor: ephemeral drainage lines that only contain flow during and immediately after significant rainfall. Permanent or semi-permanent pools that could provide refuge for aquatic biota during prolonged dry weather are absent.

Water Quality Analysis

Measurements of Dissolved Oxygen (DO), pH, Electrical Conductivity (EC), temperature and turbidity were taken using a calibrated TPS 90FLT Field Lab Analyser Water Quality Meter. Water quality was taken where available water enabled the Water Quality Meter to be used effectively, usually greater than 30cm in depth.

2.3 Threatened and migratory species likelihood of occurrence criteria

The likelihood of occurrence assessment for threatened flora and fauna and migratory species was based on previous records collated from database searches, data collected during the field survey, the current (known) distribution range of these species, and the presence and condition of suitable habitat in the Study Area. In addition to these general methods a more detailed set of criteria used to assess the likelihood of threatened or migratory species to occur within the Study Area has been adopted and these are presented in Appendix 2.

The likelihood of occurrence assessments for threatened flora and fauna are provided in Appendix 3.

2.4 Limitations

Terrestrial flora and fauna field surveys and aquatic habitat assessments were conducted over two days in Summer 2010. The survey effort was based on the level of assessment required for the proposed rezoning.

In relation to the amount of survey effort and its timing, an adequate sample of terrestrial flora and fauna species and assessment of the ecological processes that are likely to occur in the Study Area have been made from desktop assessments, background research and the site inspections. However, the full spectrum of terrestrial flora and fauna species and ecological processes likely to occur on the Subject Site and in the Study Area cannot be fully quantified or described in this report. These limitations have been addressed by identifying potential habitats for terrestrial flora and fauna species and assessing the potential for these species to occur on the Subject Site and within the Study Area based on previous records, the type and

condition of habitats present, the land use throughout the Study Area and the landscape context.

The terrestrial flora and fauna survey and aquatic habitat assessment is intended to integrate with and guide the application of current WSC planning policies for assessing land capability and subsequent design of potential future development. As such, certain aspects, definitions and criteria that assess or consider biodiversity in the Draft WLEP are referenced and incorporated into this document. Additionally, the surveys and assessment herein do not eliminate the need for further surveys and impact assessments for TSC, FM and/or EPBC Act threatened biodiversity as a result of rezoning and potential future development.

In respect to the aquatic habitat assessment, water quality parameters measured/analysed provide a snapshot of conditions at a given point in time. Some of these parameters typically exhibit a high degree of temporal variation and can change substantially over small periods of time such as weeks, days and even hours, particularly in response to significant rainfall events. Furthermore, the water quality samples were collected at intervals from within the drainage lines, creeks and streams within the Study Area. Many of the parameters measured may exhibit a high degree of spatial variation and can change considerably over small or large distances upstream and downstream of sample sites. This is especially relevant to waterbodies sampled within the Study Area, given the current conditions of riparian zones and the proximity of housing and roads to the waterbodies, receiving runoff during high rainfall.

In addition, in relation to the amount of survey effort and its timing, an adequate sample of the spectrum of aquatic flora and fauna species and assessment of the ecological processes that are likely to occur on the Study Area have been made from desktop assessments, background research and the site inspection. However, the full spectrum of aquatic flora and fauna species and ecological processes likely to occur on the Subject Site and in the Study Area cannot be fully quantified or described in this report.

No detailed surveys have been carried out on the type and extent of Groundwater Dependant Ecosystems (GDE's) associated with the study area. Assessment of GDE's is based on general field observations and desktop analysis including reports by other.

3.0 BACKGROUND REVIEW

3.1 Wollondilly Shire Biodiversity Strategy

The Wollondilly Biodiversity Strategy (ELA 2004) was prepared to guide Council and the community towards considering biodiversity in planning and management decision making processes. The Wollondilly Biodiversity Strategy considers and integrates relevant statutory and planning documents and Environmental Planning Instruments (EPI's). The synthesis of these, and in particular the vision statements from the *Wollondilly Vision 2025*, provides a

guide to formulating a coordinated approach to protecting biodiversity over the short, medium and longer term. The aims of the strategy are to:

- provide a coordinated approach to the conservation of Wollondilly's native plants, animals, their habitats, and the ecological processes that sustain them;
- provide Council and staff with direction and assistance in making effective and efficient management decisions regarding biodiversity and long term strategic planning for biodiversity;
- ensure the principles of Ecologically Sustainable Development are employed when making decisions about the use of natural resources in the Wollondilly Shire; and
- provide the Wollondilly community with processes that are transparent and accountable.

The recommended strategies focus mainly on non-protected and non-catchment lands as these areas face the greatest pressures. Not withstanding, the strategy recognises that the whole landscape of the LGA including the extensive conservation reserves and protected catchment areas contribute to the region's biodiversity.

The Biodiversity Strategy provides a 'snapshot' of the flora and fauna values of the Wollondilly LGA with inventories of threatened and non-threatened flora and fauna derived from regional vegetation mapping, local studies and database searches. Threats to biodiversity are highlighted and this is generally framed in the context of Key Threatening Processes (KTP's) listed under Schedule 3 of the TSC Act. In addition to the flora and fauna inventories, the study provides vegetation mapping based on a standardised composite of the multiple regional vegetation mapping projects that incorporate various parts of the Wollondilly LGA (ELA, 2004).

The strategy proposes eleven conservation targets to protect and improve biodiversity in the Wollondilly LGA. To meet these conservation targets a number of prioritised strategies and actions are suggested. Strategies and actions are prioritised according to WSC vision statements and goals and overall these strategies are designed to assist in reducing the loss of biodiversity within the WSC LGA (ELA, 2004).

3.2 Vegetation Mapping

3.2.1 Native Vegetation of the Cumberland Plain

Multiple regional vegetation mapping projects cover parts of the Wollondilly LGA. The *Native Vegetation of the Cumberland Plain, Western Sydney − 1:25 000 Map Series* (NPWS 2002a) incorporates the majority of the Wollondilly LGA into Maps 1 to 3 of the series including the Study Area and Subject Site. The *Native Vegetation of the Cumberland Plain, western Sydney: systematic classification and field identification of communities* (Tozer 2003)

provides a survey of vegetation communities occurring on the Cumberland Plain and adjacent plateaus characterised by Wianamatta Shale soils. The Tozer (2003) study recognises that most of the native vegetation communities of the Cumberland Plain and neighbouring Wianamatta Shale geography are listed as endangered under the TSC Act. Due to the pressures of urban expansion in western Sydney and surrounding areas, part of the rationale for the survey was to address the need for quantitative data to assist in the identification of native plant communities and provide assessment of the conservation value of vegetation remnants. The aim of the survey was to revise the existing plant community classification to take account of:

- recently described vegetation communities and other communities warranting recognition;
- provide quantitative data for characteristic species in each community (frequency of occurrence and relative abundance);
- identify species showing high fidelity to each community as a basis for diagnosing community type in the field;
- estimate the present cover of native vegetation; and
- derive a spatial model as a basis for predicting the vegetation type and conservation value of all remaining remnants.

The survey incorporated systematic, stratified field sampling to record floristic structure and composition, a classification procedure based on hierarchical, agglomerative clustering analysis, spatial modelling of community distributions using geological, climatic and topographic variables; and the interpretation of patterns in canopy composition and remnant condition in aerial photographs (Tozer 2003).

The NPWS (2002a) Cumberland Plain vegetation mapping is used as a reference for this investigation. Vegetation community descriptions from the Tozer (2003) study and *Interpretation Guidelines for the Native Vegetation Maps of the Cumberland Plain, Western Sydney, Final Edition* (NPWS 2002c) have been referenced to validate the presence or absence of native plant communities from the NPWS (2002a) mapping of the Subject Site (Figure 3) following field surveys. Further, assessment of the occurrence and distribution of TEC's in this survey and assessment has been determined by the identifying criteria and characteristic species from the final determinations for a TSC and/or EPBC Act TEC.

3.3 Terrestrial Vertebrate Fauna of the Greater Southern Sydney Region

The *Terrestrial Vertebrate Fauna of the Greater Southern Sydney Region* (DECC 2007) was a joint project undertaken by the Department of Environment and Conservation (now the OEH) and the Sydney Catchment Authority (SCA). The Greater Southern Sydney Region incorporates the following land tenures:

- Kanangra-Boyd National Park;
- Blue Mountains National Park;
- Bargo River State Conservation Area;
- Thirlmere Lakes National Park;
- Warragamba Special Area;
- Nattai National Park;
- Upper Nepean State Conservation Area;
- Metropolitan Special Area;
- Dharawal State Conservation Area;
- Heathcote National Park; and
- Royal National Park.

The main objective of this project was to gather and synthesise information to provide a greater understanding of the vertebrate fauna of the Greater Southern Sydney Region for use in land management. Specifically, this project aimed to (but was not limited to):

- collect information on vertebrate fauna and to examine fauna at a bioregional context;
- make this information accessible to land managers and the broader community for use in conservation planning;
- identify all threatened fauna species occurring in the region as listed under the TSC Act or the EPBC Act (termed Species of Conservation Concern);
- identify and assess the risk of all vertebrate and introduced pest species found with the region;
- identify any additional fauna species that are thought to be in decline, isolated or regionally under threat;
- identify particular locations, regions or habitats of high conservation significance for vertebrate fauna across the region and within each of the Special Areas;
- identify all Key Threatening Processes (as defined under the TSC Act) which operate in the region, and assess how these are impacting on the natural values of the region; and

- identify faunal migration pathways within the Greater Southern Sydney Region, and any corridors between protected areas that would be a priority for addition to the reserve system, revegetation or other conservation measures.

Regional pathways were developed as a component of the project by identifying Species of Conservation Concern that undertake migrations, are nomadic or are large bodied, wide ranging and are likely to require landscape connections for their continued survival in the area. These are defined as primary landscape connections between larger important areas of habitat. The Wollondilly LGA is encompassed within the Southern Blue Mountains to Woronora Regional Pathway, an east-west link that covers a range of regional scale physiographic and climatic gradients. This link is an extremely important link between the two major sandstone plateaux of the region.

There are two separate fauna linkages that have been identified within this Regional Pathway; the Cumberland Koala Linkage and the Bargo Linkage. Fauna linkages are defined as areas comprising a single fauna habitat and facilitate the movement of a particular species, or a suite of species about the landscape.

The Study Area is situated on the Cumberland Koala Linkage (Figure 3) which forms part of the Bargo Linkage to the southwest of the Subject Site. The Cumberland Koala Linkage consists of linked remnant vegetation around the edge of the Cumberland Plain, providing a connection of suitable habitat between the four Koala colonies at Wedderburn, Avon/Nepean, south Nattai and Glenbrook. DECC (2007) suggest that the disjunct Koala colonies at Wedderburn, Avon/Nepean, south Nattai and Glenbrook were probably once part of the same population, but have been fragmented by development on the Cumberland Plain. To the south of the Study Area, these colonies may be linked to populations in the Southern Highlands and Wollondilly. Importantly the Cumberland Koala Linkage has been defined by DECC (2007) to facilitate continued survival of the species by ensuring gene-flow between the major known colonies of the region through maintaining or enhancing suitable vegetation connectivity between colonies. In addition to providing habitat and dispersal corridors for the Koala DECC (2007) state that the Cumberland Koala Linkage provide habitat and regionally significant dispersal corridors for a range of other fauna species of Conservation Concern. These species are listed in Tables 44 and 45 of the DECC (2007) report.

3.4 Wollondilly Local Environmental Plan 2011

The *Wollondilly Local Environmental Plan 2011* (WSC 2011) has been prepared according the NSW Standard Instrument. In guiding the development and planning decisions for land in Wollondilly Shire, the WLEP sets a number of aims including those that consider the management of biodiversity in the LGA. Specific aims of the WLEP that consider biodiversity and natural resource management are:

- to provide for the management of natural resources and the protection of the natural landscape character; and

- to protect water quality in land that is situated within water supply catchments.

The WLEP addresses the management of biodiversity in multiple components of the planning and assessment process including land use zonings that have conservation as the primary land use which are;

- E1 - National Parks and Nature Reserves;
- E2 - Environmental Conservation; and
- E3 - Environmental Management.

Additionally biodiversity protection is provided for in Part 7, Clause 7.2 the objective of which is 'to maintain terrestrial and aquatic biodiversity' including:

- protecting native fauna and flora;
- protecting the ecological processes necessary for their continued existence;
- encouraging the recovery of native fauna and flora and their habitats; and
- protecting water quality within drinking water catchments.

Clause 7.2 applies to land identified as 'sensitive land' on the WLEP Natural Resources - Biodiversity Map. Before determining a development application for land to which Clause 7.2 applies, the consent authority must consider any adverse impact of the proposed development on:

- native ecological communities;
- the habitat of any threatened species, populations or ecological community;
- regionally significant species of fauna and flora or habitat;
- habitat elements providing connectivity; and
- water quality within drinking water catchments.

There are number of factors that must be considered including avoiding, minimising or mitigating potential environmental impacts before development consent can be granted by Council.

The objective of Part 7, Clause 7.3 Water protection of the WLEP is 'to maintain the hydrological functions of riparian land, waterways and aquifers' including protecting the following:

- water quality;

- natural water flows;
- the stability of the bed and banks of waterways; and
- groundwater systems.

This clause applies to land identified as "sensitive land" on the Natural Resources - Water Map. Before determining a development application for development on land to which this clause applies, the consent authority must consider any adverse impact of the proposed development on the following:

- the water quality of receiving waters;
- the natural flow regime;
- the natural flow paths of waterways;
- the stability of the bed, shore and banks of waterways; and
- the flows, capacity and quality of groundwater systems.

Development consent must not be granted to development on land to which this clause applies unless the consent authority is satisfied that:

- the development is designed, sited and will be managed to avoid any adverse environmental impact, or
- if that impact cannot be avoided—the development is designed, sited and will be managed to minimise that impact, or
- if that impact cannot be minimised—the development will be managed to mitigate that impact.

The Subject Site is zoned as RU2 Rural Landscape.

Accompanying the WLEP 2011 is the *Wollondilly Development Control Plan 2010* (WDCP). The WDCP provides the technical detail for the implementation of the WLEP 2011 and Volume 1 General of the WDCP outlines the information and plans to be submitted with any development application.

The key section of the WDCP is 2.5 Biodiversity and this focuses on the definitions of 'sensitive land' that are identified on the Natural Resources - Biodiversity Map of the WLEP. Sensitive land for the purposes of the WLEP comprise part or all of the following environmental characteristics:

- Endangered Ecological Communities (EEC's) as defined by the TSC Act;
- Core Vegetation and Critical Habitats;

- Flora and Fauna Corridors;
- Habitat for threatened species according to Schedules 1 and 2 of the TSC Act ;
- Key areas of biodiversity; and
- Riparian corridors (including Riparian Land as described under Section 2.6 of WDCP Volume 1).

In addition to 'sensitive lands' the WDCP defines 'Potential sensitive land' for Biodiversity as land identified on the DCP Natural Resources – Potential Biodiversity Map. This is land with the potential to feature part or all of the above listed environmental characteristics but is yet to be ground-truthed by detailed, qualified and independently verified field work. The 'potential sensitive land' is based on aerial photographic survey. The maps are kept in the office of Council and amended from time to time as development and planning proposals supported by specialist studies are independently assessed and verified. Once ground-truthed and surveyed, these maps may be used to make future amendments to the Natural Resources – Biodiversity Map in the WLEP.

Section 2.6 Water of the WDCP relates to the management of riparian land, waterways and ground water systems. This section specifies the requirements for the protection and preservation of land with the potential to feature surface and ground water systems or have some link with the flow, capacity and quality of surface and ground water systems. The detailed planning and assessment provisions under Section 2.6 include guidance and controls for certain actions such as the implementation of riparian buffer distances.

Section 2.3 Tree and Vegetation Provisions of the WDCP also relates to the management of terrestrial biodiversity. This section specifies the requirements for the protection and preservation or clearing of trees and bushland vegetation for where development consent is, or is not, required. The detailed planning and assessment provisions under Section 2.3 include guidance and controls for certain actions such as tree or vegetation removal and development near riparian areas.

As part of the WDCP, WSC has developed a rating system that classifies 'sensitive land' and 'potentially sensitive land' into 5 categories. Primarily, the categories from 1 to 5 consider the quality and integrity of the vegetation and are designed to ensure that biodiversity is considered as part of the development assessment process. The rating system highlights vegetation through its location, conservation and biodiversity values, opportunities to link areas of strategic importance, the potential of the vegetation in supporting threatened species and water quality outcomes. Table 1 of the WDCP, Section 2.5.2, defines the criteria for defining each vegetation category. Actions or controls to be considered in the development application and assessment process for 'sensitive land' and 'potentially sensitive land' are clearly stated.

As part of the WDCP, WSC has implemented a rating system that classifies Riparian Lands using the Strahler method of stream order classification. The Strahler method classifies three different minimum riparian buffer distances to be implemented for riparian land based on the relative importance of the watercourse within the catchment and its functioning. Each stream order in the Riparian Lands mapping has been linked to a specific riparian buffer distance with some orders requiring the same buffer distance.

Clauses 7.2 and 7.3 of the WLEP 2011 and Sections 2.5 and 2.6 of the WDCP are integral to the aims of this terrestrial and aquatic flora and fauna assessment. As such, formulation of the constraints analysis focuses on identifying and classifying 'sensitive lands' based on the six guiding features listed above. Further, the 'Classification or description' criteria for discrete 1 to 5 categories from Table 1 of the WDCP Section 2.5.2 are core to this assessment. Identification and classification of portions of the Subject Site as an area commensurate to 'sensitive land' in this survey and assessment has added elements of fauna habitat not necessarily considered by the WDCP.

3.5 Sydney Regional Environmental Plan No 20 - Hawkesbury-Nepean River (No 2 - 1997)

The *Sydney Regional Environmental Plan No 20 - Hawkesbury-Nepean River (No 2—1997)* (SREP 20) applies to the Wollondilly LGA. SREP 20 aims to 'protect the environment of the Hawkesbury-Nepean River system by ensuring that the impacts of future land uses are considered in a regional context'.

The general planning considerations implemented by SREP 20 are set out in Part 2 of the plan. In summary these are:

- Clause 4 - Application of general planning considerations, specific planning policies and recommended strategies;
- Clause 5 - General planning considerations; and
- Clause 6 - Specific planning policies and recommended strategies.

Clause 6 identifies key environmental issues and specific planning policies and recommended strategies for the implementation of SREP 20. Table 1 below highlights provisions of SREP 20 under Clause 6 that are of particular relevance to the conservation and management of biodiversity and natural resources relevant for the current investigations. Relevant strategies recommended under Clause 6 that are addressed by this terrestrial and aquatic biodiversity assessment are highlighted with reference to specific sections of this report.

Table 1: Summary of SREP 20, Clause 6 relevant to the current biodiversity investigations.

Issue	Policy	Strategies	Report section
Total catchment management	Total catchment management is to be integrated with environmental planning for the catchment.	Consider the impact of the development concerned on the catchment.	Section 8 Constraints Analysis Section 9 Conclusions and Recommendations
Environmentally sensitive areas	The environmental quality of environmentally sensitive areas must be protected and enhanced through careful control of future land use changes and through management and (where necessary) remediation of existing uses. Note. Environmentally sensitive areas in the Hawkesbury-Nepean catchment are: the river, riparian land, escarpments and other scenic areas, conservation area sub-catchments, national parks and nature reserves, wetlands, other significant floral and faunal habitats and corridors, and known and potential acid sulphate soils	Minimise adverse impacts on water quality, aquatic habitats, riverine vegetation and bank stability.	Section 8 Constraint8 Constraints Analysis Section 9 Conclusions and Recommendations
Water quality	Future development must not prejudice the achievement of the goals of use of the river for primary contact recreation (being recreational activities involving direct water contact, such as swimming) and aquatic ecosystem protection in the river system. If the quality of the receiving waters does not currently allow these uses, the current water quality must be maintained, or improved, so as not to jeopardise the achievement of the goals in the future. When water quality goals are set by the Government these are to be the goals to be achieved under this policy. Note. Aquatic ecosystems and primary contact	Consider the need to ensure that water quality goals for primary contact recreation and aquatic ecosystem protection are achieved and monitored.	Section 6 Aquatic Assessment Section 8 Constraints Analysis Section 9 Conclusions9 Conclusions and Recommendations

Issue	Policy	Strategies	Report section
	recreation have the same meanings as in the document entitled Australian Water Quality Guidelines for Fresh and Marine Waters, published in 1992 by the Australian and New Zealand Environment and Conservation Council.	Develop in accordance with the land capability of the site and do not cause land degradation.	Section 6 Aquatic Assessment Section 8 Constraints Analysis Section 9 Conclusions and Recommendations
		Site and orientate development appropriately to ensure bank stability. Plant appropriate native vegetation along banks of the river and tributaries of the river, but not so as to prevent or inhibit the growth of aquatic plants in the river, and consider the need for a buffer of native vegetation.	Section 8 Constraints Analysis Section 9 Conclusions and Recommendations
		Protect the habitat of native aquatic plants.	Section 8 Constraints Analysis Section 9 Conclusions and Recommendations
Flora and fauna	Manage flora and fauna communities so that the diversity of species and genetics within the catchment is conserved and enhanced.	Conserve and, where appropriate, enhance flora and fauna communities, particularly threatened species, populations and ecological communities, aquatic habitats, wetland flora, rare flora and fauna, riverine flora, flora with heritage value, habitats for indigenous and migratory species of fauna, and existing or potential fauna corridors.	Section 8 Constraints Analysis Section 9 Conclusions and Recommendations
		Locate structures where possible in areas which are already cleared or disturbed instead of clearing or disturbing further land.	Section 8 Constraints Analysis Section 9 Conclusions and Recommendations
		Minimise adverse environmental impacts, protect existing habitat and, where appropriate, restore habitat values by the use of management practices.	Section 8 Constraints Analysis Section 9 Conclusions and Recommendations
		Consider the range of flora and fauna inhabiting the site of the development concerned and the surrounding land, including threatened species and migratory species, and the impact of the proposal on the survival of threatened species,	Section 8 Constraints Analysis Section 9 Conclusions and Recommendations

Issue	Policy	Strategies	Report section
		populations and ecological communities, both in the short and longer terms.	
		Consider the need to provide and manage buffers, adequate fire radiation zones and building setbacks from significant flora and fauna habitat areas.	Section 8 Constraints Analysis Section 9 Conclusions and Recommendations
		Consider the need to control access to flora and fauna habitat areas.	Section 8 Constraints Analysis Section 9 Conclusions and Recommendations
		Consider the need to maintain corridors for fish passage, and protect spawning grounds and gravel beds.	Section 8 Constraints Analysis Section 9 Conclusions and Recommendations

3.6 Rezoning Scoping Study

A scoping study to assess a possible rezoning of the Allied Mills land at 330 Picton Road, Maldon has been prepared by Parsons Brinkerhoff (2007). The report evaluates the strategic opportunities of the Maldon Precinct as an employment-generating centre and outlines technical constraints and opportunities that would need to be considered in a rezoning. Management measures and development principals were suggested to maximise opportunities and manage constraints associated with the environmental and social issues of the Study Area.

The report included a desktop ecological assessment providing a broad description of the vegetation communities present in the area and identifies threatened species, populations and/or EEC's that could potentially occur in the Subject Site. Recommendations regarding the natural heritage include:

- further assessment for species listed under the TSC and/or EBPC Acts once detailed plans for the proposal are established for the Study Area;
- a 40m buffer zone to be maintained around the Carriage Creek tributary and its wetlands providing protection from the construction and operational impacts of development;
- measures to minimise the impacts of lighting from industrial developments on nocturnal fauna to be implemented (e.g. vegetative screening); and
- installation of silt fences and sediment ponds around construction areas on the site to prevent runoff of sediment and nutrient-enriched waters into nearby drainage lines and bushland areas.

The final recommendations of the report regarding the rezoning of the Subject Site, consistent with the rezoning plan, were that:

- the developable component between Picton Road and the existing railway line is developed for Business Park related uses, allowing for low rise, low density, boutique business park development, complete with suitable landscaping and native vegetation by integrating the development with the surrounding natural landscape (including dams and waterways);
- the developable component south of the railway line is rezoned to a general industry zoning (IN1 – General Industry); and
- the non-developable component south of the railway line (along the Nepean River and Carriage Creek) is rezoned to E1 Environmental Management.

Whilst the preliminary investigations of the *Rezoning Scoping Study - 330 Picton Rd, Maldon* by Parsons Brinkerhoff (2007) have provided some initial site investigations the report and recommendations summarised above have not been adopted by WSC.

3.7 Allied Grain Mill Flora and Fauna Survey and Assessment

A terrestrial and aquatic flora and fauna survey and assessment for the construction and use of the now operational Allied Mills Flour and Maize Mill at Maldon was carried out by Ambrose (2004). The surveys were restricted to the 24 ha of the Allied Mills land between Picton Road and the Great Southern Railway Line adjacent to the Subject Site. In summary Ambrose (2004) identified two highly modified plant communities described as 'Grazing land with scattered trees' and 'Drainage line vegetation' and suggests that the original vegetation was probably Shale Sandstone Transition Forest (SSTF). Native plant species richness and diversity were considered to be low and no threatened flora or EEC's were recorded in the surveys by Ambrose (2004).

Assessments by Ambrose (2004) determined fauna habitats to be significantly modified and disturbed with limited value for native terrestrial fauna. Twenty-two fauna species were recorded by Ambrose (2004) and these are included in the fauna species inventory of the current assessment (Appendix 1). Although none of these were listed under the TSC and/or EPBC Acts, it was considered that the site provided potential habitat for the following threatened fauna species:

- Red-crowned Toadlet *Pseudophryne australis*;
- Green and Golden Bell Frog *Litoria aurea*;
- Grey-headed Flying-fox *Pteropus poliocephalus*;
- Large-eared Pied Bat *Chalinolobus dwyeri*;
- Eastern Freetail Bat *Mormopterus norfolkensis*;
- Eastern Bentwing-bat *Miniopterus schreibersii oceanensis*;
- Eastern False Pipistrelle *Falsistrellus tasmaniensis*;
- Southern Myotis *Myotis macropus*; and
- Greater Broad-nosed Bat *Scoteanax rueppellii*.

Assessments under the TSC Act were conducted for these species which concluded that the proposed development would not significantly impact the status of these species. Therefore no Species Impact Statement was prepared for the grain mill development. The Grey-headed Flying-fox was also assessed under the EPBC Act criteria. Given that this species is highly mobile, it was considered that the proposal would not hinder its movement, breeding, roosting or other habitat requirements critical to the survival of the Grey-headed Flying-fox.

The proposed development was also not considered to have a significant impact on the status of migratory species that utilise the Subject Site of the Ambrose (2004) surveys.

3.8 Riparian Corridor Management Study

The Riparian Corridor Management Study (DIPNR 2004) (RCMS) was prepared in response to the 1999 Commission of Inquiry into the "Long Term Planning and Management of the Illawarra Escarpment". The RCMS included areas within the Wollongong Local Government Area and Calderwood Valley, which spans both the Wollongong and the Shellharbour Local Government Areas.

Three categories of riparian environmental objectives were developed for the streams in the RCMS that reflect their relative environmental significance and these categories, in order of importance, are:

Category 1. Environmental Corridor – provide biodiversity linkages ideally between one key destination to another, (the coast and the escarpment, or large nodes of vegetation);

Category 2. Terrestrial and Aquatic Habitat – provides basic habitat and preserves the natural features of a watercourse (not necessarily linking key destinations); and

Category 3. Bank Stability and Water Quality – has limited (if any) habitat value but contributes to the overall basic health of a catchment.

For each of the above categories, the recommended minimum width of the riparian zone varies in order to achieve the functioning identified by the objective being sought.

The RCMS made five recommendations that, if adopted, would provide recognition of the significance of riparian land and provide a logical framework to allow riparian land to be protected and properly managed. Those recommendations were to:

(i) Establish environmental objectives for riparian land;

(ii) Map the environmental objectives of all streams;

(iii) Map riparian corridors prior to rezoning/redevelopment;

(iv) Establish management zones and guidelines for riparian land; and

(v) Incorporate the envisaged riparian outcomes into the floodplain management planning process.

Given the limitations of the Strahler method when determining riparian buffer widths, such as its dependence on desktop mapping only. The RCMS method is recommended as it provides a ground-truthed method of determining buffer widths that has been used successfully in the Wollongong, Shellharbour other LGA's in the state. By adopting the procedures developed in the RCMS, riparian management can readily be incorporated into planning instruments such as Local Environmental Plans and Development Control Plans. This can provide a degree of upfront certainty and a legislative base for the protection, implementation and management of riparian land outcomes.

3.9 Hydrology Studies

3.9.1 Surface Hydrology

The hydrology study of the Subject Site by Martens and Associates (2011) focuses on flood assessments and stormwater management. The report makes a number of recommendations that may be considered in further detailed design works of lot and infrastructure lay out including;

- Altering site levels through engineered earthworks to raise levels in areas adjoining Carriageway Creek whilst not adversely affecting flood behaviour on neighbouring lots, railway line and Picton Road (i.e. maintaining flood storage, etc);
- Construction of flood detention measures upslope of the site (e.g. flood detention basin);
- On site detention of stormwater through a several measures such as rainwater tanks and porous subsurface drains;
- Re-use of collected rainwater on-site for non-potable purposes;
- Gross Pollutant Traps (GPT's) that intercept stormwater prior to on site storage and prior to discharge to road reserves.
- Detailed design of all stormwater management measures be undertaken at the sub-division stage of the development.

The report by Martens and Associates (2011) does not make any assessment of the potential impacts on groundwater or Groundwater Dependant Ecosystems (GDE's) as a result of a rezoning or potential development either in general or in relation to the specific recommendations summarised above.

3.9.2 Groundwater

The EIS by KBR (2004) addresses groundwater in relation to the previous Allied Mills development in the Study Area. In summary the EIS describes the Subject Site of the Allied Mills development as being underlain by rocks of the Ashfield Shale formation and below about RL130, by Hawkesbury Sandstone. The Ashfield Shale is estimated to be between 10 and 20 m thick at the Allied Mills site and is composed of laminite, thin-bedded siltstone, mudstone and claystone, collectively referred to as 'shale', with thin and impermeable sandstone beds in places. The underlying Hawkesbury Sandstone is reported to be exposed below about RL130 m AHD in the nearby Nepean River gorge and along its tributary gullies. This formation is composed of massive quartz sandstone with 5-10% of shale in discontinuous 'lenticular' beds. The EIS states that the sandstone geology is believed to be more than 100m thick in the Maldon area and is at least 10m below the existing ground surface within the mill area.

Based on topography and the known geology of the site, the EIS suggests it is likely that the main or regional water table beneath this site is present at approximately 50 to 60m, placing it within the Hawkesbury Sandstone, which is a low permeability aquifer, just above the level of the nearby Nepean River (around RL80).

The EIS also suggests the overlying Ashfield Shale is essentially impermeable, but it is possible for minor localised 'perched' water tables to occur within the soil profile or at the base of weathering in the shale bedrock. Additionally the shallow farm dams that were present in the EIS Study Area were assessed to be holding water well and this was determined to be an indication of the low permeability of the soil profile.

The EIS states that following database searches 'nine groundwater bores are registered within a 5 km radius of the site. Standing water levels at six of these bores varied between 59 m and 134 m.

3.10 Groundwater Dependant Ecosystems

Groundwater dependant ecosystems (GDEs) have been defined by DLWC (2002) as ecosystems which have their species composition and natural ecological processes determined by groundwater. GDEs vary in the degree of their dependency on groundwater from having no apparent dependence to being entirely dependant on it.

Terrestrial vegetation such native pant communities including forests, woodlands and wetlands in riparian zones and on coastal floodplains may be dependent on shallow groundwater either permanently or seasonally. River or stream flow is often maintained by groundwater which provides base flow emerging as springs or diffusely from sediments and rock strata underlying a stream and stream banks. Base flow groundwater can be crucial in maintaining in-stream and near-stream ecosystems such as native plant communities (DLWC 2002).

The *NSW State Groundwater Dependant Ecosystems Policy* (DLWC 2002) defines five main types of groundwater systems in NSW. Based on the topographic and physiographic features of locality there is potential that Study Area supports Fractured Rock Groundwater or Sedimentary Rock Groundwater Systems. These systems and their associated dependent ecosystems are summarised from DLWC (2002) below.

- Fractured Rock Groundwater Systems- In NSW all outcropping and sub-cropping rocks contain a mixture of fractures, joints, bedding planes and faults that contain and transmit small and occasionally large amounts of groundwater. The groundwater in these systems may support base flows to rivers, wetlands, caves, terrestrial vegetation and hypogean ecosystems.

- Sedimentary Rock Groundwater Systems - Sedimentary rock aquifers include sandstone, shale and coal. In NSW examples of sedimentary rock aquifers can be found in the Great Artesian Basin, the Sydney Basin and the Clarence Moreton Basin, all of which store significant volumes of groundwater. Sedimentary rock aquifers support a wide variety

of ecosystems, including springs and soaks, hanging swamps, terrestrial vegetation, hypogean ecosystems, hyporheic zones and base flows

4.0 FLORA

4.1 Plant species

A total of 123 plant species were recorded from random meanders, transects and quadrats on the Subject Site. The flora species inventory includes 91 locally occurring native species and 32 introduced species (Appendix 1).

The high proportion of native to exotic species is a reflection of the resilient condition of the bushland along Carriage Creek and the sandstone benches above the Nepean River and was the focus of the survey effort. Weed percent cover and weed species richness is highest in the cleared pastures. Weed infestations in bushland areas are mainly limited to; the edges with cleared pastures; the Carriage Creek lower banks and channel; and patchy, minor occurrences in intact vegetation.

4.2 Plant communities

4.2.1 Shale Sandstone Transition Forest

SSTF is present on the upper banks of Carriage Creek and sandstone terraces above the Nepean River (Figure 4). Canopy is between 15 and 25m tall and dominated by *Eucalyptus crebra* Narrow-leaved Ironbark, *Eucalyptus eugenioides* Thin-leaved Stringybark and *Eucalyptus punctata* Grey Gum with *Eucalyptus fibrosa* Red Ironbark occasional. The midstorey consists of regenerating canopy species and small trees including *Acacia decurrens* Black Wattle, *Callitris rhomboidea* Port Jackson Pine and *Allocasuarina littoralis* Black She-oak with *Acacia binervia* Coast Myall dominating in areas of shallow soils on broad sandstone benches. The understorey is well developed and is characterised by dense thickets of *Kunzea ambigua* Tick Bush in places with other areas supporting sparse to very sparse shrub cover. Other common shrub species of the understorey are *Bursaria spinosa* ssp *spinosa* Blackthorn, *Correa reflexa* var *speciosa* Common Correa, *Hemigenia purpurea* and *Notelaea longifolia* Large Mock-olive. Apart from minor patches of herbaceous weeds and along edges with the cleared pastures, the ground cover stratum is in good condition and dominated by native grasses, herbs, sedges and sub shrubs. Common native species of the groundcovers include *Anisopogon avenaceus* Oat Speargrass, *Calotis dentex, Cheilanthes sieberi* ssp *sieberi* Mulga Fern, *Entolasia marginata* Bordered Panic, *Glycine clandestina, Hibbertia diffusa* Wedge Guinea Flower, *Lepidosperma laterale*, *Microlaena stipoides* var *stipoides* Weeping Grass, *Phyllanthus hirtellus, Pomax umbellata* Pomax and *Themeda australis* Kangaroo Grass.

There is a large patch of regenerating SSTF in the south that is dominated by characteristic native shrub species with sparse emergent characteristic tree species and groundcover dominated by native grasses and herbs.

SSTF throughout the Subject Site is highly resilient with all structural layers dominated by established and recruiting native plant species.

4.2.2 Riparian Forest

There is a narrow band of Riparian Forest (RF) over the lower and mid-slopes of the gully in the southern section of Carriage Creek. Canopy of the lower and mid slopes is dominated by *Angophora subvelutina* Broad-leaved Apple, *Eucalyptus crebra* Narrow-leaved Ironbark, *Eucalyptus elata* River Peppermint and *Eucalyptus punctata* Grey Gum with *Eucalyptus eugenioides* Thin-leaved Stringybark common in the higher areas where RF intergrades with the SSTF of the upper terraces. The sparse midstorey is dominated by *Acacia binervia* Coast Myall, *Allocasuarina littoralis* Black She-oak and regenerating canopy species. The understorey over the mid to upper slopes of the gully is generally sparse and becoming denser in the southern area where the gully narrows. Common native shrubs or shrubs of the higher and northern areas of RF are *Acacia linearifolia* Narrow-leaved Wattle, *Bursaria spinosa* ssp *spinosa* Blackthorn, *Correa reflexa* var *speciosa* Common Correa, *Kunzea ambigua* Tick Bush, *Nematolepis squamea* ssp *squamea* Satinwood and *Leucopogon juniperinus* Prickly Beard-heath. Stands of *Backhousia myrtifolia* Grey Myrtle occur in the southern section of RF with *Notelaea longifolia* Large Mock-olive and *Pomaderris discolor* also common in this sheltered area.

The groundcover stratum is well developed in the northern section and over the mid to upper slopes of the gully. Apart from some exotic grasses and herbs in the lower channel (see Section 4.2.3 following) native groundcovers dominate. Common native grasses are *Austrodanthonia fulva* Wallaby Grass, *Echinopogon ovatus* Forest Hedgehog Grass, *Eragrostis leptostachya* Paddock Lovegrass, *Imperata cylindrica* Blady Grass and *Themeda australis* Kangaroo Grass and common herbs include *Brachyscome linearifolia*, *Calotis dentex*, *Lepidosperma laterale*, *Lomandra filiformis* ssp *filiformis* Wattle Mat-rush and *Lomandra longifolia* Spiny-headed Mat-rush. Common native grasses and herbs on the lower slopes and more sheltered southern areas are *Austrostipa ramosissima* Stout Bamboo Grass, *Cheilanthes sieberi* ssp *sieberi* Mulga Fern, *Dichondra repens* Kidney Weed, *Microlaena stipoides* var *stipoides* Weeping Grass, *Plectranthus parviflorus* Cockspur Flower, *Poranthera microphylla* and *Pratia purpurascens* Whiteroot.

Weed percent cover is very low and limited to minor infestations in the channel with some scattered thickets of woody weeds on the mid slopes. Exotic grasses and herbs recorded in the current surveys are *Bidens pilosa* Cobblers Pegs, *Cyperus eragrostis*, *Paspalum dilatatum* Paspalum, *Plantago lanceolata* Lamb's Tongues and *Rumex crispus* Curled Dock and woody weed are *Ligustrum lucidum* Large Leaved Privet and *Ligustrum sinense* Small Leaved Privet.

This community intergrades with SSTF on the higher northern slopes and eastern and western benches and terraces of Carriage Creek. There is a distinct change in canopy to WSGF over the steeper southern section of gully dropping into the Nepean River. RF of the Subject Site is a fully structured native plant community with a high resilience.

4.2.3 Western Sandstone Gully Forest

Western Sandstone Gully Forest (WSGF) is present on the narrow benches and escarpments of the Nepean River and lower section of Carriage Creek (Figure 4). Due to access restrictions no formal flora surveys were conducted in this plant community. Brief inspections from safe locations were made to note dominant species of the main structural layers. The distribution of WSGF in the current surveys is generally consistent with vegetation mapping of the Subject Site by NPWS (2002a). Canopy of the WSGF consists of *Eucalyptus eugenioides* Thin-leaved Stringybark, *Eucalyptus piperita* Sydney Peppermint and *Eucalyptus punctata* Grey Gum. The midstorey includes *Acacia binervia* Coast Myall and *Allocasuarina littoralis* Black She-oak in the higher areas and common shrub species are *Correa reflexa var speciosa* Common Correa, *Nematolepis squamea ssp squamea* Satinwood and *Notelaea longifolia* Large Mock-olive.

In addition to the above NPWS (2002c) identify WSGF as occurring on the lower slopes of sandstone gullies on the western side of the Woronora Plateau. The community grades into Sandstone Ridgetop Woodland less than half way up the slope from gully floors. In particularly sheltered gullies, mesic species such as *Backhousia myrtifolia* Grey Myrtle and *Pittosporum undulatum* Sweet Pittosporum form a dense small tree stratum. Vines may be locally abundant, and dense patches of ferns also occur. A narrow band of Riparian Scrub usually occupies the creek line.

4.2.4 Riparian Scrub

Due to access limitations vegetation of the Nepean River was not surveyed. Riparian Scrub is mapped by NPWS (2002a) on the Nepean River (Figure 3) and this is adopted for the current assessment (Figure 4). Riparian Scrub is described by NPWS (2002c) as being dominated by trees with species composition varying dependant on location. The shrub stratum can be locally dense, but shrub patches are frequently interspersed between rock pavement, recent deposits of sediment and water. The ground stratum is similarly variable and water plants occur intermittently. Characteristic species listed by NPWS (2002c) that are likely to occur on the Nepean River in the Study Area of the current survey are: *Backhousia myrtifolia* Grey Myrtle, *Callicoma serratifolia* Black Wattle, *Ceratopetalum apetalum* Coachwood or *Tristaniopsis laurina* Water Gum in the canopy; *Acacia floribunda* White Sally Wattle, *Lomatia myricoides* River Lomatia and *Leptospermum morrisonii* in the understorey; with ferns, sedges and herbaceous species such as *Blechnum cartilagineum* Gristle fern, *Gleichenia dicarpa* Pouched Coral Fern, *Lomandra longifolia* Spiny-headed Mat-rush, *Oplismenus imbecillis* Oplismenus, *Schelhammera undulata* and *Schoenus melanostachys* in the groundcover stratum.

4.2.5 Riparian/Aquatic

Riparian and aquatic vegetation occurs around the several dams of the Subject Site, on the disturbed northern channel and main vegetated section of Carriage Creek (Figure 4). Fringing vegetation of the five dams (one in the northwest six Lot blocks, two in the southern central Lot and two in the eastern Lots) is generally part of the surrounding Closed Grassland and dominated by exotic grasses and herbs. Common species are *Cirsium vulgare* Spear Thistle, *Oxalis corniculata*, *Pennisetum clandestinum* Kikuyu Grass, *Rumex crispus* Curled Dock, *Plantago lanceolata* Lamb's Tongues and *Phalaris aquatica* Phalaris. Aquatic vegetation of the dams is variable in percent cover and comprises a narrow range of floating attached and emergent native plant species such as *Ludwigia peploides* ssp *montevidensis* Water Primrose, *Ottelia ovalifolia* ssp *ovalifolia* Swamp Lily and *Typha domingensis* Narrow-leaved Cumbungi. Due to past or continuing impacts from livestock grazing and watering resilience of riparian vegetation fringing the dams is low.

The original vegetation of Carriage Creek between Picton Road and the Main Southern Railway has been cleared. Vegetation of the channel in this area consists mainly of exotic grasses and herbs such as *Pennisetum clandestinum* Kikuyu Grass, *Rumex crispus* Curled Dock with some damper areas and soaks dominated by the native grasses *Cynodon dactylon* Couch and *Paspalum distichum* Water Couch. At the time of survey there were some small ephemeral pools in the channel supporting *Typha domingensis* Narrow-leaved Cumbungi. This area is subject to livestock grazing and resilience is low.

The section of Carriage Creek in the main southern Lot supports riparian and aquatic vegetation in the main channel. Introduced grasses and herbs dominate the drier areas, however native grasses and herbs are present mixed through the exotic groundcovers or as minor patches. Common native and introduced species are *Centella asiatica* Indian Pennywort, *Cynodon dactylon* Couch, *Bothriochloa macra* Red Grass, *Conyza canadensis* ssp *canadensis*, *Microlaena stipoides* var *stipoides* Weeping Grass, *Paspalum distichum* Water Couch, *Pennisetum clandestinum* Kikuyu Grass, *Rumex crispus* Curled Dock and *Taraxacum officinale* Dandelion. Fringing vegetation of the permanent pools and ephemeral soaks in the channel are characterised by a groundcover stratum as described above and moderate to dense stands of *Typha domingensis* Narrow-leaved Cumbungi. Riparian and aquatic vegetation of this section of Carriage Creek has a low to moderate resilience.

4.2.6 Closed Grassland

Closed Grasslands throughout the Subject Site generally constitute a cleared and disturbed landscape and highly modified flora habitat. Closed Grasslands of the north-western six Lots, north-eastern two Lots and central Lot (Figure 4) are highly modified as a result of native vegetation clearing, introduction of pasture species, pasture improvement weed invasion and long history of agriculture. Common exotic grasses are *Nassella neesiana* Chilean Needlegrass, *Paspalum dilatatum* Paspalum, *Pennisetum clandestinum* Kikuyu Grass, *Phalaris aquatica* Phalaris with *Avena fatua* Wild Oats, *Briza minor* Shivery Grass and *Sporobolus africanus* Parramatta Grass also present. Common introduced annual and perennial herbs

include *Bidens pilosa* Cobblers Pegs, *Conyza* sp Fleabane, *Onopordum acanthium* ssp *acanthium* Scotch Thistle, *Oxalis corniculata*, *Senecio madagascariensis* Fireweed, *Taraxacum officinale* Dandelion and *Verbena bonariensis* Purpletop. Native grasses and herbs are mixed through the exotic groundcovers with some scattered patches and areas adjoining the SSTF that have a high percent cover of native species. Common native species of the groundcover stratum are *Bothriochloa macra* Red Grass, *Cynodon dactylon* Couch, *Dichelachne crinita* Longhair Plumegrass, *Microlaena stipoides* var *stipoides* Weeping Grass, *Themeda australis* Kangaroo Grass.

There are some scattered occurrences and minor patches of native and exotic shrubs including species such as *Bursaria spinosa* ssp *spinosa* Blackthorn, *Kunzea ambigua* Tick Bush, *Ligustrum lucidum* Large Leaved Privet, *Ligustrum sinense* Small Leaved Privet, *Olea europaea ssp cuspidata* Olive and *Rubus fruticosus agg sp* Blackberry. Native trees are present in the Closed Grassland mainly as very sparse and isolated individuals. Species recorded are *Eucalyptus crebra* Narrow-leaved Ironbark, *Eucalyptus moluccana* Grey Box and *Eucalyptus tereticornis* Forest Red Gum.

4.3 Threatened flora species

No direct observations were made of TSC or EPBC Act threatened flora species or populations in the current surveys. Searches of the DECCW Wildlife Atlas and DEWHA Protected Matters Search Tool have identified 21 plant threatened plant species previously recorded in the Locality or their potential habitats (Figure 5 and Appendix 3). These records include 16 plant species with dual listing under the TSC and EPBC Acts, four species solely under the TSC Act and one species only listed under the EPBC Act.

Appendix 3 provides an assessment of the likelihood of the 21 threatened flora, or their habitats, recorded in the Locality to occur on the Subject Site. Based on the habitats present in the Study Area, the Subject Site and other considerations (Appendix 2) these assessments have determined that there is:

- a nil to low likelihood for 14 of these species to be present on the Subject Site or in the Study Area;
- a medium likelihood for six species to be present on the Subject Site or in the Study Area; and
- a high likelihood for one species to be present on the Subject Site or in the Study Area.

4.4 Threatened plant communities

SSTF is an EEC listed under the TSC and EPBC Acts. This EEC is the dominant native plant community on the Subject Site and has an overall high resilience throughout.

Riparian Forest is mapped in the current surveys through a central section of Carriage Creek (Figure 4). Riparian Forest described by Tozer (2003) and mapped by NPWS (2002a) was

included in the former EEC Sydney Coastal River Flat Forest. As stated by the NSW Scientific Committee (2004) the EEC River-Flat Eucalypt Forest on Coastal Floodplains includes and replaces Sydney Coastal River-Flat Forest EEC.

5.0 FAUNA

5.1 Terrestrial Fauna Habitats

The following three major fauna habitats are present on the Subject Site:

- Woodland – encompassing the Shale Sandstone Transition Forest, Upper Georges River Sandstone Woodland and Western Sandstone Gully Forest of the Subject Site;
- Aquatic Environments – including dams, wetlands and creeklines within the Subject Site and the Nepean River in the larger Study Area; and
- Cleared and Disturbed - including Closed Grassland pastures, the Mill operations area, Main Southern Railway, culverts, carparks and access roads.

The fauna habitats present within the Study Area and their condition are discussed in the following sections.

5.1.1 Woodland

The majority of the remnant bushland of the Study Area consists of woodland habitat which is largely intact and undisturbed. The woodland habitat forms part of an extensive corridor of similar habitat along the Nepean and Bargo Rivers extending to regionally significant natural areas and conservation reserves. This connectivity provides an important regional movement corridor and is likely to be used for localised and sub-regional fauna dispersal and as part of major migratory routes for some mobile species.

The canopy of the woodland consists predominately of Eucalypt species including *Eucalyptus crebra*, *Eucalyptus fibrosa* and *Eucalyptus punctata* and reaches a height of 15 to 25m. Canopy trees provide foraging and nesting habitat for common bird species such as the Eastern Yellow Robin *Eopsaltria australis*, Grey Fantail *Rhipidura albiscapa* Rufous Whister *Pachycephala rufiventris* and White-throated Treecreeper *Cormobates leucophaea*. Although not recorded during field investigations, this habitat is also likely to support common arboreal mammal species, such as the Common Brushtail Possum *Trichosurus vulpecular* and Sugar Glider *Petaurus breviceps.* Foraging habitat for the threatened Glossy-black Cockatoo *Calyptorhynchus lathami*, in the form of Black She-oak *Allocasuarina littoralis* was present within this habitat.

Given the type of canopy trees dominating the woodland (i.e. hard barked trees), few hollow-bearing trees were observed. Tree hollows provide critical shelter and nesting habitat for a

range of hollow-dependent fauna, including threatened species of microbat and bird. Those hollow-bearing trees that are present are likely to provide nesting opportunities for these species.

Canopy connectivity is of moderate density, allowing for some sunlight to reach the ground, providing suitable basking sites for reptiles. Reptiles observed during field investigations included Eastern Water Skink *Eulamprus quoyii*, Eastern Water Dragon *Physignathus lesueurii* and Delicate Skink *Lampropholis delicata* (see Appendix 1).

The shrub layer is comprised of flora species derived from the Myrtaceae and Mimosaceae families (0.5-3m). The dense nature of this layer was found to provide habitat for a variety of small native bird species including Red-browed Finch *Neochmia temporalis*, Superb Fairy-wren *Malurus cyaneus* and White-browed Scrubwren *Sericornis frontalis*.

Native grasses, sedges and herbs dominate the groundcover, although much of this layer was covered in accumulations of logs, woody debris and leaf litter. This microhabitat provides foraging, basking, nesting and hibernation sites for reptiles, mammals and the threatened invertebrate, the Cumberland Plain Land Snail *Meridolum corneovirens*. Fallen branches and limbs also provide perching and nesting opportunities for some species of bird.

Rocky outcrops, shelves, overhangs, cliffs and terraces occur frequently throughout the woodland, particularly in the southern portion of the site along the Nepean River. Rock shelves and overhangs provide shelter and refuge sites for a range of ground mammals and reptiles including Short-beaked Echidna *Tachyglossus aculeatus* and the Common Wallaroo *Macropus robustus*. Diggings and scat of these species were found in association with rocky outcrops throughout the Subject Site. The threatened Broad-headed Snake *Hoplocephalus bungaroides* is likely to shelter in rock crevices and under flat sandstone rocks on the exposed cliff edges along the Nepean River during autumn, winter and spring. Caves are also the primary roosting habitat for a number of microbats, including the threatened Eastern Bentwing-bat *Miniopterus schreibersii oceanensis*.

The woodland habitat supports a high level of fauna habitat features that are important in the maintenance of native fauna diversity and life cycles of the Locality. Given the intact nature and connectivity of this habitat in the Subject Site and Study Area, it is considered that it is of **high** conservation value.

5.1.2 Aquatic Environments

Riparian habitats across the Study Area ranged from simple ephemeral drainage lines and farms dams to structurally complex and dynamic systems along Carriage Creek and the Nepean River.

The multiple dams of the Subject Site and contains suitable habitat to host several water birds including Australian Wood Duck *Chenonetta jubata*, Chestnut Teal *Anas* castanea, Purple Swamphen *Porphyrio porphyrio* and the Eurasian Coot *Fulica atra*. Dams of the Subject Site

are also likely to provide foraging habitat for microbat species, including the threatened Southern Myotis *Myotis macropus*.

There is a large dam on the Allied Mills property in the north of the Study Area which flows into Carriage Creek. Frogs including Common Eastern Froglet *Crinia signifera*, Bleating Tree Frog *Litoria dentata* and Eastern Dwarf Tree Frog *Litoria fallax* were heard calling from vegetation fringing this dam.

Carriage Creek, as well as a small ephemeral tributary of Carriage Creek, flows south through the Study Area and drains into the Nepean River. At the time of field survey, the creek was typically between 0.2-5m in width and contained small to medium sized pools. Water depth varied between 10-40cm and scattered emergent vegetation was recorded at several locations. Banks were typically stable and covered by both native and exotic vegetation. Sections of Carriage Creek consisted of sandstone banks and substrate, offering ideal habitat for basking reptiles including Eastern Water Skink *Eulamprus quoyii* and Eastern Water Dragon *Physignathus lesueurii*.

Riparian forest habitat lines Carriage Creek and provides both sheltering and foraging for a number of bird, reptile and mammal species. Canopy trees overhanging the creek provide perching sites for species such as the Azure Kingfisher *Alcedo azurea*. A breeding pair was observed foraging over the creek line in the Study Area. The groundcover and understorey of this habitat type is made up of low to tall shrubs (0.5-3m) of high density. An old walking trail intersects the riparian forest along the eastern side of the Carriage Creek.

A separate Aquatic Ecological Assessment has been undertaken for this project in Section 6.

5.1.3 Cleared and Disturbed

Large areas of the Study Area have been cleared of native trees for grazing purposes. This area is currently grazed by domestic stock and rabbits. Cleared and disturbed habitat dominates the northern portion of the Subject Site between Picton Road and the railway line as well as a large portion south of the railway line.

Remnant paddock trees that formed part of this habitat support hollows, cracks, pipes and fissures. These trees provide potential roosting habitat for microbats, as well as breeding habitat for common bird species such as the Red-rumped Parrot *Psephotus haematonotus*, which was observed nesting in the hollow-bearing tree located near the mill carpark just beyond the Study Area.

Several culverts exist throughout the disturbed habitat of the Study Area. Culverts provide potential roosting sites for microbats and nest sites for Fairy Martins *Hirundo ariel*. Active Fairy Martin nests were opportunistically recorded under the Main Southern Railway line over Carriage Creek. No microbats were observed using the culverts during opportunistic diurnal observations.

Other fauna species recorded in this habitat included common native bird species such as the Masked Lapwing *Vanellus miles*, Crested Pigeon *Ocyphaps lophotes*, Welcome Swallow *Hirundo neoxena* and Willie Wagtail *Rhipidura leucophrys*, as well as several exotic bird species including Common Myna *Acridotheres tristis* and Common Starling *Sturnus vulgaris*. Two birds of prey, the Nankeen Kestral *Falco cenchroides* and the Grey Goshawk *Accipiter novaehollandiae*, were recorded flying over this habitat. The presence of these species is indicative of the high availability of prey in the Locality including small birds (particularly honeyeaters), reptiles, small mammals and insects.

5.2 Animal Species

Incidental observations of animal species in the Study Area are listed in Appendix 1. A total of 63 fauna species were recorded in the Study Area, which included 55 (87%) native species (Table 2). The most abundant fauna group recorded were birds with 46 species recorded. No threatened species were recorded during field surveys. A total of eight introduced fauna species were recorded.

Table 2: Summary of fauna recorded during the field survey

Group	Native species	Introduced species	Threatened species	Migratory species
Amphibians	3	0	0	0
Reptiles	5	0	0	0
Birds	43	3	0	0
Mammals	4	5	0	0
TOTAL	**55**	**8**	**0**	**0**

5.3 Threatened Species of Animals

A total of 36 terrestrial threatened fauna species listed under the TSC Act and/or EPBC Act have been previously recorded within the Locality (Figure 6 and Appendix 3). Of these, all are listed under the TSC Act and seven are listed under the EPBC Act.[1].

No threatened fauna were recorded during field surveys, however 28 fauna species were considered likely to occur within the Study Area on the basis of previous records and the presence of suitable habitats, scoring a moderate to high likelihood of occurrence (Appendix 3). For a majority of these species the habitats present in the Study Area are restricted to the woodland habitat and may comprise marginal foraging and nesting habitat, or they may act as movement corridors to more preferable and better quality habitat in the locality.

Given that the Study Area is considered to contain suitable foraging and breeding habitat for threatened species, it is recommended that the woodland habitat be retained and protected.

5.4 Koala Habitat Assessment

SEPP 44 applies to land within local government areas (LGA's) listed in SEPP 44, Schedule 1 (including Wollondilly LGA) for which a development application has been made (SEPP 44, Section 6) and Council is the determining authority. Under this policy the following distinction is made between 'potential' and 'core' Koala habitat:

- "Potential Koala Habitat" means areas of native vegetation where the trees of the types listed in Schedule 2 constitute at least 15% of the total number of trees in the upper or lower strata of the tree component.

- "Core Koala Habitat" means an area of land with a resident population of koalas, evidenced by attributes such as breeding females (that is, females with young) and recent sightings of and historical records of a population.

There are no known records of Koalas occurring in the Study Area or in adjoining bushland areas. No Koalas were observed or heard calling during field surveys, nor were any scats or tree scratchings observed on or near trees within the Study Area. Therefore the Study Area does not constitute Core Koala Habitat.

Grey Gum *Eucalyptus punctata* and Forest Red Gum *Eucalyptus tereticornis* are considered as Koala feed trees (as listed on SEPP 44) and were recorded within the woodland habitat of the Study Area. In some areas of the woodland, these trees "constitute at least 15% of the total number of trees in the upper or lower strata of the tree component". Therefore, the woodland habitat of the Study Area is considered to be Potential Koala habitat. As such, any modification of this vegetation has potential to impact this species.

[1] An individual species may be listed under one or both Acts.

Given that the Study Area is considered to be Potential Koala Habitat and records of the species are located in close proximity of the Study Area, it is recommended that the woodland habitat be retained and protected throughout the proposal.

5.5 Migratory Species

A total of 11 migratory species have been predicted to occur within the Locality (Figure 6 and Appendix 3).

Australia is a signatory to international agreements aimed at protecting migratory species. These include the *Japan Australia Migratory Bird Agreement* (JAMBA), the *China Australia Migratory Bird Agreement* (CAMBA), the *Republic* of *Korea Australia Migratory Bird Agreement* (RoKAMBA), and the *Bonn Convention on the Conservation of Migratory Species of Wild Animals*. Migratory species are considered to be Matters of National Environmental Significance and as such are protected under the EPBC Act.

While migratory species have the potential to occur in the Study Area on occasion, they are likely to be restricted to the woodland habitat. Therefore, it is recommended that the woodland habitat be retained and protected throughout the proposal.

6.0 GROUNDWATER DEPENDANT ECOSYSTEMS

The EIS by KBR (2004) suggests it is likely that the main or regional water table beneath the Allied Mills site within the Study Area is present at approximately 50 to 60m, placing it within the Hawkesbury Sandstone, which is a low permeability aquifer, just above the level of the nearby Nepean River (around RL80). Additionally the EIS suggests the overlying Ashfield Shale is essentially impermeable, but it is possible for minor localised 'perched' water tables to occur within the soil profile or at the base of weathering in the shale bedrock.

Based on the assessments of the EIS by KBR (2004) and other topographic and physiographic features of the Study Area there is potential that terrestrial plant communities in the channel of Carriage Creek, on the Nepean Gorge escarpments and on the banks of the Nepean River have some dependence on groundwater flows. The degree of permanent or seasonal dependency of these plant communities on groundwater from flows within the Study Area is uncertain due to a lack of detailed information on; the characteristics of aquifers and the subsurface hydrology flows for the Locality; and how a potential development on the Subject Site would impact groundwater. However despite the very limited technical information that is relied on the following preliminary assessment is made.

- Riparian Forest – the community occurs on the banks of the Hawkesbury–Nepean River or on the terraces immediately adjacent to the river (Tozer 2003). On the Subject Site Riparian Forest is present in the channel of Carriage Creek. The lower sections of Carriage Creek are characterised by steep banks with sandstone outcrops and terraces and damp areas above the bedrock base of the channel. Riparian Forest on the Subject

Site may have some dependency on groundwater seepage into the Carriage Creek channel.

- Western Sandstone Gully Forest – WSGF occurs on the lower slopes of sandstone gullies(Tozer 2003). The community generally grades into more open woodland less than half way up the slope from the gully floor and may adjoin a narrow band of Riparian Scrub along the creek line. WSGF is mapped in the current assessment on the steep sandstone escarpments of the Nepean River. Moisture dependant species and trees of the WSGF may be reliant on springs or groundwater seepage from fissures, joints and strata lenses of the steep escarpment and scree slopes above the Nepean River.

- Riparian Scrub – the community occurs on the channel of creeks and rivers on recent deposits of sediment and on the banks and consolidated sediments within streams. The composition of this vegetation community will be determined by the water flow of the Nepean River and as such any base flow that contributes to the regular flows.

- Riparian/Aquatic - The southern section of Carriage Creek supports riparian and aquatic vegetation in the permanent pools and ephemeral soaks in of the main channel. Persistence of water and vegetation in the permanent pools and ephemeral soaks may have some dependency on groundwater seepage into the Carriage Creek channel.

There are no natural terrestrial vegetation GDE's in the Study Area that are likely to be primarily or entirely dependant on groundwater such as groundwater fed swamps.

7.0 AQUATIC ASSESSMENT

An aquatic ecologist assessed the Study Area on the 8th and 9th December, 2010. Aquatic ecology assessments were carried out using a combination of habitat-based assessment and water quality sampling. Survey effort was most rigorous within areas identified within the Subject Site as well as areas most likely to contain habitat for threatened species.

A total of 15 sites were assessed during the field surveys and these site locations are defined in Figure 7. The completion of habitat assessments in the field was undertaken using HABSCORE methodology and noting general habitat characteristics. Raw data is in Appendix 4.

7.1 Aquatic Habitats

7.1.1 Nepean River and Tributary

A total of 2 aquatic sites were identified within and in the vicinity of the Nepean River and its tributary (Sites 1 and 11). Aquatic habitats within this Study Area range from a stream order 1 drainage line (Site 1) with an in-line farm dam and the Nepean River (Site 11) encompassing the southern border of the Study Area. The habitat of Site 1 was found to be moderately turbid,

have poor flow and have been subjected to moderate disturbance levels due to cleared riparian vegetation, altered hydrological regime, grazing and stock access. This provides suboptimal aquatic habitat quality, as determined by the HABSCORE method and includes areas with aquatic vegetation and organic debris within the riparian zone. Water quality analysis indicated that apart from a low dissolved oxygen level all parameters were within the ANZECC guidelines. The habitat of Site 11 was found to have high flow and subjected to very low disturbance levels due to a lack of riparian vegetation clearance, grazing or stock access. Although the Nepean River has an altered hydrological regime through the construction and operation of weirs, habitat quality is considered to be optimal, as determined by the HABSCORE method and includes areas with aquatic vegetation, large woody debris, and organic debris within the riparian zone. Water quality analysis indicated that apart from a low dissolved oxygen level, likely due to the recent high flows and high debris levels, all parameters were within the ANZECC guidelines.

Waterbody type, size and flow characteristics

The average stream width of Site 1 was approximately 10m. Limited flow was evident at the time of the field assessment with ponded habitat present within the downstream sections of Site 1 and the on-line dam present within the upstream section. Site 11 had an average stream width of 75m and had high flows from recent rain and a myriad of aquatic habitats due to large woody debris mixed substrates and undercut banks. Streambeds ranged from clay/silt substrates to rock/bedrock substrates with maximum water depths ranging from >1.5m at Site 11 and 0.5m at Site 1.

Habitat cover

Along with the presence of rocky substrate, logs and branches within Sites 1 and 11, aquatic vegetation (macrophytes) provided an additional source of cover for aquatic fauna. Throughout Sites 1 and 11 the aquatic vegetation was generally dominated by floating and emergent macrophytes *Juncus usitatus, Eleocharis sphacelata, Ludwigia peploides* ssp *montevidensis, Persicaria decipiens* and *Triglochin microtuberosum*.

Land use, riparian vegetation and disturbance

Site 1 contained impact from an altered hydrological regime from the construction of an online dam and riparian vegetation clearing, resulting in a high input of sediments. Site 11 was generally absent of any major forms of disturbance being in a forested catchment with an intact riparian zone.

Threatened Species Habitats

Habitats within Site 1 provide no spawning, foraging or sheltering habitats for aquatic threatened species being highly ephemeral with significant barriers to fish movement and therefore colonisation and movement between the Study Area and downstream waterbodies is unlikely to occur. Conversely, habitats within Site 11 have a high potential to provide

preferential habitats such as, gravel-bottom pools, deep rocky holes with considerable cover and large woody debris. This provides multiple spawning, foraging or sheltering habitats for aquatic threatened species However, the presence of downstream and upstream weirs provide a barrier to fish movement. Although colonisation and movement between the Study Area and downstream waterbodies is likely to occur.

7.1.2 Carriage Creek and Tributaries

A total of 6 aquatic sites were identified within and in the vicinity of the Carriage Creek and its tributaries (Sites 2, 3, 4, 5, 6 and 7). Aquatic habitats within this Study Area range from a stream order 1 drainage line (Site 2) to stream order 4 (Sites 3, 4, 6 and 7) and a stream order 3 (Site 5) tributary of Carriage Creek. Habitats ranged from low dissolved oxygen and high conductivity (Sites 2 and 6) to sites with all parameters within the ANZECC guidelines (Sites 3, 4, 5 and 7). All sites were found to have low to moderate flow and have been subjected to moderate disturbance levels due to cleared riparian vegetation, altered hydrological regime, grazing and stock access. However, this was restricted at Sites 3 and 4 due to a largely intact riparian zone. The habitats of Sites 3 and 4 were found to have moderate flow and subjected to very low disturbance levels due to a lack of riparian vegetation clearance, grazing or stock access. Although experiencing an altered hydrological regime via upstream dams and culverts, habitat quality is considered to be optimal, as determined by the HABSCORE method and includes areas with aquatic vegetation, large woody debris, and organic debris within the riparian zone. Sites 2, 5, 6, and 7 have been impacted by altered hydrological regime via the construction of dams and culverts, habitat quality is considered to be poor to suboptimal, as determined by the HABSCORE method.

Waterbody type, size and flow characteristics

The average stream width was approximately 10m. Low to moderate flow was evident at the time of the field assessment with ponded habitat present within the upstream sections of Carriage Creek and its tributaries (Sites 2, 5, 6 and 7). The downstream sections of Carriage Creek (Site 3 and 4) had a moderate flow and multiple aquatic habitats due to large woody debris mixed substrates and undercut banks. Streambeds ranged from clay/silt substrates to rock/bedrock substrates with maximum water depths ranging from 0.5m to 1.0m.

Habitat cover

Along with the presence of rocky substrate, logs and branches, aquatic vegetation (macrophytes) provided an additional source of cover for aquatic fauna. Throughout Carriage Creek and its tributaries the aquatic vegetation was generally dominated by floating and emergent macrophytes *Eleocharis sphacelata, Myriophyllum variifolium, Ottelia ovalifolia, Paspalum distichum, Typha domingensis, Phragmites australis, Cyperus difformis, Juncus usitatus* and *Persicaria decipiens.*

Land use, riparian vegetation and disturbance

Apart from Sites 3 and 4 all sites were impacted from an altered hydrological regime and riparian vegetation clearing. Sites 3 and 4 were generally absent of any major forms of disturbance being in a forested catchment with an intact riparian zone.

Threatened Species Habitats

Apart from Sites 3 and 4 all sites provided no spawning, foraging or sheltering habitats for aquatic threatened species being highly ephemeral with significant barriers to fish movement and therefore colonisation and movement between the Study Area and downstream waterbodies is unlikely to occur. However, habitats within Sites 3 and 4 have a moderate potential to provide preferential habitats such as gravel-bottom pools, deep rocky holes with considerable cover and large woody debris. This provides spawning, foraging or sheltering habitats for aquatic threatened species However, the presence of downstream barriers to fish movement means that colonisation and movement between the Study Area and downstream waterbodies would only occur when connectivity is restored during high flows.

7.1.3 Waterbodies within Allied Mills Site

A total of 4 aquatic sites were identified within and in the vicinity of the current Allied Mills site (Sites 12, 13, 14 and 15). Aquatic habitats were largely absent from Sites 12, 13 and 14 due to the construction of facilities and car parks associated with Allied Mills. Site 15 was a large online dam and was found to have poor flow and have been subjected to moderate disturbance levels due to cleared riparian vegetation, altered hydrological regime, grazing and stock access. This provides suboptimal aquatic habitat quality, as determined by the HABSCORE method and includes areas with aquatic vegetation and organic debris within the riparian zone. Water quality analysis indicated that all parameters were within the ANZECC guidelines.

Waterbody type, size and flow characteristics

The average stream width of Site 15 was approximately 20m. Limited flow was evident at the time of the field assessment with ponded habitat present. Substrate was predominately clay/silt substrates with maximum water depths ranging from 0.5m to >1.5m.

Habitat cover

In the relative absence of rocky substrate, logs and branches, aquatic vegetation (macrophytes) provided the predominant source of cover for aquatic fauna. Other typical minor forms of cover included leaves/organic debris, vegetation overhang, bank overhang and occasional branch, log or item of urban rubbish. The aquatic vegetation of Site 15 was generally dominated by floating and emergent macrophytes *Typha domingensis, Rumex crispus, Persicaria decipiens, Persicaria attenuate, Lythrum salicaria, Urochloa mutica, Potamogeton ottelia, Lemna spp., Juncus usitatus, Pseudoraphis spinescens, Paspalum distichum, Eleocharis acuta, Potamogeton ochreatus, Najas tenuifolia, and Myriophyllum variifolium.*

Land use, riparian vegetation and disturbance

Site 15 contained impact from an altered hydrological regime from the construction of an online dam and riparian vegetation clearing, resulting in a high input of sediments.

Threatened Species Habitats

Habitats within Site 15 provide no spawning, foraging or sheltering habitats for aquatic threatened species due to significant barriers to fish movement and therefore colonisation and movement between the Study Area and downstream waterbodies is unlikely to occur. Aquatic habitats were largely absent from Sites 12, 13 and 14 and as such, do not provide habitat for threatened aquatic species.

7.1.4 Upstream of Allied Mills Site

A total of 3 aquatic sites were identified upstream of the Allied Mills site (Sites 8, 9 and 10). Aquatic habitats within these sites were assessed via road side assessment due to limited access to the waterbodies, however, sites were considered to be in poor condition and identified as providing poor habitat quality, as determined by the HABSCORE method.

Land use, riparian vegetation and disturbance

Sites 8, 9 and 10 have been impacted by historic and ongoing landuse including an altered hydrological regime from the construction of an online dam and severe riparian vegetation clearing.

Threatened Species Habitats

Habitats within Sites 8, 9 and 10 would provide no spawning, foraging or sheltering habitats for aquatic threatened species being highly ephemeral with significant barriers to fish movement and therefore colonisation and movement between the Study Area and downstream waterbodies is unlikely to occur.

7.2 Aquatic Flora and Fauna

7.2.1 Significant Aquatic Flora

No aquatic flora species listed under the FM and/or EPBC Acts have been identified for consideration in relation to the Study Area or have the potential to inhabit the Wollondilly LGA. There are no known threatened aquatic flora populations or aquatic EECs listed under the FM, TSC or EPBC Acts for the Wollondilly LGA. Threatened terrestrial flora species are reported on within Section 4.3.

7.2.2 Significant Aquatic Fauna

A total of four aquatic fauna species listed under the FM and/or EPBC Acts, or their habitats have been identified for consideration in relation to the Study Area or have the potential to

occur in the Wollondilly LGA (Appendix 3). Of these all but the Murray Cod *Maccullochella peelii* are listed on the FM Act and all but the Silver Perch *Bidyanus bidyanus* are listed under the EPBC Act.

No threatened fauna were observed during the aquatic habitat assessments, however four were considered likely to occur within the Study Area on the basis of previous records and the presence of suitable habitats, scoring a low to moderate likelihood of occurrence (Appendix 3). For all of these species the habitats present in the Study Area are restricted to the Nepean River, due to the presence of downstream barriers to fish movement (e.g. natural rock falls, ledges and cascades) within Carriage Creek and its tributaries.

Given that waterbodies within the Study Area either flow directly or indirectly into the Nepean River it is recommended that appropriate buffer widths for all waterbodies within the Study Area be applied and a minimum 100m buffer applied to the Nepean River.

There are no known threatened aquatic fauna populations listed under the FM and/or EPBC Acts for the Wollondilly LGA. Threatened terrestrial fauna is reported on within Section 5.3.

7.3 Surface Water Quality

The physio-chemical water quality results for this survey are detailed in Appendix 4. The water quality data is compared with guideline values such as the ANZECC guidelines for the Protection of Aquatic Ecosystems (ANZECC 2000).

Conductivity was low across all sites with a very low result on the downstream section of Site 2. However, two very high results were recorded at a dam on Site 2 and the upstream section of Site 6. These high results are likely to have been impacted upon by the surrounding historic and ongoing landuse, with both sites being located in an un-forested section of the Study Area. Conductivity results were within the ANZECC guidelines for all sites except the downstream section of Site 2 and the upstream section of Site 6.

Low flow conditions and high in-stream organic loads from historic and ongoing landuse can result in depressed dissolved oxygen levels within affected waterbodies, with results from Sites 1, 2, 6 and 11 falling below the ANZECC guidelines. However, results within Sites 3, 4, 5 and 15 indicated dissolved and saturated oxygen levels that were within the ANZECC guidelines. This is most likely due to the presence of moderate flow at Sites 3, 4 and 5 and a larger waterbody with high densities of macrophytes at Site 15. Dissolved oxygen levels also vary widely with temperature especially with waterbodies of a shallow nature. However, water temperatures were not overly cool and dissolved oxygen levels are most likely higher due to higher flows and aquatic macrophyte presence.

Turbidity levels were within the ANZECC guidelines at all sites with Site 1 recording the highest level (47.7 NTU) relative to all other sites. This is most likely due to the high sediment inputs from the gravel road that crosses over the drainage line upstream of this site.

It appears that historic and ongoing land-use within the catchment has affected the water quality of the surface waters within the Study Area. Riparian vegetation clearance leading to higher sediment inputs and erosion has had detrimental impacts to the surface water quality of Sites 1, 2 and 6. Conversely, sites with an intact riparian zone recorded a higher surface water quality result, indicative of forested catchments and the natural processes that are in place.

8.0 CONTRAINTS ANALYSIS

8.1 Terrestrial Flora and Fauna

This section defines the ecological constraints to be considered in the planning and design of the proposal. As discussed earlier, technical assessment criteria of the WLEP 2011 and WDCP are adopted and modified in this terrestrial flora and fauna assessment for the constraints analysis. Table 3 below determines ranked constraint classes from 5 to 1. Class 5 constraint areas have the highest conservation significance.

Terrestrial flora and fauna constraint mapping according to the convention of this report is provided in Figure 8. Constraint classes of this assessment are suitable for planning controls of parallel 'Ratings' that are specified in Section 2.5.2, Table 1 Vegetation Categories, of the WDCP.

Table 3: Terrestrial flora and fauna constraints criteria and mapping classes.

Class	Constraint class features
5	These areas are characterised by one or a combination of the following: ▪ Threatened Ecological Communities (TEC's) with a moderate to high resilience; ▪ threatened flora or fauna populations and/or species; ▪ a high likelihood of occurrence of TEC's[2], threatened flora and/or fauna populations and species known from the locality based on habitat potential and the number and distribution of previous records and surveys; ▪ a fully or partially structured native plant community over the channel or within 40m of the top of the bank of a 1 though to 5 Order Stream. One lower strata may be disturbed, but resilience is moderate to high with good canopy connectivity in at least one location to adjoining areas of similar vegetation outside the Subject Site; and ▪ in addition to the vegetation there is a large range of fauna habitat features including small to large tree hollows, logs on the ground, a leaf litter layer, rock outcrops and permanent water.

[2] The likelihood of occurrence of a TEC is with reference to the identifying criteria of a Final Determination provided for under either or both the TSC and EPBC Acts.

Class	Constraint class features
4	These areas are characterised by one or a combination of the following: ▪ TEC's with a low to moderate resilience; ▪ a medium likelihood of occurrence of TEC's, threatened flora and/or fauna populations and species known from the locality based on habitat potential and the number and distribution of previous records or surveys; ▪ a fully or partially structured native plant community within 40m of the top of the bank of a 1 though to 5 Order Stream. Two lower strata may be disturbed, but resilience is moderate with good canopy connectivity in at least one location to adjoining areas of similar vegetation outside the Subject Site; and ▪ in addition to the vegetation there is a medium range of fauna habitat features including tree hollows, logs on the ground, a leaf litter layer and rock outcrops.
3	These areas are characterised by one or a combination of the following: ▪ TEC's with a low resilience; ▪ a low likelihood of occurrence of threatened flora and/or fauna populations and species known from the locality based on habitat potential and the number and distribution of previous records or surveys; ▪ a fully or partially structured native plant community. Two lower strata may be disturbed, but resilience is moderate with good canopy connectivity in at least one location to adjoining areas of similar vegetation outside the Subject Site; and ▪ in addition to the vegetation there is a limited range of fauna habitat features which may include tree hollows, logs on the ground, a leaf litter layer and rock outcrops.
2	These areas are characterised by one or a combination of the following: ▪ a native plant community with fragmented canopy and disturbance in all lower strata and resilience is low; ▪ relatively isolated vegetation with sparse canopy connectivity to other areas of similar or better condition native vegetation; and ▪ in addition to the vegetation there is a limited range of fauna habitat features primarily restricted to foraging resources for a medium range of fauna groups.
1	These areas are characterised by one or a combination of the following: ▪ a derived plant community with or without fragmented canopy, disturbance in all lower strata and resilience is low or substantially depleted; and ▪ fauna habitat features are highly simplified and limited to foraging resources to a narrow range of fauna groups.

The terrestrial constraints analysis concluded two classes of constraint occur within the Subject Site based on the criteria in Table 3: Class 5 (the highest level) and Class 1 (the lowest level) (Figure 8). Class 5 constraint applies to areas of intact woodland and riparian vegetation. Class 1 constraint applies to predominantly cleared areas within the Subject Site.

8.2 Aquatic Flora and Fauna

Key Threatening Processes (KTP)

Key threatening processes are threatening processes that, in the opinion of the Fisheries Scientific Committee, adversely affect threatened species, populations or ecological communities, or could cause species, populations or ecological communities that are not threatened to become threatened. KTP's that are relevant to the proposal are as follows:

- Changes in Drainage Patterns and Water Quality;
- Installation and Operation of Instream Structures;
- Removal of Large Woody Debris; and
- Degradation of Native Riparian Vegetation.

The proposal would involve development in the vicinity of riparian zones and has the potential to involve a number of the above KTP's. The effect of these KTP's can be minimised through the implementation of appropriate riparian buffer widths (discussed below).

Impacts on Endangered Ecological Communities and Endangered Populations

There are no aquatic EEC's previously recorded within the Study Area. There are no aquatic Endangered Populations recorded within the Study Area.

Impacts on Threatened Species

Four threatened aquatic fauna species listed under the FM Act and EPBC Act have the potential to occur within, in the vicinity of and downstream of the Study Area (Appendix 3).

Using the criteria outlined in Appendix 2 it was found that due to previous records, modified habitat and water quality conditions within the Locality that the likelihood of the four threatened aquatic species being present within the Subject Site is low to moderate (Appendix 3). Whilst the Nepean River provides preferential habitats such as gravel-bottom pools, deep rocky holes with considerable cover and large woody debris, it should be noted that the four threatened aquatic species are considered unlikely to utilise the majority of habitats within the Subject Site due to low flows (excluding the Nepean River) and barriers to fish movement. If connectivity is restored between Carriage Creek and its tributaries to the Nepean River via moderate to high flows, fish movement and colonisation is likely to occur.

Riparian Buffer Widths

This section defines the Riparian Corridor Management Study (RCMS) riparian buffer widths to be considered in the planning and design of the proposal. As discussed earlier, technical assessment criteria of the WLEP 2011 and WDCP are adopted and modified in this aquatic flora and fauna assessment for the identification of riparian buffer widths using the RCMS method. Table 4 below describes the minimum environmental land objectives to be applied under categorisation of waterbodies within the Study Area.

The RCMS riparian buffer widths herein are based on the aquatic habitat assessments and criteria of Table 4. Aquatic flora and fauna RCMS riparian buffer width mapping according to the convention of this report is provided in Figure 9. RCMS riparian buffer widths of this assessment are suitable to be adopted as an alternative to the Strahler stream order method identified within the WLEP 2011.

The RCMS stream classification system, developed by the former DIPNR, identified minimum riparian corridor widths along watercourses. The incorporation of riparian corridor outcomes into LEPs is consistent with the state governments approach to provide better upfront planning and certainty, rather than deferring to the development stage and referrals under the *Rivers and Foreshores Improvement Act 1948.*

DIPNR's stream mapping work was initially developed for the RCMS in the Wollongong LGA. The RCMS process has since been widely adopted and applied to the NW and SW Growth Centres, other LGAs and land release sites.

The stream classification uses three categories which reflect the environmental significance of watercourses and a summary of Riparian Corridor Objectives is presented in Table 4.

The aquatic constraints analysis recommends using the riparian corridor objectives created within the RCMS process and as such three categories of constraint occur within the Subject Site based on the criteria in Table 4: Category 1 (Environmental Corridor), Category 2 (Terrestrial and Aquatic Habitat) and Category 3 (Bank Stability and Water Quality) (Figure 9). Category 1 would apply to the Nepean River located along the southern border of the Study Area, however, it is recommended that a minimum core riparian zone width of 100m be established to protect the important aquatic habitats located downstream of and within the Nepean River. Category 1 constraint applies to areas of aquatic environments that provide continuity of movement between aquatic habitats and has intact riparian zones. Category 2 constraint applies to areas of aquatic habitats that may not have complete continuity of movement, however, habitats are important within a localised context and have largely intact riparian zones. Category 3 constraint applies to predominantly cleared areas within the Subject Site and recommends that where appropriate rehabilitation and revegetation of native species is applied.

Table 4. Summary of Riparian Corridor Objectives

Minimum Environmental Objectives for Riparian Land	**Category 1 Environmental Corridor**	**Category 2 Terrestrial & Aquatic Habitat**	**Category 3 Bank Stability & Water Quality**
Delineate riparian zone on a map and zone appropriately for environmental protection	Yes	Yes	If resources are available

Minimum Environmental Objectives for Riparian Land	Category 1 Environmental Corridor	Category 2 Terrestrial & Aquatic Habitat	Category 3 Bank Stability & Water Quality
Provide a minimum core riparian zone width	40m from top of bank	20m from top of bank	10m from top of bank
Provide additional width to counter edge effects on the urban interface	10m	10m	Generally not required
Provide continuity for movement of terrestrial and aquatic habitat	Yes (Including piered crossings)	Yes (With appropriate crossing design)	Where appropriate
Rehabilitate/re-establish local provenance native vegetation	Yes	Yes	Where appropriate
Locate services outside the CRZ wherever possible	Yes	Yes	Merit consideration
Locate playing fields and recreational activities outside the CRZ	Yes	Yes	Merit consideration
Treat stormwater runoff before discharge into riparian zone or the watercourse	Yes (Outside CRZ and buffer)	Yes (Outside CRZ and buffer)	Yes

9.0 CONCLUSIONS AND RECOMMENDATIONS

This report assesses the ecological significance of the general and threatened plant and animal species, endangered populations and endangered ecological communities that occur, or have the potential to occur, within the area affected by the rezoning proposal across the Subject Site and the Study Area. Core to the conclusions and recommendations of this assessment are the aims and objectives for the rezoning process defined by WSC. For the biodiversity assessments and constraints analysis the key aims are:

- retention, protection and enhancement of riparian areas;
- retention, protection and enhancement of flora, fauna and habitats with ecological significance; and
- retention, protection and enhancement of natural and cultural assets identified as being of significance.

In addition to the site investigations and desktop biodiversity assessment methods carried out, reference has been made to current WSC strategies and policy, other regional planning instruments, and local and regional biodiversity surveys to provide a comprehensive analysis to inform the proposed rezoning. The main EPI's and previous regional and local studies referenced by this assessment are summarised in Section 3 of this report.

At this stage the impacts of the proposed rezoning and subsequent development cannot be fully assessed or quantified. However rezoning that does not consider the constraints analysis herein would likely result in the loss of at least some native plant communities and the habitat it provides for the general native terrestrial flora and fauna of the Study Area and Locality; as well as impacts on TSC and EPBC Act listed threatened biodiversity. In addition to impacts on terrestrial biodiversity, a departure from the recommended aquatic flora and fauna riparian buffer widths would increase the potential for impacts to surface water quality and the habitat it provides for the general native flora and fauna of waterbodies within the Study Area, as well as impacts on FM and EPBC Act listed threatened biodiversity.

In the absence of a detailed groundwater survey and assessment including how a potential rezoning and possible development might impact on groundwater through alteration of aquifers and flow characteristics is not possible to determine the full impacts of the proposal on GDE's. However, areas that have been identified as supporting potential GDE's are located in the high constraints zones covering Carriage Creek and the Nepean River corridors. In addition to impacts on terrestrial biodiversity, a departure from the recommended terrestrial and aquatic flora and fauna riparian buffer widths would increase the potential for impacts to the terrestrial vegetation that may have some dependency on groundwater either permanently or seasonally.

The TSC Act listed EEC's SSTF and RFEFCF occur on the Subject Site with SSTF also listed under the EPBC Act. In addition these native plant communities provide high quality habitat for a range of general native flora and fauna, a number of threatened flora and fauna species known from the Locality and migratory fauna. The terrestrial flora and fauna habitats of the Study Area form part of a regionally significant corridor that incorporates the riparian and aquatic habitats of the Nepean River.

The FM and EPBC Act listed Macquarie Perch and Murray Cod occur within the Locality in the Nepean and Cataract Rivers respectively. In addition, impacts on waterbodies within the Subject Site have the potential to impact aquatic habitats further downstream.

The following recommendations are made for consideration in the preparation of the LEP and to promote Ecological Sustainable Development (ESD) of future developments and consents consistent with WSC strategies and planning policy such as the Wollondilly Vision 2025, Wollondilly Biodiversity Strategy (ELA 2004), and the WLEP.

- Amendment of the WLEP to include the biodiversity constraints identified in Figure 8 as 'sensitive land' on the WLEP Natural Resources - Biodiversity Map. In this instance the

constraint class of the current survey is generally equivalent to the 'Vegetation Categories' defined in Table 1, Section 2.5.2, Volume 1 of the WDCP.

- Amendment of the WDCP to include the classification of waterbodies using the RCMS method and implementation of buffer widths and associated controls identified in Figure 9.

- In view of the presence of the areas of high ecological value on the subject site and extending to the study area including EEC's, habitat for threatened flora and fauna species, regionally significant wildlife corridors and riparian and aquatic habitats that are integral to the function of a major river system; and on the basis of the objectives for E2 Environmental Conservation zoning from the WLEP, it is recommended that all areas mapped in Figure 8 as Constraint Class 5 be zoned E2 Environmental Conservation in any amendment to the WLEP.

- Creation of open space or recreation areas to buffer conservation zonings to areas of potential development.

- Locate Asset Protection Zones (APZ's) in open space or recreation areas that buffer conservation areas. APZ's should not be established in either riparian or conservation zones. In this instance, allotments and location of infrastructure would be situated to eliminate the possibility of disturbance to high constraint areas without limiting APZ requirements.

- Without limiting bushfire protection considerations, planning and design of vegetated corridors through a potential industrial subdivision. At a basic level this could include street tree plantings to provide some level of canopy connectivity within and beyond a subdivided area.

- Revegetation works in open space including street tree plantings should consist of locally occurring native species (see Section 2.4 Landscaping of Volume 1, WDCP).

- Stormwater management features such as open drainage, retention or detention basins and permanent ponds should be designed to include habitat features. This could include rock armoured drainage lines with low cascades, voids and cavities. Permanent ponds with habitat features such as roosting/resting islands and margins with dense plantings of sedges, rushes and reeds are recommended.

- Implementation of Clause 7.3 (3) (e) of the WLEP to address groundwater and GDE's in more detailed concept planning phases should rezoning proceed.

- Preparation of a Vegetation Management Plan (VMP) for all retained native vegetation and restored or reconstructed riparian areas of the Subject Site. The VMP should at a minimum be based on the document *Controlled activities - Guidelines for Vegetation Management Plans* by DECCW (2010).

- Areas recommended for E2 Environmental Conservation zoning to remain as one parcel of land and in single ownership to ensure consistency with the objectives of SREP 20 and the principles of total catchment management.

- Dedication of adequate resources for the life of the potential industrial developments to maintain biodiversity of conservation significance including management of retained native plant communities and flora and fauna habitats.

FIGURES

Study Area & Subject Site

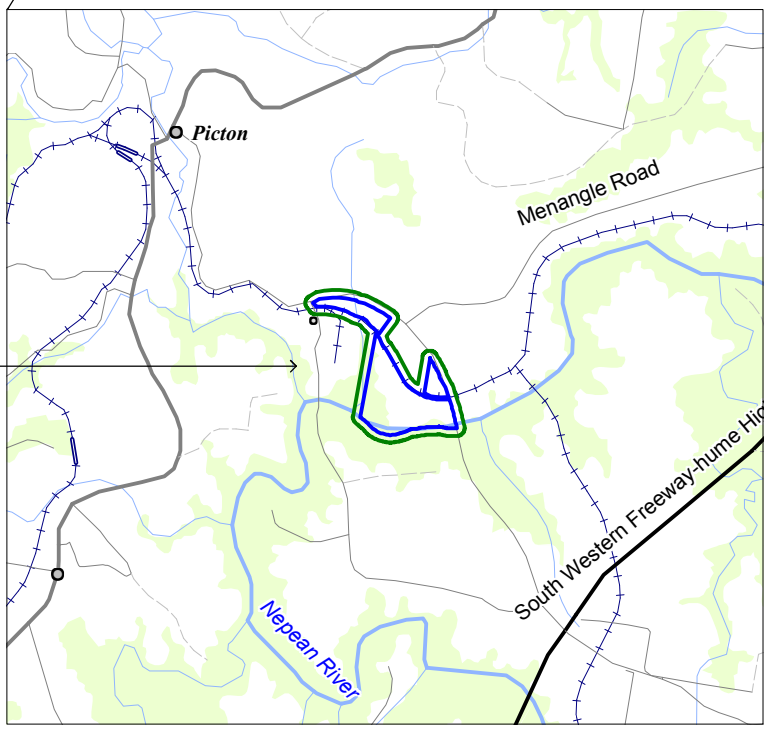

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Figure 1: Location of the Study Area and Subject Site in a regional context

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File number: 11857	Checked by: BWM
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Scale: 0 1 2 3 4 kilometres

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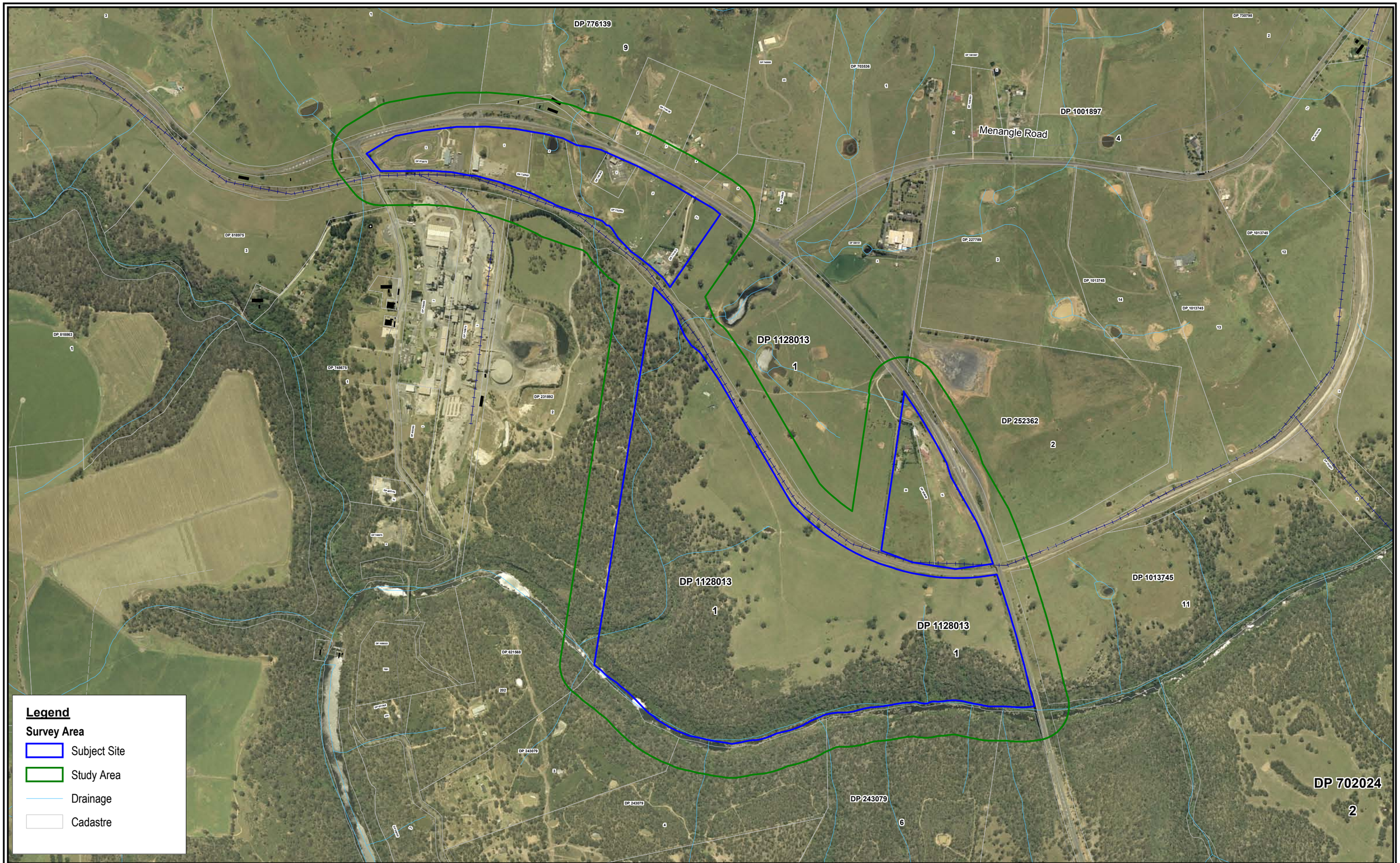

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Figure 2: Overview of Study Area and the Subject Site..

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Map Projection: Transverse Mercator
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Figure 2

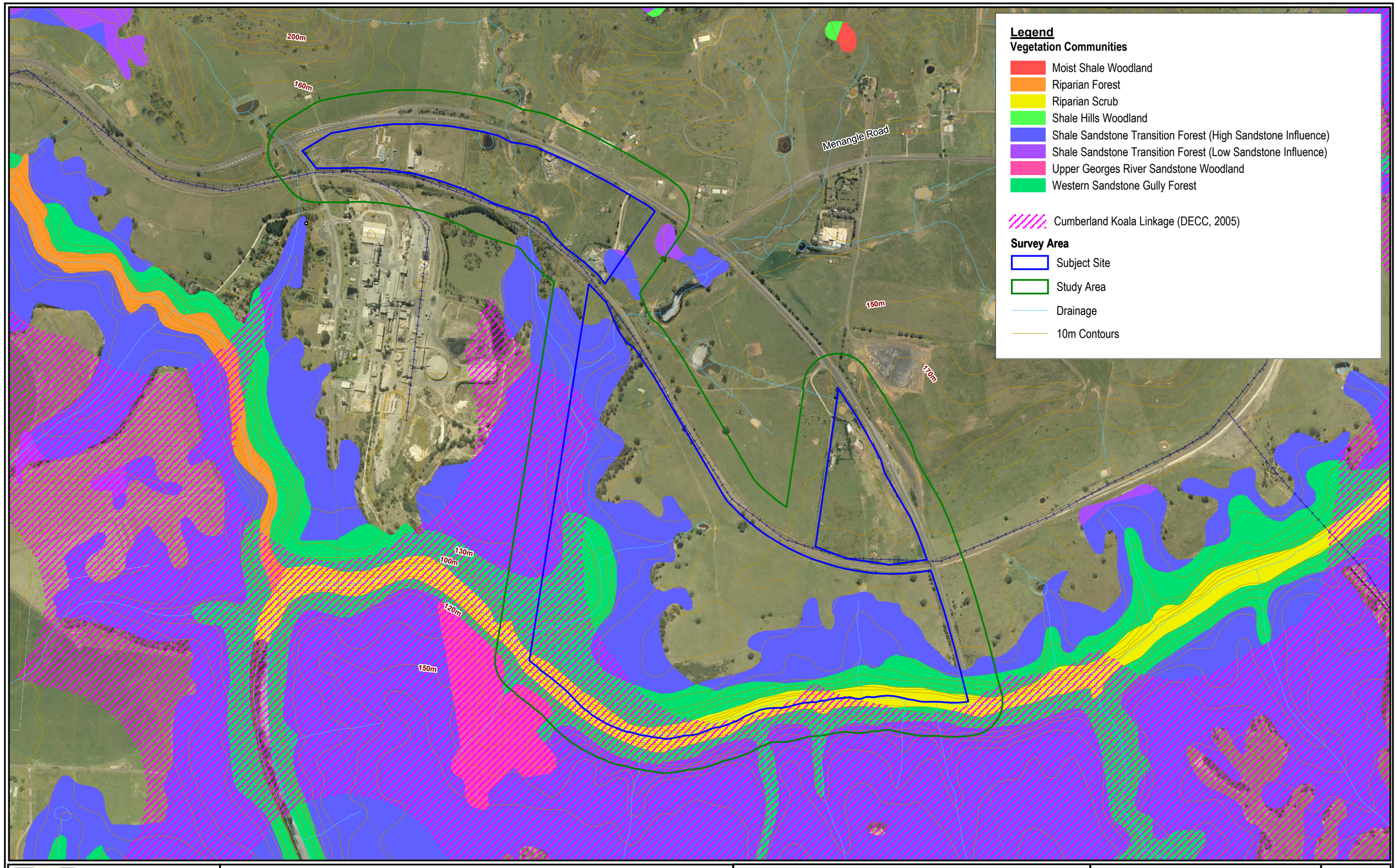

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Figure 3: NPWS 2002 Cumberland Plain mapping.

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Location:-..P:\11800s\11857\Mapping\11857 F3_Vegetation.WOR	

Acknowledgements:
Data from NPWS
Wollondilly Shire Council

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Figure 3

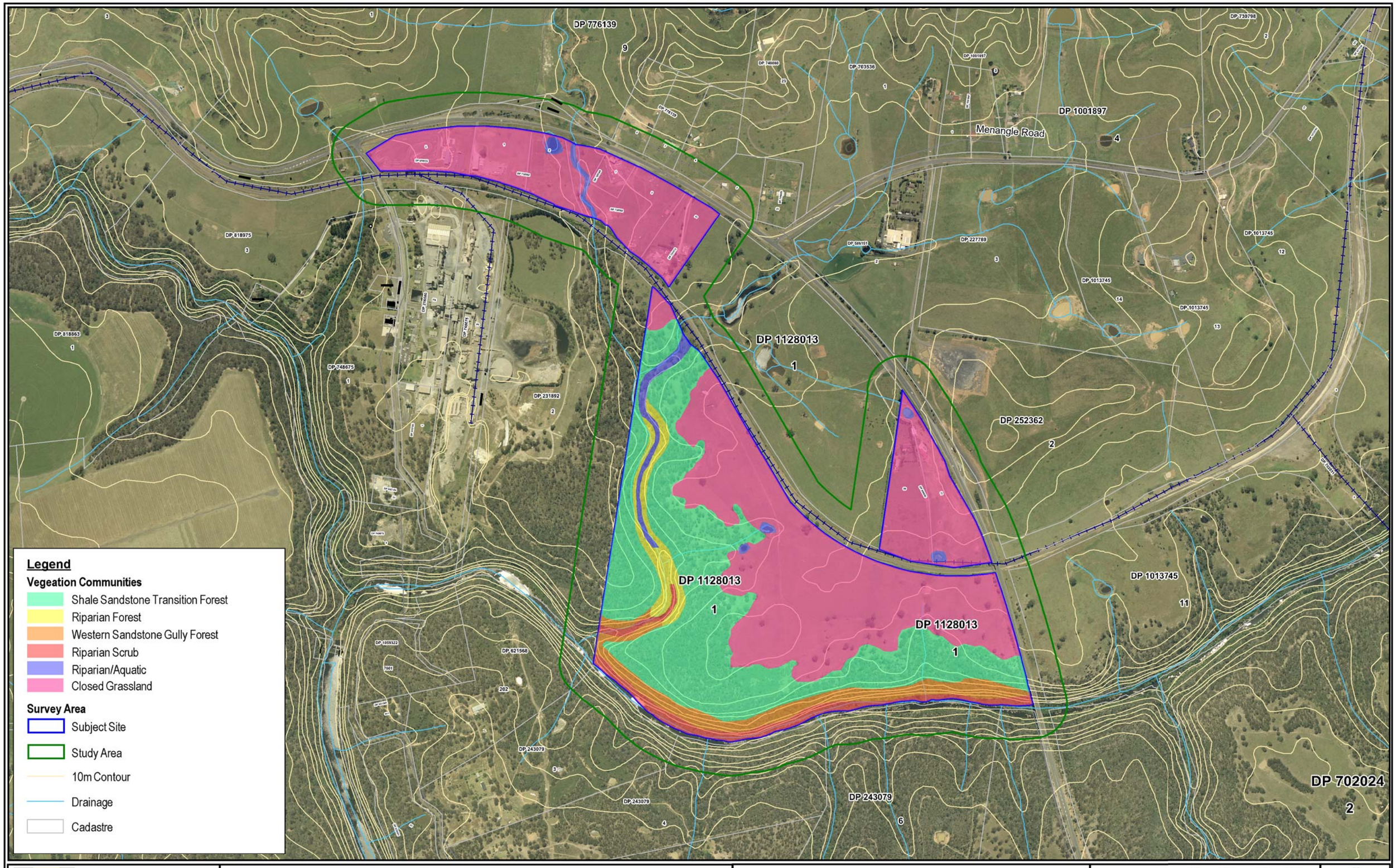

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Figure 4: Vegetation mapping of the current Biosis Research surveys.

Date: 21 March 2011	Drawn by: ANP
File number: 11857	Checked by: BWM
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Map Projection: Transverse Mercator
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Figure 4

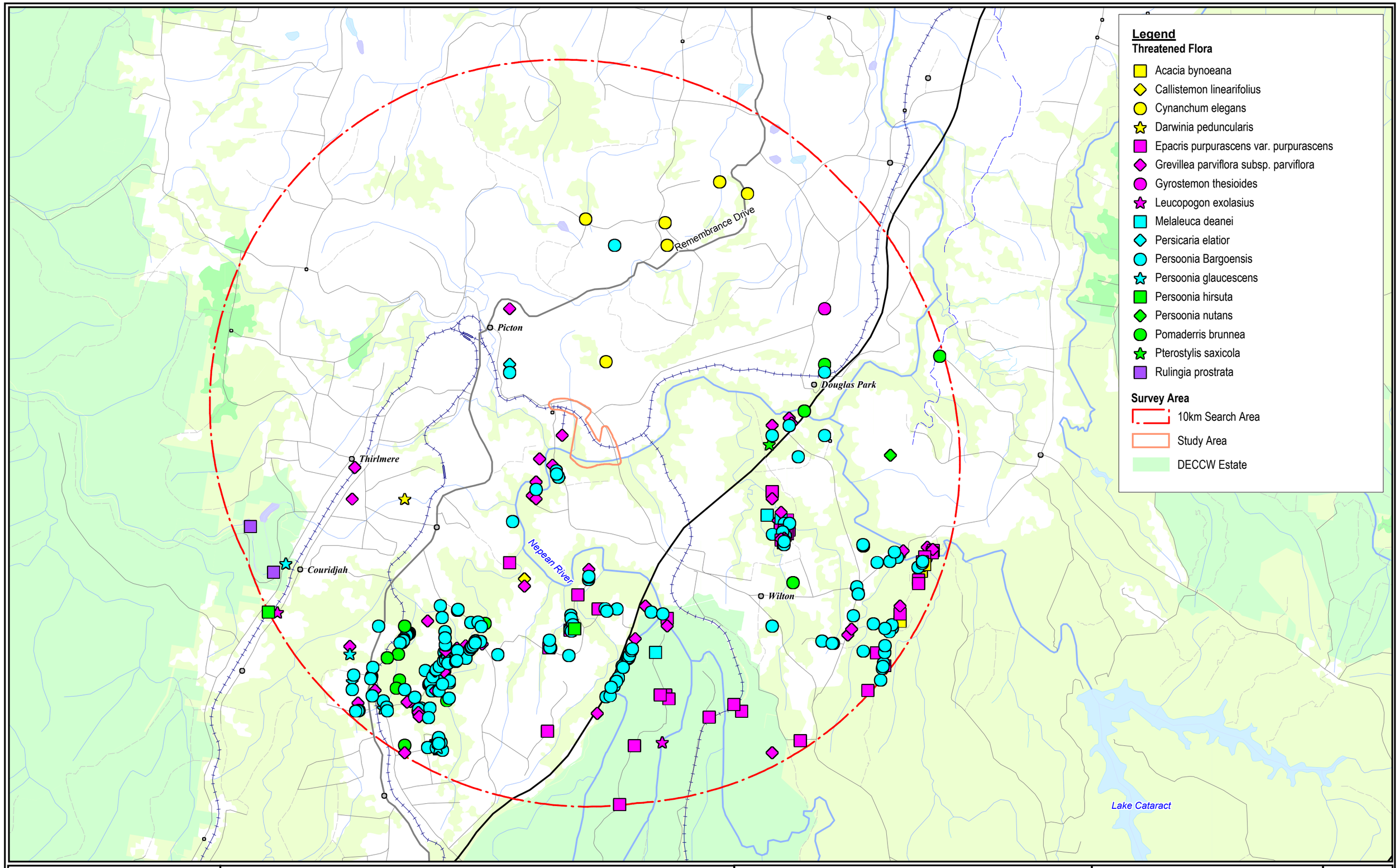

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Figure 5: TSC and EPBC Act flora previously recorded in a 10km radius of the Study Area.

Date: 10 February 2011	Drawn by: ANP
File number: 11857	Checked by: BWM
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Acknowledgements:
Species data from DECCW/NPWS
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kilometres

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Figure 5

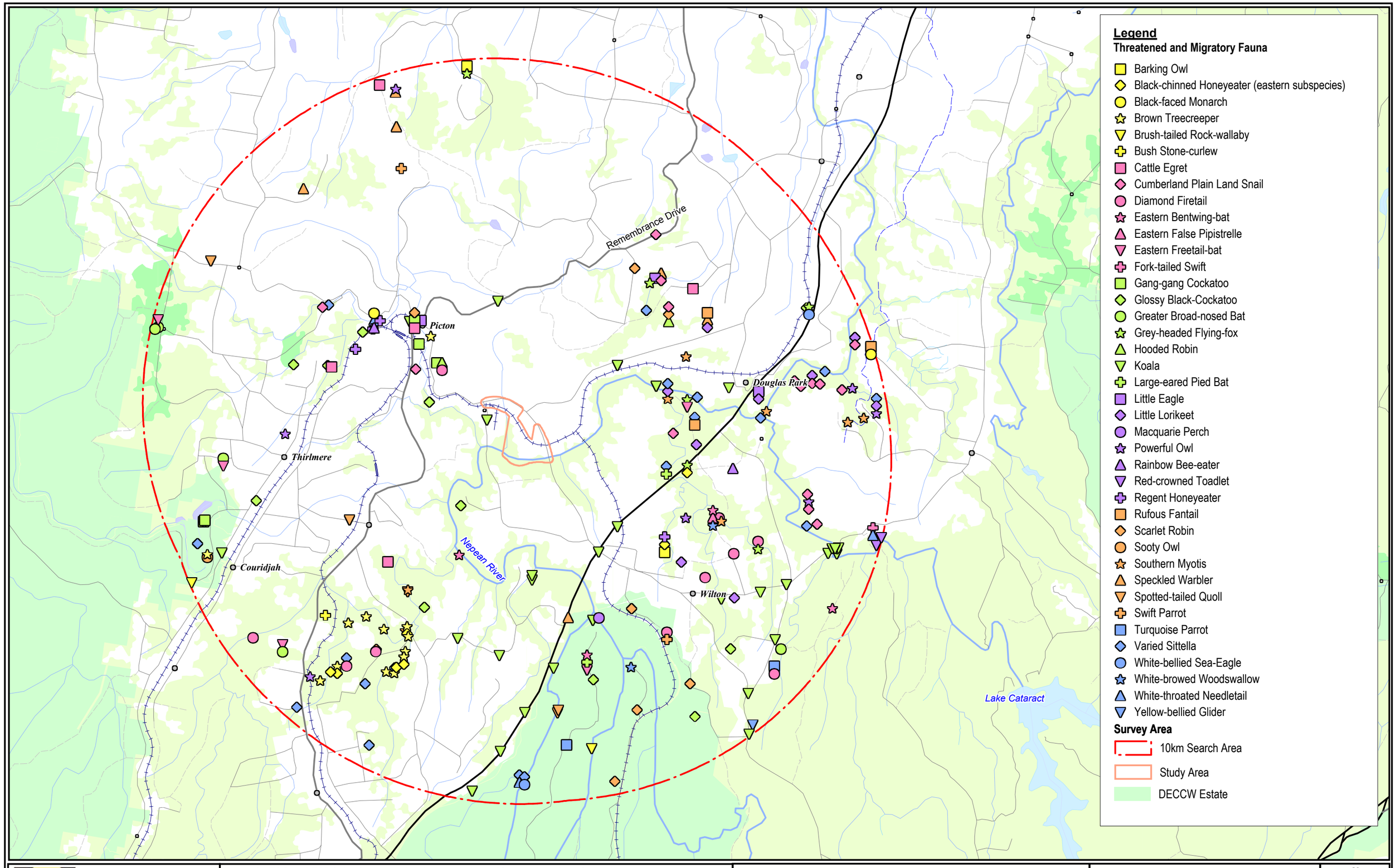

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Figure 6: TSC and EPBC Act fauna previously recorded in a 10km radius of the Study Area.

Date: 10 February 2011	Drawn by: ANP
File number: 11857	Checked by: BWM
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Acknowledgements:
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Grid: Map Grid of Australia, Zone 56

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Figure 6

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Figure 7: Site Locations

Date: 16 February 2011	Drawn by: ANP
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Figure 8

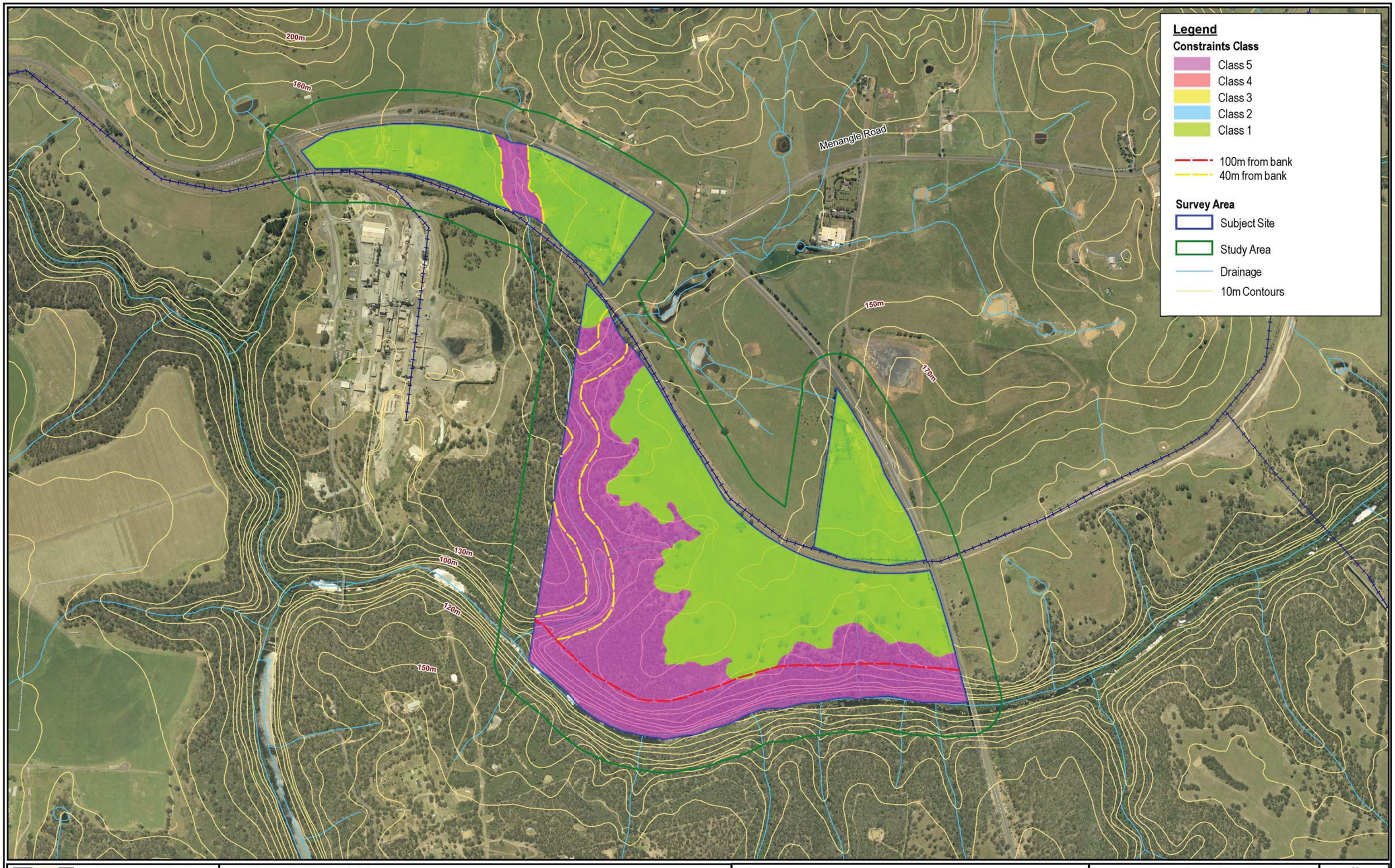

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Figure 8 Biodiversity Constraints Map.

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Acknowledgements:
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Figure 7

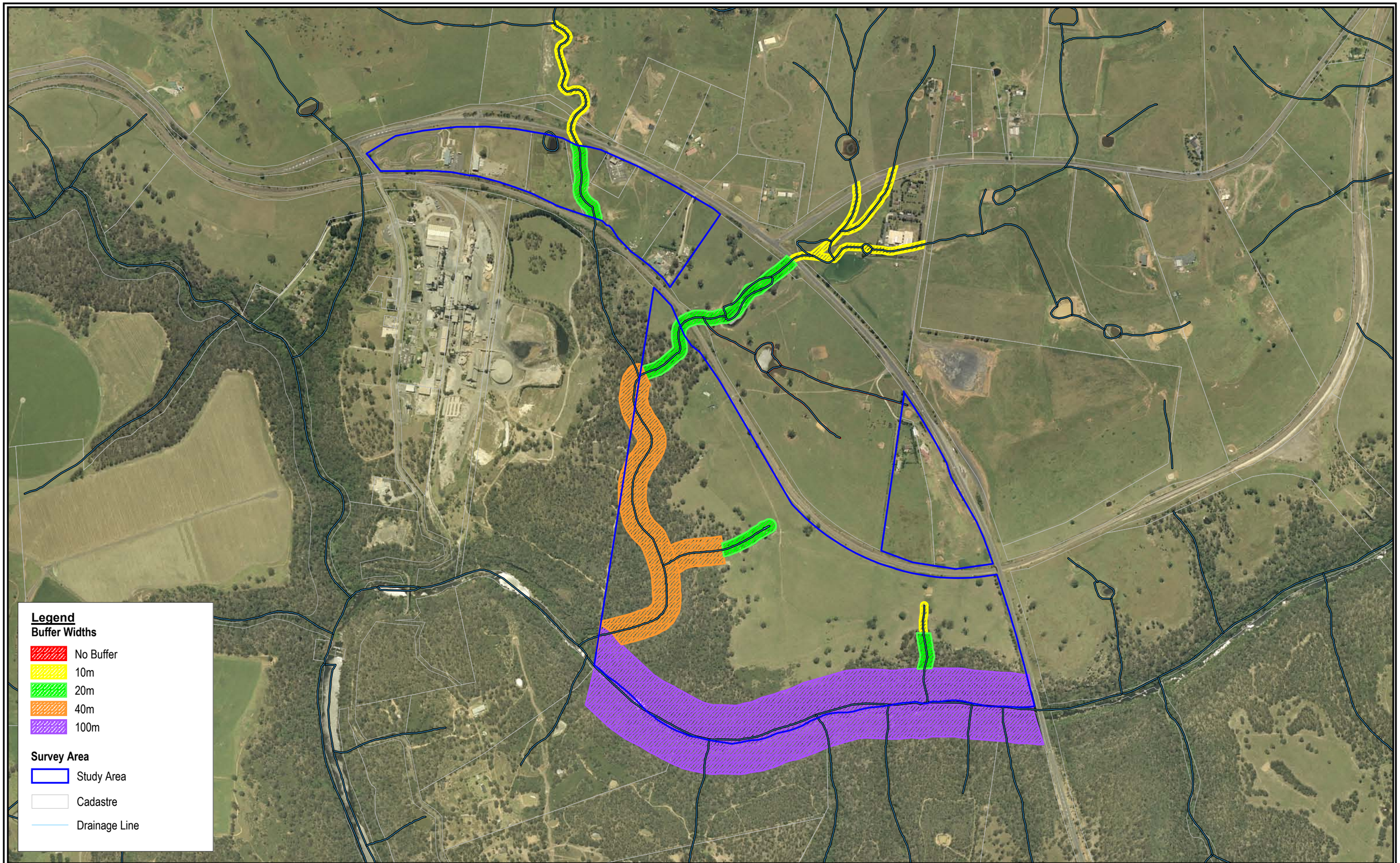

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Figure 9: Buffer Widths

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Acknowledgements:
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Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

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Figure 9

APPENDICES

APPENDIX 1

Flora and fauna species inventories

Flora inventory

General Status	
*	Exotic (not native to Australia)
N( )	Noxious weeds and 'Control Class' as listed on the NSW Noxious Weeds Act 1993 for the Wollondilly LGA
nl	Non - locally occurring native species (does not naturally occur at this locality)
Conservation Status	
CE	Critically Endangered species - listed under Schedule 1A of the TSC Act
E	Endangered species - listed under Schedule 1 of the TSC Act
E2	Endangered population for the LGA - listed under Schedule 1 of the TSC Act
V	Vulnerable species - listed under Schedule 2 of the TSC Act
CE +	Critically Endangered species - listed under the EPBC Act
E +	Endangered species - listed under the EBPC Act
V +	Vulnerable species - listed under the EPBC Act
ROTAP	Rare or Threatened Australian Plant
Plant Communities	
SSTF	Shale Sandstone Transition Forest
R Forest	Riparian Forest
Rip/Aqua	Riparian /Aquatic
CG	Closed Grassland
Modified Braun Blanquet Cover Abundance (BB)	
1	<5% - 3 or less individuals
2	<5% - more than 3 sparsely scattered
3	<5% - common throughout plot
4	5% - 25%
5	25% - 50%
6	50% - 75%
7	75% - 100%

Status	Family	Genus species	Common Name	SSTF	R Forest	Rip/Aqua	CG
	Fabaceae - Mimosoideae	*Acacia binervia*	Coast Myall	3	3		
	Fabaceae - Mimosoideae	*Acacia decurrens*	Black Wattle	2			
	Fabaceae - Mimosoideae	*Acacia linearifolia*	Narrow-leaved Wattle		3		

Status	Family	Genus species	Common Name	SSTF	R Forest	Rip/Aqua	CG
	Fabaceae - Mimosoideae	*Acacia* sp		2			
	Fabaceae - Mimosoideae	*Acacia ulicifolia*	Prickly Moses		1		
	Adiantaceae	*Adiantum aethiopicum*	Common Maidenhair		2		
	Casuarinaceae	*Allocasuarina littoralis*	Black She-oak	3	3		
*	Primulaceae	*Anagallis arvensis*	Scarlet Pimpernel		2	2	3
	Myrtaceae	*Angophora subvelutina*	Broad-leaved Apple		4		
	Poaceae	*Anisopogon avenaceus*	Oat Speargrass	3	3		
*	Apocynaceae	*Araujia sericifera*	Moth Vine				3
	Araliaceae	*Astrotricha longifolia*			2		
	Araliaceae	*Astrotricha* sp		2			
	Poaceae	*Austrodanthonia fulva*	Wallaby Grass		2		
	Poaceae	*Austrostipa ramosissima*	Stout Bamboo Grass		2		
*	Poaceae	*Avena fatua*	Wild Oats				2
	Myrtaceae	*Backhousia myrtifolia*	Grey Myrtle		4		
*	Asteraceae	*Bidens pilosa*	Cobblers Pegs		3		3
	Poaceae	*Bothriochloa macra*	Red Grass			3	3
	Sterculiaceae	*Brachychiton populneus* ssp *populneus*	Kurrajong		1		
	Asteraceae	*Brachyscome aculeata*	Hill Daisy	2			
	Asteraceae	*Brachyscome linearifolia*		2	2		
*	Poaceae	*Briza minor*	Shivery Grass				3
	Pittosporaceae	*Bursaria spinosa* ssp *spinosa*	Blackthorn	2	3		2
	Cupressaceae	*Callitris rhomboidea*	Port Jackson Pine	2			
	Asteraceae	*Calotis dentex*		3	4		
	Vitaceae	*Cayratia clematidea*	Native Grape		3		
*	Gentianaceae	*Centaurium erythraea*	Common Centaury				3
	Apiaceae	*Centella asiatica*	Indian Pennywort		3	3	

Status	Family	Genus species	Common Name	SSTF	R Forest	Rip/Aqua	CG
	Adiantaceae	*Cheilanthes sieberi* ssp *sieberi*	Mulga Fern	3	2		
*	Asteraceae	*Cirsium vulgare*	Spear Thistle			3	2
	Ranunculaceae	*Clematis aristata*	Old Man's Beard		2		
*	Asteraceae	*Conyza canadensis* ssp *canadensis*				3	2
*	Asteraceae	*Conyza sp*	Fleabane		2	2	3
	Rutaceae	*Correa reflexa* var *speciosa*	Common Correa	3	3		
*	Apiaceae	*Cyclospermum leptophyllum*	Slender Celery				3
	Poaceae	*Cymbopogon refractus*	Barbed Wire Grass	2			
	Poaceae	*Cynodon dactylon*	Couch			4	4
*	Cyperaceae	*Cyperus eragrostis*			2		3
	Cyperaceae	*Cyperus polystachyos*					3
	Poaceae	*Dichelachne crinita*	Longhair Plumegrass				2
	Poaceae	*Dichelachne* sp		3	3		
	Convolvulaceae	*Dichondra repens*	Kidney Weed	2	3	3	
	Poaceae	*Echinopogon caespitosus* var *caespitosus*	Tufted Hedgehog-grass	2			
	Poaceae	*Echinopogon ovatus*	Forest Hedgehog Grass		3		
	Chenopodiaceae	*Einadia hastata*	Berry Saltbush		2		2
	Poaceae	*Entolasia marginata*	Bordered Panic	3	3	2	
	Poaceae	*Entolasia stricta*	Wiry Panic	3			
*	Poaceae	*Eragrostis curvula*	African Lovegrass		2		
	Poaceae	*Eragrostis leptostachya*	Paddock Lovegrass		3		
	Myrtaceae	*Eucalyptus crebra*	Narrow-leaved Ironbark	3	4		1
	Myrtaceae	*Eucalyptus elata*	River Peppermint		2		
	Myrtaceae	*Eucalyptus eugenioides*	Thin-leaved Stringybark	3	3		
	Myrtaceae	*Eucalyptus fibrosa*	Red Ironbark	2			
	Myrtaceae	*Eucalyptus moluccana*	Grey Box				1

Status	Family	Genus species	Common Name	SSTF	R Forest	Rip/Aqua	CG
	Myrtaceae	*Eucalyptus punctata*	Grey Gum	3	2		
	Myrtaceae	*Eucalyptus tereticornis*	Forest Red Gum				1
	Asteraceae	*Euchiton involucratus*	Star Cudweed		2		
*	Apiaceae	*Foeniculum vulgare*	Fennel			3	
	Cyperaceae	*Gahnia aspera*	Rough Saw-sedge	2	2		
	Cyperaceae	*Gahnia* sp	Saw-sedge	2			
	Fabaceae - Faboideae	*Glycine clandestina*		3	3		
	Fabaceae - Faboideae	*Glycine tabacina*		2			
	Goodeniaceae	*Goodenia heterophylla*		2			
	Lamiaceae	*Hemigenia purpurea*		2			
	Dilleniaceae	*Hibbertia diffusa*	Wedge Guinea Flower	2			
	Hypoxidaceae	*Hypoxis* sp	Yellow Star	1			
	Poaceae	*Imperata cylindrica*	Blady Grass		3		
	Myrtaceae	*Kunzea ambigua*	Tick Bush	4	2		2
	Cyperaceae	*Lepidosperma concavum*			1		
	Cyperaceae	*Lepidosperma gunnii*		2			
	Cyperaceae	*Lepidosperma laterale*		3	2		
	Ericaceae - Styphelioideae	*Leucopogon juniperinus*	Prickly Beard-heath		2		
*	Oleaceae	*Ligustrum lucidum*	Large Leaved Privet		3	2	2
*	Oleaceae	*Ligustrum sinense*	Small Leaved Privet		3	2	2
	Lomandraceae	*Lomandra filiformis* ssp *filiformis*	Wattle Mat-rush		3		
	Lomandraceae	*Lomandra longifolia*	Spiny-headed Mat-rush		2		
	Onagraceae	*Ludwigia peploides* ssp *montevidensis*	Water Primrose			2	
N4	Solanaceae	*Lycium ferocissimum*	African Boxthorn				1
	Poaceae	*Microlaena stipoides* var *stipoides*	Weeping Grass	3	4	3	3
N4	Poaceae	*Nassella neesiana*	Chilean Needlegrass				4

Status	Family	Genus species	Common Name	SSTF	R Forest	Rip/Aqua	CG
	Rutaceae	*Nematolepis squamea* ssp *squamea*	Satinwood		3		
	Oleaceae	*Notelaea longifolia*	Large Mock-olive	2	2		
*	Oleaceae	*Olea europaea* ssp *cuspidata*	Olive				3
*	Asteraceae	*Onopordum acanthium* ssp *acanthium*	Scotch Thistle				2
	Hydrocharitaceae	*Ottelia ovalifolia* ssp *ovalifolia*	Swamp Lily			2	
*	Oxalidaceae	*Oxalis corniculata*				3	3
	Oxalidaceae	*Oxalis perennans*		2			
	Poaceae	*Panicum simile*	Two-colour Panic	3			
	Poaceae	*Paspalidium criniforme*			2		
	Poaceae	*Paspalidium distans*		2			
*	Poaceae	*Paspalum dilatatum*	Paspalum		3	3	4
	Poaceae	*Paspalum distichum*	Water Couch		3	3	4
*	Poaceae	*Pennisetum clandestinum*	Kikuyu Grass			4	4
*	Poaceae	*Phalaris aquatica*	Phalaris			3	3
	Poaceae	*Phragmites australis*	Common Reed		3		
	Euphorbiaceae	*Phyllanthus hirtellus*		3			
*	Plantaginaceae	*Plantago lanceolata*	Lamb's Tongues		3	3	
	Lamiaceae	*Plectranthus parviflorus*	Cockspur Flower		2		
	Rhamnaceae	*Pomaderris aspera*	Hazel Pomaderris		1		
	Rhamnaceae	*Pomaderris discolor*			3		
	Rhamnaceae	*Pomaderris* sp			1		
	Rubiaceae	*Pomax umbellata*	Pomax	3			2
	Euphorbiaceae	*Poranthera microphylla*		1	3		
	Lobeliaceae	*Pratia purpurascens*	Whiteroot		2		
N4	Rosaceae	*Rubus fruticosus* agg sp	Blackberry			3	3
	Rosaceae	*Rubus parvifolius*	Native Raspberry		2		

Status	Family	Genus species	Common Name	SSTF	R Forest	Rip/Aqua	CG
*	Polygonaceae	*Rumex crispus*	Curled Dock		2	3	
*	Asteraceae	*Senecio madagascariensis*	Fireweed		2		3
*	Poaceae	*Setaria gracilis*	Slender Pigeon Grass				2
	Asteraceae	*Sigesbeckia orientalis* ssp *orientalis*			3		
	Solanaceae	*Solanum prinophyllum*	Forest Nightshade	2	2		
	Solanaceae	*Solanum vescum*	A Kangaroo Apple		1		
*	Poaceae	*Sporobolus africanus*	Parramatta Grass				2
*	Caryophyllaceae	*Stellaria media*	Common Chickweed		3	3	
*	Asteraceae	*Taraxacum officinale*	Dandelion			3	3
	Poaceae	*Themeda australis*	Kangaroo Grass	3	4		3
	Apocynaceae	*Tylophora barbata*	Bearded Tylophora		3		
	Typhaceae	*Typha domingensis*	Narrow-leaved Cumbungi		3	3	3
*	Verbenaceae	*Verbena bonariensis*	Purpletop			3	2
	Asteraceae	*Vittadinia cuneata*	Fuzzweed	2			
	Campanulaceae	*Wahlenbergia gracilis*	Sprawling Bluebell		2		
	Xanthorrhoeaceae	*Xanthorrhoea* sp	Grass Tree		1		

Fauna inventory

Group	Latin Name	Common Name	EPBC Act	TSC Act	Biosis (2010)	Biosis (2009)	Ambrose (2004)	OEH Database
Amphibians	*Crinia signifera*	Common Eastern Froglet			W	*	*	*
Amphibians	*Limnodynastes peronii*	Striped Marsh Frog				*	*	*
Amphibians	*Limnodynastes tasmaniensis*	Spotted Grass Frog				*	*	*
Amphibians	*Litoria dentata*	Bleating Tree Frog			W	*		*
Amphibians	*Litoria fallax*	Eastern Dwarf Tree Frog			W	*	*	*
Amphibian	*Litoria lesueuri*	Lesueur's Frog						*
Amphibians	*Litoria peronii*	Peron's Tree Frog				*		*
Amphibians	*Litoria verreauxii verreauxii*	Verreaux's Frog				*		*
Amphibian	*Paracrinia haswelli*	Haswell's Froglet						*
Amphibian	*Pseudophryne bibronii*	Bibron's Toadlet						*
Birds - Introduced	*Acridotheres tristis*	Common Myna			O	*	*	*
Birds - Introduced	*Anas platyrhynchos*	Mallard				*		*
Birds - Introduced	*Carduelis carduelis*	European Goldfinch						*
Birds - Introduced	*Columba livia*	Rock Dove						*
Birds - Introduced	*Passer domesticus*	House Sparrow				*		*
Birds - Introduced	*Pycnonotus jocosus*	Red-whiskered Bulbul				*		*
Birds - Introduced	*Streptopelia chinensis*	Spotted Turtle-Dove				*		*
Birds - Introduced	*Sturnus vulgaris*	Common Starling			O	*		*
Birds - Introduced	*Turdus merula*	Common Blackbird			O	*		*
Birds - Native	*Acanthiza chrysorrhoa*	Yellow-rumped Thornbill				*		*
Birds - Native	*Acanthiza lineata*	Striated Thornbill				*		*
Birds - Native	*Acanthiza nana*	Yellow Thornbill			O	*		*
Birds - Native	*Acanthiza pusilla*	Brown Thornbill			O	*		*

Group	Latin Name	Common Name	EPBC Act	TSC Act	Biosis (2010)	Biosis (2009)	Ambrose (2004)	OEH Database
Birds - Native	*Acanthiza reguloides*	Buff-rumped Thornbill				*		*
Birds - Native	*Acanthorhynchus tenuirostris*	Eastern Spinebill				*		*
Birds - Native	*Accipiter fasciatus*	Brown Goshawk						*
Birds - Native	*Accipiter novaehollandiae*	Grey Goshawk				*		*
Birds - Native	*Acrocephalus australis*	Australian Reed-Warbler	M			*		*
Birds - Native	*Aegotheles cristatus*	Australian Owlet-nightjar						*
Birds - Native	*Alisterus scapularis*	Australian King-Parrot				*		*
Birds - Native	*Anas castanea*	Chestnut Teal			O	*	*	*
Birds - Native	*Anas gracilis*	Grey Teal			O		*	*
Birds - Native	*Anas superciliosa*	Pacific Black Duck			O	*	*	*
Birds - Native	*Anhinga novaehollandiae*	Australasian Darter						*
Birds - Native	*Anthochaera carunculata*	Red Wattlebird				*		*
Birds - Native	*Anthochaera chrysoptera*	Little Wattlebird				*		*
Birds - Native	*Anthus novaeseelandiae*	Australian Pipit						*
Birds - Native	*Aquila audax*	Wedge-tailed Eagle						*
Birds - Native	*Ardea ibis*	Cattle Egret	M					*
Birds - Native	*Ardea modesta*	Great Egret	M					*
Birds - Native	*Artamus cyanopterus*	Dusky Woodswallow						*
Birds - Native	*Burhinus grallarius*	Bush Stone-curlew		E				*
Birds - Native	*Cacatua galerita*	Sulphur-crested Cockatoo			O	*		*
Birds - Native	*Cacatua roseicapilla*	Galah				*		*
Birds - Native	*Cacatua sanguinea*	Little Corella			OW	*		*
Birds - Native	*Cacatua tenuirostris*	Long-billed Corella				*		*
Birds - Native	*Cacomantis flabelliformis*	Fan-tailed Cuckoo						*
Birds - Native	*Cacomantis pallidus*	Pallid Cuckoo						*

Group	Latin Name	Common Name	EPBC Act	TSC Act	Biosis (2010)	Biosis (2009)	Ambrose (2004)	OEH Database
Birds - Native	*Callocephalon fimbriatum*	Gang-gang Cockatoo		V				*
Birds - Native	*Calyptorhynchus funereus*	Yellow-tailed Black-Cockatoo				*		*
Birds - Native	*Calyptorhynchus lathami*	Glossy Black-Cockatoo		V				*
Birds - Native	*Ceyx azureus*	Azure Kingfisher			O			*
Birds - Native	*Chalcites basalis*	Horsfield's Bronze-Cuckoo						*
Birds - Native	*Chalcites lucidus*	Shining Bronze-Cuckoo						*
Birds - Native	*Chenonetta jubata*	Australian Wood Duck			O	*		*
Birds - Native	*Circus approximans*	Swamp Harrier						*
Birds - Native	*Cisticola exilis*	Golden-headed Cisticola					*	
Birds - Native	*Climacteris picumnus*	Brown Treecreeper						*
Birds - Native	*Colluricincla harmonica*	Grey Shrike-thrush						*
Birds - Native	*Coracina novaehollandiae*	Black-faced Cuckoo-shrike				*		*
Birds - Native	*Coracina papuensis*	White-bellied Cuckoo-shrike						*
Birds - Native	*Coracina tenuirostris*	Cicadabird						*
Birds - Native	*Corcorax melanorhamphos*	White-winged Chough				*		*
Birds - Native	*Cormobates leucophaeus*	White-throated Treecreeper				*		*
Birds - Native	*Corvus coronoides*	Australian Raven			OW	*		*
Birds - Native	*Coturnix ypsilophora*	Brown Quail						*
Birds - Native	*Cracticus nigrogularis*	Pied Butcherbird						*
Birds - Native	*Cracticus torquatus*	Grey Butcherbird				*		*
Birds - Native	*Dacelo novaeguineae*	Laughing Kookaburra			OW	*	*	*

Group	Latin Name	Common Name	EPBC Act	TSC Act	Biosis (2010)	Biosis (2009)	Ambrose (2004)	OEH Database
Birds - Native	*Daphoenositta chrysoptera*	Varied Sittella		V				*
Birds - Native	*Dicaeum hirundinaceum*	Mistletoebird						*
Birds - Native	*Egretta garzetta*	Little Egret						*
Birds - Native	*Egretta novaehollandiae*	White-faced Heron				*	*	*
Birds - Native	*Elanus axillaris*	Black-shouldered Kite						*
Birds - Native	*Eolophus roseicapillus*	Galah						*
Birds - Native	*Eopsaltria australis*	Eastern Yellow Robin			W	*		*
Birds - Native	*Eudynamys scolopacea*	Common Koel				*		*
Birds - Native	*Eurystomus orientalis*	Dollarbird						*
Birds - Native	*Falco berigora*	Brown Falcon						*
Birds - Native	*Falco cenchroides*	Nankeen Kestrel			O			*
Birds - Native	*Falco peregrinus*	Peregrine Falcon						*
Birds - Native	*Falcunculus frontatus frontatus*	Eastern Shrike-tit						*
Birds - Native	*Fulica atra*	Eurasian Coot			O		*	*
Birds - Native	*Gallinula tenebrosa*	Dusky Moorhen			O		*	*
Birds - Native	*Geopelia striata*	Peaceful Dove						*
Birds - Native	*Gerygone mouki*	Brown Gerygone						*
Birds - Native	*Gerygone olivacea*	White-throated Gerygone			W	*		*
Birds - Native	*Grallina cyanoleuca*	Magpie-lark			OW	*		*
Birds - Native	*Gymnorhina tibicen*	Australian Magpie			OW	*	*	*
Birds - Native	*Haliastur sphenurus*	Whistling Kite						*
Birds - Native	*Hieraaetus morphnoides*	Little Eagle						*
Birds - Native	*Hirundapus caudacutus*	White-throated Needletail	M					*
Birds - Native	*Hirundo neoxena*	Welcome Swallow			O	*		*
Birds - Native	*Hirundo nigricans*	Tree Martin				*		*

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Birds - Native	*Leucosarcia picata*	Wonga Pigeon						*
Birds - Native	*Lichenostomus chrysops*	Yellow-faced Honeyeater			O	*		*
Birds - Native	*Lichenostomus fuscus*	Fuscous Honeyeater						*
Birds - Native	*Lichenostomus leucotis*	White-eared Honeyeater			O	*		*
Birds - Native	*Lichenostomus melanops*	Yellow-tufted Honeyeater						*
Birds - Native	*Lichenostomus penicillatus*	White-plumed Honeyeater						*
Birds - Native	*Lophoictinia isura*	Square-tailed Kite		V		*		*
Birds - Native	*Macropygia amboinensis*	Brown Cuckoo-Dove						*
Birds - Native	*Malurus cyaneus*	Superb Fairy-wren			O	*		*
Birds - Native	*Malurus lamberti*	Variegated Fairy-wren			O	*		*
Birds - Native	*Manorina melanocephala*	Noisy Miner			OW	*		*
Birds - Native	*Manorina melanophrys*	Bell Miner				*		*
Birds - Native	*Megalurus gramineus*	Little Grassbird						*
Birds - Native	*Melanodryas cucullata*	Hooded Robin						*
Birds - Native	*Meliphaga lewinii*	Lewin's Honeyeater			O	*		*
Birds - Native	*Melithreptus brevirostris*	Brown-headed Honeyeater						*
Birds - Native	*Melithreptus gularis gularis*	Black-chinned Honeyeater (eastern subspecies)		V		*		*
Birds - Native	*Melithreptus lunatus*	White-naped Honeyeater			O			*
Birds - Native	*Menura novaehollandiae*	Superb Lyrebird			WF			*
Birds - Native	*Merops ornatus*	Rainbow Bee-eater	M					*
Birds - Native	*Microcarbo melanoleucos*	Little Pied Cormorant						*
Birds - Native	*Microeca fascinans*	Jacky Winter				*		*

Group	Latin Name	Common Name	EPBC Act	TSC Act	Biosis (2010)	Biosis (2009)	Ambrose (2004)	OEH Database
Birds - Native	*Monarcha melanopsis*	Black-faced Monarch	M					*
Birds - Native	*Myiagra inquieta*	Restless Flycatcher						*
Birds - Native	*Myzomela sanguinolenta*	Scarlet Honeyeater				*		*
Birds - Native	*Neochmia temporalis*	Red-browed Finch			O	*		*
Birds - Native	*Ninox novaeseelandiae*	Southern Boobook						*
Birds - Native	*Ninox strenua*	Powerful Owl		V				*
Birds - Native	*Ocyphaps lophotes*	Crested Pigeon			O	*	*	*
Birds - Native	*Origma solitaria*	Rockwarbler						*
Birds - Native	*Oriolus sagittatus*	Olive-backed Oriole						*
Birds - Native	*Pachycephala pectoralis*	Golden Whistler				*		*
Birds - Native	*Pachycephala rufiventris*	Rufous Whistler			OW	*		*
Birds - Native	*Pardalotus punctatus*	Spotted Pardalote				*		*
Birds - Native	*Pardalotus striatus*	Striated Pardalote				*		*
Birds - Native	*Petrochelidon nigricans*	Tree Martin			O			*
Birds - Native	*Petroica boodang*	Scarlet Robin						*
Birds - Native	*Petroica rosea*	Rose Robin						*
Birds - Native	*Phalacrocorax carbo*	Great Cormorant						*
Birds - Native	*Phalacrocorax varius*	Pied Cormorant						*
Birds - Native	*Phaps chalcoptera*	Common Bronzewing				*		*
Birds - Native	*Philemon citreogularis*	Little Friarbird				*		*
Birds - Native	*Philemon corniculatus*	Noisy Friarbird				*		*
Birds - Native	*Phylidonyris niger*	White-cheeked Honeyeater						*
Birds - Native	*Phylidonyris novaehollandiae*	New Holland Honeyeater				*		*
Birds - Native	*Platalea flavipes*	Yellow-billed Spoonbill				*		*

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Birds - Native	*Platalea regia*	Royal Spoonbill						*
Birds - Native	*Platycercus elegans*	Crimson Rosella			O	*		*
Birds - Native	*Platycercus eximius*	Eastern Rosella			OE	*		*
Birds - Native	*Podargus strigoides*	Tawny Frogmouth						*
Birds - Native	*Poliocephalus poliocephalus*	Hoary-headed Grebe					*	*
Birds - Native	*Porphyrio porphyrio*	Purple Swamphen			O	*	*	*
Birds - Native	*Psephotus haematonotus*	Red-rumped Parrot			OE	*	*	*
Birds - Native	*Psophodes olivaceus*	Eastern Whipbird			W			*
Birds - Native	*Ptilonorhynchus violaceus*	Satin Bowerbird				*		*
Birds - Native	*Pycnoptilus floccosus*	Pilotbird						*
Birds - Native	*Rhipidura albiscapa*	Grey Fantail			OW	*		*
Birds - Native	*Rhipidura leucophrys*	Willie Wagtail			O	*	*	*
Birds - Native	*Scythrops novaehollandiae*	Channel-billed Cuckoo			W			*
Birds - Native	*Sericornis frontalis*	White-browed Scrubwren			O	*		*
Birds - Native	*Smicrornis brevirostris*	Weebill						*
Birds - Native	*Stagonopleura guttata*	Diamond Firetail		V				*
Birds - Native	*Strepera graculina*	Pied Currawong			W	*		*
Birds - Native	*Tachybaptus novaehollandiae*	Australasian Grebe						*
Birds - Native	*Taeniopygia bichenovii*	Double-barred Finch				*		*
Birds - Native	*Threskiornis molucca*	Australian White Ibis						*
Birds - Native	*Threskiornis spinicollis*	Straw-necked Ibis						*
Birds - Native	*Todiramphus sanctus*	Sacred Kingfisher						*
Birds - Native	*Trichoglossus haematodus*	Rainbow Lorikeet			W	*		*
Birds - Native	*Turnix varius*	Painted Button-quail						*
Birds - Native	*Tyto tenebricosa*	Sooty Owl		V				*

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Birds - Native	*Vanellus miles*	Masked Lapwing			OW	*		*
Birds - Native	*Xanthomyza phrygia*	Regent Honeyeater	E	CE				*
Birds - Native	*Zoothera lunulata*	Bassian Thrush						*
Birds - Native	*Zosterops lateralis*	Silvereye				*		*
Invertebrate	*Meridolum corneovirens*	Cumberland Plain Land Snail		E				*
Mammals - Introduced	*Bos taurus*	Cow			OP		*	*
Mammals - Introduced	*Canis lupus*	Dingo, domestic dog						*
Mammals - Introduced	*Capra hircus*	Goat						*
Mammals - Introduced	*Cervus timorensis*	Rusa Deer				*		*
Mammals - Introduced	*Equus caballus*	Horse			O			
Mammals - Introduced	*Felis catus*	Cat (feral)				*		*
Mammals - Introduced	*Lepus capensis*	Brown Hare				*		*
Mammals - Introduced	*Mus musculus*	House Mouse						*
Mammals - Introduced	*Oryctolagus cuniculus*	Rabbit			OP	*		*
Mammals - Introduced	*Rattus rattus*	Black Rat			P			*
Mammals - Introduced	*Vicugna pacos*	Alpacca			O			
Mammals -	*Vulpes vulpes*	Fox				*		*

Group	Latin Name	Common Name	EPBC Act	TSC Act	Biosis (2010)	Biosis (2009)	Ambrose (2004)	OEH Database
Introduced								
Mammals - Native	*Acrobates pygmaeus*	Feathertail Glider						*
Mammals - Native	*Antechinus stuartii*	Brown Antechinus						*
Mammals - Native	*Chalinolobus gouldii*	Gould's Wattled Bat						*
Mammals - Native	*Chalinolobus morio*	Chocolate Wattled Bat						*
Mammals - Native	*Dasyurus maculatus*	Spotted-tailed Quoll	E	V				*
Mammals - Native	*Hydromys chrysogaster*	Water-rat						*
Mammals - Native	*Macropus giganteus*	Eastern Grey Kangaroo				*		*
Mammals - Native	*Macropus robustus*	Common Wallaroo			OP			*
Mammals - Native	*Miniopterus schreibersii oceanensis*	Eastern Bentwing-bat		V				*
Mammals - Native	*Mormopterus norfolkensis*	Eastern Freetail-bat		V				*
Mammals - Native	*Myotis macropus*	Southern Myotis		V				*
Mammals - Native	*Nyctophilus geoffroyi*	Lesser Long-eared Bat						*
Mammals - Native	*Ornithorhynchus anatinus*	Platypus						*
Mammals - Native	*Petauroides volans*	Greater Glider						*
Mammals - Native	*Petaurus breviceps*	Sugar Glider				*		*
Mammals - Native	*Phascolarctos cinereus*	Koala		V				*
Mammals - Native	*Pseudocheirus peregrinus*	Common Ringtail Possum						*
Mammals - Native	*Scoteanax rueppellii*	Greater Broad-nosed Bat		V				*
Mammals - Native	*Scotorepens orion*	Eastern Broad-nosed Bat						*
Mammals - Native	*Tachyglossus aculeatus*	Short-beaked Echidna			F			*
Mammals - Native	*Tadarida australis*	White-striped Freetail-bat						*
Mammals - Native	*Trichosurus vulpecula*	Common Brushtail Possum				*		*
Mammals - Native	*Vespadelus darlingtoni*	Large Forest Bat						*

Group	Latin Name	Common Name	EPBC Act	TSC Act	Biosis (2010)	Biosis (2009)	Ambrose (2004)	OEH Database
Mammals - Native	*Vespadelus pumilus*	Eastern Forest Bat						*
Mammals - Native	*Vespadelus regulus*	Southern Forest Bat						*
Mammals - Native	*Vespadelus vulturnus*	Little Forest Bat						*
Mammals - Native	*Vombatus ursinus*	Common Wombat			E	*		*
Mammals - Native	*Wallabia bicolor*	Swamp Wallaby			P	*		*
Reptiles	*Amphibolurus muricatus*	Jacky Lizard						*
Reptiles	*Chelodina longicollis*	Eastern Snake-necked Turtle						*
Reptiles	*Cryptophis nigrescens*	Eastern Small-eyed Snake						*
Reptiles	*Ctenotus taeniolatus*	Copper-tailed Skink						*
Reptiles	*Diplodactylus vittatus*	Wood Gecko						*
Reptiles	*Egernia whitii*	White's Skink						*
Reptiles	*Eulamprus heatwolei*	Yellow-bellied Water-skink						*
Reptiles	*Eulamprus quoyii*	Eastern Water Skink			O	*	*	*
Reptiles	*Eulamprus tympanum*	Highland Water Skink				*		*
Reptiles	*Furina diadema*	Red-naped Snake						*
Reptiles	*Lampropholis delicata*	Grass Skink			O	*		*
Reptiles	*Lampropholis guichenoti*	Garden Skink			O	*		*
Reptiles	*Phyllurus platurus*	Broad-tailed Gecko						*
Reptiles	*Physignathus lesueurii*	Eastern Water Dragon			O			*
Reptiles	*Pogona barbata*	Bearded Dragon				*		*
Reptiles	*Pseudechis porphyriacus*	Red-bellied Black Snake						*
Reptiles	*Pseudonaja textilis*	Eastern Brown Snake			Anecdotal			*
Reptiles	*Pygopus lepidopodus*	Common Scaly-foot						*

Group	Latin Name	Common Name	EPBC Act	TSC Act	Biosis (2010)	Biosis (2009)	Ambrose (2004)	OEH Database
Reptiles	*Ramphotyphlops nigrescens*	Blackish Blind Snake						*
Reptiles	*Tiliqua scincoides*	Eastern Blue-tongued Lizard				*		*
Reptiles	*Tympanocryptis diemensis*	Mountain Dragon				*		*
Reptiles	*Varanus varius*	Lace Monitor						*
Reptiles	*Vermicella annulata*	Bandy-bandy						*

Key: Observation Type: O – Seen, W – Heard, P – scats, K – dead, I – indirect evidence, F – Tracks, scratchings

Status: CE – Critically Endangered, E – Endangered, V – Vulnerable, M – Migratory (under the EPBC Act)

APPENDIX 2

Threatened and migratory species likelihood of occurrence assessment criteria

Likelihood of occurrence	Assessment Criteria
Low	Species considered to have a low likelihood of occurrence include species not recorded in the field surveys that fit one or more of the following criteria: ▪ have not been recorded previously in the study area or locality and the study area is beyond the known distribution or range; ▪ are dependant on a narrow range or specific habitats that do not or are not likely to occur in the study area; ▪ are considered locally extinct; ▪ are a non-cryptic perennial flora species that were targeted during field surveys; and ▪ are flora species that have a very limited range and highly specific dispersal mechanisms.
Moderate	Species considered to have a moderate likelihood of occurrence include species not recorded in the field surveys that fit one or more of the following criteria: ▪ there are infrequent records for the species in the study area and locality; ▪ preferential habitats of the species are present in the study area but these are mainly in a poor or modified condition; ▪ may use or occur in habitats within the study area opportunistically during seasonal migration but are unlikely to be present as vagrant individuals or on a permanent basis as a population; and ▪ are cryptic flowering flora species that were not seasonally targeted during 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 a high incidence of previous records in the study area and locality; ▪ preferentially use habitats that are present in the study area which are abundant and/or in good condition; ▪ resident populations are known in the study area or locality; and ▪ are known to regularly use habitats of the site or locality or are highly likely to visit the site during seasonal dispersal or migration.

APPENDIX 3

Terrestrial and aquatic flora and fauna listed on the TSC, FM and/or EPBC Acts previously recorded in the locality and their likelihood to occur on the Subject Site

Terrestrial Flora

Key: *1) Listed on the EPBC Act as Critically Endangered (Z), Endangered (E) or Vulnerable (V) or Extinct (X)*

2) Listed on the TSC Act as Endangered (E1) or Vulnerable (V) or Presumed Extinct (E4), Preliminary Determination (PD)

Latin Name	TSC Act	EPBC Act	Habitat	Likelihood of occurrence
Acacia bynoeana	E1	V	*Acacia bynoeana* is found in central eastern NSW, in the following catchment regions – Hawkesbury/Nepean, Hunter/Central Rivers, Southern Rivers, and Sydney Metropolitan. More specifically it is found from the Hunter District (Morisset) south to the Southern Highlands and west to the Blue Mountains. It has recently been found in the Colymea and Parma Creek areas west of Nowra (DEC 2005a). It seems to prefer open, sometimes slightly disturbed sites such as trail margins, edges of roadside spoil mounds and recently burnt patches (DEC 2005a). It grows in sandy clay soils often containing ironstone gravels (Fairley 2004). Main vegetation types include heath or dry sclerophyll forest on sandy soils (DEC 2005a). Associated overstorey species include *Corymbia gummifera*, *Corymbia maculata*, *Eucalyptus parramattensis*, *Banksia serrata* and *Angophora bakeri* (DEC 2005a). Flowering period is mainly summer.	Low. Very marginal habitat for the species is present. All records in the Locality are to the south-east in Scribbly Gum Woodland of the Metropolitan Special Area.
Acacia flocktoniae	V	V	*Acacia flocktoniae* is found only in the Southern Blue Mountains (at Mt Victoria, Megalong Valley and Yerranderie)(DECC 2005). It grows in dry sclerophyll forest on low nutrient soils derived from sandstone. Associated species include *A. stricta* and *Podolobium ilicifolium.* The species occurs within the Hawkesbury/Nepean and Hunter/Central Rivers (NSW) Natural Resource Management Regions. The distribution of *Acacia flocktoniae* overlaps with the following EPBC Act-listed ecological communities: Shale/Sandstone Transition Forest, White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland, Cumberland Plain Woodlands, Turpentine-Ironbark Forest in the Sydney Basin Bioregion, and Temperate Highland Peat Swamps on Sandstone. Flowers usually June to September, also recorded March, April, October, December.	Low. Although habitat for the species is present there are no records in the locality with nearest known locations at Yerranderie to the west and Yerrinbool to the south.

Latin Name	TSC Act	EPBC Act	Habitat	Likelihood of occurrence
Caladenia tessellata	E1	V	*Caladenia tessellata* is found in the Sydney Metropolitan, Southern Rivers, Hawkesbury/Nepean, and Hunter/Central Rivers Catchment Management Regions. Currently known from three disjunct areas: Braidwood on southern tablelands, Ulladulla on the south coast and three populations in Wyong area on the Central Coast (DEC 2005c). It is generally found in grassy, dry sclerophyll forests/woodland, particularly those associated with clay loam, or sandy soils. However, there is one population at Braidwood in lowland on stony soil (DEC 2005c). This species only grows in very dense shrubbery in coastal areas(Bishop 1996). Flowers appear between September and November, but generally late September or early October in extant southern populations (DEC 2005c).	Low. Although some habitat for the species may occur there are no records in the Locality with the nearest records to the north-east at Loftus.
Callistemon linearifolius	V		Occurs chiefly from Georges River to the Hawkesbury River where it grows in dry sclerophyll forest(Harden 2002), open forest, scrubland (Fairley and Moore 2000) or woodland on sandstone. Found in damp places, usually in gullies (Robinson 1994). Flowers in Spring.	Low. Although habitat for the species may occur there are very few records in the Locality.
Cynanchum elegans	E1	E	Restricted to eastern NSW where it is distributed from Brunswick Heads on the north coast to Gerroa in the Illawarra region. The species has been recorded as far west as Merriwa in the upper Hunter River valley. Catchment Management Regions include Hawkesbury/Nepean , Hunter/Central Rivers, Northern Rivers, Southern Rivers and Sydney Metropolitan (DEC 2005u). *Cynanchum elegans* usually occurs on the edge of dry rainforest vegetation. Other associated vegetation types include littoral rainforest; *Leptospermum laevigatum, Banksia integrifolia* subsp. *integrifolia; Eucalyptus tereticornis* open forest and woodland; *Eucalyptus maculata* open forest and woodland; and *Melaleuca armillaris* scrub to open scrub (DEC 2005u). Flowering occurs between August and May, with a peak in November. Flower abundance on individual plants varies from sparse to prolific (DEC 2005u).	Low. Marginal habitat for the species occurs on the Subject Site. The nearby records to the north are at higher elevations and are associated with vegetation of greater shale influence.
Darwinia peduncularis	V		Occurs in the Hawkesbury/Nepean Catchment area, from Hornsby to Hawkesbury River and west to near Glen Davis. It grows in dry sclerophyll forest on sandstone hillsides and ridges. Usually grows on or near rocky outcrops on sandy, well drained, low nutrient soil over sandstone. Flowers in winter to early spring (DEC 2005d).	Low. Although habitat for the species may occur there are very few records in the Locality.

Latin Name	TSC Act	EPBC Act	Habitat	Likelihood of occurrence
Epacris purpurascens var. purpurascens	V		Located in the Hawkesbury/Nepean, Hunter/Central Rivers/and Sydney Metropolitan catchment authority region - from Gosford in the north, to Narrabeen in the east, Silverdale in the west and Avon Dam vicinity in the South (DEC 2005e). *Epacris purpurascens* var. *purpurascens* grows in Dry Sclerophyll forests, scrub and swamps(Harden 1992). Specifically this species is thought to require wet heath vegetation (T. James pers. comm.). Characteristically found in a range of habitat types, most of which have a strong shale soil influence. These include ridge top drainage depressions supporting wet heath within or adjoining shale cap communities (including Shale Sandstone Transition Forest, Turpentine Ironbark Margin Forest, Stringybark/Scribbly Gum Woodland and Scribbly Gum/Grey Gum/Red Bloodwood Woodland). Also occurs in riparian zones draining into Sydney Sandstone Gully Forest, shale lenses within sandstone habitats and colluvial areas overlying or adjoining sandstone or tertiary alluvium (NPWS 2002d).	Moderate. The Subject Site supports are range of preferred habitats for this species including vegetation community, soils and topographic features. There is a high number of records in the Locality.
Grevillea parviflora ssp. *parviflora*	V	V	Located in Hawkesbury/Nepean, Hunter/Central Rivers and Sydney Metropolitan Catchment. Sporadically distributed throughout the Sydney Basin with the main occurrence centred in Picton, Appin, Wedderburn and Bargo. Northern populations are found in the Lower Hunter Valley. To the west of Sydney, small populations occur at Kemps Creek & Voyager Point (DEC 2005g). *Grevillea parviflora* ssp. *parviflora* grows on sandy clay loam soils, often with ironstone gravels. Soils are mostly derived from Tertiary sands or alluvium and from the Mittagong Formation with alternating bands of shale and fine-grained sandstones(NPWS 2002b). The species is found on crests, upper slopes or flat plains in both low-lying areas and on higher topography. The plant prefers open habitat conditions with the largest populations in open woodland and along exposed roadside areas (NPWS 2002b). *G. parviflora* subsp. *parviflora* has been recorded in a range of vegetation types from heath and shrubby woodland to open forest. Canopy species vary greatly with community type but generally are species that favour soils with a strong lateritic influence including *Eucalyptus fibrosa, E. parramattensis, Angophora bakeri* and *Eucalyptus sclerophylla* (NPWS 2002b)..	Moderate. The Subject Site supports are range of preferred habitats for this species including vegetation community, soils and topographic features. There is a high number of records in the Locality.

Latin Name	TSC Act	EPBC Act	Habitat	Likelihood of occurrence
Gyrostemon thesioides	E		Within NSW, has only ever been recorded at three sites, to the west and south of Sydney, near the Colo, Georges and Nepean Rivers. The most recent sighting was of a single male plant near the Colo River within Wollemi National Park. The species has not been recorded from the Nepean and Georges Rivers for 90 and 30 years respectively, despite searches. Also occurs also in Western Australia, South Australia, Victoria and Tasmania. Grows on hillsides and riverbanks and may be restricted to fine sandy soils(DEC 2005h).	Low. Although habitat for the species may occur there are very few records in the Locality. The nearest record of the species was at Douglas Park in 1910.
Leucopogon exolasius	V	V	Occurs in Hawkesbury/Nepean and Sydney Metropolitan Catchment (DEC 2005v), restricted to the Woronora and Grose Rivers (Harden 1991). The plant occurs in woodland on sandy alluvium and rocky sandstone hillsides near creeks, and on low nutrient soils (Powell 2007). Flowering occurs in August and September (Harden 1991). Associated species include *Eucalyptus piperita* and *E. sieberi* and the shrubs *Pultenaea flexilis, Leptospermum trinervium* and *Dillwynia retorta* (Powell 2007).	Low. Although habitat for the species is present most records in the Locality are to the south-east in Scribbly Gum Woodland of the Metropolitan Special Area.
Melaleuca deanei	V	V	*Melaleuca deanei* occurs in the Hawkesbury/Nepean, Southern Rivers, and Sydney Metropolitan Catchment Management Regions. Distinctly it occurs in the Ku-ring-gai/Berowra and Holsworthy/Wedderburn areas. There are also more isolated occurrences at Springwood (in the Blue Mountains), Wollemi National Park, Yalwal (west of Nowra) and Central Coast (Hawkesbury River) areas (DEC 2005j). The species grows in wet heath on sandstone (Harden 1991). Flowers appear in summer but seed production appears to be small and consequently the species exhibits a limited capacity to regenerate(DEC 2005j).	Low. Although habitat for the species may occur there are very few records in the Locality.
Persicaria elatior	V	V	Tall Knotweed has been recorded in south-eastern NSW (Mt Dromedary (an old record), Moruya State Forest near Turlinjah, the Upper Avon River catchment north of Robertson, Bermagui, and Picton Lakes. In northern NSW it is known from Raymond Terrace and the Grafton area (Cherry Tree and Gibberagee State Forests). The species also occurs in Queensland. This species normally grows in damp places, especially beside streams and lakes. Occasionally in swamp forest or associated with disturbance (DEC 2005k).	Low. Although habitat for the species may occur there are very few records in the Locality. The nearest record of the species was at Picton in 1949.
Persoonia acerosa	V	V	The Needle Geebung has been recorded only on the central coast and in the Blue Mountains, from Mt Tomah in the north to as far south as Hill Top where it is now believed to be extinct. Mainly in the Katoomba, Wentworth Falls, Springwood area. The Needle Geebung occurs in dry sclerophyll forest, scrubby low-woodland and heath on low fertility soils (DEC 2005l).	Low. Although habitat for the species may occur there are no records in the Locality.

Latin Name	TSC Act	EPBC Act	Habitat	Likelihood of occurrence
Persoonia bargoensis	E1	V	Found in the Sydney Metropolitan and Hawkesbury/Nepean Catchment Authority Regions. Restricted to a small area south-west of Sydney on the western edge of the Woronora Plateau. Its entire range falls between Picton, Douglas Park, Yanderra, Cataract River and Thirlmere(DEC 2005m). *P. bargoensis* grows in woodland to dry sclerophyll forest on sandstone and clayey laterite on heavier, well drained, loamy, gravelly soils of the Hawkesbury Sandstone and Wianamatta Shale(NPWS 2000). More specifically, *P.bargoensis* seems to prefer the interfaces between shale-derived soils such as the Blacktown Soil Landscape, the complex soils of the Mittagong Formation (Lucas Heights Soil Landscape), and the underlying sandstone (Hawkesbury and Gymea Soil Landscapes). Some of the vegetation in which *P. bargoensis* occurs can be recognised as the endangered Shale/Sandstone Transition Forest (NPWS 2000). This species seems to benefit from the reduced competition and increased light available on disturbance margins including roadsides (DEC 2005m). Flowering occurs mainly in summer but can extend into autumn(NPWS 2000).	High. The Subject Site supports a range of preferred habitats for this species including vegetation community, soils and topographic features. There is a high number of records in the Locality.
Persoonia glaucescens	E1	V	The Mittagong Geebung's historical distribution places the northern and eastern limit at Couridjah (Thirlmere Lakes), the southern limit at Fitzroy Falls and the western limit at High Range. However, it is suggested that the species no longer extends to Fitzroy Falls or Kangaloon and that the present southern limit is near Berrima. The northern limit appears to have contracted a few kilometres south to Buxton. Grows in woodland to dry sclerophyll forest on clayey and gravely laterite. More specifically this species prefers clayey and gravelly laterites with ridgetops, plateaus and upper slopes being preferred topography [NPWS, 2000].	Moderate. Although there is not a high number of records in the Locality the Subject Site supports a range of preferred habitats for this species including vegetation community, soils and topographic features.
Persoonia hirsuta	E1	E	Occurs from Gosford to Royal NP and in the Putty district from Hill Top to Glen Davis where it grows in woodland to dry sclerophyll forest on sandstone (Harden 2002) or rarely on shale(NSW Scientific Committee 1998). Two subspecies are recognised, *P. hirsuta* ssp. *hirsuta* (Gosford to Berowra and Manly to Royal NP) and *P. hirsuta* ssp. *evoluta* (Blue Mountains, Woronora Plateau and Southern Highlands). Found in sandy soils in dry sclerophyll open forest, woodland and heath on sandstone and shale-sandstone transition areas (DEC 2005n).	Moderate. Although there is not a high number of records in the Locality the Subject Site supports preferred habitats for this species including vegetation community and soils.

Latin Name	TSC Act	EPBC Act	Habitat	Likelihood of occurrence
Persoonia nutans	E1	E	Occurs in Hawkesbury/Nepean and Sydney Metropolitan Catchment. Restricted to the Cumberland Plain between Richmond in the north and Macquarie Fields in the south. Core distribution occurs within the Penrith LGA, and to a lesser extent, Hawkesbury LGA. Small populations also occur in the Liverpool, Campbelltown, Bankstown and Blacktown LGAs (DEC 2005o). Confined to aeolian and alluvial sediments and occurs in a range of sclerophyll forest and woodland vegetation communities with the majority of individuals occurring within Agnes Banks Woodland or Castlereagh Scribbly Gum Woodland (DEC 2005o). *P. nutans* also occurs on Shale/Gravel Transition Forest and Cooks River Castlereagh Ironbark Forest (DEC 2005o). In Castlereagh Scribbly Gum Woodlands it is found in open woodland with dominant overstorey species being *Angophora bakeri, Eucalyptus sclerophylla* and *Melaleuca decora*. The Agnes Banks Woodlands have a similar array of tree species, with the addition of *Banksia serrata* and *Banksia aemula* (DEC 2005o). *Persoonia nutans* is found on the Agnes Banks and Berkshire Park soil landscapes. Drainage appears to influence the distribution of *P. nutans* as the species is more common on the deeper sands at Agnes Banks. At other locations on the Cumberland Plain it occurs on low rises as opposed to swales or other low lying areas(DEC 2005o).	Low. Although marginal habitat for the species may occur there are very few records in the Locality.
Pomaderris brunnea	V	V	*Pomaderris brunnea* is found in a very limited area around the Nepean and Hawkesbury Rivers, including the Bargo area. Occurs in the Central West, Hawkesbury/Nepean, Hunter/Central Rivers Catchments. Occurs on clay & alluvial soils (Fairley and Moore 1995). In the Hawkesbury/Nepean region, the species is known to be associated with Dry sclerophyll forests (Cumberland, Upper Riverina, Sydney Coastal, Sydney Hinterland, Sydney Sand Flats), Coastal Floodplain Wetlands and Coastal Valley Grassy Woodlands (DEC 2005p).	Moderate. The Subject Site supports are range of preferred habitat features for this species including vegetation community and soils. There are several records of the species in the Locality.

Latin Name	TSC Act	EPBC Act	Habitat	Likelihood of occurrence
Pterostylis saxicola	E1	E	Restricted to western Sydney between Freemans Reach in the north and Picton in the south (Hawkesbury/Nepean and Sydney Metropolitan Catchment)(DEC 2005w). Most commonly found growing in small pockets of shallow soil in depressions on sandstone rock shelves above cliff lines. The vegetation communities above the shelves where *Pterostylis saxicola* occurs are sclerophyll forest or woodland on shale/sandstone transition soils or shale soils (DEC 2005w). All species of Pterostylis are deciduous and die back to fleshy, rounded underground tuberoids. The time of emergence and withering has not been recorded for this species, however flowering occurs from October to December and may vary due to climatic conditions. The above ground parts of the plant whither and die following seed dispersal and the plant persists as a tuberoid until the next year (DEC 2005w).	Moderate. Although there is not a high number of records in the Locality the Subject Site supports a range of preferred habitats for this species including vegetation community, soils and physiographic features.
Rulingia prostrata	E1	E	*Rulingia prostata* occurs on the Southern Tablelands, and on the North Coast, in the Hawkesbury/Nepean, Hunter/Central Rivers, Murrumbidgee and Southern Rivers Catchments. Occurs on sandy, sometimes peaty soils in a wide variety of habitats: *Eucalyptus pauciflora* Woodland at Rose Lagoon; *E. agglomerata* Open Forest at Tallong; and in *E. mannifera* Low Open Woodland at Penrose; *Eucalyptus haemostoma*/*E. robusta* Ecotonal Forest at Tomago (DEC 2005s). Associated native species may include *Imperata cylindrica*, *Empodisma minus* and *Leptospermum continentale*. Appears to respond positively to some forms of disturbance (DEC 2005s)	Low. No habitat is present for the species on the Subject Site.
Thelymitra sp. *Kangaloon*		Z	*Thelymitra* sp. *Kangaloon* is a terrestrial orchid endemic to New South Wales, and is known from three locations near Robertson in the Southern Highlands. The swamp habitat in which the species occurs has an extent of occurrence of 300km^2 and an area of occupancy of 10km^2. The three swamps are Butlers Swamp, Stockyard Swamp and Wildes Meadow Swamp, and are all located above what is known as the Kangaloon aquifer. It flowers in late October and early November. The species grows amongst tall sedges and rushes in seasonally swampy sedgeland on grey silty clay loam at 600-700m above sea level (Threatened Species Listing Advice, 2008 20176 /id).	Nil. Although habitat for the species may occur in the locality the species is highly geographically restricted.

Terrestrial Fauna

Key: *1) Listed on the EPBC Act as Endangered (E), Vulnerable (V) or Nominated for listing (N)*

2) Listed on the TSC Act as Critically Endangered (Z1), Endangered (E1) or Vulnerable (V)

Latin Name	Common Name	EPBC Act	TSC Act	Habitat	Likelihood of occurrence
Amphibians					
Heleioporus australiacus	Giant Burrowing Frog	V	V	Prefers hanging swamps on sandstone shelves adjacent to perennial non-flooding creeks (Daly 1996; Recsei 1996). Can also occur within shale outcrops within sandstone formations. Known from wet and dry forests and montane woodland in the southern part range (Daly 1996). Individuals can be found around sandy creek banks or foraging along ridge-tops during or directly after heavy rain. Males often call from burrows located in sandy banks next to water (Barker *et al.* 1995). Spends the majority of its time in non-breeding habitat 20-250m from breeding sites (Penman *et al.* 2008).	Low. Although the Study Area supports preferred vegetation type the full range of habitat features are absent.
Litoria aurea	Green and Golden Bell Frog	V	E1	Most existing locations for the species occur as small, coastal, or near coastal populations, with records occurring between south of Grafton and northern VIC(NSW Government 2009). The species is found in marshes, dams and stream sides, particularly those containing bullrushes or spikerushes. Preferred habitat contains water bodies that are unshaded, are free of predatory fish, have a grassy area nearby and have diurnal sheltering sites nearby such as vegetation or rocks(NPWS 1999c; White and Pyke 1996), although the species has also been recorded from highly disturbed areas including disused industrial sites, brick pits, landfill areas and cleared land. Breeding usually occurs in summer. Tadpoles, which take approximately 10-12 weeks to develop(DECC 2008), feed on algae and other vegetative matter. Adults eat insects as well as other frogs, including juveniles of their own species(DEC 2005f).	Low. Although the Study Area supports a small waterbody (dam), the full range of habitat features are absent.

Latin Name	Common Name	EPBC Act	TSC Act	Habitat	Likelihood of occurrence
Pseudophryne australis	Red-crowned Toadlet		V	Occurs on wetter ridge tops and upper slopes of sandstone formations on which the predominant vegetation is dry open forests and heaths. This species typically breeds within small ephemeral creeks characterised by a series of shallow pools that feed into larger semi-perennial streams (Thumm and Mahony 1997). Breeds all year round (Thumm and Mahoney 2002).	Low. Although the Study Area supports preferred vegetation type the full range of habitat features are absent.
Birds					
Anthochaera phrygia	Regent Honeyeater	E	C1	A semi-nomadic species occurring in temperate eucalypt woodlands and open forests. Most records are from box-ironbark eucalypt forest associations and wet lowland coastal forests (NPWS 1999d; Pizzey and Knight 1997). Key eucalypt species include Mugga Ironbark, Yellow Box, Blakely's Red Gum, White Box and Swamp Mahogany. Also utilises: *E. microcarpa, E. punctata, E. polyanthemos, E. mollucana, Corymbia robusta, E. crebra, E. caleyi, C.maculata, E.mckieana, E. macrorhyncha, E. laevopinea, and Angophora floribunda.* Nectar and fruit from the mistletoes *A. miquelii, A. pendula, A. cambagei* are also eaten during the breeding season (DEC 2005r).Regent Honeyeaters usually nest in horizontal branches or forks in tall mature eucalypts and sheoaks. Also nest in mistletoe haustoria. An open cup-shaped nest is constructed of bark, grass, twigs and wool by the female (DEC 2005r).	Low. Species specific feed trees are not present.
Apus pacificus	Fork-tailed Swift	M		Almost exclusively aerial (foraging). The Fork-tailed Swift breeds in Asia but migrates to Australia from September to April(Higgins 1999). Individuals or flocks can be observed hawking for insects at varying heights from only a few metres from the ground and up to 300 metres high(Boehm 1944).	Moderate. Species may occasionally fly over the Study Area.

Latin Name	Common Name	EPBC Act	TSC Act	Habitat	Likelihood of occurrence
Ardea alba	Great Egret	M		Terrestrial wetlands, estuarine and littoral habitats and moist grasslands. Inland, prefer permanent waterbodies on floodplains; shallows of deep permanent lakes (either open or vegetated), semi-permanent swamps with tall emergent vegetation and herb dominated seasonal swamps with abundant aquatic flora. Also regularly use saline habitats including mangrove forests, estuarine mudflats, saltmarshes, bare saltpans, shallows of salt lakes, salt fields and offshore reefs. Breeding requires wetlands with fringing trees in which to build nests including mangrove forest, freshwater lakes or swamps and rivers (Marchant and Higgins 1990).	Low. Species may use vegetated farm dams in the Locality on occasion.
Ardea ibis	Cattle Egret	M		Occurs in tropical and temperate grasslands, wooded lands and terrestrial wetlands (Marchant and Higgins 1990).	Low. Species may use vegetated farm dams in the Locality on occasion.
Burhinus grallarius	Bush Stone-curlew		E1	Lightly timbered open forest and woodland, or partly cleared farmland with remnants of woodland, with a ground cover of short sparse grass and few or no shrubs where fallen branches and leaf litter are present (Marchant and Higgins 1993).	Low. Although Subject Site supports habitat Red fox abundance is unmanaged in Study Area. Species highly susceptible to fox predation.

Latin Name	Common Name	EPBC Act	TSC Act	Habitat	Likelihood of occurrence
Callocephalon fimbriatum	Gang-gang Cockatoo		V	In summer, occupies tall montane forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests (Higgins 1999). Also occur in subalpine Snow Gum woodland and occasionally in temperate or regenerating forest (Forshaw and Cooper 1981). In winter, occurs at lower altitudes in drier, more open eucalypt forests and woodlands, particularly in box-ironbark assemblages, or in dry forest in coastal areas (Shields and Crome 1992). It requires tree hollows in which to breed (Gibbons and Lindenmayer 1997).	Moderate. Good quality open woodland. Species may utilise Study Area as a movement corridor to better quality habitat.
Calyptorhynchus lathami	Glossy Black-cockatoo		V	Inhabits forest with low nutrients, characteristically with key Allocasuarina species. Tends to prefer drier forest types (NPWS 1999b). Often confined to remnant patches in hills and gullies. Breed in hollows stumps or limbs, either living or dead (Higgins 1999).	High. Species may use Study Area as a movement corridor. Some foraging habitat present within woodland habitat.
Chthonicola sagittata	Speckled Warbler		V	This species occurs in eucalypt and cypress woodlands on the hills and tablelands of the Great Dividing Range. They prefer woodlands with a grassy understorey, often on ridges or gullies (Blakers *et al.* 1984; NSW Scientific Committee 2008a). The species is sedentary, living in pairs or trios and nests on the ground in grass tussocks, dense litter and fallen branches. They forage on the ground and in the understorey for arthropods and seeds (Blakers *et al.* 1984; NSW Scientific Committee 2008a). Home ranges vary from 6-12 hectares(NSW Scientific Committee 2008a).	Moderate to good quality woodland with gullies and well developed groundcovers and leaf litter suitable for foraging

Latin Name	Common Name	EPBC Act	TSC Act	Habitat	Likelihood of occurrence
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)		V	Lives in eucalypt woodlands, especially areas of relatively flat open woodland typically lacking a dense shrub layer, with short grass or bare ground and with fallen logs or dead trees present (Traill and Duncan 2000).	Moderate. Moderate to good quality woodland with rough barked trees suitable for foraging.
Daphoenositta chrysoptera	Varied Sittella		V	The Varied Sittella is a sedentary species which inhabits a wide variety of dry eucalypt forests and woodlands, usually with either shrubby understorey or grassy ground cover or both, in all climatic zones of Australia. Usually inhabit areas with rough-barked trees, such as stringybarks or ironbarks, but also in mallee and acacia woodlands, paperbarks or mature Eucalypts (Higgins and Peter 2002; NSW Scientific Committee 2010). The Varied Sittella feeds on arthropods gleaned from bark, small branches and twigs. It builds a cup-shaped nest of plant fibres and cobweb in an upright tree fork high in the living tree canopy, and often re-uses the same fork or tree in successive years (NSW Scientific Committee 2010).	Moderate. Moderate to good quality woodland with rough barked trees suitable for foraging.
Gallinago hardwickii	Latham's Snipe	M		Typically found on wet soft ground or shallow water with good cover of tussocks. Often found in wet paddocks, seepage areas below dams (Pizzey and Knight 1997).	Low.
Glossopsitta pusilla	Little Lorikeet		V	Distributed in forests and woodlands from the coast to the western slopes of the Great Dividing Range in NSW, extending westwards to the vicinity of Albury, Parkes, Dubbo and Narrabri. mostly occur in dry, open eucalypt forests and woodlands. They feed primarily on nectar and pollen in the tree canopy. Nest hollows are located at heights of between 2 m and 15 m, mostly in living, smooth-barked eucalypts. Most breeding records come from the western slopes (NSW Scientific Committee 2008b).	Moderate. Species may utilise parts of the Study Area as a movement corridor to more preferable and quality habitats.

Latin Name	Common Name	EPBC Act	TSC Act	Habitat	Likelihood of occurrence
Haliaeetus leucogaster	White-bellied Sea-eagle	M		A migratory species that is generally sedentary in Australia, although immature individuals and some adults are dispersive (Marchant and Higgins 1993). Found in terrestrial and coastal wetlands; favouring deep freshwater swamps, lakes and reservoirs; shallow coastal lagoons and saltmarshes. It hunts over open terrestrial habitats. Feeds on birds, reptiles, fish, mammals, crustaceans and carrion. Roosts and makes nest in trees (Marchant and Higgins 1993).	Moderate. Flyover potential.
Hieraaetus morphnoides	Little Eagle		V	The Little Eagle is most abundant in lightly timbered areas with open areas nearby providing an abundance of prey species (NSW Scientific Committee 2009a). It has often been recorded foraging in grasslands, crops, treeless dune fields, and recently logged areas. The Little Eagle nests in tall living trees within farmland, woodland and forests (Marchant and Higgins 1993).	Moderate. Subject Site supports remnant paddock trees and good quality open woodland.
Hirundapus caudacutus	White-throated Needletail	M		An aerial species found in feeding concentrations over cities, hilltops and timbered ranges. Breed in Asia (Pizzey and Knight 1997).	Moderate. Species may occasionally fly over the Study Area.
Lathamus discolor	Swift Parrot	E	E1	The Swift Parrot occurs in woodlands and forests of NSW from May to August, where it feeds on eucalypt nectar, pollen and associated insects (Forshaw and Cooper 1981). The Swift Parrot is dependent on flowering resources across a wide range of habitats in its wintering grounds in NSW (Shields and Crome 1992). Favoured feed trees include winter flowering species such as Swamp Mahogany *Eucalyptus robusta*, Spotted Gum *Corymbia maculata*, Red Bloodwood *C. gummifera*, Mugga Ironbark *E. sideroxylon*, and White Box *E. albens*. Commonly used lerp infested trees include Grey Box *E. microcarpa*, Grey Box *E. moluccana* and Blackbutt *E. pilularis* (DEC 2005t). This species is migratory, breeding in Tasmania and also nomadic, moving about in response to changing food availability (Pizzey and Knight 1997).	Low. Species specific feeds trees are not present.

Latin Name	Common Name	EPBC Act	TSC Act	Habitat	Likelihood of occurrence
Melanodryas cucullata cucullata	Hooded Robin (south-eastern form)		V	This species lives in a wide range of temperate woodland habitats, and a range of woodlands and shrublands in semi-arid areas (Traill and Duncan 2000).	Moderate.
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)		V	Found mostly in open forests and woodlands dominated by box and ironbark eucalypts (Higgins *et al.* 2001). It is rarely recorded east of the Great Dividing Range (Higgins *et al.* 2001).	Moderate.
Merops ornatus	Rainbow Bee-eater	M		Usually occurs in open or lightly timbered areas, often near water. Nest in embankments, including banks of creeks and rivers, in sand dunes, in quarries and in roadside cuttings. Breeding occurs from November to January. It has complex migratory movements in Australia. NSW populations migrate north for winter (Higgins 1999).	Moderate.
Monarcha melanopsis	Black-faced Monarch	M		A migratory species found during the breeding season in damp gullies in temperate rainforests. Disperses after breeding into more open woodland (Pizzey and Knight 1997).	Moderate. Dispersal habitat present in more open woodland.
Myiagra cyanoleuca	Satin Flycatcher	M		Migratory species that occurs in coastal forests, woodlands and scrubs during migration. Breeds in heavily vegetated gullies (Pizzey and Knight 1997).	Moderate.
Neophema pulchella	Turquoise Parrot		V	Occurs in open woodlands and eucalypt forests with a ground cover of grasses and understorey of low shrubs (Morris 1980). Generally found in the foothills of the Great Divide, including steep rocky ridges and gullies (Higgins 1999). Nest in hollow-bearing trees, either dead or alive; also in hollows in tree stumps. Prefer to breed in open grassy forests and woodlands, and gullies that are moist (Higgins 1999).	Moderate. Species may utilise parts of the Study Area as a movement corridor to more preferable and quality habitats.

Latin Name	Common Name	EPBC Act	TSC Act	Habitat	Likelihood of occurrence
Ninox connivens	Barking Owl		V	Generally found in open forests, woodlands, swamp woodlands and dense scrub. Can also be found in the foothills and timber along watercourses in otherwise open country (Pizzey and Knight 1997). Territories range from 30 to 200 ha (DEC 2005b).	Moderate. Some marginal foraging and breeding habitat present in the Study Area. Species may utilise parts of the Study Area as a movement corridor to more preferable habitats.
Ninox strenua	Powerful Owl		V	The Powerful Owl occupies wet and dry eucalypt forests and rainforests. It may inhabit both un-logged and lightly logged forests as well as undisturbed forests where it usually roosts on the limbs of dense trees in gully areas (Debus and Chafer 1994b; Debus and Chafer 1994a). Large mature trees with hollows at least 0.5 m deep are required for nesting (Garnett 1992). Tree hollows are particularly important for the Powerful Owl because a large proportion of the diet is made up of hollow-dependent arboreal marsupials (Gibbons and Lindenmayer 1997). Nest trees for this species are usually emergent with a diameter at breast height of at least 100 cm (Gibbons and Lindenmayer 1997). It has a large home range of between 450 and 1450 ha (DEC 2005q).	Moderate. Some marginal foraging and breeding habitat present in the Study Area. Species may utilise parts of the Study Area as a movement corridor to more preferable habitats.

Latin Name	Common Name	EPBC Act	TSC Act	Habitat	Likelihood of occurrence
Petroica boodang	Scarlet Robin		V	During the breeding season the Scarlet Robin is found in eucalypt forests and temperate woodlands, often on ridges and slopes. During autumn and winter it moves to more open and cleared areas. It has dispersive or locally migratory seasonal movements. The Scarlet Robin forages amongst logs and woody debris for insects which make up the majority of its diet (NSW Scientific Committee 2009b). The nest is an open cup of plant fibres and cobwebs, sited in the fork of a tree (often a dead branch in a live tree, or in a dead tree or shrub) which is usually more than 2 m above the ground (NSW Scientific Committee 2009b). It is conspicuous in open and suburban habitats (Morcombe 2003).	Moderate. Species may utilise parts of the Study Area on occasion.
Rhipidura rufifrons	Rufous Fantail	M		Migratory species that prefers dense, moist undergrowth of tropical rainforests and scrubs. During migration it can stray into gardens and more open areas (Pizzey and Knight 1997).	Moderate.
Rostratula australis	Australian Painted Snipe	VM	E1	Usually found in shallow inland wetlands including farm dams, lakes, rice crops, swamps and waterlogged grassland. They prefer freshwater wetlands, ephemeral or permanent, although they have been recorded in brackish waters (Marchant and Higgins 1993).	Low. Farm dams in Study Area are not considered optimal habitat for this species.
Stagonopleura guttata	Diamond Firetail		V	Found in a range of habitat types including open eucalypt forest, mallee and acacia scrubs (Pizzey and Knight 1997). Often occur in vegetation along watercourses (Higgins *et al.* 2006).	Moderate. Good quality open woodland adjacent to areas containing native ground covers and riparian zones.

Latin Name	Common Name	EPBC Act	TSC Act	Habitat	Likelihood of occurrence
Tyto tenebricosa	Sooty Owl		V	The Sooty Owl is often found in tall old-growth forests, including temperate and subtropical rainforests. In NSW it is mostly found on escarpments with a mean altitude <500 m. The Sooty Owl nests and roosts in hollows of tall emergent trees, mainly eucalypts (Higgins 1999) often located in gullies(Gibbons and Lindenmayer 1997). Nests have been located in trees 125 to 161 cm in diameter(Gibbons and Lindenmayer 1997).	Moderate. Some marginal foraging and breeding habitat present in the Study Area. Species may utilise parts of the Study Area as a movement corridor to more preferable habitats.
Invertebrates					
Meridolum corneovirens	Cumberland Plain Land Snail		E1	Most likely restricted to Cumberland Plain, Castlereagh Woodlands and boundaries between River-flat Forest and Cumberland Plain Woodland. It is normally found beneath logs, debris and amongst accumulated leaf and bark particularly at the base of trees. May also use soil cracks for refuge (NPWS 1999a).	Moderate. Key fauna habitat elements required by this species are highly disturbed in the Study Area.
Mammals					

Latin Name	Common Name	EPBC Act	TSC Act	Habitat	Likelihood of occurrence
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	Occurs from the Queensland border to Ulladulla, with largest numbers from the sandstone escarpment country in the Sydney Basin and Hunter Valley (van dyck and Strahan 2008). Primarily found in dry sclerophyll forests and woodlands, but also found in rainforest fringes and subalpine woodlands (Churchill 2008; Hoye and Schulz 2008). Forages on small, flying insects below the forest canopy. Roosts in colonies of between three and 80 in caves, Fairy Martin nests and mines, and beneath rock overhangs, but usually less than 10 individuals. Likely that it hibernates during the cooler months (Churchill 2008). The only known existing maternity roost is in a sandstone cave near Coonabarabran (Pennay 2008).	Moderate. Foraging and roosting habitat present in the Study Area.
Dasyurus maculatus maculatus	Spotted-tailed Quoll (south-eastern mainland)	E	V	Occurs along the east coast of Australia and the Great Dividing Range (Belcher *et al.* 2008). Uses a range of habitats including sclerophyll forests and woodlands, coastal heathlands and rainforests (Dickman and Read 1992). Occasional sightings have been made in open country, grazing lands, rocky outcrops and other treeless areas (NPWS 1999k). Habitat requirements include suitable den sites, including hollow logs, rock crevices and caves, an abundance of food and an area of intact vegetation in which to forage (Edgar and Belcher 1995). 70% of the diet is medium-sized mammals, and also feeds on invertebrates, reptiles and birds. Individuals require large areas of relatively intact vegetation through which to forage (NPWS 1999e). The home range of a female is between 180 – 1000 ha, while males have larger home ranges of between 2000 – 5000 ha. Breeding occurs from May to August (Belcher *et al.* 2008).	Moderate. Some marginal foraging and breeding habitat present in the Study Area.

Latin Name	Common Name	EPBC Act	TSC Act	Habitat	Likelihood of occurrence
Falsistrellus tasmaniensis	Eastern False Pipistrelle		V	Distribution extending east of the Great Dividing Range throughout the coastal regions of NSW, from the Queensland border to the Victorian border. Prefers wet high-altitude sclerophyll and coastal mallee habitat, preferring wet forests with a dense understorey but being found in open forests at lower altitudes (Churchill 2008). Apparently hibernates in winter. Roosts in tree hollows and sometimes in buildings in colonies of between 3 and 80 individuals. Often change roosts every night. Forages for beetles, bugs and moths below or near the canopy in forests with an open structure, or along trails (Law *et al.* 2008). Has a large foraging range, up to 136 ha (Churchill 2008; Law *et al.* 2008). Records show movements of up to 12 km between roosting and foraging sites (Menkhorst and Lumsden 1995).	Moderate. Foraging and roosting habitat present in the Study Area.
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat		V	Occurs from Victoria to Queensland, on both sides of the Great Dividing Range. Forms large maternity roosts (up to 100,000 individuals) in caves and mines in spring and summer. Individuals may fly several hundred kilometres to their wintering sites, where they roost in caves, culverts, buildings, and bridges. They occur in a broad range of habitats including rainforest, wet and dry sclerophyll forest, paperbark forest and open grasslands. Has a fast, direct flight and forages for flying insects (particularly moths) above the tree canopy and along waterways (Churchill 2008; Hoye and Hall 2008).	Moderate. Foraging and roosting habitat present in the Study Area.
Mormopterus norfolkensis	Eastern Freetail Bat		V	Distribution extends east of the Great Dividing Range from southern Queensland to south of Sydney (Churchill 1998). Most records are from dry eucalypt forests and woodland. Individuals tend to forage in natural and artificial openings in forests, although it has also been caught foraging low over a rocky river within rainforest and wet sclerophyll forest habitats. The species generally roosts in hollow spouts of large mature eucalypts (including paddock trees), although individuals have been recorded roosting in the roof of a hut, in wall cavities, and under metal caps of telegraph poles. Foraging generally occurs within a few kilometres of roosting sites (Churchill 2008; Hoye *et al.* 2008).	Moderate.

Latin Name	Common Name	EPBC Act	TSC Act	Habitat	Likelihood of occurrence
Myotis macropus	Large-footed Myotis		V	Scattered, mainly coastal distribution extending to South Australia along the Murray River. Roosts in caves, mines or tunnels, under bridges, in buildings, tree hollows, and even in dense foliage. Colonies occur close to water bodies, ranging from rainforest streams to large lakes and reservoirs. They catch aquatic insects and small fish with their large hind claws, and also catch flying insects ((Richards *et al.* 2008)).	Moderate. Foraging and roosting habitat present in the Study Area.
Petaurus australis	Yellow-bellied Glider		V	Restricted to tall native forests in regions of high rainfall along the coast of NSW. Preferred habitats are productive, tall open sclerophyll forests where mature trees provide shelter and nesting hollows. Critical elements of habitat include sap-site trees, winter flowering eucalypts, mature trees suitable for den sites and a mosaic of different forest types (NPWS 1999f). Live in family groups of 2-6 individuals which commonly share a number of tree hollows. Family groups are territorial with exclusive home ranges of 30-60 ha. Very large expanses of forest (>15,000 ha) are required to conserve viable populations (Goldingay 2008)	Low.
Petrogale penicillata	Brush-tailed Rock-wallaby	V	E1	Occurs along the Great Dividing Range south to the Shoalhaven, and also occurs in the Warrumbungles and Mt Kaputar. Habitats range from rainforest to open woodland. It is found in areas with numerous ledges, caves and crevices, particularly where these have a northerly aspect. Individuals defend a specific rock shelter, emerging in the evening to forage on grasses and forbs, as well as browse in drier months. Home sizes range from 2-30 ha(Eldridge and Close 1995).	Moderate. Sheltering habitat available in rocky outcrops along Nepean River.

Latin Name	Common Name	EPBC Act	TSC Act	Habitat	Likelihood of occurrence
Phascolarctos cinereus	Koala	N	V	In NSW the Koala mainly occurs on the central and north coasts with some populations in the western region (DEC 2005i). Koalas feed almost exclusively on eucalypt foliage, and their preferences vary regionally (Martin *et al.* 2008). Primary feed trees include *Eucalyptus robusta*, *E. tereticornis*, *E. punctata*, *E. haemostoma* and *E. signata* (DoP 1995). They are solitary with varying home ranges. In high quality habitat home ranges may be 1-2 ha and overlap, while in semi-arid country they are usually discrete and around 100 ha (Martin *et al.* 2008).	Moderate. Primary feed trees are present within the Study Area. Nearby records of this species occur. Species may use habitat within Study Area as a movement corridor (known as Cumberland Koala Linkage).
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	Occurs along the NSW coast, extending further inland in the north. This species is a canopy-feeding frugivore and nectarivore of rainforests, open forests, woodlands, melaleuca swamps and banksia woodlands. Roosts in large colonies (camps), commonly in dense riparian vegetation. Bats commute daily to foraging areas, usually within 15 km of the day roost (Tidemann 1995) although some individuals may travel up to 70 km (Augee and Ford 1999).	Moderate.
Scoteanax rueppellii	Greater Broad-nosed Bat		V	Occurs along the Great Dividing Range, generally at 500 m but up to 1200 m, and in coastal areas. Occurs in woodland and rainforest, but prefers open habitats or natural or human-made openings in wetter forests. Often hunts along creeks or river corridors. Flies slowly and directly at a height of 30 m or so to catch beetles and other large, flying insects. Also known to eat other bats and spiders. Roosts in hollow tree trunks and branches(Churchill 2008; Richards *et al.* 2008).	Moderate. Foraging and roosting habitat present in the Study Area.
Reptiles					

Latin Name	Common Name	EPBC Act	TSC Act	Habitat	Likelihood of occurrence
Hoplocephalus bungaroides	Broad-headed Snake	V	E1	Mainly occurs in association with communities occurring on Triassic sandstone within the Sydney Basin. Typically found among exposed sandstone outcrops with vegetation types ranging from woodland to heath. Within these habitats they generally use rock crevices and exfoliating rock during the cooler months and tree hollows during summer (Webb 1996; Webb and Shine 1998).	Moderate to High, particularly along sandstone outcrops along Nepean River.

Aquatic Fauna

Key: *1) Listed on the EPBC Act as Endangered (E) or Vulnerable (V)*

2) Listed on the FM Act as Endangered (E) or Vulnerable (V)

Latin Name	Common Name	FM Act	EPBC Act	Habitat	Likelihood of occurrence
Bidyanus bidyanus	Silver Perch		V	Inhabits a variety of streams, rivers and lakes, seeming to prefer fast-flowing open waters (NSW DPI 2005a) but also found in turbid slow-flowing rivers (Lintermans 2002). Migrate upstream in spring and summer to spawn. Juveniles may move upstream in response to rising water temperatures and levels Allen et al 2002). Originally widespread throughout the Murray Darling drainage system is now restricted to one self sustaining population in the Murray Darling Basin downstream of Yarrawonga Weir.	Low. The Study Area supports a range of habitats for this species. Furthermore, there is a record of a translocated population within Cataract Dam. However, due to barriers to fish movement (weirs) this species has been restricted to downstream of the Yarrawonga Weir.
Maccullochella macquariensis	Trout Cod	E	E	Associated with cover such as Large Woody Debris (LWD), rock outcrops, boulders and deep holes (Growns et al 2004). Occupy snags in the Murrumbidgee River that are deep and close to riverbanks. Juveniles may utilise riffle complexes (DEWHA 2008a)	Low. The Study Area supports a range of habitats for this species. Furthermore, there is a record of a translocated population within Cataract Dam. However, due to barriers to fish movement (weirs) this species has been restricted the Murrumbidgee River.
Maccullochella peelii	Murray Cod	V		Associated with deep holes in rivers and prefer habitats with instream cover such as rocks, stumps, fallen trees or undercut banks (Lintermans 2002). Found in a wide range of warm water habitats including rocky streams and slow flowing rivers, in water up to 5 m deep. Migrate upstream to spawn in late spring and early summer when water temperatures reach between 16 to 21 degrees (DEHWA 2008b).	Moderate. The Study Area supports a range of habitats for this species. There is a record within the Locality with the nearest record occurring within the Cataract River to the east in 2007. However, due to barriers to fish movement (weirs) the likelihood of occurrence within the Subject Site is moderate.

Latin Name	Common Name	FM Act	EPBC Act	Habitat	Likelihood of occurrence
Macquaria australasica	Macquarie Perch	V	E	Prefer deep rocky holes with considerable cover (DEWHA 2008). Typically found in the cooler upper reaches of the Murrumbidgee catchment. Spawning occurs in October/November with upstream migration when water temperatures reach 16.5º. Spawn at the foot of pools and eggs drift downstream and lodge amongst gravel and cobble in riffles (Lintermans 2002)	Moderate. The Study Area supports a range of habitats for this species. There is a record within the Locality with the nearest record occurring within the Nepean River to the southeast in 2007. However, due to barriers to fish movement (weirs) the likelihood of occurrence within the Subject Site is moderate.

APPENDIX 4

Water Quality and HABSCORE Results

	pH	Turbidity NTU	Temp ºC	Conductivity µS/cm	TDS ppm	D.O. ppm	Saturation %
ANZECC Guidelines	**6.8 - 8**	**7 - 50**	**-**	**125 - 2200**	**-**	**> 6**	**-**
Site 1	7.42	47.7	23.9	542	300	4.7	54.4
Site 2 Dam	7.3	11.9	23.2	2073	1210	1.93	21.8
Site 2 D/S Site	7.23	8.3	26.6	87.4	44.1	1.48	15.8
Site 3	8.29	0.6	27.6	920	517	6.83	87
Site 4	8.23	0.1	23.5	970	530	8.5	94.7
Site 5	8.3	0.1	26.1	689	382	7.53	94.4
Site 6 U/S Site	7.35	5.8	24.5	4560	2780	3.24	36.4
Site 6 Dam	7.24	0.1	28.4	255	135	2.58	33.1
Site 7	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Site 8	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Site 9	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Site 10	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Site 11	8.02	2.1	23.1	130.7	68.1	5.6	66.2
Site 12	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Site 13	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Site 14	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Site 15	7.19	3.5	20.3	793	465	6.23	81.3

	8/12/2010 Site 1	8/12/2010 Site 2	8/12/2010 Site 3	8/12/2010 Site 4	8/12/2010 Site 5	8/12/2010 Site 6	8/12/2010 Site 7	8/12/2010 Site 8
High Gradient								
Riffle Quality	7	7	12	16	11	4	2	N/A
Embeddedness	16	14	18	17	9	4	2	N/A
Velocity-depth regime	11	11	16	17	15	2	0	N/A
Low Gradient								
Pool substrate characterisation	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Pool variability	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
High and Low Gradient								
Channel Flow Status	10	10	15	13	14	3	0	N/A
Bank vegetation - LB	6	9	9	9	8	1	1	N/A
Bank vegetation - RB	6	9	9	9	8	1	1	N/A
Bank Stability - LB	7	8	10	9	9	2	1	N/A
Bank Stability - RB	7	8	10	9	9	2	1	N/A
Width of riparian zone - LB	5	9	10	10	8	1	1	N/A
Width of riparian zone - RB	5	9	10	10	8	1	1	N/A
Epifaunal substrate / available cover	9	11	19	19	12	2	0	N/A
0-25 = Poor	56	66	86	86	69	14	6	N/A
26 - 50 = Marginal	S	S	O	O	S	P	P	N/A
51 - 75 = Suboptimal								
76 - 100 = Optimal								
Not Applicable = N/A								
Stream Order	1	1	4	4	3	4	4	3
DIPNR Stream Classification	2	2	1	1	2	2	3	3

	8/12/2010 Site 9	8/12/2010 Site 10	8/12/2010 Site 11	8/12/2010 Site 12	8/12/2010 Site 13	8/12/2010 Site 14	8/12/2010 Site 15
High Gradient							
Riffle Quality	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Embeddedness	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Velocity-depth regime	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Low Gradient							
Pool substrate characterisation	1	1	17	1	1	0	13
Pool variability	1	1	17	1	1	0	13
High and Low Gradient							
Channel Flow Status	0	0	20	0	0	0	18
Bank vegetation - LB	1	1	10	1	1	0	8
Bank vegetation - RB	1	1	10	1	1	0	8
Bank Stability - LB	1	1	10	1	1	0	9
Bank Stability - RB	1	1	10	1	1	0	9
Width of riparian zone - LB	1	1	10	1	1	0	2
Width of riparian zone - RB	1	1	10	1	1	0	2
Epifaunal substrate / available cover	0	0	18	0	0	0	15
0-25 = Poor	6	6	94	6	6	0	69
26 - 50 = Marginal	P	P	O	P	P	P	S
51 - 75 = Suboptimal							
76 - 100 = Optimal							
Not Applicable = N/A							
Stream Order	2	1	7	1	1	2	3
DIPNR Stream Classification	3	3	1	3	3	3	2

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