ACS Environmental Pty Ltd

BIODIVERSITY STUDY FOR A PLANNING PROPOSAL IN WOLLONDILLY SHIRE

Prepared for:

THE PICTON TAHMOOR THIRLMERE ACTION GROUP (PTTAG)

JULY 2012
(including amendments FEBRUARY 2014)

ACS Environmental Pty Ltd

Flora and Fauna Surveys & Ecological and Biodiversity Impact Assessment Services
Australian Business Number (ABN) 24 154 491 120
3/28 Tullimbar Rd, Cronulla NSW. 2230
7 Townsend Avenue, Frenchs Forest NSW. 2086

Tel: 9527 5262, 9453 9397; Mob: 0403 081902, 0412 217896. Fax: 9527 7454

Email: acs@actinotus.com
Web: www@actinotus.com

Actinotus Environmental Consultants

Peter Stricker BSc. (Hons) (Syd) [α]

Anthony Smith-White BSc. (Syd), CertHEd., MSc., PhD. (UNSW) [α # @ +]

Margaret Smith-White BSc. (Macquarie), PhD. (UNSW) [+ * α]

α Member Ecological Consultants Association NSW Inc
\# Member of Flora Foundation of Australia.
@ Member of Linnean Society of NSW.
\+ Member of Bird Atlassers Association of NSW
* Member Birds Australia

Consultants experience

The principals of 'ACS Environmental P/L' have collectively worked in the area of biodiversity impact and bushfire hazard assessment services for a period of greater than 20 years. They also have over 30 years of experience in scientific research (ecological, genetic) and teaching in biological science.

The principals of 'ACS Environmental P/L' have completed the NSW Consulting Planners Bushfire Training Course organised by the Planning Institute of Australia NSW Division for planning consultants and allied professionals relating to the implementation of 'Planning for Bushfire Protection', in June 2003.

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(Canberra SEWPAC) assessed as having habitat within the PTTAG Study Area.

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EXECUTIVE SUMMARY

ACS Environmental P/L was commissioned to survey an area of about 232ha in the Thirlmere, Tahmoor and Picton localities of Wollondilly Shire. A Planning Proposal has been lodged by the Client's representative, Rein Warry & Co Pty Ltd (Principal Darryl Warry), on behalf of the Picton Tahmoor Thirlmere Action Group (PTTAG) in relation to a rezoning of the Study Area. The Planning Proposal has been lodged with Wollondilly Council and the Department of Planning and Infrastructure (DOP & I).

Subsequent to Council's approval, the entire upgraded Planning Proposal will be submitted to the DOP & I for comments and/or approval.

Four relatively distinct vegetation communities could be recognized over the broad Study Area. Floristically discrete ecological communities occurring over the landscape include three Endangered Ecological Communities that are described in DECCW (2009) as follows:

- Cumberland Shale Hills Woodland (CEEC),
- Cumberland Shale-Sandstone Ironbark Forest (varying degree of shale: sandstone influence) (EEC),
- Sydney Hinterland Grey Gum Ridgetop Forest, and
- Degraded mixed Riparian Forest at Myrtle Creek where natural vegetation has been extensively cleared and degraded but some canopy trees remain.

The natural vegetation of the Study Area has mostly been partially cleared, disturbed, grazed or otherwise degraded, though some patches of relatively weed-free, full-structured vegetation remain. These occur mostly along the edges of Redbank Creek, at the eastern end of Tickle Drive, Thirlmere, and to the south below Glennane Place, Tahmoor.

Many areas of bushland have been modified for grazing with mid-storey and understorey strata removed though with a significant tree canopy retained. Many of these modified woodland areas also retain a ground stratum that is rich with indigenous species of grasses, twiners and herbs.

Large sections of the Study Area have been cleared of most of the upper canopies with only a scattering of trees remaining, but still retaining a relatively high number of indigenous species in a grassy ground layer. Other areas have been extensively landscaped with some scattered indigenous trees remaining and lawn grass established in a managed curtilage.

The extant vegetation of the Study Area incorporating distributions of these three endangered ecological communities was further classified into three discrete conservation classes: high, moderate and low, depending on the extent of local retention of natural vegetation, the degree of historical clearing and disturbance, and the resultant structural and floristic attributes of the remnant vegetation. Three corresponding rankings of recovery and ecological potential, largely reflecting the patterns of conservation significance, were also identified for the vegetation.

OEH Atlas of NSW Wildlife records for an area of 5km radius around the Study Area indicate that seven (7) flora species and twenty five (25) fauna species of conservation significance have been recorded since 1987. According to guidelines listed by the EPBC 'Protected Matters Search Tool' (March 2012), it was deemed that habitat may potentially occur for a further 11 threatened flora species.

Habitat is suitable in the Study Area for three threatened plant species. These include Bargo Geebung (*Persoonia bargoensis*), Mittagong Geebung (*Persoonia glaucescens*) and Brown Pomaderris (*Pomaderris brunnea*). All of these species have typically large-life forms and targeted searches were made in suitable habitats for any individuals of these species (Cropper 2003, DEC 2004), as well as for the 15 other plant species of conservation significance, either recorded in the vicinity or where suitable habitat may occur, but none were located. As such, it is considered that none of these species are likely to occur within the Study Area.

For one species of flora of regional significance, Small Parrot-pea (*Dillwynia parvifolia*), individuals were observed in an area of open woodland at the far south-western section of the Study Area in a patch of Sydney Hinterland Grey Gum Ridgetop Forest.

Two threatened fauna species, the Varied Sittella and Little Lorikeet, were recorded during the current survey. Other threatened fauna species identified as having potential to occur on the site included the Koala, Swift Parrot, Regent Honeyeater, Hooded Robin, Scarlet Robin, Diamond Fire-tail, Gang-gang Cockatoo, Brown Tree-creeper and Eastern Bentwing Bat. Whilst no individuals of these species were recorded, an assessment of habitats concluded that potential exists for each to forage within the area.

Two introduced invasive pest species were recorded within the survey area. These were the Rabbit (*Oryctolagus cuniculus*) as indicated by the presence of warrens and digging activity in most of the pasture areas, and the European Red Fox, recorded by scat evidence in several locations near areas containing rabbit warrens

Notwithstanding the diverse array of avifauna present throughout the survey area, a low diversity of small ground dwelling mammalian fauna was recorded. Factors influencing this low diversity possibly include predation by the European Fox.

The highest fauna diversity was recorded within the riparian buffer zone of Redbank Creek. As such Redbank Creek and its associated vegetation is an important area for faunal biodiversity.

Myrtle Creek is surrounded by urban development and has been impacted upon by weed incursions from the close proximity to this development. Fauna biodiversity in the vicinity of the creek was poor.

In relation to potential biobanking assessment and application, there is potential for biobanking schemes to be utilized and undertaken in relation to large areas of the study site and also potential for offsets that would occur off site within the Hawkesbury – Nepean CMA. It is considered, however, that patches of vegetation assessed as belonging to a threatened ecological community, having moderate or high conservation value and

moderate to high recovery and ecological potential, may present greater constraints in relation to potential development.

Conclusions

A Planning Proposal has been lodged by the Client's representative, Rein Warry & Co Pty Ltd (Principal Darryl Warry), on behalf of the Picton Tahmoor Thirlmere Action Group (PTTAG) in relation to a rezoning of the Study Area. The Planning Proposal has been lodged with Wollondilly Council and the Department of Planning and Infrastructure (DOP & I).

The Study Area includes areas in the townships of Thirlmere and Tahmoor.

The natural vegetation of the Study Area has mostly been partially cleared, disturbed, grazed or otherwise degraded, though some patches of relatively weed-free, full-structured vegetation remain. These occur mostly along the edges of Redbank Creek, at the eastern end of Tickle Drive, Thirlmere, and to the south below Glennane Place, Tahmoor. The pattern of remnant vegetation represents a mosaic of relatively natural and modified vegetation structure and floristics across the landscape, including areas of variably modified Endangered Ecological Communities. The pattern of assessed ecological communities and their conservation significance assessment broadly reflects assessments of the same by DEC (2002).

The vegetation has been mapped according to separate assessments of conservation significance value, recovery and ecological potential and biodiversity potential. No threatened flora species were recorded and two species of threatened avifauna were observed.

On the basis of the various assessments of significance of flora, fauna (including aquatic fauna) and ecological communities, and on the basis of the current zoning for the Study Area, it was concluded that re-zoning of the Study Area is feasible.

A minimum allotment size of, for example 4000m^2, would be an appropriate strategic mechanism as it allows a greater density of allotments within areas of 'low biodiversity value' whilst simultaneously allowing larger combined allotment sizes within areas assessed as having 'high biodiversity values'. In relation to the biodiversity and ecological values of the Study Area, this strategy is of considerable importance in cases where areas of 'high biodiversity' occur within different land ownerships (Warry *pers comm.*). It would be a strategic priority to maintain an area of 'high biodiversity land' within each currently existing allotment in one new combination of lots rather than the allotment being fragmented into many multiple ownerships (Warry *pers comm.*).

An indicative lot number (assuming area of 4000m^2) of new allotments of around **250 - 300 lots** is based on consideration of areas of **low biodiversity** and **low conservation significance value** and in recognition of site constraints such as corresponding areas of remnant moderate and high conservation/biodiversity values in the Study Area as indicated in Figures 5, 19 & 20, as well as other site restrictions such as road networks etc.

GLOSSARY

CCPD – Crown Canopy Projective Density (DEC 2002)

CEEC – Critically Endangered Ecological Community

CMA – Catchment Management Authority

CSHW – Cumberland Shale Hills Woodland (DECCW 2009)

CSSIF – Cumberland Shale-Sandstone Ironbark Forest (DECCW 2009)

DEC – State Department of Environment and Conservation

DECCW – State Department of Environment, Climate Change and Water

DOP & I - Department of Planning and Infrastructure

EEC – Endangered Ecological Community

EPA Act – Environment Protection Act

EPBC Act – Environment Protection and Biodiversity Conservation Act

ESD – Ecologically Sustainable Development

LPI – NSW Land and Property Information

NPWS – State National Parks and Wildlife Service

OEH – Office of the Environment and Heritage

PCL – Priority Conservation Lands

PTTAG – Picton Tahmoor Thirlmere Acion Group

RoTAP – Rare and Threatened Australian Plants

SEWPaC – Commonwealth Department of Sustainability, Environment, Water, Populations and Communities

SHGGRF – Sydney Hinterland Grey Gum Ridgetop Forest (OEH 2013)

SMCMA – Sydney Metropolitan Catchment Management Authority

TSC Act – Threatened Species Conservation Act

1.0 Introduction

1.1 Background

A Planning Proposal has been lodged by the Client's representative, Rein Warry & Co Pty Ltd (Principal Darryl Warry), on behalf of the Picton Tahmoor Thirlmere Action Group (PTTAG) in relation to a rezoning of an area of land located in the Wollondilly Shire Council (hereafter described as the Study Area). The Planning Proposal has been lodged with the Wollondilly Council and the Department of Planning and Infrastructure (DOP & I). The DOP & I's 'Gateway Determination' requires that the Planning Proposal be upgraded by a total of 13 Specialist Studies.

The planning process requires that both the Council and the DOP & I give approvals for the Planning Proposal once the Planning Proposal has been upgraded by the Clients' representative (Rein Warry & Co P/L) on the basis of the results of the various Specialist Studies.

The 'Specialist Biodiversity Study Assessment Report' will be used by the client to upgrade the current Planning Proposal.

Subsequent to Council's approval, the entire upgraded Planning Proposal will be submitted to the DOP & I for comments and/or approval.

The extent of the Study Area encompasses areas in the townships of Thirlmere and Tahmoor and is generally bound by Redbank Creek to the north, Myrtle Creek to the south, and a small frontage to the Main Southern Rail Line to the east. The boundaries of the Study Area are depicted in Figure 1.

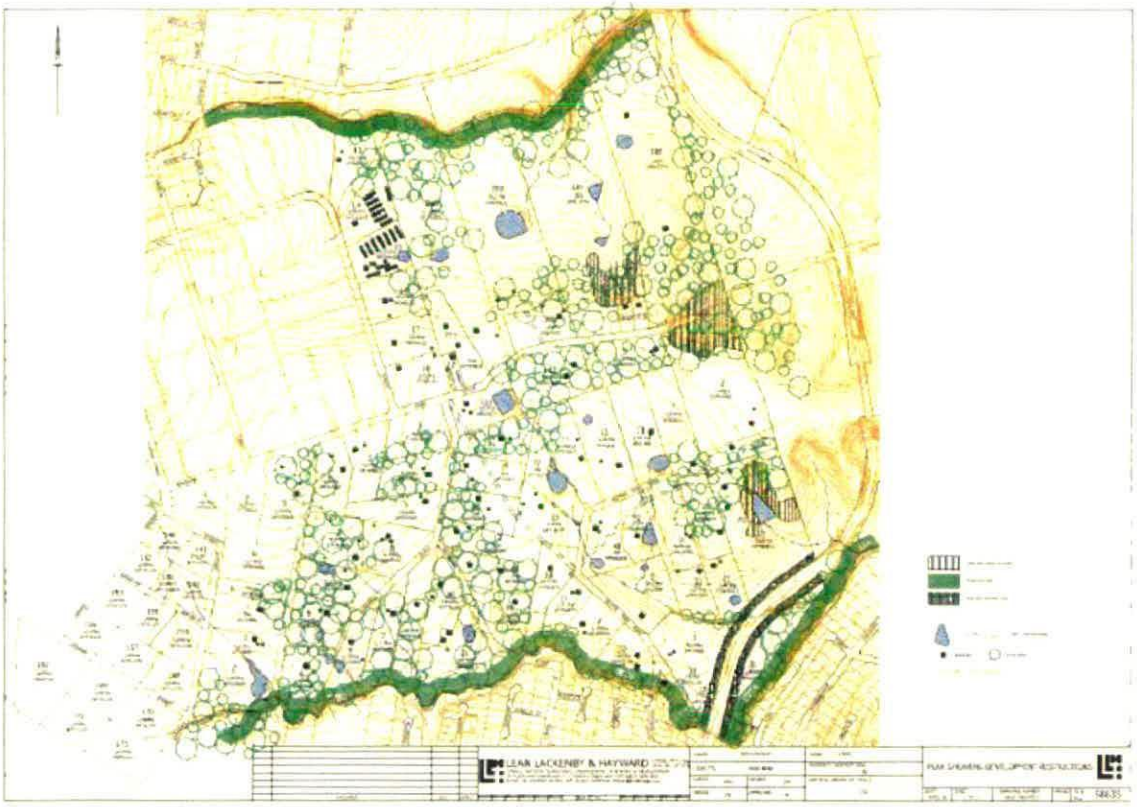

Figure 1 - Plan of the extent of the PTTAG Study Area (from Lean Lackenby and Hayward)

1.2 Objectives and scope of the study

The objectives and scope of the study are:

- To identify, locate and describe the biodiversity values of the Study Area and its environmental context in the region by undertaking detailed flora and fauna field surveys, including aquatic flora and fauna as may occur in the creek systems of the Study Area. A description of the flora and fauna communities will be prepared and related to that contained in existing maps, aerial photography, reports and studies. Current and detailed information will be obtained on the following:

  - Identification of the flora and fauna, including aquatic flora and fauna, that occur within the Study Area including documentation of species lists and mapping of identifiable plant communities;
  - Identification of Threatened (Endangered and Vulnerable) species, populations, communities and habitats as listed in Schedules 1 & 2 of the Threatened Species Conservation Act 1995 (TSC Act), including Preliminary Determinations of the NSW Scientific Committee, and the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act), RoTAP species (Briggs & Leigh 1996) and regionally and locally significant species;

- Identification of fauna species including amphibians, reptiles, birds or mammals, not directly recorded during surveys but that could potentially occur in the Study Area as indicated by the presence of associated habitat;
- Description of the identifiable vegetation communities occurring within the Study Area indicating their current condition, conservation value and level of degradation;
- Recording of the area and extent of Noxious (and other significant) weed species in the Study Area;

- To assess the condition and recovery potential of the identified communities and to recommend strategies to conserve the ecological attributes of the landscape;
- To develop a strategy to conserve biodiversity values, in accordance with the principles and objectives of the *Threatened Species Conservation Act 1995*, of the Study Area and to improve the potential condition of the remnant vegetation communities and regional linkages to support native flora and fauna;
- To develop principles for the integration of rural/residential development and the ecological values of the Study Area, whilst considering the requirements for bushfire management and asset protection;
- To recommend zoning regimes and minimum lot sizes to support and maintain the ecological values of the Study Area;
- To identify Bio-banking potential within the Study Area;
- To identify biodiversity values that developer contributions should address;
- To review and integrate all relevant requirements of Government Departments detailed in the Planning Proposal and Gateway Determination; and
- To prepare a comprehensive report on the assessment for the review, comment and approval of the Client's representative, Council and the DOP & I.

1.3 Environmental Planning Instruments

1.3.1 Planning Proposal and Gateway Determination

The rezoning of land indicated by the natural and cadastral boundaries shown in Figure 1 has been the subject of a Gateway Determination by the Director General of the DPI in accordance with section 56 of the EPA Act 1979, for the Planning Proposal for the 'Picton Tahmoor Thirlmere New Urban Lands' project.

At its Ordinary Council meeting (20.6.2011) Wollondilly Shire Council has resolved the following:

- That the Picton Tahmoor Thirlmere New Urban Lands project be forwarded to the Minister as a Planning Proposal for Gateway Determination;
- That subject to Gateway Determination, Council support a change to the Planning Proposal project that would involve the preparation of an LES for public exhibition;
- That Council commit to progressing the Planning Proposal project in a manner that is efficient, timely and legislatively correct.

As such, under the Gateway Determination, a fixed time is allocated to the rezoning process and time will be of the essence in preparation of this specialist study

1.3.2 *Environmental planning instruments*

Environmental Planning Instruments consulted as part of this survey included:

- *Threatened Species Conservation Act 1995 (TSC Act) (NSW)*
  The objectives of this Act are:
  - *to provide for the conservation of threatened species, populations and ecological communities of animals and plants. The Act sets out a number of specific objects relating to the conservation of biological diversity and the promotion of ecologically sustainable development.*

- *Environmental Planning and Assessment Act 1979 (EP&A Act)* (NSW)
  The objectives of this Act are:
  - *to encourage the proper management, development and conservation of natural and artificial resources, specifically the protection of the environment, native animals and plants and threatened species, populations and ecological communities, and their habitats.*

- *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) (Comm.)*
  The objectives of this Act are:
  - *to provide for the protection of the environment, especially matters of national environmental significance*
  - *conserve Australian biodiversity*
  - *provide a streamlined national environmental assessment and approval process*
  - *enhance the protection and management of important natural and cultural places*
  - *promote ecologically sustainable development through the conservation and ecologically sustainable use of natural resources*

- *Noxious Weeds Act 1993 (NW Act) (NSW)*
  The objects of this Act are:
  - *to reduce the negative impact of weeds on the economy, community and environment of this State by establishing control mechanisms to:*
  - *prevent the establishment in this State of significant new weeds, and*
  - *restrict the spread in this State of existing significant weeds, and*
  - *reduce the area in this State of existing significant weeds,*
  - *to provide for the monitoring of and reporting on the effectiveness of the management of weeds in this State*

- *Native Vegetation Conservation Act 1997 (NVC Act) (NSW)*
  The objects of this Act are:
  - *to provide for the conservation and management of native vegetation on a regional basis.*
  - *to encourage and promote native vegetation management in the social, economic and environmental interests of the State.*

- *to protect native vegetation of high conservation value.*
- *to improve the condition of existing native vegetation.*
- *to encourage the revegetation of land, and the rehabilitation of land, with appropriate native vegetation.*
- *to prevent the inappropriate clearing of vegetation.*
- *to promote the significance of native vegetation.*

- *State Environmental Planning Policy No. 44 - Koala Habitat Protection (SEPP 44)*
  This Policy aims to encourage the proper conservation and management of areas of natural vegetation that provide habitat for koalas to ensure a permanent free-living population over their present range and reverse the current trend of koala population decline.

- *Wollondilly Local Environmental Plan 2011*
  The objectives of this plan are as follows:

  - to make local environmental planning provisions for land in Wollondilly in accordance with the relevant standard environmental planning instrument under section 33A of the Act.

  - The particular aims of this Plan are as follows:

  (a) to provide for the management of natural resources and the protection of the natural landscape character,

  (b) to protect, conserve and enhance the built, landscape and Aboriginal cultural heritage,

  (c) to protect water quality in land that is situated within water supply catchments,

  (d) to encourage development that provides for an integrated transport and infrastructure system and adequate facilities and service provision for future growth,

  (e) to recognise, manage and protect rural resource lands for sustainable agriculture and extractive industry practices,

  (f) to maintain the separation between towns and villages to retain their unique character and rural and natural settings.

1.4 Ecologically sustainable development

Four principles of Ecologically Sustainable Development (ESD) that should be considered whenever any development is planned for an area of land containing native bushland include: Conservation of Biological Diversity and Ecological Integrity, Precautionary Principle, Inter-generational Equity, and Improved Valuation and Pricing of Environmental Resources.

2.0 Existing environment of Study Area

2.1 Site location

The Study Area incorporates approximately 232 hectares comprising 87 allotments of land as shown in Figure 1. The Study Area is located between the townships of Tahmoor and Thirlmere in the Wollondilly Shire. The Study Area is generally bound by and includes Redbank Creek, Thirlmere to the north, Myrtle Creek, Tahmoor, to the south and a small frontage to the Main Southern Rail Line to the east. Figure 2 is an aerial depiction of the Study Area.

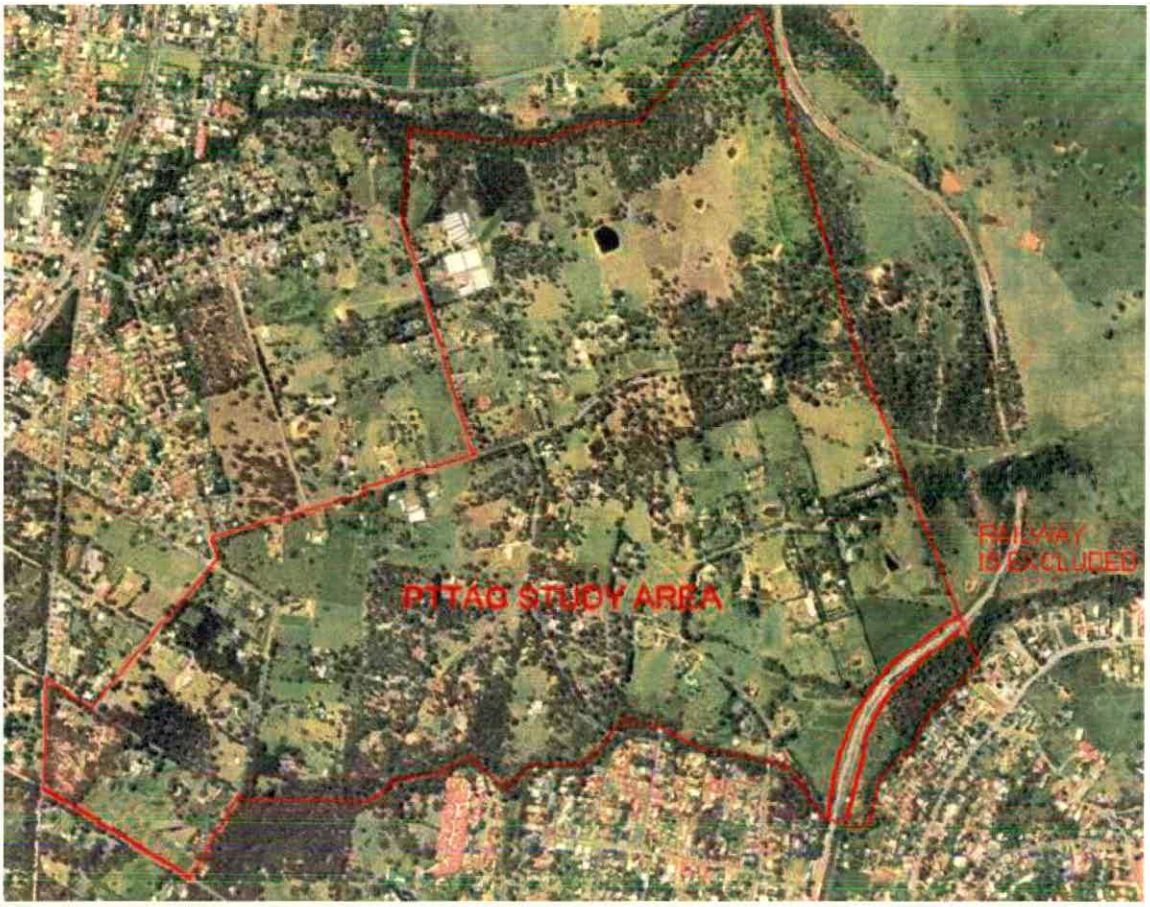

Figure 2 Aerial depiction of the subject land indicating the extent of the boundary of the PTTAG Study Area

2.2 Site description and land use of the Study Area

The Study Area occurs largely within rural allotments with much of the area having been cleared for grazing with remnant trees remaining. Grazing by cows, horses, sheep, goats etc is currently occurring on various allotments in the Study Area. The vegetation of some allotments has been highly modified with pasture improvement, landscaping and planting

of exotic ground cover grasses and ornamental trees. Patches of less cleared or wholly uncleared land, with full or modified structural plant assemblages remaining create a mosaic of vegetation distribution across the landscape (Figure 2).

Vegetation occurring along the banks of Redbank Creek to the north is largely undisturbed along this section of the Study Area boundary (except near the headwaters to the west), whereas along Myrtle Creek, in the more developed southern sections of the Study Area, the vegetation occurring along the banks is highly degraded with a high incidence of noxious woody weed species.

2.3 Topography, geology and soils

Tickle Drive and the western section of Brundah Road are aligned along a ridgeline from east to west through the Study Area. The general terrain along the central section of the Study Area is a relatively narrow ridgetop sloping gently to the south and north respectively. Generally hillslope gradients vary from $1 - 5^0$.

Figure 3 is an aerial map of the geology of the Study Area (scale of 1:100,000), overlain with an indicative soil landscape distribution (1:100,000).

The lithological parent material on which the greater part of the Study Area is located is the Ashfield Shale Sub-group of the Wianamatta Group of Shales (Figure 3). The lithology of this substrate is largely comprised of laminite and dark grey siltstone (Sherwin & Holmes 1985).

The Soil Landscape series associated with Ashfield Shale sedimentology is largely the residual 'Blacktown' Soil Landscape Series (Hazelton, Bannerman & Tille 1990). This soil landscape is characterised by gently undulating rises on Wianamatta Shale on broad rounded crests and ridges with gently inclined hillslopes having gradients of $< 3^0$ (Hazelton, Bannerman & Tille 1990). Soils derived from this Soil Landscape Series include shallow to moderately deep red and brown podzolics on crests, upper slopes and well-drained areas, and deep yellow podzolics on lower slopes and drainage depressions (Hazelton, Bannerman & Tille 1990).

To the east and south-east of the Study Area along Tickle Drive, patches of the erosional 'Luddenham' Soil Landscape Series occur (Figure 3). This soil landscape is also characterised by undulating to low rolling hills on Wianamatta Shale, often associated with the upper layers of Minchinbury Sandstone, occurring along narrow ridges, hillcrests and valleys with gradients from $3 - 10^0$ (Hazelton, Bannerman & Tille 1990). Soils derived from this Soil Landscape Series include shallow brown podzolics and massive earths on crests, moderately deep red podzolics on upper slopes and prairie soils on lower slopes and drainage depressions (Hazelton, Bannerman & Tille 1990).

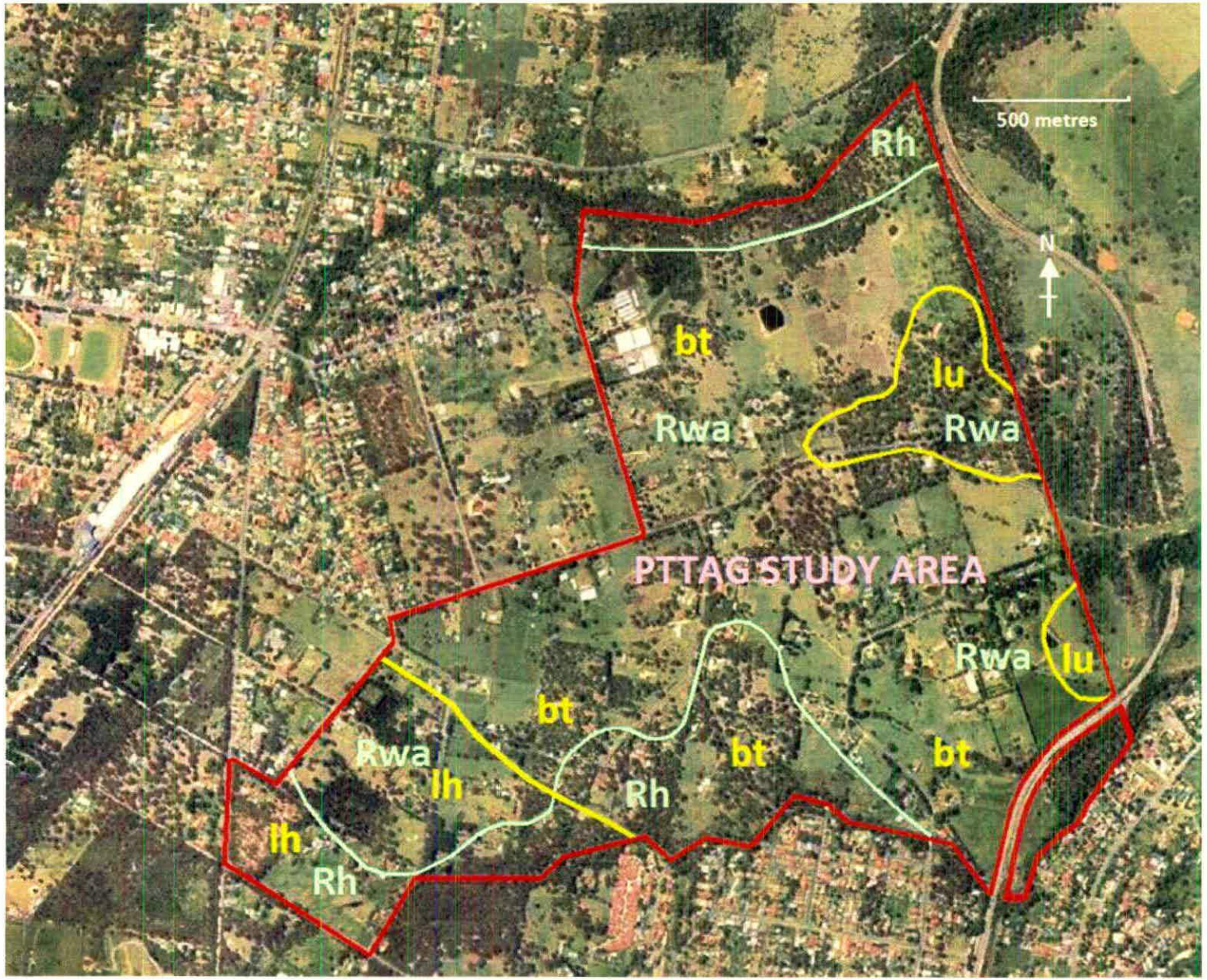

Figure 3 – Study Area showing geological distribution of the Ashfield Shale Formation of the Wianamatta Group of Shales (Rwa) and Hawkesbury Sandstone (Rh) parent material overlain by indicative Soil Landscape groups ('bt' – 'Blacktown' and 'lu' – 'Luddenham' Soils Landscapes primarily derived from Winamatta Shale sediments and 'lh'- 'Lucas Heights' primarily derived from Hawkesbury Sandstone parent material).

The lithological parent material of the lower lying area along Redbank Creek and the far southern sections of the Study Area is Hawkesbury Sandstone. The lithology of the sediments include medium to coarse-grained quartz sandstone, very minor shale and laminite lenses (Sherwin & Holmes 1985).

The soil landscape of the Study Area occurring in association with Hawkesbury Sandstone geology is defined as the residual Lucas Heights Soil Landscape Group and is characterized by gently undulating crests, ridges and plateau surfaces of the Mittagong Formation (alternating bands of shale and fine-grained sandstones) with relatively shallow gradients (<6%) and where rock outcropping is generally absent (Hazelton, Bannerman & Tille 1990).

Soils include moderately deep hard-setting yellow podsolic and yellow soloths on ridges and plateau surfaces with lateritic podsolics on crests and yellow earths on hillslopes (Hazelton, Bannerman & Tille 1990).

3.0 Methods

3.1 Background searches and literature reviews

Existing information on 'Threatened Flora of the Locality', defined as a 5km radius around the Study Area, was accessed from the OEH Atlas of NSW Wildlife (1:100,000 map sheet 9029 Wollongong (March 2012), EPBC 'Protected Matters Environmental Reporting Tool' (March 2012) and RoTAP (Briggs & Leigh, 1996) databases. Other literature detailing locally threatened flora and fauna, as well as endangered populations and plant communities of the Study Area included NSW Scientific Committee Final Determinations (1996-2012), Native Vegetation of the Cumberland Plain – Final Edition (DEC 2002) and The Native Vegetation of the Sydney Metropolitan Catchment Management Authority Area – Draft (DECCW 2009).

Searches for terrestrial fauna were undertaken from the OEH Atlas of NSW Wildlife database (March 2012) for a 5km radius of the site, as well as the Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) 'Protected Matters Search Tool' Database (2012) for threatened fauna species or populations of fauna likely to occur in the Study Area. Searches of JAMBA (Japan and Australia Migratory Bird Agreement), CAMBA (China and Australia Migratory Bird Agreement) and ROKAMBA (Republic of Korea Migratory Bird Agreement) databases were also consulted in regard to the distribution of migratory bird species.

3.2 Field surveys

The Study Area was inspected by 'ACS Environmental P/L' on the 28th of March, 3rd, 4th, 11th and 27th of April 2012 for the presence of flora and fauna.

The presence of aquatic flora and fauna was assessed on 23rd June by ACS Environmental P/L and JP Scientific P/L, respectively, in the drainage channels of Redbank and Myrtle Creeks.

Access was readily available to the 42 properties belonging to landholders forming the PTTAG association.

Ecological plant community distribution was assessed within other properties not belonging to PTTAG association landholders by observation along public thoroughfares and by aerial map interpretation.

3.2.1 Terrestrial Flora Survey

Comprehensive surveys of the Study Area were undertaken on foot by the diversity search method of Cropper (1993) and DEC 'Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities' (2004) to identify the existence of extant flora.

Initial examination of the Study Area indicated that up to four distinct vegetation assemblages could be recognized. These assemblages equate to discrete, floristically variable ecological communities over the landscape, described in DECCW (2009) as follows:

- Cumberland Shale Hills Woodland,
- Cumberland Shale-Sandstone Ironbark Forest (varying degree of shale: sandstone influence),
- Sydney Hinterland Grey Gum Ridgetop Forest, and
- Mixed Riparian Forest (At Myrtle Creek the natural vegetation has been extensively cleared and degraded but some canopy trees retained)

Larger allotments contain various patches of bushland that may include a range of ecological communities. Often within an ecological community type occurring in a larger allotment, a range of vegetation structural types could be identified. Smaller allotments, however, often contained only a single structural type within a single ecological community type. Structural vegetation types are indicated as follows:

- Full structured vegetation (relatively natural occurrence, relatively unmodified and un-degraded),
- Modified vegetation (unstructured vegetation with relatively moderate to high tree frequency retained but with understorey and mid-storey strata removed and current condition maintained by grazing or slashing, though often with large areas of indigenous ground strata remaining), or
- Highly modified (few remnant trees remaining but having either a mostly natural ground cover, or a pasture-improved ground cover, or including landscaped areas having a mixture of indigenous and exotic trees with a largely exotic ground cover).

As variation in structure of the vegetation occurs over the range of ecological plant community variation, floristic data from representative sample quadrats of 20m x 20m ($400m^2$) (DEC 2004) were collected throughout these communities over the range of possible disturbance or structural modification regimes.

Numbers of quadrats were selected in various assemblages according to ease of access, extent of area of a particular ecological community and the extent of area of variously disturbed/undisturbed habitat present. Where access to allotments was restricted, or the area of extent of a particular ecological habitat was relatively low, or where the extent of disturbance was less in a particular habitat regime, fewer quadrat data were sampled (DEC 2004). However, in relation to mapping information, quadrat data was augmented by extensive visual observation and spot recording of tracts of vegetation within allotments.

The floristic data from a total of 21 quadrats, including species occurring in the vicinity of quadrats, was recorded. Representative quadrat locations throughout the Study Area are shown in Figure 4.

Figure 4 – Location of sampled quadrats throughout the representative range of ecological variation occurring in the Study Area.

Table 1 details the number of quadrats collected over the range of ecological communities and the range of various disturbance regimes in the Study Area (DEC 2004).

The survey included a complete floristic inventory of indigenous and exotic species and an assessment of the presence, or likelihood of occurrence, of any threatened, rare (RoTAP), regionally or locally significant species or ecological plant community occurring in the Study Area.

Table 1 – Number of quadrats from which floristic data was collected over a range of ecological communities and disturbance regimes

ECOLOGICAL COMMUNITIES / **DISTURBANCE REGIME**	CUMBERLAND SHALE HILLS WOODLAND	CUMBERLAND SHALE-SANDSTONE IRONBARK FOREST (with a high shale influence)	CUMBERLAND SHALE-SANDSTONE IRONBARK FOREST (with a high sandstone influence such as along Redbank Creek)	SYDNEY HINTERLAND GREY GUM RIDGETOP FOREST (incorporating Upper Georges River Sandstone Woodland)	RIPARIAN VEGETATION
RELATIVELY UNCLEARED	3	1	3	1	1 (Redbank Creek)
MODERATELY CLEARED (NO UNDERSTORY; >10% TREES	3	3	1		na
EXTENSIVELY CLEARED (NO NATURAL UNDERSTORY; <5% TREES	3	na	na	na	2 (Myrtle Creek)

3.2.2 Terrestrial Fauna Survey

The terrestrial fauna survey was undertaken as a habitat based assessment. The survey involved different search strategies and protocols and all extant fauna or evidence of fauna was recorded. Threatened fauna species not recorded in the surveys but with the potential to be present as indicated by habitat were recorded.

Strategies employed for the field investigation of the Study Areas were:

Assessment of the value of habitat suitable for native fauna species and specific habitat structures/resources was identified that were considered important in life cycles. These structures or resources included:

- Mature trees with hollows for breeding, roosting and/or nesting;

- Large woodland stands for sheltering, roosting and foraging;
- Particular foraging resources such as certain tree or shrub species;
- Dispersal, migratory or foraging corridors for fauna;
- Leaf litter and ground search for reptiles, frogs and threatened invertebrates;
- Identification of scats and other indirect evidence to suggest fauna utilisation such as tracks, scratch marks or diggings;
- Assessment was carried out with particular regard for species listed as 'threatened' under the Threatened Species Conservation Act, 1995 (TSC Act).

3.2.3 Aquatic Flora and Fauna Survey

The drainage channels of Redbank Creek, Thirlmere, and Myrtle Creek, Tahmoor, are documented by the Fisheries Ecosystems Branch, Division of Agriculture and Fisheries, NSW Department of Primary Industries, as containing potential 'Key Fish Habitat' (see Section 4.9.2 'Aquatic fauna results').

As such, Joseph Pera Scientific (JPS) was engaged by ACS Environmental P/L to undertake fish surveys in Redbank and Myrtle Creeks, near the towns of Thirlmere and Tahmoor, respectively.

Electrofishing was conducted in conformity with requirements of the NSW Department of Primary Industries: Fisheries permit P05/0052, and in accordance with all safety requirements.

All fish or other faunal macroorganisms captured would be identified to species and measured to the nearest 1mm (head to caudal fork). All native species would be returned to the water body in a similar location.

A backpack electrofisher (Smith Root LR24) was used for electrofishing. Electrofishing was undertaken by sampling for 20 minutes (10 by 2 minutes) in each creek. Captured fish or other aquatic macroorganisms would be processed at the completion of each 2 minute shot. Effort was made to sample as diverse a range of habitats within each creek.

3.2.4 Limitations of the study

Limitations of the study may arise where certain cryptic species of plants may occur as soil-stored seed or as subterranean vegetative structures. Some species are identifiable above-ground only after particular environmental circumstances occur that may be related to factors such as periodic fire frequency, intensity or seasonality, soil moisture regime, grazing pressure, biological life-cycle patterns as in the case of small geophytic taxa such as species of orchids etc.

Diurnal surveys at one time of the year cannot be expected to detect the presence of all species occurring, or likely to occur, in the Study Area. This is because some species may (a) occur seasonally, (b) utilise different areas periodically (as a component of a more extensive home range), or (c) become dormant during specific periods of the year. Rather, the survey provides the opportunity to sample the area, search specifically for species likely to be

encountered within the available time frame, and assess the suitability of habitat for particular species.

These potential limitations to the location of certain cryptic or diurnally active species are not expected to cause any significant constraints to the purposes of this assessment.

4.0 Results

4.1 Background searches and literature reviews

OEH Atlas of NSW Wildlife (March 2012) records for an area of 5km radius around the Study Area indicate that 7 flora species of conservation significance have been recorded since 1987. According to guidelines listed by the EPBC 'Protected Matters Search Tool' (March 2012), it was deemed that habitat may potentially occur for a further 11 threatened flora species. Appendix 2 lists these 18 species with an account of their threatened status, geographical range, physiognomic attributes, habitat features and likelihood of occurrence in the Study Area.

The OEH Atlas of NSW Wildlife database (March 2012) listed twenty five (25) species of fauna classified as threatened under the Threatened Species Conservation Act, 1995 (TSC Act) and Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) within a 5 km radius of the Study Area. Searches of JAMBA, CAMBA and ROKAMBA databases determined that eleven (11) migratory bird species had been recorded within 5km of the Study Area since 1987.

4.2 Terrestrial Flora Results

4.2.1 Indigenous and exotic species

Appendix 1 is a floristic species list of terrestrial indigenous and exotic species occurring in quadrats (400m^2) and associated species recording collected throughout the Study Area.

Table 2 indicates the mean number and range of numbers of indigenous and exotic species occurring within the Study Area (Figures 1, 2 & 3) over the range of ecological community types and relative disturbance/modification regimes.

ECOLOGICAL COMMUNITIES	*SPECIES*	CUMBERLAND SHALE HILLS WOODLAND	CUMBERLAND SHALE-SANDSTONE IRONBARK FOREST (low sandstone influence)	CUMBERLAND SHALE-SANDSTONE IRONBARK FOREST (high sandstone influence such as along Redbank Creek)	SYDNEY HINTERLAND GREY GUM RIDGETOP FOREST	RIPARIAN VEGETATION (MOSTLY CUMBERLAND SHALE-SANDSTONE IRONBARK FOREST)
DISTURBANCE REGIME						
RELATIVELY UNCLEARED	***INDIGENOUS***	Max = 42 X = 26 (n=3) (Range 24 – 29)	25 (n=1)	Max = 67 (n=3) X = 39 (Range 38 – 40)	37 (n=1)	28 (n=1) Redbank Creek
	EXOTIC	Max = 10 X = 4 (n=3) (Range 1 – 6)	8 (n=1)	Max = 6 (n=3) X = 2	11 (n=1)	2 (n=1) Redbank Creek
MODERATELY CLEARED (NO UNDERSTORY; >10% TREES	***INDIGENOUS***	22 (n=1)	Max = 29 (n=3) X = 19 (Range 17 – 23)	7 (n=1)		na
	EXOTIC	3 (n=1)	Max = 15 X = 8 (n=3) (Range 3 – 11)	6 (n=1)		na
MODERATELY CLEARED (NO UNDERSTORY; >10% TREES; PASTURE IMPROVED	***INDIGENOUS***	Max = 5 X = 4 (n=2) (Range 3 – 5)	na	na	na	na
	EXOTIC	Max = 13 X = 9 (n=2) (Range 7 – 10)	na	na	na	na
EXTENSIVELY CLEARED (NO NATURAL UNDERSTORY; <5% TREES	***INDIGENOUS***	Max = 18 X = 9 (n=3) (Range 8 – 11)	na	na	na	Max = 6 (Myrtle Creek) X = 4)(n=2) (Range 3 – 4)
	EXOTIC	Max = 9 X = 6 (n=3) (Range 5 – 7)	na	na	na	Max = 11 (Myrtle Creek) X = 8 (n=2) (Range 6 – 9)

Table 2: Indicates the maximum number, mean number and range of number of indigenous and exotic species (based on 400m^2 area) occurring within the Study Area (Figures 1, 2 & 3) based on ecological community type and relative disturbance regime.

4.2.2 Vegetation Communities

Four distinct vegetation communities can be delineated within the Study Area with variation occurring in relation to floristic assemblages within some communities depending on the extent and nature of past disturbance/structural modification history. Descriptions of these communities are derived from descriptions given in current mapping of the SMCMA by DECCW (2009), and even though the subject Study Area lies outside the Sydney Metropolitan Catchment Area, the descriptions of the ecological communities can be interpolated to include those occurring in the Study Area.

Equivalent Endangered Vegetation Communities (EEC's) listed by State and Commonwealth registers to comparable ecological community descriptions given by DECCW (2009) are as follows:

Listed EEC (TSC Act; EPBC Act) (description as given by DEC (2002))	**EEC Description given by OEH (2013)**
Shale Hills Woodland	***Cumberland Shale Hills Woodland***
Shale-Sandstone Transition Forest	***Cumberland Shale-Sandstone Ironbark Forest***
Upper Georges River Sandstone Woodland* (*not listed as EEC)	***Sydney Hinterland Grey Gum Ridgetop Forest****

Figure 5 indicates the distribution of these communities in relation to extent of structural modification. The degree of structural and floristic modification of patches of an ecological community directly reflects their conservation significance status as also depicted in Figure 5. Figure 6 indicates previous mapping of the subject area in relation to ecological community terminology as described in DEC (2002).

Figures 5 & 6 indicate that patterns in the intrinsic ecological distributions of plant communities are closely associated with patterns in the physical environment. Distributions of Cumberland Shale Hills Woodland on ridgelines and crests appear associated with deeper erosional soils of the Luddenham Soil Landscape Series derived from the Ashfield Shale Sub-group of the Wianamatta Group of Triassic Shales (Figure 3).

As the landscape slopes away to the west, the mantle of Ashfield Shale-derived soil of the Blacktown Soil Landscape Series becomes thinner overlying sandstone-derived soils. Here the woodland floristics change to that more associated with Cumberland Shale-Sandstone Ironbark Forest, a transitional community type occurring on shale-derived soils that overlie sandstone-derived soils, but where the shale influence is still relatively high.

In the north of the Study Area, the mantle of shale-derived soils overlying sandstone-derived soils thins as the gradient slopes downhill towards Redbank Creek. Here the sandstone subsoil has a higher influence compared to that occurring upslope, and as such the floristics resemble that of transitional Cumberland Shale-Sandstone Ironbark Forest where the sandstone influence is higher than that of shale.

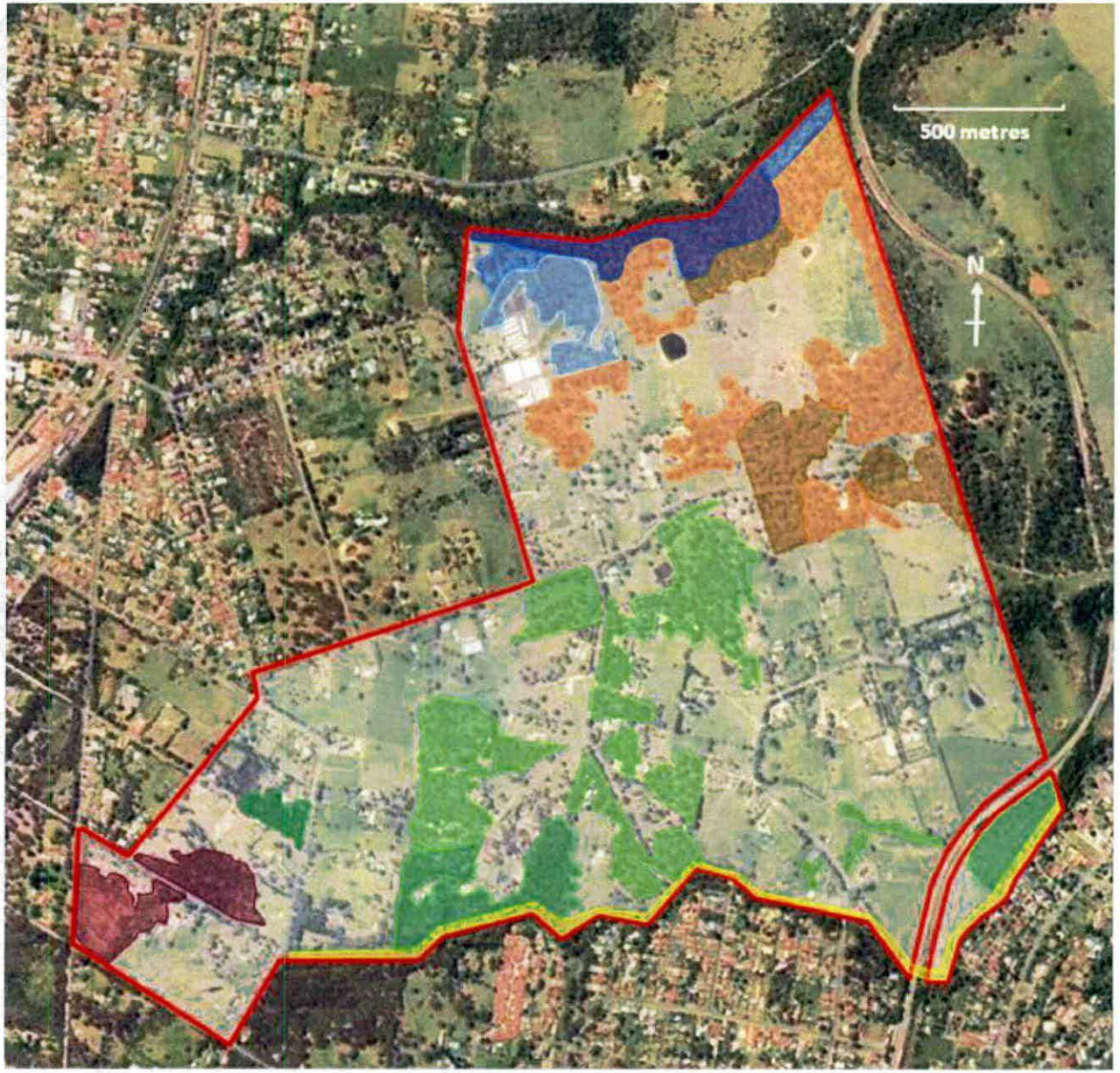

Figure 5 - Distribution of ecological communities in the PTTAG Study Area with reference to conservation value assessment.

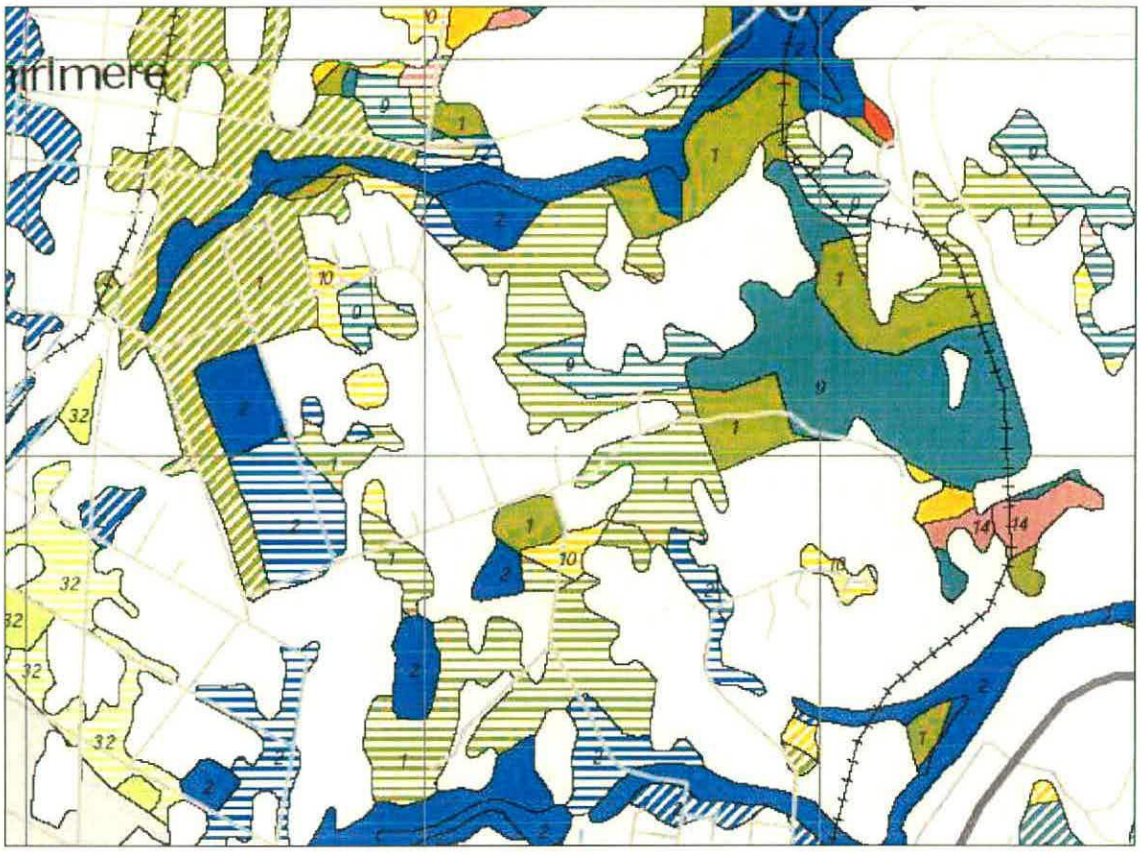

Figure 6 – Mapping of ecological communities over the locality including the Study Area (DEC (2002) indicating the distribution of relative variation in crown canopy cover of vegetation types (Mapping Codes: No. 1 & 2 are 'Shale-Sandstone Transition Forests' on low sandstone and high sandstone influence respectively; No. 9 is 'Shale Hills Woodland' and No. 32 is ' Upper Georges River Sandstone Woodland'. Hatched polygons represent less crown canopy projective densities of woodland assemblages)

To the south-west towards Thirlmere Way, the mantle of shale soil gives way to sandstone-derived soils, probably associated with the transitional Mittagong Formation that occurs between the Hawkesbury Sandstone and Wianamatta Shale sediments (Figure 3). The floristics associated with this landscape closely resembles that of vegetation associated with Hawkesbury Sandstone-derived soils. As the area is proximal to the shale-sandstone boundary, the vegetation in this location is likely to represent Sydney Hinterland Grey Gum Ridgetop Forest (OEH 2013).

The drainage line of Myrtle Creek that forms the southern boundary of the Study Area is proximal to established residential development. As such, these vegetation assemblages contain a high incursion of woody noxious weeds and other exotic species, though with a canopy cover of indigenous eucalypt species. Dominant eucalypt species indicate that the drainage line vegetation formerly appeared representative of Cumberland Shale-Sandstone Transition Ironbark Forest but with current extensive weed incursion does not appear to closely represent any particular remnant riparian ecological community.

Descriptions of the ecological communities as mapped in Figure 5 and described by DECCW (2009) are detailed as follows:

4.2.2.1 *Cumberland Shale Hills Woodland (Figures 5, 7 & 8)*

Location

Cumberland Shale Hills Woodland appears to occur primarily in the more elevated eastern sections of the Study Area, particularly in relation to the distribution of the Luddenham Soil Landscape Series as indicated in Figure 3.

Description and distinguishing features

Within the Study Area, Cumberland Shale Hills Woodland is primarily distinguished as a woodland assemblage dominated by Forest Red Gum (*Eucalyptus tereticornis*) and Narrow-leaved Ironbark (*Eucalyptus crebra*) with Thin-leaved Stringybark (*Eucalyptus eugenioides*) occurring less frequently. Full structured assemblages have a %CCPD from 15 – 30% with trees attaining heights from 22 to 27m and have relatively open mid-storey and understorey strata as shown in Figures 7 & 8. Figures 7 & 8 indicate relatively undisturbed and unmodified areas of woodland occurring in the vicinity of Tickle Drive, Thirlmere.

Individuals of Hickory Wattle (*Acacia implexa*) often characteristically occur in the lower strata (DECCW 2009). Blackthorn (*Bursaria spinosa*) is a common shrub species.

Species richness

The community is relatively diverse including maximum indigenous species numbers over three sites in structurally integrated woodlands of up to 42 indigenous species/1200m^2, (mean of 26 species/400m^2 recorded in this vegetation over a range of 24 – 29 species/400m^2) (Table 2).

Relatively undisturbed Cumberland Shale Hills Woodland communities have a mean number of about 4 exotic species/400m^2 (Table 2).

Figure 7 – Area of Cumberland Shale Hills Woodland occurring along the ridge at Lot 3 Tickle Drive, Thirlmere.

Figure 8 – Area of Cumberland Shale Hills Woodland occurring at Lot 2 Tickle Drive, Thirlmere.

Floristic composition

Woodland assemblages of Cumberland Shale Hills Woodland are dominated by Forest Red Gum (*Eucalyptus tereticornis*) and Narrow-leaved Ironbark (*Eucalyptus crebra*), with Thin-leaved Stringybark (*Eucalyptus eugenioides*) occurring less frequently (Appendix 1).

A relatively low diversity of common small tree and understorey species includes Blackthorn, Wallaby Bush (*Olearia viscidula*), Parramatta Green Wattle (*Acacia parramattensis*), Sydney Green Wattle (*Acacia decurrens*) and Hickory Wattle (Appendix 1).

A relatively diverse herb, climber and grass-dominated ground stratum commonly includes Forest Nightshade (*Solanum prinophyllum*), Native Summer Grass (*Digitaria ramularis*), Hedgehog Grass (*Echinopogon caespitosis*), Bordered Panic (*Entolasia marginata*), Paddock Lovegrass (*Eragrostis leptostachya*), Weeping Grass (*Microlaena stipoides*), Kangaroo Grass (*Themeda australis*), Rock Fern (*Cheilanthes sieberi*), White Burr-daisy (*Calotis dentex*), Spreading Bluebell (*Wahlenbergia gracilis*), Kidney Weed (*Dichondra repens*), Twining Glycine (*Glycine clandestina*) and Whiteroot (*Pratia purpurascens*) (Appendix 1).

Previous Mapping

Mapping by DEC (2002) (Figure 6) broadly confirms the current assessment of the distribution of Cumberland Shale Hills Woodland in the eastern, upslope section of the Study Area.

Vegetation classification and status

Cumberland Shale Hills Woodland is a component of Cumberland Plain Woodland and is listed as a 'Critically Endangered Ecological Community' under Part 2 of Schedule 1A of the NSW *TSC Act (1995)*. This community is also listed as a 'Critically Endangered Ecological Community' as a component of Cumberland Plain Shale Woodlands under the *EPBC Act (1999)*. Areas of the vegetation community are represented and conserved in Prospect Nature Reserve, Western Sydney Regional Park and Leacock Regional Park (DECCW 2009).

The Biometric Vegetation Type for the Hawkesbury-Nepean CMA Data Base (DECCW 2008) describes this community as 'Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin' listed as an Endangered Ecological Community.

4.2.2.2 *Cumberland Shale-Sandstone Ironbark Forest – Low Sandstone Influence (Figures 5, 9 & 10)*

Location

Cumberland Shale-Sandstone Transition Ironbark Forest (with low sandstone influence) occurs on the fringes of the Cumberland Plain in the central and western sections of the Study Area and appears associated with the Blacktown Soil Landscape Series as indicated in Figure 3.

This assemblage is associated with the subtle intergrade between clay rich shale soils overlying coarse sandy substrates of the Hawkesbury Sandstone plateau (DECCW 2009).

Description and distinguishing features

Within the Study Area, Cumberland Shale-Sandstone Transition Ironbark Forest with a low sandstone influence is primarily distinguished as a woodland assemblage dominated by Forest Red Gum (*Eucalyptus tereticornis*), Narrow-leaved Ironbark (*Eucalyptus crebra*), Grey Gum (*Eucalyptus punctata*), Woollybutt (*Eucalyptus longifolia*) and Rough-barked Apple (*Angophora floribunda*) (Appendix 1). Full structured, relatively natural unmodified assemblages with a shrubby understory are uncommon in the Study Area, though distributions occur that have a relatively high tree canopy cover ranging from 5 – 30%CCPD with trees attaining heights from 15 to 27m. Where a sparse understorey occurs, the cover is usually <5% with shrubs to 2m in height. The ground stratum is well developed though often floristically modified through grazing. Blackthorn (*Bursaria spinosa*) is a common shrub species.

Species richness

Even where structural modification has occurred through historical clearing and tree-thinning regimes, the ecological community is relatively diverse including maximum indigenous species numbers over three sites of up to 29 indigenous species/1200m^2, (with means of 19 – 25 species/400m^2 recorded in variously modified areas of this vegetation over a range of 17 – 25 species/400m^2) (Table 2).

Structurally modified Cumberland Shale-Sandstone Transition Ironbark Forest communities with low sandstone influence in the Study Area have a mean number of about 8 exotic species/400m^2 with a maximum number of 15 exotic species/1200m^2 and a range of 3 – 11 exotic species/400m^2 (Table 2).

Figure 9 – Area of grazed and structurally modified Cumberland Shale-Sandstone Transition Ironbark Forest with low sandstone influence having a relatively high tree canopy cover, occurring at Lot 192 Tickle Drive, Thirlmere.

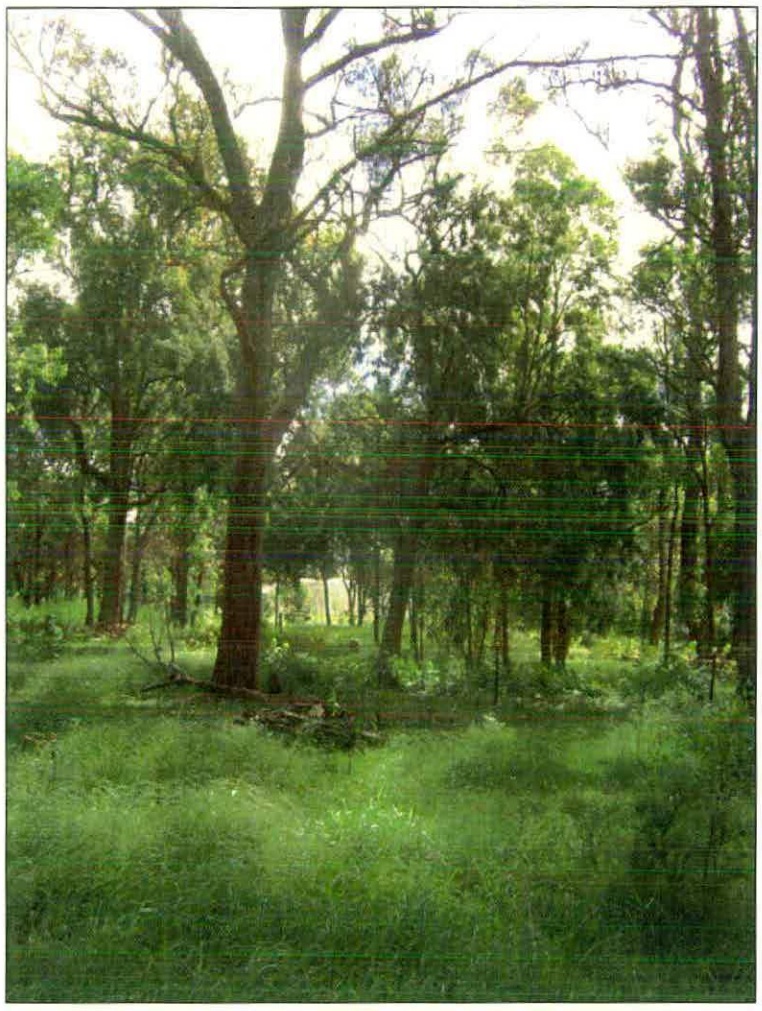

Figure 10 – Patch of remnant Cumberland Shale-Sandstone Transition Ironbark Forest with low sandstone influence having a relatively high tree canopy cover, occurring at Lot 12 Hilton Park Road, Thirlmere.

Floristic composition

Woodland assemblages of Cumberland Shale-Sandstone Transition Ironbark Forest with low sandstone influence are dominated by combinations of canopy species such as Forest Red Gum (*Eucalyptus tereticornis*), Narrow-leaved Ironbark (*Eucalyptus crebra*), Grey Gum (*Eucalyptus punctata*), Woollybutt (*Eucalyptus longifolia*) and Rough-barked Apple (*Angophora floribunda*) (Appendix 1).

Blackthorn and Sydney Green Wattle are common understorey species occurring in low abundance in structurally-modified assemblages of this ecological community (Appendix 1).

As for the closely related community Cumberland Shale Hills Woodland, a relatively diverse number of species of herb, climber and grass dominate the ground stratum. This stratum commonly includes Forest Nightshade (*Solanum prinophyllum*), Native Summer Grass (*Digitaria ramularis*), Hedgehog Grass (*Echinopogon caespitosis*), Bordered Panic (*Entolasia marginata*), Paddock Lovegrass (*Eragrostis leptostachya*), Short-hair

Plumegrass (*Dichelachne micrantha*), Weeping Grass (*Microlaena stipoides*), Kangaroo Grass (*Themeda australis*), Rock Fern (*Cheilanthes sieberi*), White Burr-daisy (*Calotis dentex*), Yellow Autumn Lily (*Tricoryne elatior*), Kidney Weed (*Dichondra repens*), Twining Glycine (*Glycine clandestina*) and Whiteroot (*Pratia purpurascens*) (Appendix 1).

Previous Mapping

Mapping by DEC (2002) (Figure 6) broadly confirms the current assessment of the distribution of Cumberland Shale-Sandstone Transition Ironbark Forest with low sandstone influence occurring in the central and southern upper and mid-slope sections of the Study Area.

Vegetation classification and status

Cumberland Shale-Sandstone Transition Ironbark Forest with low sandstone influence is a component of Shale-Sandstone Transition Forest listed as an 'Endangered Ecological Community' under Part 1 of Schedule 3 of the NSW *TSC Act (1995)*. This community is also listed as an 'Endangered Ecological Community' as a component of Shale-Sandstone Transition Forest under the *EPBC Act (1999)*. Areas of the vegetation community are represented and conserved in Georges River National Park (DECCW 2009).

The Biometric Vegetation Type for the Hawkesbury-Nepean CMA Data Base (DECCW 2008) describes this community as 'Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin' listed as an Endangered Ecological Community.

4.2.2.3 Cumberland Shale-Sandstone Ironbark Forest – High Sandstone Influence (Figures 5 & 11)

Location

Cumberland Shale-Sandstone Transition Ironbark Forest (with high sandstone influence) occurs on the fringes of the Cumberland Plain. This assemblage has been well conserved and largely incorporates the vegetation along the uncleared sections of bushland adjoining Redbank Creek that forms the northern boundary of the Study Area (Figure 3).

This assemblage is associated with the intergrade between a relatively thin mantle of clay rich shale soils overlying deeply weathered coarse sandy substrates of the Hawkesbury Sandstone plateau (DECCW 2009).

Description and distinguishing features

Within the Study Area, Cumberland Shale-Sandstone Transition Ironbark Forest with a high sandstone influence is primarily distinguished as a woodland assemblage dominated by Narrow-leaved Ironbark (*Eucalyptus crebra*), Grey Gum (*Eucalyptus punctata*), Thin-leaved Stringybark (*Eucalyptus eugenioides*), Red Bloodwood (*Corymbia gummifera*) and

Rough-barked Apple (*Angophora floribunda*) (Appendix 1). Fully structured assemblages have a shrubby understorey and small tree mid-storey stratum, the %CCPD ranging from 15 – 30% with trees attaining heights from 20 to 25m. Mid-storey strata vary in %CCPD from 5 – 30% with small trees from 4 – 10m in height. Understorey shrubs attain %CCPD values from 5 – 10% with heights from 1 – 3m. The ground stratum is almost always well developed though floristically modified where historical grazing has occurred.

Black Sheoak (*Allocasuarina littoralis*), Tick Bush (*Kunzea ambigua*), Mock Olive (*Notelaea longifolia*) and Narrow-leaved Geebung (*Persoonia linearis*) are common shrub and small tree species.

Species richness

This ecological community, preserved mainly along and in the vicinity of the edges of the low rocky cliffed Redbank Creek, has a relatively high species diversity including a maximum indigenous species number over three unmodified sites of up to 67 indigenous species/1200m^2 and a mean number of 39 species/400m^2 over a range of 38 – 40 species/400m^2) (Table 2).

Structurally integrated Cumberland Shale-Sandstone Transition Ironbark Forest communities with high sandstone influence in the Study Area have a low mean number of 2 exotic species/400m^2 with a maximum number of 6 exotic species/1200m^2 (Table 2).

Floristic composition

Woodland assemblages of Cumberland Shale-Sandstone Transition Ironbark Forest with high sandstone influence are dominated by combinations of canopy species such as Narrow-leaved Ironbark (*Eucalyptus crebra*), Grey Gum (*Eucalyptus punctata*) and Thin-leaved Stringybark (*Eucalyptus eugenioides*) with Rough-barked Apple (*Angophora floribunda*) and Red Bloodwood (*Corymbia gummifera*) occurring less frequently (Appendix 1).

Black Sheoak (*Allocasuarina littoralis*), Tick Bush (*Kunzea ambigua*), Mock Olive (*Notelaea longifolia*), Common Hop Bush (*Dodonaea triquetra*), Hairy Clerodendrum (*Clerodendrum tomentosum*), Prickly beard Heath (*Leucopogon juniperinus*) and Narrow-leaved Geebung (*Persoonia linearis*) are common shrub and small tree species in the understorey stratum (Appendix 1).

Figure 11 – Area of well-structured Cumberland Shale-Sandstone Transition Ironbark Forest with high sandstone influence occurring at the lower slopes of Lot 210 Tickle Drive, Thirlmere.

The relatively diverse herb, climber and grass dominated ground stratum commonly includes Forest Nightshade (*Solanum prinophyllum*), Native Summer Grass (*Digitaria ramularis*), Hedgehog Grass (*Echinopogon caespitosis*), Bordered Panic (*Entolasia marginata*), Variable Sword Sedge (*Lepidosperma laterale*), *Lepidosperma tortuosum*, Weeping Grass (*Microlaena stipoides*), Slender Rice Flower (*Pimelea linifolia*), Rock Fern (*Cheilanthes sieberi*), White Burr-daisy (*Calotis dentex*), Slender Devil's Twine (*Cassytha glabella*), Kidney Weed (*Dichondra repens*), Twining Glycine (*Glycine clandestina*), Whiteroot (*Pratia purpurascens*) Spiny-headed Mat-rush (*Lomandra longifolia*), Nodding Blue Lily (*Stypandra glauca*), Speargrass (*Austrostipa pubescens*) and Barb-wire Grass (*Cymbopogon refractus*) (Appendix 1).

Previous Mapping

Mapping by DEC (2002) (Figure 6) broadly confirms the current assessment of the distribution of Cumberland Shale-Sandstone Transition Ironbark Forest with high sandstone influence particularly as occurs in the northern lower slope section of the Study Area adjacent to Redbank Creek.

Vegetation classification and status

Cumberland Shale-Sandstone Transition Ironbark Forest with high sandstone influence is a component of Shale-Sandstone Transition Forest listed as an 'Endangered Ecological Community' under Part 1 of Schedule 3 of the NSW *TSC Act (1995)*. This community is also listed as an 'Endangered Ecological Community' as a component of Shale-Sandstone Transition Forest under the *EPBC Act (1999)*. Areas of the vegetation community are represented and conserved in Georges River National Park (DECCW 2009).

The Biometric Vegetation Type for the Hawkesbury-Nepean CMA Data Base (DECCW 2008) describes this community as 'Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin' listed as an Endangered Ecological Community.

4.2.2.4 Sydney Hinterland Grey Gum Ridgetop Forest (Figures 5 & 12)

Location

Sydney Hinterland Grey Gum Ridgetop Forest occurs on the fringes of the Cumberland Plain often associated with Mittagong Formation Sandstone that is comprised of interbanded layers of shale and sandstone material (DECCW 2009). Previously described as Upper Georges River Sandstone Woodland (Tozer 2003) and Hinterland Sandstone Transition Grey Gum Forest (DECCW 2009), these assemblages occur in the far south-western section of the Study Area on Lucas Heights Soil Landscapes (Figure 3).

Description and distinguishing features

Within the Study Area, Sydney Hinterland Grey Gum Ridgetop Forest forms moderately tall woodlands and open forests dominated by Grey Gum and Red Bloodwood with Sydney Peppermint (*Eucalyptus piperita*) and Thin-leaved Stringybark occurring less frequently (Appendix 1). Assemblages at the study site along and in the vicinity of Thirlmere Way are characterised by %CCPD values of up to 20% with trees attaining heights from 12 to 20m. Mid-storey and understorey strata vary in %CCPD from 5 – 10% with small trees and shrubs ranging from 1 – 8m in height. Understorey shrubs attain %CCPD values from 5 – 10% with heights from 1 – 3m. The ground stratum is well developed with some bare patches of ground.

Black Sheoak (*Allocasuarina littoralis*) and Sweet Pittosporum (*Pittosporum undulatum*) are common small tree species.

Species richness

This ecological community has a relatively high species diversity of 71 indigenous species/400m^2 with an exotic species number of 6 species/400m^2 (Table 2).

Figure 12 – Area of regenerating Sydney Hinterland Grey Gum Ridgetop Forest occurring at Lot 167 Thirlmere Way, Thirlmere.

Floristic composition

Sydney Hinterland Grey Gum Ridgetop Forest assemblages are dominated by a combination of tree species such as Grey Gum, Red Bloodwood, Sydney Peppermint (*Eucalyptus piperita*) and Thin-leaved Stringybark (Appendix 1).

Small trees such as Black Sheoak (*Allocasuarina littoralis*) and Sweet Pittosporum are common in the understorey stratum. A variety of small shrub species, also commonly occurring on Hawkesbury Sandstone substrates include Matted Bossiaea (*Bossiaea buxifolia*), Blunt-leaf Bitter Pea (*Daviesia mimosoides*), Prickly Shaggy Pea (*Podolobium ilicifolium*), Sunshine Wattle (*Acacia terminalis*), Prickly Moses (*Acacia ulicifolia*) and Pine-leaved Geebung (*Persoonia pinifolius*) (Appendix 1).

A relatively diverse herb, climber and grass dominated ground stratum commonly includes Rocket Goodenia (*Goodenia bellidifolia*), Native Summer Grass (*Digitaria ramularis*), Hedgehog Grass (*Echinopogon caespitosis*), Bordered Panic (*Entolasia marginata*), Variable Sword Sedge (*Lepidosperma laterale*), Threeawn Speargrass (*Aristida vagans*), Wallaby Grass (*Austrodanthonia fulva*), Weeping Grass (*Microlaena stipoides*), Slender Rice Flower (*Pimelea linifolia*), Appleberry (*Billardiera scandens*), Pomax (*Pomax umbellata*), Silky Purple Flag (*Patersonia sericea*), Many-flowered Mat-rush (*Lomandra multiflora*), Twining Glycine (*Glycine clandestina*), Whiteroot (*Pratia purpurascens*) Spiny-

headed Mat-rush (*Lomandra longifolia*), Twisted Mat-rush (*Lomandra obliqua*), Speargrass (*Austrostipa pubescens*) and Kangaroo Grass (*Themeda australis*) (Appendix 1).

Previous Mapping

Mapping by DEC (2002) (Figure 6) broadly confirms the current assessment of the distribution of Sydney Hinterland Grey Gum Ridgetop Forest with mapping of the distribution of the formerly described Upper Georges River Sandstone Woodland in the south-western corner of the Study Area in the vicinity of Thirlmere Way. The community is closely associated with Hawkesbury Sandstone lithology that occurs in this section of the Study Area (Figure 3).

Vegetation classification and status

The previously titled 'Hinterland Sandstone Transition Grey Gum Forest' (DECCW 2009) ecological community (formerly known as 'Upper Georges River Sandstone Woodland' in DEC 2002) has been re-named 'Sydney Hinterland Grey Gum Ridgetop Forest' (OEH 2013). The status of the re-named ecological community is not considered to be included in the definition of 'Shale Sandstone Transition Forest' and is subsequently not considered as an Endangered Ecological Community listed under either State of Commonwealth registers (OEH 2013, Tozer, Hagar *pers comm.* OEH 2013). Areas of the vegetation community are represented and conserved in Georges River National Park (DECCW 2009).

The Biometric Vegetation Type for the Hawkesbury-Nepean CMA Data Base (DECCW 2008) describes this community as 'Red Bloodwood - Grey Gum woodland on the edges of the Cumberland Plain, Sydney Basin' where it is not listed as an Endangered Ecological Community.

4.2.2.5 Riparian vegetation (Figures 5, 13 & 14)

Location

i) Redbank Creek

The drainage line of Redbank Creek that forms the northern boundary of the Study Area is characterised by low, steep rocky cliffs formed by stream erosion through Hawkesbury Sandstone parent material. The afore-described Cumberland Shale-Sandstone Transition Ironbark Forest with high sandstone influence that occurs along the lower northern slopes of the Study Area (Figure 5) merges with vegetation that occurs along the Redbank Creek drainage channel.

ii) Myrtle Creek

The drainage line of Myrtle Creek forms the southern boundary of the Study Area and traverses Hawkesbury Sandstone parent material. The creek channel has not been excised to the extent that the lower reaches of Redbank Creek have been eroded. Due

to a long and pervasive disturbance history, former naturally-occurring shrub and ground cover vegetation has been replaced by woody weeds and climbers many of which are listed as noxious woody weeds.

Description and distinguishing features

i) Redbank Creek

The riparian corridor along Redbank Creek is characterized by low rocky clifflines supporting a low closed forest of Grey Myrtle (*Backhousia myrtifolia*) at their base (Figure 13). Tall eucalypt species, mostly Grey Gum and Narrow-leaved Ironbark, form an emergent canopy to 28m tall with %CCPD of 20 – 25%. A mid-storey stratum of small trees has a %CCPD of ~20% with tree heights <10m. A shrub and small tree understorey is relatively dense with %CCPD of ~70%, attaining heights of 2 – 4m. Ground cover is restricted to areas of soil among the shrubs and rocks and has a %CCPD of 10 – 15%. The extent of rock outcropping in the Study Area ranges from 15 – 20%.

i) Myrtle Creek

The vegetation of the riparian corridor along Myrtle Creek is characterised by a closed scrub of noxious exotic woody weed species, associated exotic climbers and exotic ground cover species (Figure 14). Tall remnant eucalypt species, mostly Grey Gum, Narrow-leaved Ironbark, Woollybutt and Forest Red Gum form an emergent canopy ranging from 18 to 28m in height with %CCPD up to 25 – 30%. Individuals of River Peppermint (*Eucalyptus elata*) were also observed along the lower reaches of Myrtle Creek near York Road, Tahmoor. A mid-storey to understorey stratum of mostly exotic small trees and shrubs has a %CCPD of 40 - 80% with tree heights ranging from 5 - 10m.

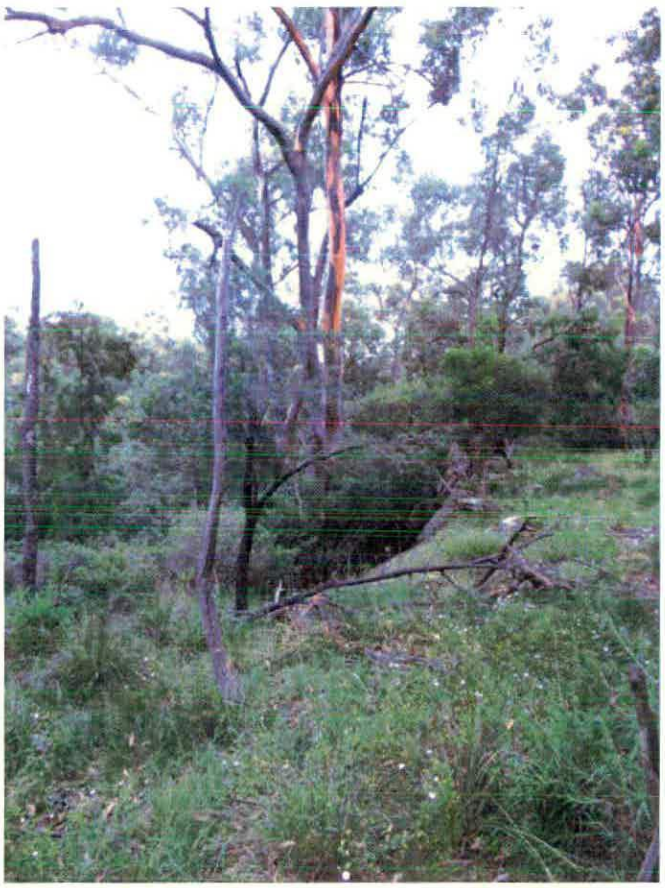

Figure 13 – Natural riparian vegetation occurring along the drainage channel of Redbank Creek at Lot 101 Tickle Drive, Thirlmere

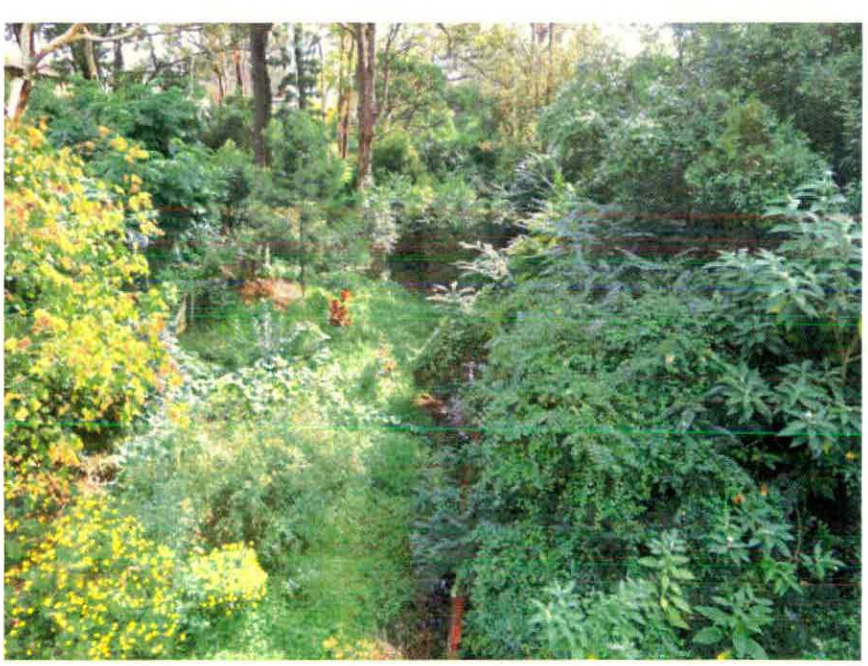

Figure 14 – Weed-infested riparian vegetation occurring along drainage channel of Myrtle Creek

Species richness

i) Redbank Creek

While difficult to distinguish specific riparian vegetation from adjoining Cumberland Shale-Sandstone Transition Ironbark Forest vegetation, the sandstone substrates of the soils being enriched by clay material, this ecological community has a relatively high species diversity of 28 indigenous species/400m^2 with 2 exotic species/400m^2 recorded (Table 2).

ii) Myrtle Creek

The former vegetation along this creekline would likely have resembled Cumberland Shale-Sandstone Transition Ironbark Forest, but with extensive weed incursion this ecological community currently has a low species diversity of 4 indigenous species/400m^2 with a mean of 8 exotic species/400m^2 (Table 2).

i) Redbank Creek

Floristic composition

The ecological assemblage within and along the Redbank Creek riparian corridor is dominated by a combination of tree species such as Grey Gum, Narrow-leaved Ironbark, Rough-barked Apple (*Angophora floribunda*), Red Bloodwood, Sydney Peppermint (*Eucalyptus piperita*) and Thin-leaved Stringybark with Grey Myrtle forming a low closed forest within the creek channel (Figure 13) (Appendix 1).

Small trees such as Black Sheoak (*Allocasuarina littoralis*), Forest Sheoak (*Allocasuarina torulosa*), Mock Olive (*Notelaea longifolia*), Hairy Clerodendrum (*Clerodendrum tomentosum*), Parramatta Green Wattle (*Acacia parramattensis*) and Narrow-leaved Geebung (*Persoonia linearis*) are common in the mid-storey/understorey stratum.

A relatively diverse herb, climber and grass dominated ground stratum commonly includes Rock Fern, Native Summer Grass (*Digitaria ramularis*), Hedgehog Grass (*Echinopogon caespitosis*), White Burr-daisy, Variable Sword Sedge (*Lepidosperma laterale*), *Lepidosperma tortuosum*, Violet-leaved Goodenia (*Goodenia hederacea*), Weeping Grass (*Microlaena stipoides*), Jasmine Morinda (*Morinda jasminoides*), Pomax (*Pomax umbellata*), Forest Nightshade, Wattle Mat-rush (*Lomandra filiformis*), Twining Glycine (*Glycine clandestina*), Nodding Blue Lily (*Stypandra glauca*), Spiny-headed Mat-rush (*Lomandra longifolia*), Twisted Mat-rush (*Lomandra obliqua*), Speargrass (*Austrostipa pubescens*) and Kangaroo Grass (*Themeda australis*) (Appendix 1).

ii) Myrtle Creek

Floristic composition

The tree canopy within and along the Myrtle Creek riparian corridor is dominated by a combination of tree species such as Grey Gum, Narrow-leaved Ironbark, Forest Red Gum and Woollybutt, with River Peppermint occurring less frequently (Figure 14) (Appendix 1).

A few indigenous small tree species occur scattered throughout a weed-infested scrub stratum including Sydney Green Wattle (*Acacia decurrens*) and Sally Wattle (*Acacia floribunda*). Most of the floristic composition of this stratum is comprised of the noxious woody weeds Small-leaved Privet (*Ligustrum sinense*) and Large-leaved Privet (*Ligustrum lucidum*) with Japanese Honeysuckle (*Lonicera japonica*) a common vine species occurring throughout the assemblage and Wandering Jew (*Tradescantia fluminensis*) occurring in a limited ground cover stratum (Appendix 1).

Previous Mapping

i) Redbank Creek

Mapping by DEC (2002) (Figure 6) includes vegetation occurring along this drainage line as Cumberland Shale-Sandstone Transition Ironbark Forest concurring with the current assessment.

The linear distribution of Grey Myrtle dominated low closed forest occurring within the rock-walled channel of the creek however could be recognised as a form of Hinterland Ranges Dry Rainforest, previously recognised as Western Sydney Dry Rainforest (DEC 2002, Tozer 2003).

ii) Myrtle Creek

The vegetation along this section of the Study Area has been extensively modified and degraded due to historical clearing and uncontrolled activity adjacent to residential development. The remnant natural tree cover has been retained but the composition of the assemblage does not currently resemble Cumberland Shale-Sandstone Transition Ironbark Forest as indicated by previous mapping by DEC (2002) (Figure 6).

Vegetation classification and status

i) Redbank Creek

The vegetation aligned along Redbank Creek is assessed as Cumberland Shale-Sandstone Transition Ironbark Forest with high sandstone influence. This community is a component of Shale-Sandstone Transition Forest listed as an 'Endangered Ecological Community' under Part 3 of Schedule 1 of the NSW *TSC Act (1995)*. This community is also listed as an

'Endangered Ecological Community' as a component of Shale-Sandstone Transition Forest under the *EPBC Act (1999)*.

The Biometric Vegetation Type for the Hawkesbury-Nepean CMA Data Base (DECCW 2008) describes this community as 'Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin' listed as an Endangered Ecological Community.

The linear distribution of Grey Myrtle dominated low closed forest occurring within the creek line channel however could be recognised as a form of Hinterland Ranges Dry Rainforest, a component of Western Sydney Dry Rainforest listed on Part 3 of Schedule 1 of the NSW *TSC Act (1995)*.

ii) Myrtle Creek

The vegetation along this section of the Study Area has been extensively modified and degraded due to clearing and uncontrolled activity adjacent to residential development. The remnant natural tree cover is retained but the composition of the assemblage does not resemble Cumberland Shale-Sandstone Transition Ironbark Forest as indicated by previous mapping.

The canopy of naturally-occurring trees established along this drainage line are remnant of a former distribution of Cumberland Shale-Sandstone Transition Ironbark Forest, this community being a component of Shale-Sandstone Transition Forest listed as an 'Endangered Ecological Community' under Part 3 of Schedule 1 of the NSW *TSC Act (1995)*. This community is also listed as an 'Endangered Ecological Community' as a component of Shale-Sandstone Transition Forest under the *EPBC Act (1999)*.

As such, the status of the degraded nature of this vegetation community is unclear.

4.2.3 Flora species of conservation significance

Threatened species

OEH Atlas of NSW Wildlife (March 2012) records for an area of 5km radius around the Study Area indicate that 7 flora species of conservation significance have been recorded since 1985. According to guidelines listed by the EPBC 'Protected Matters Search Tool' (March 2012), it was deemed that habitat may potentially occur for a further 11 threatened flora species. Appendix 2 lists these 18 species with an account of their threatened status, geographical range, physiognomic attributes, habitat features and likelihood of occurrence in the Study Area.

Most records of threatened flora species occur from locations in natural bushland either associated with the creekline vegetation along the Bargo River well to the east, south-east and south or with Thirlmere Lakes National Park to the south-west of the Study Area (OEH Atlas of NSW Wildlife Wollongong 1:100 000 Sheet April 2012).

Habitat is suitable in the Study Area for three threatened flora species. These include Bargo Geebung (*Persoonia bargoensis*), Mittagong Geebung (*Persoonia glaucescens*) and Brown Pomaderris (*Pomaderris brunnea*). These species have been recorded from 3 to 4km to the east, south-east, south and south-west of the Study Area in natural bushland. All of these species have typical large-life forms and targeted searches were made in suitable habitats for any individuals of these species (Cropper 2003, DEC 2004), as well as for the 15 other flora species of conservation significance either recorded in the vicinity or where suitable habitat may occur, but none were located. As such, it is considered that none of these species are likely to occur within the Study Area.

RoTAP species

No RoTAP species (Briggs & Leigh 1996) were recorded in the subject area.

Species of local or regional significance

Individuals of a species of regional significance, Small Parrot-pea (*Dillwynia parvifolia*), were observed in an area of open woodland along Thirlmere Way in a patch of Sydney Hinterland Grey Gum Ridgetop Forest.

4.2.4 Key threatening processes

No key threatening processes currently occur in relation to ecosystem processes in the Study Area. The current principal modifying effect on natural vegetation, particularly the ground stratum, is through limited but persistent grazing by domestic animals.

4.3 Conclusions of the terrestrial flora assessment

Conclusions from the flora assessment are as follows:

Four relatively distinct vegetation communities could be recognized over the broad region of the Study Area. These floristically discrete ecological communities occurring over the landscape include three Endangered Ecological Communities that are described in DECCW (2009) as follows:

- Cumberland Shale Hills Woodland (CEEC),
- Cumberland Shale-Sandstone Ironbark Forest (varying degree of shale: sandstone influence) (EEC),
- Sydney Hinterland Grey Gum Ridgetop Forest, and
- Mixed Riparian Forest at Myrtle Creek where the natural vegetation has been extensively cleared and degraded but some canopy trees remain

The natural vegetation of the Study Area has mostly been partially cleared, disturbed, grazed or otherwise degraded, though some patches of relatively weed-free, full-structured vegetation remain. These occur mostly along the edges of Redbank Creek and at the eastern end of Tickle Drive, Thirlmere, and to the south below Glennane Place, Tahmoor (Figure 5).

Many areas of bushland have been modified for grazing with mid-storey and understorey strata removed though with a significant tree canopy retained. Many of these modified woodland areas also retain a ground stratum that is rich with indigenous species of grasses, twiners and herbs.

Large areas of the Study Area have been cleared of most of the upper canopies with only a scattering of trees remaining, but still retaining a relatively high number of indigenous species in a grassy ground layer. Other areas have been extensively landscaped with few indigenous trees remaining and lawn grass established in a managed curtilage.

The relative Conservation Value or 'disturbance' level of the vegetation can be ranked as follows:

- Full structured, stratified vegetation with three to four identifiable strata (relatively unmodified and un-degraded), with relatively high indigenous species richness and relatively few weed species.

  These patches of less disturbed, more natural vegetation distributions equate to areas of High Biodiversity Conservation Value.

- Modified vegetation (unstructured vegetation) with relatively moderate to high tree frequency retained (from about 15 – 30% CCPD), but with understorey and mid-storey stratum removed. The current ground stratum condition is maintained by grazing or slashing but usually includes a diverse indigenous ground stratum. Other areas may have a high-retained native tree canopy (15 – 30%CCPD) but the ground stratum has been landscaped or pasture-improved with exotic grass cover.

  These patches of modified vegetation with relatively high tree cover, but sparse if any, mid-stratum or understorey species canopies, equate to areas of Moderate Biodiversity Conservation Value.

- Highly modified assemblages with few remnant indigenous trees remaining but having either a partial natural ground cover stratum or pasture-improved ground cover or including landscaped areas with exotic trees and managed grassy lawn ground cover.

  These patches of highly modified vegetation with relatively low tree cover but large expanses of grassy ground cover equate to areas of Low Biodiversity Conservation Value.

OEH Atlas of NSW Wildlife records for an area of 5km radius around the Study Area indicate that 7 flora species of conservation significance have been recorded since 1985. According to guidelines listed by the EPBC 'Protected Matters Search Tool' (March 2012), it was deemed that habitat may potentially occur for a further 11 threatened flora species.

Most records of threatened flora species occur from locations in natural bushland either associated with the creekline vegetation along the Bargo River well to the east, south-east and south, or with Thirlmere Lakes National Park to the south-west of the Study Area.

Habitat is suitable in the Study Area for three threatened flora species. These include Bargo Geebung (*Persoonia bargoensis*), Mittagong Geebung (*Persoonia glaucescens*) and Brown Pomaderris (*Pomaderris brunnea*). All of these species have typical large-life forms and targeted searches were made in suitable habitats for any individuals of these species (Cropper 2003, DEC 2004), as well as for the 15 other species of conservation significance either recorded in the vicinity or where suitable habitat may occur, but none were located. As such, it is considered that none of these species are likely to occur within the Study Area.

Individuals of a species of regional significance, Small Parrot-pea (*Dillwynia parvifolia*), were observed in an area of open woodland at the far south-western section of the Study Area in a patch of Sydney Hinterland Grey Gum Ridgetop Forest.

4.4 Terrestrial Fauna Results

4.4.1 Weather conditions during survey periods

28.03.12 - 0900hrs-1600hrs, temp 23°C; light rain, cloud cover 85%; light wind
03.04.12 - 0900hrs-1500hrs, temp 23°C; no cloud cover; no wind
04.04.12 - 0900hrs-1500hrs, temp 22°C; no cloud cover; light wind
11.04.12 - 0915hrs-1530hrs, temp 18°C; no cloud cover; no wind
27.04.12 - 0915hrs-1430hrs, temp 20°C; no cloud cover; no wind

4.4.2 Site potential to form part of a fauna habitat corridor

The Nepean River forms a riparian corridor (centre of photograph in Figure 15) for fauna movement with small extensions in the form of creeks and tributaries branching off at intervals. The Study Area is situated between two small tributaries, Myrtle Creek to the south and Redbank Creek to the north. Fauna utilise the Nepean riparian corridor extensions to forage, however terrestrial fauna movement is limited to unfenced land within the corridor.

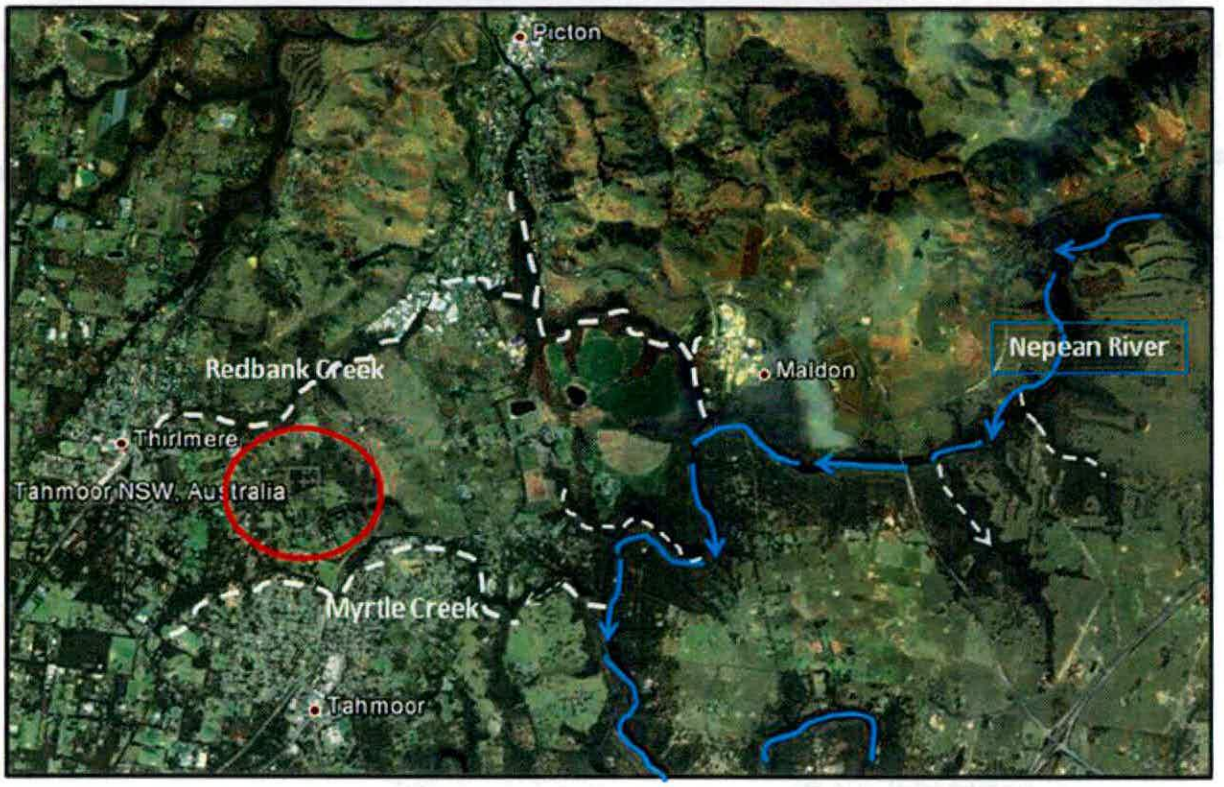

Figure 15 Aerial view of the riparian corridor in the vicinity of the Study Area (red circle). Redbank Creek and Myrtle Creek are tributaries of the Nepean River system. Both terrestrial and avifauna are able to move along riparian corridors to forage.

4.4.3 Terrestrial fauna habitats

Quality of fauna habitat is categorised by the presence of certain features that include whether or not the vegetation provides shelter, food resources and nesting or roosting opportunity for native fauna species. Other elements that contribute to the quality of habitat are the presence of tree hollows, dead and fallen timber, rock crevices and caves. Additionally, fauna habitat also includes the contribution an area has towards a fauna movement corridor. There are three categories chosen for this survey to qualify fauna habitat value within the Study Area (Figure 16):

Good: contains a combination of any of the following: good canopy coverage with a relatively undisturbed indigenous floristic ground cover; established mid-storey vegetation coverage; high number of nesting structures and shelter present in the form of fallen timber, hollow logs or tree hollows; water structure; high diversity of fauna species; contribution to a fauna movement corridor.

Moderate: contains a combination of any of the following: moderate canopy coverage with a moderate coverage of indigenous floristic ground cover; some to no mid-storey coverage; some nesting structures in the form of fallen timber, hollow logs; no tree hollows; a moderate diversity of fauna species; a fragmented contribution to fauna movement corridor.

Poor: contains a combination of any of the following: very open to no canopy coverage with a low number of indigenous floristic ground cover; no mid-storey coverage; very few nesting structures, no fallen timber, no hollow logs or tree hollows; a very low diversity of fauna species; no contribution to a fauna movement corridor.

4.4.4 Fauna habitats recorded

i) Forest

Tall canopy trees provide sheltering and food resources for many arboreal species. Some mature trees contained some small hollows that are large enough for some bird or bat species to nest. Large hollows for the big owl species were not recorded within the Study Area. Where mid-storey indigenous vegetation is dense creating sheltering and roosting opportunity for fauna, habitat quality is considered to be good. These areas are located within the riparian corridor at the eastern end of Redbank Creek.

Within the forest are individuals of the tree species Forest Red Gum (*Eucalyptus tereticornis*) which provide nectar during winter for some threatened bird species such as the Regent Honeyeater and Swift Parrot. Individuals of Grey Gum (*Eucalyptus punctata*) present at the northern section of Lots 101 and 104 are a preferred food resource for Koala.

Cleared agricultural land adjacent to the forest has created edge effects reducing potential fauna diversity and in some areas the Bell Miner (*Manorina melanophrys*) is present in large numbers effecting die-back in many of the forest trees. Fauna habitat quality in these areas is reduced to moderate, located at the western end of Redbank Creek and on the western side of the railway line.

ii) Woodland

Woodland habitat within the Study Area is mostly Cumberland Plain Woodland vegetation. Some canopy trees within the woodland contained small hollows, large enough for small birds or bats to nest. Leaf litter was present and in general the area was covered in tall pasture grass. A past history of agricultural disturbance rendered the area not optimal for the Cumberland Plain Land Snail.

The grass pasture provides a foraging resource for macropods but the presence of barbed-wire fencing surrounding properties reduces their likely presence. In some areas weed incursions of spiky and thorny weeds provides shelter for small woodland birds. In several locations dams were present with emergent vegetation that provides a water resource for small woodland birds, large aquatic bird species and frogs.

In many areas agricultural activity has produced significant edge effects, reducing fauna diversity and connectivity to fauna movement corridors is fragmented. Therefore the quality of fauna habitat in these areas is rated as moderate.

iii) Exotic/native pasture

Exotic/native pasture covers most of the developed agricultural areas of the Study Area. Heavily grazed paddocks represent very poor habitat for most native species. Where tall native grasses are present they provide habitat for small birds and reptiles. Dams are often present but with no supporting vegetation surrounding the banks they offer poor quality habitat for frogs and waterfowl. In many locations rabbits have caused severe erosion. The rabbits however do provide a food resource for birds of prey. Cattle, horse, goat and rabbit foraging has left eroded areas that offer no protection for native species from predators. There is connectivity to fauna movement corridors.

Therefore the quality of fauna habitat in these areas is rated as poor.

4.4.5 Terrestrial fauna recorded

Opportunistic fauna were recorded at locations throughout the Study Area as shown in Figure 16. These are listed in Appendix 3 and include 5 amphibian species, 4 reptiles, 66 birds and 5 native and 6 introduced mammals.

Some bird species occur in relatively high frequency such as;

(i) Bell Miner that has caused significant indirect damage to eucalypts in several areas along Redbank and Myrtle Creeks;

(ii) Magpie Lark in open paddock and developed areas; and

(iii) Eastern Rosella in woodland close to railway corridor. This relatively natural vegetation, together with the riparian vegetation in the eastern part of Redbank Creek, showed the greatest bird diversity.

A low diversity of native mammalian species was found across the Study Area. Macropods recorded occurred within the riparian corridor of Redbank Creek. There was no evidence of small ground dwelling native mammalian species. The presence of the predatory Fox could have produced these results. Microchiropteran bats are expected to occur due to the presence of small hollows and fissures suitable for roosting. Reptilian fauna species diversity was low possibly due to the cooler daytime and cold night temperatures experienced during the survey.

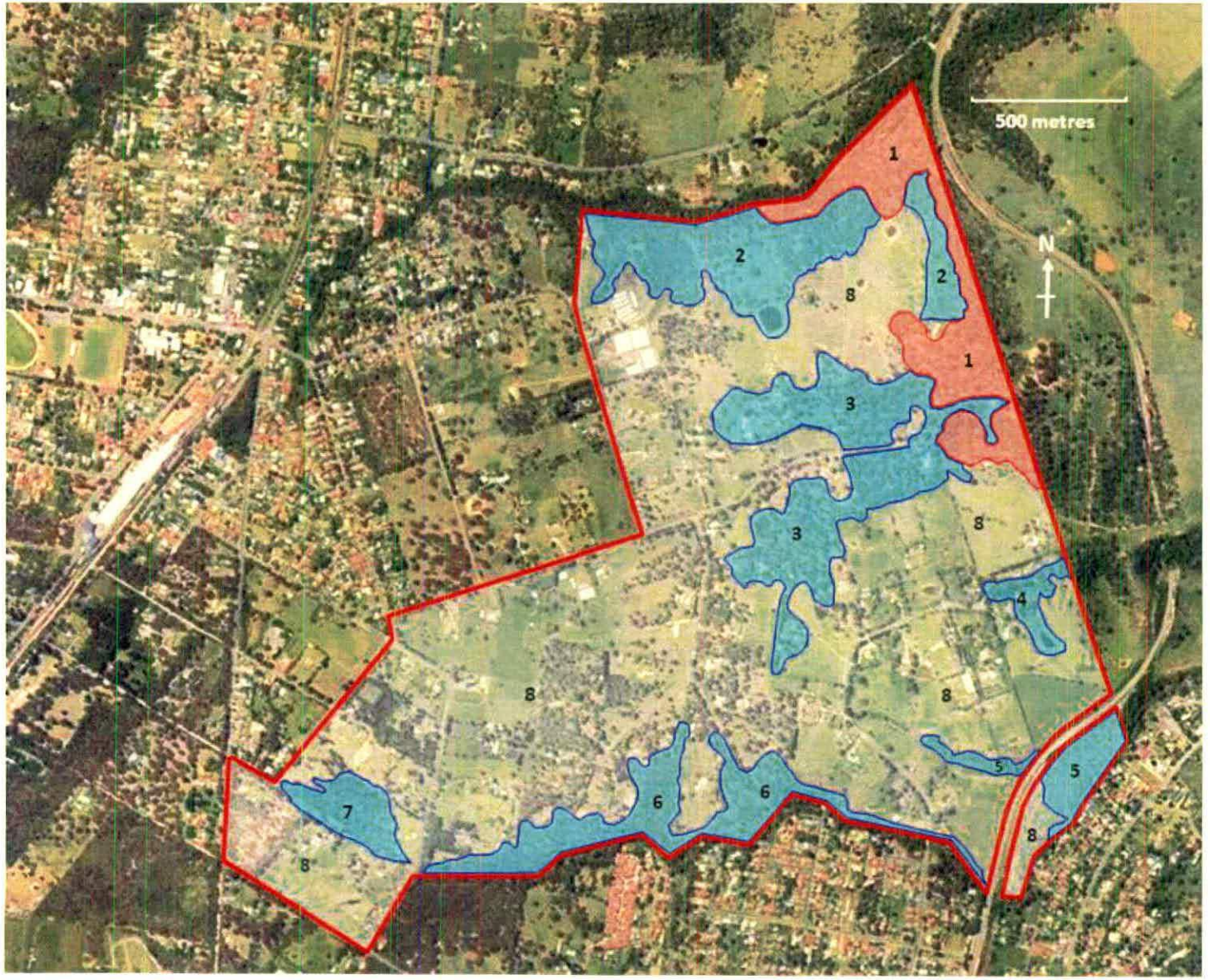

Figure 16
Fauna habitats within PTTAG Study Area (Section 4.4.3).

Good habitat (area 1)

Moderate habitat (areas 2 -7)

Poor habitat (area 8)

Numbers indicate locations of fauna recorded as listed in Appendix 3

4.5 Terrestrial fauna species of conservation significance

4.5.1 Threatened species

The Atlas of NSW Wildlife database (March 2012) (Office of Environment and Heritage) lists twenty five (25) species of fauna classified as threatened under the Threatened Species Conservation Act, 1995 (TSC Act) and Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) within a 5 km radius of the Study Area (Table 3).

Table 3 Sightings of threatened species of fauna recorded within 5 km radius
(Sightings numbers source: OEH Atlas of NSW Wildlife Database 2012.

Scientific Name	Common Name	EPBC Act	TSC Act	Number of Sightings within 5km of the site
Pseudophryne australis	Red-crowned Toadlet		V	1
Lophoictinia isura	Square-tailed Kite		V	1
Hieraaetus morphnoides	Little Eagle		V	1
Burhinus grallarius	Bush Stone-curlew		E1	1
Callocephalon fimbriatum	Gang-gang Cockatoo		V	7
Calyptorhynchus lathami	Glossy Black-Cockatoo		V	7
Glossopsitta pusilla	Little Lorikeet		V	1
Ninox strenua	Powerful Owl		V	1
Tyto tenebricosa	Sooty Owl		V	1
Climacteris picumnus victoriae	Brown Treecreeper (eastern subsp.)		V	5
Anthochaera phrygia	Regent Honeyeater		E4A	3
Melithreptus brevirostris	Brown-headed Honeyeater		V	5
Daphoenositta chrysoptera	Varied Sittella		V	3
Melanodryas cucullata cucullata	Hooded Robin (south-eastern form)		V	1
Petroica boodang	Scarlet Robin		V	1
Stagonopleura guttata	Diamond Firetail		V	1
Dasyurus maculatus	Spotted-tailed Quoll	V	V	2
Phascolarctus cinereus	Koala	V	V	2
Petrogale penicillata	Brush-tailed Rock-wallaby	V	E1	1
Mormopterus norfolkensis	Eastern freetail-Bat		V	1
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	1
Miniopterus schreibersii oceanensis	Eastern Bentwing Bat		V	2
Myotis macropus	Southern Myotis		V	1
Scoteanax ruepelli	Greater Broad-nosed Bat		V	1
Meridolum corneovirens	Cumberland Plain Land Snail		E1	3

Key	
Environmental Protection and Biodiversity Conservation Act (EPBC Act) 1999	*Threatened Species Conservation Act (TSC Act) 1995*
	E1 - Endangered
E - Endangered	E4 - critically endangered
V - Vulnerable	V - Vulnerable

Two threatened species listed were recorded during the survey. These were the Varied Sittella and Little Lorikeet.

Other threatened fauna species identified as having potential to occur on the site were also assessed. These included the Koala, Swift Parrot, Regent Honeyeater, Hooded Robin, Scarlet Robin, Diamond Firetail, Gang-gang Cockatoo, Brown Tree-creeper and Eastern Bentwing Bat. Assessment of habitat in the woodland concluded that these species may occasionally forage within the Study Area.

4.5.2 Species listed by the Commonwealth SEWPaC (Commonwealth Protected Matters Search Tool) as potential inhabitants of the site.

Threatened species listed by the Department of SEWPaC (Canberra) were reviewed in relation to the distribution, habitat and likelihood of occurrence. The current study concluded that some areas do contain foraging habitat for the Grey-headed Flying Fox, which may occasionally visit the site of the Study Area during flowering periods of eucalypts, the Swift Parrot specifically when Forest Redgum is in flower.

4.5.3 Species listed by the Commonwealth SEWPaC (Commonwealth Protected Matters Search Tool) as potential migratory inhabitants of the site.

Each of the migratory species listed by the Commonwealth SEWPaC (Canberra) was reviewed in relation to the distribution, habitat and likelihood of occurrence. Those expected to occur are the Black-faced Monarch in woodland areas, the Rufous Fantail within riparian areas and the Cattle Egret in areas of pasture.

4.6 Introduced/ invasive pest fauna

One introduced invasive pest species and one feral predator was recorded within the Study Area. They included the Rabbit (*Oryctolagus cuniculus).* Warrens and digging activity were recorded in most of the pasture areas and the European Red Fox was recorded by scat evidence in several locations near locations containing rabbit warrens.

4.7 Key threatening processes

Key Threatening Processes (as per Schedule 3 of the *TSC Act, 1995*) that may affect fauna habitat in, and surrounding, the Study Area.

Listed under the TSC Act:

1. Clearing of native vegetation - Destruction of habitat is the major cause of loss of biological diversity. For species of restricted distribution, clearing of native vegetation may result in total extinction, for more widespread species there may be loss of local genotypes. Clearing, as defined by the determination, refers to the destruction of a sufficient proportion of one or more strata (layers) within a stand or stands of native vegetation.
2. Removal of dead wood and dead trees - Removal of old dead trees (either standing or on the ground) results in the loss of important habitat such as hollows and decaying wood for a wide variety of vertebrates, invertebrates and microbial

organisms. Dead wood or hollow logs that may contribute to a fire path should be relocated within the compound.

3. Competition and grazing by the feral rabbit- Grazing and burrowing by rabbits can cause massive erosion problems, reduce recruitment and survival of native plants, and alter entire landscapes. Rabbits also threaten the survival of a number of native animal species by altering habitat, reducing native food sources, displacing small animals from burrows and attracting introduced predators such as foxes.

4.8 Conclusions of terrestrial fauna assessment

This terrestrial fauna survey was undertaken to record fauna species currently utilizing the Study Area and to assess the habitat values for threatened species listed in the database for the Study Area.

Database searches at Local, State and Federal Government level were undertaken to identify threatened species that had been recorded previously in the Study Area. Two threatened fauna species listed were recorded during this current survey. These were the Varied Sittella and Little Lorikeet.

Other threatened species identified as having potential to occur within the Study Area were also assessed. These included the Koala, Swift Parrot, Regent Honeyeater, Hooded Robin, Scarlet Robin, Diamond Firetail, Gang-gang Cockatoo, Brown Tree-creeper and Eastern Bentwing Bat. Assessment of habitats concluded that potential exists for these species to forage within the Study Area.

The diverse array of avifauna present throughout the Study Area reflects the varied structure and vegetation assemblages present. The presence of fallen tree trunks and branches, which serve as nesting structures and protective hides, in the floristically denser riparian areas, would be expected to support a high diversity of small mammals. This was not found to be the case, however, as only a relatively low diversity of small ground dwelling mammalian fauna was recorded. Factors influencing this low diversity possibly include predation by the European Fox. Currently there is easy access along the Nepean River for Fox to enter the Study Area and the presence of Rabbit ensures a continual food source.

4.9 Aquatic Flora and Fauna Results

4.9.1 Aquatic flora

i) Redbank Creek

No aquatic vegetation was found to occur in the shallow and periodically fast-flowing stream channel of Redbank Creek.

ii) Myrtle Creek

At the lower reaches of Myrtle Creek (adjacent to York Road, Tahmoor), the following aquatic vegetation was recorded (Table 4):

Table 4 – Aquatic vegetation occurring in the lower reaches of the waterway channel of Myrtle Creek

Status	Scientific Name	Common Name	Relative Ranked Frequency *
	MAGNOLIOPSIDA: MAGNOLIDAE		
	Brassicaceae		
Exotic	*Rorippa micropylla*	One-rowed Watercress	c
	Haloragaceae		
Exotic	*Myriophyllum aquaticum*	Parrot-feather	c
	Polygonaceae		
Indigenous	*Persecaria decipiens*	Slender Knotweed	c
	MAGNOLOPSIDA: LILIDAE		
	Cyperaceae		
Exotic	*Isolepis prolifera*		o
	Juncaceae		
Indigenous	*Juncus usitatus*	Common Rush	o

Relative ranked frequency of occurrence *
c very common – common
o moderately common – occasional
u relatively uncommon – uncommon

A total of 5 water plant species were recorded at the lower reaches of Myrtle Creek near York Road, Tahmoor (Table 4). Three of these species are exotic and two indigenous, but all are common species occurring in and around waterways in much of NSW.

4.9.2 *Aquatic fauna*

Redbank Creek and Myrtle Creek have nominally been listed as containing 'Key Fish Habitat' (NSW DPI, NSW OEH and NSW LPI). Figure 17 indicates that most of the streams mapped in the Wollondilly LGA are considered to have key fish habitat.

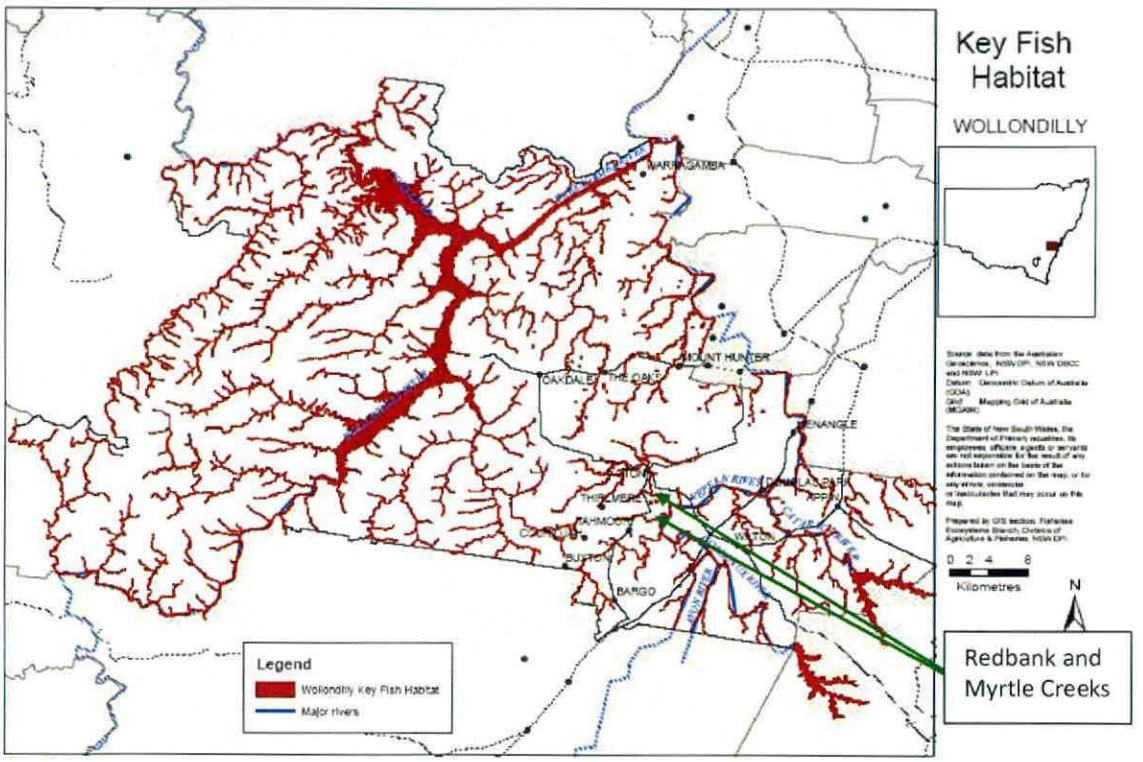

Figure 17 - Indicates that Redbank Creek and Myrtle Creek are considered to contain 'key fish habitat'.

i) Redbank Creek

No fish were caught during the survey. Five yabbies (*Cherax destructor*), not locally indigenous, were caught ranging in length from from 20 to 50 mm. The creek had potentially good fish habitat including rock shelves, pools, runs and woody debris. Water depth was quite shallow with the majority of the creek surveyed only 50mm deep. There was one deeper section of up to half a meter in depth.

The absence of fish in Redbank Creek could be attributed to the creek being ephemeral. A local resident had observed that the headwaters of the creek would dry out completely during dry periods. The absence of species of eel also suggests that the creek could dry out.

Although yabbies were found they can move overland or upstream during wet periods to inhabit new areas. There may also be a natural or manmade barrier downstream preventing the migration of fish.

A conductivity estimate of the stream water was about 400μm/ml, which suggests a relatively unpolluted catchment.

ii) Myrtle Creek

No fish were caught during the survey. There were many earthworms present and one individual of dragonfly larvae captured. The creek was sampled in two separate locations, the lower section being heavily urbanized and the upper section heavily infested with Privet.

The absence of fish in Myrtle Creek could be attributed to the creek being ephemeral. There were several sections of the creek that were currently dry, and as the region has just had one of the wettest summers on record, this suggests that the creek may dry out to the point that there is no habitat remaining for fish. The absence of species of eels also suggests the creek could dry out. Las in the case of Redbank Creek, there may also be a natural or manmade barrier downstream prevent migration of fish.

A conductivity estimate of the stream water was about 500μm/ml, which suggests a relatively greater polluted catchment than that for Redbank Creek.

5 Assessment of biodiversity values

5.1 Conservation significance of remnant vegetation communities in Study Area.

5.1.1 Assessed conservation significance of remnant vegetation communities in Study Area.

Figure 5 indicates the distribution of relative ranked conservation significance assessed for the vegetation of the Study Area, with areas denoted as being either of 'high', 'moderate' or 'low' conservation significance.

Figure 18 indicates the mapping of the locality including the Study Area as an Assessment of Conservation Significance by DEC (2002).

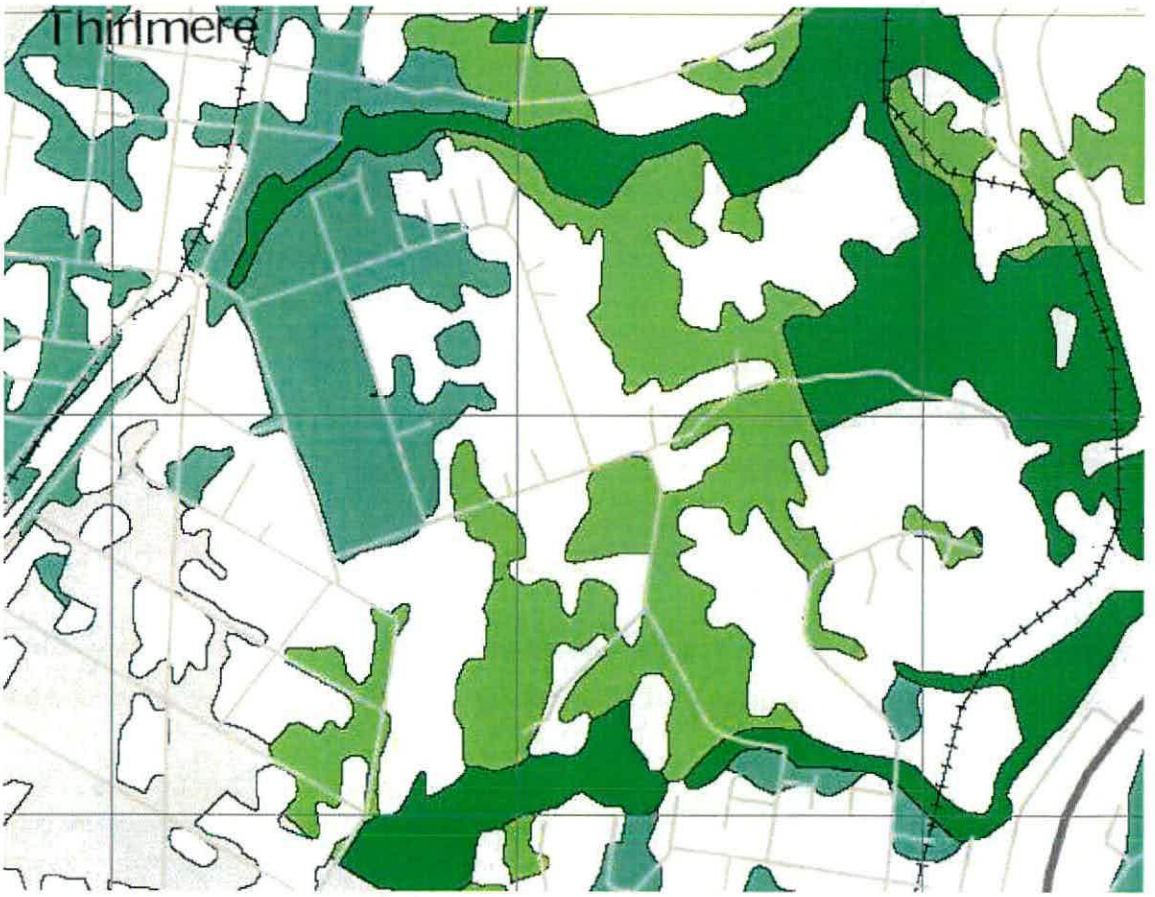

Figure 18 – Indicates mapping by DEC (2002) of the Conservation Significance Assessment of the locality including the PTTAG Study Area. The dark green polygons represent 'Core Habitat', the light green polygons represent 'Areas that are Support for Core Habitat', the blue-green polygons represent 'Other Vegetation' and the grey areas represent 'Unclassified Vegetation' (DEC 2002)

'Core Habitat' includes areas of vegetation that constitute a framework of a viable conservation network across the local landscape (core areas) or, as in the case of Cumberland Plain Woodland, endangered communities that are at imminent risk of extinction (critically endangered communities) (DEC 2002).

Areas denoted as 'Support for Core Habitat' are areas of vegetation that provide a range of supporting values to the areas of 'Core Habitat', including an increase in potential size of remnant, providing corridor connections and providing buffering relief from potential edge effects (DEC 2002). Usually this includes areas where the remnant vegetation has less than 10% CCPD or lacks floristic diversity and structure with understorey and mid-storey strata having been removed, but where these areas are contiguous with areas of 'Core Habitat'.

Figure 5 indicates that the vegetation of the Study Area represents fragmented distributions of two discrete, currently retained or modified Endangered Ecological Communities: Cumberland Shale Hills Woodland and Cumberland Shale-Sandstone Transition Ironbark Forest (Figures 5 & 6).

The extant vegetation of the Study Area incorporating distributions of these two ecological communities can be further delineated into three discrete conservation classes depending on the extent of local retention of natural vegetation, the degree of historical clearing and disturbance, and the resultant structural and floristic attributes of the remnant vegetation.

These three levels of conservation value relating to vegetation remnants are as follows (Figure 5):

High Conservation Value

Where there has been little historical clearing, disturbance or degradation, or where the patch of vegetation has been previously disturbed but has had time for understorey and mid-storey strata to recover, then a stratified, or structurally intact vegetation results. This vegetation is usually associated with relatively high indigenous species diversity or species richness and relatively few weed species (Table 2). Tree canopy cover (%CCPD) in these patches is usually greater than 15% and up to 30% over areas >0.5 ha (Figure 5).

This delineation is comparable to that used for mapping of Cumberland Plain vegetation by DEC (2002), the classification Code 'A' given to natural remnant vegetation where the canopy is intact forming a natural overstorey density and including a relatively undisturbed understorey stratum (DEC 2002 extracted from Roberts (1999)).

Areas of High Conservation Value mapped within the Study Area in Figure 5 generally compare with those mapped by DEC (2002) as 'Core Habitat', with potential linkages from ridgeline vegetation through to creeklines to the north and south (Figures 5 & 18). 'Core Habitat' includes areas of vegetation that constitute a framework of a viable conservation

network across the local landscape (core areas) or, as in the case of Cumberland Plain Woodland, endangered communities that are at imminent risk of extinction (critically endangered communities) (DEC 2002). Exception to this similarity in mapping possibly occurs along Myrtle Creek where extensive weed infestation precludes most of this area from having a high conservation assessment (Figures 5 & 18).

Areas of vegetation mapped as having High Conservation Value (Figure 5), equivalent to those mapped by DEC (2002) as 'Core Habitat' (Figure 18), have significant conservation attributes in relation to both flora and fauna and meet the criteria for recognition as a listed threatened ecological community as defined in the TSC Act or by the NSW Scientific Committee (2009).

Stands of relatively undisturbed remnant vegetation contain varied and valuable habitat resources such as mature trees with nesting and breeding hollows, roosting sites, food sources for insectivorous birds, dead or hollow fallen logs, diverse groundcovers of grass, sedge and forb species, watercourses, rills and damp courses, rocks, understorey shrubs, and leaf litter. Restoration of the structural and floristic diversity of extensively disturbed or cleared areas is difficult to recreate and emphasis is given to retaining areas of relatively natural remnant vegetation (DEC 2005).

Such patches of bushland occur in vegetated landscapes aligned along the edges of Redbank Creek, in the vicinity of the upslope eastern extremities of Tickle Drive, Thirlmere, and in sections of bushland in the south-west of the Study Area in the vicinity of Myrtle Creek and Thirlmere Way (Figure 5).

These relatively large patch size areas of less disturbed, more natural vegetation distributions, equate to remnant areas of High Biodiversity Conservation Value having high regenerative potential and diverse flora and faunal habitats.

Moderate Conservation Value

Much of the remnant natural vegetation of the Study Area has incurred significant historical clearing or modification to the structural integrity of the vegetation, though often with relatively moderate to high tree frequency retained. The understorey and mid-storey strata have mostly been removed in these structurally modified woodlands and current ground stratum condition is continuously maintained by grazing or slashing.

This vegetation usually contains relatively high indigenous species diversities or species richness, including a wide array of native grass and herb species, but with relatively higher numbers and abundances of exotic grass and herb species than observed in less disturbed vegetation (Table 2). Tree canopy cover (%CCPD) in these patches is usually greater than 10% and up to 30% over areas >0.5 ha.

This delineation is loosely comparable to that used for mapping of Cumberland Plain vegetation by DEC (2002) (Figure 6). DEC (2002) gives the classification Code 'B' to natural remnant vegetation where the canopy includes substantial gaps, particularly the small tree and shrub canopies, and where crown canopies may be clustered rather than

evenly spaced (DEC 2002, extracted from Roberts (1999)). This class also includes dense younger regenerating woodland canopies with no understorey strata and areas where the indigenous tree canopy has been retained but the ground stratum is a landscaped or managed exotic grassland cover (Figure 5).

Some areas of Moderate Conservation Value mapped in this report, particularly in the eastern sections of the Study Area, are included with those mapped as 'Core Habitat' by DEC (2002). However, most of the distribution of vegetation over the Study Area assessed as having Moderate Conservation Value is mapped equivalently by DEC (2002) as vegetation constituting 'Support for Core Habitat' (Figures 5 & 18).

Areas of vegetation mapped as having Moderate Conservation Value (Figure 5) equivalent to those mapped by DEC (2002) as 'Support for Core Habitat' (Figure 18) have significant conservation attributes and meet the criteria for recognition as a listed threatened ecological community as defined in the TSC Act or by the NSW Scientific Committee (2009).

Stands of structurally modified vegetation where mature trees have been retained still contain valuable habitat resources such as nesting and breeding hollows, roosting sites and food sources for insectivorous birds. Other habitat features such as dead or hollow fallen logs, understorey shrubs and leaf litter are not well represented in these structurally modified vegetations. Restoration of the structural and floristic diversity of many of these partially cleared or modified areas is feasible given sufficient time and where natural regeneration from soil stored or windborne seed sources is facilitated by the exclusion of grazing and other modifying anthropogenic management regimes.

Such fragmented patches of bushland occur over the greater part of the Study Area, a relatively high tree canopy cover having been retained to provide shading for grazing animals and around dwellings for privacy screening (Figure 5).

These patches of modified vegetation with relatively high native tree cover, but sparse if any, mid-stratum or understorey species canopies, constitute areas of Moderate Biodiversity Conservation Value.

Low Conservation Value

Much of the remnant natural vegetation of the Study Area has incurred extensive historical clearing of the vegetation, including the upper canopies, for grazing, and is currently continually exposed to grazing pressure. These areas are characterised by having few individuals of remnant indigenous trees remaining providing a cover of <5% CCPD, having no understorey or mid-storey strata, but including either a partial natural grassy ground cover, a pasture-improved ground cover or landscaped areas with exotic trees and exotic lawn ground cover (Figure 5).

This vegetation usually contains relatively low indigenous species diversities or species richness, though whilst including some indigenous grass and herb species, the ground cover includes relatively higher numbers and abundances of exotic grass and herb

species (Table 2). Tree canopy cover (%CCPD) in these areas is less than 5% over areas >0.5 ha. Figure 19 indicates an area of mostly cleared vegetation, with few scattered trees, though containing relatively high numbers of indigenous grass and forb species and having a relatively high percentage cover of native grasses.

This delineation is comparable to that used for mapping of Cumberland Plain vegetation by DEC (2002), the classification Code 'Tx' and 'Txr' given to remnant vegetation where the canopy includes scattered native tree species associated with agriculture or rural residential development (DEC 2002 extracted from Roberts (1999)).

Most cleared, grazed areas containing only a few scattered trees (Figure 5) are denoted as having no conservation significance in mapping of the Study Area by DEC (2002) (Figure 18).

Most areas of vegetation mapped as 'Tx' and 'Txr' (DEC 2002) have little conservation value (DEC 2002) and would not likely meet the criteria for recognition as a listed threatened ecological community as defined in the TSC Act or by the NSW Scientific Committee (2009).

Figure 19 – Extensive areas of grazed grassland abutting woodland, often containing a relatively high ground cover percentage of indigenous grass and herb species with few scattered trees, occur throughout the Study Area

Conversely, according to the Biobanking Assessment Methodology and Credit Calculator Operational Manual (DECC 2009), cleared, grazed areas with few remnant trees but where

the indigenous component of the grassy ground cover exceeds 50% CCPD, are considered to be in 'moderate' condition. Some of the areas of grazed grasslands in the Study Area would, as such, be representative of this condition (Figure 19).

Stands of structurally modified vegetation where a few mature trees remain contain limited habitat resources such as nesting and breeding hollows, roosting sites and food sources for insectivorous birds. Restoration of the structural and floristic diversity of these extensively cleared areas is a slow process where the desired end point may take decades or may never be reached at all (Wilkins *et al* 2003, DEC 2005).

These patches of mostly cleared vegetation with relatively low native tree cover and no mid-stratum or understorey species canopies, constitute areas of Low Biodiversity Conservation Value (Figures 5, 18 & 19).

5.1.2 Indicative conservation significance attributes of Study Area as shown on maps in Wollondilly LEP 2011.

The following maps available on the Wollondily Local Environmental Plan 2011 were examined and assessed as to indicative criteria of conservation significance in the Study Area:

1. **Land Reservation Acquisition Map**

   Land reservation acquisition maps indicate that there is no criteria for land reservation acquisition in either the western and central sections (Figure 20a), or the more eastern sections of the Study Area (Figure 20b)

Figure 20a - Land reservation acquisition map Thirlmere, showing no land reservation acquistion in western and central sections of the Study Area

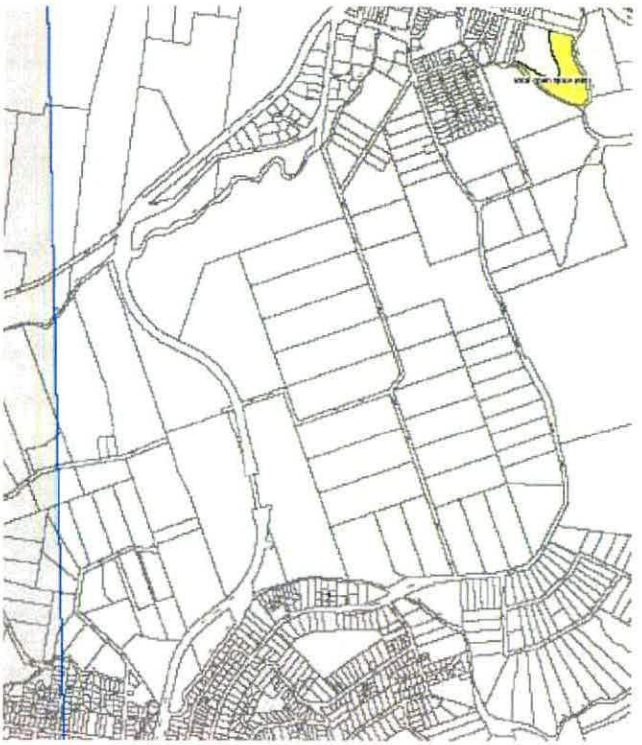

Figure 20b - Land Reservation Acquisition Map showing no land reservation acquisition in eastern section of Study Area

2. Natural Resource - Water Resource Map

The Natural Resource – Water Resource map indicates that the buffer zones along the banks of Redbank and Myrtle Creeks are indicted as 'Sensitive Land'. This buffer zone allows the retention of natural, or no longer readily disturbed vegetation, along these creekbanks conferring an extent of filtration and buffering of animal and other run-off waste from entering the stream channels. The upper sections of the creeks have a buffer area of 10m while the majority of the drainage lines maintain a 30m buffer area (Figure 21).

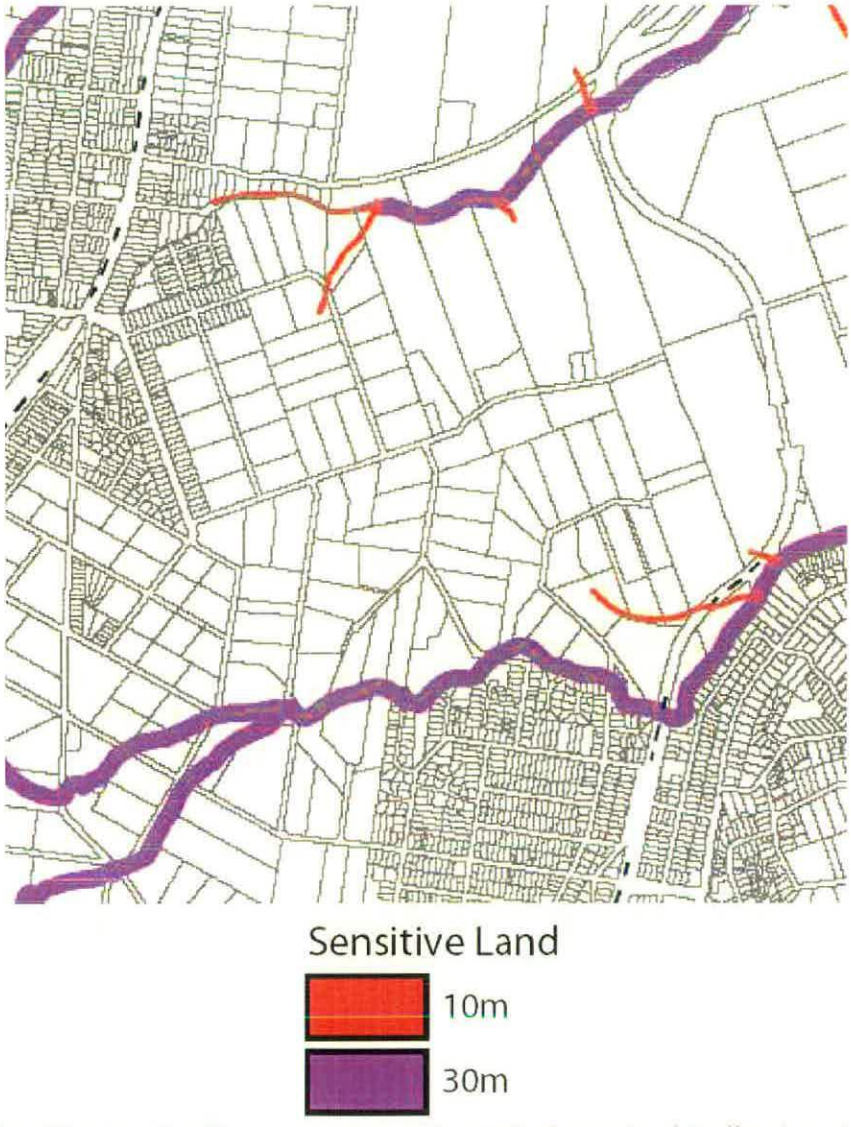

Figure 21 - Sensitive land buffer zones alongside creek channels of Redbank and Myrtle Creeks (Natural Resource - Water Resource Map).

3. Natural Resource – Biodiversity Map

The mapping contained within the Wollondilly LEP 2011 does not indicate any narural biodiversity resource areas mapped within the Study Area or for the townships of Thirlmere or Tahmoor.

The principal indicators of mapped biodiversity have previously been indicated by DEC (2002) mapping of Ecological Communities of Conservation Significance (Figure 6) and assessment of Conservation Significance (Figure 18)

5.2 Recovery potential and ecological potential of vegetated and cleared land

The Study Area lies well outside areas denoted as Priority Conservation Lands (PCLs) for Wollondilly Shire as mapped in the Recovery Plan for Cumberland Plain Woodlands (DECCW 2011).

Figure 22 indicates the potential and ecological recovery assessment for vegetated and cleared areas of the Study Area. It also indicates that significant patches of vegetation form loosely connected mosaics and linkages of high to moderate recovery potential across the landscape, these potential linkages located as follows:

- along the eastern boundary of the Study Area from Tickle Drive, Thirlmere, to vegetated landscapes along Redbank Creek.
- from Tickle Drive, Thirlmere, in a diagonal pattern from east to north-west to vegetated landscapes along Redbank Creek, and
- from Tickle Drive, Thirlmere, across a patchy cluster of vegetated areas to the south-east towards Myrtle Creek and its headwaters

Extensive areas where recovery potential is considered to be low include largely cleared grazing paddocks and landscaped allotments between Tickle Drive and Redbank Creek and much of the south-east and south-west of the Study Area (Figures 19 & 22).

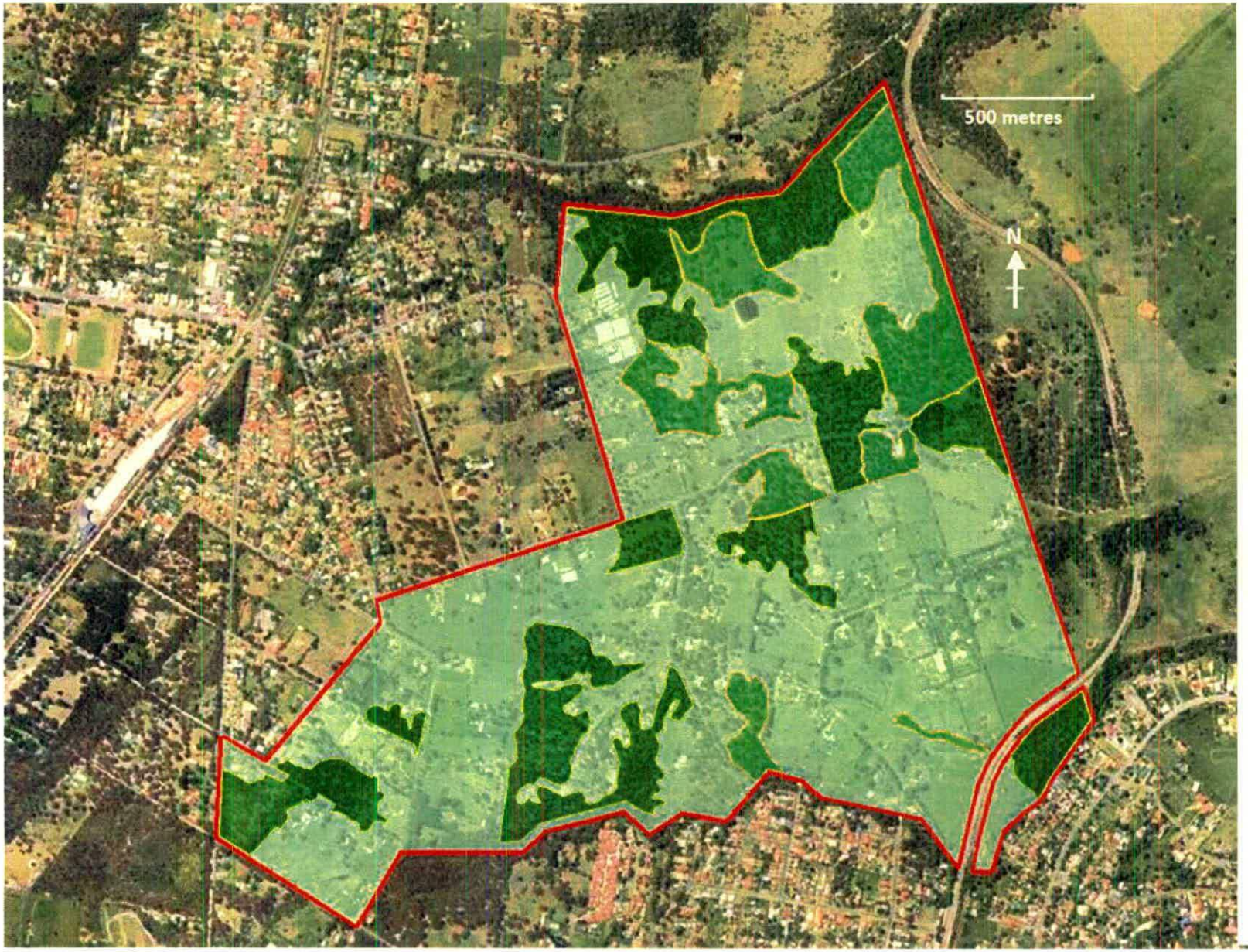

Figure 22 – Assessment of recovery and ecological potential for areas of vegetation occurring within the PTTAG Study Area.

High recovery and ecological potential

Moderate recovery and ecological potential

Low recovery and ecological potential

Descriptions of criteria distinguishing relative recovery and related ecological potential of discrete vegetation patches over the Study Area landscape are as follows:

Areas of high recovery potential and ecological significance

Figure 22 indicates areas having the greatest potential for recovery within the Study Area. These areas include patches of vegetation assessed as having a high conservation value as indicated in Figure 5. In some cases, vegetation assessed as having moderate conservation value that adjoins patches of vegetation of high conservation value, would also be considered to have a high recovery potential (Figure 22). This is because, if grazing and other modifying management regimes were removed, as well as undertaking the removal and control of invasive weeds, then proximity to sources of seed and vegetative regeneration from adjoining vegetation would stimulate significant recovery in these areas.

Areas of moderate recovery potential and ecological significance

Areas of vegetation with moderate recovery potential typically form linkages to more intact structural forms of natural vegetation (Figure 22). These areas of vegetation have retained tree canopies greater than 10% CCPD and up to 25% CCPD but have experienced relatively greater and/or more prolonged historical clearing and grazing pressures than less disturbed areas, though still retaining many indigenous grass and forb species in the ground stratum. In some cases, patches of vegetation of moderate recovery potential occurring contiguously with more intact vegetation has been subject to 'pasture improvement' resulting in the dominance of exotic grass and herbaceous weed cover (Figures 5 & 22).

Where patches of an ecological community have been mapped as having 'moderate recovery potential', these areas of vegetation are capable of some recovery where appropriate restoration technologies are undertaken (Scientific Determination Cumberland Plain Woodland 2009, OEH 2012).

Areas of low recovery potential and ecological significance

Areas of vegetation having a low recovery potential typically include the majority of mostly cleared land in the Study Area, where tree canopy cover (%CCPD) is < 5% and the ground stratum is a mixture of indigenous and exotic grass species (Figures 5, 19 & 22). Other patches of vegetation that are included as having low recovery potential are those where tree canopies may exceed 5% CCPD but where the natural grassy ground stratum has been replaced with landscaped exotic lawn cover such as Couch, Buffalo Grass or Kikuyu and where natural vegetation assemblages would prove difficult to restore (Scientific Determination 2009, OEH 2012).

Theoretically, even where areas of vegetation have been assessed as having a 'low recovery potential', interventional techniques can be employed to restore comparable native assemblages. Such techniques include 'reconstruction', where active steps are undertaken to plant out native seedlings amongst an underlying matrix of native ground cover species

to commence the process of native plant restoration, or 'fabrication' where the entire 'restored' woodland is undertaken by revegetation and reseeding (DEC 2005).

5.3 Significance of habitat for terrestrial flora and fauna species of conservation significance

5.3.1 Flora

Threatened species

Targeted searches for 18 species of threatened flora, either recorded within the last 25 years, or where habitat was deemed to be suitable, were undertaken. No threatened species of flora were located within any part of the accessible Study Area. Habitat for three species of threatened status (OEH Atlas Of NSW Wildlife April 2012) was considered to occur within the Study Area. These species included Bargo Geebung (*Persoonia bargoensis*), Mittagong Geebung (*Persoonia glaucescens*) and Brown Pomaderris (*Pomaderris brunnea*). These species all have typically conspicuous large life-forms but were not observed in targeted searches of representative vegetation assemblages. Potential habitat for these species is as follows:

- Bargo Geebung – occurs in woodland and open forest on sandy or lateritic soils or loamy clays derived from Wianamatta Shales (Fairley 2004). The nearest records occur about 2.8km to the south-east of the Study Area apparently associated with natural vegetation occurring along the Bargo River (OEH Atlas of NSW Wildlife Bionet 2012).

  The described habitat could potentially occur in well-structured vegetation along the eastern section of Tickle Drive, Thirlmere, or within relatively natural vegetation along Redbank Creek (Figure 5).

- Mittagong Geebung – occurs in woodland on ridges and plateaux on clayey or sandy soils in an area bounded by Picton, Fitzroy Falls and Berrima (Fairley 2004). The nearest records occur about 4km to the south-east, south and south-west of the Study Area associated with natural vegetation (OEH Atlas of NSW Wildlife Bionet 2012).

  The described habitat could potentially occur in vegetation along the eastern section of Tickle Drive, Thirlmere (Figure 5).

- Brown Pomaderris – occurs in open woodland and open forest on clayey soils overlying shale (Fairley 2004). The nearest records occur about 4km to the south and south-east of the Study Area associated with natural vegetation.

  The described habitat could potentially occur in vegetation along the eastern section of Tickle Drive, Thirlmere (Figure 5).

Regionally significant species

Individuals of one regionally significant species, Small-leaved Dillwynia (*Dillwynia parvifolia*) (James *et al* 1999, Fairley 2004), were located in a relatively natural section of bushland in Sydney Hinterland Grey Gum Ridgetop Forest along Thirlmere Way, Thirlmere (Figure 12).

This species grows in a variety of habitats including in shale-sandstone transition areas (Fairley 2004). The species is deemed to be uncommon and vulnerable in the Sydney region (James *et al* 1999, Fairley 2004).

Locally significant species

No individuals of locally significant species were recorded in the Study Area

5.3.2 Fauna

Threatened Species

Two species of conservation significance listed in Table 3 were recorded during this survey: these included the Varied Sittella, which was recorded in two locations on the one Lot number (Lot 104 on Tickle Drive, Thirlmere). Approximately 10 individuals were foraging on Rough-barked Apple (*Angophora floribunda*). The second threatened species recorded was the Little Lorikeet. Two individuals of this species were travelling within a flock of Rainbow Lorikeet along the riparian corridor of Myrtle Creek. They were sighted foraging within tall eucalypts and planted species of *Callistemon*.

Species of the 'threatened' fauna, listed in Table 3, with potential to occur in the survey area as indicated by both foraging and roosting habitat being present are:

1. Varied Sittella (*Daphoenositta chrysoptera*). Foraging habitat for this species is found in eucalypt woodlands and forests with a preference for rough-barked trees like stringybarks and ironbarks. They feed by moving downwards or along tree branches, searching for insects. This species was sighted at two locations on one property within Cumberland Shale Hills Woodland on Lot 104. Approximately 10 individuals were foraging on rough barked trees.
2. Regent Honeyeater (*Anthochaera Phrygia*). Foraging is present for this species in Forest Redgum during the winter months. As Capertee Valley, near Lithgow, is a recorded breeding area for the species, it is possible for individuals to fly over the Great Dividing Range to forage during winter.
3. Little Lorikeet (*Glossopsitta pusilla*). Little Lorikeets mostly occur in dry, open eucalypt forests and woodlands. They have been recorded from both old-growth and logged forests in the eastern part of their range, and in remnant woodland patches and roadside vegetation. Two individuals were recorded travelling within a flock of Rainbow Lorikeet. They were observed foraging for nectar within tall

eucalypts and in a roadside planted *Callistemon sp*, located close to riparian vegetation beside Hilton Park Road.

4. Gang-gang Cockatoo (*Callocephalon fimbriatum*). Gang-gang Cockatoo tend to occur during the winter months at lower altitudes than during the summer months and in often in drier more open eucalypt forests and woodlands occurring in, and in the vicinity of, urban areas.
5. The Brown Treecreeper (*Climacteris picumnus victoriae*) occupies eucalypt woodlands, particularly open woodland lacking a dense understorey. It is sedentary and nests in tree hollows within permanent territories, breeding in pairs or communally in small groups. Birds forage on tree trunks and on the ground amongst leaf litter and on fallen logs for ants, beetles and larvae.
6. The Hooded Robin (*Melanodryas cucullata cucullata*) prefers lightly wooded country, usually open eucalypt woodland, acacia scrub and mallee, often in or near clearings or open areas. It requires structurally diverse habitats featuring mature eucalypts, saplings, some small shrubs and a ground layer of moderately tall native grasses.
7. Scarlet Robin (*Petroica boodang*). In autumn and winter many populations of Scarlet Robin live in open grassy woodlands and grasslands or grazed paddocks with scattered trees. Suitable habitat is present close to Redbank Creek and Tickle Drive.
8. Diamond Firetail *(Stagonopleura guttata*). Often found in riparian areas and sometimes in lightly wooded farmland. Suitable habitat is present close to Redbank Creek and Tickle drive.
9. Koala (*Phascolarctus cinereus*) Inhabit eucalypt woodlands and forests. They feed on the foliage of more than 70 eucalypt species and 30 non-eucalypt species, but in any one area will select preferred eucalypt browse species. Home range size varies with quality of habitat, ranging from less than two hectares to several hundred hectares. Grey Gum (*Eucalyptus punctata*) is a critical habitat component and occurs near Redbank Creek. Other favoured food trees within the Study Area include Forest Red Gum (*Eucalyptus tereticornis*).
10. The Eastern Bentwing Bat (*Miniopterus schreibersii oceanensis*). Foraging habitat is present for populations of this species, however it is unlikely that the bat roosts within the Study Area, as no large caves are present. Larger caves may be present within the Nepean River valley for roosting. Deep cave sites that are required as maternity caves may be present within the larger expanse of the Wollondilly locality.

Regionally significant species

1. Grey-headed Flying Fox (Grey-headed Flying Fox (*Pteropus poliocephalus*), may potentially visit the study Area during the flowering periods of eucalypts.
2. Swift Parrot (*Lathamus discolor*). During the winter months the Swift Parrot will forage for lerp and nectar from specific eucalypt trees along the NSW coastal area. Swift Parrot will feed in Forest Redgum (*Eucalyptus tereticornis*) extensively recorded in the Study Area. Spotted Gum (*Eucalyptus maculata*), also a favoured

food tree occurs scattered in roadside verge areas where it may have been planted. Although favoured food resources are present in the Study Area, no recent recordings have been made of the Swift Parrot in the Thirlmere-Tahmoor area.

Migratory species

1. Black-faced Monarch (*Monarcha melanopsis*), migrating from Papua New Guinea, dwells in rainforest, wet broad-leafed forests, denser eucalypt forests, damp gullies, mangroves and sometimes in open woodlands. This species was observed during this survey in wet gully vegetation close to fauna habitat zone 2.
2. Rufous Fantail (*Rhipidura rufifrons*) returns to Australia from a northward migration in the summer months. It is generally recorded in rainforests, wet forests, swamp woodlands and mangroves in northern and eastern coastal Australia. Habitat is present in the same location where the Black-faced Monarch was recorded. Habitat is also present in the gully vegetation of fauna habitat zone 4.
3. Cattle Egret (*Ardea ibis*). Cattle Egrets nesting in Australia migrate to cooler climes in Tasmania and New Zealand in the winter and return in the spring (Maddock 1990). The breeding season in Australia is from November to early January, with one brood laid per season (Beruldsen 2003). The Cattle Egret is a popular bird with cattle breeders for its perceived role as a bio-control of cattle parasites such as ticks and flies. This species was not recorded during the current survey.

5.4 Relative biodiversity value of the Study Area

From an integration of the assessment of Conservation Value of Endangered Ecological Communities occurring across the Study Area (Figure 5), the assessed recovery and ecological potential of the patches of vegetation occurring within the Study Area (Figure 22), and the conservation significance of potential distributions of threatened species of flora and fauna within the Study Area, a map of assessed biodiversity values within the Study Area can be constructed (Figure 23).

This map is derived from a generalised pattern of the overlay of EEC conservation value and vegetation recovery potential assessment throughout the Study Area.

The map of relative biodiversity values indicates a 'high biodiversity value' in the following sections of the Study Area:

- throughout a band of vegetated bushland along Redbank Creek,
- a patch connecting this bushland along the north-eastern perimeter of the Study Area with a patch of forest on either side of the road at the eastern extremity of Tickle Drive,
- a small patch of bushland between the western end of Hilton Park Road and Tickle Drive, Thirlmere, and

- an area of little disturbed bushland extending from north-west of Glennane Place, south to Myrtle Creek.

Figure 23
Biodiversity values

An area assessed as having a 'High biodiversity value' would contain either a well-structured, less modified woodland/forest, or where modified, the opportunities for recovery are good, particularly where the patch is contiguous with less disturbed vegetation and also where linkages through ample connectivity occurs between patches.

'Moderate biodiversity values' occur where either recovery potential or assessed conservation value is moderate, or where connectivity is not closely linked between various patches in the mosaic of vegetation across the Study Area (Figures 5, 22 & 23).

'Moderate values for biodiversity' are assessed as occurring in the following sections of the Study Area:

- a relatively large vegetated patch occurring in the north-west of the Study Area between Tickle Drive and Redbank Creek,
- small patches of structurally modified vegetation occurring along the ridgeline to the south of the central part of Tickle Drive, and
- a loosely connected distribution of structurally modified vegetation extending in an alignment with the eastern side of Brundah Road to Myrtle Creek in the south.

Areas where significant linked patches of vegetation do not occur in highly structurally modified vegetation, evident as extensive grassy areas with few scattered trees, are considered to have 'low biodiversity values'.

5.5 *Conclusions including assessment of biodiversity values required to be addressed by developer contributions*

5.5.1 Flora

Endangered Ecological Communities

Vegetation defined as representative of two endangered ecological communities (EECs) occurs in a mosaic over different sections of the Study Area as depicted in Figure 5. These two EECs include:

- Cumberland Shale Hills Woodland (critically endangered ecological community as component of Cumberland Plain Woodland with regard to listings by TSC Act & EPBC Act); and
- Cumberland Shale-Sandstone Ironbark Forest (endangered ecological community as component of Shale-Sandstone Transition Forest listing by TSC Act); and

Conservation Significance of Endangered Ecological Communities

The conservation significance of the mosaic of endangered ecological communities that occurs in the Study Area is depicted in Figure 5 (see also Figure 18).

Those distributions of high and moderate conservation significance would likely be constraints to potential development within those vegetated areas. Areas of low conservation significance would not likely be considered a significant impediment to potential development (Figures 5 & 18).

Recovery and ecological potential of Endangered Ecological Communities

Distributions of vegetation that have greater relative recovery and ecological potential largely reflect the patches of vegetation assessed as having high or moderate conservation significance, these compared in Figures 5, 18 & 22.

The recovery potential identified among these vegetation distributions provides local ecological linkages and corridors for the floristic exchange of genetically variable pollen and genetically variable dispersed seed. These areas of assessed recovery potential of endangered ecological communities in the Study Area reflect a similar level of constraint to development as described for the relative levels of similarly distributed conservation significance (Figures 5 & 22).

5.5.2 Fauna

Riparian Corridors

Within the PTTAG Study Area, riparian vegetation forms a critical landscape component. Riparian areas are integral ecosystems with the health of ecological communities elsewhere in the landscape dependent upon the health of riparian areas. Riparian corridors are particularly important drought refuges for native fauna. The role of riparian areas as corridors for fauna movement also becomes increasingly important as surrounding ecosystems are modified for urban and agricultural purposes.

Few of the bird species recorded in the riparian areas were restricted to this habitat. Many bird species typically found in forests, woodlands and grasslands were recorded within the riparian areas and some birds strongly associated with riparian zones, such as waterbirds, were also found in wetlands outside the riparian zone (such as farm dams). Riparian areas are also an important component of the habitats used in seasonal migration by some bird species.

The highest fauna diversity was recorded within the riparian buffer zone of Redbank Creek. As such Redbank Creek and its associated vegetation is an important area for biodiversity and should be protected from any potential impact.

Myrtle Creek is surrounded by urban development and has been impacted upon by weed incursions from the close proximity to this development. Fauna biodiversity in the vicinity of the creek was poor.