

**2.1 BIO-REGIONAL CONTEXT**

The Camden LGA covers an area of 206sq. km and is located 52km south-west of the Sydney CBD. The Camden LGA is located in the south-west corner of the Cumberland Plain, which is part of the Sydney Basin Bio-region. Camden adjoins the LGAs of Wollondilly to the south and west, Campbelltown to the east and Liverpool LGA to the north.

**2.2 TOPOGRAPHY**

Camden is characterised by broad river-flat floodplains and gently undulating hills. Slopes are generally <5%, but may exceed 10% on the edges of terraces (Hazelton & Tille, 1990). The levee banks are not distinctive but there are broad depressions with saline influence in the south-west of Camden near Cawdor (Benson & Howell, 1993). The Nepean River is a major topographical feature of the LGA meandering from south-west corner and along the western boundary of the LGA and associated with large alluvial floodplains.

**2.3 GEOLOGY AND SOILS**

The geology and soils of the area have been described and mapped by Hazelton and Tille (1990) and are shown on the Wollongong – Port Hacking 1:100 000 map sheet.

Tertiary and Quaternary alluvium is the dominant geological unit covering the riparian areas of Camden, the floodplain and terraces of the Nepean River and its tributary creeks (including Narellan Creek and Matahil Creek). Smaller tributaries higher up in the catchment are underlain with Bringelly shale of the Wianamatta group of shales, which is the dominant geological unit covering the surface of Camden LGA.

Three main soil landscapes are found within the riparian areas of Camden covered by this study, namely Theresa Park, Blacktown and Luddenham. The soil landscapes relate strongly to native vegetation characteristics and distribution. The characteristics of these soil landscapes are summarised in Table 1, below. A total of eight soil landscapes are found within Camden LGA and summarised in the *Draft Rural Lands Study* (Camden Council, 1998).

**Table 1. Soil landscape characteristics in the riparian areas of Camden LGA**

Soil Landscape	Geology	Landscape type	Position	Vegetation	Soil Material	Limitations
Luddenham	Wianamatta Shale	Erosional	Ridge tops	Cumberland Plain Woodland	Yellow podzolic soils (loamy sand, clay) on lower slopes and drainage lines	High soil erosion hazard, highly plastic and moderately reactive subsoils, potential mass movement hazard
Blacktown	Wianamatta Shale	Residual	Valley side	Cumberland Plain Woodland	Yellow podzolic soils (loam topsoil, yellow clay subsoil) on lower slopes and drainage lines	Moderately reactive, highly plastic subsoils, low soil fertility, seasonal waterlogging, soils often saline

Theresa Park	Quaternary & Tertiary alluvium	Fluvial	Valley bottom	Sydney Coastal River-flat Forest	Solodic soils (sandy clays) along drainage lines & Red Earth / Red Podzolic Soils (sand, clay, loam) on the floodplain and near terrace edges	Localised flooding, seasonal waterlogging, very high soil erosion hazard for concentrated flows.
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**2.4 CLIMATE**

The Camden LGA is characterised by warm to hot summers and cool to mild winters. Rainfall is highest in the periods from January to April and October to November, with relatively dry winter months. Camden is drier than the coastal areas of Sydney, experiences increased occurrences of frosts in the cooler months, and has a slightly greater seasonal temperature range than Sydney (Camden Council, 1998).

**2.5 FLOODING**

Camden has a long history of flooding from the Nepean River. Land adjacent to the Nepean River and its tributaries are prone to flooding following prolonged periods of heavy rain within their catchments and floodwaters can inundate large areas of the plains up to 1km wide (Camden Council, 1998). Flooding has a major affect on riparian lands, can destabilise banks and cause bank erosion. Additionally, it has the beneficial impact of replenishing alluvium and the value of Class I agricultural lands. The Quaternary and Tertiary alluvium present along the Nepean River and tributary creeks has a high soil erosion hazard for concentrated flows.

**2.6 CATCHMENT CONTEXT**

The whole of the Camden LGA lies within the Hawkesbury-Nepean River catchment. The Upper Nepean River and South Creek comprise the two major sub-catchments of the Hawkesbury Nepean System within the Camden LGA. The southern half of the Camden LGA lies within the Upper Nepean River catchment (refer Map 2) and includes the minor tributary catchments of Narellan, Sickles and Matahil Creeks. The northern half of the LGA falls into both sub-catchments.

The headwaters of the Nepean River originate in the Illawarra Ranges west of Wollongong. The three main tributaries are the Avon, Cordeaux and Cataract Rivers, which are regulated by dams which supply water to the Illawarra, Wollongong and Sydney regions (Adams, 2000).

Waterways in the Upper Nepean River catchment comprise permanent and ephemeral streams draining predominantly rural lands. Many tributary creeks have been dammed to provide water supply for stock and irrigation purposes.

A series of weirs on the Nepean River has transformed the natural pool and riffle system to a series of weir lakes (Adams, 2000).

Due to past and present landuse in the catchment, the riparian lands in the Camden LGA are under significant stress. Clearing of vegetation, stock access and sand extraction has resulted in degraded and eroding riverbanks.

## 2.7 FLORA AND FAUNA ISSUES

A flora and fauna report (Gunninah, 1999) has been prepared as part of the Structure Plan Report for Camden LGA (Don Fox and Associates, 1999). The flora and fauna report has reviewed and collated existing flora and fauna information and identified areas of high conservation significance to determine the biological constraints on future land use in Camden.

## 2.8 NATIVE VEGETATION

Large tracts of native vegetation were originally cleared in the early 1800's when agricultural production commenced in the area and more recently with urban development. Currently only 350 ha (2%) of bushland remains in Camden LGA, with most remnants less than 30ha in size and occurring on private land (NPWS, 1997).

Disturbance, native vegetation clearing, changing flood patterns and increasing nutrient levels in the river has enabled exotic weeds to establish and naturalise along the Nepean River and tributary creeks.

Riparian areas of Camden contain some of the last native vegetation remnants remaining in the LGA due to the limitations (particularly flooding) that prevent development in these zones.

The riparian vegetation communities of the Camden LGA are described and mapped by Benson & Howell (1993), in the Urban Bushland Biodiversity Survey (NPWS, 1997) and Native Vegetation Mapping of the Cumberland Plain (NPWS, 2000).

This section presents a brief overview of the four native vegetation communities occurring in the riparian open space to which the Plan applies, and their significance. Most of these are endangered on a State and National level and inadequately conserved in reserves. As well as being identified as threatened, these vegetation communities also contain rare and threatened plant and animal species. These four native vegetation communities are:

- Sydney Coastal River-Flat Forest:
  - Riparian Forest,
  - Alluvial Woodland,
- Cumberland Plain Woodland:
  - Shale Plains Woodland,
  - Shale Hills Woodland,
- Freshwater Wetlands, and

- Elderslie Banksia Scrub Forest

All information from the Native Vegetation of the Cumberland Plain (NPWS, 2000) mapping for Camden is contained within Council's GIS system and so can be readily cross referenced with any land parcel.

### 2.8.1 Sydney Coastal River-Flat Forest

Sydney Coastal River Flat Forest is associated with rivers and creeks and occurs in the riparian zone and associated floodplains, terraces and flats on alluvial soils (NSW Scientific Committee, 1999a). This is the major vegetation type associated with the riparian environment in Camden, made up of the following sub units (NPWS, 2000):

#### Riparian Forest

Riparian Forest occurs along the banks of the Nepean River or on the terraces immediately adjacent to the river and along major tributary creeks near their outlet points to the Nepean River (NPWS, 2000). Three associations of this forest type have been identified in the Camden LGA as follows:

- Cabbage Gum – Broad-leaved Apple (*Eucalyptus amplifolia* – *Angophora subvelutina*)  
The dominant Riparian Forest community on most of the alluvium along the Nepean River. Other tree species occurring in this association include *Casuarina cunninghamiana*, *E. elata*, *E. baueriana*, *E. tereticornis*, and *E. benthamii*.
- Bangalay-Peppermint-Blue Box Forest (*E. botryoides-saligna* – *E. elata* – *E. baueriana*)  
Confined to the banks along the Nepean River from Menangle to Cobbitty (Benson and Howell, 1993). Tree species present in this distinctive association include *E. elata*, *E. baueriana*, *E. botryoides-saligna*, *E. viminalis*, *E. eugenioides*, *E. amplifolia*, *A. subvelutina*, *Tristaniopsis laurina* and *C. cunninghamiana*.
- River Oak Forest  
Occurs in small sections along the Nepean River in Camden LGA with the canopy dominated by *C. cunninghamiana* (NPWS, 1997).

#### Alluvial Woodland

Alluvial Woodland occurs along, or in close proximity to minor watercourses draining soils derived from Wianamatta Shale and on the floodplains of the Nepean River, on soils of recent alluvial deposition (NPWS, 2000).

Remnants of this vegetation type occur in Camden in various areas including along Sickles Creek, the upper reaches of Narellan Creek in Harrington Park and adjacent to the Riparian Forest on terraces along the Nepean River (e.g. at Belgenny and Kings Bush Reserves). The two most common species are *E. tereticornis* and *E. amplifolia*, with *A. floribunda* occurring less frequently (NPWS, 2000).

Swamp Oak Forest (another association of Alluvial Woodland) occurs along South Creek, Lowes Creek and Rileys Creek in the northern section of Camden LGA (beyond the study area). This community is associated

with saline conditions and dominated by *Casuarina glauca*, often with a dense understorey of *Phragmites australis*, where watercourses are intermittent or slow flowing (Benson and Howell, 1993).

### Conservation Status

Sydney Coastal River-Flat Forest is inadequately conserved in conservation areas and has been listed as an “endangered ecological community” under the TSC Act (NSW Scientific Committee, 1999a). Only small patches of Sydney Coastal River-Flat Forest occur in Council reserves in the Camden LGA including parts of Belgenny, Chellaston Street and Elizabeth Macarthur Reserves (Gunninah, 1999).

### Threats

Due to the fertile nature of river flat soils most Sydney Coastal River-Flat Forest has been cleared for agriculture, with only small, scattered remnants remaining, mostly in cleared agricultural country (NSW Scientific Committee, 1999a). Large areas of this vegetation type have also been cleared for mining and other development. Major threats include weed invasion, grazing and mowing, clearing, physical damage from recreational activities and rubbish dumping (NSW Scientific Committee, 1999a) sand extraction, recreational and residential developments (NPWS, 1997).

### 2.8.2 Cumberland Plain Woodland

The vegetation community on Wianamatta Shale soils, in association with the riparian environment is Cumberland Plain Woodland, which is divided into two sub-units (NPWS, 2000):

#### Shale Plains Woodland

Dominant canopy species are Grey Box (*Eucalyptus moluccana*), Forest Red Gum (*E. tereticornis*) and occasionally Narrow-leaved Stringybark (*E. eugenoides*). This is the most widely distributed community on the Cumberland Plain (NPWS, 2000). The largest remnants of this community are found at Cobbitty, Narellan and in the north and south-east of the LGA (Gunninah, 1999).

#### Shale Hills Woodland

This vegetation type occurs predominantly in the hilly areas of Camden. Dominant canopy species are Narrow-leaved Ironbark (*E. crebra*), Grey Box (*E. moluccana*) and Forest Red Gum (*E. tereticornis*). Remnants occur in Narellan, Spring Farm, Currans Hill, and Harrington Park in the southern half of the Camden LGA, with the largest remnants remaining between Bringelly Creek and the Nepean River (Gunninah, 1999).

### Conservation Status

Only 6% of the original cover of Cumberland Plain Woodland remains in western Sydney (NSW Scientific Committee, 1997). The community is considered threatened at a State and National level and is listed as an “endangered ecological community” under the TSC Act and the EPBC Act. Only small areas of Cumberland Plain Woodland are represented in Council reserves. Areas covered by this Plan containing remnant Cumberland Plain Woodland include Gundungurra Reserve, William Howe Regional Park, riparian land in Currans Hill and Mount Annan.

### Threats

Threats to the survival of Cumberland Plain Woodland in Camden LGA include clearing for agriculture, grazing, hobby and poultry farms, housing and other developments, weed invasion, mowing in reserves and stormwater pollution, in particular increased nutrient loads from fertiliser runoff from gardens and farmland, dumped refuse and sewage discharge (NSW Scientific Committee, 1997). In many areas of Camden the regenerating understorey may be dominated by woody weeds such as Small-leaved Privet (*Ligustrum sinense*) and African Olive (*Olea euroaea spp. africana*).

### 2.8.3 Freshwater Wetlands

Freshwater wetlands occur in low-lying depressions of the Nepean River floodplain, in association with Sydney Coastal River-Flat Forest. Significant wetlands include Menangle and Belgenny Lagoons, and Camden Lagoon to the north of Bicentennial Park, a SREP 20 listed wetland that is proposed to be, but not yet under Council care, control and management. A wetland with a number of restricted local native species is situated at the northern end of Rotary Cowpasture Reserve near Cowpasture Bridge (see Map 3 [CA2]). The wetland is of great interest as it is one of the few floodplain wetlands on the Nepean still retaining a range of native species including, *Eleocharis equisetina*, *Marsilea mutica*, *Persicaria hydropiper*, *Ranunculus inundatus* and *Myriophyllum* species (Benson & Howell, 1993).

#### Conservation Status

Freshwater wetland communities are considered to be rare and endangered and inadequately conserved on a regional level (NPWS, 1997).

#### Threats

Major threats to the freshwater wetlands in the Camden LGA are clearing of riparian vegetation, changes in natural hydrology, stormwater pollution and invasion by exotic weeds (NPWS, 1997).

### 2.8.4 Elderslie Banksia Scrub Forest

This vegetation community comprises small remnants in the vicinity of Spring Creek, a tributary of the Nepean River in the Spring Farm area (NPWS, 1997). It is associated with high level alluvium of the Tertiary age and characterised by an open-scrub or woodland structure, with *Banksia integrifolia* in the understorey, intergrading with Grey Box Woodland.

#### Conservation Status

Elderslie Banksia Scrub Forest is restricted to the Camden LGA, and no occurrences are presently included in conservation reserves. This is an isolated occurrence of *Banksia integrifolia*, which typically grows on the coast, but also occurs in other sand deposits in the Maroota district (NPWS, 1997). Elderslie Banksia Scrub Forest has been listed as an “endangered ecological community” under the TSC Act (NSW Scientific Committee, 1997b).

#### Threats

Mining and land clearing have reduced the community to tiny remnants which are subject to disturbance by refuse dumping, weed invasion, clearing, grazing and edge effects due to their small size.

**2.8.5 Threatened Flora Species**

Of the 320 native plant species recorded in the Camden LGA, 5 are of National and State significance, approximately 60 are of regional significance and over 195 are considered vulnerable and inadequately conserved in Western Sydney as determined by the NPWS Urban Bushland Biodiversity Survey of Western Sydney (Gunninah, 1999).

**Table 2. Flora species of National and State conservation significance in Camden LGA (from Gunninah, 1999)**

Species	Conservation Status		Habitat	Occurrence in Camden
	ROTAP <sup>#</sup>	TSC Act <sup>†</sup>		
<i>Cynanchum elegans</i>	3ECi	E	Dry rainforest gullies and scree slopes	Sydney Dry Rainforest at Cobbitty (outside the study area)
<i>Eucalyptus benthamii</i>	2VCi	V	Wet open forest on sandy alluvium	Sydney Coastal River-flat Forest on the Nepean River including Spring Farm and Cobbitty
<i>Pimelea spicata</i>	3ECi	E	Open woodland and grassland, particularly moist depressions near creeklines.	Cumberland Plain Woodland, primarily Shale Plains Woodland, at Narellan Cemetery, Studley Park Golf Course, Mount Annan.
<i>Pomaderris brunnea</i>	2VC-	V	Sandy alluvium on levee and creek banks	Sydney Coastal River-flat Forest at Spring Farm on the Nepean River
<i>Thesium australe</i>	3VCi+	V	Grassland or eucalypt woodland, often in damp areas.	Now considered extinct in the Sydney region

<sup>#</sup>Conservation Codes for ROTAP flora (Briggs & Leigh, 1996)

Distribution Category

- 2 Species with a geographic range of less than 100km.
- 3 Species with a geographic range of greater than 100km.

Conservation Status

- E Endangered: taxon in serious risk of disappearing from the wild within 10-20 years if present landuse and other threats continue to operate.
- V Vulnerable: not currently endangered; at risk of disappearing from the wild state within 20-50 years.
- C Reserved: has at least one population within a national park, conservation reserve or area dedicated for the protection of flora.

Size class of all reserved populations

- i less than 1000 plants are known to occur within a conservation reserve(s). reserved population size is currently unknown.
- + overseas occurrence (included if the population has a natural occurrence overseas).

<sup>†</sup>TSC Act codes

- E Species is listed as Endangered under Schedule 1 of the TSC Act.
- V Species is listed as Vulnerable under Schedule 2 of the TSC Act.

## 2.9 FAUNA

At least 287 vertebrate fauna species have been recorded in the Camden LGA comprising 222 birds, 32 mammals, 16 amphibians and 17 reptiles (Gunninah, 1999).

### 2.9.1 Fauna in the Riparian Environment

Waterbodies (rivers, creeks, wetlands, lakes, farm dams) and riparian vegetation in the Camden LGA provide a variety of habitats (foraging, shelter, nesting resources) for a wide range of native fauna, including birds, arboreal and ground dwelling mammals, reptiles, amphibians, molluscs, fish and invertebrates. This is in contrast to the predominantly agricultural and urban landscapes of Camden, which are generally of limited value to most fauna species because of a lack of shelter and foraging resources. In waterbodies, varying water depth, aquatic and emergent vegetation, woody debris and tree roots all provide a range of habitats for food, shelter and breeding. Riparian vegetation provides numerous habitat resources, such as leaf litter, ground cover, shrub layer and canopy vegetation, logs and mature hollow bearing trees.

Riparian corridors assist in the movement of fauna between isolated remnants of bushland and the Nepean River and its tributary creeks, and the riparian environment provides an abundant food and water source for native aquatic and terrestrial fauna.

Camden Council has recently adopted a new corporate identifier comprising a platypus with the words 'sustainable camden' below it. The identifier is a symbol of Council's aspirations for the future of Camden, as embodied within the Camden 2025 Strategy (Camden, 1999). Three of the 'Environmental Systems' performance measures for the Camden 2025 Strategic Plan of particular relevance to fauna within the context of this Plan are that:

- the platypus is back;
- fish can be seen in the water, and
- ANZECC protection of Aquatic Ecosystems water standard is achieved.

Relevant information on the platypus within the context of Camden is contained within Appendix 5.

### 2.9.2 Threatened Fauna Species

Due to the abundance of resources and the fact that remnant riparian vegetation is important for fauna movement, many fauna species inhabit the riparian areas in Camden, including threatened species such as:

- Swift Parrot,
- Greater Broad-nosed Bat,
- Eastern Freetail Bat,
- Large-footed Myotis, and
- Cumberland Land Snail.

The Cumberland Land Snail is thought to be the only threatened species permanently found in the LGA, whilst the other threatened species in the area are mobile and wide ranging.



Fauna species of National and State conservation significance within the Camden LGA are summarised in Table 3.

**Table 3. Fauna species of National and State conservation significance in Camden LGA**

Common Name	Scientific Name	Conservation Status	Preferred Habitat	Occurrence in Camden
Cattle Egret	<i>Bubulcus ibis</i>	JAMBA/CAMBA	Moist, low-lying areas, drainage ditches with long grasses. Nests in woodland in or adjacent to waterbodies and roosts or among ground vegetation in or near lakes and swamps.	Spring Farm (Gunninah, 1999) Observed at Lake Annan during site investigations for this Plan
Swift Parrot	<i>Lathamus discolor</i>	Vulnerable on Schedule 2 of the TSC Act	Woodlands and open-forest, and isolated stands of mature eucalypts where it feeds on eucalypt flowers. Observed in western Sydney feeding in Narrow-leaved Ironbark ( <i>Eucalyptus crebra</i> ) of the Cumberland Plain and ridge-top shales (NPWS, 1997).	Highly nomadic species and wide ranging.
Greater Broad-nosed Bat	<i>Scoteanax rueppellii</i>	Vulnerable on Schedule 2 of the TSC Act	Woodland and open forest habitats, tree-lined creeks and interface between woodland and cleared paddocks are preferred foraging habitat, feeds mainly on insects, roosts in tree hollows.	Elderslie and Spring Farm (Gunninah, 1999) and has the potential to occur elsewhere in the LGA given suitable foraging and roosting habitat
Eastern Freetail Bat	<i>Mormopterus norfolkensis</i>	Vulnerable on Schedule 2 of the TSC Act	Woodland and open forest habitats, roosts in mature hollow bearing trees. Little information is available regarding the ecology of this species (Gunninah, 1999)	Elderslie and Spring Farm (Gunninah, 1999) and has the potential to occur elsewhere in the LGA given suitable foraging and roosting habitat
Large-footed Myotis	<i>Myotis adversus</i>	Vulnerable on Schedule 2 of the TSC Act	Near waterbodies ranging from creeks to lakes. Rakes the surface of water to catch aquatic insects, which make up the majority of its diet.	Mater Dei site in Camden (Gunninah, 1999) and could potentially occur elsewhere in the LGA, as suitable foraging habitat including farm dams, waterways and riparian vegetation is present.

Section 2: NATURAL RESOURCE INFORMATION

Cumberland Land Snail	<i>Meridolum comeovirens</i>	Endangered on Schedule 1 of the TSC Act	Cumberland Plain Woodland, found under fallen logs, bark and leaf litter around the base of eucalypt trees	Spring Farm, Mount Annan, Harrington Park and Mater Dei. Only threatened species found permanently in the LGA (Gunninah, 1999). Possible that this species occurs at other locations with suitable habitat.
Grey-headed Flying-fox	<i>Pteropus poliocephalus</i>	Vulnerable on Schedule 2 of the TSC Act	Canopy-feeding frugivore, blossom-eater and nectarivore of rainforests, open forests, woodlands, <i>Melaleuca</i> swamps and <i>Banksia</i> woodlands. Also feed on introduced trees including commercial fruit crops.	

It should be noted that species are regularly being added to the schedules of National ([www.ea.gov.au](http://www.ea.gov.au)) and State ([www.npws.nsw.gov.au](http://www.npws.nsw.gov.au)) legislation, and that the above list can therefore be expected to grow over time.

### 3.1 THE VISION

The Strategic Plan for Camden (Camden Council, 1999) sets out a vision for what Camden will be like in the year 2025, stating:

*“The natural environment of Camden has been managed so that ecosystems have been successfully restored. Our river lives, the platypus is back and the vegetation is no longer threatened. A network of bush corridors has been established, and the floodplain has been protected (p.2).”*

*“The community values its natural environment and enjoys it in diverse yet responsible ways (p.2).”*

Drawing from the above, the outcome that will derive from the implementation of this Plan is that:

*The riparian areas of the Camden LGA comprise an ecologically diverse, sustainable network of green corridors that stretch unbroken from the Nepean River to the catchment headwaters, and successfully integrate with the needs and desires of those who live and work in the surrounding urban and rural environment.*

### 3.2 MANAGEMENT OBJECTIVES

The objectives for the management of Camden's riparian environment are:

- To protect and enhance biodiversity and ecological values of wetlands and watercourses, particularly in relation to water quality and quantity, native vegetation, and fauna habitat.
- To restore and regenerate degraded wetlands and watercourses.
- To create new wetlands and watercourses that strongly embody biodiversity and ecological values, particularly in relation to water quality and quantity, native vegetation, and fauna habitat.
- To design (where required) and manage wetlands and watercourses in such a way as to minimise long-term maintenance costs.
- To facilitate community education, access and use of wetlands and watercourses without compromising ecological values.
- To conserve and enhance the scenic qualities and endemic landscape character of Camden's riparian areas.

### 3.3 KEY SUPPORTING PLANS

The following are the key supporting plans that should inform decision-making in association with this Plan:

- Statement of Joint Intent for the Hawkesbury Nepean River System (EPA *et. al*, 2001).
- Hawkesbury Lower Nepean Catchment Blueprint (DLWC and Joint Government Advisory Group, 2002).
- Sydney Regional Environmental Plan No. 20 Hawkesbury-Nepean River (DUAP, 1997).
- Camden 2025: A Strategic Plan for Camden (Camden Council, 1999),