
Rebecca Wright
Engineer Water Resources
Penrith Lakes Development Corporation Limited
Penrith NSW 2750

2 February 2007

**RE: Penrith Lakes Scheme Flora and Fauna Assessment: Opportunities and Constraints (s4662)**

Dear Rebecca,

Biosis Research Pty Ltd (Biosis Research) was commissioned by Penrith Lakes Development Corporation Pty Ltd (PLDC) to undertake a flora and fauna investigation of Penrith Lakes, in the western suburbs of Sydney, NSW. The purpose of the investigation was to identify potential constraints and opportunities in relation to the flora and fauna of the site and review and update previous studies in light of changes to legislation and the revised Concept Plan, in particular the Environmental Resources Management Australia Pty Ltd (ERM 2001), Penrith Lakes Scheme Flora and Fauna Management Study and more recent targeted studies.

**Study Area**

The study area comprises the entire PLDC Scheme Area (the Scheme). The study area lies within the Penrith Local Government Area (LGA) and is managed by the PLDC. The PLDC Scheme Area is bounded by residential, rural and industrial development to the east, north and south respectively and dense vegetation adjoining Blue Mountains National Park to the west. The Nepean River borders the Scheme to the south and the west and dense areas of vegetation occur at Castlereagh to the north-east.

A large sand and gravel quarrying operation on the Hawkesbury-Nepean River floodplain occurs within the Scheme boundary. There are a number of man-made lakes and dams present that are the result of rehabilitation of past quarrying and are used for recreational activities such as rowing and canoeing.

The majority of native vegetation within the study area has been historically cleared. Remaining remnants of native vegetation are mainly restricted to the banks of the Nepean River and the Cranebrook Escarpment.

For the purposes of this report:

- Concept Plan includes the plans provided by Hassell dated January 2007, which are included in Appendix 1.
- The "study area" is defined as the PLDC Scheme Area and the adjoining section of the Nepean River;
- The "locality" is defined as the area within a 10 km radius of the study area; and,
- The "region" is defined as the Sydney Basin Bioregion, as described by (Thackway and Cresswell 1995).

**Proposed Development**

The proposed Concept Plan features urban areas, employment precincts, recreational facilities and parkland all connected by landscape corridors, including (Castlereagh Development Corporation 2007):

- Approximately 325 ha of residential land comprising approximately 5,000 dwellings in a variety of densities and dwelling types distributed across the site, from large 2 ha rural residential lots in the north of the site, to medium and high density development to the south;
- Approximately 60 ha of land for a new employment precinct;
- A variety of community facilities including a 6,700 sqm leisure and aquatic centre and neighbourhood facilities;
- A network of wetlands to treat stormwater, recycled effluent and recycled site grey and blackwater;
- A 700 ha network of lakes (including the Sydney International Regatta Centre) that will focus on recreation and wildlife habitat in a constructed wetland system.
- New regional parkland and rehabilitation of natural areas; and
- Regional walking, equestrian trails and cycleways throughout the urban parkland area.

## LEGISLATIVE UPDATES

Legislation and planning policies relevant to flora and fauna that have been updated since the ERM (2001) report include: PART 3A provisions of *Environment Planning & Assessment Act* 1979, NSW *Threatened Species Amendment Act* 2004; NSW *Native Vegetation Act* 2003; *Catchment Management Authorities Act* 2003; *Rural fires Act* 2002 and Metropolitan Strategy 'City of Cities,'. In addition, the following best practice guidelines have been written since the ERM (2001) report: Recovering the Bushland of the Cumberland Plain and Bringing Back the bush to Western Sydney. These are briefly discussed below:

### State Legislation

#### PART 3A provisions of *Environment Planning & Assessment Act* 1979

The *Environment Planning & Assessment Act* 1979 (EP&A Act) was amended in June 2005 to reform the land-use planning and development assessment and approval system, particularly as it relates to major infrastructure and other significant development (DIPNR 2005). In the new Part 3A, the Act provides a single assessment and approval regime for all major infrastructure and other projects previously undertaken under Part 4 and/or Division 4 of Part 5 of the EP&A Act. The new Part applies to major State government infrastructure projects, development that previously was classified as State significant development and other projects, plans or programs declared by the Minister for Planning (DIPNR 2005).

Provisions have been made in the Act for (DIPNR 2005):

- Independent Hearings and Panel Assessments to strengthen the assessment process;
- Concept Plans for complex projects, plans or programs so that the overall provisions can be evaluated prior to consideration of the details of the project(s). This provides for matters such as the suitability of the site/route and environmental issues to be resolved up-front and provides for the simplification of subsequent approvals where environmental impacts can be avoided or minimised; and,
- the Minister to declare projects to be 'critical infrastructure projects'. Prior to making such a declaration, a preliminary risk assessment will be required to consider the financial, economic, social and environmental risks of declaring the project a critical infrastructure project. These projects only require a concept approval and there are no appeal rights except if initiated by the Minister.

PLDC is applying for development consent of the Concept Plan, integrating the residential land and Parklands, under a single Part 3A application.

**NSW *Threatened Species Amendment Act* 2004**

The *Threatened Species Legislation Amendment Act* 2004 sets in place a number of reforms which provide more powerful tools for conserving biodiversity and protecting threatened species, populations, communities and their habitats at the landscape scale (DEC 2006).

Key reform areas include (DEC 2006):

- in urban and coastal areas - the integration of biodiversity into strategic land-use planning and improvements to the development assessment process
- the accreditation of flora and fauna consultants
- in rural areas - threatened species conservation embedded within native vegetation protection and incentives for landholders
- transparent prioritisation of recovery and threat abatement actions
- upgraded enforcement and compliance provisions
- the listing of threatened species maintained as a scientific process and based on defined criteria
- expert advisory councils to advise the Minister for the Environment on social, economic and biodiversity implications.

Biodiversity Certification

Biodiversity certification enables local government in areas with high development pressure to provide for the protection of biodiversity, including threatened species at the strategic planning stage. Certification can switch off the need for threatened species assessment under the EP&A Act, providing more certainty for local government, development applicants and other stakeholders. Biodiversity must be maintained or improved for certification to be conferred. Certification may be granted for part of a local environmental plan (LEP) or individual species within the LEP, depending on the quality of the available data (DEC 2006).

***Catchment Management Authorities Act* 2003**

The *Catchment Management Authorities Act* 2003 (CMA Act) establishes Catchment Management Authorities, which are locally driven organisations with a board that reports directly to the NSW Minister for Natural Resources. They are responsible for involving regional communities in management of the NRM issues facing their region, developing and implementing the Catchment Management Action Plans and are the primary means for the delivery of funding from the NSW and Commonwealth Governments to help land managers improve and restore the natural resources of the State (CMA 2005).

The objectives of the CMA Act are as follows:

- to establish authorities for the purpose of devolving operational, investment and decision-making natural resource functions to catchment levels,

- to provide for proper natural resource planning at a catchment level,
- to ensure that decisions about natural resources take into account appropriate catchment issues,
- to require decisions taken at a catchment level to take into account State-wide standards and to involve the Natural Resources Commission in catchment planning where appropriate,
- to involve communities in each catchment in decision making and to make best use of catchment knowledge and expertise,
- to ensure the proper management of natural resources in the social, economic and environmental interests of the State,
- to apply sound scientific knowledge to achieve a fully functioning and productive landscape,
- to provide a framework for financial assistance and incentives to landholders in connection with natural resource management.

PLDC could consult with Hawkesbury Nepean Catchment Management Authority in development of management of riparian and waterway areas.

***Rural Fires and Environmental Assessment Legislation Amendment Act* 2002**

On 1 August 2002, the *Rural Fires and Environmental Assessment Legislation Amendment Act 2002* commenced. This Act amends both the EP&A Act and the *Rural Fires Act 1997* to provide a stronger, more streamlined system for planning for bushfire protection (Department of Planning undated-a). The changes affect councils currently required to prepare Bush Fire Risk Management Plans under the *Rural Fires Act 1997*. The changes cover hazard reduction activities as well as planning and development control matters on land that is identified as being prone to bushfire (Department of Planning undated-a).

The implementation of Asset Protection Zones for urban development within Penrith Lakes should not impact on existing stands of native vegetation. Impacts from bushfire management and hazard reduction activities on areas of native vegetation will need to be assessed under the relevant threatened species legislation.

***Native Vegetation Act* 2003**

The *Native Vegetation Act* 2003 (NV Act) regulates the clearing of native vegetation on all land in NSW except for land listed in Schedule 1 of the Act (NSW Government undated). Excluded land falls into the following categories (NSW Government undated):

- National Parks and other conservation areas
- State forests and reserves, and
- urban areas.

The clearing of native vegetation is subject to differing requirements depending on whether the vegetation is classified as remnant vegetation, protected regrowth or non–protected regrowth (NSW Government undated).

Urban areas within Penrith LGA are included in a list of areas excluded from the NV Act.

## Policies and Strategies

### Metropolitan Strategy 'City of Cities'

The Environment and Resources section of the Metropolitan Strategy sets out a number of objectives (Department of Planning undated-b):

- Establish targets for sustainable growth
- Protect Sydney's natural environment
- Achieve sustainable use of natural resources
- Protect valuable rural activities and resource lands

Actions set out under the strategy include (Department of Planning undated-b):

- Establish targets for sustainable growth
- Protect Sydney's natural environment
- Achieve sustainable use of natural resources
- Protect valuable rural activities and resource lands

Special reference is made in the Strategy to the current situation of Sydney's rivers and the degraded state of the riparian vegetation and wetlands. The Penrith Lakes Concept Plan will aim to improve the condition of the riparian vegetation along the Nepean River within the study area and introduce a number of wetlands, providing valuable habitat for local fauna.

### Hawkesbury Lower Nepean Catchment Blueprint 2003

Hawkesbury Lower Nepean Catchment Blueprint 2003 is being superseded by the Hawkesbury Nepean Catchment Action Plan, which is currently in draft form.

The Hawkesbury Nepean Catchment Action Plan (CAP) is the first stage of managing the catchment in a way that will (Hawkesbury Nepean Catchment Management Authority 2007):

- improve river health
- protect biodiversity and
- encourage best practice soil and land management.

The CAP details a state wide biodiversity target of increasing native vegetation extent and improving its condition; increasing recovery of threatened species, populations and ecological

communities; reducing impact of invasive species; and improving the sustainability of key native fauna populations. The CAP also details a state-wide river heath target of improving condition of riverine ecosystems, and condition and extent of important wetlands; reducing declines in the condition of marine waters and ecosystems; improving the ability of groundwater systems to support groundwater-dependent ecosystems and designated beneficial uses; and improving estuary condition (Hawkesbury Nepean Catchment Management Authority 2007). The CAP lists a number of condition targets and management targets that will assist the overall state wide targets to be achieved.

The Penrith Lakes Concept Plan is generally in line with the CAP statewide biodiversity and river health targets in conserving and enhancing areas of native vegetation in the study area, particularly along the Nepean River. The CAP could be used to assist in developing the management plans for the Nepean River.

**Best Practice Guidelines**

**Recovering the Bushland of the Cumberland Plain**

DEC (2005o) have produced guidelines on managing and restoring native vegetation on the Cumberland Plain, including management techniques for bringing back fauna, managing riverside vegetation and buffer zones. These guidelines should be followed in development of the site-specific management plans for the study area, particularly the management of the areas of native vegetation.

**Bringing Back the bush to Western Sydney**

The Department of Infrastructure, Planning and Natural Resources have produced a set of guidelines for Bush Regeneration on the Cumberland Plain (DIPNR 2003). These guidelines should be followed in development of the site-specific vegetation management plan and weed control plans for the areas of native vegetation.

## METHODS

### Literature and Database Review

Database searches have been updated to account for any additional listings or changes in status of threatened species under the TSC Act and EPBC Act since the ERM (2001) study. Database records for the area within a 10 km radius of the study area were obtained, as follows:

- records of NSW-listed threatened species, populations and communities were obtained from the NSW Department of Environment and Conservation (DEC) *Atlas of NSW Wildlife* (data obtained February 2007);
- records of matters of national environmental significance were obtained from the Commonwealth Department of Environment and Heritage (DEH) *Protected Matters Database* (data obtained January 2007); and,

- records of potential fish species were obtained from the NSW Resource Atlas, the Australian Museum database and the Department of Primary Industries (DPI) Bionet database for the Penrith LGA (data obtained January 2007).

Data and information regarding the flora and fauna of Penrith Lakes and adjacent areas were obtained from a variety of sources. These included:

- Plan of Management for the Nepean Riverbank (Northern Section) adjacent to the Penrith Lakes Scheme: Site Mechanism Assessment and Development of Rehabilitation Strategies. (Beveridge 2002);
- River Bank Fauna Report for Penrith Lakes Scheme (Abel Ecology 2007b) and Literature review and Draft Knowledge Gap Analysis of Fauna at Penrith Lakes Scheme (Abel Ecology 2007a);
- Nepean River Pump & Pipeline Investigation into Aquatic Weed Transfer Control & Water Quality (Australian Wetlands 2006);
- Nepean River – Penrith Lakes Pipeline: Additional Aquatic Impact Assessment (Biosis Research 2006);
- Penrith Lakes Nepean Pump and Pipeline: Terrestrial and Aquatic Flora and Fauna Impact Assessment (Biosis Research 2006);
- Ecological Considerations for Plant Communities and Land Rehabilitation for the Penrith Lakes Scheme (Total Catchment Management Services 2005) and Review of PLDC New Concept Plan with Respect to Ecological Considerations for Plant Communities and Land Rehabilitation (Total Catchment Management Services 2007);
- Penrith Lakes Scheme Flora and Fauna Management Study (ERM 2001); and
- Vegetation mapping carried out by NPWS (2002c).

**Site inspection**

As this is an opportunities and constraints assessment, a detailed flora and fauna survey was not undertaken. Instead data from previous reports (listed above) has been used to assist in the assessment. A site visit was undertaken on 24 January 2007. Inspections were made at representative locations along the Nepean River and areas where remnant native flora and fauna persist in the study area. Plant communities within the study area were identified and their condition assessed.

## RESULTS

### Threatened Plant Species

Twenty seven flora species listed as threatened on the TSC Act and/or the EPBC Act have been previously recorded within a 10 km radius of the study area or have potential habitat in the local area (Table 1). However, it is considered unlikely that 21 of these species would occur within the study area on the basis of habitat requirements (Table 1). Potential habitat for five threatened plant species, *Dillwynia tenuifolia, Eucalyptus benthamii, Micromyrtus minutiflora, Pimelia spicata* and *Pultenaea parviflora* occurs within the study area in the Cumberland Plain Woodland and the River-flat Eucalypt Forest along the Nepean River (see Table 1).

The ERM (2001) report states that a population of *Grevillea juniperina* ssp. *juniperina,* a threatened plant species listed on the TSC Act, has been previously recorded in the study area in the Cumberland Plain Woodland in the vicinity of Church Lane.

The ERM (2001) study did not consider the occurrence of potential habitat for threatened plant species that occurs in the study area. Consequently, *Grevillea juniperina* ssp. *juniperina* was the only threatened plant species considered in the ERM (2001) report. It is important to use the presence of suitable habitat for threatened species as an indicator that threatened species could be present as it is likely that many threatened species may be missed during surveys as they are, by definition, rare. Using potential habitat as an indicator that threatened species may be present and thus further considering these threatened species in impact assessments is a more conservative approach and one which follows the DEC Threatened Species Assessment Guidelines (DEC 2005p).

### Plant Communities

The study area has been highly disturbed due to historical quarrying and agricultural use. As such, most of the native vegetation has been removed and little resilience remains due to the highly modified soil profile. Furthermore, areas supporting native vegetation are highly disturbed and degraded.

Two native plant communities were identified in the study area during the brief site inspection: Cumberland Plain Woodland and River-flat Eucalypt Forest. River-flat Eucalypt Forest was restricted to the banks of the Nepean River and was in poor condition, with weed species dominating each structural layer and the canopy reduced to scattered trees in many areas. Cumberland Plain Woodland was recorded in the escarpment area and a few scattered locations across the study area. The Cumberland Plain Woodland along the escarpment area was considered to be in moderate condition, with a relatively intact tree canopy and weed management reducing the dominance of exotic species. From the brief site inspection, it was found that the native vegetation of the area is relatively consistent with what was reported in the ERM (2001) study.

Cumberland Plain Woodland and River-flat Eucalypt Forest area both listed as Endangered Ecological Communities on the TSC Act. Cumberland Plain Woodland is also listed as an Endangered Ecological Community on the EPBC Act.

**Existing Vegetation Maps**

ERM (2001) has mapped four vegetation communities as occurring in the study area: Cumberland Plain Woodland, Sydney Coastal River Flat Forest, Rehabilitation and Exotic planting/rehabilitation. The majority of the study area is not mapped as supporting any vegetation. Cumberland Plain Woodland is mapped as occurring along the Cranebrook escarpment and as scattered patches to the north and south of the escarpment and one small isolated patch in the centre of the study area. Sydney Coastal River Flat Forest is mapped as occurring along the Nepean River and as scattered patches within the study area. This is relatively consistent with what was recorded in the study area during the recent site inspection. Since the ERM (2001) study, the EEC Sydney Coastal River Flat Forest has been removed from the TSC Act and has been replaced by a number of EECs representing native vegetation of the floodplains along the coast of NSW, including River-flat Eucalypt Forest. The native vegetation along the Nepean River is representative of this EEC.

NPWS (2002c) vegetation mapping of the study area is relatively consistent with that of ERM (2001), with the exception of an area of Shale Gravel Transition Forest and Alluvial Woodland mapped amidst the Shale Plains Woodland occurring in the north-east of the study area in the vicinity of Church Lane. Shale Plains Woodland is a sub-community of Cumberland Plain Woodland. Alluvial Woodland dominated by eucalypts is part of River-flat Eucalypt Forest and Alluvial Woodland dominated by *Casuarina glauca* is part of Swamp Oak Floodplain Forest, both of which are EEC's on the TSC Act (NSW Scientific Committee 2004). Shale Gravel Transition Forest is also listed as an EEC on the TSC Act.

Vegetation mapping of the study area should be updated and refined when detailed flora and fauna investigations are undertaken as part of the development application process.

**Threatened Fauna Species**

Forty one threatened fauna species listed on the TSC and/or EPBC Acts have either been recorded within 10 km of the study area or have potential habitat within 10 km of the study area (Table 2). Limited potential habitat is considered to exist for 14 of these species in the remnant vegetation and rehabilitation areas in the study area, including the lakes and wetlands. These included:

- Green and Golden Bell Frog *Litoria aurea*;
- Freckled Duck *Stictonetta naevosa*;
- Australasian Bittern *Botaurus poiciloptilus*;
- Bush Stone-curlew *Burhinus grallarius*;
- Painted Honeyeater *Grantiella picta*;

- Speckled Warbler *Chthonicola sagittata*;
- Black-necked Stork *Ephippiorhynchus asiaticus*
- Australian Painted Snipe *Rostratula australis*;
- Cumberland Plain Land Snail *Meridolum corneovirens*;
- Eastern Freetail Bat *Mormopterus norfolkensis*;
- Grey-headed Flying-fox *Pteropus poliocephalus*;
- Eastern Bent-wing Bat *Miniopterus schreinersii*; and
- Large-footed Myotis *Myotis adversus*.

Some of these species have been recently or historically recorded in the study area including Eastern Freetailed Bat, Eastern Bent-wing Bat, Grey Headed flying fox, Green and Golden Bell Frog, Large Footed Myotis, Speckled Warbler, Australian Painted Snipe and Freckled Duck (Abel Ecology 2007). This is significantly more threatened species than those considered during the ERM (2001) report, where only three species were considered and assessed as unlikely to be present. The ERM report did not appear to consider the presence of potential habitat for threatened species for except for those that had been historically recorded at the site.

In addition, nine species of birds listed under the migratory provisions of the EPBC Act may also occur within Penrith Lakes.

**Fauna Habitat**

The fauna habitat types within the study area were generally consistent with the plant communities described above and included disturbed grassland; woodland; riparian forest and freshwater wetlands and dams. The woodlands are generally in poor quality and isolated to small patches with limited understorey generally heavily impacted by weeds. However, some ground habitat such as logs and exfoliated bark was present particularly in the area of the escarpment. The riparian forest is highly impacted from previous land use and exotic weeds. Some native eucalypts were present, with a limited number of hollows but the mid storey and understorey were dominated by weeds. Recent fires have cleared areas of weeds, though regrowth of the weeds was observed.

The riparian habitats and fauna community are detailed in Abel Ecology (2007). There are large areas of reconstructed and rehabilitated wetlands and lakes which will increase as the scheme progresses. These areas are providing excellent foraging and roosting habitat for waterbirds and grassland bird species and may be providing habitat for migratory waterbirds.

**Threatened Aquatic Fauna**

Two species of freshwater fish and two species of aquatic invertebrate that are listed as threatened under the FM Act and/or EPBC Act are known, or have potential to, inhabit the

catchments of Sydney Region (Table 3). No potential habitat for any of these species occurs within the study area, although Macquarie Perch, *Macquaria australasica* are known to occur in Glenbrook Creek approximately 8 km to the south.

## CONSTRAINTS AND OPPORTUNITIES

The study area has been considered with regard to identifying potential constraints and opportunities for future development in relation to threatened flora and fauna and their habitats. This has involved an assessment of the natural environment and consideration of relevant environmental and planning statutory requirements. As a result of this process, stands of native vegetation and other natural features have been identified as potential constraints to future development in the study area. However, previous and current land use has reduced the ecological significance of these features. This presents an opportunity for development design to examine potential off-sets or improvements to the existing natural environment in some locations within the study area and surrounds.

The chief constraints associated with flora and fauna and their habitats are the presence of:

- endangered ecological communities;
- threatened species;
- migratory species;
- habitat for threatened species;
- habitat for migratory species; and,
- potential local and regional corridors.

### Conservation Significance

Two Endangered Ecological Communities were recorded in the study area, Cumberland Plain Woodland and River-flat Eucalypt Forest. River-flat Eucalypt Forest occurs as a strip of vegetation of varying width along the Nepean River and as small isolated remnants across the study area. River-flat Eucalypt Forest was considered to be in poor condition in the study area, with current and past land uses reducing the species and structural diversity of the community and resulting in severe weed invasion. The Cumberland Plain Woodland mainly occurs on the Cranebrook Escarpment and was considered in be in moderate condition, but also occurs in small isolated patches across the study area in poor condition.

*Grevillea juniperina* subsp. *juniperina* was recorded in the study area in Cumberland Plain Woodland in the vicinity of Church Lane. The plant occurs as a dominant in the understorey of this patch of vegetation. In addition, potential habitat for five threatened plant species occurs in the study area: *Dillwynia tenuifolia, Eucalyptus benthamii, Micromyrtus minutiflora, Pimelea spicata* and *Pultenaea parviflora*. Potential habitat for these species occurs within the study area in Cumberland Plain Woodland and the River-flat Eucalypt Forest along the Nepean River.

The fauna habitat is generally consistent with the vegetation communities and considered to in poor to moderate condition dependent on the regeneration work undertaken. The poor condition of the understorey and ground habitat along the riparian areas limits their value for

ground based fauna. Despite this, potential habitat occurs for 14 threatened species of fauna and a number of migratory species within the study area. The significant areas of habitat included the escarpment woodland and riparian forest along the Nepean River. The escarpment provides potential habitat for a number of species including the Cumberland Plain Land Snail. The riparian forest contains foraging and potential roosting habitat for a number of species of bat.

The lakes area provides a locally significant source of open wetland habitat, which may be important to migratory and threatened waterbirds. This could include nationally and internationally significant species such as Latham's Snipe *Gallinago hardwickii*.

The Nepean River is an important regional river, however it is considered to be in poor condition due to a number of historical and current impacts which are largely outside the scope of Penrith lakes and this report. These impacts include flow reduction, habitat removal and barriers to fish passage. The area around Penrith is dominated by aquatic weeds, many of which have not yet been recorded in Penrith lakes. Despite the poor condition of the river, rehabilitation of the banks and protection of the river corridor will assist in protecting and improving the river, thereby providing habitat for a large number of native fish, water birds and other fauna associated with riparian areas. The riffle habitat at the ford in the south west of the study area is relatively rare in the lower Nepean River and efforts should be made to preserve this habitat and maintain fish passage through these areas.

**Opportunities**

Opportunities for development exist within the existing cleared and quarried areas of the study area. These areas have been highly disturbed for decades, providing little to no habitat for native flora and only limited foraging habitat for common fauna species, and are therefore are generally suitable for development.

The Concept Plan provides opportunities for improving the existing flora and fauna values of the study area. Such opportunities have been incorporated into the Concept Plan, with areas of native vegetation being conserved and enhanced, including rehabilitation and restoration activities and weed management being proposed as part of the management of the study area.

Given the poor condition, dominance of weed species, lack of native species diversity and severely altered structure, it is likely that the remaining native vegetation of the study area, particularly that along the Nepean River, would further degrade with time if not managed appropriately. The proposed management and restoration programs will be of benefit to the native vegetation on site and in surrounding lands, with control of weed species preventing further spread off site and reintroduction of local native species increasing the native species diversity of the local area. Improvement of the flora and fauna habitats in the study area through the proposed management programs is likely to improve the long-term viability of the remaining remnants of native vegetation in the study area.

***Corridors***

Further opportunities could be achieved if woodland vegetation corridors were created to connect the vegetation along the Nepean River with other patches of on-site vegetation, such as the escarpment, as well as vegetated areas off-site. Currently the proposed vegetation overlay provides for rehabilitation of native vegetation communities in a relatively fragmented nature, with woodland patches interspersed between areas of grassland and parkland. Increasing connectivity between patches of native vegetation will further enhance the conservation value of the native vegetation in the study area and provide links for fauna to access areas between the study area, the lakes and the river corridor. Although these corridors would be minor on a regional scale they may assist with fauna movement within both Penrith Lakes and local areas to the east.

**Constraints**

Constraints are restricted to areas where native vegetation communities or remnant stands of native species occur, including the riparian areas of River-flat Eucalypt Forest along the Nepean River and the Cumberland Plain Woodland (CPW) along the Escarpment. These areas provide known and potential habitat for a number of threatened species listed under the EPBC and/or TSC Act, including *Grevillea juniperina* ssp. *juniperina,* which is known to occur in the patch of CPW along Church Lane. These areas also provided potential habitat for a number of threatened fauna species, such as Cumberland Plain Land Snail.

Constraints are also identified in protecting the water quality and habitat values of the lakes, wetlands and the Nepean River. These areas provide habitat for a wide range of native fish, birds and frogs and are an important part of the regional landscape. The Concept Plan provides buffer zone and water quality control guidelines to protect the habitat value of the lakes and similar measures should be implemented for the Nepean River.

The Concept Plan incorporates these areas as on-site conservation areas and proposes to improve the condition and viability of the flora and fauna values of the study area through appropriate management.

## IMPACT ASSESSMENT

Impacts on flora and fauna values of the study area will be minimised through careful positioning of development in areas previously disturbed and where possible not directly upslope or adjoining areas of native vegetation.

The Concept Plan (Attachment 1) incorporates a number of aspects that may impact on the flora and fauna values of the study area. These include: roads, urban footprint, recreational opportunities and flood weirs. The impacts of each of these aspects of the Concept Plan (as shown in Appendix 1) are discussed below. As the Concept Plan is in its early phases, details regarding the different aspects are not yet available. Therefore, the impact assessment is restricted to a general discussion of the likely impacts and mitigation measures that should be considered, rather than a detailed assessment, which will be required for the subsequent development application process.

### Roads

A number of main roads and local streets are proposed as part of the Concept Plan. The main impacts of roads on flora values of the study area are likely to be vegetation clearance, fragmentation and edge effects (including weed invasion and stormwater runoff).

The majority of the proposed roads do not result in vegetation clearance or fragmentation of any existing areas of native vegetation as they are restricted to cleared areas. Edge effects such as runoff and weed invasion, however, may have an impact on the native vegetation of the study area. Positioning of roads in the landscape should be considered in relation to nearby stands of native vegetation, avoiding being placed upslope of or immediately adjoining native vegetation where possible. Given the highly fragmented nature of the native vegetation of the study area, it is to already be completely impacted by edge effects, made evident by the extent of weed invasion and highly altered structure of the vegetation communities present. It is possible, however, that the introduction of roads will increase the extent of existing impacts if not mitigated properly.

The design of the riverside road should avoid the existing native vegetation, which is primarily on the down slope of the eastern bank of the river. Edge effects, generally considered to be an additional 60% of the road width, may impact upon the River-flat Eucalypt Forest and will need to be taken into account in the detailed investigation during the development application process. In addition, runoff controls should be directed to the east, away from the Nepean River and through water quality control structures. The Russell Street bridge will require significant clearing and works on both sides of the Nepean River in the south west of the study area. The bridge will be designed to be well above the major flood level. Further assessment of the bridge will be required, however, the design should follow Department of Primary Industries guidelines for river crossings (NSW Fisheries 1999), including;

- minimising impacts within the river channel,

- minimising cleared area,
- substantial light penetration beneath the bridge for regeneration of native plant species and,
- providing for fauna movement,
- drainage controls.

Proposed mitigation measures such as weed management, revegetation and buffer zones are likely to increase the resilience of the native vegetation in the study area. These areas will, however, still be vulnerable to indirect impacts given their location in relation to proposed surrounding land uses. As such, mitigation measures such as appropriate sedimentation basins to collect storm water runoff and establishment of roadside vegetation to reduce erosion will reduce the impacts of the proposed roads on the native vegetation of the study area.

The road system may provide a barrier or hazard to fauna movement from the riparian corridor into the lakes, between lakes or within habitat corridors between habitat patches. The movement between lakes and woodland areas would be especially relevant for waterbirds, particularly during breeding season. Fauna passage or exclusion fences may need to be considered.

**Urban footprint**

The urban footprint covers an area of 325 ha, supporting approximately 5,000 dwellings of a variety of sizes. Proposed urban development introduces a number of potential impacts to the native vegetation of the study area, including vegetation clearance, fragmentation, isolation, runoff, weed invasion, rubbish dumping and increased pedestrian traffic.

The proposed urban footprint appears to result in the partial clearance of a small patch of vegetation mapped as Sydney Coastal River-flat Forest by ERM (2001). This area was not inspected as part of the recent survey due to access restrictions. Given the small, fragmented nature of the patch and the surrounding land uses, it is likely that this patch is in poor condition. The potential impacts of the clearance of this patch of vegetation on the EEC will need to be assessed in more detail during the development application process.

The proposed urban footprint is not likely to result in isolation or fragmentation of any patches of existing native vegetation, as the proposed residential areas are interspersed between proposed lakes, vegetated areas and parklands. The proposed landscape corridors provide opportunities to introduce connectivity between existing native vegetation stands, however, these would be improved with an increase in woodland areas and reduction in grasslands. Such corridors would improve the east-west fauna corridors and provide links between isolated stands of bushland.

Urban runoff may impact on bushland areas and waterways through increased stormwater, pollutants, weed invasion and rubbish dumping. The proposed residential areas adjoining the Cumberland Plain Woodland of the escarpment and the River-flat Eucalypt Forest of the

Nepean River have the potential to increase these impacts. Implementation of the proposed flora and fauna management plans, including weed management plans, revegetation/restoration of the bushland areas and buffer zones is likely to reduce the impact of weed invasion and rubbish dumping. Raising community awareness of the issues associated with urban bushland and residential development, through involving the local community in bush regeneration and weed management programs, is also likely to assist in reducing these impacts. Appropriate storm water drainage should be incorporated at the detailed design phase to reduce impacts from runoff.

The mixing of urban and recreational areas and wildlife areas creates proximity to wildlife that is generally beneficial. However, fauna such as large waterbirds and other animals can cause significant impact or discomfort to other wildlife, residents and other users. Management of human-wildlife conflict, public education of the place for wildlife within the scheme and plans for dealing with wildlife in the urban environment should be investigated. With the development of urban areas, there is a marked increase in domestic animals, particularly cats and dogs, in the local area. Given the emphasis placed upon native wildlife, particularly around the northern lakes and the proximity to large regionally significant national parks, restrictions on domestic animal control (such as confining cats to their owners land in high risk areas) could also be implemented at the development stage.

Increased pedestrian traffic could result in trampling of native plants and creation of tracks through bushland areas. Proposed installation of established walking trails and cycling paths is likely to reduce the impact of increased pedestrian traffic. Fencing off sensitive areas and areas designated for conservation purposes should also be considered to prevent public access.

Required asset protection zones for bushfire management surrounding the urban areas should not be included in areas of existing native vegetation. Fuel management in these areas is likely to include the reduction of plant biomass and canopy cover, which will reduce the ecological integrity and resilience of the native vegetation.

**Recreational Opportunities**

Proposed recreational opportunities include water related, extreme adventure and outdoor and indoor sporting activities, education and research facilities, cultural centres, entertainment areas and eco resorts. Parklands are also proposed to be incorporated into the landscape design to facilitate outdoor recreational activities. A number of walking tracks and cycle ways are also proposed within the study area.

The riparian areas supporting River-flat Eucalypt Forest and other native vegetation are currently classified under the Concept Plan as a Riverside Recreational Park. Consideration should be given to inclusion of these areas into conservation areas. Conservation and rehabilitation goals should be an important focus of management plan for the riverside recreational park area. High impact recreational activities and facilities should be excluded from theses areas.

Proposed public access to the riparian areas along the Nepean River is likely to impact on the River-flat Eucalypt Forest in the area. Any facilities or development such as walkways within the proposed riverside recreational park is likely to require clearing of native vegetation along the Nepean River and possible earthworks to allow access. The impacts of any developments within this area will need to be assessed in more detail during the development application process. Native plant species such as *Casuarina cunninghamiana* should be incorporated into the design of the riverside recreational park, whilst retaining existing vegetation where possible.

The proposed extension of the Great River Walk along the banks of the Nepean River should be designed to minimise disturbance to the native vegetation of the riverbank. Local native trees should be retained and the area regenerated. A raised boardwalk should be considered to allow the persistence of native groundcover species and reduce impacts from erosion during high flows on the Nepean River. The walk will result in some removal or impact to the River-flat Eucalypt Forest but will assist in preventing creation of additional tracks to access the riverbank area. Indirect impacts of increased human traffic and access are likely to impact on adjoining bushland areas and the Nepean River. A litter control plan should also be included and signs erected, informing the public of the importance and sensitivity of the native bushland and riparian areas.

The establishment of riverfront and lake recreation and the nearby urban development, greatly increases the risk of introduction of aquatic weeds and fish species not yet present within Penrith Lakes. Aquatic weed species which are common in the Nepean River, but not yet present or are well controlled in Penrith Lakes, include *Egeria densa*, *Salvinia molesta* and *Elodea canadensis*. Public awareness, ongoing and active control measures and exclusion zones should be implemented to control the risk of the introduction of these weeds. The presence of these weeds in the river needs to be considered when developing the riverside recreation. Apart from the risk of translocation, these weeds can impact on river recreation activities such as swimming, boating and fishing. This may result in the need for physical control and management of the weeds.

Proposed development near areas of existing native vegetation, such as the proposed Indoor Cultural Centre, Education/Research centre and Eco Resort, should be designed to allow retention of the existing native vegetation. Landscaping around these areas should use local native species.

The proposed wilderness conservation areas create an opportunity to enhance existing flora and fauna values of the study area and increase public awareness of conservation issues. These conservation areas should have limited public access to assist in sustaining the ecological function and resilience of the areas protected within.

**Flood weirs**

The flood weirs are proposed to connect the Nepean River to the Penrith Lakes during times of extreme flood events. These weirs are very large, approximately 500 m wide and will

require the lowering of the bank by approximately 5 m. The weirs will also be cleared of woody vegetation. The proposed weirs are located at Lake A, Lake B, Quarantine Lake and Wildlife Lake. The western entrance of the flood weirs is in part of the river corridor and the construction of the weirs will result in the loss of some sections of River-flat Eucalypt Forest. Further detailed assessment of the flood weirs would be undertaken in the development process. It is considered highly important that native vegetation between the flood weirs and river be retained and enhanced. This will prevent fragmentation, providing a continuation of the riparian corridor and protect against erosion.

If flood levels breach the weir there is likely to be significant movement of aquatic fauna and flora from the lakes to the Nepean River and visa versa. This may result in alterations to the community structures within the lakes.

## CONCLUSION AND KEY RECOMMENDATIONS

The study area provides opportunities for development in the cleared and quarried areas due to extensive and ongoing disturbances leaving the area with little or no resilience. The Concept Plan proposes development within these areas, incorporated with conservation and enhancement of the remnant native vegetation of the study area through weed management, restoration/revegetation, buffer zones and creation of linkages between remnants of native vegetation. The incorporation of residential and recreational areas alongside conservation areas provides challenges for management of natural areas. Enhancing the ecological integrity of the flora and fauna habitats of the area will require ongoing management and resources prior to and following development.

Overall, the findings of the ERM (2001) study remain applicable to the revised Concept Plan. The terrestrial and aquatic flora and fauna are generally consistent with that described in ERM (2001) and updates from various reports including Abel Ecology (2007b, 2007a). The database searches were updated to include recent listings of threatened species, populations and ecological communities under the TSC and EPBC Acts. Consequently, a number of additional threatened species, or their habitats, were found to occur in the study area. Despite this, the broad opportunities and constraints analysis of the ERM (2001) study is consistent with that of the current review, with areas supporting remnant native vegetation generally considered to be constraints to development, with opportunities to conserve and enhance such vegetation and improve corridors across the study area. The management measures and the key recommendations detailed in the ERM (2001) study remain relevant to the revised Concept Plan. In additional to those recommendations by ERM (2001), the following is recommended:

- A detailed flora survey of the study area should be undertaken to identify areas that support flora of conservation significance that may require specific management or protection.
- Any part of the Concept Plan likely to impact (directly or indirectly) on native flora and fauna values of the study area will need to be addressed under relevant legislation, namely the EPBC Act and the TSC Act. Detailed flora and fauna assessments should be undertaken for any such developments and impact assessments under the TSC Act and/or the EPBC Act undertaken as required to determine significance of the impacts.
- Asset protection zones for urban development should not be undertaken within the existing native vegetation.
- Buffers zones of at least 10 m to 40 m width should be developed around the existing patches of native vegetation and the Nepean River to protect the areas from indirect impacts associated with the proposed Concept Plan. These buffer zones should be vegetated using local native species commensurate with the adjoining vegetation communities and should be excluded from development areas.

- Public access should be restricted in sensitive areas, such as parts of the riverbank and areas supporting threatened species and ecological communities.
- Public education programmes should be established that promote care for bushland and riverine areas.

Should you have any queries regarding this report, please do not hesitate to contact us. We can be reached in the Biosis Research Sydney office on (02) 9690 2777.

Yours sincerely,

Sian Wilkins and Matt Beitzel
Botanist Ecologist

**Table 1: Terrestrial plant species listed on the TSC Act or EPBC Act that have been recorded within 10 km of the study area**

| Species | Status | | Habitat | Potential Habitat |
|---|---|---|---|---|
| | EPBC Act[1] | TSC Act[2] | | |
| *Acacia bynoeana* | V | E1 | Bynoe's wattle is found in central eastern NSW, from the Hunter District (Morisset) south to the Southern Highlands and west to the Blue Mountains. It has recently been found in the Colymea and Parma Creek areas west of Nowra. Occurs in heath or dry sclerophyll forest on sandy soils. Seems to prefer open, sometimes slightly disturbed sites such as trail margins, edges of roadside spoil mounds and in recently burnt patches (DEC 2005a). | No. No native vegetation on sandy soils left in study area. |
| *Acacia gordonii* | E | E1 | Restricted to the north-west of Sydney. Has a disjunct distribution, occurring in the lower Blue Mountains in the west, and in the South Maroota/Glenorie area in the east. Occurs within the Hawkesbury, Blue Mountains and Baulkham Hills local government areas. Grows in dry sclerophyll forest and heathlands amongst or within rock platforms on sandstone outcrops. Flowers August to September and produces fruit October to February (DEC 2005b). | No. No sandstone outcrops in study area. |
| *Acacia pubescens* | V | V | Grows in open sclerophyll forest or woodland on clay soils (Harden 1991, Robinson 1994), usually on gravelly clay containing ironstones. This species typically occurs at the integrade between shales and sandstones in Cooks River/ Castlereagh Ironbark Forest, Shale/Gravel Transition Forest or Cumberland Plain Woodland (NPWS 2003a). | No. No gravelly ironstones in study area. |
| *Acrophyllum australe* | V | V | Restricted to an area between Springwood and Lawson in the Blue Mountains. Usually found near waterfalls where it grows in damp crevices in sandstone, usually near waterfalls (Harden 1990) or under drip ledges below sandstone cliffs (Fairley and Moore 2000). Flowers November - December. | No. Study area not within known distribution. |
| *Allocasuarina glareicola* | E | E1 | Primarily restricted to the Richmond (NW Cumberland Plain) district, but with an outlier population found at Voyager Point, Liverpool. Grows in Castlereagh woodland on lateritic soil. Found in open woodland with *Eucalyptus parramattensis, Eucalyptus fibrosa, Angophora bakeri,* | No. Listed associate species not recorded in study area. |

| Species | Status | | Habitat | Potential Habitat |
|---|---|---|---|---|
| | EPBC Act[1] | TSC Act[2] | | |
| | | | *Eucalyptus sclerophylla* and *Melaleuca decora*. Common associated understorey species include *Melaleuca nodosa, Hakea dactyloides, Hakea sericea, Dillwynia tenuifolia, Micromyrtus minutiflora*, *Acacia elongata, Acacia brownei, Themeda australis* and *Xanthorrhoea minor*. Not killed outright by fire but resprouts from the rootstock (DEC 2005c). | |
| *Cryptostylis hunteriana* | V | V | This species typically grows in swamp-heath on sandy soils chiefly in coastal districts (Harden 1993) but has also been recorded on steep bare hillsides (Bishop 1996). | No. No swamp heath in study area. |
| *Cynanchum elegans* | E | E1 | Rainforest gullies scrub and scree slopes in Gloucester and Wollongong districts (Harden 1992). Occurs mainly at the ecotone between dry subtropical rainforest and sclerophyll forest/woodland communities (NPWS 2002a). Has been recorded in dry subtropical rainforest, littoral rainforest, Leptospermum laevigatum-Banksia integrifolia Coastal scrub, Eucalyptus tereticornis forest and woodland, Corymbia maculata forest and woodland and Melaleuca armillaris scrub to open scrub (NPWS 2002a). | No. No rainforest gullies in study area. |
| *Dillwynia tenuifolia* | V | V1 | The core distribution is the Cumberland Plain from Windsor to Penrith east to Deans Park. Other populations in western Sydney are recorded from Voyger Point and Kemps Creek in the Liverpool LGA, Luddenham in the Penrith LGA and South Maroota in the Baulkham Hills Shire. Disjunct localities include: the Bulga Mountains at Yengo in the north, Kurrajong Heights and Woodford in the Lower Blue Mountains. Locally abundant particularly within dry areas within Castlereagh Ironbark Forest and Shale Gravel Transition Forest on tertiary alluvium or laterised clays. Flowering occurs sporadically from August to March depending on environmental conditions (DEC 2005d). | Possibly along the Nepean River. |
| *Epacris sparsa* | V | V | Only known to grow beside lower Grose River where it is found on in sandy soil among rocks (Harden 1992). Grows in Riparian Sandstone Scrub, where it is found on the base of | No. Riparian Sandstone Scrub not recorded in study area. . |

| Species | Status | | Habitat | Potential Habitat |
|---|---|---|---|---|
| | EPBC Act[1] | TSC Act[2] | | |
| | | | cliffs or rock faces, on rock ledges or among rocks in the riparian flood zone. Grows in small pockets of damp clay soil, chiefly on south-west facing slopes (DEC 2005e). | |
| *Eucalyptus benthamii* | V | V | Known from two main locations: Bents Basin and Kedumba Valley. A few scattered individuals are recorded from other sites on the sandy alluvial flats of the Kedumba/Cox/Nepean River system. Occurs only in wet open forest on sandy alluvial soils along valley floors at an elevation of 140-750 m. The soils are shallow to moderately deep and are well drained alluvial sands and gravels along stream channels, small terraces and alluvial flats (NPWS 2000). Restricted but locally abundant (Harden 1991). ROTAP; 2Vi | Possibly along the Nepean River. |
| *Grevillea juniperina* ssp. *juniperina* | - | V | It's distribution is centred on an area bounded by Blacktown, Erskine Park, Londonderry and Windsor with outlier populations at Kemps Creek and Pitt Town (NPWS 2002b). It is found on clay soils in open forest on the Cumberland Plain (Robinson 1994). Grows in moist sites, usually near creek on acidic soils (Harden 1991) | Yes. Recorded in CPW in study area. |
| *Grevillea parviflora* ssp. *parviflora* | V | V | Sporadically distributed throughout the Sydney Basin with the main occurrence centred around Picton, Appin and Bargo. Separate populations are also known further north from Putty to Wyong and Lake Macquarie on the Central Coast and Cessnock and Kurri Kurri in the Lower Hunter. Grows in sandy or light clay soils usually over thin shales. Occurs in a range of vegetation types from heath and shrubby woodland to open forest. Often occurs in open, slightly disturbed sites such as along tracks. Flowering has been recorded between July to December as well as April-May (DEC 2005f). | No. Study area outside known distribution. |
| *Haloragodendron lucasii* | E | E1 | Grows in dry sclerophyll forest or low open woodland on sheltered sandstone slopes near creeks in moist sandy loam soil (Harden 1991, NPWS 1999f). Often found below cliff lines with an understorey of ferns and sedges (Fairley and Moore 2000). The known locations of this species are confined to a very narrow distribution on the north shore of Sydney in St Ives and Turramurra | No. Study area outside known distribution of this species. |

| Species | Status | | Habitat | Potential Habitat |
|---|---|---|---|---|
| | EPBC Act[1] | TSC Act[2] | | |
| | | | (B Smith, Pers Comm). | |
| *Leucopogon fletcheri* ssp. *fletcheri* | - | E1 | Found in woodland (Harden 1992) on clayey lateritic soils between the Wianamatta Shale and Hawkesbury Sandstone, generally on flat to gently sloping along ridges and spurs (NSW Scientific Committee 1999). Flowers August to September. Restricted to north-western Sydney between St Albans in the north and Annangrove in the south, within the local government areas of Hawkesbury, Baulkham Hills and Blue Mountains (DEC 2005g). | No. Study area outside known distribution for this species. |
| *Marsdenia viridiflora* ssp. *viridiflora* | - | EP | This species has a wide distribution in subcoastal and southern Queensland but has been recorded rarely in NSW and from a disjunct occurrence near Sydney where it occurs as very scattered plants in areas of remnant vegetation (NSW Scientific Committee 2003) and is typically found in Sydney Turpentine Ironbark Forest (NSW Scientific Committee 1998b). Grows in vine thickets and open shale woodland. Recent records are from Prospect, Bankstown, Smithfield, Cabramatta Creek and St Marys. Previously known north from Razorback Range (DEC 2005h). | No. No Sydney Turpentine Ironbark Forest in study area. |
| *Melaleuca deanei* | V | V | Grows in wet heath on sandstone (Harden 1991). Occurs in two distinct areas of Sydney (Ku-Ring-Gai/Berowra and Holsworthy/Wedderburn) and has isolated occurrences in the Blue Mountains, Nowra and Central Coast areas (DEC 2005i). The species grows in heath on sandstone. Flowers appear in summer but seed production appears to be small and consequently the species exhibits a limited capacity to regenerate. ROTAP; 3R | No. No wet heath in study area. |
| *Micromyrtus minutiflora* | V | E1 | Found on the Cumberland Plain within dry sclerophyll forest (Harden 1992) on old alluviums (Robinson 1994). Restricted to the general area between Richmond and Penrith, western Sydney. Grows in Castlereagh Scribbly Gum Woodland, Ironbark Forest, Shale/Gravel Transition Forest, open forest on tertiary alluvium and consolidated river sediments. Sporadic flowering, June to March (DEC 2005j). | Possible, along the Nepean River. |
| *Persoonia acerosa* | V | V | The Needle Geebung has been recorded only on the central coast and in the Blue Mountains, from Mt Tomah | No. Study area outside known distribution for |

| Species | Status | | Habitat | Potential Habitat |
|---|---|---|---|---|
| | EPBC Act[1] | TSC Act[2] | | |
| | | | in the north to as far south as Hill Top where it is now believed to be extinct. Mainly in the Katoomba, Wentworth Falls, Springwood area. The Needle Geebung occurs in dry sclerophyll forest, scrubby low-woodland and heath on low fertility soils (DEC 2005k). | the species. |
| *Persoonia hirsuta* | E | E1 | Occurs from Gosford to Royal NP and in the Putty district from Hill Top to Glen Davis where it grows in woodland to dry sclerophyll forest on sandstone (Harden 2002) or rarely on shale (NSW Scientific Committee 1998a). Two subspecies are recognised, *P. hirsuta* ssp*. hirsuta* (Gosford to Berowra and Manly to Royal NP) and *P. hirsuta* ssp. *evoluta* (Blue Mountains, Woronora Plateau and Southern Highlands). Found in sandy soils in dry sclerophyll open forest, woodland and heath on sandstone and shale-sandstone transition areas (DEC 2005l). | Unlikely. Sandstone areas in study area heavily mined and not supporting native vegetation. |
| *Persoonia nutans* | E | E1 | Grows in Woodland to dry sclerophyll forest on clay soils and old alluviums on the Cumberland Plain (Robinson 1994, Harden 2002). It is restricted to Castlereagh Scribbly Gum Woodlands, Agnes Banks Woodland, Shale Gravel Transition Forest and Cooks River Castlereagh Ironbark Forest (NPWS 2003b). Peak flowering is from December to January with sporadic flowering all year round. | No. listed vegetation communities not recorded in study area. |
| *Pimelea spicata* | E | E1 | In western Sydney, *P. spicata* is restricted to areas supporting, or that previously supported, Cumberland Plain Woodland. *Pimelea spicata* has been recorded from both shale hills and shale plains woodland. Pimelea *spicata* has also been recorded from highly degraded areas that no longer support native vegetation, but that would have supported CPW previously (DEC 2004). | Yes. In CPW and adjoining areas. |
| *Pomaderris brunnea* | V | V | Open forest confined to the Colo River & upper Nepean River (Harden 1990), on clay & alluvial soils (Fairley and Moore 1995). In the Hawkesbury/Nepean region, the species is known to be associated with Dry sclerophyll forests (Cumberland, Upper Riverina, Sydney Coastal, Sydney Hinterland, Sydney Sand Flats), Coastal Floodplain Wetlands and Coastal Valley Grassy | No. Study area not on upper Nepean River. |

| Species | Status | | Habitat | Potential Habitat |
|---|---|---|---|---|
| | EPBC Act[1] | TSC Act[2] | | |
| | | | Woodlands (DEC 2005m). | |
| *Pterostylis saxicola* | E | E1 | Most commonly found growing in small pockets of shallow soil in depressions on sandstone rock shelves above cliff lines (NSW Scientific Committee 1997). The vegetation communities that occur above the shelves are either shale/sandstone transition or shale communities. Often occurs near streams. Picnic Point to Picton (Harden 1993). Currently known from only 5 localities (NSW Scientific Committee 1997). ROTAP; 2E | No. No sandstone rock shelves above cliff lines in study area. |
| *Pultenaea glabra* | V | V | Found in dry sclerophyll forest on sandstone in the higher Blue Mountains and Glen Davis area (Harden 1991). Grows above south facing escarpments of the main plateau and sometimes in forest with an open canopy and moist soil (Baker and Corringham 1995). Flowers September to November, fruit matures October to December. | No. Study area outside known range of the species. |
| *Pultenaea parviflora* | V | E1 | *Pultenaea parviflora* is endemic to the Cumberland Plain, with a core distribution from Windsor to Penrith and east to Dean Park. Outlier populations are recorded from Kemps Creek and Wilberforce. P. parviflora may be locally abundant, particularly within scrubby/dry heath areas within Castlereagh Ironbark Forest and Shale Gravel Transition Forest on tertiary alluvium or laterised clays and in transitional areas where these communities adjoin Castlereagh Scribbly Gum Woodland (NPWS 2002d). Often found in association with other threatened species such as *Dillwynia tenuifolia, Dodonaea falcata, Grevillea juniperina, Micromyrtus minutiflora, Persoonia nutans* and *Styphelia laeta*. Flowering may occur between August and November depending on environmental conditions (DEC 2005n). | Possibly along the Nepean River. |
| *Pultenaea villifera* | - | EP | Occurs from the Blue Mountains to Eden where it grows in dry sclerophyll forest on sandy soil (Harden 2002). The population in the Blue Mountains occurs in the Springwood-Woodford area and is listed as an Endangered Population (NSW Scientific Committee 2002). | No. Study area outside known distribution. |
| *Zieria involucrata* | V | E1 | Has a disjunct distribution north and west of Sydney, in the Baulkham Hills, | No. Listed associate |

| Species | Status | | Habitat | Potential Habitat |
|---|---|---|---|---|
| | EPBC Act[1] | TSC Act[2] | | |
| | | | Hawkesbury, Hornsby and Blue Mountains local government areas. Occurs primarily on Hawkesbury sandstone. Also occurs on Narrabeen Group sandstone and on Quaternary alluvium. Found primarily in sheltered forests on mid- to lower slopes and valleys, e.g. in or adjacent to gullies which support sheltered forest, although some populations extend upslope into drier vegetation. Also known from at least two atypical ridgetop locations. The canopy typically includes *Syncarpia glomulifera* subsp*. glomulifera* (Turpentine), *Angophora costata* (Smooth-barked Apple), *Eucalyptus agglomerata* (Blue-leaved Stringybark) and *Allocasuarina torulosa* (Forest Oak). Flowering usually takes place in spring (DEC 2005q). | species not recorded ins study area. |

Key: 1) Listed on the EPBC Act as Endangered (E) or Vulnerable (V)
2) Listed on the TSC Act as Endangered (E1), Vulnerable (V) or Endangered Population (EP)

**Table 2: Threatened and migratory animal species or their habitat that have previously been recorded within 10 km of the study area**

| Scientific Name | Common Name | EPBC Act | TSC Act | Habitat | Potential habitat |
|---|---|---|---|---|---|
| *Litoria aurea* | Green and Golden Bell Frog | V | E1 | Found in marshes, dams and stream sides, particularly those containing bullrushes or spikerushes (NPWS 1999e). Preferred habitat contains water bodies that are unshaded, are free of predatory fish, have a grassy area nearby and have diurnal sheltering sites nearby such as vegetation or rocks (White and Pyke 1996, NPWS 1999e). | Yes |
| *Litoria littlejohni* | Littlejohn's Tree Frog | V | V | Occurs in wet and dry sclerophyll forests associated with sandstone outcrops between 280 and 1000 m on the eastern slopes of the Great Dividing Range (Barker *et al.* 1995). Prefers rock flowing streams, but individuals have also been collected from semi-permanent dams with some emergent vegetation (Barker *et al.* 1995). Forages both in the tree canopy and on the ground, and has been observed sheltering under rocks on high exposed ridges during summer. It is not known from coastal habitats. | No |
| *Heleioporus australiacus* | Giant Burrowing Frog | V | V | Prefers hanging swamps on sandstone shelves adjacent to perennial non-flooding creeks (Daly 1996, Recsei 1996). Can also occur within shale outcrops within sandstone formations. In the southern part of its range can occur in wet and dry forests, montane sclerophyll woodland and montane riparian woodland (Daly 1996). Individuals can be found around sandy creek banks or foraging along ridge-tops during or directly after heavy rain. Males often call from burrows located in sandy banks next to water (Barker *et al.* 1995). | No |
| *Mixophyes balbus* | Stuttering Frog | V | E1 | This species is usually associated with mountain streams, wet mountain forests and rainforests (Barker *et al.* 1995). It rarely wanders very far from the banks of permanent forest streams, although it will forage on nearby forest floors. Eggs are deposited in leaf litter on the banks of streams and are washed into the water during heavy rains (Barker *et al.* 1995). | No |
| *Mixophyes iteratus* | Giant Barred Frog | E | E1 | Usually found in coastal riverine rainforest and upland areas such ass the Border Ranges (Barker *et al.* 1995). | No |
| *Pseudophryne australis* | Red-crowned Toadlet | | V | Occurs on wetter ridge tops and upper slopes of sandstone formations on which the predominant vegetation is dry open forests and heaths. This species typically breeds within small ephemeral creeks that feed into larger semi-perennial streams. These creeks are characterised after rain by a series of shallow pools lined by dense | No |

| Scientific Name | Common Name | EPBC Act | TSC Act | Habitat | Potential habitat |
|---|---|---|---|---|---|
| | | | | grasses, ferns and low shrubs (Thumm and Mahony 1996, Thumm and Mahoney 1997). | |
| *Lophoictinia isura* | Square-tailed Kite | M | V | Typically inhabits coastal forested and wooded lands of tropical and temperate Australia (Marchant and Higgins 1993b). In NSW it is often associated with ridge and gully forests dominated by Woollybutt Eucalyptus longifloria, Spotted Gum E. Maculata or Peppermint Gum E. elata, E. smithii (NPWS 1999h). | No |
| *Stictonetta naevosa* | Freckled Duck | M | V | The freckled duck breeds in permanent fresh swamps that are heavily vegetated. Found in fresh or salty permanent open lakes, especially during drought. Often seen in groups on fallen trees and sand spits (Simpson and Day 1996). | Yes |
| *Botaurus poiciloptilus* | Australasian Bittern | | V | Inhabits terrestrial and estuarine wetlands, generally where there is permanent water. Prefers wetlands with dense vegetation including rushes and reeds (NPWS 1999a). | Yes |
| *Burhinus grallarius* | Bush Stone-curlew | | E1 | Lightly timbered open forest and woodland, or partly cleared farmland with remnants of woodland, with a ground cover of short sparse grass and few or no shrubs where fallen branches and leaf litter are present (Marchant and Higgins 1993a). | Yes |
| *Callocephalon fimbriatum* | Gang-gang Cockatoo | | V | In summer, occupies tall montane forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests (Higgins 1999). Also occur in subalpine Snow Gum woodland and occasionally in temperate or regenerating forest (Forshaw and Cooper 1981). In winter, occurs at lower altitudes in drier, more open eucalypt forests and woodlands, particularly in box-ironbark assemblages, or in dry forest in coastal areas (Shields and Crome 1992). It requires tree hollows in which to breed (Gibbons and Lindenmayer 1997). | No |
| *Calyptorhynchus lathami* | Glossy Black-cockatoo | | V | Inhabits forest with low nutrients, characteristically with key Allocasuarina species. Tends to prefer drier forest types (NPWS 1999d) with a middle stratum of Allocasuarina below Eucalyptus or Angophora. Often confined to remnant patches in hills and gullies (Higgins 1999). Breed in hollows stumps or limbs, either living or dead (Higgins 1999). | No |
| *Grantiella picta* | Painted Honeyeater | | V | Found mainly in dry open woodlands and forests, where it is strongly associated with mistletoe (Higgins *et al.* 2001). Often found on plains with scattered eucalypts and remnant trees on farmlands. | Yes |
| *Melithreptus gularis gularis* | Black-chinned Honeyeater | | V | Found mostly in open forests and woodlands dominated by box and ironbark eucalypts (Higgins *et al.* 2001). It is rarerly recorded east of the Great Dividing Range | No |

| Scientific Name | Common Name | EPBC Act | TSC Act | Habitat | Potential habitat |
|---|---|---|---|---|---|
| | | | | (Higgins *et al.* 2001). | |
| *Xanthomyza phrygia* | Regent Honeyeater | E | E1 | A semi-nomadic species occurring in temperate Eucalypt woodlands and open forests. Most records are from box-ironbark eucalypt forests associations and wet lowland coastal forests (Pizzey 1983, NPWS 1999g). | Yes |
| *Pyrrholaemus sagittata* | Speckled Warbler | | V | This species occurs in eucalypt and cypress woodlands on the hills and tablelands of the Great Dividing Range. They prefer woodlands with a grassy understorey, often on ridges or gullies (Blakers *et al.* 1984, NSW Scientific Committee 2001). The species is sedentary, living in pairs or trios and nests on the ground in grass tussocks, dense litter and fallen branches. They forage on the ground and in the understorey for arthropods and seeds (Blakers *et al.* 1984, NSW Scientific Committee 2001). Home ranges vary from 6-12 hectares (NSW Scientific Committee 2001). | Yes |
| *Stagonopleura guttata* | Diamond Firetail | | V | Found in a range of habitat types including open Eucalypt forest, mallee and acacia scrubs (Pizzey and Knight 1997). | No |
| *Ephippiorhynchus asiaticus* | Black-necked Stork | | E1 | Found in swamps, mangroves and mudflats. Can also occur in dry floodplains and irrigated lands and occasionally forages in open grassy woodland. Nests in live or dead trees usually near water (Pizzey 1983). | Yes |
| *Petroica rodinogaster* | Pink Robin | | V | Found in dense, dank forest/treefern gullies and disperses in autumn-winter to open forests, woodlands and scrublands (Pizzey and Knight 1997). | No |
| *Lathamus discolor* | Swift Parrot | EM | E1 | The Swift Parrot occurs in woodlands and forests of NSW from May to August, where it feeds on eucalypt nectar, pollen an associated insects (Forshaw and Cooper 1981). The Swift Parrot is dependent on flowering resources across a wide range of habitats in its wintering grounds in NSW (Shields and Crome 1992). This species is migratory, breeding in Tasmania and also nomadic, moving about in response to changing food availability (Pizzey 1983). | No |
| *Neophema pulchella* | Turquoise Parrot | | V | Occurs in open woodlands and eucalypt forests with a ground cover of grasses and understorey of low shrubs (Morris 1980). Generally found in the foothills of the Great Divide, including steep rocky ridges and gullies (Higgins 1999). Nest in hollow-bearing trees, either dead or alive; also in hollows in tree stumps. Prefer to breed in open grassy forests and woodlands, and gullies which are moist (Higgins 1999). | No |
| *Polytelis swainsonii* | Superb Parrot | V | V | Found mainly in open, tall riparian River Red Gum forest or woodland. Often found | No |

| Scientific Name | Common Name | EPBC Act | TSC Act | Habitat | Potential habitat |
|---|---|---|---|---|---|
| | | | | in farmland including grazing land with patches of remnant vegetation. Breeds in hollow branches of tall Eucalypt tress within 9 km of feeding areas (Higgins 1999). | |
| *Rostratula australis* | Australian Painted Snipe | V | E1 | Usually found in shallow inland wetlands including farm dams, lakes, rice crops, swamps and waterlogged grassland. They prefer freshwater wetlands, ephemeral or permanent, although they have been recorded in brackish waters (Marchant & Higgins 1993). | Yes |
| *Ninox connivens* | Barking Owl | | V | Generally found in open forests, woodlands, swamp woodlands and dense scrub. Can also be found in the foothills and timber along watercourses in otherwise open country (Pizzey 1983). | No |
| *Ninox strenua* | Powerful Owl | | V | Occupies wet and dry eucalypt forests and rainforests. Can occupy both un-logged and lightly logged forests as well as undisturbed forests where it usually roosts on the limbs of dense trees in gully areas. It is most commonly recorded within Red Turpentine in tall open forests and Black She-oak within open forests (Debus and Chafer 1994). Large mature trees with hollows at least 0.5 m deep are required for nesting (Garnett 1992). Tree hollows are particularly important for the Powerful Owl because a large proportion of the diet is made up of hollow-dependent arboreal marsupials (Gibbons and Lindenmayer 1997). Nest trees for this species are usually emergent with a diameter at breast height of at least 100 cm (Gibbons and Lindenmayer 1997). | No |
| *Tyto novaehollandiae* | Masked Owl | | V | Inhabits a diverse range of wooded habitat that provide tall or dense mature trees with hollows suitable for nesting and roosting (Higgins 1999). Mostly recorded in open forest and woodlands adjacent to cleared lands. Nest in hollows, in trunks and in near vertical spouts or large trees, usually living but sometime dead (Higgins 1999). Nest hollows are usually located within dense forests or woodlands (Gibbons and Lindenmayer 1997). Masked owls do prey upon hollow-dependent arboreal marsupials, but terrestrial mammals make up the largest proportion of the diet (Gibbons and Lindenmayer 1997, Higgins 1999). | No |
| *Tyto tenebricosa* | Sooty Owl | | V | Often found in tall old-growth forests, including temperate and subtropical rainforests. In NSW mostly found on escarpments with a mean altitude <500 m. Nests and roosts in hollows of tall emergent trees, mainly eucalypts (Higgins 1999) often located in gullies (Gibbons and | No |

| Scientific Name | Common Name | EPBC Act | TSC Act | Habitat | Potential habitat |
|---|---|---|---|---|---|
| | | | | Lindenmayer 1997). Nests have been located in trees 125 to 161 centimeters in diameter (Gibbons and Lindenmayer 1997). | |
| *Meridolum corneovirens* | Cumberland Plain Land Snail | | E1 | Most likely restricted to Cumberland Plain, Castlereagh Woodlands and boundaries between River-flat Forest and Cumberland Plain Woodland. It is normally found beneath logs, debris and amongst accumulated leaf and bark particularly at the base of trees. May also use soil cracks for refuge (NPWS 1999c). | Yes |
| *Dasyurus maculatus* | Spotted-tailed Quoll | E | V | Uses a range of habitats including sclerophyll forests and woodlands, coastal heathlands and rainforests (Dickman and Read 1992). Habitat requirements include suitable den sites, including hollow logs, rock crevices and caves, an abundance of food and an area of intact vegetation in which to forage (Edgar and Belcher 1995). | No |
| *Cercartetus nanus* | Eastern Pygmy-possum | | V | Inhabits rainforest through to sclerophyll forest and tree heath. Banksias and myrtaceous shrubs and trees are a favoured food source. Will often nest in tree hollows, but can also construct its own nest (Turner and Ward 1995). Because of its small size it is able to utilise a range of hollow sizes including very small hollows (Gibbons and Lindenmayer 1997). Individuals will use a number of different hollows and an individual has been recorded using up to 9 nest sites within a 0.5ha area over a 5 month period (Ward 1990). | No |
| *Phascogale tapoatafa* | Brush-tailed Phascogale | | V | Occurs in dry sclerophyll open forest with a sparse ground cover of herbs, grasses, shrubs or leaf litter (Soderquist 1995, NPWS 1999b). Individuals may also inhabit heathland, swamps, rainforest and wet sclerophyll forest (NPWS 1999b). Nests and shelters in tree hollows, utilizing many different hollows over a short period of time. Suitable hollows are 25-40 mm wide (NPWS 1999b). | No |
| *Petrogale penicillata* | Brush-tailed Rock-wallaby | V | E1 | Found in rocky areas in a wide variety of habitats including rainforest gullies, wet and dry sclerophyll forest, open woodland and rocky outcrops in semi-arid country. Commonly sites have a northerly aspect with numerous ledges, caves and crevices (Eldridge and Close 1995). | No |
| *Mormopterus norfolkensis* | Eastern Freetail Bat | | V | Most records are from dry eucalypt forests and woodlands to the east of the Great Dividing Range. Appears to roost in trees, but little is known of this species habits (Allison and Hoye 1995, Churchill 1998). | Yes |
| *Petaurus australis* | Yellow-bellied Glider | | V | Restricted to tall native forests in regions of high rainfall. Preferred habitats are productive, tall open sclerophyll forests | No |

| Scientific Name | Common Name | EPBC Act | TSC Act | Habitat | Potential habitat |
|---|---|---|---|---|---|
| | | | | where mature trees provide shelter and nesting hollows. Critical elements of habitat include sap-site trees, winter flowering eucalypts, mature trees suitable for den sites and a mosaic of different forest types (NPWS 1999i). | |
| *Petaurus norfolcensis* | Squirrel Glider | | V | Generally occurs in dry sclerophyll forests and woodlands but is absent from dense coastal ranges in the southern part of its range (Suckling 1995). Requires abundant hollow bearing trees and a mix of eucalypts, banksias and acacias (Quin 1995). There is only limited information available on den tree use by Squirrel gliders, but it has been observed using both living and dead trees as well as hollow stumps (Gibbons and Lindenmayer 1997). Within a suitable vegetation community at least one species should flower heavily in winter and one species of eucalypt should be smooth barked (Menkhorst *et al.* 1988). | No |
| *Phascolarctos cinereus* | Koala | | V | Inhabits eucalypt forests and woodlands. The suitability of these forests for habitation depends on the size and species of trees present, soil nutrients, climate and rainfall (Reed and Lunney 1990, Reed *et al.* 1990). | No |
| *Potorous tridactylus* | Long-nosed Potoroo | V | V | Inhabits coastal heath and wet and dry sclerophyll forests. Generally found in areas with rainfall greater than 760 mm. Requires relatively thick ground cover where the soil is light and sandy (Johnston 1995). | No |
| *Pteropus poliocephalus* | Grey-headed Flying-fox | V | V | This species is a canopy-feeding frugivore and nectarivore of rainforests, open forests, woodlands, Melaleuca swamps and Banksia woodlands. Bats commute daily to foraging areas, usually within 15 km of the day roost (Tidemann 1995) although some individuals may travel up to 70 km (Augee and Ford 1999). | Yes |
| *Miniopterus schreinersii* | Eastern Bent-wing Bat | | V | This species uses a broad range ogf habitat including rainforest, wet and dry sclerophyll forest, paper bark forest and open woodland and grassland (Churchill 1998). The species is cave dweller (although some individuals occasionally roost in human constructed tunnels and buildings) (Strahan 1995, Churchill 1998). | Yes |
| *Chalinolobus dwyeri* | Large-eared Pied Bat | V | V | Located in a variety of drier habitats, including the dry sclerophyll forests and woodlands to the east and west of the Great Dividing Range (Hoye and Dwyer 1995). Can also be found on the edges of rainforests and in wet sclerophyll forests (Churchill 1998). This species roosts in caves and mines in groups of between 3 and 37 individuals (Churchill 1998). | No |
| *Falsistrellus* | Eastern | | V | Inhabit sclerophyll forests, preferring wet | No |

| Scientific Name | Common Name | EPBC Act | TSC Act | Habitat | Potential habitat |
|---|---|---|---|---|---|
| *tasmaniensis* | False Pipistrelle | | | habitats where trees are more than 20 m high (Churchill 1998). Two observations have been made of roosts in stem holes of living eucalypts (Phillips 1995). There is debate about whether or not this species moves to lower altitudes during winter, or whether they remain sedentary but enter torpor (Menkhorst and Lumsden 1995). This species also appears to be highly mobile and records showing movements of up to 12 km between roosting and foraging sites (Menkhorst and Lumsden 1995). | |
| *Myotis adversus* | Large-footed Myotis | | V | Occurs in most habitat types as long as they are near permanent water bodies, including streams, lakes and reservoirs. Commonly roost in caves, but can also roost in tree hollows, under bridges and in mines (Richards 1995, Churchill 1998). | Yes |
| *Scoteanax rueppellii* | Greater Broad-nosed Bat | | V | Prefer moist gullies in mature coastal forests and rainforests, between the Great Dividing Range and the coast. They are only found at low altitudes below 500 m (Churchill 1998)In dense environments they utilise natural and human-made opening in the forest for flight paths. Creeks and small rivers are favoured foraging habitat (Hoye and Richards 1995). This species roosts in hollow tree trunks and branches (Churchill 1998). | No |
| *Hoplocephalus bungaroides* | Broad-headed Snake | V | E1 | Mainly occurs in association with communities occurring on Triassic sandstone within the Sydney Basin. Typically found among exposed sandstone outcrops with vegetation types ranging from woodland to heath. Within these habitats they generally use rock crevices and exfoliating rock during the cooler months and tree hollows during summer (Webb 1996, Webb and Shine 1998). | No |

Key: 1) Listed on the TSC Act as Endangered (E), Vulnerable (V)
2) Listed on the EPBC Act as Endangered (E) or Vulnerable (V) or covered under migratory provisions (M) on the EPBC Act

**Table 3. Aquatic fauna listed on the FM Act or the EPBC Act that have the potential to occur in the locality**

| Scientific Name | Common Name | FM Act | EPBC Act | Habitat | Potential habitat |
|---|---|---|---|---|---|
| *Archaeophya adamsi* | Adams emerald dragonfly | Vulnerable | - | Small creeks in gravel sandy riffles with large amounts of aquatic vegetation and moss from Gosford to western Sydney. | No |
| *Macquaria australasica* | Macquarie Perch | Vulnerable | Endangered | Cool clean water preferring deep slow flowing pools and lakes with access to riffles for breeding. Eastern populations are genetically distinct from western populations. | No |
| *Prototroctes maraena* | Australian Grayling | Protected | Vulnerable | Clear gravely coastal streams and rivers from the sea to the first barrier, up to 1000 m above sea level. | No Not generally found in the Nepean River |
| *Austrocordulia leonardi* | Sydney Hawk Dragonfly | Endangered | - | Deep cool pools on slow flowing rocky rivers in the Sydney region. | No |

## Attachment 1: Penrith Lakes Concept Plan

HASSELL

1 PRECINCT NUMBER

LAKES

RESIDENTIAL PRECINCTS

EMPLOYMENT PRECINCTS

PARKLANDS

CONSERVATION AREAS

SMITH RD

CHURCH LANE

CASTLEREAGH RD

TADMORE RD

CRANEBROOK RD

VINCENT RD

BOUNDARY RD

NEPEAN ST

TO STOCKLAND DEVELOPMENT

ANDREWS RD

RUSSELL ST

CASTLEREAGH RD

0 200 500m

Castlereagh
penrith lakes

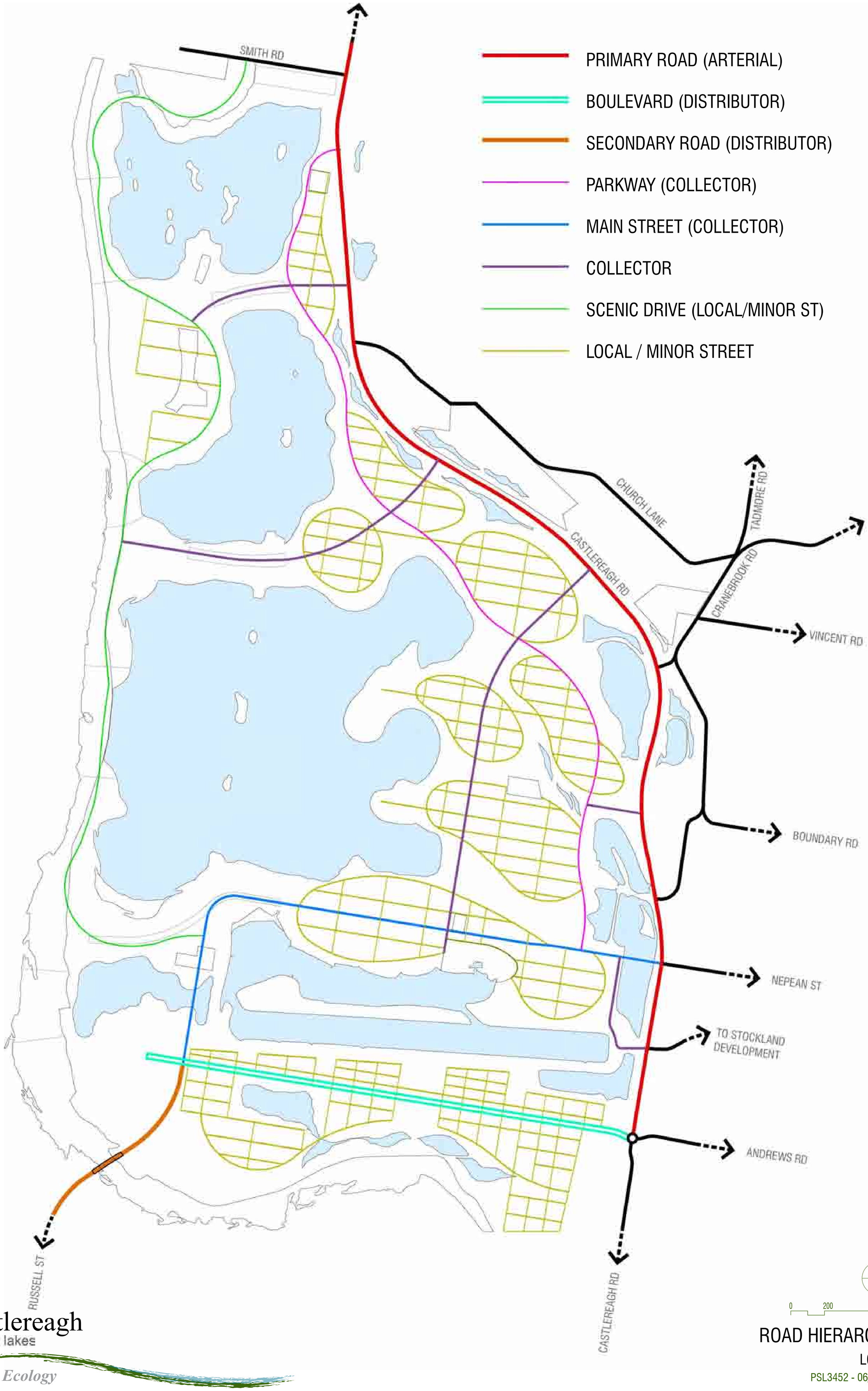
*Urban Ecology*

# STRUCTURE PLAN

L001C

PSL3452 - 06/02/07

HASSELL




Castlereagh
penrith lakes

*Urban Ecology*

# ROAD HIERARCHY

L003C

PSL3452 - 06/02/07

HASSELL

GREAT RIVER WALK

COMMUTER SPORTS LOOP

ON ROAD CYCLE PATHS

RECREATION / SHAREPATH OFF ROAD LINK

PEDESTRIAN CONNECTIONS

SMITH RD

CHURCH LANE

CASTLEREAGH RD

TADMORE RD

CRANEBROOK RD

VINCENT RD

BOUNDARY RD

NEPEAN ST

TO STOCKLAND DEVELOPMENT

ANDREWS RD

RUSSELL ST

0 200 500m

Castlereagh
penrith lakes

*Urban Ecology*

# PEDESTRIAN & CYCLEWAY CONNECTIONS

L004C

PSL3452 - 06/02/07

HASSELL

LANDS ABOVE 1:100
YEAR FLOOD LEVEL

WL 10.00
50YR = 19.60
100YR = 21.70
200YR = 23.20
500YR = 24.30

WL 12.00
50YR: 19.00
100YR: 22.30
200YR: 23.30
500YR: 24.40

WL 15.00
50YR = 19.10
100YR = 22.90
200YR = 24.00
500YR = 24.80

50YR: 21.30
100YR: 23.80
200YR: 24.70
500YR: 25.10

CHURCH LANE
TADMORE RD
VINCENT RD
BOUNDARY RD
NEPEAN ST
TO STOCKLAND DEVELOPMENT
ANDREWS RD
RUSSELL ST

0 200 500m

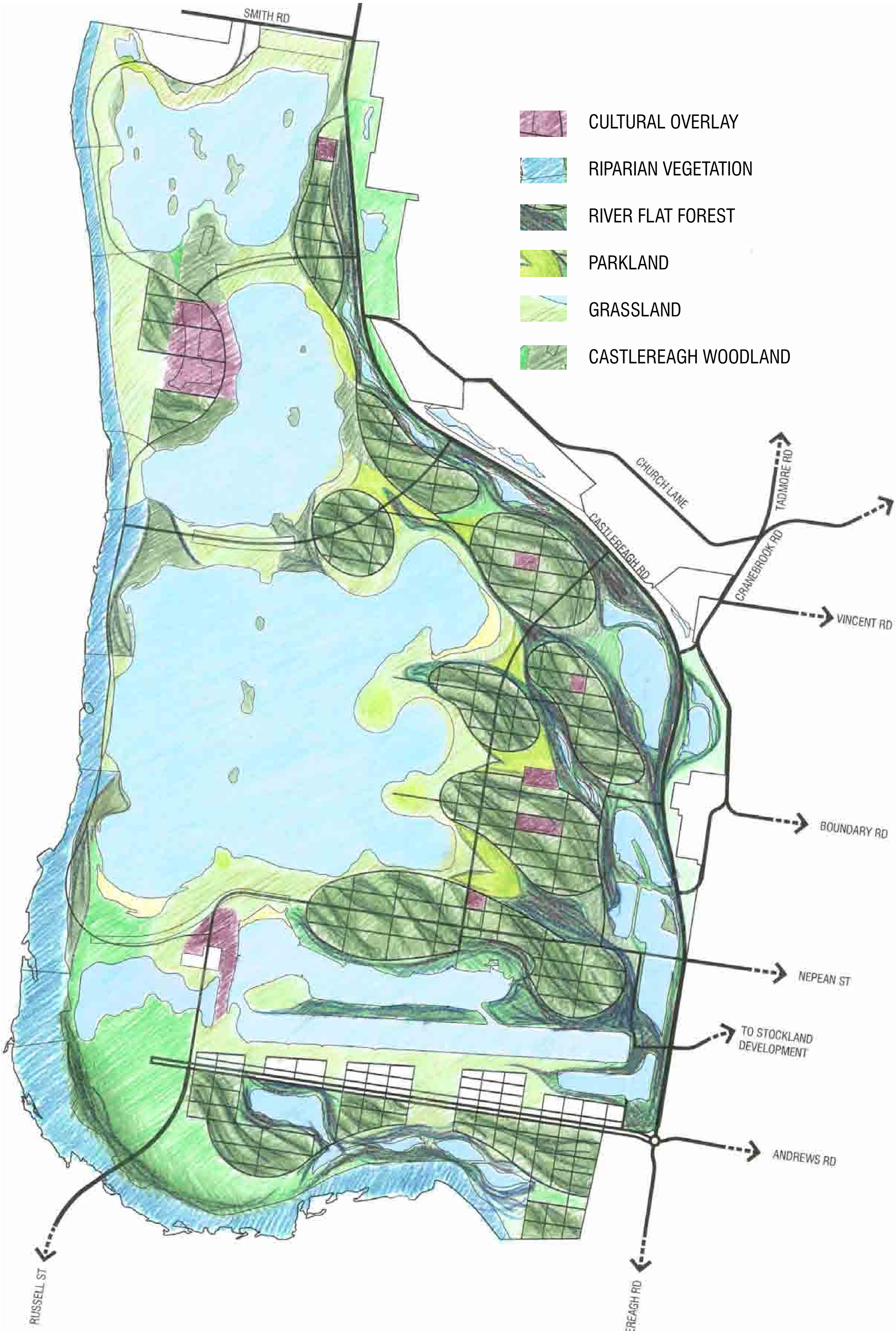
Castlereagh
penrith lakes
*Urban Ecology*

# TOPOGRAPHY & 100 YEAR FLOOD LEVEL

L005B

PSL3452 - 06/02/07

HASSELL




Castlereagh
penrith lakes

*Urban Ecology*

# VEGETATION OVERLAY

L012B

PSL3452 - 06/02/07

HASSELL

## PARKLAND SETTINGS

- RIVERSIDE RECREATION PARK
- LAKES
- LAKESIDE PARKLANDS
- COMMUNITY RECREATION FACILITIES
- WETLAND SETTING
- WILDERNESS / CONSERVATION

## SPECIAL ACTIVITIES

- W — Water Related
- E — Education / Research
- IC — Indoor Cultural
- OH — Outdoor Heritage
- OS — Outdoor Sports
- IN — Indoor Health and Fitness
- EX — Extreme / Adventure
- U — Urban / Entertainment
- ER — Eco Resort
- EC — Equestrian Centre
- DR — Golf Driving Range

SMITH RD
CHURCH LANE
CASTLEREAGH RD
CRANEBROOK RD
VINCENT RD
BOUNDARY RD
NEPEAN ST
TO STOCKLAND DEVELOPMENT
ANDREWS RD
RUSSELL ST
CASTLEREAGH RD
Sydney International Regatta Centre

IC EC OH E ER OH Ex W U W IN W OH E W OS W DR IN W U U U

0 200 500m

# Castlereagh
penrith lakes

*Urban Ecology*

## RECREATION PROVISION STRATEGY

L013B

PSL3452 - 06/02/07

**References**


Abel Ecology 2007a, *DRAFT Literature review and knowledge gap analysis of Fauna at Penrith Lakes Scheme*, Prepared for Penrith Lakes Development Corporation Ltd.,

Abel Ecology 2007b, *River Bank Fauna Report for Penrith Lakes Scheme*, Prepared for Penrith Lakes Development Corporation Ltd,

Allison, F.R. & Hoye, G.A. 1995, 'Eastern Freetail-bat', pp 484-485 in Strahan, R. (ed) *The Mammals of Australia*, Reed New Holland, Sydney.

Augee, M. & Ford, D. 1999, 'Radio-tracking studies of Grey-headed Flying-foxes, *Pteropus poliocephalus*, from the Gordon colony, Sydney.' *Proceedings of the Linnaean Society of New South Wales*, vol 121, pp. 61-70.

Baker, M. & Corringham, R. 1995, *Native plants of the Blue Mountains*, Three Sisters Productions Pty Ltd, Winmalee.

Barker, J., Grigg, G.C. & Tyler, M.J. 1995, *A Field Guide to Australian Frogs*, Surrey Beatty and Sons, Sydney.

Bishop, T. 1996, *Field Guide to the Orchids of New South Wales and Victoria*, UNSW Press, Sydney.

Blakers, M., Davies, S.J.J.F. & Reilly, P.N. 1984, *The Atlas of Australian Birds*, Melbourne University Press, Melbourne.

Castlereagh Development Corporation 2007, *Castlereagh Penrith Lakes: Concept Plan (Draft)*,

Churchill, S. 1998, *Australian Bats*, Reed New Holland, Sydney.

CMA 2005, *Catchment Management Authorities*, Accessed 30 January 2007, Last Update http://www.cma.nsw.gov.au/

Daly, G. 1996, 'Observations of the Eastern Owl Frog *Helioporous australiacus* (Anura: Myobatrachidae) in Southern NSW', *Herpetofauna*, vol 26, no 1, pp. 33-42.

Debus, S. & Chafer, C. 1994, 'The Powerful Owl *Ninox strenua* in New South Wales', *Australian Birds*, vol 28, pp. 21-39.

DEC 2004, *Draft Recovery Plan for Pimelea spicata*, Department of Environment and Conservation,

DEC 2005a, *Acacia bynoeana - Threatened Species Profile*, Accessed 19 May 2006, Last Update 1 Sep 2005, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10006

DEC 2005b, *Acacia gordonii - Threatened Species Profile*, Accessed 19 May 2006, Last Update 1 Sep 2005, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10015

DEC 2005c, *Allocasuarina glareicola - Threatened Species Profile*, Accessed June 2006, Last Update Sep 2006, http://threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10038

DEC 2005d, *Dillwynia tenuifolia*, Accessed June 2006, Last Update September 2005, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10226

DEC 2005e, *Epacris sparsa - Threatened Species Profile*, Accessed June

2006, Last Update Sep 2006, http://threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10274

DEC 2005f, *Grevillea parviflora subsp. parviflora - Threatened Species Profile*, Accessed June 2006, Last Update Sep 2005, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10373

DEC 2005g, *Leucopogon fletcheri ssp. fletcheri - Threatened Species Profile*, Accessed June 2006, Last Update Sep 2006, http://threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10474

DEC 2005h, *Marsdenia viridiflora R. Br subsp. viridiflora - Threatened Species Profile*, Accessed June 2006, Last Update Sep 2006, http://threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10508

DEC 2005i, *Melaleuca deanei - Threatened Species Profile*, Accessed 19 May 2006, Last Update 1 Sep 2005, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10515

DEC 2005j, *Micromyrtus minutiflora - Threatened Species Profile*, Accessed June 2006, Last Update Sep 2006, http://threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10529

DEC 2005k, *Persoonia acerosa - Threatened Species Profile*, Accessed July 2006, Last Update Sep 2005, http://threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10591

DEC 2005l, *Persoonia hirsuta - Threatened Species Profile*, Accessed 19 May 2006, Last Update 1 Sep 2005, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10595

DEC 2005m, *Pomaderris brunnea - Threatened Species Profile*, Accessed June 2006, Last Update Sep 2006, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10647

DEC 2005n, *Pultenaea parviflora - Threatened Species Profile*, Accessed June 2006, Last Update Sep 2006, http://threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10715

DEC 2005o, *Recovering Bushland on the Cumberland Plain*, NSW Department of Environment and Conservation,

DEC 2005p, *Threatened Species Guidelines*,

DEC 2005q, *Zieria involucrata - Threatened Species Profile*, Accessed June 2006, Last Update Sep 2006, http://threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10858

DEC 2006, *Threatened Species Reforms*, Accessed 30 January 2007, Last Update 29 May 2006, http://www.environment.nsw.gov.au/threatspec/notcert.htm

Department of Planning undated-a, *Bushfire Protection*, Accessed 30 January 2007, Last Update http://www.planning.nsw.gov.au/plansforaction/bushfire.asp

Department of Planning undated-b, *City of Cities: A Plan for Sydney's Future*, Accessed 30 January 2007, Last Update http://www.metrostrategy.nsw.gov

.au/dev/uploads/paper/environment/index.html

Dickman, C.R. & Read, D.G. 1992, *The biology and management of dasyurids of the arid zone in NSW.*, Species Management Report, NSW NPWS, Hurstville.

DIPNR 2003, *Bringing the Bush Back to Western Sydney*,

DIPNR 2005, *Part 3A and the Planning Reforms: Part 3A of the EP&A Act, Fact Sheet 1*, Department of Infrastructure Planning and Natural Resources,

Edgar, R. & Belcher, C. 1995, 'Spotted-tailed Quoll', pp 67-68 in Strahan, R. (ed) *The Mammals of Australia*, Reed New Holland, Sydney.

Eldridge, M.D.B. & Close, R.L. 1995, 'Brush-tailed Rock-wallaby', pp 383-385 in Strahan, R. (ed) *The Mammals of Australia*, Reed New Holland, Sydney.

ERM 2001, *Penrith Lakes Scheme: Flora and Fauna Management Study*, Prepared for Urban Pacific Pty Ltd,

Fairley, A. & Moore, P. 1995, *Native Plants of the Sydney District*, Kangaroo Press, Sydney.

Fairley, A. & Moore, P. 2000, *Native Plants of the Sydney District*, Kangaroo Press, Sydney.

Forshaw, J.M. & Cooper, W.T. 1981, *Australian Parrots (2nd Ed)*, Lansdowne Press, Melbourne.

Garnett, S. 1992, *Threatened and Extinct Birds of Australia*, York Press, Richmond.

Gibbons, P. & Lindenmayer, D.B. 1997, *Conserving Hollow-dependent Fauna in Timber-production Forests*, NPWS, Hurstville.

Harden, G. 1990, *Flora of New South Wales Volume 1*, NSW University Press, Kensington.

Harden, G. 1991, *Flora of New South Wales Volume 2*, NSW University Press, Kensington.

Harden, G. 1992, *Flora of New South Wales Volume 3*, NSW University Press, Kensington.

Harden, G. 1993, *Flora of New South Wales Volume 4*, NSW University Press, Kensington.

Harden, G. 2002, *Flora of New South Wales Volume 2 (Revised Edition)*, University of New South Wales Press Ltd., Kensington.

Hawkesbury Nepean Catchment Management Authority 2007, *Catchment Action Plan*, Accessed 30 January 2007, Last Update 19 January 2007, http://www.hn.cma.nsw.gov.au/topics/2181.html

Higgins, P.J. 1999, *Handbook of Australian, New Zealand and Antarctic Birds. Volume 4: Parrots to Dollarbird.*, Oxford University Press, Melbourne.

Higgins, P.J., Peter, J.M. & Steele, W.K. 2001, *Handbook of Australian, New Zealand and Antarctic Birds. Volume 5: Tyrant-flycatchers to Chats*, Oxford University Press, Melbourne.

Hoye, G.A. & Dwyer, P.D. 1995, 'Large-eared Pied Bat', pp 510-511 in Strahan, R. (ed) *The Mammals of Australia*, Reed New Holland, Sydney.

Hoye, G.A. & Richards, G.C. 1995, 'Greater Broad-nosed Bat', pp 527-528 in Strahan, R. (ed) *The Mammals of Australia*, Reed New Holland, Sydney.

Johnston, P.G. 1995, 'Long-nosed Potoroo', pp 301-302 in Strahan, R. (ed) *The Mammals of Australia*, Reed New Holland, Sydney.

Marchant, S. & Higgins, P.J. 1993a, *Handbook of Australian, New Zealand and Antactic Birds. Volume 2 Raptors to Lapwings*, Oxford University Press, Melbourne.

Marchant, S. & Higgins, P.J. 1993b, *Handbook of Australian, New Zealand and Antarctic Birds. Volume 2 Raptors to Lapwings*, Oxford University Press, Melbourne.

Menkhorst, P.W. & Lumsden, L.F. 1995, 'Eastern False Pipistrelle', in Menkhorst, P.W. (ed) *Mammals of Victoria*, Oxford University Press, Melbourne.

Menkhorst, P.W., Weavers, B.W. & Alexander, J.S.A. 1988, 'Distribution, habitat and conservation status of the Squirrel Glider *Petaurus australis* (Petauridae: Marsupialia) in Victoria', *Australian Wildlife Research*, vol 15, pp. 59-71.

Morris, A.K. 1980, 'The status and distribution of the Turquoise Parrot in New South Wales', *Australian Birds*, vol 14, pp. 57-67.

NPWS 1999a, *Australasian Bittern: Threatened Species Information*, NPWS, Hurstville.

NPWS 1999b, *Brush-tailed Phascolgale: Threatened Species Information*, NPWS, Hurstville.

NPWS 1999c, *Cumberland Plain Land Snail: Threatened Species Information*, NPWS, Hurstville.

NPWS 1999d, *Glossy Black Cockatoo: Threatened Species Information*, NPWS, Hurstville.

NPWS 1999e, *Green and Golden Bell Frog: Threatened Species Information*, NPWS, Hurstville.

NPWS 1999f, *Haloragodendron lucasii: Threatened Species Information*, NPWS, Hurstville.

NPWS 1999g, *Regent Honeyeater: Threatened Species Information*, NPWS, Hurstville.

NPWS 1999h, *Square-tailed Kite: Threatened Species Information*, NPWS, Hurstville.

NPWS 1999i, *Yellow-bellied Glider: Threatened Species Information*, NPWS, Hurstville.

NPWS 2000, *Eucalyptus benthamii - Threatened Species Profile*, NPWS, Hurstville.

NPWS 2002a, *Cynanchum elegans - Threatened Species Profile*, NSW National Parks and Wildlife Service,

NPWS 2002b, *Grevillea juniperina ssp. juniperina: Threatened Species Information*,

NPWS 2002c, *Native Vegetation Maps of the Cumberland Plain*, NSW National Parks and Wildlife Service, Hurstville.

NPWS 2002d, *Pultenaea parviflora: Threatened Species Information*,

NPWS 2003a, *Acacia pubescens: Threatened Species Information*, NPWS, Hurstville.

NPWS 2003b, *Persoonia nutans - Threatened Species Information*, NSW National Parks and Wildlife Service,

NSW Fisheries 1999, *Policy and Guidelines for Bridges, Causeways, Culverts and Similar Structures.*, NSW Fisheries, Sydney.

NSW Government undated, *Native Vegetation Management in NSW*, Accessed 20 January 2007, Last Update http://www.nativevegetation.nsw.gov.au/fs/fs_04.shtml

NSW Scientific Committee 1997, *Final Determination to list Pterostylis saxicola as an endangered species*, NPWS, Hurstville.

NSW Scientific Committee 1998a, *Final determination to list Persoonia hirsuta as an endangered species*, NPWS, Hurstville.

NSW Scientific Committee 1998b, *Final determination to list Sydney Turpentine Ironbark Forest as an endangered ecological community*, NPWS, Hurstville.

NSW Scientific Committee 1999, *Final determination to list Leucopogon fletcheri ssp. fletcheri as an endangered species*, NPWS, Hurstville.

NSW Scientific Committee 2001, *Final Determination for Speckled Warbler*, NPWS, Hurstville.

NSW Scientific Committee 2002, *Final determination to list the population of Pultenaea villifera in the Blue Mountains LGA as an endangered population.*, NPWS, Hurstville.

NSW Scientific Committee 2003, *Final determination to list the population of Marsdenia viridiflora ssp viridiflora in Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith Local Government Areas as an Endangered Population.*, NPWS, Hurstville.

NSW Scientific Committee 2004, *River-flat eucalypt forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions - endangered ecological community listing*,

Phillips, W. 1995, 'Eastern False Pipistrelle', pp 520-521 in Strahan, R. (ed) *The Mammals of Australia*, Reed New Holland, Sydney.

Pizzey, G. 1983, *A Field Guide to the Birds of Australia*, Collins, Sydney.

Pizzey, G. & Knight, F. 1997, *The Field Guide to the Birds of Australia*, Angus and Robertson, Sydney.

Quin, D.G. 1995, 'Population ecology of the squirrel glider (Petaurus norfolcensis) and the sugar glider (P. breviceps) (Marsupialia: Petauridae) at Limeburners Creek, on the central North Coast of New South Wales.' *Wildlife Research*, vol 22, pp. 471-505.

Recsei, J. 1996, 'Eastern Owl Frog, Helioporus australiacus', pp 55-64 in Ehmann, H. (ed) *Threatened Frogs of New South Wales: Habitats, Status and Conservation.*, Frog and Tadpole Study Group of NSW, Sydney South.

Reed, P.C. & Lunney, D. 1990, 'Habitat loss: the key problem for the long-term survival of koalas in New South Wales', in Lunney, D., Urquhart, C.A. & Reed, P.C. (eds) *Koala Summit: Managing Koalas in New South Wales*, NSW NPWS, Hurstville.

Reed, P.C., Lunney, D. & Walker, P. 1990, 'The 1986-1987 survey of the koala *Phascolarctos cinereus*

(Goldfuss) in New South Wales and an ecological interpretation of its distribution.' pp 55-74 in Lee, A.K., Handasyde, K.A. & Sanson, G.D. (eds) *Biology of the Koala*, Surrey Beatty and Sons, Sydney.

Richards, G.C. 1995, 'Large-footed Myotis', pp 521-523 in Strahan, R. (ed) *The Mammals of Australia*, Reed New Holland, Sydney.

Robinson, L. 1994, *Field Guide to the Native Plants of Sydney.*, Kangaroo Press, Sydney.

Shields, J. & Crome, F. 1992, *Parrots and Pigeons of Australia*, Angus and Robertson, Sydney.

Simpson, K. & Day, N. 1996, *Field guide to the birds of Australia*, Viking. Penguin Books Australia Ltd., Ringwood.

Soderquist, T. 1995, 'Brush-tailed Phascogale, *Phascogale tapoatafa*', pp 104-106 in Strahan, R. (ed) *The Mammals of Australia*, Reed Books, Sydney.

Suckling, G.C. 1995, 'Squirrel Glider', pp 234-235 in Strahan, R. (ed) *The Mammals of Australia*, Reed New Holland, Sydney.

Thackway, R. & Cresswell, I.D. 1995, Biogeographic regionalisation for Australia: A framework for establishing the national system of reserves, Version 4.0. Nature Conservation Agency, Canberra,

Thumm, K. & Mahoney, M. 1997, 'Red-crowned Toadlet *Pseudophryne australis*', pp 125-135 in Ehmann, H. (ed) *Threatened Frogs of New South Wales: Habitats, Status and Conservation.*, Frog and Tadpole Study Group of NSW, Sydney South.

Thumm, K. & Mahony, M. 1996, 'The red-crowned Toadlet, Pseudophyrne australis', pp 126-135 in Ehmann, H. (ed) *Threatened Frogs of New South Wales: Habitats, Status and Conservation.*, Frog and Tadpole Study Group of NSW, Sydney South.

Tidemann, C.R. 1995, 'Grey-headed Flying-fox', pp 439-440 in Strahan, R. (ed) *The Mammals of Australia*, Reed New Holland, Sydney.

Turner, V. & Ward, S.J. 1995, 'Eastern Pygmy-possum', pp 217-218 in Strahan, R. (ed) *The Mammals of Australia*, Reed New Holland, Sydney.

Ward, S.J. 1990, 'Life history of the eastern pygmy possum, Cercatetus nanus (Burramyidae, Marsupialia) in south-eastern Australia.' *Australian Journal of Zoology*, vol 38, pp. 287-304.

Webb, J.K. 1996, Ecology and Conservation of the Threatened Broad-headed Snake *Hoplocephalus bungeroides*., PhD Dissertation. University of Sydney.

Webb, J.K. & Shine, R. 1998, 'Ecological characteristic of an endangered snake species *Hoplocephalus bungeroides* (Serpentes: Elapidae)', *Animal Conservation*, vol 1, pp. 185-193.

White, A.W. & Pyke, G.H. 1996, 'Distribution and conservation status of the Green and Golden Bell Frog *Litoria aurea* in New South Wales', *Australian Zoologist*, vol 30, no 2, pp. 177-189.