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Ecological Constraints Report

PROPOSED REZONING
Lot 1 DP 581034
'Coopers Paddock'
Governor Macquarie Drive
WARWICK FARM

AUGUST 2011
(REF: A11012)

ECOLOGICAL CONSTRAINTS REPORT

PROPOSED REZONING
Lot 1 DP 581034
Governor Macquarie Drive
'COOPERS PADDOCK'
WARWICK FARM

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Disclaimer:

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Executive Summary

This Ecological Constraints Report has been prepared by *Travers bushfire & ecology* to identify the flora and fauna constraints of Lot 1 DP 581034 (30.97 ha) also known as Coopers Paddock which is a portion of the Warwick Farm Racecourse located at Warwick Farm in Sydney's south-west within the local government area (LGA) of Liverpool.

Proposed Rezoning

The proposal seeks to permit rezoning within the subject site lands which are currently zoned as RE2 Private Recreation to IN1 General Industrial, RE1 Public Recreation and E2 Conservation.

Recorded Threatened Species and Endangered Ecological Communities

Ecological survey and assessment has been undertaken in accordance with relevant legislation including the *Environmental Planning and Assessment Act 1979*, the *Threatened Species Conservation Act 1995*, the *Environment Protection and Biodiversity Conservation Act 1999* and the *Fisheries Management Act 1994*.

EPA Act 1979 & TSC Act 1995

In respect of matters required to be considered under the *Environmental Planning & Assessment Act* (1979) and relating to the species / provisions of the *Threatened Species Conservation Act* (1995):

- Eight (8) threatened fauna species were recorded within or in close proximity to the subject site. Threatened fauna species recorded included Powerful Owl (*Ninox strenua*), Varied Sittella (*Daphoenositta chrysoptera*), Little Lorikeet (*Glossopsitta pusilla*), Grey-headed Flying-fox (*Pteropus poliocephalus*), Large-footed Myotis (*Myotis macropus*), Eastern Bentwing-bat (*Miniopterus orianae oceansis*), East-coast Freetail Bat (*Micronomus norfolkensis*) and Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*). The Yellow-bellied Sheathtail-bat was recorded only to a 'possible' level of certainty. One (1) additional threatened fauna species - Black-chinned Honeyeater (eastern subspecies - *Melithreptus gularis gularis*) has been previously recorded on the other side of the Georges River as evident from the Atlas of NSW Wildlife Database records (OEH 2011);

- One (1) endangered ecological community was recorded, River-flat Eucalypt Forest on Coastal Floodplains; and

- No endangered populations were recorded on site or considered likely to occur.

EPBC Act 1999

In respect of matters required to be considered under the *Environment Protection and Biodiversity Conservation Act* (1999):

- One (1) threatened fauna species - Grey-headed Flying-fox (*Pteropus poliocephalus*) - was recorded within the subject site;

- Two (2) protected migratory fauna species listed under the EPBC Act (1999) - Rufous Fantail (*Rhipidura rufifrons*) and Satin Flycatcher (*Myiagra cyanoleuca*) - were recorded within the subject site;

- No threatened flora species were recorded within the subject site;

- No endangered ecological communities under national legislation were recorded within the subject site; and

- No endangered populations were recorded on site or considered likely to occur (limited potential for *Marsdenia viridiflora subsp. viridiflora)*.

FM Act 1994

In respect of matters relative to the *Fisheries Management Act 1994*, the adjacent Georges River provides no potential for threatened fish species occurrence. This river portion is not identified as critical habitat under the FM Act. It is assumed there will be no detrimental effect on water quality, water quantity or any direct / indirect impacts upon threatened fish species habitat from the proposed action. As such the provisions of this Act do not require any further consideration.

Ecological Constraints

The key ecological constraints are as follows:

Threatened Flora and Endangered Ecological Communities

The site contains the endangered ecological community (EEC) - *Riverflat Eucalypt Forest on Coastal Floodplains* (approximately 15.4ha) which consists of a contiguous area of foreshore vegetation in low to moderate condition and fragmented or isolated stands of low condition vegetation or remnant canopy trees in cleared areas. This vegetation adjoins the Georges River and is an example of native vegetation that once existed along the Georges River corridor and currently acts as a significant ecological buffer which is classed as a 'Vegetated Buffer' under REP 2 – Georges River Catchment;

A significant portion of the *Riverflat Eucalypt Forest* is forest vegetation with heavily weed infested understorey areas and regrowth vegetation. Whilst significant regeneration effort is required, the vegetation is recoverable.

Approximately 15 ha of the site is highly degraded from past and ongoing use of the site as a trotting/exercise area for horses. These areas are not recoverable and have significantly reduced to negligible ecological value.

The site does not appear to contain threatened flora species but weed control works or ecological burns in better quality areas may stimulate the growth of threatened flora typical of this habitat.

Threatened fauna species habitat

The fauna habitat present on site is diverse as indicated by the presence of a diverse range of recorded native fauna. With regards to threatened fauna, the subject site provides:

- Recorded foraging, roosting and breeding habitat for the Powerful Owl,

- Recorded foraging and expected roosting and nesting habitat for the Varied Sittella,
- Recorded foraging habitat tor the Grey-headed Flying-fox and Eastern Bentwing-bat,
- Recorded foraging and possible roosting and breeding habitat for the East-coast Freetail Bat and Yellow-bellied Sheathtail-bat,
- Likely foraging and potential roosting/nesting habitat for the Little Lorikeet,
- Possible roosting and breeding habitat for the Large-footed Myotis,
- Potential for other threatened species such as the Black-chinned Honeyeater to pass through and utilise the available habitats,
- Potential Green and Golden Bell Frog shelter, foraging and breeding habitat, and
- Hollow bearing trees that provide habitat for prey species, potential nesting habitat for Powerful Owl and threatened microbats.

The potential impact of the proposes industrial zoning has been considered within this report and specific threatened fauna matters (Powerful Owl & Varied Sittella) have been supported by specialist advise. The existing condition of the *Riverflat Eucalypt Forest* has been investigated and assessed using current biometric condition assessment protocol.

The proposed rezoning and setting aside of the foreshore conservation area has likewise considered the ecological constraints to provide a balanced conservation and development zone outcome.

Impact on EEC's and Threatened Species

The impact on all recorded threatened species and EEC's has been assessed in this report. The following ecological matters of importance required specific consideration as part of the Gateway Determination process.

EEC - River-flat Eucalypt Forest on Coastal Floodplains

The proposed rezoning will remove 3.226 ha of the EEC – *River-flat Eucalypt Forest on Coastal Floodplains*. The level of offsetting afforded by the proposed rezoning is considered from the perspective of the EEC – *River-flat Eucalypt Forest on Coastal Floodplains*. We note that the critically endangered ecological community - Cumberland Plain Woodland, is not present in Coopers Paddock. The recommended adjustment to the zoning boundary, as proposed for protection of the Powerful Owl, increases the vegetation offset ratio (area restored/conserved to area removed) from 2.84:1 with the current proposed boundary to 5.2:1 with the new boundary. The total conservation area has been increased to 16.95 ha.

Powerful Owl

As a result of target fauna surveys and specialist advice, the area and level of protection has been increased in the southern portion of the site. This affords conservation of the identified Powerful Owl roosting and nesting area as well as increasing the amount of existing habitat on site for the recorded threatened species.

On the basis of specialist advice a 70 m ecological buffer which includes regrowth native vegetation, has been retained and restoration works are proposed to enhance the quality of the vegetation in the proposed foreshore conservation area.

Varied Sittella

Target surveys for Varied Sittella indicate that the recorded family group utilises adjoining Sydney Water lands to the west of the subject site and also potentially utilise adjacent habitat across the Georges River to the south and east. Observations also indicate that

whilst suitable foraging habitat is present within the proposed IN1 Industrial zone, access is severely limited by the highly competitive Noisy Miner.

The survey and habitat mapping provide evidence that competitive pressures from other species such as Bell Miner and more so the Noisy Miner restrict the available habitat that is currently available to Varied Sittella. Despite this, Varied Sittella has the ability and has been observed to utilise surrounding habitat on an opportunistic basis subject to variations and changes in the foraging behaviour of Miner species.

A known specialist on Varied Sittella - Dr Richard Noske, was engaged by *Travers bushfire & ecology* to provide an independent review of the proposed zoning and to advise of the likely use of the site, habitat requirements and adequacy of the proposed foreshore conservation area for Varied Sittella. Dr Noske's report on Varied Sittella is provided in Attachment 2. Dr Noske concluded the following:

> *"Based on my observations of the foraging behaviour of the Varied Sittellas onsite, and review of the habitat assessment and information provided by Travers Bushfire & Ecology in their Ecological Constraints report (2011), I see no reason why the proposed conservation area could not support the existing population.*
>
> *Based on the behaviour and locations of the presumed breeders, I expect that the most suitable nesting sites for the sittellas lie within the proposed conservation zone, which therefore most likely represents the core area of the main group.*
>
> *Thus it is my professional opinion that in conjunction with appropriate restoration of currently disturbed areas, the proposed conservation area is able to meet the needs of the Varied Sittella population onsite."*

A revised version of the Varied Sittella Habitat Assessment (12th August 2011) has been prepared in consultation with Dr Noske.

The proposed conservation area is 16.95 ha including 6.25 ha of restoration. Based on target survey the Varied Sittella is actively utilising a high quality habitat area of 8.87ha which is likely to be the core activity and nesting area (Figure 4). The majority of high quality habitat areas (8.01 ha or 90.3 % conserved – 0.86 ha loss) is being retained within the conserved lands. There is an additional 12.8 ha of suitable extended foraging habitat available for use by Varied Sittella outside of the subject site to use on an opportunistic basis. The total available habitat of varying quality for Varied Sittella within the proposed conservation area and adjoining the subject site is estimated to be 23.25 ha prior to restoration and 29.5 ha post restoration.

Removal and restoration of vegetation within the subject site will cause a shift in the habitat usage patterns of all birds utilising proposed development areas. Varied Sittella is however likely to retain a secure hold on its high quality habitat area because it contains vegetation that favours Varied Sittella above other species. Noisy Miners are likely to spread out into other fragmented remnants of land surrounding the site, whilst Bell Miners will remain in a united colony dominating the tall gully forest remnant within the conserved lands.

To compensate for the loss of higher quality habitat for Varied Sittella and competitive pressures between bird species, the restoration works within the conservation area should provide habitat for Varied Sittella which will discourage establishment by miners, in particular Noisy Miners. Restoration of habitat in the south western portion of the conserved lands will also provide habitat connectivity to the adjoining STP lands. This is an important mitigating strategy to address the key threatening process that Bell Miners represent for Varied Sittella.

Given that 90.3 % of the high quality habitat area for Varied Sittella is being conserved and a total of 23.25 ha of suitable habitat is available post development (excluding restoration of 6.25 ha), *Travers bushfire & ecology* concludes that sufficient habitat is present within the conserved portion of the foreshore to continue to support the Varied Sittella population insitu.

Green & Golden Bell Frog

The Green and Golden Bell Frog has not been recently recorded onsite and whilst there is suitable habitat present it is not expected to be found. However the proposed conservation area protects potential breeding habitat and surrounding shelter for the Green and Golden Bell Frog within the proposed restoration zone. The habitat for this species is adequately conserved.

Conclusions

A proposed foreshore conservation area is illustrated on Figure 7. The proposed foreshore conservation area considers the habitat requirements of the Powerful Owl and Varied Sittella, adequately conserves the existing native vegetation and provides foraging and roosting habitat for the recorded threatened species.

A total of 10.7 ha of open forest retention areas will be protected with the foreshore conservation area. A total of 6.25 ha of disturbed landscapes will be restored to compensate for partial loss of vegetation and habitat within the proposed development area. The restoration areas occur just to the north of the Powerful Owl sightings and around/within the circular track in the south-western portion of the subject site. A total of 16.95 ha will be protected and restored.

The level of habitat protection has been increased in the southern portion of the site. This affords conservation of the identified Powerful Owl roosting and nesting area as well as increasing the amount of existing habitat on site for the recorded threatened species.

Adequate buffers have been provided in accordance with REP 2 – Georges River Catchment and alternative measures are proposed to compensate for edge effects where buffers are compromised.

List of abbreviations

APZ	asset protection zone
BPA	bushfire protection assessment
CLUMP	conservation land use management plan
DCP	Development Control Plan
DEC	NSW Department of Environment and Conservation (superseded by DECC from 4/07)
DECC	NSW Department of Environment and Climate Change (superseded by DECCW from 10/09)
DECCW	NSW Department of Environment, Climate Change and Water– now the Office of Environment & Heritage (OEH) under the Department of Premier & Cabinet (DPC)
EEC	endangered ecological community
EPA	Environmental Protection Agency
EP&A Act	*Environmental Planning and Assessment Act 1979*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
ESMP	ecological site management plan
FF	flora and fauna assessment
FM Act	*Fisheries Management Act 1994*
FMP	fuel management plan
HTA	habitat tree assessment
IPA	inner protection area
LEP	Local Environment Plan
LGA	local government area
NES	national environmental significance
NPWS	NSW National Parks and Wildlife Service
NSW DPI	NSW Department of Industry and Investment
OEH	Office of Environment and Heritage
OPA	outer protection area
PBP	*Planning for Bush Fire Protection 2006: A Guide for Councils, Planners, Fire Authorities and Developers*
POM	plan of management

RF Act	*Rural Fires Act*
RFS	NSW Rural Fire Service
ROTAP	rare or threatened Australian plants
SEPP 44	*State Environmental Protection Policy No 44 – Koala Habitat Protection*
SEWPAC	Federal Department of Sustainability, Environment, Water, Population and Communities
SIS	species impact statement
SULE	safe useful life expectancy
TPO	tree preservation order
TPZ	tree preservation zone
TRRP	tree retention and removal plan
TSC Act	*Threatened Species Conservation Act 1995*
VMP	vegetation management plan

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1 Introduction

Travers bushfire & ecology has been engaged to carry out a flora and fauna assessment within Lot 1 DP 581034 Governor Macquarie Drive, Warwick Farm, known as 'Coopers Paddock' and hereafter referred to as the subject site.

Figures 1, 2 and 3 provide an aerial appraisal of the subject site and provide the proposed ecological survey effort undertaken for flora and fauna respectively. Figure 3 - Fauna Survey incorporates additional Powerful Owl recordings obtained by *John Young Wildlife* and Varied Sittella recordings obtained from *Dr Richard Noske*.

1.1 Aims of the assessment

The aims of the flora and fauna assessment are to:

- Carry out a botanical survey to describe the vegetation communities and their conditions
- Carry out a fauna survey for the detection and assessment of fauna and their habitats
- Complete target surveys for threatened species, populations and ecological communities
- Assess the conservation value of the site
- Prepare a flora and fauna impact assessment in accordance with the requirements of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), the *Threatened Species Conservation Act 1995* (TSC Act), the *Fisheries Management Act 1994* (FM Act) and guidelines issued by the National Parks and Wildlife Service (NPWS).

1.2 Information collation

A review of the relevant information pertinent to the subject site was undertaken prior to the initiation of field surveys as background to the study. Standard information sources reviewed include the following:

Standard Technical Resources:

- *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities 2004* (working draft), Department of Environment and Conservation (DEC)
- Aerial photographs (scale 1:25,000) and topographical maps (scale 1:25,000)
- *Atlas of NSW Wildlife 2011* (DECCW/OEH) 1:100,000 scale map sheet
- The *Threatened Species Conservation Act (TSC Act)*
- The *Fisheries Management Act (FM Act)*
- Lists of threatened species and communities in the *Environmental Protection and Biodiversity management Act (EPBC Act)*
- Rare or Threatened Australian Plants (ROTAP)
- Vegetation mapping of the Cumberland Plain (NPWS 2003)

1.3 Statutory requirements

1.3.1 Threatened Species Conservation Act 1995

The specific requirements of the *TSC Act* must be addressed in the assessment of flora and fauna matters. This requires the consideration of potential impacts on threatened species, populations and ecological communities. The factors to be taken into account in deciding whether there is a significant effect are set out in Section 5A of the *Environmental Planning and Assessment Act 1979* (EPA Act) and are based on a 7 part test of significance. Where a proposed activity is located in an area identified as critical habitat, or such that it is likely to significantly affect threatened species, populations, ecological communities, or their habitats, a Species Impact Statement (SIS) is required to be prepared.

1.3.2 Fisheries Management Act 1994

The *FM Act* provides a list of threatened aquatic species that require consideration when addressing the potential impacts of a proposed development. Where a proposed activity is located in an area identified as critical habitat, or such that it is likely to significantly affect threatened species, populations, ecological communities, or their habitats, an SIS is required to be prepared.

1.3.3 Environment Protection and Biodiversity Conservation Act 1999

The *EPBC Act* requires that Commonwealth approval be obtained for certain actions. It provides an assessment and approvals system for actions that have a significant impact on matters of *national environmental significance* (NES). These may include:

- World Heritage Properties and National Heritage Places
- Wetlands of International Importance protected by international treaty
- Nationally listed threatened species and ecological communities
- Nationally listed migratory species
- Commonwealth marine environment

Actions are projects, developments, undertakings, activities, and series of activities or alteration of any of these. An action that needs Commonwealth approval is known as a controlled action. A controlled action needs approval where the Commonwealth decides the action would have a significant effect on an NES matter.

Where a proposed activity is located in an area identified to be of NES, or such that it is likely to significantly affect threatened species, ecological communities, migratory species or their habitats, then the matter needs to be referred to the Department of Sustainability, Environment, Water, Population and Communities (SEWPAC) for assessment. In the case where no listed federal species are located on site then no referral is required. The onus is on the proponent to make the application and not the Council to make any referral.

A significant impact is regarded as being:

> *important, notable, or of consequence, having regard to its context or intensity and depends upon the sensitivity, value, and quality of the environment which is impacted and upon the duration, magnitude, and geographical extent of the impacts. A significant impact is likely when it is a real or not a remote chance or possibility.*
>
> *Source: EPBC Policy Statement*

Guidelines on the correct interpretation of the actions and assessment of significance are located on the department's web site http://www.environment.gov.au/epbc/publications.

1.3.4 Greater Metropolitan Regional Environmental Plan No 2 - Georges River Catchment

Greater Metropolitan Regional Environmental Plan No 2 - Georges River Catchment applies to the Georges River Catchment, which is part of the region declared under the Act and known as the Greater Metropolitan Region. The Catchment consists of parts of Bankstown City, Blacktown City, Campbelltown City, Camden, Canterbury City, Fairfield City, Holroyd City, Hurstville City, Kogarah, Liverpool City, Rockdale City, Sutherland, Wollondilly and Wollongong City local government areas that are within the Georges River Catchment. The catchment map indicates the boundary of the Catchment.

The specific aims and objectives of this plan are as follows:

(a) to preserve and protect and to encourage the restoration or rehabilitation of regionally significant sensitive natural environments such as wetlands (including mangroves, saltmarsh and seagrass areas), bushland and open space corridors within the Catchment, by identifying environmentally sensitive areas and providing for appropriate land use planning and development controls,

(b) to preserve, enhance and protect the freshwater and estuarine ecosystems within the Catchment by providing appropriate development,

(c) to ensure that development achieves the environmental objectives for the Catchment.

(e) to identify land uses in the Catchment which have the potential to impact adversely on the water quality and river flows in the Georges River and its tributaries and to provide appropriate planning controls aimed at reducing adverse impacts on the water quality and river flows,

(f) to conserve, manage and improve the aquatic environment within the Catchment which is a significant resource base for the aquaculture industry, by providing controls aimed at reducing pollution entering the Catchment's watercourses,

(g) to protect the safety and well-being of the local and regional community in accordance with standards and processes aimed at improving the water quality and river flows in the Catchment to enable recreation,

(h) to aid in the improvement of the environmental quality of Botany Bay in conjunction with other regional planning instruments.

Due to the known presence of the various threatened species and an EEC within the site, the vegetation on site meets the definition in the GMREP 2 of 'environmentally sensitive natural areas'. The vegetation is both a vegetated buffer area (riparian land) and a significant fauna habitat. The vegetation is also mapped as a Biodiversity Core regional management area in Figure 45 of the report "Biodiversity of the Georges River Catchment" Terrestrial biodiversity" (DEC2004).

Planning principles of REP No 2 applies when:

(a) a council prepares a local environmental plan, or

(b) a consent authority determines a development application, or

(c) a public authority or another person proposes to carry out development or an activity which does not require development consent but which has the potential to adversely affect the water quality, river flows, flood regime or ecosystems within the Catchment.

As the proposal is to rezone the subject lands, the planning principles of Greater Metropolitan Regional Environmental Plan No 2-Georges River Catchment apply to the site.

Section 21 - Development in Vegetated Buffer Areas of the Planning Control Table defines development in a vegetated buffer as development on land within the Catchment that adjoins, and is within 100 metres of, a drainage line, creek, wetland or river foreshore area within the Catchment. The proposed development is within 100 m a river foreshore area hence the primary conditions of compliance need to be addressed.

The proposal needs to demonstrate that the following specifications have been satisfied for the proposed vegetated buffer area:

(a) 100 metre minimum buffer width from the edge of the gorge or the top of the banks of the Georges River and its tributaries on currently forested Crown lands and natural bushland classified as community land under the *Local Government Act 1993* ,

(b) 40 metre minimum buffer width from the edge of the gorge or the top of the banks of the Georges River and its tributaries on freehold land that has not been previously developed or cleared,

(c) 40 metre minimum buffer widths from wetlands identified by the National Parks and Wildlife Service and local council State of the Environment Reports required under the *Local Government Act 1993* ,

(d) 40 metre minimum buffer width from other environmentally sensitive areas, including remnant vegetation and steep slopes, identified on maps prepared by and available from the National Parks and Wildlife Service.

The proposal must also address:-

- The requirements of the document entitled *Planning for Bush Fire Protection, ISBN 0 9751033 2 6,* prepared by the NSW Rural Fire Service in co-operation with the Department of Planning, dated December 2006.
- The requirements of the *NSW State Rivers and Estuaries Policy* prepared by and available from the Department of Land and Water Conservation and the *NSW Wetlands Management Policy* prepared by and available from that Department where the development proposals are likely to impact on the quality of water and river flows of the Georges River or its tributaries.
- The need to filter runoff from developed areas to improve water quality within the Georges River and its tributaries.
- The need to reduce the loss of riparian vegetation and to remove invasive weed species.
- The need to minimise damage to river banks and channels so as to reduce bank erosion.
- The need to increase or maintain terrestrial and aquatic biological diversity and to provide fauna habitat and corridors.

With respect to each of these conditions of compliance we make the following conclusions (Section 4.18). The relevant buffers as provided are illustrated on Figure 6 – Buffer Plan

1.4 Proposed Rezoning

The proposal seeks to rezone Coopers Paddock from RE2 Private Recreation to part IN1 General Industrial, part RE1 Public Recreation and part E2 Environmental Conservation. The industrial areas will have some restrictions on noise given the activity of horses within the Australian Turf Club lands north of Governor Macquarie Drive.

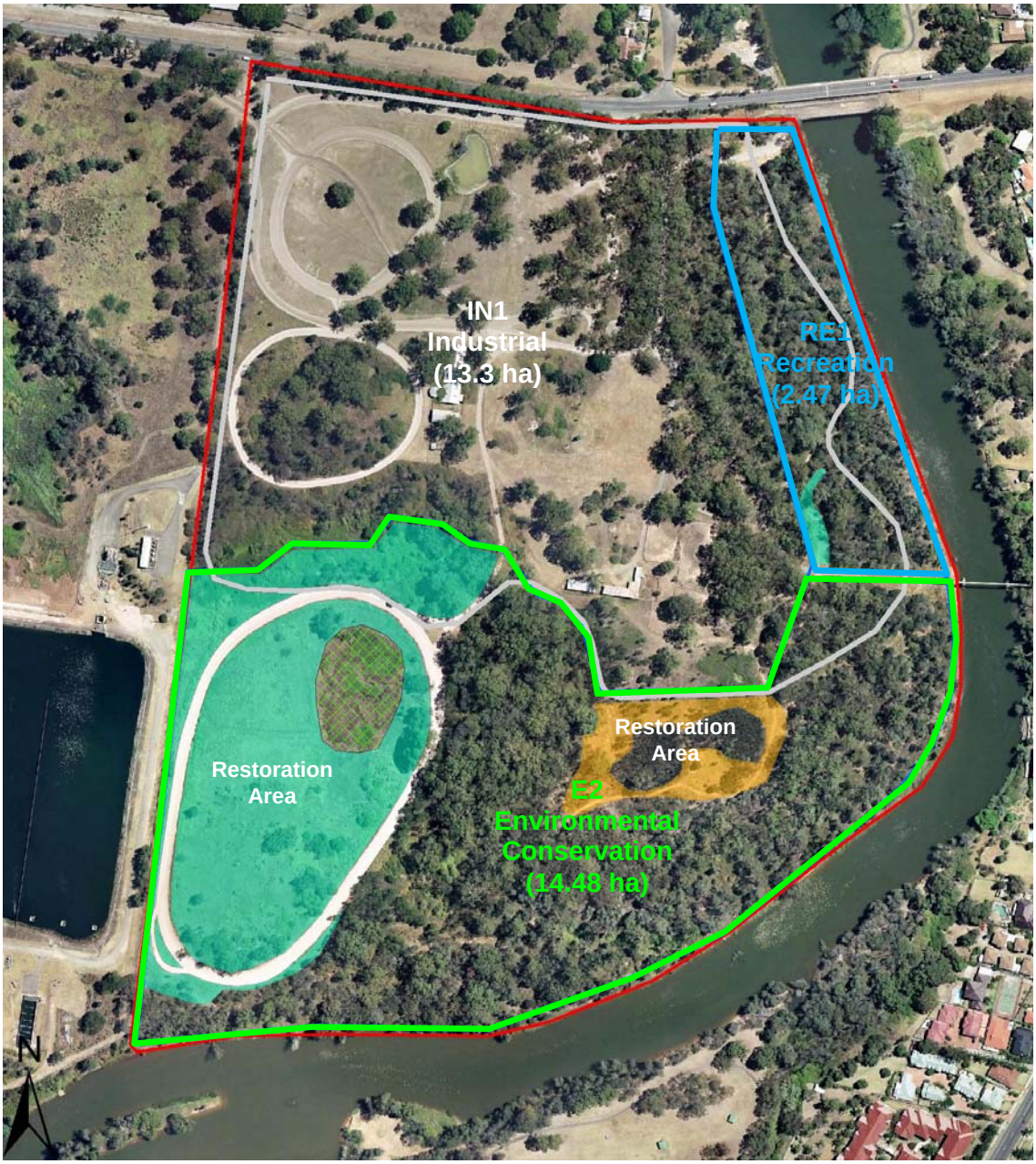

Figure 1 - Proposed rezoning & associated restoration areas

1.5 Site description

The planning, cadastral and general site characteristics of the subject site are provided in Table 1.1.

Table 1.1 – Site details and characteristics

Location	Lot 1 DP 581034 - Governor Macquarie Drive, Warwick Farm
Description of location	Situated on the southern side of Governor Macquarie Drive with borders to the Georges River (east and south) and a Sewage Treatment Plan (west). Approximately 3km to the north-east of Liverpool and part of the Warwick Farm Racecourse (horses)
Area	30.97 ha
Topographic map	Liverpool 1:25000
Local government area	Liverpool Council
Existing land use	Partly remnant riparian vegetation and partly for horse training
Elevation	Approximately 0-10m AHD
Topography	Situated on gentle slopes, mostly less than 5% gradients except immediate adjacent to Georges River
Geology and soils	Geology within the site is medium rained sand, silt and clay as well as Clayey quartzose sand, and clay. Soils are weakly pedal orange heavy clays and clayey sands along the open forest areas which area often mottled; and disturbed in south-western portions where previous sandmining excavation appear to have occurred. The remaining areas have shallow to moderately deep (<100cm) hardsetting mottled texture contrast soils.
Catchment	Georges River
Drainage	Georges River
Vegetation	Open forest or woodland that is riparian in nature.
Introduced weeds	Exotic vegetation occurs in high frequencies across the subject site. Within remnant bushland areas the mid-storey has been highly degraded through the explosion of Lantana, Green Cestrum, Privet and Balloon Vine.
Evidence of feral, introduced or domestic fauna	Feral Cat, Horses, European Red Fox, Common Blackbird, Common Mynas, Black Rat, Rock Dove, Red-whiskered Bulbul, Spotted Turtle-doves and exotic snails were recorded during survey. These species have varying impacts on locally occurring native fauna species with particular impacts resulting from the presence of terrestrial feral mammal species.

2 Survey Techniques

2.1 Survey constraints

It is important to note that field survey data collected during the survey period is representative of species occurring within the subject site for that occasion. Due to effects of fire, breeding cycles, migratory patterns, camouflage, weather conditions, time of day, visibility, predatory and / or feeding patterns, increased species frequency or richness may be observed within the subject site outside the nominated survey period. Habitat assessments based on the identification of micro-habitat features for various species of interest, including regionally significant and threatened species, have been used to overcome this survey limitation.

2.2 Survey process

To determine the likely and actual occurrence of flora species, fauna species and plant communities on the subject site a variety of assessments were undertaken to supplement previous surveys of the area and literature reviews. The methods utilised included:

- ***Literature review*** – A review of readily available literature for the area was undertaken to obtain reference material and background information for this survey.

- ***Data search*** – A search of the *Atlas of NSW Wildlife* (DECCW/OEH, 2011) was undertaken to identify records of threatened flora and fauna species located within a 10km radius of the site. Searches were also undertaken on the SEWPAC – 'protected matters search tool' website to generate a report that will help determine whether matters of national environmental significance or other matters protected by the EPBC Act are likely to occur in the area of interest. The search was broadened to a 10km radius like the Atlas search. These two searches combined enabled the preparation of a list of threatened flora and fauna species that could potentially occur within the habitats found on the site (Tables 4.1, 4.2 and 4.3).

- ***Aerial photograph interpretation*** – Aerial photographs at 1:25,000 scale were utilised to identify the extent of vegetation with respect to the site and surrounding areas.

- ***Accuracy of identification*** – Specimens of plants not readily discernible in the field were collected for identification. Structural descriptions of the vegetation were made according to Specht *et al* (1995). Scat and hair samples collected are sent to Barbara Triggs for identification. Invertebrates are sent to the Malacology Section of the Australian Museum.

- ***Licences -*** Individual staff members are licensed under Clause 20 of the *National Parks and Wildlife (Land Management) Regulation 1995* and Section 120 & 131 of the *National Parks and Wildlife Act 1974* to conduct flora and fauna surveys within service and non-service areas. NPWS Scientific Licence Numbers: S10359. The staff of *Travers bushfire & ecology* are licensed under an Animal Research Authority

issued by the Department of Agriculture. This authority allows *Travers bushfire & ecology* staff to conduct various fauna surveys of native and introduced fauna for the purposes of environmental consulting throughout New South Wales.

2.3 Flora survey methodology

A biometric field analysis has been conducted to ascertain the condition of existing vegetation on site and see if it fits the categorisation of low quality or medium to good quality vegetation.

In accordance with the biometric field assessment method, a 20x20m quadrat is placed on the ground and every plant identified. The percentage foliage cover at the overstorey is estimated by walking a 50m transect (20m inside quadrat and another 30m along the extended transect) and estimating the coverage at 5m intervals. The mid-storey and ground layers (grasses, shrubs and other) are estimated visually. Exotic plants are also considered with their foliage cover estimated as a percentage.

Additionally, along the 50m transect, the number of hollow-bearing trees are measured as too the amount of fallen logs (20x50m plot incorporating the original 20x20m). In linear patches of vegetation, the plot/transect may be 40x10m and 100x10m.

The data collected is then referenced to benchmark figures for the Sydney Metro Catchment for vegetation types as listed by (the then) DECCW.

When applying the Biometric assessment a number of conditions apply. To be called *low condition* under state legislation, the vegetation within the assessed quadrat must conform to the following;

- The over-storey per cent foliage cover is <25% of the lower value of the over-storey per cent foliage cover benchmark for that vegetation type and

- <50% of vegetation in the ground layer is indigenous species or >90% is ploughed or fallow

Or in lieu of the above the biometric assessment methodology includes *low condition* as being

- Patches of remnant vegetation less than 0.25ha.

A random meander survey in accordance with Cropper (1993). has been conducted to determine species composition and to ascertain vegetation structure. Following an understanding of the vegetation structure quadrat surveys were undertaken in a stratified manner. Target survey for threatened species was conducted during the initial random meander surveys and whilst undertaking quadrat surveys.

The species targeted were those with potential to occur in accordance with Table 4.1.

A total of approximately 16hrs has been spent undertaking the above surveys over 2 days during March 2011.

Previous surveys undertaken by Wheelans Insites have not been noted. They did not note the presence of any threatened flora species during their surveys.

2.4 Fauna survey methodology

2.4.1 Diurnal birds

Visual observation and call identification of birds was carried out during visits to the site.

Opportunistic bird counts are also made while undertaking other survey work and during spotlight surveys of the site.

Birds were observed and identified using handheld binoculars. Calls were generally identified in the field by the observer. If an unknown call was heard it is cross-matched to bird call reference libraries taken into the field.

2.4.1.1 Varied Sittella

The Varied Sittella was recorded during surveys in February - March and then also during Powerful Owl surveys by John Young. Additional target survey was undertaken over three days on the 22nd, 23rd and 27th June 2011, to assess suitability of available habitat in the nearby locality and determine species utilisation of habitat outside of the subject site.

OEH provided a map indicating four areas labelled A-D of potential habitat areas to be surveyed. OEH recommended "3 x 60 minute searches for Varied Sittella in each of the areas labelled A-D, and also the vegetation on site that is not already considered/known to be Varied Sittella habitat. That is, on site vegetation that the applicant intends be zoned for industrial use and any areas that you intend to argue are used by Varied Sittella". Survey areas A-D are indicated on Figure 4.

The first two days of survey were devoted to effort as advised by OEH. Areas A, B & C were surveyed by boat transects along the foreshore as well as foot transects within. Area B was surveyed for less than the recommended time on the first day as this area was contained less suitable habitat area for Varied Sittella. A pre-recorded call of Varied Sittella (BOCA 2007) was played through a mobile phone at no greater than 100m apart on all boat and foot transects to stimulate an active response.

The forested fringe to a wetland within the central portions of Area D was inaccessible. This area was therefore observed by binoculars from a distance from points along the surrounding foot transect as well as from three (3) spotting scope points (see Figure 4 for locations).

As Varied Sittella was not recorded within adjacent lands on the first two days of survey and habitat assessment identified areas that were not as suitable, survey focused on the areas proposed for development. The third day of survey was devoted to repeat foot transects within the most suitable habitat areas and where the species was recorded previously within the subject site. When found, parties were actively followed to determine habitat utilisation and local behaviour.

Call-playback through a mobile phone was utilised on one occasion where the species was observed just within adjoining STP lands to the west, to determine if the species will actively utilise areas further into these neighbouring lands. The Varied Sittella was attracted into adjoining lands suggesting it will move into the eastern portions of survey area D which is the STP lands.

A summary of the total target effort undertaken by *Travers bushfire & ecology* is provided in Table 2.2. The peer review and advice by Dr Noske describing additional survey undertaken on this species within the study area is provided in Attachment 2.

2.4.2 Nocturnal birds

The presence of nocturnal birds is first determined by quiet listening after dusk for calls by individuals emerging from diurnal roosts. Following this and provided no calls were heard call-playback techniques are employed. This involves broadcasting recorded calls through a 15 watt Toa 'Faunatech' amplifier to evoke a response from species known to reply.

Given the suitability of habitat present Masked Owl (*Tyto novaehollandiae*), Powerful Owl (*Ninox strenua*), Barking Owl (*Ninox connivens*) and Bush Stone-curlew (*Burhinus grallarius*) were targeted. Each call was played for 5-minute periods with 5-minute intervals of quiet listening for a response. This was followed with spotlighting and periods of quiet listening throughout the nocturnal survey.

Call-playback stations are shown on Figure 3.

Searches for evidence of Owl roosts and potential Owl roosting / breeding hollows were made during surveys of the subject site. Any whitewash, or regurgitated pellets found were noted.

Given that Powerful Owl was recorded during survey a search was undertaken predominantly within the proposed development areas of the subject site for hollows suitable for nesting.

Target Survey by *John Young Wildlife* was undertaken to determine the sites significance to Powerful Owl, identify any further constraints and mitigation measures that might apply. The supplementary survey report by John Young is provided in Attachment 1.

2.4.3 Arboreal and terrestrial mammals

Elliott type A and B traps were used for trapping arboreal and terrestrial mammals during surveys. Trapping consisted of 60 arboreal trap nights and 60 terrestrial trap nights.

Arboreal trap-lines using 30-50 metre separations were placed in the most suitable trees along 200m transects. Alternating Elliott type A & B traps were placed onto platforms that were attached to the trunks of trees 2-3 m above the ground at an incline of 10 degrees to facilitate drainage during inclement weather. A mixture of honey and water was then sprayed onto the trunk up to 7 metres above the trap and around the platform as a lure.

Terrestrial trap-lines of alternating type A and B Elliott traps using 30-50 metre separations were placed along the same line as the arboreal traps in the most suitable terrestrial habitats.

The traps were baited with a mixture of rolled oats, honey and peanut butter.

Four (4) trap-lines were set on the nights of 28th February, 1st and 2nd March 2011. The location of the trap-lines are shown in Figure 2.

Cage trapping was also conducted during surveys. The cage traps used are 28cm x 28cm x 60cm (foldout tread-plate mechanism). Cage trapping consisted of a total of 15 trap nights. Cage traps were placed in suitable areas of dense shrub and ground cover along each of the Elliott trap lines. The cage traps were baited with sardines (targeting Spotted-tailed Quoll), White Truffle Oil (targeting Bandicoots) and a mix of rolled oats, peanut butter and honey (targeting other terrestrial species). Despite unlikely presence of Spotted-tailed Quoll, trees surrounding the cage traps were smeared with Jellymeat cat food as a lure.

Spotlighting within the subject site

Spotlighting for nocturnal mammalian fauna was carried out using a hand held lamp of 750,000 candlelight power (100W halogen globe). This technique involved walking along the forest edges and openings so that a maximum number of trees could be observed.

Call-playback techniques for nocturnal mammals

Despite unlikely presence, Koala (*Phascolactos cinereus*) and Squirrel Glider (*Petaurus norfolcensis*) were targeted by broadcasting taped calls through a 15 watt Toa 'Faunatech' amplifier. Calls were played for 5-minute periods during nocturnal surveys. This was followed by quiet listening and spotlighting. Call-playback stations are shown on Figure 3.

Secondary indications within the subject site

Assessment was made of 'found' scats, markings, diggings, runways and scratches during visits to the site. Any scats or pellets not readily identifiable were collected and sent to noted expert Barbara Triggs for identification of contents, hair or bone fragments. Habitat was also assessed to determine the likelihood of threatened native species of fauna occurring within the subject site.

Koala assessment

The subject area was assessed for activity by Koalas using the following methods:

- A search of the *Atlas of NSW Wildlife* (DECCW/OEH 2011) databases.

- Identification and an assessment of the density of tree species listed as Koala feed trees in *State Environmental Protection Policy No. 44 – Koala Habitat Protection* (SEPP 44) was undertaken across the site. An estimate of the percentage density of each tree species within vegetation communities was determined by averaging the percentage of stems counted.

- The site was surveyed on foot, with known Koala food trees being inspected for signs of use. Trees were inspected for characteristic scratch and claw marks on the trunk and scats around the base of each tree. The proportion of trees showing signs of Koala use was calculated. Additionally the location and density of droppings if found were documented.

- Koalas were also targeted during spotlight surveys which included the use of call-playback techniques described above.

2.4.4 Bats

Micro-chiropteran bats were surveyed by echolocation using Anabat Mk 2 and SD-1 detectors in fixed passive monitoring positions as well as during active monitoring throughout the subject site. Recording locations were determined in order to represent different available foraging structures for various micro-chiropteran bat species.

Fixed passive monitoring involves leaving the bat recorder in a position to record call-sequences of passing bats. Two fixed monitoring positions were deployed during nocturnal survey undertaken on the 28th February as well as on the 2nd March 2011.

Active recording was undertaken throughout the nocturnal survey undertaken on the 28th February as well as on the 2nd March 2011. Active monitoring involves an SD-1 recorder

allied with a PDA for viewing call-sequences in real-time. When calls are heard the transducer microphone is actively directed towards the calling animal with the aid of a spotlight, so longer and clearer call sequences may be recorded. When calls of a potential threatened species are observed on the PDA screen a view by spotlight of the bat size and wing morphology is attempted for greater identification accuracy.

Bat call recordings were interpreted through Anabat V and Anabat CF Storage and Interface Module ZCAIM devices and analysed using Anabat 6 and Analook 3.3q computer software packages.

Harp (Constantine) traps were also used to survey for micro-chiropteran bat species. One harp trap was set on the 28th February and again on the 1st March 2011 along a flyway en-route to the river located within the open forest community. This harp trap was moved on the 2nd March to the entry of a large old stables building to target any emerging bats roosting within this structure. Harp trapping consisted of a total of 3 trap nights.

Harp traps are checked each morning of surveys with all captured bats identified using field identification guides. Bats are then released at the point of capture after dusk the following night or placed under bark or within trunk splits of nearby trees.

Anabat active monitoring transects, passive recording stations and harp trap locations are shown on Figure 3.

Mega-chiropteran bat species, such as Grey-headed Flying-fox (*Pteropus poliocephalus*), were surveyed by targeting flowering / fruiting trees during spotlighting activities.

2.4.5 Amphibians

Amphibians were surveyed by vocal call identification, spotlighting and call-playback response. For similar calling species, male calls were compared to recorded calls from a field reference library for accuracy of identification. Amphibians were also surveyed by habitat searches.

The presence of Green & Golden Bell Frog was considered unlikely at this site given the condition of habitat a nearby breeding opportunities however a previous record does exist from within the subject site in 1964. Subsequently, this species was targeted by broadcasting recorded calls through a 15 watt Toa 'Faunatech' amplifier in locations within the south-western portions of the site where most suitable shelter habitat exists. The calls were played for a 5-minute period with 5-minute quiet listening for response. This was followed with quiet listening and spotlighting. Call-playback stations are shown on Figure 3. It should be noted that target surveys for Green and Golden Bell Frog were not undertaken during the peak breeding months of September to December nor during ideal survey conditions.

Any amphibians found are visually identified and when required to be examined are handled with latex gloves and kept moist until release. Any tadpoles requiring capture are collected with a scoop net and placed within a snaplock clear plastic bag for analysis of colour and morphological features.

2.4.6 Reptiles

Searches for reptiles in likely localities such as under logs, rubbish debris, and in deep leaf litter were undertaken during diurnal visits to the site.

Spotlighting of terrestrial habitats suitable for reptiles occurred during nocturnal surveys.

2.4.7 Invertebrates

The *Insites - Ecological and Riparian Issues* (2007) report describes the woodland portions on upper levels within Coopers Paddock as being consistent with Cumberland Plain Woodland. Despite this, the mapping within this report and a following *Additional Information and Habitat Offsets Policy Analysis* (2009) report does not support this assessment.

Notwithstanding our opinion fauna survey included searches for the Cumberland Plain Land Snail (*Meridolum corneovirens*).

Searches were undertaken throughout all fragments of woodland identified by Insites. Figure 3 shows the extent of this target search area. Within the search area the most appropriate areas of observed habitat were targeted. Dense areas of leaf litter with likely moisture retaining properties were scraped using a three pronged rake. Logs, stumps, artificial refuse and rocks were also turned over.

The top (spiral side), side (showing aperture) and underside (showing umbilicus) of snail specimens found that resemble *M. corneovirens*, are photographed and sent to (Michael Shea) the Australian Museum Malacology Unit for confirmation of identification.

2.5 Field survey effort

Tables 2.1 and 2.2 below detail the flora and fauna survey effort undertaken for the subject site.

Table 2.1 – Flora survey methodology and dates

Flora survey	Method	Dates
Vegetation communities	Survey of the boundaries of all communities – field verification and aerial photographic interpretation (3 hours) Vegetation condition assessment – Biometric field method (5 hours)	8-9/2/11
Stratified sampling	20x20 metre quadrats in all existing bushland or remnant areas(5 hours)	8-9/2/11
Target searches	Target searches in known habitats (3 hours)	8-9/2/11

Table 2.2 – Fauna survey methodology and dates

Fauna group	Date	Weather conditions	Survey method	Survey effort / time (24hr)
Diurnal birds	28/2/11	7/8 cloud, no wind, no rain, temp 28^{o}C	Diurnal opportunistic	4hrs 35min 1325 - 1800
		8/8 cloud, no wind, prev rain, temp 24^{o}C	Diurnal opportunistic	1hr 1900 - 2000
	1/3/11	7/8 cloud, nil-mod SE wind, light rain, temp 27^{o}C	Diurnal opportunistic	3hrs 25min 0900 - 1225
	2/3/11	8/8 cloud, no wind, no rain, temp 20-26^{o}C	Diurnal opportunistic	8hrs 0900 - 1700
		8/8 cloud, no wind, no rain, temp 20-26^{o}C	Diurnal opportunistic	1hr 20min 1840 - 2000
	3/3/11	0/8 cloud, no wind, no rain, temp 19^{o}C	Diurnal opportunistic	3hr 40min 0835 - 1215
	11/4/11	3/8 cloud, light SW wind, no rain, temp 21-26^{o}C	Diurnal opportunistic	2hr 30min 1200 - 1430
		0/8 cloud, no wind, no rain, temp 2 ^{o}C	Diurnal opportunistic	1hr 15min 1515 - 1630
	22/6/11	0/8 cloud, mod-gusty W wind, temp 16-18^{o}C	Varied Sittella target - Area A	1hr 1410 - 1510
			Varied Sittella target - Area B	35mins 1340 - 1415
			Varied Sittella target - Area C	1hr 40min 1200 - 1340

Fauna group	Date	Weather conditions	Survey method	Survey effort / time (24hr)
			Varied Sittella target - Area D	1hr 55min 1135 - 1200 & 1530 - 1700
			Varied Sittella target - Subject Site	1hr 1510 - 1530 & 1700 - 1740
	23/6/11	0/8 cloud, light W wind, temp 15-20^{o}C	Varied Sittella target - Area A	1hr 1055 - 1155
			Varied Sittella target - Area B	1hr 15min 1155 - 1310
			Varied Sittella target - Area C	1hr 10min 1310 - 1420
			Varied Sittella target - Area D	1hr 1455 - 1555
			Varied Sittella target - Subject Site	1hr 0925 - 1055 & 1420 - 1450
	27/6/11	0/8 cloud, nil-light W wind, temp 17-20^{o}C	Varied Sittella target - Subject Site	5hrs 5min 1040 - 1545
Nocturnal birds	28/2/11	8/8 cloud, no wind, light rain, temp 23-24^{o}C	Spotlighting	2hrs 2000 - 2200
			Call playback (Section 2.3.2 species)	Commenced @ 2015
	2/3/11	8/8 cloud, no wind, no rain, temp 21-22^{o}C	Spotlighting	1hr 25min 2015 - 2140
			Call playback (Section 2.4.2 species)	Commenced @ 2040
Arboreal mammals	28/2/11	8/8 cloud, no wind, light rain, temp 23-24^{o}C	Spotlighting	2hrs 2000 - 2200
			Call playback (Section 2.4.3 species)	Commenced @ 2020
		5-8/8 cloud, no wind, light rain, temp ~21^{o}C	Elliot trapping	20 trap nights
	1/3/11	6-8/8 cloud, no wind, lights showers, temp 20^{o}C	Elliot trapping	20 trap nights
	2/3/11	8/8 cloud, no wind, no rain, temp 21-22^{o}C	Spotlighting	1hr 25min 2015 - 2240
			Call playback (Section 2.4.3 species)	Commenced @ 2035
		8-0/8 cloud, no wind, no rain, temp 18^{o}C	Elliot trapping	20 trap nights
Terrestrial mammals	28/2/11	8/8 cloud, no wind, light rain, temp 23-24^{o}C	Spotlighting	2hrs 2000 - 2200
		5-8/8 cloud, no wind, light rain, temp ~21^{o}C	Elliot trapping	20 trap nights
			Cage Traps	5 trap nights
	1/3/11	6-8/8 cloud, no wind, lights showers, temp 20^{o}C	Elliot trapping	20 trap nights
			Cage Traps	5 trap nights
	2/3/11	8/8 cloud, no wind, no rain, temp 21-22^{o}C	Spotlighting	1hr 25min 2015 - 2240
		8-0/8 cloud, no wind, no rain, temp 18^{o}C	Elliot trapping	20 trap nights
			Cage Traps	5 trap nights
Bats	28/2/11	8/8 cloud, no wind, no rain, temp 24^{o}C	Anabat SD-1 (Active monitoring)	1hr 50min 2005 - 2155

Fauna group	Date	Weather conditions	Survey method	Survey effort / time (24hr)
Bats			Anabat II & SD-1 (Passive monitoring) x2	Overnight from 2000
			Spotlighting	2 hrs 2000 - 2200
		5-8/8 cloud, no wind, light rain, temp ~21^{o}C	Harp Trap	1 trap night
	1/3/11	6-8/8 cloud, no wind, lights showers, temp 20^{o}C	Harp Trap	1 trap night
	2/3/11	8/8 cloud, no wind, no rain, temp 21-22^{o}C	Anabat SD-1 (Active monitoring)	1hr 20mins 2015 - 2135
			Anabat II & SD-1 (Passive monitoring) x2	Overnight from 1945
			Spotlighting	1hr 25min 2015 - 2140
		8-0/8 cloud, no wind, no rain, temp 18^{o}C	Harp Trap	1 trap night
Reptiles	28/2/11	7/8 cloud, no wind, no rain, temp 28^{o}C	Habitat search, opportunistic	4hrs 35min 1325 - 1800
		8/8 cloud, no wind, prev rain, temp 24^{o}C	Habitat search, opportunistic	1hr 1900 - 2000
	1/3/11	7/8 cloud, nil-mod SE wind, light rain, temp 27^{o}C	Habitat search, opportunistic	3hrs 25min 0900 - 1225
	2/3/11	8/8 cloud, no wind, no rain, temp 20-26^{o}C	Habitat search, opportunistic	8hrs 0900 - 1700
		8/8 cloud, no wind, no rain, temp 20-26^{o}C	Habitat search, opportunistic	1hr 20min 1840 - 2000
	3/3/11	0/8 cloud, no wind, no rain, temp 19^{o}C	Habitat search, opportunistic	3hr 40min 0835 - 1215
Amphibians	28/2/11	8/8 cloud, no wind, light rain, temp 23-24^{o}C	Spotlighting & call identification	2hrs 2000 - 2200
			Call-playback (Green and Golden Bell Frog)	Commenced @ ~2100
	2/3/11	8/8 cloud, no wind, no rain, temp 21-22^{o}C	Spotlighting & call identification	1hr 25min 2015 - 2140
			Call-playback (Green and Golden Bell Frog)	Commenced @ ~2100
Molluscs	1/3/11	8/8 cloud, no wind, no rain, temp 20-26^{o}C	2x quadrats & target searches in woodland area	2 hours 1335 - 1810

3 Survey Results

3.1 Flora results

Three (3) vegetation communities were identified within the subject site through aerial photographic interpretations and extensive ground truthing. These include;

- Riparian Open Forest (and variant – Planted *Corymbia citriodora*)
- Riparian Woodland (Managed Understorey)
- Cleared or Managed Landscape

A detailed description of the vegetation communities is provided in Section 4 of this report.

A total of two hundred and eight (208) flora specimens were observed within the subject site during the March 2011 survey. Whilst several planted or cultivated specimens occur within the list of those species observed, these were not targeted as part of the survey and if they could not be identified easily were not included within the list.

The plants observed within the vegetation communities of the subject site are listed in the Table 3.1 below.

Table 3.1 – Flora observations for the subject site

Family	Scientific Name	Common Name
TREES		
Mimosaceae	*Acacia baileyana*	Cootamundra Wattle
Mimosaceae	*Acacia decurrens*	Black Wattle
Mimosaceae	*Acacia falciformis*	Broad-leaved Hickory
Mimosaceae	*Acacia parramattensis*	Sydney Green Wattle
Mimosaceae	*Acacia prominens*	Gosford Wattle
Aceraceae	*Acer* sp. (cultivar)*	Maple
Casuarinaceae	*Allocasuarina littoralis*	Black She-oak
Myrtaceae	*Angophora floribunda*	Rough-barked Apple
Myrtaceae	*Angophora subvelutina*	-
Myrtaceae	*Backhousia myrtifolia*	Grey Myrtle
Cunoniaceae	*Callicoma serratifolia*	Black Wattle
Casuarinaceae	*Casuarina glauca*	Swamp Oak
Lauraceae	*Cinnamomum camphora**	Camphor Laurel
Myrtaceae	*Corymbia citriodora*	Lemon-scented Gum
Myrtaceae	*Corymbia maculata*	Spotted Gum
Fabaceae	*Erythrina sykesii**	Coral Tree
Myrtaceae	*Eucalyptus acmenoides*	White Mahogany
Myrtaceae	*Eucalyptus amplifolia*	Cabbage Gum
Myrtaceae	*Eucalyptus baueriana*	Blue Box
Myrtaceae	*Eucalyptus bosistoana*	Coast Grey Box
Myrtaceae	*Eucalyptus botryoides*	Bangalay / Southern Mahogany
Myrtaceae	*Eucalyptus capitellata*	Brown Stringybark

Family	Scientific Name	Common Name
Myrtaceae	*Eucalyptus eugenioides*	Thin-leaved Stringybark
Myrtaceae	*Eucalyptus fibrosa*	Broad Leaved Ironbark
Myrtaceae	*Eucalyptus moluccana*	Grey Box
Myrtaceae	*Eucalyptus pilularis*	Blackbutt
Myrtaceae	*Eucalyptus tereticornis*	Forest Red Gum
Myrtaceae	*Eucalyptus umbra* subsp. *umbra*	Broad-leaved White Mahogany
Santalaceae	*Exocarpos cupressiformis*	Native Cherry
Moraceae	*Ficus rubiginosa*	Port Jackson Fig
Proteaceae	*Grevillea robusta*	Silky Oak
Arecaceae	*Livistona australis*	Cabbage Tree Palm
Myrtaceae	*Lophostemon confertus*	Brush Box
Myrtaceae	*Melaleuca decora*	-
Myrtaceae	*Melaleuca stypheloides*	Prickly-leaved Tea Tree
Oleaceae	*Olea europaea* subsp. *cuspidata**	African Olive
Arecaceae	*Phoenix canariensis**	Canary Island Date Palm
Pinaceae	*Pinus sp.** (Cultivar)	-
Pittosporaceae	*Pittosporum undulatum*	Sweet Pittosporum
Plantanaceae	*Plantanus x acerifolia**	Sycamore
Salicaceae	*Populus alba**	White Poplar
Fagaceae	*Quercus robur**	English Oak
Salicaceae	*Salix babylonica**	Weeping Willow
Myrtaceae	*Syncarpia glomulifera*	Turpentine
SHRUBS		
Mimosaceae	*Acacia binervia*	Coast Myall
Mimosaceae	*Acacia floribunda*	Sally Wattle
Mimosaceae	*Acacia implexa*	Hickory
Mimosaceae	*Acacia podalyriifolia*	Queensland Silver Wattle
Mimosaceae	*Acacia saligna*	Orange Wattle
Mimosaceae	*Acacia ulicifolia*	Prickly Moses
Amaranthaceae	*Amaranthus viridis**	Green Amaranth
Euphorbiaceae	*Breynia oblongifolia*	Coffee Bush
Pittosporaceae	*Bursaria spinosa* var. *spinosa*	Blackthorn
Myrtaceae	*Callistemon linearis*	Narrow-leaved Bottlebrush
Theaceae	*Camellia sp.* (cultivar)*	Camellia
Solanaceae	*Cestrum parqui**	Chilean Cestrum
Asteraceae	*Chrysanthemoides monilifera* subsp. *monilifera**	Boneseed
Malaceae	*Cotoneaster pannosus**	Cotoneaster (cultivar)
Fabaceae	*Dillwynia sieberi*	Prickly Parrot-pea
Sapindaceae	*Dodonaea triquetra*	Hop Bush
Fabaceae	*Jacksonia scoparia*	Dogwood
Myrtaceae	*Kunzea ambigua*	Tick Bush
Verbenaceae	*Lantana camara**	Lantana
Epacridaceae	*Leucopogon ericoides*	-
Epacridaceae	*Leucopogon juniperinus*	Prickly Beard-heath
Oleaceae	*Ligustrum lucidum**	Large-leaved Privet
Oleaceae	*Ligustrum sinense**	Small-leaved Privet
Solanaceae	*Lycium ferocissimum**	African Boxthorn
Myrtaceae	*Melaleuca nodosa*	Ball Honey Myrtle
Apocynaceae	*Nerium oleander**	Oleander Bush
Ochnaceae	*Ochna serrulata**	Mickey Mouse Plant
Euphorbiaceae	*Omalanthus populifolius*	Bleeding Heart
Asteraceae	*Ozothamnus diosmifolius*	Ball Everlasting

Family	Scientific Name	Common Name
Phytolaccaceae	*Phytolacca octandra**	Inkweed
Plumbaginaceae	*Plumbago sp.**	-
Euphorbiaceae	*Ricinus communis**	Castor Oil Plant
Rosaceae	*Rubus fruticosus* sp. agg.*	Blackberry Complex
Fabaceae	*Senna pendula* var. *glabrata**	-
Solanaceae	*Solanum mauritianum**	Wild Tobacco
GROUNDCOVERS		
Polygonaceae	*Acetosa saggitata**	Turkey Rhubarb
Asteraceae	*Ageratina adenophora**	Crofton Weed
Amaranthaceae	*Alternanthera denticulata*	Lesser Joyweed
Amaranthaceae	*Alternanthera philoxeroides**	Alligator Weed
Myrsinaceae	*Anagallis arvensis**	Scarlet Pimpernel
Poaceae	*Andropogon virginicus**	Whisky Grass
Poaceae	*Aristida vagans*	Three-awn Speargrass
Poaceae	*Arundo donax**	Giant Reed
Asparagaceae	*Asparagus aethiopicus**	Asparagus Fern
Asphodelaceae	*Asphodelus fistulosus**	Onion Weed
Poaceae	*Austrodanthonia racemosa*	Wallaby Grass
Poaceae	*Austrostipa ramosissima*	Stout Bamboo Grass
Poaceae	*Avena sativa**	Oats
Poaceae	*Axonopus fissifolius**	Narrow-leaf Carpet Grass
Asteraceae	*Bidens pilosa**	Cobbler's Pegs
Poaceae	*Bothriochloa macra*	-
Brassicaceae	*Brassica juncea**	Indian Mustard
Brassicaceae	*Brassica rapa**	Wild Turnip
Poaceae	*Bromus cartharticus**	Prairie Grass
Acanthaceae	*Brunoniella pumilio*	Dwarf Blue Trumpet
Crassulaceae	*Bryophyllum delagoense**	Mother of Millions
Anthericaceae	*Caesia parviflora* var. *parviflora*	Pale Grass Lily
Brassicaceae	*Capsella bursa-pastoris**	Shepherds purse
Cyperaceae	*Carex appressa*	Tall Sedge
Gentianaceae	*Centaurium erythraea**	Pink Stars
Gentianaceae	*Centaurium tenuiflorum**	Branched Century
Apiaceae	*Centella asiatica*	Swamp Pennywort
Sinopteridaceae	*Cheilanthes sieberi* subsp. *sieberi*	Poison Rock Fern
Chenopodiaceae	*Chenopodium album**	Fat Hen
Poaceae	*Chloris virgata**	Feathertop Rhodes Grass
Asteraceae	*Cirsium vulgare**	Spear Thistle
Commelinaceae	*Commelina cyanea*	Scurvy Weed
Asteraceae	*Conyza bonariensis**	Flax-leaf Fleabane
Asteraceae	*Conyza canadensis**	Tall Fleabane
Poaceae	*Cortaderia selloana**	Pampas Grass
Iridaceae	*Crocosmia* X *crocosmiiflora**	Montbretia
Apiaceae	*Cyclospermum leptophyllum**	Slender Celery
Poaceae	*Cynodon dactylon*	Common Couch
Cyperaceae	*Cyperus congestus**	-
Cyperaceae	*Cyperus eragrostis**	Umbrella Sedge
Convolvulaceae	*Dichondra repens*	Kidney Weed
Poaceae	*Echinopogon ovatus*	Forest Hedgehog Grass
Poaceae	*Ehrharta erecta**	Panic Veldtgrass
Chenopodiaceae	*Einadia hastata*	Berry Saltbush
Chenopodiaceae	*Einadia polygonoides*	-
Chenopodiaceae	*Einadia trigonos* subsp. *leiocarpa*	Fishweed

Family	Scientific Name	Common Name
Poaceae	*Eleusine indica**	Crowsfoot Grass
Poaceae	*Entolasia marginata*	Bordered Panic
Poaceae	*Entolasia stricta*	Wiry Panic
Poaceae	*Eragrostis brownii*	Brown's Lovegrass
Poaceae	*Eragrostis curvula**	African Lovegrass
Apiaceae	*Foeniculum vulgare**	Fennel
Rubiaceae	*Galium aparine**	Cleavers
Asteraceae	*Gamochaeta spicata**	Cudweed
Zingiberaceae	*Hedychium gardnerianum**	Ginger Lily
Clusiaceae	*Hypericum gramineum*	Small St Johns Wort
Asteraceae	*Hypochaeris radicata**	Flatweed
Hypoxidaceae	*Hypoxis hygrometrica*	Golden Star
Poaceae	*Imperata cylindrica* var. *major*	Blady Grass
Juncaceae	*Juncus usitatus*	Common Rush
Brassicaceae	*Lepidium africanum**	Common Peppercress
Cyperaceae	*Lepidosperma laterale*	Variable Sword-sedge
Loganiaceae	*Logania pusilla*	-
Lomandraceae	*Lomandra filiformis*	Wattle Mat-rush
Lomandraceae	*Lomandra gracilis*	-
Lomandraceae	*Lomandra longifolia*	Spiky-headed Mat-rush
Lomandraceae	*Lomandra multiflora*	Many-flowered Mat-rush
Lomandraceae	*Lomandra obliqua*	Twisted Mat-rush
Malvaceae	*Malva parviflora**	Small-flowered Mallow
Poaceae	*Microlaena stipoides* var. *stipoides*	Weeping Rice Grass
Malvaceae	*Modiola caroliniana**	Red-flowered Mallow
Onagraceae	*Oenothera stricta**	Evening Primrose
Poaceae	*Oplismenus aemulus*	Basket Grass
Poaceae	*Oplismenus imbecillis*	-
Cactaceae	*Opuntia* sp. (cultivar)*	Prickly Pear
Oxalidaceae	*Oxalis corniculata**	Yellow Wood Sorrel
Oxalidaceae	*Oxalis debilis**	-
Oxalidaceae	*Oxalis perennans*	-
Oxalidaceae	*Oxalis pes-caprae**	Soursob
Poaceae	*Panicum effusum*	Hairy Panic
Poaceae	*Paspalum dilatatum**	Paspalum
Poaceae	*Paspalum distichum*	Water Couch
Poaceae	*Paspalum quadrifarium**	Tussock Paspalum
Poaceae	*Paspalum urvillei**	Vasey Grass
Poaceae	*Pennisetum clandestinum**	Kikuyu
Poaceae	*Phragmites australis*	Common Reed
Thymelaeaceae	*Pimelea linifolia* subsp. *linifolia*	Slender Rice Flower
Plantaginaceae	*Plantago lanceolata**	Ribwort
Lamiaceae	*Plectranthus parviflorus*	Cockspur Flower
Poaceae	*Poa affinis*	-
Euphorbiaceae	*Poranthera microphylla*	
Lobeliaceae	*Pratia purpurascens*	Whiteroot
Dennstaedtiaceae	*Pteridium esculentum*	Bracken
Rubiaceae	*Richardia brasiliensis**	White Eye
Rubiaceae	*Richardia stellaris**	-
Polygonaceae	*Rumex crispus**	Curled Dock
Asteraceae	*Senecio madagascariensis**	Fireweed
Poaceae	*Setaria parviflora**	-
Malvaceae	*Sida rhombifolia**	Paddy's Lucerne
Solanaceae	*Solanum nigrum**	Black Nightshade

Family	Scientific Name	Common Name
Asteraceae	*Sonchus oleraceus**	Common Sow-thistle
Poaceae	*Sporobolus africanus**	Parramatta Grass
Caryophyllaceae	*Stellaria media**	Common Chickweed
Asteraceae	*Tagetes minuta**	Stinking Roger
Asteraceae	*Taraxacum officinale**	Dandelion
Poaceae	*Themeda australis*	Kangaroo Grass
Commelinaceae	*Tradescantia fluminensis**	Wandering Jew
Fabaceae	*Trifolium repens**	White Clover
Typhaceae	*Typha orientalis*	Cumbungi
Verbenaceae	*Verbena bonariensis**	Purpletop
Verbenaceae	*Verbena officinalis**	Common Verbena
Verbenaceae	*Verbena rigida**	Veined Verbena
Campanulaceae	*Wahlenbergia gracilis*	Australian Bluebell
Asteraceae	*Xanthium occidentale**	Noogoora Burr
EPIPHYTES		
Loranthaceae	*Amyema miquelii*	Mistletoe
Loranthaceae	*Amyema pendulum*	Mistletoe
VINES		
Basellaceae	*Anredera cordifolia**	Madiera Vine
Apocnyaceae	*Araujia sericifera**	Mothvine
Asparagaceae	*Asparagus asparagoides**	Bridal Creeper
Sapindaceae	*Cardiospermum grandiflorum**	Balloon Vine, Love in a Puff
Lauraceae	*Cassytha pubescens*	Common Devil's Twine
Ranunculaceae	*Clematis aristata*	Old Man's Beard
Ranunculaceae	*Clematis glycinoides* var. *glycinoides*	Clematis
Fabaceae	*Glycine clandestina*	Twining Glycine
Fabaceae	*Glycine tabacina*	Twining Glycine
Convolvulaceae	*Ipomoea cairica**	Blue Morning Glory
Caprifoliaceae	*Lonicera japonica**	Japanese Honeysuckle
Passifloraceae	*Passiflora edulis**	Common Passionfruit
Fabaceae	*Wisteria sinensis**	Wisteria
Species name^{TS} = Threatened Species * = Introduced Species		

3.2 Fauna results

Fauna species observed throughout the duration of fauna surveys are listed in Table 3.2 below.

Table 3.2 – Fauna observations for the study area

Common name	Scientific name	Method observed
Birds		**Feb/Mar 2011**
Australian Magpie	*Gymnorhina tibicen*	O C
Australian Raven	*Corvus coronoides*	O C
Azure Kingfisher	*Alcedo azurea*	O
Barn Owl	*Tyto alba*	C
Bell Miner	*Manorina melanophrys*	O C
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	O C
Brown Gerygone	*Gerygone mouki*	O C
Brown Goshawk	*Accipiter fasciatus*	O
Common Blackbird *	*Turdus merula*	O
Common Myna *	*Acridotheres tristis*	O C

Common name	Scientific name	Method observed
Common Starling *	*Sturnus vulgaris*	C
Crested Pigeon	*Ocyphaps lophotes*	O
Crested Shrike-tit	*Falcunculus frontatus*	O C
Darter	*Anhinga melanogaster*	O
Dusky Woodswallow	*Artamus cyanopterus*	O
Eastern Spinebill	*Acanthorhynchus tenuirostris*	O
Eastern Yellow Robin	*Eopsaltria australis*	O C
Fairy Martin	*Hirundo ariel*	O PR
Galah	*Cacatua roseicapilla*	C
Grey Butcherbird	*Cracticus torquatus*	C
Grey Fantail	*Rhipidura fuliginosa*	O C
Grey Goshawk	*Accipiter novaehollandiae*	O
Little Black Cormorant	*Phalacrocorax sulcirostris*	O
Little Lorikeet TS	*Glossopsitta pusilla*	O C
Magpie-lark	*Grallina cyanoleuca*	O C
Masked Lapwing	*Vanellus miles*	C
New Holland Honeyeater	*Phylidonyris novaehollandiae*	O C
Noisy Miner	*Manorina melanocephala*	O C
Painted Button-quail	*Turnix varia*	O I
Pied Currawong	*Strepera graculina*	O C
Powerful Owl TS	*Ninox strenua*	O I
Rainbow Lorikeet	*Trichoglossus haematodus*	O C
Red-browed Finch	*Neochmia temporalis*	O C
Red Wattlebird	*Anthochaera carunculata*	O
Red-whiskered Bulbul *	*Pycnonotus jocosus*	O C
Rock Dove *	*Columba livia*	O
Rufous Fantail MS	*Rhipidura rufifrons*	O
Satin Flycatcher MS	*Myiagra cyanoleuca*	O C
Scaly-breasted Lorikeet	*Trichoglossus chlorolepidotus*	O C
Silvereye	*Zosterops lateralis*	O C
Spotted Turtle-Dove *	*Streptopelia chinensis*	O C
Sulphur Crested Cockatoo	*Cacatua galerita*	O C
Superb Fairy-wren	*Malurus cyaneus*	O C
Varied Sittella TS	*Daphoenositta chrysoptera*	O C
Welcome Swallow	*Hirundo neoxena*	O I
White-bellied Cuckoo-shrike	*Coracina papuensis*	O
White-browed Scrubwren	*Sericornis frontalis*	O C
White-plumed Honeyeater	*Lichenostomus penicillatus*	O
Willie Wagtail	*Rhipidura leucophrys*	O C
Yellow Thornbill	*Acanthiza nana*	O C
Mammals		
Black Rat *	*Rattus rattus*	T
Cat (feral)*	*Felis cattus*	T
Common Ringtail Possum	*Pseudocheirus peregrinus*	S
East-coast Freetail Bat TS	*Micronomus norfolkensis*	A
Eastern Bentwing-bat TS	*Miniopterus orianae oceansis*	A PR
Eastern Freetail-bat	*Mormopterus ridei*	A PR
European Red Fox *	*Vulpes vulpes*	S
Gould's Wattled Bat	*Chalinolobus gouldii*	A
Grey-headed Flying-fox TS	*Pteropus poliocephalus*	S C
Horse *	*Equus caballus*	O
Large-footed Myotis TS	*Myotis macropus*	A
Long-eared Bat	*Nyctophilus sp.*	A PO
Little Forest Bat	*Vespadelus vulturnus*	A PR
Southern Forest Bat	*Vespadelus regulus*	A PO
White-striped Mastiff-bat	*Austronomus australis*	A

Common name	Scientific name	Method observed
Yellow-bellied Sheathtail-bat [TS]	*Saccolaimus flaviventris*	A [PO]
Reptiles		
Delicate Skink	*Lampropholis delicata*	O
Eastern Water Skink	*Eulamprus quoyii*	O
Grass Skink	*Lampropholis guichenoti*	O H
Three-toed Skink	*Saiphos equalis*	H
Red-Bellied Black Snake	*Pseudechis porphyriacus*	O
Weasel Skink	*Saproscincus mustelina*	H
Amphibians		
Laughing Tree Frog	*Litoria tyleri*	C
Mollusc		
Common Garden Snail *	*Helix aspersa*	H
Exotic garden snail *	*Bradybaena similaris*	H

Note: * indicates introduced species
[TS] indicates threatened species
[MS] indicates nationally significant migratory species

All species listed are identified to a high level of certainty unless otherwise noted as:

[PR] indicates species identified to a 'probable' level of certainty
[PO] indicates species identified to a 'possible' level of certainty

A	-	Anabat II/SD-1	C	-	Call Identification
O	-	Observation	P	-	Call-playback Response
T	-	Trap (Elliott, cage, etc)	H	-	Habitat Search
S	-	Spotlight	I	-	Scat, Track or Sign Identification

4 Ecological Assessment

4.1 Previous surveys reviewed

- *Vegetation mapping of the Cumberland Plain (NPWS 2003)*

An extensive vegetation mapping survey of the Cumberland Plain area of western Sydney which shows the vegetation within the subject site to be Map Unit 12 – Riparian Forest

- *Ecological and Riparian Issues (Whelans Insites Pty Ltd – 2007)*

Depicted the vegetation as either;

- Riparian Forest – Bangalay Apple Coastal Myall Wattle Riparian Forest with Scattered Blue Box
- Riparian Woodland - Stringybark Riparian Woodland with Exotic Grassland Understorey.

4.2 Flora species

A total of two hundred and eight (208) flora species were observed within the subject site during the survey under by *Travers bushfire & ecology*. No threatened flora species were observed.

All species are listed in Table 3.1.

4.3 Vegetation communities

Three (3) vegetation communities were identified within the subject site through aerial photographic interpretations and extensive ground truthing. These include;

- Riparian Open Forest (and variant – Planted *Corymbia citriodora*)
- Riparian Woodland (Managed Understorey)
- Cleared or Managed Landscape

Riparian Open Forest (and variant – Planted *Corymbia citriodora*)

This vegetation community occupies the majority of the more heavily vegetated sections of the subject site in close proximity to Georges River. The estimated coverage of this community is 15.48ha or 50 % of the subject site. The Riparian Open Forest is considered to be commensurate with the EEC – River-flat Eucalypt Forest on Coastal Floodplains.

The canopy is generally 18-25m in height with the presence of common Eucalypt/Angophora species such as *Eucalyptus baueriana* (Blue Box), *Eucalyptus amplifolia, Eucalyptus bosistoana* (Coast Grey Box), *Eucalyptus botryoides* (Bangalay) and *Angophora subvelutina,* and the projected foliage cover is 10-30%. Some portions contain an overstorey of *Casuarina glauca* (Swamp Oak) on the western side of Coopers Paddock.

There was a sub-canopy layer present throughout most of the vegetation in close proximity to Georges River, dominated by *Acacia binervia* (Coast Myall) to a height of around 10-15m tall.

The native mid-storey layer has been heavily reduced because of the overwhelming presence of Lantana and vines. Common mid-storey species include *Acacia decurrens* (Black Wattle), *Acacia parramattensis* (Sydney Golden Wattle) and *Bursaria spinosa* (Blackthorn). There were very few other native shrubs encountered and they were generally sparse.

The ground layer of vegetation rarely exceeds 10% projected foliage cover for native species unless dominated by *Pteridium esculentum* (Bracken) and *Carex* species around the swale areas. Common species include *Themeda australis* (Kangaroo Grass), *Cynodon dactylon* (Couch), *Entolasia stricta* (Wiry Panic), *Microlaena stipoides* var. *stipoides* (Weeping Rice Grass), *Einadia hastata* (Berry Saltbush) and *Glycine clandestina* (Twining Glycine).

The vegetation comprising this community is heavily disturbed throughout by the introduction of in particular *Lantana camara* (Lantana) to the mid-storey. In some of the more gullied areas near flora quadrats 5, 6, 9, 10 and those located in swale areas including quadrats 7 and 8, the additional moisture content within the soil has allowed for a significant incursion of *Cardiospermum grandiflorum* (Balloon Vine) and *Ligustrum sinense* (Small-leaved Privet).

Photo 1 *– Riparian forest vegetation near quadrat 6.*

In the north-eastern portion of the subject site, *Corymbia cirtiodora* (Lemon-scented Gum) is a dominant species in the canopy as it has been planted. Within this same area were some

Photo 2 *– Riparian forest vegetation between quadrat 9 and 10.*

Photo 3 *– Corymbia citriodora variant in the north-eastern corner of the subject site*

large Ironbark trees *(Eucalyptus fibrosa*) and occasional Turpentine trees (*Syncarpia glomulifera*).

Riparian Woodland (Managed Understorey)

This vegetation community occurs as small highly disturbed clumps of vegetation in the northern portion of the subject site, typically distinguished by scattered remnant trees with a mown or cleared understorey. This vegetation community is estimated to occupy 0.7ha or 2 % of the subject site.

This area is slightly higher in elevation to the surrounding vegetation hence the useability for recreation (less constrained by flooding events).

The vegetation here is on the verge of being Cumberland Plain Woodland, a critically endangered ecological community however there is very little variation to that further south considering the grasses present and the saplings of shrub layer vegetation. Hence, the patchy fragmented vegetation is considered to be part of the same EEC, River-flat Eucalypt Forest on Coastal Floodplains. The determination is relatively consistent with that mapped by NPWS in 2003.

Vegetation would generally be similar to that described for Riparian Open Forest had it not been previously cleared.

Photo 4 *– Riparian woodland vegetation in the central northern portion of the subject site.*

The structure is more a woodland because of past clearing events and lack of shrub layer with a projected foliage cover of 3-10%. The most common tree was *Eucalyptus eugenioides*

(Thin-leaved Stringybark). These were recorded within the Riparian Open Forest but not as a common species.

Cleared or Managed Landscape

This vegetation community occurs in all un-vegetated areas or those which are essentially just a grassland community that is typically mown. Those areas which are not mown normally contain well in excess of 50% weed coverage in the understorey. This community occupies 14.93 ha or 48 % of the subject site and contains the grassed and landscaped area near the central building and the tracks nearer the western portion of the subject site. Prior to vegetation clearing it would have likely been further EEC – River-flat Eucalypt Forest on Coastal Floodplains.

Previous sand mining within the southern portion of the subject site has changed the natural topography and levels and caused some un-natural swales which would occasionally contain water after heavy rain, hence there is a presence of occasional tussock-type grasses, Carex and sedge species within this community.

Photo 5 *– Cleared / managed vegetation in the far north-western corner looking south-east.*

Photo 6 *– Heavily disturbed weedy vegetation between quadrats 3 and 4.*

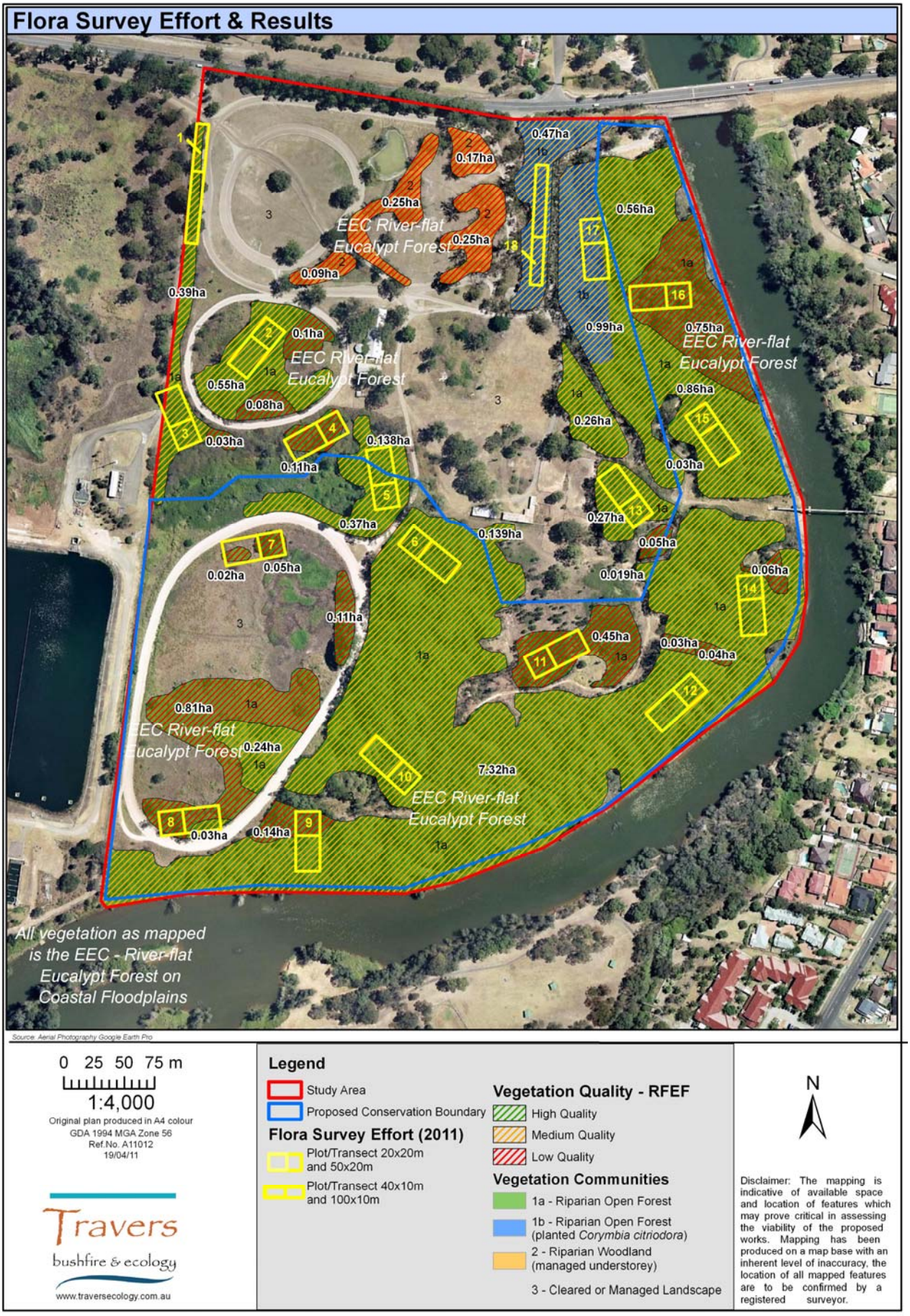

Figure 2 – Flora Survey Effort & Results

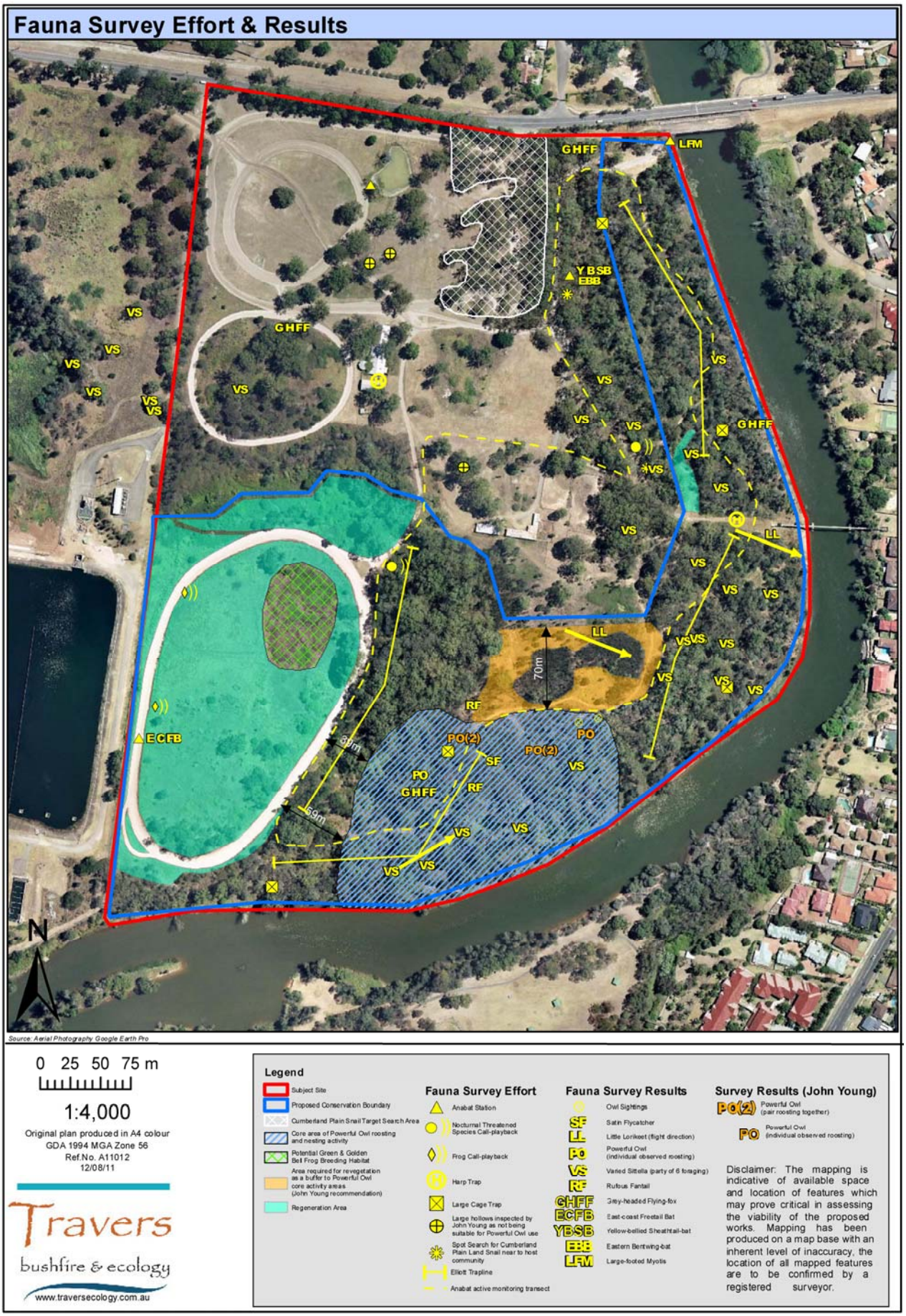

Figure 3 – Fauna Survey Effort & Results

(John Young and Dr Richard Noske survey results included)

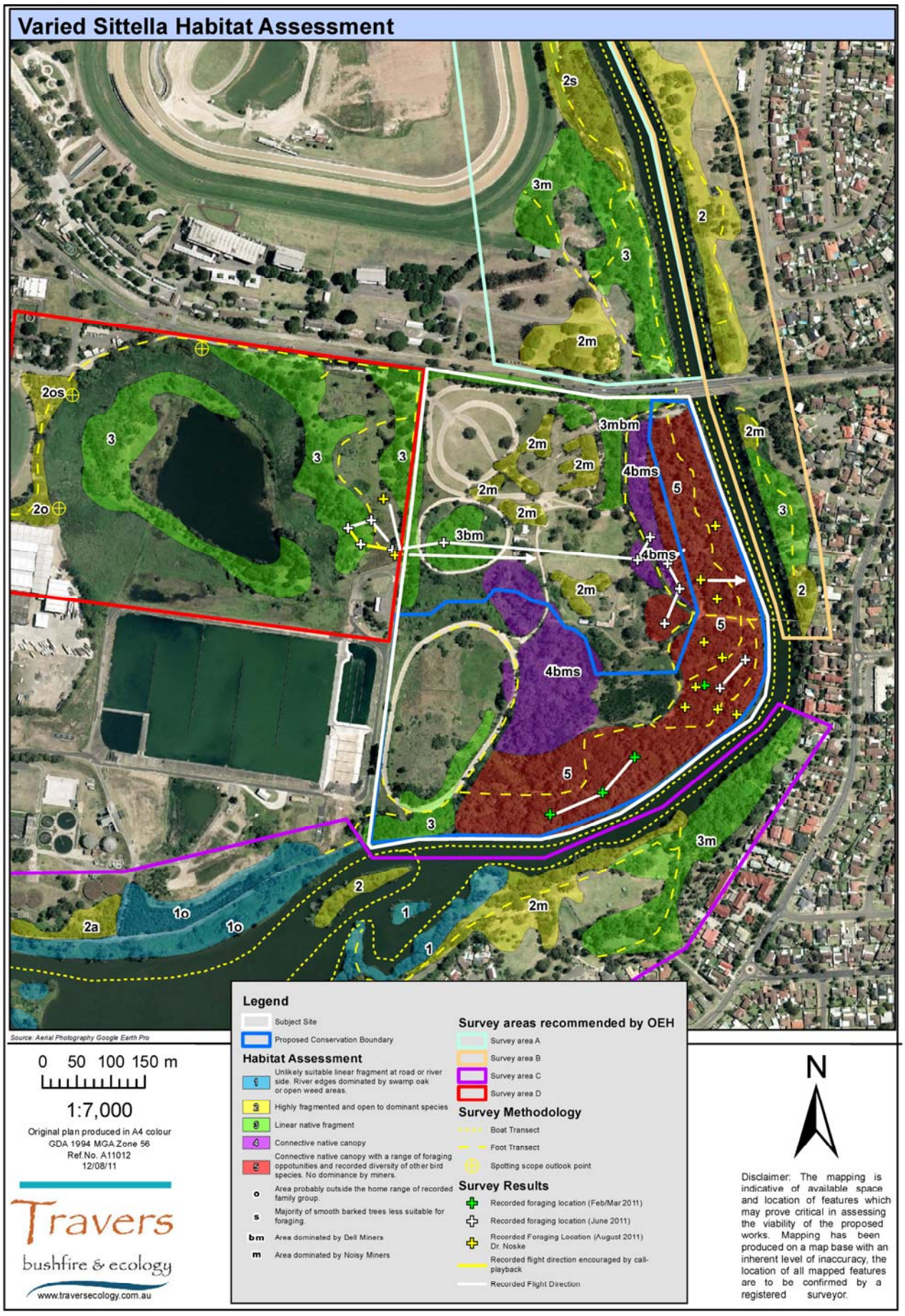

Figure 4 – Varied Sittella Habitat Assessment
(as amended by Dr Richard Noske)

4.4 State legislative flora matters

4.4.1 Threatened species

No threatened flora species were observed during the surveys undertaken by *Travers bushfire & ecology* nor those previous undertaken by *Wheelans Insites* (2007).

TSC Act – A search of the *Atlas of NSW Wildlife* (OEH 2011) database indicated that twenty five (25) species have been recorded within a 10 km radius of the study area. Those species are listed in Table 4.1.

Of those twenty five (25) threatened flora species, three (3) have the potential to occur within the subject site. One (1) further species known to occur approximately 4km away at Bankstown Airport which is critically listed under the schedules of the TSC Act was not present within the Atlas of NSW Wildlife database (2011) but has a low potential to occur – *Hibbertia* sp. Bankstown. The other three (3) species within potential to occur are *Acacia pubescens, Persoonia nutans* and *Pultenaea parviflora.* None of these species were observed within the subject site.

4.4.2 Endangered populations

There is one (1) known endangered populations within the Liverpool LGA, *Marsdenia viridiflora* subsp. *viridiflora* population in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith local government areas. This species was not observed within the subject site.

There are three (3) other populations which occur within a 10km radius however they are not endangered populations within the Liverpool LGA. These are *Acacia prominens* (Gosford Wattle) in the Hurstville and Kogarah Local Government Areas, *Pomaderris prunifolia* in the Parramatta, Auburn, Strathfield and Bankstown Local Government Areas and *Wahlenbergia multicaulis* (Tadgell's Bluebell) in the local government areas of Auburn, Bankstown, Baulkham Hills, Canterbury, Hornsby, Parramatta and Strathfield. It is considered that the populations would not occur within the subject site due to geographic limitations.

4.4.3 Endangered ecological communities

One (1) endangered ecological community (EEC), River-flat Eucalypt Forest on Coastal Floodplains was observed within the subject site.

Two vegetation communities comprise this EEC, that being Riparian Open Forest and Riparian Woodland.

The cleared or managed landscape is likely to have one comprised this EEC too however given the level of disturbance and lack of native flora species, is no longer typical of the structure or composition that denotes this community.

4.5 National environmental significance - flora

4.5.1 Threatened species

A review of the schedules of the *EPBC Act* indicated the potential for fifteen (15) threatened flora species to occur within a 10km radius of the site (Table 4.1).

Of those fifteen (15) threatened flora species, four (4) have the potential to occur within the subject site. Those species are *Acacia pubescens, Hibbertia* sp. Bankstown, *Persoonia*

nutans and *Pultenaea parviflora.* No nationally listed species was observed within the subject site and therefore a referral to SEWPAC should not be required.

4.5.2 Endangered ecological communities

Riverflat Eucalypt Forest on Coastal Floodplains is not listed under the EPBC Act. The actions associated with the development are not likely to significantly affect any nationally listed threatened species or ecological communities.

Conclusion: A referral to SEWPAC is not required.

4.6 Threatened flora species habitat assessment

Table 4.1 below provides an assessment of threatened flora species habitat likely to occur within the subject site.

Table 4.1 – Threatened flora habitat assessment

Scientific name	Growth form and habitat requirements	Conservation status	Comments	TSC Act	EPBC Act
Acacia pubescens OEH EPBC	Spreading shrub 1-4 m high open sclerophyll growing in open forest and woodlands on clay soils. Distribution limits N-Bilpin S-Georges River.	Wollemi NP, Scheyville NP	Nearest record is 0.5km away. Suitable habitat present in the northern portion of the subject site. Not observed.	V	V
Allocasuarina glareicola OEH	Small shrub 1-2 m high growing in open sclerophyll forest on lateritic soils derived from tertiary alluviums. Distribution limits Castlereagh NR region.	Castlereagh NR	Nearest record is 6.5km away and the only record within 10lm made in 1996. No suitable habitat present.	E1	E
Caesia parviflora var. minor OEH	Small tufted plant usually < 20cm high. Grows in heath and woodland on sandstone derived soil, chiefly north coast, Central Tablelands & Central western Slopes. Distribution limits N-Corindi S-Albury.	Nil	Nearest record is 7.5km away. No suitable habitat present.	E1	-

Scientific name	Growth form and habitat requirements	Conservation status	Comments	TSC Act	EPBC Act
Caladenia tessellata EPBC	Terrestrial orchid. Clay-loam or sandy soils. Distribution limits N-Swansea S-south of Eden.	Munmorah SRA, Popran NP, Wyrrabalong NP	No records within 10km. There is only one record on the Sydney or Penrith 1:100,000 map sheet in 1945 which would suggest that the habitat around the Sydney urban area is unlikely to be unsuitable for the species. Given the lack of nearby records despite potential habitat, we believe the species is unlikely to occur given the level of weed inundation and previous vegetation clearance.	E1	V
Callistemon linearifolius OEH	Shrub to 4 m high. Dry sclerophyll forest on coast and adjacent ranges. Distribution limits N-Nelson Bay S-Georges River.	Ku-ring-gai Chase NP Lion Island NR Spectacle Island Nature Reserve Yengo NP, Brisbane Water NP, Munmorah SRA, Werakata NP	Nearest record is 3.5km away. More typical of clay soils as opposed to those sandier types on site. No potential habitat present.	V	-
Cynanchum elegans OEH	Climber or twiner to 1 m. Grows in rainforest gullies, scrub & scree slopes. Distribution limits N-Gloucester S-Wollongong.	Camel's Hump NR, Woko NP, Booti Booti NP, Oxley Wild Rivers NP, Goulburn River NP, Glenrock SRA, Kooragang Island NR, Camels Hump NR, New England NP, Sea Acres NR, Wollemi NR Darawank NR Khappingaht NR	Nearest record is 10km away. No suitable habitat present.	E1	E
Deyeuxia appressa OEH EPBC	Erect grass to 0.9 m high. Grows on wet ground. Distribution limits N-Hornsby S-Bankstown.	Not currently known from conservation reserves.	Nearest record is 7km away. Only 2 records within 10km both made in 1930. No suitable habitat present as the 'wet' areas are man-made.	E1	E

Scientific name	Growth form and habitat requirements	Conservation status	Comments	TSC Act	EPBC Act
Diuris aequalis OEH	Terrestrial orchid which occurs in montane Eucalypt forest with grassy-heathy understorey. Very rare apart from Boyd Plateau. Distribution limits N-Blue Mountains S-Braidwood.	Kanangra Boyd NP	Nearest record is 3km away and the only record within 10km which was made in 1905. Outside of known geographic range.	E1	V
Epacris purpurascens var. purpurascens OEH	Erect shrub to 1.5m high growing in sclerophyll forest and scrub and near creeks and swamps on Sandstone. Distribution limits N-Gosford S-Blue Mountains.	Ku-ring-gai Chase NP Muogamarra NR Brisbane Water NP Berowra Valley RP Bents Basin SRA	Nearest record is 5.5km away. No suitable habitat present.	V	-
Eucalyptus camfieldii OEH	Stringybark to 10 m high. Grows on coastal shrub heath and woodlands on sandy soils derived from alluviums and Hawkesbury sandstone. Distribution limits N-Norah Head S-Royal NP.	Brisbane Water NP, Ku-ring-gai Chase NP, Royal NP, Sydney Harbour NP, Awabakal NR, Popran NP, Berowra Valley RP	Nearest record is 10km away. No suitable habitat present.	V	V
Eucalyptus nicholii OEH	This species is widely planted as an urban street tree and in gardens but is quite rare in the wild. It is confined to the New England Tablelands of NSW, where it occurs from Nundle to north of Tenterfield, largely on private property.	Nil	Nearest record is 2.5km away. Outside of known geographic range although sometimes occurring as a planted specimen.	V	-
Eucalyptus scoparia OEH	Smooth-barked tree only known from vicinity of Bald Rock.	Bald Rock NP	Nearest record is 9.5km away. Outside of known geographic range although sometimes occurring as a planted specimen.	E1	V
Grevillea parviflora subsp parviflora OEH EPBC	Open to erect shrub to 1 metre. Grows in woodland on light clayey soils Distribution limits N-Cessnock S-Appin.	Werakata NP	Nearest record is 3.5km away. Only 2 records within 10km. No suitable habitat present.	V	V
Gyrostemon thesioides OEH	Multi-stemmed shrub to 70 cm. Grows on hillsides and riverbanks. Confined to Georges and Nepean Rivers and believed extinct.	Not currently known from conservation reserves.	Nearest record is 9km away. All records are from the one location in 1966 and 1967. Potential habitat may be present but highly unlikely to occur as it is believed extinct.	E1	-

Scientific name	Growth form and habitat requirements	Conservation status	Comments	TSC Act	EPBC Act
Hibbertia sp. Bankstown EPBC	A prostrate shrub only known to grow within the grounds of Bankstown Airport which flowers Oct-Dec. Growing in a River-flat Eucalypt Forest vegetation type (EEC).	Nil	Despite Bankstown Airport being only 4km east, there are no records listed in the Atlas of NSW Wildlife Database (2011). The vegetation on site has some consistency with that recorded on the known site. The soils are sandy alluviums, again consistent. Potential habitat present; low likelihood of occurrence.	Critic. E	Critic. E
Leucopogon exolasius OEH	Erect shrub to 2 metres high. Rocky hillsides and creek banks in Sydney Sandstone Gully Forest. Confined to Woronora and Georges Rivers and Stokes Creek.	Heathcote NP	Nearest record is 3.5km away. Only 2 records occur within 10km. No suitable habitat present.	V	V
Melaleuca biconvexa EPBC	Tall shrub. Grows in wetlands adjoining perennial streams and on the banks of those streams, generally within the geological series known as the Terrigal Formation. Distribution limits N-Port Macquarie S-Jervis Bay.	Bouddi NP, Wyrrabalong NP	Nearest record is greater than 10km away. No suitable habitat present.	V	V
Melaleuca deanei OEH EPBC	Shrub to 3 m high. Grows in heath on sandstone. Distribution limits N-Gosford S-Nowra.	Berowra Valley Regional Park, Brisbane Water NP, Ku-ring-gai Chase NP, Garigal NP, Lane Cove NP, Royal NP, Heathcote NP	Nearest record is 7.5km away. No suitable habitat present.	V	V
Persoonia hirsuta OEH	Erect to decumbent shrub. Grows in dry sclerophyll forest and woodland on Hawkesbury sandstone with infrequent fire histories. Distribution limits N-Glen Davis S-Hill Top.	Blue Mountains NP, Wollemi NP, Dharug NP, Ku-ring-gai Chase NP, Marramarra NP, Royal NP, Sydney Harbour NP	Nearest record is 3.5km away. No suitable habitat present	E1	E
Persoonia nutans OEH EPBC	Erect to spreading shrub. Grows in dry sclerophyll forest and woodland on laterite and alluvial sands. Distribution limits Cumberland Plain.	Agnes Banks NR, Windsor Downs NR, Castlereagh NR	Nearest record is 2km. Suitable habitat present. Not observed.	E1	E

Scientific name	Growth form and habitat requirements	Conservation status	Comments	TSC Act	EPBC Act
Pimelea curviflora var. curviflora EPBC	Woody herb or sub-shrub to 0.2-1.2 m high. Grows on Hawkesbury sandstone near shale outcrops. Distribution Sydney.	Not currently known from conservation reserves.	No records within 10km. No suitable habitat present.	V	V
Pimelea spicata OEH EPBC	Decumbent or erect shrub to 0.5 m high. Occurs principally in woodland on soils derived from Wianamatta Shales. Distribution limits N-Lansdowne S-Shellharbour.	Killalea SRA	Nearest record is 3km away. Typically restricted to Cumberland Plain Woodland vegetation as opposed to riparian River-flat Eucalypt Forest. The subject site appears to be too disturbed to retain suitable habitat for this species.	E1	E
Pomaderris brunnea EPBC	Shrub to 3 metres high. Confined to Upper Nepean and Colo Rivers where it grows in open forest.	Wollemi NP	Nearest record is more than 10km away. No suitable habitat present.	V	V
Pterostylis gibbosa EPBC	Terrestrial orchid which occurs near Wollongong and in Hunter Valley in sclerophyll forest, sometimes with paperbarks.	Worrigee NR.	Nearest record is more than 10km away. No suitable habitat present.	E1	E
Pterostylis nigricans OEH	Terrestrial orchid. Prefers coastal heathland with Heath Banksia (Banksia ericifolia), and lower-growing heath with lichen-encrusted and relatively undisturbed soil surfaces, on sandy soils. The Dark Greenhood occurs in north-east NSW north from Evans Head, and in Queensland.	Unknown	Nearest record is 8km away and the only record within 10km made in 1967. No potential habitat present.	V	-
Pterostylis saxicola OEH EPBC	Terrestrial orchid. Grows in shallow sandy soil above rock shelves, usually near Wianamatta / Hawkesbury transition. Distribution limits N-Hawkesbury River S-Campbelltown.	Not currently known from conservation reserves.	Nearest record is 7.5km away. No suitable habitat present.	E1	E
Pultenaea parviflora OEH EPBC	Erect shrub. Grows in dry sclerophyll forest at the intergrade between Tertiary Alluviums and Wianamatta Shales. Distribution limits Cumberland Plain.	Scheyville NP, Windsor Downs NR, Castlereagh NR	Nearest record is 4.5km away. Only one record within 10km. Marginal habitat present; low likelihood of occurrence. Not recorded.	E1	V

Scientific name	Growth form and habitat requirements	Conservation status	Comments	TSC Act	EPBC Act
Pultenaea pedunculata OEH	Prostrate shrub. Grows in dry sclerophyll forest and disturbed sites. Confined to Prestons and Villawood in the Sydney region. Other disjunct populations occur elsewhere in the state.	Not currently known from conservation reserves.	Nearest record is 2.5km away. The vegetation associations within the subject site do not match those listed on the DECC website. As such, there is no suitable habitat present.	E1	-
Syzygium paniculatum OEH	Small tree. Subtropical and littoral rainforest on sandy soil. Distribution limits N-Forster S-Jervis Bay.	Booti Booti NP, Myall Lakes NP, Wamberal Lagoon NR, Wyrrabalong NP, Captain Cooks Landing Place HS, Jervis Bay NP, Munmorah SRA, Glenrock SRA	Nearest record is 9.5km away. No suitable habitat present.	V	V
Tetratheca glandulosa OEH	Spreading shrub to 0.2 m high. Sandy or rocky heath or scrub. Distribution limits N-Mangrove Mountain S-Port Jackson.	Berowra Valley RP, Dharug NP, Garigal NP, Ku-ring-gai Chase NP, Popran NP, Parr SRA, Cattai NP, Brisbane Water NP, Yengo NP, Cattai NP, Marramarra NP, Muogamarra NR, Wollemi NP	Nearest record is 9.5km away recorded pre 1900. No suitable habitat present.	V	V
Thelymitra sp. 'Kangaloon' EPBC	A terrestrial orchid with dark blue flowers, presented in mid-late spring. Only known from the Robertson area in the Southern Highlands. Often in association with the endangered ecological community *Temperate Highland Peat Swamps on Sandstone.*	Unknown	Outside of geographic range. No potential habitat present. Not observed.	-	Critic. E

Scientific name	Growth form and habitat requirements	Conservation status	Comments	TSC Act	EPBC Act
Wilsonia backhousei OEH	Perennial subshrub with procumbent branches. Grows in coastal saltmarshes. *Wilsonia backhousei* is salt tolerant and is found in intertidal saltmarshes and, more rarely, on seacliffs. In New South Wales *Wilsonia backhousei* is scattered along the coast, reaching a northern limit at Wamberal Lagoon. In the Sydney region there has been a considerable decline in the abundance of the species over the last 100yrs, largely as a result of loss of habitat. Distribution limits N-Sydney S-South of Eden.	Unknown	Nearest record is 6.5km away. Suitable habitat not present.	V	-

OEH	- Denotes species listed within 10km of the subject site on the *Atlas of NSW Wildlife* database
EPBC	- Denotes species listed within 10km of the subject site in the *EPBC Act* habitat search
V	- Denotes vulnerable listed species under the relevant Act
E or E1	- Denotes endangered listed species under the relevant Act

4.7 Fauna species

A total of seventy-five (75) fauna species were observed within or in close proximity to the subject site during the survey. This number comprised 50 species of bird, 16 species of mammal, 6 species of reptile, 1 species of amphibian and 2 species of mollusc.

All species are listed in Table 3.2.

4.8 Fauna Habitat

The fauna habitats present throughout the site include:

- Vegetated areas of riparian forest with a highly disturbed understorey
- Nectar producing tree species, principally *Eucalyptus, Angophora, Corymbia, Callistemon, Acacia* and *Melaleuca*
- Seed producing trees, notably *Casuarina*
- Sparse to dense shrublayers
- Sparse to moderate density ground cover
- Large, medium and small hollows of varying quality and low density
- Fallen logs and branches
- Loose soil suitable for foraging
- Adjacent river along the southern and eastern margins of the site
- Ephemeral drainages within a shallow gullies of dense vegetative growth
- Farm dam with fringing vegetation

- Reedy depression providing soaks after rainfall
- Sparse to dense litter layers
- Exfoliated bark on trunks and piles at the base of smooth-barked *Eucalyptus* species
- Abandoned stables and buildings
- Artificial debris and refuse

4.9 Habitat trees

A complete assessment of the location of habitat trees and the size of hollows was not conducted. However the available size range and quality of hollows were noted during site visits. Hollows of all size classes were observed in low density with the number of large hollows (>30cm) likely to be less than ten (10) across the entire site.

Large hollows with potential for use by Powerful Owl were searched within the complete areas of previous clearing (subject to the development proposal) and within the fringes of riparian forest. There is a very dense occurrence of Lantana throughout most of the riparian forest areas making complete access difficult. Two trees containing large hollows were observed within the central portions of existing cleared areas (see Figure 3). Despite the quality of one of these hollows, owl expert John Young has determined them to be too far and isolated from open forest areas to have potential for use by Powerful Owl.

4.10 Locally significant fauna

There are no locally significant fauna identified on the Liverpool City Council website. It is considered that the following species recorded within the subject site, whilst not listed as threatened or of national significance, are locally and regionally rare:

- White-bellied Cuckoo-shrike
- Crested Shrike-tit
- Grey Goshawk
- Painted Button-quail

The presence of these species gives greater value to the subject site as an isolated haven of habitat in the locality. The proposed retention of open forest areas is considered a valued conservation contribution to the above mentioned species.

4.11 State legislative fauna matters

4.11.1 Threatened species

Eight (8) threatened fauna species were recorded within or in close proximity to the subject site. Threatened fauna species recorded included Powerful Owl (*Ninox strenua*), Varied Sittella (*Daphoenositta chrysoptera*), Little Lorikeet (*Glossopsitta pusilla*), Grey-headed Flying-fox (*Pteropus poliocephalus*), Large-footed Myotis (*Myotis macropus*), Eastern Bentwing-bat (*Miniopterus orianae oceansis*), East-coast Freetail Bat (*Micronomus norfolkensis*) and Yellow-bellied Sheathtail Bat (*Saccolaimus flaviventris*). The Yellow-bellied Sheathtail Bat was recorded only to a 'possible' level of certainty. One (1) additional threatened fauna species - Black-chinned Honeyeater (eastern subspecies - *Melithreptus gularis gularis*) has been previously recorded on the opposite side of the Georges River as evident from the Atlas of NSW Wildlife Database records (DECCW/OEH 2011) and likely utilised the subject site on occasion.

It is considered that the subject site provides suitable habitat for the following twenty one (21) threatened fauna species previously recorded within 10km (see Table 4.3 for likelihood of each species presence based on available habitat and records):

- Green and Golden Bell Frog
- Little Eagle
- Square-tailed Kite
- Osprey
- Bush Stone-curlew
- Gang-gang Cockatoo
- Little Lorikeet
- Swift Parrot
- Powerful Owl
- Black-chinned Honeyeater
- Regent Honeyeater
- Varied Sittella
- Scarlet Robin
- Flame Robin
- Grey-headed Flying-fox
- Yellow-bellied Sheathtail-bat
- East-coast Freetail Bat
- Eastern Falsistrelle
- Eastern Bentwing-bat
- Large-footed Myotis
- Greater Broad-nosed Bat

TSC Act – A search of the *Atlas of NSW Wildlife* (DECCW/OEH 2011) database for threatened species resulted in records of thirty-four (34) threatened fauna species within a 10km radius of the subject site. These species are listed in Table 4.3 and are considered for potential habitat within the subject site.

FM Act – The subject site does not include the immediately adjacent Georges River. It is considered that this river does not likely provide threatened fish species habitat and as such the provisions of this act do not require any further consideration.

4.11.2 Endangered populations

There are no endangered fauna populations identified specifically to the Liverpool LGA; however the site does fall within the Sydney Metropolitan Catchment Management Authority area. An endangered population of White-fronted Chat (*Epthianura albifrons*) is identified to this area however this is made up of two known isolated sub-populations; one at Newington Nature Reserve on the Parramatta River and one at Towra Point Nature Reserve in Botany Bay. The subject site is not located in close proximity to these locations such that it would contribute to known habitat. The subject site provides suitable habitat for the White-fronted Chat however this species was not recorded present during surveys. The subject site is thus not considered to contribute to any endangered fauna populations.

4.11.3 SEPP 44 Koala Habitat Protection

SEPP 44 Koala Habitat Protection applies to land within Local Government Areas (LGAs) listed under Schedule 1 of the Policy. In addition, Part 2 of the Policy outlines a three (3) step process to assess the likelihood of the land in question being potential or core koala habitat. Part 2 applies to land which has an area of greater than 1 hectare or has, together with any adjoining land in the same ownership, an area of more than 1 hectare.

The subject site is required to be considered under SEPP 44 as it falls within the Liverpool LGA, which is listed on Schedule 1 of this Policy. In addition, the total area of the subject site is greater than 1 hectare, hence Part 2 – Development Control of Koala Habitats, of the Policy applies.

Potential Koala Habitat (PKH) is defined as land where at least 15% of the total number of trees in the upper or lower strata constitutes any of the tree species listed in Schedule 2 of the policy.

Core Koala Habitat (CKH) is defined as an area of land with a resident population of koalas, evidenced by attributes such as breeding females (i.e. females with young) and recent sightings of and historical records of a population.

Step 1 – Is the land PKH*?*

One Koala food tree species (*Eucalyptus tereticornis*) as listed on Schedule 2 of State Environmental Planning Policy No. 44 - Koala Habitat Protection, was recorded within the subject site. This species made up less than the 15% of trees within the Riparian Open Forest community. As such the subject site is not considered to comprise 'potential Koala habitat' as defined under SEPP 44 and no further assessment under this policy is required.

4.12 National environmental significance - fauna

4.12.1 Threatened species

EPBC Act – A review of the schedules of the *EPBC Act* identified the presence of fifteen (15) threatened fauna species or species habitat likely to occur within a 10km radius of the subject site.

These species have been listed in Table 4.3, and those with potential to utilise the subject site will be considered in the seven-part test within Section 5.

Of those fifteen (15) species, 4 were considered to have potential habitat within the subject site. Of these, one (1) nationally listed threatened fauna species, Grey-headed Flying-fox (*Pteropus poliocephalus*), was recorded foraging within the subject site.

Grey-headed Flying-fox assessment

Grey-headed Flying-fox was either seen or heard foraging within trees located within the subject site. The Powerful Owl observed roosting during survey was also clutching a Grey-headed Flying-fox prey item. There is no likelihood of Grey-headed Flying-fox utilising the site for roosting and subsequent breeding habitat. Rezoning will cause some loss of foraging habitat predominantly clumps and individual trees within the higher disturbance areas. However, the majority of foraging habitat available within the site will be retained within the connective forested portions. This species is not likely to provide a constraint to the current rezoning application.

4.12.2 Protected migratory species

The EPBC Act Protected Matters Report provides additionally listed terrestrial, wetland and marine migratory species of national significance likely to occur, or with habitat for these species likely to occur, within a 10km radius of the subject site. These migratory species are assessed in Table 4.2.

Threatened migratory species are assessed in Table 4.3.

Table 4.2 - Migratory fauna habitat assessment

COMMON NAME *Scientific Name*	PREFERRED HABITAT	COMMENTS
White-bellied Sea Eagle (*Haliaeetus leucogaster*)	Coasts, islands, estuaries, inlets, large rivers, inland lakes, reservoirs. *Sedentary; dispersive.*	Suitable foraging, roosting and nesting habitat present. Indicated by a horse trainer (with up to 20 years' experience on the site) to have previously nested over a number of years within the subject site and last seen probably about two years ago. Not recorded present during survey by *Travers bushfire & ecology* and *John Young Wildlife* in the period expected to occur leading up to nesting. The proposed rezoning conservation area does retain the most suitable habitat for nesting and perching.
White-throated Needletail (*Hirundapus caudacutus*)	Airspace over forests, woodlands, farmlands, plains, lakes, coasts, towns; companies forage often along favoured hilltops and timbered ranges. *Breeds Siberia, Himilayas, east to Japan. Summer migrant to eastern Australia.*	Suitable foraging habitat and low potential roosting habitat present. Not recorded during surveys.
Rainbow Bee-eater (*Merops ornatus*)	Open woodlands with sandy, loamy soil; sandridges, sandspits, riverbanks, road cuttings, beaches, dunes, cliffs, mangroves, rainforest, woodlands, golf courses. *Breeding resident in northern Australia. Summer breeding migrant to south-east & south-west Australia.*	Suitable roosting, breeding and foraging habitat present. Not recorded during surveys and a low potential to occur based on the nearest record being over 9km away.
Black-faced Monarch (*Monarcha melanopsis*)	Rainforests, eucalypt woodlands; coastal scrubs; damp gullies in rainforest, eucalypt forest; more open woodland when migrating. *Summer breeding migrant to coastal south-east Australia, otherwise uncommon*.	Suitable roosting and foraging habitat on migration present. Not recorded during surveys.
Satin Flycatcher (*Myiagra cyanoleuca*)	Heavily vegetated gullies in forests, taller woodlands, usually above shrub-layer; during migration, coastal forests, woodlands, mangroves, trees in open country, gardens. *Breeds mostly south-east Australia & Tasmania over warmer months, winters in north-east Qld.*	Suitable roosting and foraging habitat on migration present, low potential breeding habitat. Recorded within the gully area of River Flat Eucalypt Forest during surveys (see Figure 3 for location). The proposed conservation area retains all of the most suitable habitat for this species.

COMMON NAME *Scientific Name*	PREFERRED HABITAT	COMMENTS
Rufous Fantail (*Rhipidura rufifrons*)	Undergrowth of rainforests/wetter eucalypt forests/gullies; monsoon forests, paperbarks, sub-inland and coastal scrubs; mangroves, watercourses; parks, gardens. On migration, farms, streets buildings. *Breeding migrant to south-east Australia over warmer months. Altitudinal migrant in north-east NSW in mountain forests during warmer months.*	Suitable roosting, breeding and foraging habitat present. A single individual was recorded foraging within tall weedy scrub within the proposed development areas of the rezoning proposal (see Figure 3 for location). Given the extent of weed scrub within the proposed conservation areas and the potential to stage habitat restoration during weed management, there will be suitable amounts of habitat provided for this species.
Great Egret (*Ardea alba*)	Shallows of rivers, estuaries; tidal mudflats, freshwater wetlands; sewerage ponds, irrigation areas, larger dams, etc. *Dispersive; cosmopolitan.*	Suitable roosting and foraging habitat present limited to the small dam present and along the fringes of the Georges River (outside of the subject site). Not recorded during surveys.
Cattle Egret (*Ardea ibis*)	Stock paddocks, pastures, croplands, garbage tips, wetlands, tidal mudflats, drains. *Breeds in summer in warmer parts of range including NSW*.	Suitable roosting and foraging habitat present. Not recorded during surveys.
Latham's Snipe (*Gallinago hardwickii*)	Soft wet ground or shallow water with tussocks and other green or dead growth; wet parts of paddocks; seepage below dams; irrigated areas; scrub or open woodland from sea-level to alpine bogs over 2000m; samphire on saltmarshes; mangrove fringes. *Breeds Japan. Regular summer migrant to Australia. Some overwinter.*	Suitable roosting and foraging habitat present within the reedy depressions in the south-western corner of the subject site and to a lesser extent around the small dam. Not recorded during surveys.
Fork-tailed Swift (*Apus pacificus*)	Aerial: over open country, from semi-arid deserts to coasts, islands; sometimes over forests, cities. *Breeds Siberia, Himilayas, east to Japan south-east Asia. Summer migrant to east Australia. Mass movements associated with late summer low pressure systems into east Australia. Otherwise uncommon.*	Suitable foraging habitat and low potential roosting habitat present. Not recorded during surveys.

The actions associated with the development are not likely to significantly affect any nationally listed threatened fauna species or nationally listed migratory fauna species.

Conclusion: A referral to SEWPAC should not be required.

4.13 Threatened fauna species habitat assessment

Table 4.3 below provides an assessment of state and nationally listed threatened fauna species habitat likely to occur within the subject site.

Table 4.3 - Threatened fauna habitat assessment

COMMON NAME *Scientific Name*	PREFERRED HABITAT	COMMENTS	TSC Act	EPBC Act
Giant Burrowing Frog *Heleioporus australiacus* EPBC	Inhabits open forests and riparian forests along non-perennial streams, digging burrows into sandy creek banks. Distribution Limit: N-Near Singleton S-South of Eden.	No suitable habitat present.	V	V
Red-crowned Toadlet *Pseudophryne australis* OEH	Prefers sandstone areas, breeds in grass and debris beside non-perennial creeks or gutters. Individuals can also be found under logs and rocks in non-breeding periods. Distribution Limit: N-Pokolbin. S-near Wollongong.	No suitable habitat present.	V	-
Green and Golden Bell Frog *Litoria aurea* OEH EPBC	Prefers the edges of permanent water, streams, swamps, creeks, lagoons, farm dams and ornamental ponds. Often found under debris. Distribution Limit: N-Byron Bay S-South of Eden.	Suitable shelter and foraging habitat, and sub-optimal breeding habitat present. Not recorded during surveys. Previously recorded within the subject site with a record from 1964. There are no records of this species within 10km and within the last 10 years. Not expected to be locally present anymore however target survey during a more appropriate season in suitable conditions is warranted in light of the previous record.	E	V
Littlejohn's Tree Frog *Litoria littlejohnii* EPBC	Found in wet and dry sclerophyll forest associated with sandstone outcrops at altitudes 280-1000m on eastern slopes of Great Dividing Range. Prefers flowing rocky streams. Distribution Limit: N-Hunter River S-Eden.	No suitable habitat present.	V	V
Southern Bell Frog *Litoria raniformis* EPBC	Prefers the edges of permanent water, streams, swamps, creeks, lagoons, farm dams and ornamental ponds. Often found under debris. Distribution Limit: N-ACT Bay. S-Albury.	No suitable habitat present.	E	V
Broad-headed Snake *Hoplocephalus bungaroides* EPBC	Sandstone outcrops, exfoliated rock slabs and tree hollows in coastal and near coastal areas. Distribution Limit: N-Mudgee Park. S-Nowra.	No suitable habitat present.	E	V

COMMON NAME *Scientific Name*	PREFERRED HABITAT	COMMENTS	TSC Act	EPBC Act
Black-necked Stork *Ephippiorhynchus asiaticus* OEH	Occurs in tropical to warm temperate terrestrial wetlands, estuarine and littoral habitats such as mangroves, tidal mudflats, floodplains, open woodlands, irrigated lands, bore drains, sub-artesian pools, farm dams and sewerage ponds. Distribution Limit: N-Tweed Heads. S-Nowra.	Limited foraging habitat present. Not recorded during surveys. 1 record within 10km over 4km away in 1978. Not likely to occur and not considered any further.	E	-
Spotted Harrier *Circus assimilis* OEH	Utilises grassy plains, crops and stubblefields; saltbush, spinifex associations; scrublands, mallee, heathlands; open grassy woodlands. Distribution Limit: N-Tweed Heads. S-South of Eden.	Limited foraging habitat present and sub-optimal roosting and nesting habitat present. Not recorded during surveys. 1 record within 10km over 7km away in 1986. Not likely to occur and not considered any further.	V	-
Little Eagle *Hieraaetus morphnoides* OEH	Utilises plains, foothills, open forests, woodlands and scrublands; river red gums on watercourses and lakes. Distribution Limit - N-Tweed Heads. S-South of Eden.	Suitable foraging, roosting and nesting habitat present. Not recorded during surveys. 15 records within 10km, the closest at 900m east in 1996 and 1.5km SE in 2003. Potential to occur.	V	-
Square-tailed Kite *Lophoictinia isura* OEH	Utilises mostly coastal and sub-coastal open forest, woodland or lightly timbered habitats and inland habitats along watercourses and mallee that are rich in passerine birds. Distribution Limit: N-Goondiwindi. S-South of Eden.	Sub-optimal foraging, roosting and nesting habitat present. Not recorded during surveys. 1 record within 10km over 4km east in 1992. Not likely to occur.	V	-
Osprey *Pandion haliaetus* OEH	Utilises waterbodies including coastal waters, inlets, lakes, estuaries and offshore islands with a dead tree for perching and feeding. Distribution Limit: N-Tweed Heads. S-South of Eden.	Suitable roosting and nesting habitat present close to foraging areas of the Georges River. Not recorded during surveys. 1 record just beyond 10km SE in 2007. Low potential to occur.	V	-

COMMON NAME *Scientific Name*	PREFERRED HABITAT	COMMENTS	TSC Act	EPBC Act
Bush Stone-curlew *Burhinus grallarius* OEH	Utilises open forests and savannah woodlands, sometimes dune scrub, savannah and mangrove fringes. Distribution Limit: N-Border Ranges National Park. S-Near Nowra.	Sub-optimal foraging, roosting and breeding habitat present, particularly with the recorded presence of European Red Fox within the subject site. Not recorded during surveys. 3 records within 10km, none within 5km or since 1996. Not likely to occur.	E	-
Australian Painted Snipe *Rostratula australis* EPBC	Most numerous within the Murray-Darling basin and inland Australia within marshes and freshwater wetlands with swampy vegetation. Distribution Limit: N-Tweed Heads. S-South of Eden.	No suitable habitat present.	V	V
Gang-gang Cockatoo *Callocephalon fimbriatum* OEH	Prefers wetter forests and woodlands from sea level to > 2000m on Divide, timbered foothills and valleys, timbered watercourses, coastal scrubs, farmlands and suburban gardens. Distribution Limit: mid north coast of NSW to western Victoria.	Sub-optimal foraging, roosting and breeding habitat present. Not recorded during surveys. 2 records within 10km, both in recent years but none within 6km. Not likely to occur.	V	-
Little Lorikeet *Glossopsitta pusilla* OEH	Inhabits forests, woodlands; large trees in open country; timbered watercourses, shelterbeds, and street trees. Distribution Limit: N-Tweed Heads. S-South of Eden.	Suitable foraging, roosting and breeding habitat present. Recorded in flight over the subject site on two separate days during surveys, in the same flight direction.	V	-
Swift Parrot *Lathamus discolour* OEH EPBC	Inhabits eucalypt forests and woodlands with winter flowering eucalypts. Distribution Limit: N-Border Ranges National Park. S-South of Eden.	Suitable foraging and roosting habitat present. Not recorded during surveys, however surveys were not undertaken during the migratory period. 10 records within 10km, closest at 2km south in 1983 and the most recent in 2006 at 10km away. Low potential to occur.	E	E

COMMON NAME *Scientific Name*	PREFERRED HABITAT	COMMENTS	TSC Act	EPBC Act
Orange-bellied Parrot *Neophema chrysogaster* EPBC	Favours small islands, peninsulas in coastal areas; with saltmarsh plants; coastal pastures, golf courses; crops of millet and sunflowers; dunes, beaches. Distribution Limit: N-Southern Sydney coast. S-South of Eden.	No suitable habitat present.	E	E
Barking Owl *Ninox connivens* OEH	Inhabits principally woodlands but also open forests and partially cleared land and utilises hollows for nesting. Distribution Limits: N-Border Ranges National Park. S-Eden.	Marginally suitable habitat present. 1 record within 10km at 3km away in 1903. Not likely to occur and not considered any further.	V	-
Powerful Owl *Ninox strenua* OEH	Forests containing mature trees for shelter or breeding & densely vegetated gullies for roosting. Distribution Limits: N-Border Ranges National Park. S-Eden.	Suitable roosting, foraging and breeding habitat present. Recorded roosting within the subject site during surveys.	V	-
Speckled Warbler *Chthonicola sagittata* OEH	Found in temperate eucalypt woodland and open forest including forest edges, wooded farmland and urban areas with mature eucalypts. Distribution Limit: N-Urbanville. S-Eden.	No suitable habitat present.	V	-
White-fronted Chat *Epithianura albifrons* OEH	Found in open damp ground, grass clumps, fencelines, heath, samphire saltmarshes, mangroves, dunes, saltbush plains. Distribution Limit: N-Tweed Heads. S-South of Eden.	Suitable roosting, foraging and breeding habitat present. Not recorded during surveys. 1 record within 10km at just beyond 9km south in 1996. Not likely to occur and not considered any further.	V	-

COMMON NAME *Scientific Name*	PREFERRED HABITAT	COMMENTS	TSC Act	EPBC Act
Black-chinned Honeyeater *Melithreptus gularis gularis* OEH	Found in woodlands containing box-ironbark associations and River Red Gums, also drier coastal woodlands of the Cumberland Plain and Hunter Richmond and Clarence. Distribution Limit: N-Cape York pen. Qld. S-Victor H. Mt Lofty Ra & Flinders Ra. SA.	Suitable roosting, foraging and breeding habitat present. Not recorded during surveys. 4 records within 10km with 3 of these within 1km. The two closest records from 2007 and 1999 are located on the immediate other side of the Georges River. Potentially utilising the subject site seasonally as foraging resources permit.	V	-
Regent Honeyeater *Xanthomyza Phrygia* OEH EPBC	Found in temperate eucalypt woodland and open forest including forest edges, wooded farmland and urban areas with mature eucalypts. Distribution Limit: N-Urbanville. S-Eden.	Suitable foraging and roosting habitat present. Not recorded during surveys, however surveys were not undertaken during the migratory period. 9 records within 10km, the closest at 1.5km west in 1977. No records since 1995. Low potential to occur.	E	E
Varied Sittella *Daphoenositta chrysoptera* OEH	Open eucalypt woodlands/forests (except heavier rainforests); mallee, inland acacia, coastal tea-tree scrubs; golfcourses, shelterbelts, orchards, parks, scrubby gardens. N-Border Ranges National Park. S-South of Eden.	Suitable foraging, roosting and breeding habitat present. Recorded as a small party of between 3 and 6 foraging within the subject site during surveys by *Travers bushfire & ecology* and Dr Richard Noske.	V	-
Scarlet Robin *Petroica boodang* OEH	Found in foothill forests, woodlands, watercourses; in autumn-winter, more open habitats: river red gum woodlands, golf courses, parks, orchards, gardens. Distribution Limit: N-Tweed Heads. S-South of Eden.	Suitable foraging, roosting and breeding habitat present. Not recorded during surveys. 2 records within 10km both in 2006 but none within 7km. Low potential to occur.	V	-

COMMON NAME *Scientific Name*	PREFERRED HABITAT	COMMENTS	TSC Act	EPBC Act
Flame Robin *Petroica phoenicea* OEH	Summer: forests, woodlands, scrubs, from sea-level to *c.* 1800 m. Autumn-winter: open woodlands, plains, paddocks, golf courses, parks, orchards. Distribution Limit: N northern NSW tablelands. S-South of Eden.	Suitable foraging, roosting and breeding habitat present. Not recorded during surveys. 3 records within 10km. The 2 closest records are both just beyond 4km away at the same location in 1991 & 92. Low potential to occur.	V	-
Pink Robin *Petroica rodinogaster* OEH	Found in dense gullies, rainforests and open forests, dispersing into drier more open habitats in winter. Distribution Limit: N-Sydney. S-South of Eden.	No suitable habitat present.	V	-
Spotted-tailed Quoll *Dasyurus maculatus* OEH EPBC	Dry and moist open forests containing rock caves, hollow logs or trees. Distribution Limit: N-Mt Warning National Park. S-South of Eden.	No suitable habitat present.	V	E
Koala *Phascolarctos cinereus* OEH	Inhabits both wet & dry eucalypt forest on high nutrient soils containing preferred feed trees. Distribution Limit: N-Tweed Heads. S-South of Eden.	No suitable habitat present.	V	-
Eastern Pygmy Possum *Cercatetus nanus* OEH	Found in a variety of habitats from rainforest through open forest to heath. Feeds on insects but also gathers pollen from banksias, eucalypts and bottlebrushes. Nests in banksias and myrtaceous shrubs. Distribution Limit: N-Tweed Heads. S-Eden.	No suitable habitat present.	V	-
Squirrel Glider *Petaurus norfolcensis* OEH	Mixed aged stands of eucalypt forest & woodlands including gum barked & high nectar producing species & hollow bearing trees. Distribution Limit: N-Tweed Heads. S-Albury.	Sub-optimal foraging, denning and breeding habitat present. Not recorded during surveys. 1 record within 10km beyond 6km away. Not likely to occur and not considered any further.	V	-
Long-nosed Potoroo *Potorous tridactylus* EPBC	Coastal heath and dry and wet sclerophyll forests with a dense understorey. Distribution Limit: N-Mt Warning National Park. S-South of Eden.	No suitable habitat present.	V	V

COMMON NAME *Scientific Name*	PREFERRED HABITAT	COMMENTS	TSC Act	EPBC Act
Brush-tailed Rock-wallaby *Petrogale penicillata* OEH EPBC	Found in rocky gorges with a vegetation of rainforest or open forests to isolated rocky outcrops in semi-arid woodland country. Distribution Limit: N-North of Tenterfield. S-Bombala.	No suitable habitat present.	E	V
Grey-headed Flying-fox *Pteropus poliocephalus* OEH EPBC	Found in a variety of habitats including rainforest, mangroves, paperbark swamp, wet and dry open forest and cultivated areas. Forms camps commonly found in gullies and in vegetation with a dense canopy. Distribution Limit: N-Tweed Heads. S-Eden.	Suitable foraging habitat present. Recorded foraging within the subject site during surveys.	V	V
Yellow-bellied Sheathtail-bat *Saccolaimus flaviventris* OEH	Rainforests, sclerophyll forests and woodlands. Distribution Limit: N-North of Walgett. S-Sydney.	Suitable foraging, roosting and breeding habitat present. Recorded foraging within the subject site to a 'possible' level of certainty during surveys.	V	-
East-coast Freetail Bat *Micronomus norfolkensis* OEH	Inhabits open forests and woodlands foraging above the canopy and along the edge of forests. Roosts in tree hollows, under bark and buildings. Distribution Limit: N-Woodenbong. S-Pambula.	Suitable foraging, roosting and breeding habitat present. Recorded foraging within the subject site during surveys.	V	-
Large-eared Pied Bat *Chalinolobus dwyeri* EPBC	Warm-temperate to subtropical dry sclerophyll forest and woodland. Roosts in caves, tunnels and tree hollows in colonies of up to 30 animals. Distribution Limit: N-Border Ranges Nation Park. S-Wollongong.	No suitable habitat present.	V	V
Eastern Falsistrelle *Falsistrellus tasmaniensis* OEH	Recorded roosting in caves, old buildings and tree hollows. Distribution Limit: N-Border Ranges National Park. S-Pambula.	Sub-optimal foraging, roosting and breeding habitat present. Not recorded during surveys. 6 records within 10km, none within 5km. Low potential to occur.	V	-
Eastern Bentwing-bat *Miniopterus orianae oceansis* OEH	Prefers areas where there are caves, old mines, old buildings, stormwater drains & well timbered areas. Distribution Limit: N-Border Ranges National Park. S-South of Eden.	Suitable foraging and roosting habitat present. Recorded foraging within the subject site during surveys.	V	-

COMMON NAME *Scientific Name*	PREFERRED HABITAT	COMMENTS	TSC Act	EPBC Act
Large-footed Myotis *Myotis macropus* OEH	Roosts in caves, mines, tunnels, buildings, tree hollows and under bridges. Forages over open water. Distribution limits: N-Border Ranges National Park. S-South of Eden.	Suitable foraging, roosting and breeding habitat present. Recorded foraging just outside of the subject site along the Georges River during surveys.	V	-
Greater Broad-nosed Bat *Scoteanax rueppellii* OEH	Inhabits areas containing moist river & creek systems especially tree lined creeks. Distribution Limit: N-Border Ranges National Park. S-Pambula.	Suitable foraging, roosting and breeding habitat present. Not recorded during surveys. 8 records within 10km, the closest at 3km SW in 1998km. Low potential to occur.	V	-
New Holland Mouse *Pseudomys novaehollandiae* EPBC	Occurs in heathlands, woodlands, openforest and paperbark swamps and on sandy, loamy or rocky soils. Coastal populations have a marked preference for sandy substrates, a heathy understorey of leguminous shrubs less than 1m high and sparse ground litter. Recolonise of regenerating burnt areas. Distribution Limit: N-Border Ranges National Park. S-South of Eden.	Sub-optimal habitat present. Not recorded during surveys. Not previously recorded within 10km. Not likely to occur and not considered any further.	-	V
Cumberland Plain Land Snail *Meridolum corneovirens* OEH	Inhabits remnant eucalypt woodland of the Cumberland Plan. Shelters under logs, debris, clumps of grass, around base of trees and burrowing into loose soil. Distribution Limit: Cumberland Plain of Sydney Basin Region.	No suitable habitat present following more detailed assessment of vegetation community presence within the site.	E	-

OEH	-	Denotes species listed within 10km of the subject site on the *Atlas of NSW Wildlife* database
EPBC	-	Denotes species listed within 10km of the subject site in the *EPBC Act* habitat search
NOTE:	-	'records' refer to those provided by the *Atlas of NSW Wildlife* database. Updated 1:100,000 database mapsheet requests to DECCW/OEH are undertaken every 3 months as recommended.

A detailed assessment in accordance with Section 5A of the *EPA Act* will be completed for these species in Section 5 of this report.

4.14 Summary of threatened species recorded during surveys

Powerful Owl (*Ninox strenua*)

The Powerful Owl breeds in open or closed sclerophyll forests and woodlands, including wet sclerophyll forest and dry sclerophyll forest and woodlands. They nest in hollows in large old trees; usually living Eucalyptus, within or below canopy in stumps or broken-off trunks. (Higgins 1999). Powerful Owls are sedentary within home ranges of about 1,000 hectares within open eucalypt, casuarina or Callitris pine forest and woodlands, though they often roost in denser vegetation, including rainforest or exotic pine plantations (Garnett & Crowley 2000). Powerful Owls feed mainly on those medium-sized species of arboreal marsupials that are most readily available at any given locality (Lavazanian et.al. 1994).

Optimal habitat includes a tall shrub layer and abundant hollows supporting high densities of arboreal mammals. Roosting is generally within dense foliage of mid-canopy trees in sheltered gullies. Large trees with hollows at least 45cm in diameter and 100cm deep are required for nesting. Mated pairs of Powerful Owl roost together or separately, maintaining several roost sites throughout their territory, which are used in rotation (Lindsey 1992), shifting with the availability of prey. A pair is generally faithful to a traditional nesting hollow. Powerful Owls form pairs for life, and are strongly territorial. Estimates of the home range of this species vary greatly, but territories are thought to range from 800 to 1500 hectares (Kavanagh 1997).

It is considered that the subject site provides suitable foraging, roosting and breeding habitat for the Powerful Owl. In the absence of recording this species, the subject site would have been considered sub-optimal given the large home range area requirements and the fragmented and isolated remnant of approximately 14-15 ha of open forest present.

This species was first recorded present by finding a feather on the 28th February 2011. Following this, searches for other signs of activity was undertaken whereby an individual was observed roosting clutching a Grey-headed Flying-fox within the small gully in the southern portions of the site (see Figure 3).

Owl expert John Young of *John Young Wildlife* (Cairns, QLD) was engaged to determine the site's value for Powerful Owl. Mr Young's visit during mid-April coincided with the onset of the breeding season. Mr Young's fundamental objective was to determine if the site was utilised by both individuals of a pair at this time of year, indicating nearby nest preparation. Mr Young found this to be the case with a pair observed showing nesting behaviour in the southern portions of the open forest area.

The recording and activity by a pair coming into the breeding season highlights the resilient nature of this species to cling onto the fringes and inner areas of Sydney's urban landscape. Having said this, the Powerful Owl is known to be particularly susceptible to nest disturbance during breeding season and the subject site provides an isolated and quiet haven for breeding activity which is not otherwise well represented within the local area.

Mr Young has prepared a supplementary report of his findings provided in Attachment 1. In summary, Mr Young has advised that most open forest areas are to be retained with a 50 m buffer to this in the southern portions given that roosting was observed along the fringes here. Furthermore, an area has been identified by Mr Young as the core area of roosting and breeding activity which has higher protection status awarded to it. This area is to be free from any recreational activity such as the proposed walk/cycleway. Weed management works are to be restricted to the non-breeding season. All recommendations to prevent significant impacts on Powerful Owl are provided in Attachment 1 and also Section 6.2 of this report.

Varied Sittella (*Daphoenositta chrysoptera*)

Varied Sittellas inhabit open eucalypt woodlands/ forests (except heavier rainforests), mallee, inland acacia, coastal tea-tree scrubs, golf courses, shelterbelts, orchards, parks, scrubby gardens (Pizzey & Knight 1999).

Varied Stella's feed mainly by gleaning arthropods from crevices on tree trunks or small branches and twigs in the tree canopy, moving downwards or along branches, searching for insects. They prefer rough or decorticating bark barked trees like stringybarks and ironbarks, standing dead trees, or mature trees with hollows or dead branches. It builds a cup-shaped nest of plant fibres and cobweb in an upright tree fork high in the living tree canopy, and often re-uses the same fork or tree in successive years.

The apparent decline of this species has been attributed to declining habitat cover and quality (*e.g.* Watson *et al.* 2003). The sedentary nature of the Varied Sittella makes cleared agricultural land a potential barrier to movement. Survival and population viability are sensitive to habitat isolation, reduced patch size and habitat simplification, including reductions in tree species diversity, tree canopy cover, shrub cover, ground cover, logs, fallen branches and litter (Watson *et al.* 2001; Seddon *et al.* 2003).

The Varied Sittella is also adversely affected by the dominance of Noisy Miners in woodland patches (Olsen *et al.* 2005). Current threats include habitat degradation through small-scale clearing for fence lines and road verges, rural tree decline, loss of paddock trees and connectivity, 'tidying up' on farms, and firewood collection.

One paper, Noske (1998), reports that Varied Sittellas hold weakly defended territories of 13-20ha in north-eastern NSW. Whilst the far north-eastern NSW is a separate race showing differences in plumage they are not reported as being different in size. Differences in habitat preference for the local nominate race have not been reported. Dr Noske also advises (Attachment 2) that the territory size of family groups is highly variable subject to the size of the family group and the quality of the habitat.

Maron (2007) reports that small-bodied insectivorous birds which are experiencing population decline in southern Australia were recorded on average six times more often in transects without noisy miners (low-eucalypt density transects).

Also of relevance to this site, Maron (2007) further advises that revegetation and restoration practices should take into account subtle floristic differences to result in substantial variation in conservation outcomes.

It is considered that the subject site provides suitable foraging, roosting and nesting habitat for the Varied Sittella. This species was observed on the 2nd March 2011 foraging within the open forest areas in the far southern portions of the subject site. A possible six (6) individuals were observed foraging together at this time in an eastward direction.

Owl expert John Young has identified a boundary of conservation area for Powerful Owl which also considers suitable amounts of habitat retention for Varied Sittella. The conserved area contains the majority of the better quality connective open forest area which totals approximately 10.7ha. This is less than the territory found by Noske (1998) to be weakly defended by Sittellas.

Target survey - Travers bushfire & ecology

Additional target survey was undertaken over three days on the 22nd, 23rd and 27th June 2011, to assess suitability of available habitat in the nearby locality and determine species

utilisation of habitat outside of the subject site (Figure 4). The species was not recorded outside of the subject site on the first two days of survey. The species was however observed again within the subject site on the second day of survey. Subsequently, the third day of survey was devoted exclusively to the most suitable habitat areas within the subject site to observe and record its movement patterns.

A party of four (4) Varied Sittellas were recorded at 11:45am in the central eastern portion of higher quality habitat within the site. These birds were followed for five minutes as they headed in a north-easterly direction and then a more easterly direction towards the Georges River. Dense Lantana prevented the birds to be followed at this time. As the species moved in the direction of the Gorges River, this area and areas immediately to the north and south, were continually searched for the following hour with no observations.

The same party of four birds were recorded at 3:00pm near the western edge of the high quality open forest remnant. At this time the birds foraged on Broad Leaved Ironbark before taking flight for approximately 280m towards an isolated remnant in the western portions of the subject site (see Figure 4). The family party foraged within this remnant before flying further west just into neighbouring STP lands owned by Sydney Water. The party foraged within Rough-barked Apple for several minutes at this location.

Call-playback of pre-recorded calls (BOCA 2007) out of a mobile phone was played in open grassland to the west of this tree to encourage movement further west. When the birds commenced flight towards the call, the call was paused and the birds continued flight to a linear fragment further west. At this location the birds were observed to be harassed by New Holland Honeyeater and soon moved north then back to the original tree. It appeared that the party may be at the extent of their current foraging range.

The western remnants within and immediately adjoining the western boundary of the site did not contain Bell Miners or Noisy Miners at this time. Both of these highly territorial species have been recorded in the large area of fragmented landscape onsite between the eastern and western foraging areas.

Peer review & advice - Dr Richard Noske

Dr Noske was engaged by *Travers bushfire & ecology* to review the OEH opinion in regard to suitable habitat and on site behaviour. Dr Noske's peer review and advice on Varied Sittella is provided in Attachment 2. Dr Noske concluded (p6) the following:

> *"Based on my observations of the foraging behaviour of the Varied Sittellas onsite, and review of the habitat assessment and information provided by Travers Bushfire & Ecology in their Ecological Constraints report (2011), I see no reason why the proposed conservation area could not support the existing population.*
>
> *Based on the behaviour and locations of the presumed breeders, I expect that the most suitable nesting sites for the sittellas lie within the proposed conservation zone, which therefore most likely represents the core area of the main group.*
>
> *Thus it is my professional opinion that in conjunction with appropriate restoration of currently disturbed areas, the proposed conservation area is able to meet the needs of the Varied Sittella population onsite."*

A revised version of the Varied Sittella Habitat Assessment (Figure 4 - 12th August 2011) has been prepared in consultation with Dr Noske.

Habitat Assessment

The habitat assessment in Figure 4 indicates five levels of habitat suitability in the locality based on vegetation type, shape and condition. Categories 1 and 2 were considered to be poor quality habitat and are not likely to be used by Varied Sittella. Categories 3 & 4 contained suboptimal habitat but provided opportunistic foraging opportunities. Large areas of Category 3 & 4 were occupied by miner bird species which defend their territories against other foraging birds. Category 5 is considered to be high quality habitat for Varied Sittella providing suitable foraging value and miner bird species were absent.

Based on the survey it may be concluded that habitat within the open and fragmented landscape of the subject site is being loosely utilised by Varied Sittella. The penetration of Varied Sittella into the open space and fragmented landscapes is limited by the presence of miner birds in much of this landscape. Based on the observed activity levels within the higher quality habitat areas, the western and central vegetation fragments onsite are not expected to be the core area of activity.

The highest quality areas of Varied Sittella habitat is identified as the large open forest remnant on the foreshore of the Georges River within the subject site (Figure 4). Furthermore, a diversity of rough-baked foraging opportunities and the absence of miner bird species were observed within this remnant.

Recorded flight distances (of up to 280m) and utilisation of adjacent remnants by Varied Sittella indicate that the species may easily cross the Georges River to forage within similar habitat that is in fact closer to the high quality habitat on the foreshore.

As noted by Dr Noske (Attachment 2), the current understanding of the spatial (territory) requirements of sittellas is meagre due to the lack of targeted studies. Group territory size has been estimated in only two studies (Marchant 1984, Noske 1998). In both cases, estimates varied from 13 (or 15) to 20 ha.

The proposed conservation area is 16.95 ha including 7 ha of restoration. Based on target survey the Varied Sittella is actively utilising a high quality habitat area of 9.5 ha which is likely to be the core activity and nesting area (Figure 4). The majority of high quality habitat areas (90.3 % conserved – 0.86 ha loss) is being retained within the conserved lands.

There is an additional 12.8 ha of suitable extended foraging habitat available for opportunistic use by Varied Sittella outside of the subject site within STP lands and along the Georges River. These areas are determined only as ‘opportunistic’ due to the presence of Noisy Miners and Bell Miners. Because of the constantly changing interactions between miner species and Varied Sittella it is difficult to quantify the exact area of available habitat. The total available habitat of varying quality for Varied Sittella within the proposed conservation area and adjoining the subject site is estimated to be 23.25 ha prior to restoration and 29.5 ha past restoration.

Observation of Varied Sittella by *Travers bushfire & ecology* and Dr Noske suggests that the family grouping is likely to utilise adjacent habitats to the subject site. The survey and habitat mapping also provide evidence that competitive pressures from other species such as Bell Miner and Noisy Miner further restrict the available habitat that is currently available to Varied Sittella. Dr Noske reports that pressures may be less for the Bell Miner which in fact may counter the impact of Noisy Miners on the sittellas. This is more likely the case in areas outside of the Bell Miner core activity areas where Dr. Noske found further yet unconsolidated dispersal by the species had occurred in August 2011.

Removal of habitat within the subject site will cause a shift in the habitat usage patterns of all birds utilising proposed development areas. Varied Sittella is however likely to retain a

secure hold on its high quality habitat area because it contains favourable vegetation. Noisy Miners may spread out into other fragmented remnants of land surrounding the site, whilst the Bell Miners will remain in a united colony dominating the tall gully forest within the conserved lands.

To compensate for the loss of quality habitat for Varied Sittella and competitive pressures between bird species, the restoration works within the conservation area should provide habitat for Varied Sittella which will discourage establishment by miners. Restoration of habitat in the south western portion of the conserved lands will also provide habitat connectivity to the adjoining STP lands. This is an important mitigating strategy to address the key threatening process that Bell Miners may represent for Varied Sittella.

Travers bushfire & ecology considers that sufficient habitat is present within the conserved portion of the foreshore to continue to adequately support the life-cycle requirements of the local Varied Sittella population. This is supported by Dr Noske's findings (see Attachment 2).

Little Lorikeet (*Glossopsitta pusilla*)

Little Lorikeets mostly occur in dry, open eucalypt forests and woodlands. Little Lorikeets are gregarious, usually foraging in small flocks, often with other species of lorikeet. They feed primarily on nectar and pollen in the tree canopy, particularly on profusely-flowering eucalypts, but also on a variety of other species including Melaleucas and mistletoes.

There is no evidence of regular migration, but Little Lorikeets are generally considered to be nomadic (Higgins 1999), with irregular large or small influxes of individuals occurring at any time of year, apparently related to food availability. Long term investigations indicate that breeding birds are resident from April to December, and even during their non-resident period, they may return to the nest area for short periods if there is some tree-flowering in the vicinity (Courtney & Debus 2006).

Approximately 3 cm diameter nest hollows are located mostly in living, smooth-barked eucalypts, and are kept open by the activities of the occupants, which use their beaks to bite away living bark from around the opening. When nest hollows are deserted, e.g. after storm-damage to trees, hollows can close over within 14 months (Courtney & Debus 2006). Nest hollows are occasionally located in dead trees, but birds generally desert hollows within two years of tree death. Nest-hollows are used 'traditionally', with the same hollow (not necessarily by the same individuals) (Courtney & Debus 2006). The breeding season extends from May to September (Higgins 1999) and, if eucalypt nectar and pollen are available throughout this period, two broods of fledglings can be raised in a season.

The major threats to Little Lorikeets are loss of breeding sites and food resources from ongoing land clearing. New nest hollows are not being recruited at a rate that compensates this loss.

It is considered that the subject site provides suitable foraging, roosting and nesting habitat for the Little Lorikeet. This species was observed as small flocks in flight directly over the subject site on separate occasions during survey. This species was heard to appear stationary and foraging within trees but this was not confirmed. It is expected that the subject site would be utilised on occasion for foraging at the very least.

Owl expert John Young has identified a boundary of conservation area for Powerful Owl which also retains the higher occurrence of Lemon-scented Gum and Spotted Gum within the north eastern portions of the subject site. These two tree species, along with other eucalyptus trees dispersed within remaining open forest areas, provide the more likely trees

selected for nesting given the preference for smooth-bark burls for roost and nest construction.

It can therefore be said that the proposed conservation area boundary identified by John Young may also provide sufficient habitat retention for Little Lorikeet within the subject site, such that this species will not likely be significantly impacted upon.

Grey-headed Flying-fox (*Pteropus poliocephalus*)

Grey-Headed Flying-foxes (GHFF) are canopy feeding frugivores and nectarivores, inhabiting a wide range of habitats including rainforest, mangroves, paperbark forests, wet and dry sclerophyll forests and cultivated areas. This species roosts in camps, which may contain tens of thousands of individuals.

Camps are commonly formed in gullies, typically not far from water and usually in vegetation with a dense canopy (Tidemann 1998). Camps can be found in riparian rainforest patches, Melaleuca stands, mangroves, riparian woodland or modified vegetation in urban areas. Loyalty to a site is high and some camps in NSW have been used for over a century (NSW NPWS 2001). Some camps are used at the same time every year by hundreds of thousands of flying-foxes while others are used sporadically by a few hundred individuals (Strahan 1995). Generally foraging is within 20km of camps but individuals are known to commute up to 50km to a productive food source.

The main threats to the GHFF in NSW are habitat modification and clearing. In NSW less than 15% of potentially suitable habitat for the GHFF occurs in conservation reserves; only 5% of roost sites are similarly reserved (Nature Conservation Council, 2007). It has been estimated that the national population may have declined by up to 30% with an estimated decrease of at least 20% over the next three generations (NSW Scientific Committee 2004).

It is considered that the subject site provides suitable foraging habitat for the Grey-headed Flying-fox. This species was either seen or heard foraging within trees located within the subject site during nocturnal surveys undertaken on the 28th February and 2nd March 2011.

Powerful Owl was also observed on separate occasions during survey clutching a Grey-headed Flying-fox prey item during diurnal roosting. There is no likelihood of Grey-headed Flying-fox utilising the site for roosting and subsequent breeding habitat. Rezoning will cause some loss of foraging habitat predominantly clumps and individual trees within the higher disturbance areas. However, the majority of foraging habitat available within the site will be retained within the connective forested portions. As foraging habitat will continue to be well represented and the site does not provided any roosting or subsequent breeding habitat, this species will not cause any constraint to the existing subdivision layout.

East-coast Freetail-bat (*Micronomus norfolkensis*)

The East-coast Freetail Bat forages above the canopy of open forests and woodlands and in clearings at forest edges, feeding on small insects (Allison, Hoye & Law 2008). This species is thought to roost predominantly in tree hollows but also under loose bark and occasionally in houses and outbuildings (Allison, Hoye & Law 2008). Until recent findings of a roost within mangroves, all known natural roosts had occurred within hollow spouts of large mature eucalypts. The species is often found close to dams and waterholes. The East-coast Freetail Bat species will utilize paddock trees and isolated remnant vegetation when in proximity to larger forest remnants (Allison, Hoye & Law 2008).

PhD student Anna McConvill from the University of Newcastle recently has undertaken a more formal and detailed analysis to investigate landscape habitat use by this species. She found that cleared and semi-cleared landscapes were found to have higher activity levels

than urban or forested landscapes. Riparian sites were also found to have high activity levels.

It is considered that the subject site provides suitable foraging, roosting and breeding habitat for the East-coast Freetail Bat. This is a highly mobile species and local habitat would not be exclusive to the subject site. Hoy et. al (2008) suggest that despite a female recorded 6km from its roost, this species generally forages within a few kilometres of roosts.

The proposed open forest retention area will provide a high amount of potential roosting, breeding and foraging habitat for the East-coast Freetail Bat. It should however be outlined that this species often shows a preference for the more cleared open areas and will utilise isolated paddock trees for roosting. This increases the value of the south-western portions (where the species was recorded) for retention but more so the potential that roosting and breeding may occur within the proposed development landscape.

The subject site provides much of the open paddock type habitat in the locality and this combines well with nearby open water foraging opportunities along the Georges River and particularly within the neighbouring sewerage treatment works and lands to the west. Therefore semi-cleared landscapes should continue to be represented within the subject site in other areas, for example as asset protection buffers along the complete open forest fringe. Suitable hollows removed should be supplemented with bat boxes within the retention areas and hollow-bearing tree removal within future development areas should be supervised by a fauna ecologist with suitable experience micro-chiropteran bat handling and recovery.

Microbats are sometimes inaccurately assessed as the exact location of roosting (and subsequent breeding) habitat is difficult to locate without exhaustive and costly surveys. Subsequently, it is preferable to ensure that habitat otherwise continues to be well represented in the nearby locality. The subject site has the constraint of providing unique habitat values in the locality and in respect to the East-coast Freetail Bat this habitat is not necessarily the same as the other more forest/woodland dependent threatened species recorded. The narrowing of semi-cleared areas is often acceptable for this and other microbat species by determining authorities.

Large-footed Myotis (*Myotis adversus*)

The Large-footed Myotis inhabits rainforests and open forests containing creeks and lakes over which it feeds and roosts in tree hollows, caves, mines, under bridges, in tunnels and occasionally buildings (Richards 1995). The Large-footed Myotis predominantly forages along creeklines and over water bodies where it takes insects and small fish from on and just below the water surface (Richards 1995). This species thus has a strong association with streams and permanent waterways, most frequently at low elevations and in flat or undulating country and usually in areas that are vegetated rather than cleared. They will live in most habitat types as long as it is near water (Churchill 2008).

It is considered that the subject site provides suitable foraging and breeding habitat for the Large-footed Myotis. This species was recorded foraging over the George River below the Governor Macquarie Drive bridge during overnight Anabat recording on the 28th February 2011. Nearby recorded calls from a recorded within the subject site were similar but could not effectively be distinguished from the Long-eared Bat species.

As the Large-footed Myotis forages over open water areas, the subject site provides only limited foraging opportunity over the small dam present in the northern portions. The site is however located central to three somewhat different potential foraging areas being the Georges River, the neighbouring sewerage treatment works and also the large neighbouring dam to the west. The subject site may have higher potential for roosting use given that it is

central to these areas and that the vegetated open forest portions present are more extensive than other areas in the locality.

The Large-footed Myotis is known to inhabit a diverse range of roosting locations which include man-made structures near water such as culverts, bridges and buildings. The species is therefore somewhat resilient and receptive to habitat modification provided foraging potential remains. Therefore the extent of riparian vegetation along the Georges River proposed for retention would be considered more than sufficient to contain hollow tree resources for this species.

Eastern Bentwing-bat (*Miniopterus orianae oceanensis*)

The Eastern Bentwing-bat forages above and below the canopy within open forests and woodlands, feeding on small flying insects, predominantly moths (Dwyer 1995). The Eastern Bentwing-bat is known to roost in a range of habitats including stormwater channels, under bridges, occasionally in buildings, old mines and, in particular, caves (Dwyer 1995). Caves are an important resource for this species, particularly for breeding where maternity caves must have suitable temperature, humidity and physical dimensions to permit breeding (Dwyer 1995). Roost sites in tree hollows have not been reported within the literature reviewed.

This species has not been identified as utilising culverts for maternity roosts. Maternity roosts rather are occupied by up to 100 000 females with only 12 maternity roosts known throughout the complete range (Hoy & Hall 2008).

It is considered that the subject site provides suitable foraging habitat throughout for this highly mobile species and provides low potential roosting habitat for the Eastern Bentwing-bat. Roosting habitat is limited to the abandoned buildings present. The subject site does not provide any breeding habitat for this species.

This species was recorded to a 'probable' level of certainty foraging along the entry road to the Coopers Paddock during survey on the 28th February 2011. This species is unlikely to provide a constraint to the subdivision proposal as breeding habitat is not present and foraging and roosting habitat would continue to be well represented within the locality.

Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*)

The Yellow-bellied Sheathtail-bat inhabits a wide variety of Eucalypt forests, foraging above the canopy in high flying, high speed movements (Richards 2008). In mallee or open country it comes closer to the ground. Usually found in mixed sex groups of two to six and occasionally up to 30, the Yellow-bellied Sheathtail-bat roosts in large tree hollows and has been found in the abandoned nests of Sugar Gliders (Churchill 2008).

A colony of six have been found roosting inside the trunk of a large hollow tree clinging to the walls, hanging head down and propped up by their forearms; They were well separated but tended to cluster around the entrance hole (Churchill 2008). Large maternity colonies may exceed 100 individuals. Occasionally it has been found resting on the walls of buildings in broad daylight, possibly due to exhaustion from migratory habits or disease.

This bat is only recorded in southern Australia between January and April when they migrate during the summer.

It is considered that the subject site provides suitable foraging, roosting and breeding habitat for the highly mobile Yellow-bellied Sheathtail-bat. This species was recorded only to a 'possible' level of certainty foraging along the entry road to the Coopers Paddock during survey on the 28th February 2011. The recorded call was a single sequence (fly-by) and

although it was within the distinctive call range of the Yellow-bellied Sheathtail-bat, it showed call shape similar to a high harmonic call of the White-striped Mastiff Bat, which was also recorded during survey.

This is a very highly mobile migratory species and habitat in the locality and region would not be exclusive to the subject site. The proposed retention open forest area is considered to provide the higher numbers and better quality large hollows suitable for this species. The retention of this area also maintains a continuation of riparian connective habitat for direct flight foraging which is the widest riverside remnant in the nearby locality. This species is not considered likely to provide constraint to the proposed rezoning.

4.15 Summary of threatened species previously recorded

Green and Golden Bell Frog (*Litoria aurea*)

The Green and Golden Bell Frog is largely aquatic and is found among vegetation, utilising abundant growth of bulrushes within or at the edges of permanent water (Cogger 1999). The males call mainly after rain from spring to autumn while afloat among vegetation, usually in larger permanent dams, swamps and lagoons. Breeding often peaks after heavy rains in January to February. It will occasionally inhabit ornamental ponds and farm dams, where these occur close to the preferred habitat (Robinson 1998). It is active by day and night.

It is considered that the subject site provides suitable foraging, shelter and possible breeding habitat for the Green and Golden Bell Frog. This species has been previously recorded along the drainage line in the southern open forest areas of the subject site in 1964 (Atlas database – DECCW/OEH 2011).

The more appropriate areas of habitat within the subject site are located within the central confines of the south-western training ring where previous sandmining has created a depression where moist surface conditions and sedges occur. The large dam located within neighbouring lands to the west provides ideal habitat for the Green and Golden Bell Frog also increasing the site's habitat potential.

There are over forty (40) records of this species within 10km however there are no records since 1999 highlighting the species' decline from a common species to an endangered status in recent decades.

Given the previous recording of Green and Golden Bell Frog within the subject site and the presence of suitable habitat both within the site and particularly nearby, additional target survey is recommended during the peak breeding period of September to mid-January when males are calling. This survey should be undertaken over two separate nights during suitable conditions which include high humidity immediately following or during a high rainfall period.

Black-chinned Honeyeater (*Melithreptus gularis spp. gularis*)

The Black-chinned Honeyeater inhabits forest and woodlands over much of eastern Australia. This species shows a special preference for areas having rough-barked eucalypts such as ironbark and ash (Longmore 1991). In drier areas it is found within timber along watercourses, often with little understorey. In New South Wales this species is mainly found in woodlands containing box-ironbark associations and River Red Gum (NSW Scientific Committee 2001).

It is considered that the subject site provides suitable foraging, roosting and breeding habitat for the Black-chinned Honeyeater. The Black-chinned Honeyeater was not recorded during surveys of the subject site which included effort undertaken by John Young (see Attachment

1). There are however three previous nearby recordings of this species on the Atlas of NSW Wildlife database (2011). These three records are the only records of the species within 10km and all three are located within 1km of the subject site. Two records, one from 1999 and the second from 2007, were recorded within the narrow remaining vegetation on the other side of the Georges River opposite the subject site. Subsequently, visitation to the subject site on these occasions and other times is expected.

The proposed retention area of open forest is considered suitable to maintain seasonal foraging opportunities for this species as well as nesting habitat. The area identified for retention contains all eucalypt tree species recorded present and would allow for diverse seasonal blossom not just limited to winter. This species is therefore not considered likely to provide a constraint to the proposed rezoning.

4.16 Vegetation connectivity and wildlife corridors

A corridor is used to ensure wildlife can move between vegetation parcels that contain habitat characteristics suitable for each taxa and foraging opportunities for those taxa. In other words they need protection and food. For some wildlife the dispersal (home) range is quite small whilst others migrate over larger areas.

Vegetation connectivity to the subject site from other local remnants are limited to the narrow strips of riparian vegetation along the fringes of the Georges River that continues to the north and south-west – see Figure 5 below and also Figures 2 & 3.

Figure 5 – Remnant Vegetation

These narrow linear strips do eventually connect to other larger remnant patches however it may be said that the subject site provides the largest patch of remnant trees within 2km.

This gives obvious value to the subject site as a haven for fauna utilising the riverine corridors. In respect to native fauna species, the riverine corridors would assist movement mainly for waterbirds, forest birds of various sizes, raptors, owls, micro-chiropteran bats, and some small reptiles.

4.17 Potential ecological impacts and potential for better outcomes

The impact on all recorded threatened species and EEC's has been assessed in this report.

Flora

The proposed rezoning affects the EEC vegetation – River-flat Eucalypt Forest on Coastal Floodplains. All remnant vegetation that is mapped as Riparian Open Forest or Riparian Woodland is considered to be EEC vegetation - River-flat Eucalypt Forest on Coastal Floodplains.

The proposed rezoning will remove 3.226 ha of the EEC – *River-flat Eucalypt Forest on Coastal Floodplains*. The level of offsetting afforded by the proposed rezoning is considered from the perspective of the EEC – *River-flat Eucalypt Forest on Coastal Floodplains*. We note that the critically endangered ecological community - Cumberland Plain Woodland, is not present in Coopers Paddock. The recommended adjustment to the zoning boundary, as proposed for protection of the Powerful Owl, increases the vegetation offset ratio (area restored/conserved to area removed) from 2.84:1 with the current proposed boundary to 5.2:1 with the new boundary. The total conservation area has been increased to 16.95 ha.

The vegetation is considered poor with respect to the level of weeds within the mid-storey in particular which also suppresses the ground-layer of vegetation. Despite this, the majority of vegetation cannot be considered as low condition under a biometric assessment because either the over-storey is relatively intact, or the understorey does not contain greater than 50% exotic species (foliage cover). For vegetation to be classed as low condition, the over-storey projected foliage cover must be below 25% of the benchmark and the exotic vegetation is to comprise greater than 50% (or 90% is cleared or fallowed).

Portions of the remnant vegetation are expected to provide potential habitat for the threatened species *Acacia pubescens* (northern portion of site), *Persoonia nutans, Pultenaea parviflora* and *Hibbertia* sp. Bankstown.

Fauna

The proposed rezoning will remove suitable habitat for all threatened fauna species recorded during surveys. Whilst the proposed development areas of the subdivision proposal are centred mainly on the areas of higher clearance and disturbance, these areas still contain isolated individual and patches of remnant trees that provide the following habitat features:

- Foraging structure for microbats, particularly the East-coast Freetail Bat.
- Hollows suitable for hollow dependent microbats and Little Lorikeet.
- Foraging blossom for Little Lorikeet and Black-chinned Honeyeater.
- Dead limbs and rough-bark trees suitable for foraging and nesting by Varied Sittella.
- Powerful Owl prey species foraging and denning habitat, namely the Common Ringtail Possum and Grey-headed Flying-fox, and subsequent Powerful Owl foraging areas.

The subject site has also shown habitat value for other non-threatened fauna species which are generally rare or locally significant including Painted Button-quail, Grey Goshawk and Satin Flycatcher, White-bellied Cuckoo-shrike and Crested Shrike-tit.

Much of the proposed habitat retention area does provide suitable habitat for all above mentioned species, however habitat supplementation initiatives could be undertaken to enrich the suitability of fauna habitat within the retention areas. Such initiatives should include:

- Nest box installation for microbats as well as Powerful Owl prey species.
- Maintain open foraging lines for microbats along paths within the retained open forest area and along the outer fringes as a buffer to development areas.
- Regeneration and revegetation of locally endemic species that encourage foraging by Grey-headed Flying-fox as well as other Powerful Owl prey species.
- Retaining dead trees and limbs for foraging and nesting by Varied Sittella and walk/cycleways should be located to avoid any removal of deadwood and dead trees. Deadwood removed from the development landscape should be relocated to conserved areas. These should ideally be placed in existing trees as Sittellas typically do not forage off the ground. Revegetated areas should not have a high dominance of eucalypt plantings to avoid colonisation by Noisy Miners.

Of the potentially impacted threatened fauna species only Powerful Owl and Varied Sittella required more detailed consideration.

Powerful Owl

As a result of target fauna surveys and specialist advice, the area and level of protection has been increased in the southern portion of the site. This affords conservation of the identified Powerful Owl roosting and nesting area as well as increasing the amount of existing habitat on site for the recorded threatened species.

On the basis of specialist advice a 70 m ecological buffer which includes regrowth native vegetation, has been retained and restoration works are proposed to enhance the quality of the vegetation in the proposed foreshore conservation area.

Varied Sittella

The survey and habitat mapping provide evidence that competitive pressures from other species such as Bell Miner and more so the Noisy Miner restrict the available habitat that is currently available to Varied Sittella. Despite this, Varied Sittella has the ability and has been observed to utilise surrounding habitat on an opportunistic basis subject to variations and changes in the foraging behaviour of Miner species.

The proposed conservation area is 16.95 ha including 6.25 ha of restoration. Based on target survey the Varied Sittella is actively utilising a high quality habitat area of 8.87ha which is likely to be the core activity and nesting area (Figure 4). The majority of high quality habitat areas (8.01 ha or 90.3 % conserved – 0.86 ha loss) is being retained within the conserved lands. There is an additional 12.8 ha of suitable extended foraging habitat available for use by Varied Sittella outside of the subject site to use on an opportunistic basis. The total available habitat of varying quality for Varied Sittella within the proposed conservation area and adjoining the subject site is estimated to be 23.25 ha prior to restoration and 29.5 ha post restoration.

To compensate for the loss of higher quality habitat for Varied Sittella and competitive pressures between bird species, the restoration works within the conservation area should provide habitat for Varied Sittella which will discourage establishment by miners, in particular Noisy Miners. Restoration of habitat in the south western portion of the conserved lands will also provide habitat connectivity to the adjoining STP lands. This is an important mitigating strategy to address the key threatening process that Bell Miners represent for Varied Sittella.

Given that 90.3 % of the high quality habitat area for Varied Sittella is being conserved and a total of 23.25 ha of suitable habitat is available post development, *Travers bushfire & ecology* concludes that sufficient habitat is present within the conserved portion of the foreshore to continue to support the Varied Sittella population insitu.

4.18 Greater Metropolitan Regional Environmental Plan No 2-Georges River Catchment

Travers bushfire & ecology makes the following comments with respect to the conditions of compliance of REP No 2:-

(a) 100 m buffer from the top of bank of Georges River

The rezoning plan exceeds this condition on all aspects (Figure 6) except in the north eastern portion which provides an 80m buffer. An addition 10 m managed setback in the form of an APZ is required for industrial development providing a total setback of 90 m from the Georges River top of bank. The proposed zone boundary compensates in the southern portions by providing a buffer to Georges River of up to 180m.

Additional measures are proposed below to mitigate for the reduced vegetated buffer in the north eastern portion of the site.

(b) 40m minimum buffer width from the edge of the gorge or top of banks of the Georges River and its tributaries

The rezoning plan fully complies with this condition.

(c) 40 m minimum buffer from wetlands

As no wetlands existing within the subject site this condition is not applicable. A 40 m buffer has been provided to the area mapped as potential Green & Golden Bell Frog habitat (Figure 6).

(d) 40 m minimum buffer from other environmentally sensitive areas, including remnant vegetation & Steep slopes

The imposition of this condition in its strictest sense places an unreasonable burden on the site which is not consistent with approved developments within the LGA. Practical solutions need to be provided that allows integration of both development and conservation as part of the rezoning plan. The proposed conservation area currently contains sufficient buffer capacity for key threatened species and associated habitat (Figure 6).

The key buffer issues to address when a development abuts remnant vegetation are to minimise the edge effects such as the risk of weed invasion, drainage, trampling, waste disposal and light penetration into the forest remnant.

Vegetation management as per an approved VMP will target existing weeds mostly lantana and to control invasive vines along the foreshore & riverbank. It is important that drainage and weeds are controlled along the forest edge and overland and piped runoff is intercepted so that it does not create conditions that will promote additional weed growth into the EEC.

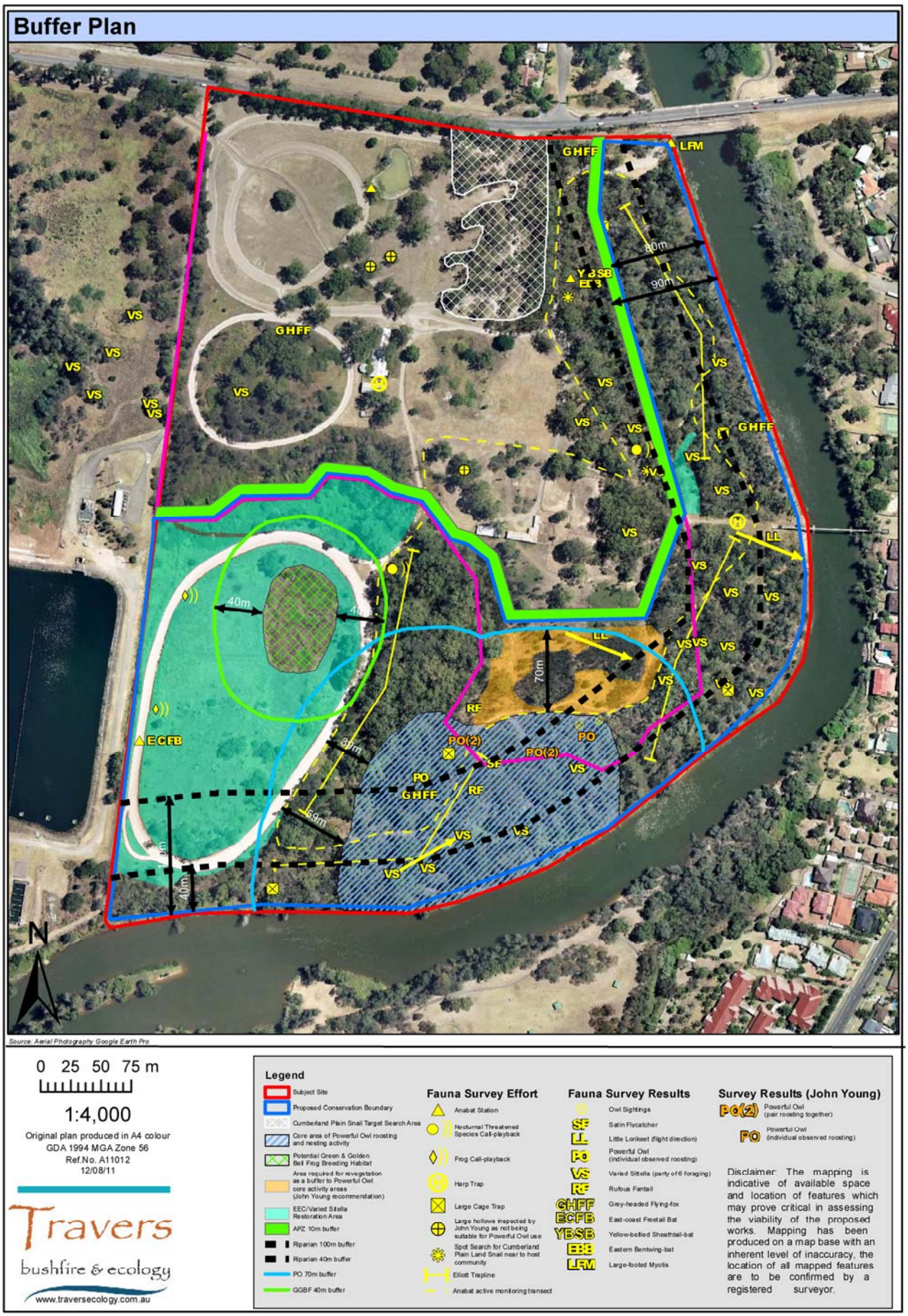

Figure 6 – Buffer Plan

The following measures are proposed to mitigate against edge effects surrounding the proposed development.

1. The forest remnant is to be delineated and protected by a pathway or similar structure that forms a barrier to invasive grasses and weeds.

2. Native vegetation on the remnant side of the pathway is to be regenerated and planted densely to outcompete invasive weed species. In this case the outer 20 m of the EEC buffer is to be densely planted or regenerated with acacias and other similar subcanopy species to suppress weed regrowth.

3. Surface drainage is to be collected and directed away from the remnant edge so as to minimise the potential for weed invasion.

4. The 10 m asset protection zone setback is to be landscaped with native canopy and understorey vegetation that complies with the minimum requires for fuel management within asset protection zones. The use of non-native turf is to be avoided within the asset protection zone.

4.19 Proposed foreshore conservation area

Travers bushfire & ecology considers the proposed rezoning boundary (Figure 1), in combination with the proposed restoration measures (Figure 7) provides adequate habitat for all the recorded threatened species. Implementation of the mitigation measures to reduce edge effects on the reserve and restoration of native vegetation as part of an overall vegetation management plan is likely to result in a positive outcome for the recorded threatened species.

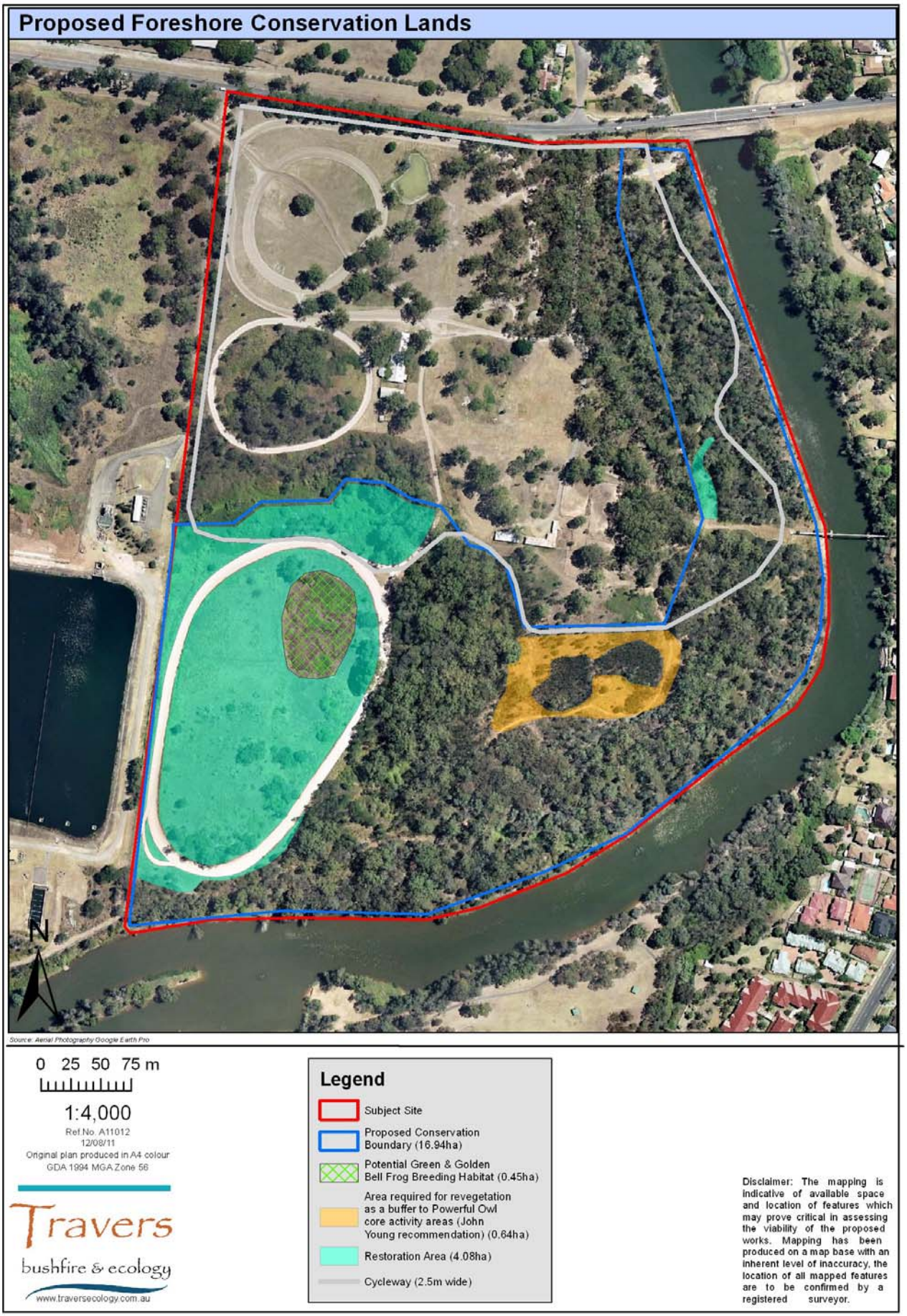

Figure 7 – Proposed Foreshore Conservation Area

5 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusions

The document forms the basis of assessment required under Section 5A of the *EPA Act*.

This assessment determines if future development of the site is likely to have a significant effect on threatened species, populations and / or EECs.

EPA Act and TSC Act

In respect of matters required to be considered under the *EPA Act* and relating to the species / provisions of the *TSC Act.*

- Eight (8) threatened fauna species were recorded within or in close proximity to the subject site. Threatened fauna species recorded included Powerful Owl (*Ninox strenua*), Varied Sittella (*Daphoenositta chrysoptera*), Little Lorikeet (*Glossopsitta pusilla*), Grey-headed Flying-fox (*Pteropus poliocephalus*), Large-footed Myotis (*Myotis macropus*), Eastern Bentwing-bat (*Miniopterus orianae oceansis*), East-coast Freetail Bat (*Micronomus norfolkensis*) and Yellow-bellied Sheathtail Bat (*Saccolaimus flaviventris*). The Yellow-bellied Sheathtail-bat was recorded only to a 'possible' level of certainty. One (1) additional threatened fauna species - Black-chinned Honeyeater (eastern subspecies - *Melithreptus gularis gularis*) has been previously recorded on the other side of the Georges River as evident from the Atlas of NSW Wildlife Database records(DECCW/OEH 2011) and likely utilised the subject site on occasion;

- No threatened flora species were recorded within the subject site, however it is believed that the subject site provides some potential habitat for *Acacia pubescens, Persoonia nutans, Pultenaea parviflora* and even though not on the Atlas of NSW Wildlife database but known to occur 4km away, *Hibbertia* sp. Bankstown;

- One (1) endangered ecological community was recorded, River-flat Eucalypt Forest on Coastal Floodplains; and

- No endangered populations were recorded on site or considered likely to occur.

EPBC Act

In respect of matters required to be considered under the *EPBC Act:*

- One (1) threatened fauna species, Grey-headed Flying-fox (*Pteropus poliocephalus*), was recorded within the subject site;

- Two (2) protected migratory fauna species listed under the EPBC Act (1999) - Rufous Fantail (*Rhipidura rufifrons*) and Satin Flycatcher (*Myiagra cyanoleuca*)- were recorded within the subject site;

- No threatened flora species were recorded within the subject site;

- No endangered ecological communities under national legislation were recorded within the subject site; and

- No endangered populations were recorded on site or considered likely to occur (limited potential for *Marsdenia viridiflora subsp. viridiflora*).

Assessment of these species within Section 4 of this report concluded that the proposed rezoning is not considered likely to have a significant impact on matters of NES. As such a referral to SEWPAC should not be required.

FM Act

In respect of matters relative to the *Fisheries Management Act 1994*, the adjacent Georges River to the subject site provides no potential for threatened fish species occurrence. This river portion is not identified as critical habitat under the FM Act. It is assumed there will be no detrimental effect on water quality, water quantity or any direct / indirect impacts upon threatened fish species habitat from the proposed action. As such the provisions of this act do not require any further consideration.

Conclusions

The proposed rezoning:-

- Satisfies the requirements of REP No 2 – Georges River Catchment and proposed additional measures to mitigate against areas of inadequate vegetation buffers.
- Satisfies the requirements of *Planning for Bush Fire Protection* 2006.
- Satisfies the requirements of the *NSW State Rivers and Estuaries Policy* and the *NSW Wetlands Management Policy.*
- Runoff from developed areas can be collected, treated and filtered to improve water quality within the Georges River and its tributaries.
- Reduces the loss of riparian vegetation and controls invasive weed species through an implemented vegetation management plan.
- Avoids damage to river banks and channels.
- Maintains terrestrial and aquatic biological diversity and provides fauna habitat and corridors.

The proposed rezoning will remove 3.226 ha of the EEC – *River-flat Eucalypt Forest on Coastal Floodplains*. The level of offsetting afforded by the proposed rezoning is considered from the perspective of the EEC – *River-flat Eucalypt Forest on Coastal Floodplains*. We note that the critically endangered ecological community - Cumberland Plain Woodland, is not present in Coopers Paddock. The proposed zoning boundary, as proposed for protection of the Powerful Owl, increases the vegetation offset ratio (area restored/conserved to area removed) from 2.84:1 with the current proposed boundary to 5.2:1 with the new boundary. The total conservation area has been increased to 16.95 ha.

The proposed conservation area is sufficient the habitat requirements of the Powerful Owl and Varied Sittella. Experts in their respective fields, John Young and Dr Richard Noske, have been engaged to ensure that these two main species of concern have been appropriately considered. The area also adequately conserves the existing native vegetation

and provides foraging, roosting and breeding habitat for the other recorded threatened fauna species and those with potential to occur.

A total of 10.7 ha of open forest retention areas will be protected. 6.25 ha of disturbed landscapes will be restored to compensate for partial loss of vegetation and habitat within the proposed development area. The restoration areas occur just to the north of the Powerful Owl sightings and around/within the circular track in the south-western portion of the subject site.

Adequate buffers have been provided in accordance with REP 2 – Georges River Catchment and alternative measures are proposed to compensate for edge effects where buffers are compromised.

5.2 Recommendations

The following recommendations have been identified by John Young specifically for the Powerful Owl pair identified nesting within the site:

- A recommended conservation area boundary line has been identified as necessary to maintain a viable nesting and roosting area for observed pair of owls (Figure 3). The proposed conservation area covers all of the major activity areas as well as including all major connective strips of forest habitat. John Young would therefore like it to be totally protected with native habitat enhancement works where possible to improve habitat also for prey species.

- The 70 m Powerful Owl buffer (Figure 3) is to be revegetated. Revegetation should utilise plants native to the area such as the dark rough barked eucalypt species preferred by Powerful Owl.

- Disturbance is to be avoided within the core roosting and nesting territory for Powerful Owl (Figure 3). At present Lantana is providing a positive role to this by preventing human access and disturbance. Where native revegetation is to occur in this area it should not be undertaken in the breeding period between March and September or any time the owls are observed present. No machinery is permitted and native regeneration should be undertaken in small areas at a time with no large open clearings at any time.

- There is an existing horse trail which runs through the roosting site, is to be relocated to reduce the risk of disturbance to the Powerful Owl during the laying/nesting period.

Dr Noske (Attachment 2) specifically identified for the family group of Varied Sittella recorded onsite (p5) the that their chances of breeding success (and thus, recruitment) would be enhanced by the restoration of the south-western trotting track in Coopers paddock right up to boundary of the proposed foreshore conservation area, to improve the connectivity of the eastern parts of the foreshore conservation area to the Sydney Water land in the northwest, as well as revegetation of the Powerful Owl "buffer zone" as recommended by Mr John Young. Revegetation or habitat enrichment of these areas should include a mix of rough-barked species (*Eucalyptus, Acacia* and *Angophora*), rather than the smooth-barks and Coast Grey Box that dominate marginal foraging areas.

The following recommendations are to be incorporated into the management of the proposed foreshore conservation area (Figure 7) in order to reduce potential impacts on threatened species and their habitat:

- It is recommended that the VMP (prepared by *Travers bushfire & ecology, 2010*) be updated to identify the ongoing management of habitat resources, weeds, future landscaping and site works to retain mature trees and habitat movement corridors to ensure the access options to foraging resources are maintained for the Powerful Owl, Varied Sittella and other recorded threatened birds.

- The proposed cycleway is to be re-routed to the north along the rezoning boundary which is then away from the core Powerful Owl roosting/breeding areas. The proposed cycleway can then pass into existing bushland areas along the existing walking trail.

- All pedestrian access to the Powerful Owl roosting area is also to be avoided, particularly during the breeding period of March to Late September.

- Weed control within the yellow revegetation area to the north of the core Powerful Owl roosting area is also only to be undertaken outside of the breeding period of March to Late September.

- Weed control is to be progressively implemented over a 5 year period within all remain vegetation areas outside of the core Powerful Owl roosting and nesting area. The weed control works are to ensure adequate regeneration of native understorey species to maximise foraging habitat minimise disturbance to existing fauna. Low impact bush regeneration methods are to be implemented across the site in preference to large scale and rapid works.

- In respect to the East-coast Freetail Bat, semi-cleared (open space) landscapes should be represented within the subject site in areas such as within asset protection zones that occur along the open forest fringes.

- Dead trees and limbs within the open forest retention areas are to be retained for foraging and nesting by Varied Sittella and walk/cycleways should be located to avoid any removal of deadwood and dead trees.

- Revegetation and restoration practices within the subject site should also provide a high representation of non-eucalypt rough-barked tree species for the Varied Sittella and to mitigate against the further encroachment of Noisy and Bell Miners into quality passerine bird habitat areas. These miner species tend to have higher presence in eucalypt dominant areas.

- Shrub layer revegetation works are to use locally endemic native plant species that may permit foraging by Grey-headed Flying-fox as well as other Powerful Owl prey species.

- The boundaries of the protected areas should be clearly marked out on-site to ensure their protection.

- The felling of all hollow-bearing trees should be conducted under the supervision of a fauna ecologist. Hollows of high quality or with fauna recorded residing within should be sectionally dismantled and all hollows should be inspected for occupation, activity and potential for reuse. Re-used hollows or those with likely occupation are to be relocated to natural areas within close proximity to the site.

- Where possible existing EEC - *River-Flat Eucalypt Forest on Coastal Floodplains,* should be restored or regenerated is open areas through a combination of biotic translocation and revegetation works.

The following measures are proposed to mitigate against edge effects surrounding the proposed development.

- The forest remnant is to be delineated and protected by a pathway or similar structure that forms a barrier to invasive grasses and weeds.

- Native vegetation on the remnant side of the pathway is to be regenerated and planted densely to out-compete invasive weed species. In this case the outer 20 m of the EEC buffer is to be densely planted or regenerated with acacias and other similar subcanopy species to suppress weed regrowth.

- Surface drainage is to be collected and directed away from the remnant edge so as to minimise the potential for weed invasion.

- The 10 m asset protection zone setback is to be landscaped with native canopy and understorey vegetation that complies with the minimum requires for fuel management within asset protection zones. The use of non-native turf is to be avoided within the asset protection zone.

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Attachment 1

Powerful Owl Supplementary Survey Report

By: John Young

Re: Powerful Owl Supplementary Survey
Coopers Paddock – Warwick Farm

John Young 15th April 2011.

Background

In early March 2011 a fauna survey was undertaken on the property in question by Mr Corey Mead of *Travers bushfire & ecology* to determine presence of threatened species and species of national significance.

During the early part of the survey a single Powerful Owl was located roosting clutching a Grey-headed Flying-fox in a dense eucalypt gully on the south western end of the property at co-ordinates S 33 55 13.9 E 150 56 55.6.

A systematic search followed by Mr Mead to seek out any hollow-bearing tree's that may have suited as a Powerful breeding site. One large, high quality hollow was found approximately 300 metres north within the cleared open paddock areas.

Survey Visit and Objectives

I have been engaged by *Travers bushfire & ecology* to undertake an assessment of the site's significance for Powerful Owl. I visited the site between the 11th and 14th April 2011. Mr Mead accompanied me on the 11th to provide a background on previous survey and locations.

The visit coincided with the onset of the Powerful Owl breeding period, when pairing and activity increases proximate to a selected nesting location. For my mind, the objective of the visit was specifically to determine the establishment of any pairing within the site and subsequent areas of breeding value.

Findings

11th April 2011

I located a single owl (most likely a male by its dark face) clutching a Grey-headed Flying-fox in its talons at co-ordinates S 33 55 12.8 E 150 56 59.6. The bird was photographed for our files as evidence. Later in the afternoon it was harassed by a pair of Pied Currawongs until it flew back into the cover of the gully. At this stage there was no sign of a second bird.

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A systematic search for hollows was conducted over the whole site except down south west of the roosting bird's position. Dense lantana throughout this area made access impossible for closer inspection of trees. At a distance a number of large eucalypts were visible that were considered of adequate size to provide large and suitable hollows.

5.55pm - I visited the site again and positioned myself less than 50 metres from where the owl was last seen earlier in the day.

6.24pm - The male began calling with a slow deliberate soft call as if he was sitting near his mate.

6.29pm - The male was still calling with about 10 seconds between each double note. At this time my suspicions were confirmed as the female began calling softly also from exactly the same location. They were obviously roosting together.

6.47 pm - Both birds seemed to move around 100 metres to the south west towards the river and amongst the large eucalypts that stood within the Lantana.

Soft calling continued from this spot till around 7.15pm indicating to me, with my experience of nearly 45 years observing Powerful Owl behaviour that they were at the nest site. They were still there calling very softly when I departed at 7.35pm.

12th April

Both male and female were found roosting together high in the canopy of a eucalypt at co-ordinates S 33 55 13.1 E 150 56 56.9. By the amount of excreta beneath this perch and other branches nearby, they had obviously been here for weeks. There was no food in their talons this time.

The hollow identified by Mr Mead located within the open paddock area was examined during the afternoon period for potential use. I noticed a small piece of grey feather down stuck to the rims of the hollow which appeared consistent with Wood Duck. Whilst the hollow was the only good quality large hollow within the accessible areas of the site, I believed it to be too far from the remnant forest edges for Powerful Owl suitability. In order to satisfy my thoughts I inspected for activity on dusk, observing a female Wood Duck flying straight in to the hollow. Obviously her clutch of between 8 and 12 eggs were not completed, as they only incubate when all the eggs are laid and otherwise leave the hollow all day.

In the distance I could hear the Powerful Owl pair again calling from the vicinity of the river bank. This ruled out any breeding activity on the open paddock areas as per the plan.

13th April

9.55am - The owl pair were again discovered roosting together above a horse trail around 12 metres above ground and well hidden amongst the foliage. The co-ordinates of this roost is S 33 55 12.8 E 150 56 56.4. This location is without doubt the centre of all their roosting activity and an area that must be conserved.

At this stage I became absolutely convinced that the nest tree is located close to the river, well protected by Lantana which is over 3 metres high in places. Some attempts were made to

penetrate the lantana to confirm exact nest location, however this proved to be too difficult and more importantly appeared to cause a risk to disturbing nesting behaviour.

Later in the afternoon, management of Warwick Farm and others were shown the roosting pair.

Recommendations:

After examining the site over three days and assessing the protection of the pair – I make the following comments:

1 – I have identified a recommended conservation area boundary line that is necessary to keep territory viable for the local owl pair. This line is identified in blue on Figure 4 of the Ecological Constraints Report prepared by *Travers bushfire & ecology*. The conserved area within this covers all of the major activity areas as well as including all major connective strips of forest habitat. I would therefore like it to be totally protected with native habitat enhancement works where possible to improve habitat also for prey species.

2 – The small area in yellow on Figure 3 needs to be revegetated as a buffer to currently utilised roosting areas that are being used right up to the forest edge. Revegetation should be with plants native to the area such as the eucalypt species that the birds are roosting in.

3 – I would like to see as little disturbance as possible to their core roosting and nesting territory that I have validated on Figure 3. At present Lantana is providing a positive role to this by preventing human access and disturbance. Where native revegetation is to occur in this area it should not be undertaken in the breeding period between March and September or any time the owls are observed present. No machinery is permitted and native regeneration should be undertaken in small areas at a time with no large open clearings at any time.

4 – There is an existing horse trail which runs through the roosting site which I would like closed immediately simply because – they are at the highest risk of disturbance when they are just about to lay.

Conclusions:

Finally I believe that the male is of some age because of his darker markings and may have lost his first mate, some time back. The female with him now is maybe only two or three years old as there is brownish tinges to some of her feathers, indicative of young birds.

I would suspect that the male has occupied this territory for many years and has become quite tolerant of humans given the surrounding urban landscape and the presence of a regularly used horse trail below.

I strongly believe that if my recommendations adhered to then this pair of owls will be here for many years to come.

Also worth mentioning is that this pair are obviously hunting for many kilometres in all directions, which includes through most of the surrounding suburbs.

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Attachment 2

Specialist Report on Varied Sittella

By: Dr Richard Noske

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Peer Review and Advice on Varied Sittella Coopers Paddock, Warwick Farm Proposed Industrial Rezoning

Prepared by: **Dr Richard Noske BSc (Hons), PhD, Grad. Dip. Ed**

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Introduction

I have been requested to provide a professional opinion on the adequacy of the proposed conservation area for the recorded threatened species Varied Sittella at Warwick Farm NSW.

As relevant background I completed my PhD in 1982 at the University of New England, Armidale, NSW. My PhD thesis was entitled "Comparative Ecology and behaviour of some Australian Bark-foraging Birds". A copy of my curricula vitae is attached to this advice (Attachment 5).

I have authored nine journal papers on the Varied Sittella or related matters (see additional reading list), as well as the chapter on the Family Neosittidae (Sittellas) in the *Handbook of the Birds of the World (2007), Vol 12* (eds. J. del Hoyo, A. Elliott and D.A. Christie), pp 628-641. Lynx Edicions, Barcelona. ISBN: 84-96553-42-6.

Purpose of Report

To provide a peer review of the proposed conservation zone in terms of:-

- inspect habitat along the river (both sides) to advise on suitability for Varied Sittella;
- observe and provide an opinion on the behavioural use of the site by Varied Sittella;
- estimate the insitu population of Varied Sittella;
- identify likely and alternative breeding areas within the conservation zone as shown on Figure 6 – Proposed Open Space Boundaries (Ecological Constraints Report May 2011);
- advise on the effectiveness of the current zoning boundary;
- advise on the need or otherwise for protection and mitigation measures e.g the likely habitat enrichment requirements to support Varied Sittella within the conservation area;
- advise in regard to the stated minimum size for Varied Sittella on this site; and
- adequacy in meeting the conservation needs of the Varied Sittella.

The following headings provide a summary of my field observations and a professional opinion as to the adequacy of the proposed conservation measures.

Field Observations

On 2 August 2011, Corey Mead (*Travers bushfire & Ecology*) and I searched for Varied Sittellas over the whole site between 11:30 and 13:00 by foot and/or vehicle, then tried likely areas on the other side of the river (13:30-14:30). As might be expected owing to the time of day (midday, when avian activity is generally lowest) and the typically soft vocalisations of the species, none were located. The proposed conservation zone (CZ) was traversed again from 15:00, but sittellas were not found until 16:00, when they were heard in the northwest STP Lands. Here four birds foraged simultaneously in one large Thin-leaved Stringybark tree (*Eucalyptus eugenioides*) (Fig. 1) and although I suspected another one or two birds in a nearby red gum at the start of observations, I concentrated on the larger group in the hope of following them to their roost. They foraged in this tree for at least 55 minutes, then flew c. 90 m south to the aforementioned red gum, before flying at least 180 m east towards CZ at 17:10, presumably to their roost site. I failed to locate the birds again despite thorough scanning of many suitable roost trees.

From 06:30 on 3 August 2011, I searched the area where I had last seen the sittellas as well as along the trajectory of their pre-roost flight from the previous evening, then the main trail through the CZ, but sittellas were not located until 08:00 at the northernmost location shown in Figure 2. Observations were intermittent for the next two hours, but more or less continuous for the last hour (10:00 to 11:00) before I was obliged to leave the site. The birds rarely vocalised throughout the morning, and this unobtrusiveness made it difficult to re-locate them once they disappeared from view. Precise locations of foraging trees and flight paths could not be recorded but were mapped on a field plan and updated *Travers bushfire & ecology* on Fig. 1 & 2. It was impossible to follow the birds directly due to the dense lantana in many places, so flight paths of birds were not mapped, except for one movement eastwards that might have taken the group over the river.

During the 3 hours, no more than three birds were seen concurrently, and for much of that time only two were seen in close proximity to each other. These two birds were presumed to be the breeding pair, as the male fed the female three times during the last hour. There was no evidence of nesting, and indeed, the low frequency of courtship-feeding suggests that nest building had not yet commenced.

Foraging Substrates

Foraging substrates, and sometimes heights, were recorded at 1-2 minute intervals where possible to determine approximate duration of foraging time in each type of tree visited. When two, and occasionally three, individuals were observed on the same tree concurrently, I scored this as two separate foraging events, with total duration of 2 birds x 2 minutes in tree = 4 minutes. The exception was the group of four watched on the first day (2 August), when no birds were visible for about half of the time that they were in the tree (55 minutes, but possibly much longer).

During 152 minutes (c. 2.5 hours) of individual foraging observations on the morning of 3 August, birds spent 59% of their time on Thin-leaved Stringybarks and 41% on Coastal Myall (*Acacia binervia*), involving 15 and 17 individual trees, respectively. Including the observation of the previous evening, the amount of time spent in Stringybarks increases to 76%. The average estimated height of foraging in 15 trees was 7.8 m, and the mean estimated height of 13 of those trees was 10.6 m. However these data are obviously biased towards the lower canopy where birds, in particular males which forage lower than females (Noske 1986), are most easily seen.

In summary, sittella groups were observed for 2.3 hours (21%) of the 11 hours of sampling (search) time. Of the total observation time, 40% involved the birds foraging in one tree located outside the study site (STP land) on the first day, while the remainder involved at least 33 trees, all within the CZ. The longest flight observed was at least 180 m as four birds moved swiftly towards their roost site on the first evening, whereas the area covered by three birds over 3 hours on the following morning covered c. 2.2 ha only (estimated from Fig. 2). It is likely that the latter birds spent most, if not all, of the morning in the northern half of the CZ as there was no indication of their presence in the western half of the site (outside the CZ) when traversed earlier in the morning.

Population Size

No more than four birds were ever seen at one time, though one or two additional birds may have been observed on the first day. *Travers bushfire & ecology* observed a possible six individuals during the first (March) survey, and a definite five individuals during the subsequent (June) survey. Thus whilst the main group appears to consist of four birds, it is possible that six occupy the site at least partially, e.g. some birds may range over a wide area that only partially includes the site, and which may or may not overlap the area occupied by the main group. However, group membership in this species is fairly fluid, and adjacent groups may contain individuals that split off the main group, only to re-join subsequently (if tolerated by the breeders). Moreover only three birds were seen together on the second day, and for much of the time, only two of these birds, the presumed breeding pair, were visible. Courtship feeding and some agonistic behaviour observed between individuals suggest that one or both of the breeders were repelling other, possible sexual rival, individuals.

Observed Habitat Preferences

Although birds were not seen in the southern half of the CZ during the 11 hours of sampling over the 2 days, it is possible that some birds occupied that area earlier in the morning, but were undetected during traverses. *Travers bushfire & ecology* observed them there earlier in the year. The southern half of CZ contains a moderately large stand of Blue Box (*E. bauerana*), which whilst being almost entirely rough-barked, may not be as suitable for foraging as the stringybarks because the bark of the trunks and larger branches consist of small blocks of firmly compacted short fibres (vs. loosely arranged long fibres), separated by shallower fissures, and possibly fewer dead branches.

It is well established that sittellas have a strong preference for rough-barked tree species, and in particular, dead branches on such trees, for foraging (see references in Higgins & Peter 2002). Thus it is not surprising that apart from dead trees (three visited, but only one definitely foraged upon for c. 1 minute), all foraging was within Thin-leaved Stringybarks or Coastal Myall, both having persistent rough bark from the trunk to the smaller branches. As most studies of bird communities in Australia have focussed on forests, most of the tree species known to be used by sittellas are eucalypts, yet in inland areas where eucalypts are rare and acacias dominate, this species forages predominantly on the latter (e.g. Recher & Davis 1997). Therefore frequent use of Coastal Myall at the present site is not unexpected, and this tree species seems to be largely restricted to the CZ. Stringybarks, on the other hand, are widespread on site, and it is the major species that persists in the northern section of the Category 2 - highly fragmented habitat (Fig. 3 of Ecological Constraints Report). Whilst sittellas are known to use isolated stringybarks in such environments (Noske 1980, 1998), their use of this area is likely to be severely limited by the numerous Noisy Miners occupying it.

Although *Travers bushfire & ecology* observed the sittellas in the Category 5 - higher quality habitat just west of the northern section of CZ (Fig. 3 - Varied Sittella Habitat Assessment of Ecological Constraints Report), that area appears less optimal than the CZ itself, since the vegetation contains a high proportion of smooth-barked gums of various species, as well as both miner species. Many studies have shown that Noisy Miners exclude most small insectivorous bird species from their colonial territories, and a recent study by Maron & McNally (in press) shows that the Varied Sittella is (as expected) one such excluded species. The effect of Bell Miners on sittellas is less well understood, and at this site, this species was often seen in close proximity to the sittellas without any obvious sign of aggressive behaviour by the former towards the latter.

Notwithstanding possibly 'friendlier' relations between the Bell Miner and sittella, it was noted that Bell Miners occupied a much larger area than noted by *Travers bushfire & ecology* on previous surveys. This includes areas around the dwellings north of the Category 4 zone – connective native canopy in the central-west, most of the lower (southern) section of the Category 2 – highly fragmented habitat to the east and adjacent open shrubland within the CZ to the south, much of the forest on the western side of the main trail within the CZ, as far north as the bridge over the river and as far south as the southern tip of the south-western trotting track with Coopers Paddock. This considerable expansion of the range of the Bell Miner colony at the time of the present survey may have been related to the widespread flowering of Black Wattle (*Acacia decurrens*) on the flatter land both within and outside the CZ.

As the sittellas were seen only on the eastern side of the main vehicle access within the conservation zone boundary on the second day, it is possible that they were avoiding areas occupied by Bell Miners, yet their presence in the STP land on the previous evening suggests that they were able to 'penetrate' the Bell Miner 'belt'. Whilst almost nothing is known about relations between the two miner species where they co-occur (which is rare), it is feasible that the dominance of the Bell Miner over a large proportion of the site ameliorates the impact of Noisy Miners on the sittellas. Thus revegetation of the south-west area with plant species amenable to Bell Miner colonies, but not Noisy Miners, might not adversely affect the sittellas.

Conclusions

Breeding Habitat

Up to six sittellas occupy the site, and although the survey was too early to witness breeding, it is highly likely that they nest on site. As suggested in the Ecological Constraints Report (*Travers Bushfire & Ecology* 2011), the CZ most likely represents the core area of the main group, and is where nests may be expected to be found.

Habitat Use of the Cleared Lands

Although these birds use the STP land to the northwest of the site, probably because it supports many stringybarks, they appear not to use the mostly cleared areas between there and the CZ, possibly due to the presence of the pugnacious Noisy Miner (perhaps more so than the Bell Miner).

Expansion of the Proposed Conservation Areas

The NSW Office of Environment and Heritage (OEH), recommended the retention of further vegetation (correspondence dated 19th July 2011) namely the areas coloured red and purple (connective native canopy and connective native canopy with a range of foraging opportunities

and recorded diversity of other bird species – no dominance of miners on figure 3 of the Ecological Constraints Report) on the eastern portion of the proposed IN 1 Industrial General zoning.

Based on the vegetation map and descriptions of the Ecological Constraints Report, the vegetation in the northern category 4 (purple-shaded) area and northern portions of the category 5 (red-shaded) area, are dominated by smooth barked species (including *E. citriodora*) with scattered Thin-leaved Stringybark. The southern portions of the Category 4 area is dominated by half-barked Coast Grey Box (*E. bositoana*), and the Smooth-barked Cabbage Gum (*E. amplifolia*) and Forest Red Gum (*E. tereticornis*). Whilst the vegetation in these areas is native canopy, there is no doubt that there are many more smooth-barked eucalypts occur here than elsewhere at the site, and certainly more than in the areas visited by the sittellas; they were also occupied by Bell Miners. The northernmost section of the Category 4 area had more rough-barks, but was also being used by Noisy Miners (which also lined the vehicular track from the road "tunnel"), so that it appeared to have lower habitat value to sittellas.

It's my professional opinion that the Category 4 & 5 areas as nominated by the OEH have diminished habitat value to sittellas due to (1) the prevalence of smooth-barked or half-barked eucalypts; and/or (2) the presence of one or other of the miner species. I also think the purple-shaded area should extend further southwards, on both sides of the vehicular track and around the gate at the southern end.

A revised version of the Varied Sittella Habitat Assessment (attached as Fig. 2 - dated 10th August 2011) has been prepared by *Travers Bushfire & Ecology* which more closely reflects my own habitat assessment.

Based on my habitat assessment and observations I am satisfied that the proposed conservation boundary contains the better quality habitat and the inclusion of the OEH areas into the conservation area is of lower priority.

Spatial Territory Requirements of Varied Sittella

Our understanding of the spatial (territory) requirements of sittellas is meagre due to the lack of targeted studies. Densities derived from general bird surveys vary from 0.06-0.46 birds/ha at several sites in the New England Tablelands; 0.02-0.24 b/ha near Canberra; 0.1-0.6 near Eden, southwest NSW; and 0.27-0.5 in Victoria (Higgins & Peter 2002).

Unfortunately these values do not provide a reliable indicator of territory size, as sittellas are social birds, living in cohesive groups of up to 12 individuals (average, 4-5; Noske 1998) so that a density of 0.2 birds/ha (= 5 ha per individual) does not necessarily indicate that an average group of five requires 25 ha, any more than a density of 0.02 birds/ha (= 50 ha per individual) means a similar group of five birds requires 250 ha! However the reported densities demonstrate a wide variation that is most likely correlated with habitat suitability and reflects large habitat differences between sites.

Group territory size has been estimated in only two studies (Marchant 1984, Noske 1998). In both cases, estimates varied from 13 (or 15) to 20 ha, equating to densities of 0.25 to 0.38 birds/ha for an average group of five birds, clearly at the higher end of the densities noted above. The habitats at these two sites differed from that of the site in question e.g. tall Acacias were scarce on the study sites, so it is quite feasible that 10 ha of good quality habitat is sufficient to maintain a group of four-six birds as seen in the CZ. Moreover small patches of

suitable habitat on the east side of the Georges River and the north side of Governor Macquarie Drive are quite probably used from time to time, as the river and road should be no impediments for sittellas, which are capable of crossing inhospitable areas of several hundred metres (Noske 1998 and unpubl. data; *Travers bushfire & Ecology* 2011).

Notwithstanding the likelihood that the sittellas would be maintained by the 10 ha of high quality habitat, their chances of breeding success (and thus, recruitment) would be enhanced by the restoration of the south-western trotting track in Coopers Paddock right up to CZ boundary, to improve the connectivity of the eastern parts of the CZ to the STP land in the northwest, as well as revegetation of the Powerful Owl "buffer zone" as recommended by Mr John Young. Revegetation or habitat enrichment of these areas should include a mix of rough-barked species (*Eucalyptus, Acacia* and *Angophora*), rather than the smooth-barks and Coast Grey Box that dominate marginal foraging areas.

Adequacy of the Proposed Conservation Zone

Based on my observations of the foraging behaviour of the Varied Sittellas onsite, and review of the habitat assessment and information provided by *Travers Bushfire & Ecology* in their Ecological Constraints report (2011), I see no reason why the proposed conservation area could not support the existing population.

Based on the behaviour and locations of the presumed breeders, I expect that the most suitable nesting sites for the sittellas lie within the proposed conservation zone, which therefore most likely represents the core area of the main group.

Thus it is my professional opinion that in conjunction with appropriate restoration of currently disturbed areas, the proposed conservation area is able to meet the needs of the Varied Sittella population onsite.

Yours faithfully

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Attachments:

1. Figure 1 - Fauna Survey Effort & Results (August 2011 - updated for recent Dr Noske survey effort and findings)
2. Figure 2 - Varied Sittella Habitat Assessment (August 2011 -updated for purposes of this specialist report)
3. Figure 3 - Varied Sittella Habitat Assessment (30th June 2011)
4. Figure 4 - Existing & proposed zoning boundary (August 2011 - showing restoration zones)
5. Dr Richard Noske – Curricula Vitae.

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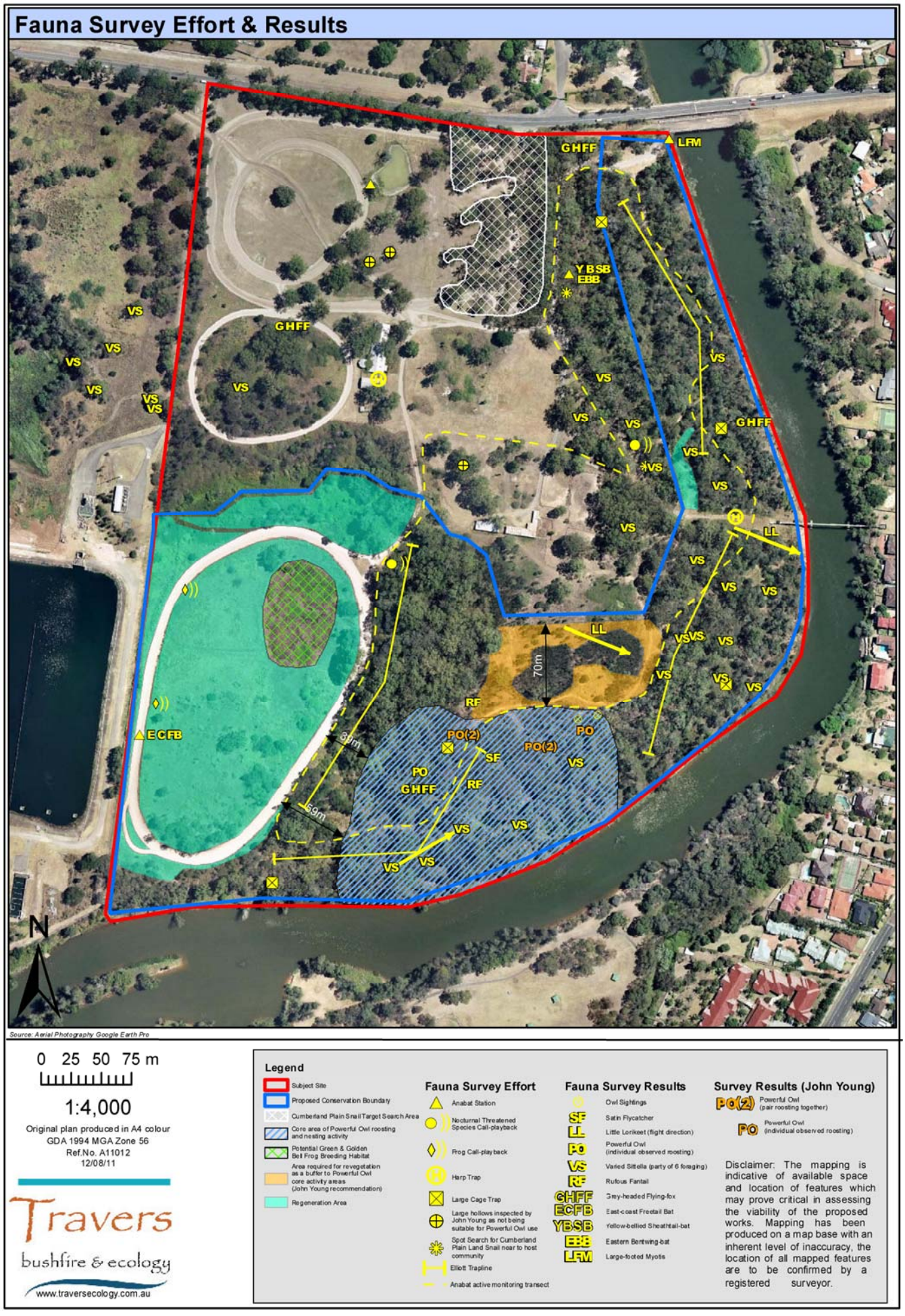

Figure 1 - Fauna Survey Effort & Results

(Updated August 2011 for Dr Noske survey effort and findings)

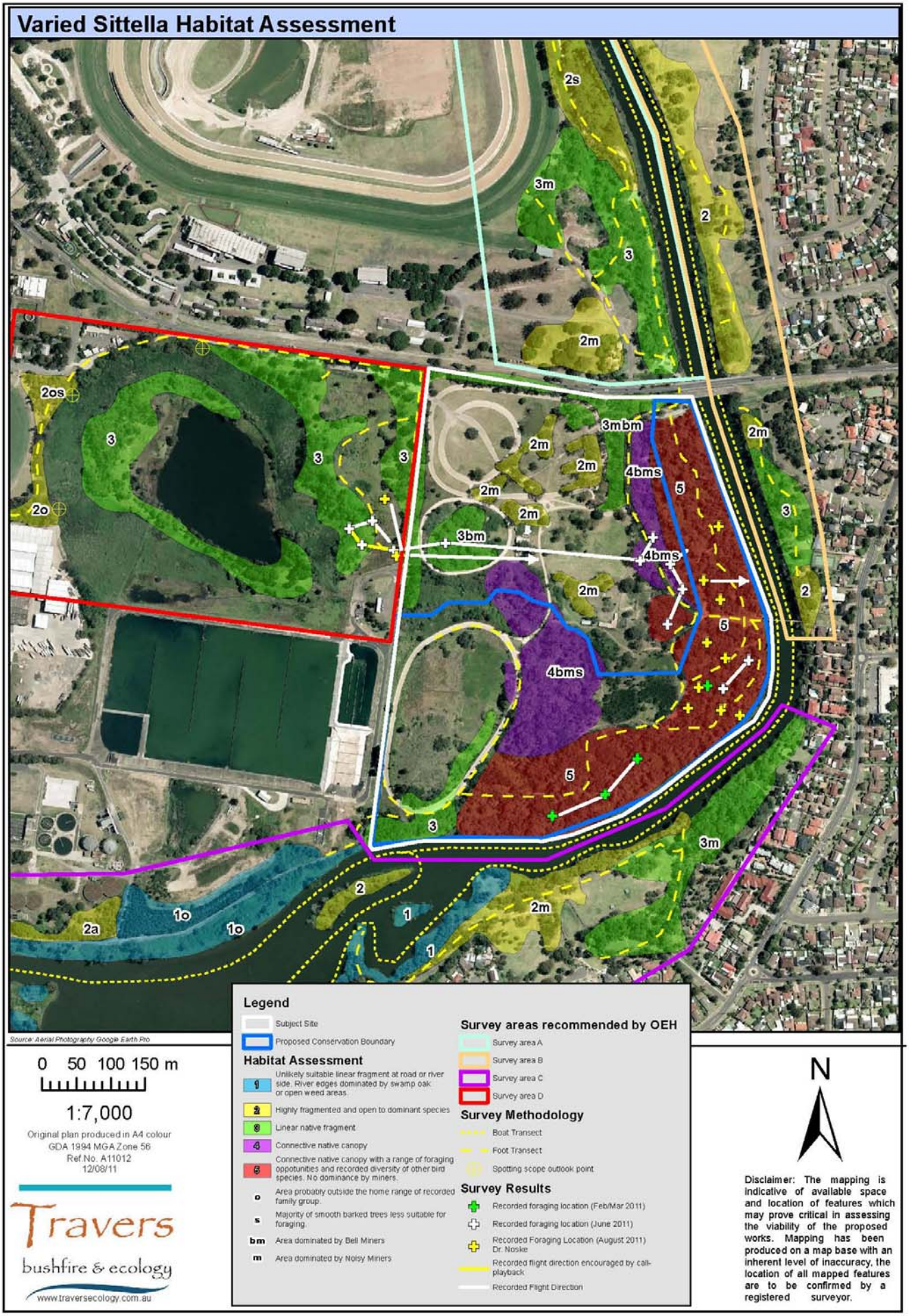

Figure 2 - Varied Sittella Habitat Assessment

(12th August 2011 - updated for purposes of this report)

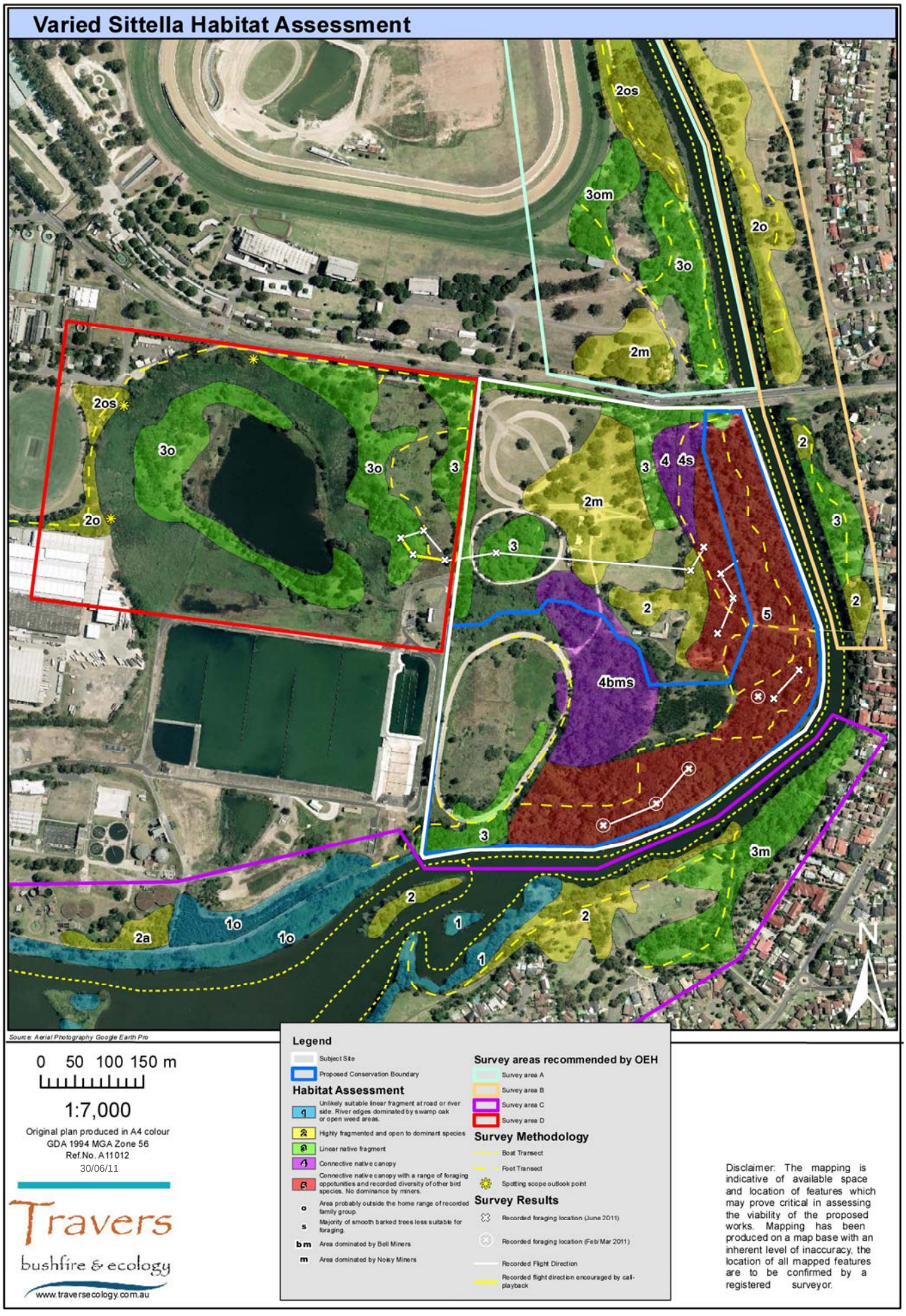

Figure 3 - Varied Sittella Habitat Assessment
(30th June 2011)

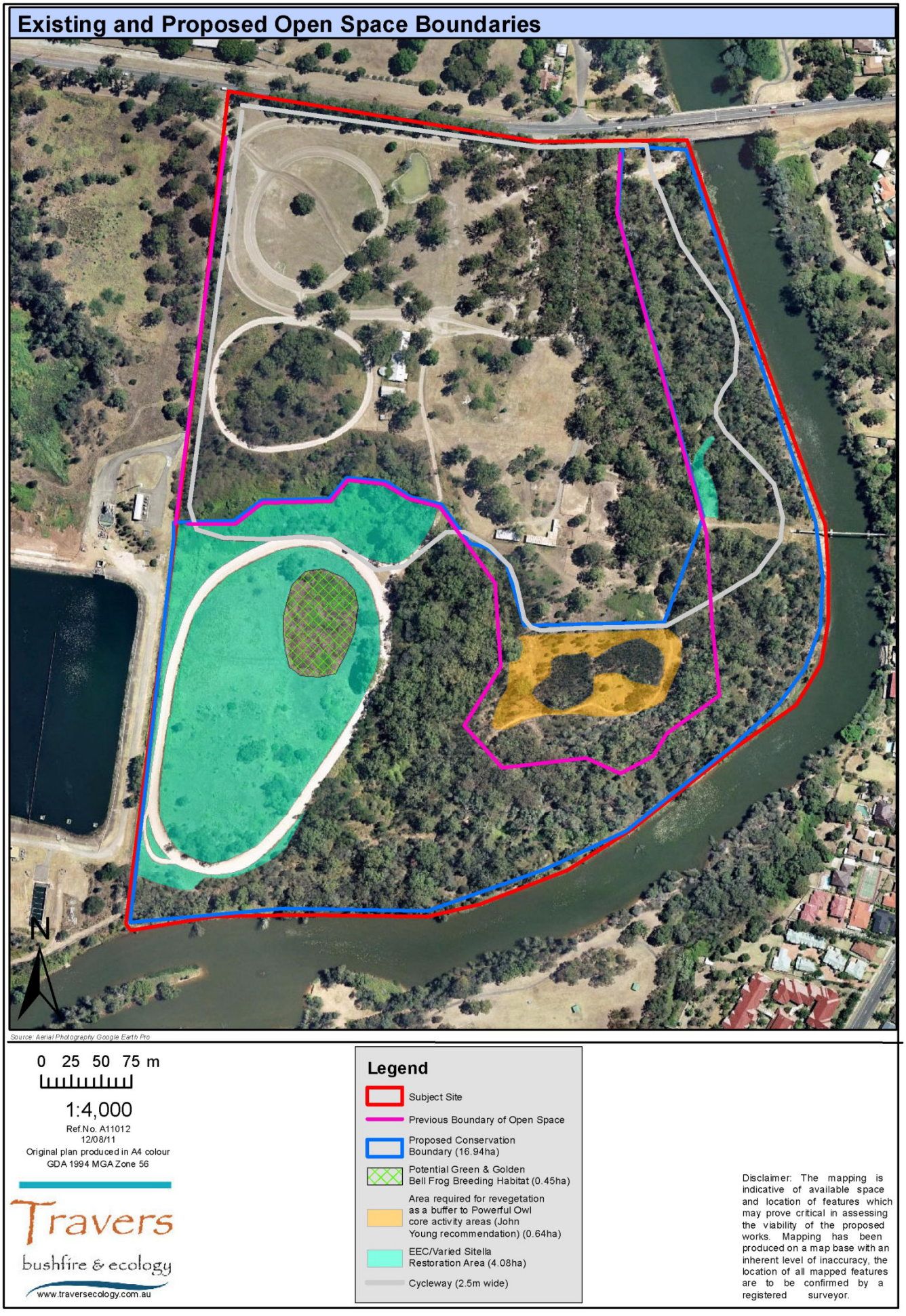

Figure 4 - Existing & proposed zoning boundary

(12th August 2011 - showing proposed restoration zones)

CURRICULUM VITAE

Richard Alfred Noske

Qualifications

1977 B.Sc. Hons (1), University of New England (UNE), Armidale, Australia
1982 Ph.D., UNE, Armidale
1984 Grad. Dip. Ed., Canberra College of Advanced Education, Canberra, Australia

Academic employment

1985 Teacher, Dripstone High School, Darwin, NT

1985-94 Lecturer, Darwin Institute of Technology, Darwin, NT

2001-02 Postdoctoral fellow (for 12 months), Centre for Nature Conservation, University of Goettingen, Germany

1995-2009 Senior Lecturer in Biology, Charles Darwin University, Darwin, NT, teaching, and in most cases, developing the following BSc/BEnvS units (and levels):

- Introductory biology (I; in whole or part)
- Introductory ecology (II, in whole)
- Behavioural and physiological ecology (III, in part)
- Biogeography and evolution of the Australian flora and fauna (II, in whole)
- Ecosystems and biodiversity (II, part)
- Tropical environments (II, part)
- Fire ecology (III, whole)
- Pests and invaders (III, part)
- Field techniques/ Flora & Fauna survey techniques (I-VET; II/III - HED)
- Invertebrate biology (II)
- Entomology (III)
- Vertebrate biology (II)
- Botany (II)
- Conservation biology and wildlife management (III)
- Scientific writing (IV, part)
- Scientific literacy (III, whole)
- Professional practice in applied science (III)

Contributions to University Governance

- Coordinator: Bachelor Science Honours programme, 1999-2002 and 2007-09
- Board of Centre of SE Asian Studies, 1987-90
- Steering committee, Centre for Sustainable Use of Tropical Savannas, 1995
- Committee member/ Acting Chairman for Animal Ethics Committee, 2004-09
- Board Member of CDU Press, 1996-2009
- Organizing Committee for Siemens Science Experience, 2007-09.
- Board of Management, Centre for Tropical Wetlands Management, NTU, 2000
- Curriculum Development team for the E Indonesian Field Intensive unit, 2007

External Research Grants and consultancies (with funding sources)

1987 *Status of the Threatened White-throated Grasswren* (Aust National Parks & Wildlife Service, Canberra)
1991 *Fauna Survey of Groote Eylandt Mining Corporation Mineral Leases* (Groote Eylandt; for G. Webb Pty Ltd)
1992 *Flora & Fauna Survey of Casuarina Campus, NTU* (Vice-Chancellor, NT University)
1993 *Flora & Fauna Survey of Merbok estuary, Kedah, Malaysia* (Asian Wetland Bureau, Kuala Lumpur)
1993 *Conservation Status of Lowland Forest Birds of West Timor, Indonesia* (EMI, Canada/ Oriental Bird Club, UK)
1995 *Flora & Fauna Surveys of RAAF Receiving Stations, Darwin* (RAAF, Darwin/ Kinhill)
1997 *Breeding Bird Survey of Wisconsin* (Wisconsin Breeding Bird Atlas, USA)
1999 *Management of Forest Remnants* (University Cenderawasih, Irian Jaya, Indonesia)
2000 *Bird survey of Marawai leases, East Kalimantan, Indonesia* (BHP/WMI)
2001-3 *Birds as Bio-Indicators of Mine Rehabilitation Success* (Nabalco/Alcan, Gove)
2002-7 *Cooperative Breeding Systems among Monsoon-Tropical Birds* (Japanese Society of Promotion for Science, Tokyo)
2006-08 *Co-evolution of Cuckoos and their Hosts in Australia* (Japanese Society of Promotion for Science, Tokyo)
2007-09 *Village-based Ecotourism in West Papua, and the Role of ICT* (Computer Services Corporation, Perth)
2008 *Scientific Writing for Environmental and Agricultural Biologists, Bogor, Indonesia* (Crawford Fund for Agricultural Science).
2008 *Birds of Rum Jungle Rehabilitation Area* (GHD Pty Ltd, Darwin)
2008-9 *Seasonality of Birds in Western Arnhem Land* (North Australia Fishing Assoc., Darwin)
2009 *Development of a Birdwatching Tourism Training Course for Indigenous Stakeholders* (NT Research & Innovation Grant, NT Government)
2009-10 Indonesian Bird-banding Scheme training, Indonesia (AusAID and Australian Bird and Bat Banding Scheme, Canberra)

University Research Grants (with collaborators)

1987 *Ecology of mangrove birds of Darwin region*. NTU Internal grant.
1990 *Nectar use and pollination of the mangrove Bruguiera exaristata.* NTU Internal grant (Collab: P Donaldson)
1992 *Wet season ecology of Red-headed Honeyeater Myzomela erythrocephala.* NTU Project grant (Collab: M Bezuijen)
1995 *Abundance and seasonality of insects in tropical woodland*. CDU Project grant (Collab: G Husband)
1999 *Nest predation rates of birds in Australian monsoonal tropics*. CDU Project grant (Collab: S Fischer)
2001 *The role of incubation behaviour in the life history of Australian birds*. CDU UTROP grant (Collab: C Bramley)
2005 *Do Little Bronze-cuckoo chicks mimic their hosts?* CDU Project grant (Collab: K Tokue, K Ueda).
2006 *Responses of three tropical birds to predators at their nests.* CDU UTROP grant (Collab: R. Law).
2007 *Vegetation cover change in West Timor.* USC/CDU. Project grant (Collab: R Fisher, G Hill)
2007-09 *Livelihoods and natural resource management in Indonesia and East Timor*. CDU Research Panel Infrastructure Support Scheme (Collab: B Myers, R. Fisher, S Pickering, I Falk)

Services to Professional Organisations

1977-82	Sub-regional organizer for the RAOU Bird Atlas Scheme
1988-91	President, Northern Territory Field Naturalists' Club, Darwin
1993-99	Chief Editor, *NT Naturalist* (journal of Northern Territory Field Naturalists'Club)
1989-95	Member of Northern Territory Natural Environment Panel for Australian Heritage Commission
1995-2005	Regional Organiser for Australian Bird Banders' Asssociation.
1996-99	Regional representative (Australia) for Oriental Bird Club
1998	Co-organiser of Australian Institute of Biology Annual Symposium (Darwin)
2000-	Chief Editor, *Kukila* (journal of Indonesian Ornithological Society)
2001	Co-organiser of Indonesian Ornithological Society workshop (Universitas Padjadjaran, Bandung, Indonesia)
2001-	Editorial Board, *Ornithological Science*
2006	Chairman, Organising Committee for Birds Australia Members Day and AGM, Darwin
2008	Chairman, Curriculum Development in Biology (Phase 2), Biology Faculty, UGM, Indonesia

Formal presentations to Learned Societies

1977, 1982, 1991, 1995, 2006	Royal Australian Ornithologists Union Annual Congresses
1979, 1994	Ecological Society of Australia
1986, 1988, 1989, 1995	CSIRO Division of Wildlife Research
1986, 1990, 1993, 2000, 2009	NT Field Naturalists Club
1989, 1993	Malayan Nature Society (Kuala Lumpur)
1990, 2002	International Ornithological Congress (Christchurch, Hamburg)
1994, 1996	Eastern Indo-Australian Biodiversity Conference (Lombok, Indonesia)
1996, 2000	Southern Hemisphere Ornithological Congress
2007, 2009	Australasian Ornithological Conference
2009	DAAD German Alumni Summer School (Manado, Indonesia)
2009 (Plenary)	International Conference on Biology (UGM, Yogyakarta, Indonesia)

Publications

Journal articles

Brady, C.J. and **Noske, R.A.** In review. Avian indicators of mine rehabilitation success in the monsoon tropics of Australia. Submitted to *Ecological Indicators*

Noske, R.A. and Carlson A.J. 2011. The breeding biology of the Dusky Honeyeater *Myzomela obscura* in the Northern Territory, and the importance of nectar in the diet of nestling honeyeaters. *Aust. Field Orn.*

Hampton, V., Kaestli, M., Mayo, M., Low Choy, J., Harrington, G., Haslem, A., Benedict, S., **Noske, R.**, Garnett, S., Godoy, D., Spratt, B.G. and Currie, B.J. 2011. Melioidosis in birds and *Burkholderia pseudomallei* dispersal, Australia. *Emerging Infectious Diseases* **17**, 1310-1312.

Woxvold, I and **Noske, R.A**. 2011. The avifauna of *kerangas*, mixed dipterocarp and riparian forests in Central-East Kalimantan, Indonesia, and its conservation significance. *Forktail* **27**, 44-59.

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Okida, T., Katsuno, Y., Eguchi, K. and **Noske, R.A.** 2010. How interacting multiple male sexual signals influence female choice in the Great Bowerbird. *J. Yamashina Inst. Ornithol.* **42**, 35-46.

Nakamura, M., Takaki, Y., Mori, S., Ueda, K., Nishiumi, I., Takagi, M., **Noske, R.A.** and Eguchi, K. 2010. Impacts of fire on the group composition of the Red-backed Fairy-wren *Malurus melanocephalus cruentatus* in the non-breeding season. *J. Yamashina Inst. Ornithol.* **42**: 47-64.

Sato, N.J., Morimoto, G., **Noske, R.A.** and Ueda, K. 2010. Nest form, colour, and nesting habitat affect predation rates of Australasian warblers (*Gerygone* spp.) in tropical mangroves. *J. Yamashina Inst. Ornithol.* 42: 65-78.

Nurza, A.Z., Mulyawati, D., Husnurrizal, Jaya, R.L., Sanir, T. M. and **Noske, R.A**. 2009. First breeding records of Shikra *Accipiter badius* in Indonesia. *Kukila* **14**, 54-58.

Noske, R.A. 2009. Nest and eggs of the Plain Gerygone *Gerygone inornata*, a Lesser Sundas-endemic bird species. *Kukila* **14**, 44-48.

Noske, R.A. and Spaeth, T. 2009. Vocalisations, morphology and possible nest of Black-chinned Robin *Poecilodryas brachyura* in Cyclops Mountains Nature Reserve, Irian Jaya (Papua). *Kukila* **14**, 36-40.

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Mulyani, Y., **Noske, R.A.** and Mardiastuti, A. 2007. Keberhasilan bersarang burung Remetuk Rawa (*Gerygone magnirostris*) dan Remetuk Bakau (*G. levigaster*) di habitat mangrove di Darwin, Northern Territory, Australia (Nesting success of Large-billed Gerygone *Gerygone magnirostris* and Mangrove *Gerygone G. levigaster* in the mangroves of Darwin, Northern Territory, Australia. *Media Konservasi* **12**, 10-15.

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Zimmermann, U. and **Noske, R.A.** 2003. The breeding ecology of the monsoon rainforest-endemic Rainbow Pitta *Pitta iris*. *Emu* **103**, 245-254.

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Franklin, D.C., Woinarski, J.C.Z. and **Noske, R.A.** 2000. Geographic patterning of species richness among granivorous birds in Australia. *Journal of Biogeography* **27**, 829-842.

Franklin, D.C. and **Noske, R.A.** 2000. The nesting biology of the Brown Honeyeater *Lichmera indistincta* in the Darwin Region of northern Australia with notes on tidal flooding of nests. *Corella* **20**, 38-44.

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Noske, R.A. 1996. Abundance, zonation and feeding ecology of birds in mangroves of Darwin Harbour, Northern territory. *Wildlife Research* **23**, 443-74.

Noske, R.A. 1995. The ecology of mangrove forest birds in Peninsular Malaysia. *Ibis (UK)* **137**, 250-263.

Noske, R.A. 1994. Shining Bronze-cuckoo and Channel-billed Cuckoo: first records for Timor. *Kukila* **7**, 68-69.

Noske, R.A. & Brennan, G. 1993. First record of the Spectacled Monarch *Monarcha trivirgatus* in Northern Territory. *Northern Territory Naturalist* **14**, 32-33.

Noske, R.A. 1993. *Bruguiera hainesii*: another bird-pollinated mangrove? *Biotropica* **25**, 481-483.

Noske, R.A. 1992. Do grasswrens have the numbers: reply to Woinarski (1992). *Northern Territory Naturalist* **13**, 5-8.

Noske, R.A. 1992. The status and ecology of the White-throated Grasswren. *Emu* **92**, 39-51.

Balen, van S. & **Noske, R.A**. 1991. Note on two sight records of the Yellow-rumped Flycatcher *Ficedula zanthopygia* on Bali. *Kukila* **5**, 142.

Noske, R.A. 1991. Field Identification and ecology of the Greater Goldenback Woodpecker. *Forktail* **6**, 72-74.

Noske, R.A. 1991. A demographic comparison of cooperatively-breeding and non-cooperative treecreepers (Climacteridae). *Emu* **91**, 73-86.

Holmes, G. and **Noske, R.A**. 1990. New locality records of birds in Arnhem Land and southern Gulf of Carpentaria. *Northern Territory Naturalist* **12**, 13-19.

Noske, R.A. 1990. Seed dispersal of Black Wattles *Acacia auriculiformis* by birds. *Northern Territory Naturalist* **12**, 24-25.

Ford, H.A., Bell, H.L., Nias, R. and **Noske, R.A.** 1988. The relationship between ecology and the incidence of cooperative breeding in Australian birds. *Behavioural Ecology & Sociobiology* **22**, 239-49.

Noske, R.A. & Gessel, F. van. 1987. First record of the Blue-billed Duck for the Northern Territory. *Northern Territory Naturalist* **10**, 13.

Noske, R.A. 1986. Intersexual niche segregation among 3 bark-foraging birds of eucalypt forests. *Australian Journal of Ecology* **11**, 255-67.

Throckmorton, G.S., de Bavay, J., Chaffey, W., Merrotsy, B., Noske, S. and **Noske, R.A**. 1985. The mechanism of frill erection in the Bearded Dragon *Amphibolurus barbatus* with comments on the Jacky Lizard *A. muricatus* (Agamidae). *Journal of Morphology* **183**, 285-92.

Noske, R.A. 1985. Left-footedness and tool-using in the Varied Sittella *Daphoenositta chrysoptera* and Crested Shrike-tit *Falcunculus frontatus*. *Corella* **9**, 63-4.

Noske, R.A. 1985. Huddle-roosting behaviour of the Varied Sittella *Daphoenositta chrysoptera* in relation to social status. *Emu* **85**, 188-194.

Noske, R.A. 1984. Sexual dichromatism in nestling and juvenile treecreepers. *Australian Bird Watcher* **10**, 177-185.

Short, L.L., Schodde, R., **Noske, R.A.** and Horne, J.F.M. 1983. Hybridization of 'White-headed' and 'Orange-winged' Varied Sittellas, *Daphoenositta chrysoptera* and *D. c. chrysoptera* (Aves: Neosittidae), in eastern Australia. *Australian Journal of Zoology* **31**, 517-31.

Noske, R.A. 1983. Communal behaviour of Brown-headed Honeyeaters. *Emu* **83**, 38-41.

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Howe, R.W. & **Noske, R.A.** 1980. Cooperative feeding of fledglings by Crested Shrike-tits. *Emu* **80**,40.

Noske, R.A. 1980. Cooperative breeding and plumage variation in the Orange-winged (Varied) Sittella. *Corella* **4**, 45-53.

Noske, R.A. 1980. Cooperative breeding by treecreepers. *Emu* **80**, 35-6.

Noske, R.A. & Sticklen, R. 1979. Nest and eggs of the Yellow-legged Flycatcher. *Emu* **79**, 148-9.

Noske, R.A. 1979. Coexistence of three species of treecreepers in north-eastern New South Wales. *Emu* **79**, 120-8.

Noske, R.A. 1978. Range extensions of the Grey-headed Honeyeater and Fan-tailed Cuckoo. *Sunbird* **9**, 12.

Noske, R.A. 1978. Comments on some of the scientific names used in the Interim List of Australian Songbirds. *Australian Birds* **13**, 27-35.

Noske, R.A. 1977. Roosting of treecreepers. *Sunbird* **8**, 41-43.

Noske, R.A. 1975. The Common Sandpiper in New South Wales. *Australian Birds* **10**, 1-9.

Noske, R.A. 1974. Two days of birdwatching at "Turkey's Nest". *Australian Birdlife* **7**, 148-50.

Noske, R.A. 1974. Some tern observations in north Queensland. *Australian Bird Watcher* **5**, 103-11.

BOOKS

Noske, R.A. & Brennan, G. 2002. *The Birds of Groote Eylandt.* CDU Press, Darwin. 196 pp.

BOOK CHAPTERS/ CONFERENCE PROCEEDINGS

Noske, R.A. 2010. The potential impacts of climate change on the birds of Indonesia. In ***Impact of Climate Change on Biodiversity; does Nature Conservation need New Strategies?*** **(eds.** J. Slowik, M. Pangau-Adam & K. Barua), pp 23-37**. Proceedings of the International** German Alumni Summer School, Manado, Indonesia. Cuvillier Verlag, Göttingen, Germany.

Pangau-Adam, M. & **Noske, R.A.** 2010. Wildlife hunting and bird trade in northern Papua (Irian Jaya), Indonesia. In *Ethno-ornithology. Global Studies in Indigenous Ornithology: Culture, Society and Conservation* (eds. Tidemann, S., Gosler, A. & Gosford, R.), pp 73-86. Earthscan, London.

Noske, R.A. 2007. Family Neosittidae (Sittellas). In *Handbook of the Birds of the World, Vol 12* (eds. J. del Hoyo, A. Elliott and D.A. Christie), pp 628-641. Lynx Edicions, Barcelona. ISBN: 84-96553-42-6

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Noske, R.A. 1997. The ecology of Timorian birds. In *The Ecology of Nusa Tenggara and Maluku.* (eds K.A. Monk, Y. de Fretes & G. Reksodiharjo-Lilley), pp 353-362 . Periplus Editions/ Oxford University Press, Oxford.

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Book reviews

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Noske, R.A. 1992. Birds in mangroves. *Wingspan* **8**, 16-18.

Noske, R.A. 1992. Mangrove birds of Peninsular Malaysia and their conservation. *Asian Wetlands News* **5**, 15-16.

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