



Additions to Awaba Waste Management Facility

Environmental Assessment - VOLUME 3 (Appendices I to K)

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29 August 2012

Prepared for Lake Macquarie City Council
138 Main Road Speers Point NSW 2284



Additions to Awaba Waste Management Facility

Appendix I

AWMF Site Flora and Fauna Report

FLORA AND FAUNA
INVESTIGATIONS

AWABA LANDFILL
LOT 372 DP723259

REPORT TO

LAKE
MACQUARIE
CITY COUNCIL



Study Area - Lot 372 (Awaba Waste Facility)

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27 AUGUST 2012

Forest Fauna Surveys Pty Ltd
Hunter ECO
Eastcoast Flora Survey

Flora and Fauna Investigations

Awaba Landfill
Lot 372 DP723259

Report prepared for Lake Macquarie City Council

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EXECUTIVE SUMMARY

Lake Macquarie City Council operate the Awaba waste facility, which is approaching the end of its current operational life in 4-5 years. The facility requires expansion to extend the operational life span for another 24 years based on current deposition rates. This report presents the results of ecological investigations to identify the potential impacts of the proposed expansion on threatened species and their habitat.

Ecological investigations on the landfill site (Lot 372) recorded a total of 3 threatened species, including 2 plant and 1 fauna species. Within the wider study area, which includes adjoining Lot 373 to the east, a total of 4 threatened plants and 5 threatened fauna were recorded. None of the five vegetation units described and mapped for Lot 372 equate to listed Threatened Ecological Communities in New South Wales (*TSC Act 1995*), or Nationally (*EPBC Act 1999*).

The proposed action on the landfill site will result in loss of 2,302 *Tetratheca juncea* plants, or 98.6% of the site population. For threatened fauna species, the extent of native vegetation / fauna habitat that would be cleared by the proposed expansion is 8.55 hectares. This area contains habitat attributes that may be utilised by up to 11 threatened species listed under national or state threatened species legislation. The landfill site area to be disturbed also provides habitat for a number of fauna species listed as Migratory under the national *EPBC Act 1999*. The potential removal of 8.55 hectares of habitat may result in the loss of the habitat trees which provide an important habitat resource for tree hollow dependent threatened and protected fauna and foraging and sheltering habitat for threatened and protected fauna.

The “maintain or improve” principle means the result of an action should at least not result in a net loss of a species and its habitat, and preferably a net gain. This can be accomplished by setting aside in perpetuity parts of populations and habitat in a proportion of land and habitat that offsets the loss from the action. Lake Macquarie City Council is currently undertaking compulsory acquisition of the adjoining lands at Lot 373 DP 723269. The proposal to acquire this Lot, which supports a significant population of *Tetratheca juncea* plants, would offer a substantial offset to those plants removed by the proposed expansion of the Awaba waste facility.

The landfill site and adjoining Lot are contiguous with an approximate area of 1,530 hectares of similar vegetation community, Coastal Plains Smooth-barked Apple Woodland or Coastal Plains Scribbly Gum Woodland communities (NPWS, 2000). The NPWS vegetation mapping shows that the aforementioned 1,530 ha of vegetation is almost entirely made up of these two communities and so would be suitable habitat for *Tetratheca juncea*. There is no suggestion that the extraordinary population density recorded in the Awaba waste site would continue unabated into this surrounding habitat. However, based on an average of 40 clumps per hectare within the 1,530 hectares, this would estimate the population approaching 70,000 clumps. A significant proportion of the additional 1,530 hectares occurs on land zoned 7(2) – Conservation Secondary with limited potential for future development (LMCC, 2004).

Under the current development plan for the Awaba site, there is limited scope for conservation of remnant vegetation and habitat along the western, northern and eastern boundaries. The impact is unlikely to have a significant impact on threatened plant species local population, but is considered likely to require referral to the National Department of Sustainability, Environment, Water, Population & Communities (DSEWPac). The proposed Action is being assessed as a project application under Part 3A of the *Environmental Planning & Assessment Act 1979*. In this instance, the preparation of a Species Impact Statement to support a project application is not required.

1.0 INTRODUCTION

1.1 Background

Lake Macquarie City Council (LMCC) is a coastal local government area (LGA) in NSW with a population of around 200,000 and predicted growth rate of 0.7% per annum. Council provides a diverse range of waste services to the community as well as maintaining key associated waste infrastructure such as a landfill and a worm farm. Council operates a single landfill at Wilton Road, Awaba, licensed by the NSW Environment Protection Authority to accept Class 1 waste. Class 1 includes putrescibles (decomposable) waste, which characterises current kerbside domestic waste and biannual kerbside collections, which are all disposed of entirely at Awaba landfill. The location of the Awaba landfill site within the LGA is presented below in **Figure 1**.

This site is approaching the end of its current lifespan, with only 4-5 years capacity remaining, based on current filling rates and with projected population increases over that time period. Development and implementation of alternative waste management strategies is necessary. LMCC has embarked upon a Waste Strategy Development Project to identify and develop a number of activities and / or infrastructure that would lead to improved outcomes for Lake Macquarie's waste management. An immediate action arising from the project analysis and endorsed by Council is the physical expansion of the Awaba landfill site.

LMCC has engaged landfill-engineering consultants GHD to complete concept designs for the expansion of Awaba landfill within the current site boundary. The concept, if implemented, would lead to significant increases in landfill capacity at the site and extension of Awaba's lifespan is a priority action as part of Lake Macquarie's waste strategy. LMCC (the proponent) submitted a Preliminary Environmental Assessment (PEA) to the Department of Planning (DoP) that outlined potential aspects, impacts and mitigating actions associated with the development. The PEA identified fauna and flora impacts as potentially having a high significance to the project. Council has commenced flora, fauna and biodiversity assessments of the site and the proposed expansion. This work is to assess the ecological values of the land, in order to capture data at particularly sensitive and necessary periods during possible flowering seasons.

This report has been prepared for the proposed expansion of the Awaba waste facility [Lot 372 DP 723259], and documents the biodiversity values and potential impact of the expansion proposal on threatened species.

1.2 Site Description (Lot 372 DP 723259)

The Awaba Waste facility site occurs on Lot 372 DP723259 off Wilton Road, Awaba [hereafter referred to as the *landfill site*]. The landfill site occupies an area of 32.5 hectares, of which 20 hectares is devoted to the landfill operation and the remainder used for setbacks and buffer zones (refer to **Figure 2** below). Concept plans are also reproduced in **Appendix 5** of this report. The landfill site slopes south from a ridgeline on the north-western and northern boundary, reaching a height of 117m AHD on Awaba Hill. The native vegetation on the landfill site occupies approximately 12.5 hectares and is dominated by *Coastal Plains Smooth-barked Apple Woodland* and *Coastal Plains Scribbly Gum Woodland* (LHCCREMS, 2003). A small creek drains west to east along the southern boundary between the landfill operation and Wilton Road. This small creek line connects eventually to Kilaben Creek downstream and into Lake Macquarie, a further 2.7 kilometres to the east of the landfill site.

At the landscape scale, the landfill site is contiguous with an extensive area of forested land, with direct connectivity to a forested patch approximately 530 hectares, with an adjoining patch of approximately 1,000

hectares supporting Coastal Plains Smooth-barked Apple Woodland or Coastal Plains Scribbly Gum Woodland communities as classified in NPWS (2000).



Figure 1. Location of Awaba Landfill Site, City of Lake Macquarie (Image copyright LMCC)



Study Area - Lot 372 (Awaba Waste Facility)

Map produced by Forest Fauna Surveys Pty Ltd
Base Aerial Photograph copyright LMCC
Aerial Photo Date: 2007

Figure 2. Landfill Site, Lot 372 DP723259 (Aerial photograph copyright LMCC)

1.3 The Proposal

The purpose of the expansion proposal is not to develop, or extend, a regional landfill site to accept more waste, but rather to extend the lifespan of the existing facility, whilst developing additional sustainable waste minimisation practices. The extension of the current landfill site is preferred to development of a new landfill site elsewhere, particularly as the site is already disturbed by current operations. The proposed expansion of the existing Awaba Waste facility will extend the life of the current operation by 24.9 years, based on current deposition rates.

The expansion proposes to excavate two new landfill cells known as Area A (3.3 ha) and Area B (2.8 ha). Additional expansion areas include a Waste Transfer Station located on the eastern boundary, new weighbridge and an upgrade to the Amenities and Reuse Centre located in the southern portion of Lot 372. The expansion would result in earthworks and clearing of 8.55 hectares of native vegetation. New sedimentation ponds and access roads would also be constructed to the south of the proposed Area B cell in area referred to in this report as Additional Area 3. This ecological investigation is to identify the potential impacts of the proposed expansion of the landfill site on threatened species and their habitat.

1.4 Scope of Works

The study brief specifies the scope of ecological works, which require assessment within Lot 372 and Lot 373 Deposited Plan 723259. The first investigation (this report), is required to identify and assess aspects and direct and indirect impacts at the proposed areas for landfill expansion and development at the Awaba landfill site itself (Areas A and B, waste transfer station and new amenities and reuse centre). On-site investigations must also include desktop research and reference to online databases and reports including consideration of fauna, flora and biodiversity guidelines of the relevant state and federal statutory organizations i.e. NSW Office of Environment and Heritage.

This report has been prepared for LMCC to present the following:

- i) a discussion of potential impacts of the proposed expansion on threatened species and or their habitat; and
- ii) suggested mitigation measures to offset the impact.

The study brief specifies the following must be undertaken:

- (1). Review available information for the land and its vicinity (including regional context, databases and studies undertaken for the site and land in the general area);
- (2) undertake field surveys to confirm biodiversity values of the sites, targeting threatened species and endangered ecological communities. Survey and reporting is required to meet the requirements of the Lake Macquarie Flora and Fauna Survey Guidelines (2001) and any requirements of the Commonwealth Department of the Sustainability, Environment, Water, Population and Communities (DSEWPaC), where applicable. This would quantify as far as possible the quality, condition, extent, significance, and connectivity of native vegetation and habitat on the site;
- (3) summarise the ecological values of the land (at landscape and site scales), and identify issues relating to the ecological requirements and viability of each significant species, population and/or vegetation community occurring within the area;

-
- (4) identify the strategic biodiversity planning issues (e.g. key biodiversity values, population viability and landscape context, fragmentation of native vegetation, connectivity requirements, zoning requirements). This is to enable:
 - subsequent review of the ecological consequences of options for future urban structure, and
 - evaluation of the extent to which these options meet Council's Lifestyle 2020 Strategy objectives;
 - (5) recommend principles for long-term conservation of important biodiversity values on the site; and,
 - (6) address the Director-General's Requirements for fauna and flora assessment.

In addition to points 1 – 6 above, the following general tasks would also be required to be undertaken:

- (7) review appropriate literature and databases, and compile information from previous studies (including existing site and regional studies). A summary of properly referenced existing data is required;
- (8) identify the landscape scale (regional) biodiversity context of the site;
- (9) undertake vegetation community and flora survey (terrestrial and aquatic species);
- (10) undertake fauna and fauna habitat survey;
- (11) undertake targeted surveys for national and state listed threatened species and endangered ecological communities as well as migratory species as required;
- (12) document biodiversity values of the site in a comprehensive species list;
- (13) undertake a strategic review to inform decisions in relation to the preferred future use of the land (including reference to Council and regional biodiversity conservation policies and principles);
- (14) identify biodiversity values that should be retained on the land and identify areas with biodiversity value (potentially this could extend to a review of alternative land use options);
- (15) identify principles and development guidelines to be incorporated in the future planning and development of the land (e.g. minimum areas of habitat to be retained, EEC retention and buffer widths, riparian corridor widths, minimum and desirable corridor widths, road and culvert design, hydrological regime, desirable bush fire regime);
- (16) determine under what circumstances the proposed development on Lot 372 Deposited Plan 723259 would be likely to have a significant effect on threatened species, populations, or ecological communities within the area;
- (17) assess vegetation and habitat condition and management issues that are relevant to the study objectives;
- (18) make recommendations with regard to meeting the "improve and maintain test" by; firstly, avoiding, secondly offsetting, and as a last resort minimising impacts from subsequent land uses;
- (19) document the limitations of the ecological surveys conducted and any assumptions made in deriving recommendations;
- (20) address the matters raised within the Director-General's Requirements (DGR's); and
- (21) make recommendations with regard to additional surveys or supplementary studies that should be conducted.

2.0 METHODOLOGY

2.1 Flora Survey

Four separate but related tasks were undertaken in order to meet the objectives of this project:

- Collection of Rapid Data Points to assist classification and mapping
- Systematic flora survey to sample all observable variations
- Analysis of floristic data to classify the vegetation
- Mapping the distribution of defined vegetation communities or their variants

2.1.1 Rapid Data Points

The collection of Rapid Data Points (RDPs) is a relatively new method of vegetation mapping for accurate spatial depiction of vegetation biodiversity. Central to this method is the recognition that variability in vegetation distribution cannot yet be predicted blindly using computer GIS programs, and that documenting what actually occurs on the ground is an essential component in producing a reliable final map. Many mapping programs have relied heavily on GIS capabilities to predict where certain vegetation communities occur, with often disappointing results (e.g.: the LHCCREMS vegetation modelling, NPWS 2000).

RDPs are essentially summaries of floristic information recorded at specific points in the field. At specific and regular locations, summaries of the vegetation are noted and way pointed in the GPS, and later transferred to the GIS. Information recorded includes:

- Canopy layer dominant species
- Shrub layer dominant species
- Ground layer dominant species
- Draft vegetation unit
- Miscellaneous notes

Initially, all trafficable paths across the study area are driven in 4WD vehicle recording RDPs. Those areas lacking extensive trail networks are then walked on foot with hand-held GPS units, recording the same information. In this way, a large dataset of summary information can be rapidly collected to use in vegetation mapping procedures. The data also proves invaluable as a ground-truthing mechanism for the final vegetation map. Bell (2009) describes the method in more detail.

2.1.2. Systematic Flora Survey

Systematic flora survey conducted across the landfill site consisted of the following steps:

2.1.2.1 Plot selection

Plot selection was guided by knowledge of local vegetation types and their variations, supported by extensive ground truthing. This process recognised the fact that environmental stratification of the area (such as through the use of habitat surrogates like soil landscapes) was not adequately highlighting some floristic variations, which were evident in the field. Other workers have also recognised the problems of stratification in some

environments (eg: Griffith *et. al.*, 2000), and this process of expert intuition is one of the central themes in the Braun-Blanquet system of plant classification (Braun-Blanquet, 1928).

2.1.2.2 Plot Sampling

Within areas considered to be representative of the major floristic variations present, detailed survey within 0.04ha quadrats was completed. Methods used were those adopted as standard by New South Wales government agencies (Sivertsen, 2010). The same methods are also consistent with the large body of existing data in the region (Bell, 2000; NPWS, 2000). Benson (1999) provides an overview of how important consistent survey methods are for vegetation management across the State. Within each 0.04ha site (nominally 20 X 20m, but can be 40 X 10m in riparian zones, etc), all vascular plant species present are recorded and given a cover abundance rating, based on a modified Braun-Blanquet scale (1 to 6). Physical attributes of the site (vegetation structure, soil type, elevation, slope, aspect, physiographical position, etc) are also recorded, and photographs taken of the site for later reference. Plant specimens of unknown or significant status are collected for later identification or lodgement with the National Herbarium in Sydney.

2.1.2.3 Ground Truthing

General reconnaissance undertaken as part of the mapping process (see below) validated trends observed in the floristic data. During such reconnaissance, searches for rare or threatened Australian plants were also made. Levels of disturbance and fire history of the general area could also be assessed in this manner.

2.1.3 Data Analysis

A review of plant taxonomy was undertaken for all taxa included in the final dataset to ensure consistency of nomenclature. Nomenclature according to Harden (1990-1993; 2002) and Harden and Murray (2000) was used as the standard, except where more recent revisions have been published in recognised scientific journals and accepted by the National Herbarium of New South Wales (as per their Plantnet web site <http://plantnet.rbgsyd.nsw.gov.au/>).

Cluster analysis and non-metric multidimensional scaling (nMDS) on the dataset was performed using *Primer V6* (Clarke & Gorley 2006), utilizing the group averaging strategy, the Bray-Curtis association measure and a Beta value of -0.1. The SIMPER routine was used to generate diagnostic species lists for each defined floristic group. Analysis of similarity within and between pre-defined floristic groups was undertaken with the ANOSIM routine. Additional data analysis was also undertaken using the same methods for a larger regional dataset (principally the lower Hunter Valley and Central Coast), to test how the derived groups for Awaba related to other native vegetation in the region. Information on the structure of vegetation within each community has been calculated and averaged from data collected at each of the floristic data plots. Estimates of height and percentage cover for each of the emergent, tallest layer, mid layer, and lowest layers have been used.

2.1.4 Vegetation Mapping

Within Mapinfo © GIS, observable photo-patterns from 2007 digital ortho-rectified aerial photographs (supplied by Lake Macquarie City Council) were initially digitised on-screen to form a base map layer. Subsequent to this, each RDP collected via GPS (see Section 2.1.1) was attributed a map unit code reflecting the floristic classification, and overlain on the base map to code each polygon accordingly. Updating of the vegetation map layer was done progressively after each field day.

2.2 Fauna Survey

The fauna survey was conducted over two separate periods, November 2010 and February 2011. A total of 3 sampling sites were established within the larger study area (Lots 372 and Lot 373). Due to the mobility of fauna species, one fauna survey site (FA1) was located entirely within the landfill site, whilst the remaining two sites (FA2, FA3) were located in close proximity to Lot 372. This meant that whilst two sites effectively sampled offsite to the landfill site, their close proximity ensured that fauna species recorded would likely utilise habitats on the landfill site as a component of their larger foraging range. A summary of the key fauna groups and survey dates is summarised below in **Table 1**.

Table 1. Survey Dates for Fauna Groups, Study Area.

TASK / Fauna Group		Survey Dates, Fauna Survey 2010 - 2011		
Habitat Tree Mapping		8 – 18 November 2010		
	Survey Sites	FA1	FA2	FA3
Coordinates (GDA94)		364490 E; 6344950 N	364995 E; 6344988 N	365000 E; 6345370 N
Habitat Type		Creekline	Scribbly Gum Woodland	Scribbly Gum Woodland – Creekline
BIRDS	Diurnal Census	9/11/2010	10/11/2010	12/11/2010
	Nocturnal Census	10/11/2010	8/11/2010	12/11/2010
MAMMALS	Small (Elliott trapping)	7 -10/02/2011	7 -10/02/2011	7 -10/02/2011
	Terrestrial / Arboreal / Flying Mammals (spotlight)	10/11/2010	8/11/2010	12/11/2010
	Larger (cage trapping)	8 - 11/11/2010	8 - 11/11/2010	7 -10/02/2011
	Arboreal (tree trapping)	Not sampled	7 -10/02/2011	7 -10/02/2011
	Microbats	HT1	HT2	HT3
	Micro-bats (Harp Trap)	8 - 10/11/2010	8 - 10/11/2010	7-9/02/2011
	Micro-bats (Anabat)	8 - 10/11/2010	8 - 10/11/2010	7-9/02/2011
	Survey Sites	FA1	FA2	FA3
REPTILES and AMPHIBIANS	Diurnal Searches	8 – 18/11/2010	8 – 18/11/2010	8 – 18/11/2010
	Spotlight Searches	10/11/2010	8/11/2010	12/11/2010

The location of fauna sampling sites is presented below in **Figure 3**.

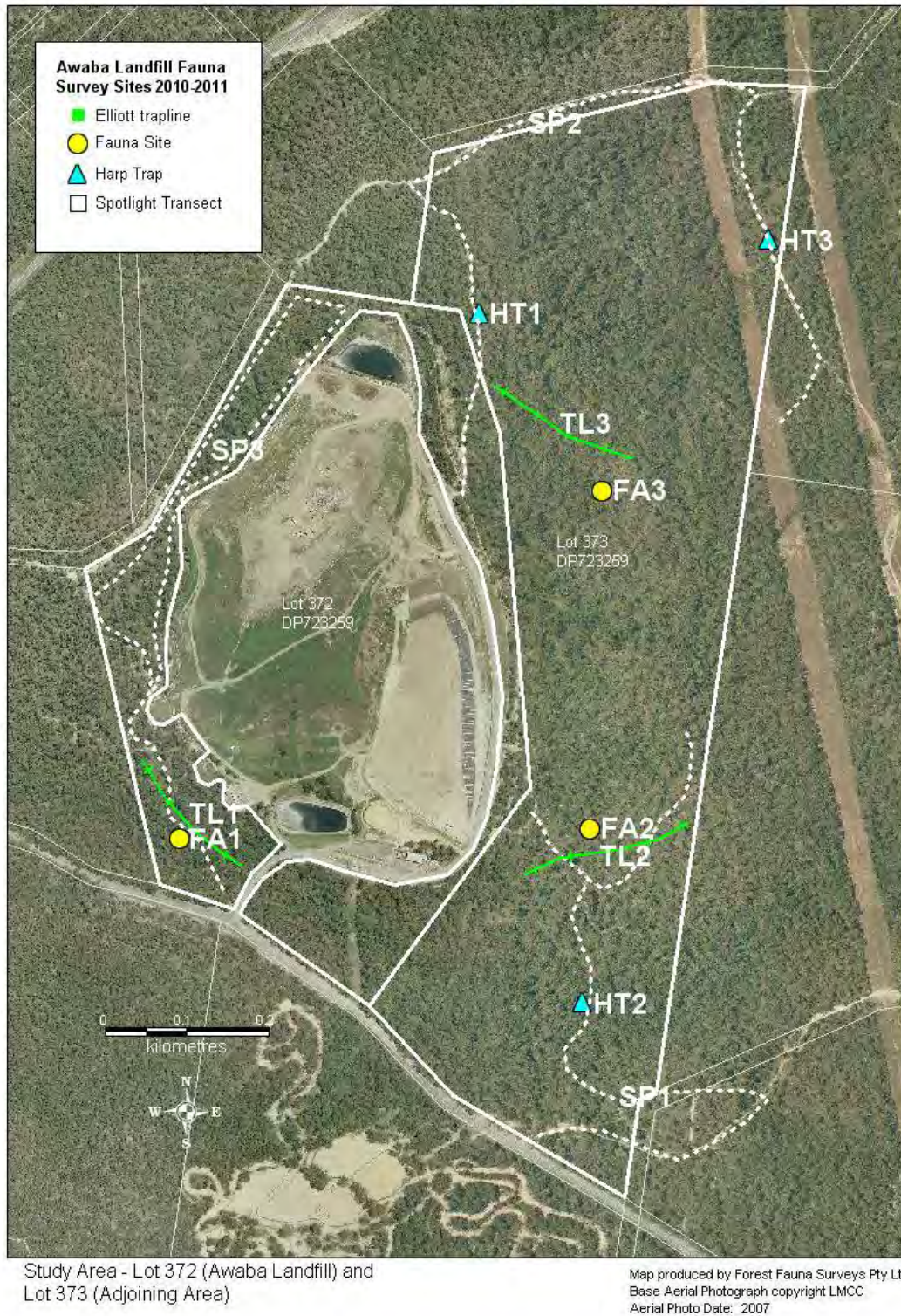


Figure 3. Location of Fauna Survey Sites, Awaba Waste Facility and Adjoining Land

2.2.1 Fauna Habitat Assessment

An assessment of the habitat types occurring within the study area was undertaken based on selected criteria to indicate the habitat attributes essential for fauna. Such attributes include:

- i the dominant vegetation type(s) within the study area;
- ii the density of mature trees with hollows for hollow dependent birds such as owls, arboreal marsupials such as possums and gliders, and microchiropteran bat species;
- iii density of ground litter such as fallen tree limbs, ground logs, decorticated bark, leaf litter and ground vegetation;
- iv degree of disturbance to habitats from impacts including clearings for vehicular tracks, infestations of introduced plant species;
- v frequency of fire regime to canopy, understorey and ground layer vegetation;
- vi presence of standing or flowing water and water soaks for amphibians, and
- vii presence of food trees for Koala as a requirement of SEPP 44 (Koala Habitat Protection).

The habitat attributes are determined by sampling within a one hectare plot of each vegetation community. Attributes are scored along a 100 metre line intercept transect, recording all plant species (canopy, understorey, ground layer vegetation). All species were identified where possible, and all canopy species were rated into size categories. Abundance of all species is recorded within a 100 x 50 metre quadrat, and scores are doubled to determine density per hectare.

2.2.2 Habitat Tree Mapping

Habitat trees were located by walking the entire study area (which includes Lot 372 and Lot 373) and plotting their location with a hand held GPS (Garmin 60CSx). Where a habitat tree was located, the following data was recorded:

- Tree ID,
- Tree species,
- Location recorded as easting and northing in MGA (GDA94) projection,
- diameter at breast height (dbh) (cm),
- height of tree (metres),
- % dead,
- number of major and minor limb spouts or hollows, number of trunk hollows or spouts, and
- assessment of likely fauna species to utilise hollows.

The assessment of likely fauna to utilise hollows was based on a size class of each hollow, where the following rating applied:

- (1) Hollows with small openings <20mm or small fissures on dead branches, main trunk or split bark were classed as potential hollows for microchiropteran bats and small reptiles,
- (2) Hollows with small openings >20mm <50 mm were classed as potential hollows for gliders and small birds (i.e. treecreepers),
- (3) Hollows with medium sized openings >50mm <200mm were classed as potential hollows for possums and larger birds (i.e. Eastern Rosella)

- (4) Hollows with large openings >200mm diameter were classed as potential hollows for large birds (large forest owls, cockatoos, ducks) and reptiles such as Lace Monitor and Diamond Python.

Tracks recorded by GPS were downloaded to the GIS and overlaid on the aerial photograph to indicate coverage of the subject site by foot traverses.

2.2.2.1 Limitations of Habitat Tree Mapping

Habitat trees were located by walking the entire study area and plotting their location with a hand held GPS (Garmin 60CSx). The apparent accuracy of this instrument is $\pm 5 -10$ metres. However, it must be acknowledged that the error will be significantly greater whilst recording beneath tree canopy cover. This can be overcome to a small degree by averaging the location fix by at least 2-5 minutes per tree. As a consequence, locations of habitat trees should be referred to as indicative location only, and should not be relied upon for accuracy.

Additionally, the assessment of potential fauna species that may utilise each tree hollow is based on a visual assessment conducted at ground level. There was no scope in this study to conduct internal inspections of each tree hollow to determine adequacy for fauna species. Hence, the count is likely to over-estimate the number of actual hollows utilised by tree hollow dependent fauna. For instance, a ground based assessment of habitat trees at a site in Lake Macquarie determined that 18 of 117 habitat trees located, were identified as suitable for large forest owls. However, upon inspection of each potential large forest owl hollow, only 1 habitat tree was identified as actually utilised.

2.2.3 Birds

Three survey methodologies to census for bird species are adopted for the fauna survey:

2.2.3.1 Opportunistic Observations

Opportunistic sightings of bird species are recorded whilst undertaking other field duties. This includes direct observations of bird species and identification of their characteristic calls. Opportunistic observations are also undertaken whilst conducting nocturnal spotlight searches, where calls of nocturnal bird species are commonly heard.

2.2.3.2 Nocturnal Surveys

Nocturnal bird census follows the standard survey methodology and was undertaken at three survey locations (FA1, FA2, FA3) on three separate evenings (8, 10 and 12 November 2010). This involves quiet listening for calls of owls at dusk and also during spotlight searches. Playback of pre-recorded calls of the threatened Powerful, Masked, Barking and Sooty Owl were broadcast through a 15 watt portable amplifier. Following playback calls, a period of 15 minutes quiet listening to detect any vocal responses from the owls.

2.2.3.3 Diurnal Census

Sample plot counts employ a standard 20 minute search within a 1 hectare area (i.e. 100m x 100m, 50m x 200m, etc.) at each of the three fauna survey sites. Counts of all bird species observed or heard were conducted during periods of relatively high bird activity (i.e. early morning) and with reasonable detectability. All bird species and

individuals seen or heard are recorded, being scored as on-site if detected within plot, or off-site if recorded in adjacent vegetation types or flying overhead. A list of the bird species recorded during the survey period and previous surveys / fauna databases is presented in **Appendix 2**. Previous records were sourced in the locality (<5km radius) of the Awaba Waste site by records held on the Office of Environment and Heritage Wildlife Atlas (OEH, October 2011) and LMCC fauna database (LMCC, 2000).

2.2.4 Mammals

Trapping for small and medium sized terrestrial mammals was along 3 transects established at each survey site. Arboreal traps for possums and gliders were established at two sites (FA1, F2) with suitable habitat (and less potential for disturbance / damage to traps). Microbats were surveyed for with the use of 3 Anabat detectors set in proximity to three harp trap sites HT1, HT2 and HT3. The selection of harp trap sites reflected discreet locations away from main visitation areas by local residents.

2.2.4.1 Small Terrestrial Mammals

Three transects (TL1, TL2 and TL3) of Elliott A traps (15 x 16 x 33cm) were set along a linear transect with 25 traps spaced approximately 10 metres apart (approximate length of transect 200 – 250 metres). Each trap was baited with a mixture of peanut butter, rolled oats and honey and set for three consecutive nights (6 – 9 February 2011). Traps were inspected daily and any individuals captured were identified, weighed, sexed, measured and released at point of capture. A total of 75 Elliott trap nights was surveyed per site, with a total survey effort by Elliott traps for all sites of 225 trap nights.

2.2.4.2 Larger Terrestrial Mammals

Cage traps for larger mammals were set at specific sites (TL1, TL2) to target the presence of species such as bandicoots. A total of 5 traps were set for 3 consecutive nights, with each trap baited with a mixture of tinned sardines and or bread with jam. Trapping survey effort by cage trapping was 15 cage trap nights.

Spotlight searches were undertaken along major and minor tracks and walking transects throughout the study area. These were conducted on foot using a 50 watt spotlight for a period of 80 - 90 minutes per transect. Each transect was surveyed once during the survey period. The following data was recorded for each transect;

- time at commencement and completion of transects, and
- the identity and number of animal's observed and weather conditions.

2.2.4.3 Arboreal Mammals

Arboreal Trapping

Arboreal trapping for possums and gliders was undertaken with Elliott Type B (15 x 16 x 45 cm) folding aluminium traps mounted on platforms attached to the tree trunk. Two survey sites were established within the subject site. Trapping site selection was based on a number of parameters:

- each grid being located in major vegetation types (Scribbly Gum – Red Bloodwood Open Woodland and Riparian Forest),
- spatially separate from each other to ensure no re-captures from adjoining grids,
- obscurity from the public visiting the study area.

At each site, Elliott type B traps were mounted on trees at a height of 3.0 metres. Traps were established in a trapping grid configuration of 2 lines of 5 traps, with each trap spaced approximately 50 metres apart. The effective trap area of this grid configuration (4.0 hectares), plus a boundary strip of 45 metres wide is 2.0 hectares. Each trap grid was active for three consecutive nights, resulting in 60 arboreal trap nights for this study. Each trap was baited with a mixture of peanut butter, rolled oats and honey and the trunk of the tree adjacent to the trap sprayed with a mixture of water and honey to act as an attractant.

Spotlight Searches

Spotlight searches undertaken by foot across the subject site for approximately 60 minutes on three separate evenings in early November 2010. Transects were located in proximity to each trapping grid with searches were conducted with a 55 watt spotlight, coupled with periods of quiet listening in darkness to detect any animal movements or vocalisations. Particular attention was paid to trees in flower as these provide a source of blossom and nectar for arboreal mammals such as gliders and bats such as the Grey-headed Flying-fox.

Spotlight searches were conducted on the evenings of 8, 10 and 12 November 2010. A total of 4.5 hours spotlight searches was undertaken during the survey period.

Stag-watch Observations

Stag watching involves direct counts of active nocturnal animals emerging at dusk. The technique involves observers stationed beneath hollow bearing dead or living trees in a defined area and recording the identity and number of emergent animals following dusk for a period of about 40 minutes until complete darkness. This technique is useful as it provides an accurate measure of absolute abundance providing all individuals emerge following dusk, and all individuals in a population or group den in tree hollows (Smith *et al.*, 1989). Stag watching of habitat trees was conducted on two evenings in proximity to the harp trap sites to ensure no vandalism of the equipment during the last period of daylight.

2.2.4.4 Bats

Surveys for microchiropteran (insectivorous) and mega-chiropteran (flying foxes) bat species comprise:

- trapping using two bank AustBat harp traps (4.2 m²) at three sites (HT1, HT2 and HT3) to determine the presence of sub-canopy species;
- Detection of echolocation calls via Anabat II detectors onto digital Zcain storage discs for subsequent computer analysis.
- Spotlighting for flying foxes and larger microchiropteran bats.

Echolocation Calls

Echolocation calls of microchiropteran bats were recorded at each of the three Anabat monitoring site. Calls were recorded by an Anabat II detector and stored onto a digital storage card which is processed by Titley Zcain recording units. This technique enables sampling of bat activity for the duration of the night, providing a more comprehensive recording of bat species utilising each site. All recorded calls were down loaded to a computer for subsequent analysis. Sampling with Anabat detectors was undertaken at the same time as harp trapping. Anabat sampling was conducted on the evenings of 9 and 10 November 2010, but due to the low number of bat calls recorded, this was repeated in early February 2011 (2 nights).

Several species of insectivorous bats have distinctive echolocation calls that are unlikely to be confused with another species. However, some bat species overlap in call frequency and structure, making identification difficult in some cases. The degree of confidence attached to call identifications will depend on the duration of the recorded call and quality of the recording. For example, echolocation calls of the Lesser Long-eared Bat (*Nyctophilus geoffroyi*) and Gould's Long-eared Bat (*Nyctophilus gouldi*) cannot be reliably differentiated, and are therefore grouped as *Nyctophilus sp.* Similarly, calls of Greater Broad-nosed Bat (*Scoteanax rueppellii*), Eastern Broad-nosed Bat (*Scotorepens orion*) and Eastern Falsistrelle (*Falsistrellus tasmaniensis*) sometimes cannot be reliably differentiated and were therefore grouped together.

Harp Traps

Harp traps are used to capture bats and used as an adjunct to the echolocation call recordings. Austbat 4.2m² dual bank harp traps were set along suitable flyways to capture sub-canopy microchiropteran bat species. The Harp traps were set at three sites (HT1, HT2 and HT3) for two consecutive nights each. Total trapping survey effort was 6 harp trap nights.

Spotlight Searches

Flying-foxes were surveyed by spotlighting of potential food trees and by identification of their characteristic social calls. The presence of flying bats was also monitored by dusk activity by visually watching the skyline for bats.

2.2.5 Reptiles and Amphibians

2.2.5.1 Systematic and Opportunistic Searches

Reptiles were searched for under natural (ground logs) and artificial cover (dumped domestic rubbish) distributed throughout the study area and surrounds. Opportunistic records of reptiles were also noted during other phases of field survey. Nocturnal reptiles such as geckos were searched for during spotlight searches.

2.2.6 Opportunistic Observations

Opportunistic observations were recorded for direct and indirect evidence of these, and additional threatened fauna species. Searches were also conducted around the base of suitable habitat trees for evidence of whitewash and regurgitation pellets of the Masked Owl. Additionally, in areas of dense understorey vegetation such as along riparian creek lines, opportunistic observations were conducted for presence of whitewash and or roosting individuals of the Powerful Owl. Often the presence of whitewash and regurgitation pellets on the ground is indicative of roosting sites for the species.

2.3 Threatened Species

A 5km search of the locality on the LMCC, OEH and DSEWPaC fauna databases indicate 34 threatened species have been recorded, which include 5 plant species, 15 birds, 12 mammals, 1 reptile and 1 amphibian. The Department of Sustainability, Environment, Water, Populations and Communities (DSEWPaC) also list a number of threatened species for consideration from their Environmental Reporting Tool. This list included species derived from a greater distance from the Awaba site (~15 - 25 kilometres) to those assessed for this report, and included species not represented in habitats found on the subject site.

2.3.1 Threatened Flora

A full description of the survey methodology is presented in **Appendix 4** of this report (Hunter ECO, 2010). In summary, the survey method was to walk the entire study area in systematic transects close enough so that the majority of the survey area was seen. The separation between transects varied depending on visibility and the density of the target species being encountered. A handheld GPS attached to an external antenna (for better satellite reception under canopy) was used to record species occurrences. The GPS resolution was between +/- 4 – 6 metres, so each GPS waypoint became a record of the number of individuals within about a 4 metre radius of the location. To avoid double counting, a small piece of flagging tape was dropped on each counted individual and a strip of flagging tape marked the waypoint location. Because of its clonal plant structure it is not always possible to identify a single *Tetratheca juncea* plant. The method used here describes a single clump as being separate from the adjoining clump by 30 cm or more (Payne et al. 2002).

2.3.2 Threatened Birds

For the majority of threatened birds, targeted surveys include the standardised census at each fauna survey site, and opportunistic observations whilst undertaking other duties was considered sufficient to identify their likely presence. A summary of monitoring techniques to detect their presence (and abundance) is presented below in **Table 2**.

Table 2. Summary of Survey Methodology and Effort for Threatened Species.

Threatened FLORA	Systematic Transects	Quadrats	Opportunistic
<i>Acacia bynoeana</i>	22 days	2 days	24 days
<i>Angophora inopinata</i>	22 days	2 days	24 days
<i>Cryptostylis hunteriana</i>	22 days	2 days	24 days
<i>Grevillea parviflora ssp. parviflora</i>	22 days	2 days	24 days
<i>Tetratheca juncea</i>	22 days	2 days	24 days
Threatened BIRDS	Diurnal Census	Nocturnal Census	Opportunistic
Black Bittern	No suitable habitat		
Eastern Osprey	3.0 hours		8 days
Australian Pied Oystercatcher	No suitable habitat		
Black-winged Stilt	No suitable habitat		
Glossy Black Cockatoo	3.0 hours		8 days
Gang-gang Cockatoo	3.0 hours		8 days
Little Lorikeet	3.0 hours		8 days

Swift Parrot	3.0 hours		8 days
Turquoise Parrot	3.0 hours		8 days
Powerful Owl		3.0 hours	4.5 hours spotlight
Sooty Owl		3.0 hours	4.5 hours spotlight
Masked Owl		3.0 hours	4.5 hours spotlight
Regent Honeyeater	3.0 hours		8 days
Scarlet Robin	3.0 hours		8 days
Varied Sittella	3.0 hours		8 days
Threatened MAMMALS	Trapping	Spotlight Searches	Harp Trapping
Spotted-tail Quoll	15 cage trap nights	4.5 hours	
Koala		4.5 hours	
Squirrel Glider	60 arboreal trap nights	4.5 hours	
Grey-headed Flying-fox		4.5 hours	
East-coast Freetail Bat			6 trap nights
Little Bent-wing Bat			6 trap nights
Eastern Bent-wing Bat			6 trap nights
Large-eared Pied Bat			6 trap nights
Eastern False Pipistrelle			6 trap nights
Southern Myotis			6 trap nights
Greater Broad-nosed Bat			6 trap nights
Eastern Cave Bat			6 trap nights
Threatened Reptiles and Amphibians		Spotlight Searches	Opportunistic
Stephens Banded Snake		4.5 hours	
Green and Golden Bell Frog		4.5 hours	8 days
Heath Frog <i>Litoria littlejohni</i>		4.5 hours	8 days
Wallum Froglet		4.5 hours	8 days

2.4 Research Licensing

The flora and fauna surveys were undertaken under the following licences and approvals;

Michael Murray - Forest Fauna Surveys Pty Ltd

Office of Environment & Heritage Scientific Licence
 Department of Primary Industries Animal Research Authority
 Department of Primary Industries Director-General's Animal Care
 and Ethics Committee

SL100096

01/1108

DG ACEC 01/1108

Colin Driscoll – Hunter ECO

NSW NPWS Scientific Licence S10565

Stephen Bell – Eastcoast Flora Survey

NSW NPWS Scientific Licence S S11115

3.0 RESULTS

Weather Conditions

A summary of the weather conditions experienced during the fauna surveys is presented below in **Table 3**.

Table 3. Weather Conditions during fauna survey, Awaba Landfill Investigations.

Date	Min. Temp °C	Max. Temp °C	Wind Speed (km/h) and Direction		Cloud Cover	Rainfall (mm) 24 hrs	Moon Phase
			9 am	3 pm			
8/11/2010	12.7	30.8	N - 2	NE - 9	2/8	0.0 mm	0 / 4
9/11/2010	17.1	25.2	SW - 4	ESE - 7	8/8	17.4 mm	0 / 4
10/11/2010	16.2	27.3	NE - 4	N - 7	6/8	0.2 mm	0 / 4
12/11/2010	14.8	28.9	ESE - 4	ESE - 19	1/8	0.0 mm	0 / 4
7/02/2011	16.3	23.1	WSW - 4	SE - 6	3/8	28.8 mm	3 / 4
8/02/2011	17.1	26.3	SSW - 4	ESE - 15	2/8	0.0 mm	3 / 4
9/02/2011	14.6	27.1	SSW - 6	SE - 13	1/8	0.0 mm	4 / 4
10/2/2011	18.5	27.4	NNW - 2	E - 15	2/8	2.2 mm	

Data collected from Cooranbong Weather Station (10.0 km to the south-west of subject site)

3.1 Flora Survey

3.1.1 Rapid Data Points

Sixty-one Rapid Data Points were collected during field reconnaissance for this study. Eighteen rapid data points were collected within the landfill site. At each of these points, information on dominant plant species in each stratum was recorded and imported directly into the vegetation mapping process. Where possible, foot traverses were made into the more remote areas to increase the density of data points and hence improve the accuracy of the final map. **Figure 4** shows the distribution of RDPs across the study area.

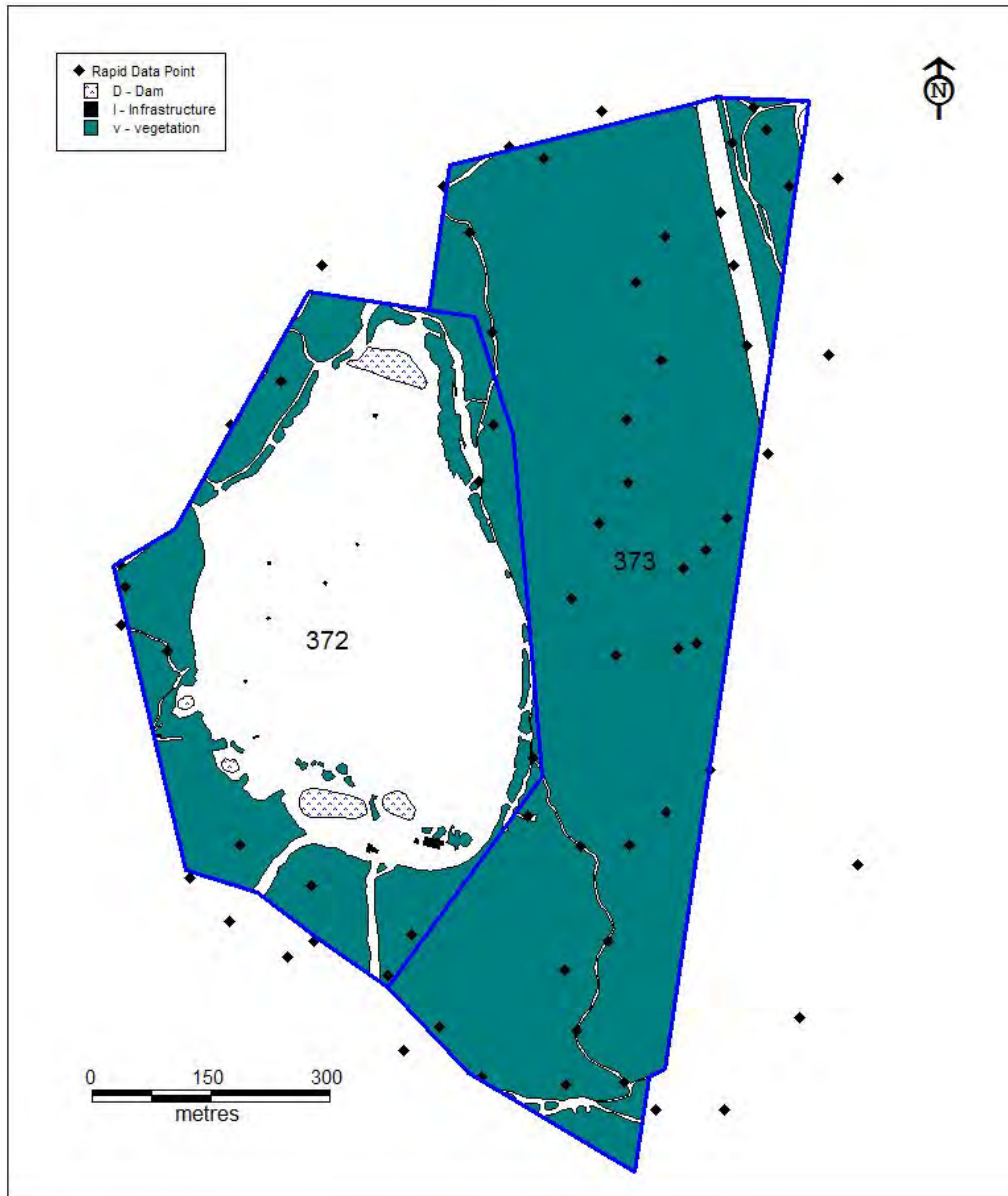


Figure 4. Distribution of Rapid Data Points (RDPs) across Study Area (Lots 372 and 373).

3.1.2 Floristic Survey

3.1.2.1 Survey Periods and Sampling Intensity

The majority of vegetation survey and mapping within the study area was undertaken during February 2011. Previous to this, intensive surveying for threatened species had been completed between September 2010 and December 2010 (Driscoll, 2010).

3.1.2.2 Floristic Diversity and Plot Sampling

A total of 189 plant taxa (including 16 weed / non-endemic species) have been recorded through systematic plot and other surveys for the study area. However, this diversity of plant species should not be seen as complete. Several more species, such as ephemeral and seasonal taxa may not have been recorded during systematic surveys or random meanders completed to date. Twelve full systematic survey plots were completed for the present study (5 in Lot 372 and 7 in the adjoining Lot 373). In addition, a single sample plot completed during the CRA surveys of 1998-9 (NPWS 1999) was also available, bringing to thirteen the total sample size for data analysis across the study area (Refer to **Figure 5** below)

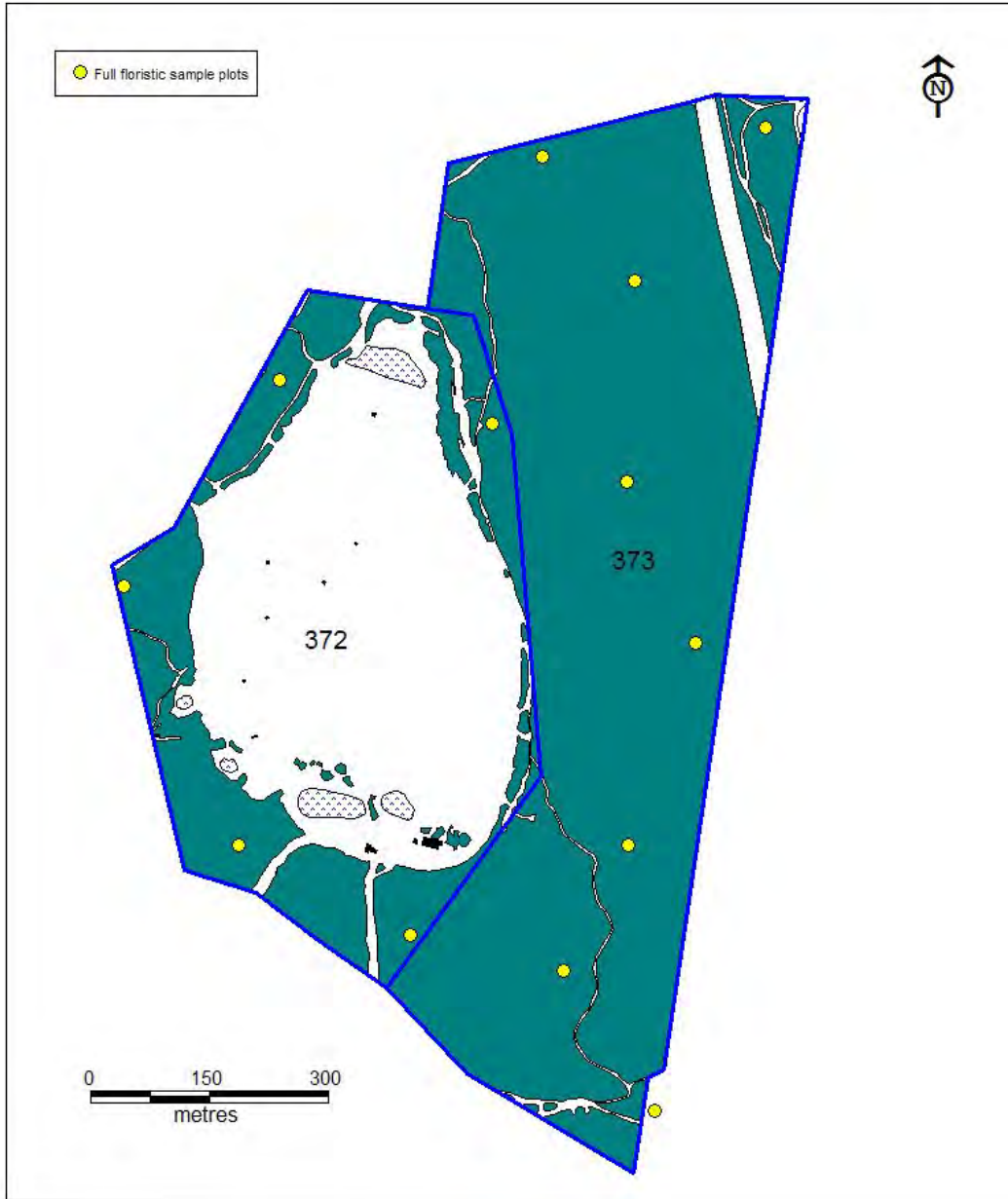


Figure 5. Distribution of floristic survey sites across the Study Area (Lots 372 and 373).

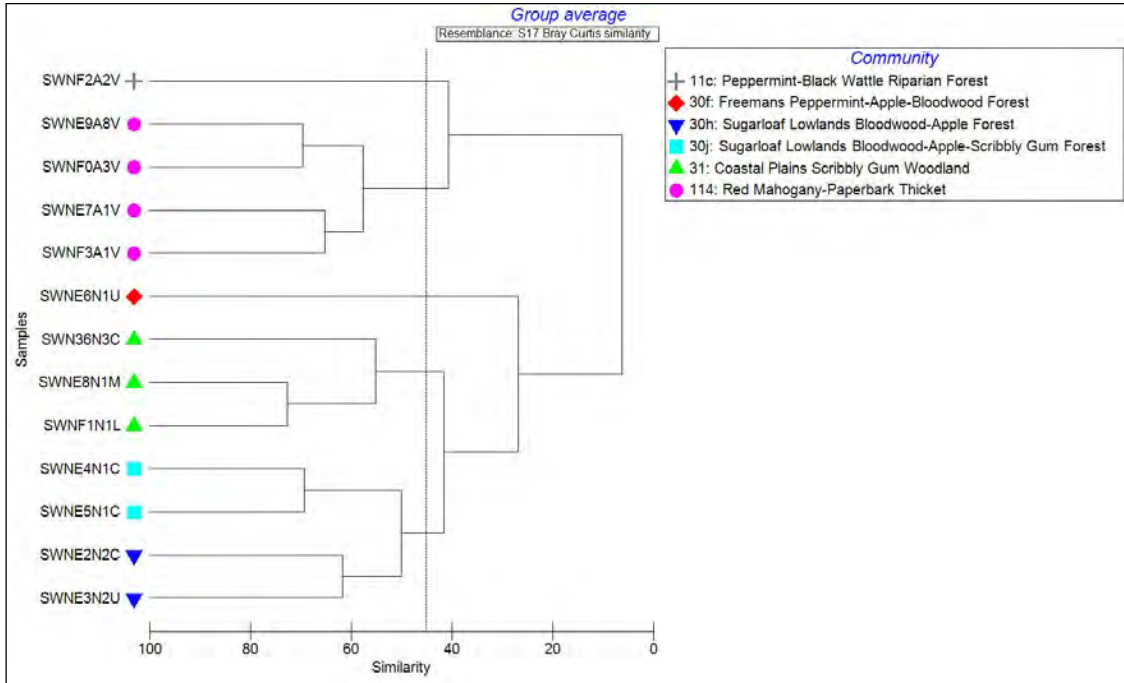


Figure 6. Cluster dendrogram of sample plots produced from Primer analysis. Cut-point taken at 45%.

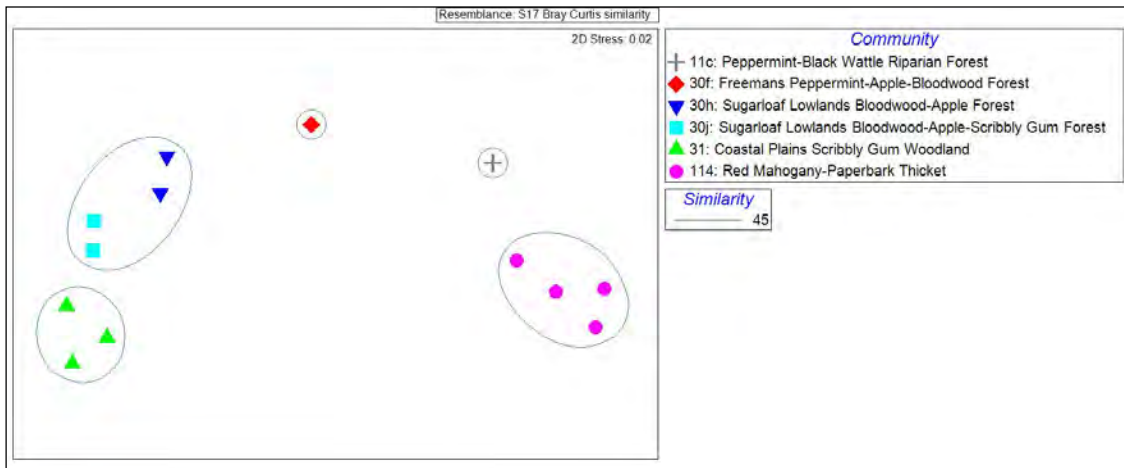


Figure 7. nMDS plot showing the relationship between all sample plots, overlain with cluster analysis groups (45% similarity, Bray-Curtis association measure) from **Figure 6**.

Table 4. ANOSIM results (Global R values) for pair-wise comparisons of aprior vegetation groups.

	31	30h	30j	30f	114	11c
31: Coastal Plains Scribbly Gum Woodland						
30h: Sugarloaf Lowlands Bloodwood-Apple Forest	1					
30j: Sugarloaf Lowlands Bloodwood-Apple-Scribbly Gum Forest	0.83	1				
30f: Freemans Peppermint-Apple-Bloodwood Forest	1	1	1			
114: Red Mahogany-Paperbark Thicket	1	1	1	1		
11c: Peppermint-Black Wattle Riparian Forest	1	1	1	n/a	0.83	

3.1.3.2 Central Coast Analysis

Within the considerably larger Central Coast regional dataset maintained by Stephen Bell (Newcastle, Lake Macquarie, Wyong, Gosford LGA's: 928 sites), cluster analysis confirmed the delineation of vegetation communities noted above. In nearly all cases, sub-groups (communities) the Awaba data arranged themselves with other similar data from elsewhere in the region, such that community groupings (clusters) became larger with the additional data available. Some exceptions to this were those cases where an Awaba community was represented only by a small number of sites. The low frequency of similar sites elsewhere in the region meant that these sites were subsumed into larger regional groups within the dendrogram. Such site mobility is common in large datasets where small sample sizes of distinct communities are evident. On the whole, however, the larger regional analysis strongly supported the groupings evident from the Awaba analysis.

3.1.3.3 Defined Vegetation Communities

Table 5 summarises the extent of each vegetation unit within the landfill site. Vegetation community codes broadly equate with the regional classification established by NPWS (2000), but have been expanded upon to accommodate newer communities and finer resolution of others for the Lake Macquarie LGA (see Bell & Driscoll 2010).

Table 5. Summary of vegetation units delineated for this study.

Vegetation Unit		Area (ha)
30f	Freemans Peppermint-Apple-Bloodwood Forest	2.73
30h	Sugarloaf Lowlands Bloodwood-Apple Forest	0.73
30j	Sugarloaf Lowlands Bloodwood-Apple-Scribbly Gum Forest	5.28
31	Coastal Plains Scribbly Gum Woodland	0.83
114	Red Mahogany-Paperbark Thicket	1.12
Total (ha)		10.69

Detailed descriptions of all communities follow, based on the results of the SIMPER analysis in Primer (Clarke & Gorley 2006). SIMPER analysis provides the relative contributions of each species to the Bray-Curtis similarity within each of the defined vegetation communities. Only those species contributing to a total cumulative contribution of 99% of the average similarity (ie: the value shown at the top of each table) for each community are listed. These species can be described of as *typical* of that community, and have a consistently large presence within the data as reflected in the ratio of their contribution to the standard deviation (the Sim/SD field in each

table) across the within-group similarities (the average similarity). Community groups with less than two samples (ie: Units 11c & 30f) cannot be analysed in this way. Instead, the full species list from the single plot in each community is shown, in decreasing cover abundance value.

For those communities where >2 sample plots occur:

- Average similarity is the within-group similarity for all pairs of sample plots comprising the community. Higher average similarity indicates a better defined community.
- Av.Abund is the average cover abundance of that species within sample plots comprising the community
- Av.Sim is the average similarity (contribution) made by each species to the within-group similarity (the overall average similarity).
- Sim/SD is the ratio of average similarity to standard deviation for each species across all pairs of samples. A high ratio represents a good discriminating species. At least three samples are required for this ratio to be calculated.
- Contrib % is the percentage contribution of each species to the overall average similarity for the community.

30f: Freemans Peppermint-Apple-Bloodwood Forest

Within the landfill site, this community occupies an area of 2.73 hectares and occurs in two separate areas, the north-western corner of Lot 372, and also the southern part of the landfill site along the un-named creekline.



Community ID	30f: Freemans Peppermint-Apple-Bloodwood Forest
Occurrence	occurs on more sheltered slopes at moderate elevations, Often characterized by localized stands of <i>Doryanthes excelsa</i> , <i>Dodonaea triquetra</i> and <i>Leptospermum</i> spp. in the understorey, where they form often dense stands.
Canopy	<i>Corymbia gummifera</i> , <i>Angophora costata</i> , <i>Eucalyptus piperita</i> , <i>Eucalyptus umbra</i> , <i>Allocasuarina littoralis</i>
Mid	<i>Polyscias sambucifolia</i> subsp. <i>sambucifolia</i> , <i>Ceratopetalum gummiferum</i> , <i>Gompholobium latifolium</i> , <i>Acacia myrtifolia</i> , <i>Acacia longifolia</i> subsp. <i>longifolia</i> , <i>Lomatia silaifolia</i> , <i>Banksia serrata</i> , <i>Banksia spinulosa</i> var. <i>collina</i> , <i>Glochidion ferdinandi</i> var. <i>ferdinandi</i> , <i>Bossiaea obcordata</i> , <i>Persoonia levis</i> , <i>Leptospermum trinervium</i> , <i>Xylomelum pyriforme</i>
Ground	<i>Doryanthes excelsa</i> , <i>Pteridium esculentum</i> , <i>Macrozamia reducta</i> , <i>Xanthorrhoea latifolia</i> subsp. <i>latifolia</i> , <i>Pandorea pandorana</i> , <i>Billardiera scandens</i> , <i>Blechnum cartilagineum</i> , <i>Eustrephus latifolius</i> , <i>Lomandra confertifolia</i> subsp. <i>pallida</i> , <i>Hibbertia dentate</i> , <i>Desmodium rhytidophyllum</i> , <i>Microlaena stipoides</i> var. <i>stipoides</i> , <i>Entolasia stricta</i> , <i>Imperata cylindrical</i> , <i>Calochlaena dubia</i> , <i>Themeda australis</i> , <i>Pseuderanthemum variabile</i> , <i>Dianella caerulea</i> var. <i>assera</i> , <i>Hardenbergia violacea</i> , <i>Scaevola ramosissima</i> , <i>Hibbertia obtusifolia</i> , <i>Smilax glyciophylla</i> , <i>Hibbertia empetrifolia</i> subsp. <i>empetrifolia</i>

30h: Sugarloaf Lowlands Bloodwood-Apple Forest

Within the landfill site, only a small area of this vegetation community occurs, covering an area of 0.73 hectares and is located in the north-western corner of Lot 372. This community is more widespread within the adjoining Lot 373.



Community ID	30h: Sugarloaf Lowlands Bloodwood-Apple Forest
Occurrence	occurs on the higher elevation ridgelines and exposed slopes
Canopy	<i>Eucalyptus capitellata</i> , <i>Corymbia gummifera</i> , <i>Angophora costata</i> ,
Mid	<i>Gompholobium latifolium</i> , <i>Podolobium ilicifolium</i> , <i>Acacia myrtifolia</i> , <i>Allocasuarina littoralis</i> , <i>Banksia spinulosa</i> var. <i>collina</i> , <i>Dillwynia retorta</i> , <i>Doryphora excelsa</i> , <i>Epacris pulchella</i> , <i>Leptospermum trinervium</i> , <i>Persoonia linearis</i> , <i>Pultenaea paleacea</i>
Ground	<i>Themeda australis</i> , <i>Xanthorrhoea latifolia</i> subsp. <i>latifolia</i> , <i>Brunoniella australis</i> , <i>Entolasia stricta</i> , <i>Imperata cylindrical</i> , <i>Lepidosperma laterale</i> , <i>Lomandra oblique</i> , <i>Panicum simile</i> , <i>Phyllanthus hirtellus</i> ,

Community ID	30h: Sugarloaf Lowlands Bloodwood-Apple Forest
	<i>Dianella caerulea</i> var. <i>assera</i> , <i>Glycine clandestine</i> , <i>Hovea linearis</i> , <i>Opercularia diphylla</i>

30j: Sugarloaf Lowlands Bloodwood-Apple-Scribbly Gum Forest

This vegetation community is the most abundant on the landfill site, occupying an area of 5.28 hectares. This community is situated in the north-eastern corner and western boundary of the landfill site.



Community ID	30j: Sugarloaf Lowlands Bloodwood-Apple-Scribbly Gum Forest
Occurrence	occurs at mid-elevations on slopes, between Units 30h and 31.
Canopy	<i>Eucalyptus capitellata</i> , <i>Eucalyptus haemastoma</i> , <i>Angophora costata</i> , <i>Corymbia gummifera</i> , <i>Eucalyptus umbra</i>
Mid	<i>Acacia brownii</i> , <i>Acacia myrtifolia</i> , <i>Dillwynia retorta</i> , <i>Epacris pulchella</i> , <i>Isopogon anemonifolius</i> , <i>Lambertia formosa</i> , <i>Podolobium ilicifolium</i> , <i>Pultenaea tuberculata</i> , <i>Acacia longifolia</i> subsp. <i>longifolia</i> , <i>Allocasuarina littoralis</i> , <i>Astrotricha obovata</i> , <i>Banksia spinulosa</i> var. <i>collina</i> , <i>Leptospermum trinervium</i> , <i>Monotoca scoparia</i> , <i>Persoonia levis</i>
Ground	<i>Ptilothrix deusta</i> , <i>Entolasia stricta</i> , <i>Lepidosperma laterale</i> , <i>Lomandra glauca</i> , <i>Lomandra obliqua</i> , <i>Mirbelia rubiifolia</i> , <i>Themeda australis</i> , <i>Xanthorrhoea latifolia</i> subsp. <i>latifolia</i> , <i>Hovea linearis</i>

31: Coastal Plains Scribbly Gum Woodland

Only a very small area of this vegetation community occurs on the landfill site, covering an area of 0.83 hectares. This community is located along the eastern boundary of the landfill site, but is much more extensive in the adjoining Lot 373.



Community ID	31: Coastal Plains Scribbly Gum Woodland
Occurrence	occurs at lower elevations in low relief areas. Typified by an open forest or woodland of <i>Eucalyptus haemastoma</i> and <i>Corymbia gummifera</i> , over a heathy understorey and dense <i>Ptilothrix deusta</i> on the ground.
Canopy	<i>Eucalyptus haemastoma</i> , <i>Corymbia gummifera</i>
Mid	<i>Banksia oblongifolia</i> , <i>Epacris pulchella</i> , <i>Leptospermum trinervium</i> , <i>Pultenaea tuberculata</i> , <i>Dillwynia retorta</i> , <i>Lambertia formosa</i> , <i>Bossiaea stephensonii</i> , <i>Hakea laevipes</i> subsp. <i>laevipes</i> , <i>Isopogon anemonifolius</i> , <i>Persoonia levis</i> , <i>Leucopogon microphyllus</i> var. <i>microphyllus</i> , <i>Acacia myrtifolia</i> , <i>Allocasuarina littoralis</i> , <i>Daviesia mimosoides</i> subsp. <i>mimosoides</i> , <i>Pimelea linifolia</i> subsp. <i>linifolia</i> , <i>Pultenaea paleacea</i>
Ground	<i>Ptilothrix deusta</i> , <i>Xanthorrhoea latifolia</i> subsp. <i>latifolia</i> , <i>Cassylia glabella</i> forma <i>glabella</i> , <i>Entolasia stricta</i> , <i>Lindsaea linearis</i> , <i>Lomandra obliqua</i> , <i>Patersonia sericea</i> , <i>Goodenia heterophylla</i> subsp. <i>heterophylla</i> , <i>Melichrus procumbens</i> , <i>Themeda australis</i> , <i>Billardiera scandens</i> , <i>Panicum simile</i> , <i>Thysanotus tuberosus</i> subsp. <i>tuberosus</i> , <i>Lepidosperma laterale</i> , <i>Mirbelia rubiifolia</i> , <i>Platysace ericoides</i> , <i>Schizaea bifida</i> , <i>Comesperma ericinum</i> , <i>Comesperma sphaerocarpaceum</i> , <i>Scaevola ramosissima</i>

114: Red Mahogany-Paperbark Thicket

This community occupies an area of 1.12 hectares and occurs along the riparian zone of the un-named creek line in the southern portion of Lot 372.

Community ID	114: Red Mahogany-Paperbark Thicket
Occurrence	restricted to major stream channels and depressions, in low relief areas. Characterised by dense stands of <i>Melaleuca linariifolia</i> with mesic species such as <i>Callicoma serratifolia</i> , <i>Glochidion ferdinandi</i> var. <i>ferdinandi</i> and <i>Acmena smithii</i> . <i>Cyathea cooperi</i> is unique to this community within the study area.
Canopy	<i>Eucalyptus piperita</i> , <i>Eucalyptus resinifera</i> subsp. <i>resinifera</i> , <i>Angophora costata</i>
Mid	<i>Melaleuca linariifolia</i> , <i>Callicoma serratifolia</i> , <i>Glochidion ferdinandi</i> var. <i>ferdinandi</i> , <i>Acmena smithii</i> , <i>Acacia irrorata</i> var. <i>irrorata</i> , <i>Cyathea cooperi</i> , <i>Callistemon salignus</i>
Ground	<i>Gahnia clarkei</i> , <i>Calochlaena dubia</i> , <i>Adiantum aethiopicum</i> , <i>Oplismenus imbecillus</i> , <i>Dioscorea transversa</i> , <i>Hypolepis muelleri</i> , <i>Smilax australis</i> , <i>Carex longebrachiata</i> , <i>Eustrephus latifolius</i> , <i>Parsonia straminea</i> , <i>Entolasia marginata</i> , <i>Glycine clandestina</i> , <i>Hibbertia dentata</i>

114: Red Mahogany-Paperbark Thicket



3.1.4 Vegetation Community Map

A vegetation community map of the study area, which includes the Awaba landfill area is presented in **Figure 8**, and incorporates the information obtained from field-collected RDP's, and results from the numerical data analysis.

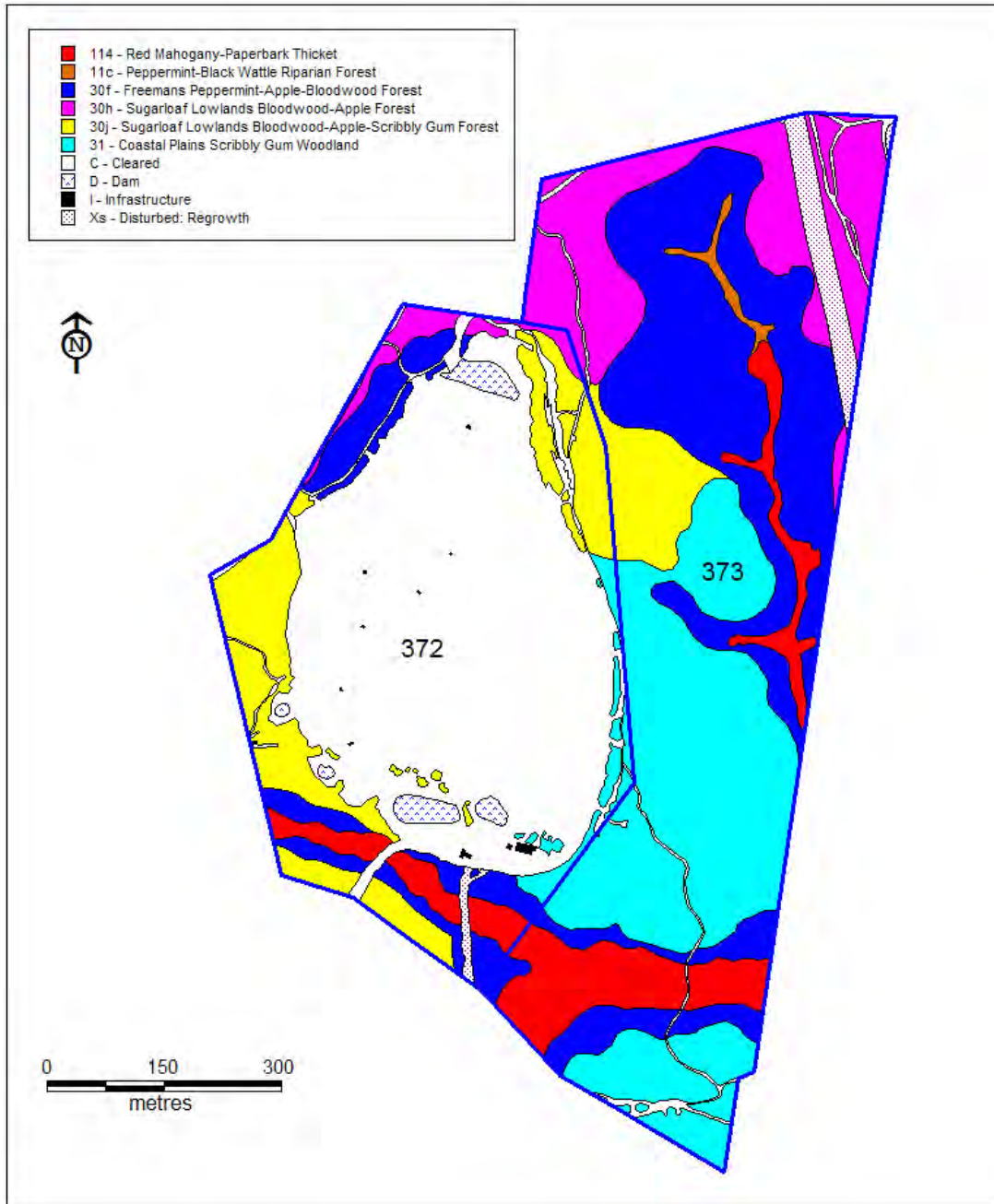


Figure 8. Vegetation Community map for Lots 372, Awaba.

3.2 Fauna Survey

3.2.1 Fauna Habitat Assessment

Three broad habitat types exist within the Awaba landfill site, Open Forest / Woodland, Riparian Forest and Cleared Grassland.

3.2.1.1 Open Forest / Woodland

The Open Forest is dominated by taller trees to 20 metres in height with a tall and low understorey vegetation layer. Tree species occurring in this habitat include Sydney Red Gum *Angophora costata*, Sydney Peppermint *Eucalyptus piperita*, Brown Stringybark *E. capitellata* and Red Bloodwood *Corymbia gummifera*. Taller understorey plant species to 3 metres in height include *Banksia serrata* and low understorey dominated by *Banksia spinulosa*, *B. oblongifolia* and Mountain Devil *Lambertia formosa*. Areas of Open Woodland occur also which include tree species *Eucalyptus haemastoma* and *E. piperita* with a very open understorey lacking taller understorey species, with the low understorey dominated by *Banksia spinulosa*, *Xanthorrhoeae latifolia* ssp. *latifolia*. and grasses.

Density of habitat trees within this habitat type is high, with an approximate density of 5.0 habitat trees per hectare. The habitat trees support a wide range of tree hollow sizes, ranging from small to very large suitable for large vertebrates such as Lace Monitor and large forest owls. Density of ground litter is high, although in parts this is exacerbated by illegal dumping of domestic rubbish. Disturbance to this habitat type on the landfill site include clearing for vehicle tracks, illegal rubbish dumping around the periphery of the landfill site, and stray domestic refuse from the landfill site. Lightweight domestic rubbish has dispersed into the remnant vegetation on the landfill site as a consequence of high winds, often penetrating significant distances from the landfill boundary. Fire regime does not appear to be regular, with parts of the landfill site supporting very dense understorey vegetation and ground litter. Due to the slope and terrain, there are no areas of standing water in this habitat on the landfill site. Presence of food trees for Koala is restricted to the Scribbly Gum *Eucalyptus haemastoma* trees, with no other schedule 2 tree species recorded in this habitat type.

3.2.1.2 Riparian Forest

The Riparian Forest occurs along the ephemeral creek lines and support similar tree species composition to the Open Forest / Woodland. However, due to the more sheltered and moister environment, the trees are taller in height, reaching to 22-25 metres. The understorey is tall to 4 metres in height and includes *Leptospermum polygalifolium*, Black Wattle *Callicoma serratifolia*, Christmas Bush *Ceratopetalum gummiferum* and Gynea Lily *Doryanthes excelsa*. Low understorey and ground layer vegetation include ferns and herbs.

Density of habitat trees within this habitat type is high, with an approximate density of 5.0 habitat trees per hectare. The habitat trees support a wide range of tree hollow sizes, ranging from small to very large suitable for large vertebrates such as Lace Monitor and large forest owls. Density of ground litter is high due to absence of regular fire. Disturbance along the riparian zone is limited. Due to the ephemeral nature of the drainage lines along the riparian zone, areas of standing water are very limited in area and duration. These drainage lines would flow during periods of high rainfall and retain small pools of water in deeper depression for short periods of time. No Schedule 2 tree species were recorded in this habitat type.

3.2.1.3 Cleared Area

The landfill operation area is cleared of remnant native vegetation. The fauna habitats existent in this cleared area is foraging areas for a number of bird species that scavenge on domestic rubbish, whilst the infrastructure dwellings would provide sheltering habitat for smaller terrestrial vertebrates such as reptiles and small mammals (mainly introduced rats and mice). The areas of open grassland would provide foraging habitat for rabbits and hares, and possibly macropods that may feed on the verge of the grassland / forest / woodland interface. A number of dams which function as sedimentation ponds and leachate basins would provide foraging habitat for aquatic birds such as cormorants, and potentially Long-necked Tortoises may frequent these ponds. The ponds may also function as a drinking source for a variety of fauna species.

No habitat trees occur within this habitat type. Density of ground litter is low, except where domestic refuse such as green waste is stockpiled. No Schedule 2 tree species for Koala occur in this habitat type.

3.2.2 Habitat Tree Mapping

Within Lot 372, a total of 40 habitat trees were located within 12.5 hectares of remnant forest, for an average density of 3.2 habitat trees per hectare. In comparison, the adjoining Lot 373 supports a total of 228 habitat trees within 39.76 hectares of remnant forest, for an average density of 5.73 habitat trees per hectare. Smith and Murray (2003) found that the highest diversity and abundance of tree hollow dependent fauna occur when habitat tree densities are equivalent to 18 habitat trees per hectare. The abundance of habitat trees in each of the size classes (expressed as diameter at breast height) is summarised below in **Table 6**.

Table 6. Distribution of Habitat Tree Size Classes, Awaba Landfill Site.

Habitat Tree Size Class	No. Habitat Trees Lot 372	% Proportion Lot 372
36 – 60 cm dbh	10	25.0%
60 – 80 cm dbh	12	30.0%
80 – 100 cm dbh	15	37.5%
100 – 120 cm dbh	3	7.5%
120 - 140 cm dbh	0	0.0%
Total Habitat Trees	40	100.0%

The highest representation of habitat tree hollow size classes within the landfill area are habitat trees with Very Small and Small tree hollows. These size classes are considered suitable for smaller vertebrates such as microchiropteran bats (Very Small Hollows) and gliders (Small Hollows). The distribution of habitat trees for the various tree hollow size classes are presented below in **Figure 11** (Very Small Hollows), **Figure 12** (Small Hollows), **Figure 13** (Medium Hollow) and **Figure 14** (Large to Very Large Hollow).



Figure 9. Habitat Trees by Diameter at Breast Height, Awaba Waste Facility



Figure 10. Habitat Trees by Number of Hollows, Awaba Waste Facility



Figure 11. Location of Habitat Trees with Very Small Hollows, Awaba Landfill.



Figure 12. Location of Habitat Trees with Small Hollows, Awaba Landfill.



Figure 13. Location of Habitat Trees with Medium Size Hollows, Awaba Landfill.



Figure 14. Location of Habitat Trees with Large to Very Large Hollows, Awaba Landfill.

3.2.3 Birds

Within the landfill site, a total of 21 bird species were recorded by census surveys, with an additional 17 species recorded by opportunistic observations outside of the census period. Within the locality, a total of 206 bird species have been recorded, but this total includes a large number of bird species that would not occur on the landfill site due to absence of suitable habitat. For example, the locality (<5km radius) includes aquatic and estuarine habitats associated with Lake Macquarie. Many bird species associated with habitats in Lake Macquarie would not occur on the landfill site, or utilise the habitats as part of their regular movements.

3.2.3.1 Opportunistic Sightings

Opportunistic sightings of birds were conducted whilst undertaking other survey tasks, such as mapping of habitat trees, moving between areas or whilst conducting searches for other vertebrate species such as reptiles. A total of 59 bird species were recorded, which probably approaches the upper limit of bird species diversity for the landfill site. Surveys were conducted at appropriate time of the year to record summer migratory bird species.

3.2.3.2 Nocturnal Surveys

No threatened large forest owls were recorded in the landfill site during the nocturnal census. One nocturnal bird species was recorded at Site FA1 in the landfill site, the Australian Owlet-nightjar, and one additional species, the Tawny Frogmouth was recorded in adjacent bushland and would forage on the landfill site as part of its foraging range.

3.2.3.3 Diurnal Census

As indicated previously, a total of 21 bird species were recorded by diurnal census on the landfill site. The majority of bird species recorded are forest dependent species, with a small number of aquatic bird species observed foraging within the landfill operation area (i.e. Australian Pelican, Silver Gull, Australian White Ibis). No threatened bird species was recorded within the landfill site. The threatened Varied Sittella was observed foraging in the Open Forest / Woodland in adjoining bushland and would likely forage in the areas of remnant forest on the landfill site.

3.2.4 Mammals

Seven native mammal species were recorded on the landfill site, including three smaller terrestrial mammals, one possum species and 3 microchiropteran bats. No macropods were observed directly, but scats were noted in areas of remnant forest. The remnant forest and woodland parts of the landfill site support populations of small, medium and larger native mammals due to connectivity to large expanses of similar habitat in the locality. Fragmentation of forest habitat in this larger forest remnant is restricted to relatively narrow transport corridors (roads and minor tracks) and infrastructure (power line easements), enabling movement of populations between the landfill site and adjoining forested areas.

3.2.4.1 Small Terrestrial Mammals

Three species of native small terrestrial mammals were recorded on the landfill site, the Brown Antechinus *Antechinus stuartii*, Swamp Rat *Rattus lutreolus* and Northern Brown Bandicoot *Isodon macrourus*. Whilst not recorded on the landfill site, the introduced Black Rat *Rattus rattus* was captured nearby and would likely occur.

The Brown Antechinus was captured in Scribbly Gum Open Woodland and the denser riparian forest. In contrast, the Swamp Rat was restricted in its distribution, being captured in areas of dense understorey vegetation along the riparian zone, particularly where dense growth of *Gahnia sp.* was present. Diggings of bandicoot species were also widespread, with one capture in the riparian creek line near the entrance to the landfill site. The introduced Black Rat was captured in proximity to the landfill site in Scribbly Gum Open Woodland. Other small terrestrial mammal species that have previously been captured in the locality include Common Dunnart and Bush Rat, and suitable habitat exists within the landfill site to suggest their potential occurrence. A summary of the number and location of each small to medium terrestrial mammal captured is presented below in **Table 7**.

Table 7. Captures of Smaller Terrestrial Mammals, Awaba Landfill Site and Adjoining Area.

Common Name	Scientific Name	Landfill Site	Adjoining Lot 373		Total Captures
		FA1	FA2	FA3	
Brown Antechinus	<i>Antechinus stuartii</i>	3	2	4	9
Northern Brown Bandicoot	<i>Isodon macrourus</i>	1			1
Swamp Rat	<i>Rattus lutreolus</i>	1		1	2
Black Rat *	<i>Rattus rattus</i> *		1		1
Total Captures		5	3	5	13

3.2.4.2 Larger Terrestrial Mammals

No larger native terrestrial mammal species was recorded on the landfill site, but macropod scats were observed to indicate their presence. The Swamp Wallaby was observed along the riparian zone of the adjoining Lot 373 and would likely forage on the landfill site. Two additional larger macropods have previously been recorded in the locality, including the Red-necked Wallaby and Eastern Grey Kangaroo. No evidence of the threatened Spotted-tail Quoll was observed, although the landfill site contains several habitat trees with hollows, and also ground logs that may be suitable as den sites for the species. Dog tracks were regularly observed along the minor tracks around the perimeter of the landfill site.

3.2.4.3 Arboreal Mammals

Arboreal Trapping

No arboreal mammals were captured by tree trapping during this survey. A problem associated with the arboreal tree trapping survey was the limitation on the number of survey sites that could be sampled. Arboreal tree traps are highly visible when attached to trees, and the study area experiences very high visitation by trial bike riders and general public dumping domestic refuse. Only two sites could be established within the study area that was sufficiently discreet to not enable traps to be visible to passing traffic. One Common Brushtail Possum was captured in a terrestrial cage trap located on the landfill site at site FA1.

Spotlight Searches

No arboreal possum and glider species were recorded on the landfill site, but four were recorded by this technique on the adjoining Lot 373. Those species include the Common Ringtail Possum, Common Brushtail Possum, Squirrel Glider and Feathertail Glider. All four species are considered likely to occur in the remnant forest and woodland on the landfill site.

Stag-watch Observations

No possums and gliders were observed departing tree hollows observed during this survey.

SEPP 44 (Koala Habitat) Assessment

The list of tree species in Schedule 2 of SEPP 44 that were recorded in the landfill site is listed below in **Table 8**.

Table 8. Schedule 2 Tree Species, SEPP 44 (Koala Habitat Protection)

Common Name	Scientific Name	Occurrence in Landfill Site	>15% Schedule 2 Tree Species
White Box	<i>Eucalyptus albens</i>	No	
River Red Gum	<i>Eucalyptus camaldulensis</i>	No	
Broad-leaved Scribbly Gum	<i>Eucalyptus haemastoma</i>	YES	YES
Tallowwood	<i>Eucalyptus microcorys</i>	No	
Bimble Box	<i>Eucalyptus populnea</i>	No	
Large-fruited Grey Gum	<i>Eucalyptus punctata</i>	No	
Swamp Mahogany	<i>Eucalyptus robusta</i>	No	
Scribbly Gum	<i>Eucalyptus signata</i>	No	
Forest Red Gum	<i>Eucalyptus tereticornis</i>	No	
Ribbon Gum	<i>Eucalyptus viminalis</i>	No	

Based on the SEPP44 habitat assessment, one Schedule 2 tree species occurs in the landfill site, which indicates occurrence of “*potential koala habitat*” (as defined in SEPP44). However, there is no evidence of Koala utilising the landfill site and wider study area based on scat searches and spotlight searches. No “*core Koala habitat*” as defined by SEPP44 occurs on the landfill site as no evidence of a resident Koala population was determined. There is one record of Koala near the township of Awaba recorded in 1952 (OEH, 2011), which is 1.6 km to the north-west, and an additional record of Koala on Waring Hill in Kilaben Bay in 1972. There are no recent sightings of Koala in the Awaba locality since that time. Based on the results of the habitat assessment and spotlight / scat searches of the study area, no Core Koala habitat occurs on the landfill site.

3.2.4.4 Bats

Bat species recorded in the landfill site was restricted to micro-chiropteran species. No flying-foxes were observed or heard, but no trees were flowering during the fauna survey to attract the species. One harp trap site (HT1) was located near the northern boundary of Lot 372. No microchiropteran bat species were captured by harp trapping at this location, but two individuals of two separate species were captured at Site HT2 on the adjoining Lot 373. Selection of good flyways for microchiropteran bats was restricted by the high degree of visitation by trial bike and 4WD vehicles, which restricted the number of suitable sampling sites. Sites that were sampled during this study were considered sub-optimal as bat flyways.

Echolocation Calls

Anabat recordings were conducted at three sites (HT1, HT2 and HT3) for two consecutive nights each. A total of 67 calls were identified to species, whilst a significant number of calls recorded were of ground crickets and other nocturnal insects, which compromised the quality of many calls. Five bat species were recorded by echolocation calls on the landfill site, and a further two species were recorded in the adjacent bushland (see **Table 9** below). By comparison, analysis of microchiropteran bat species recorded in the locality of Awaba landfill reveal a total of

17 species have been recorded. The landfill site at Awaba is likely to support greater bat diversity than the 7 recorded during this survey. The list of bat species recorded in the subject site and study area is presented below in **Table 9**.

Table 9. Bat Species recorded on Study area, Awaba Landfill and Adjoining Area.

Site	Common Name	Scientific Name	Status		No. Calls Analysed
			EPBC	TSC	
HT1 - Landfill Site	Eastern Horseshoe-bat	<i>Rhinolophus megaphyllus</i>			2
	East-coast Freetail-bat	<i>Micronomus norfolkensis</i>		V	5
	White-striped Freetail-Bat	<i>Austronomus australis</i>		P	3
	Gould's Wattled Bat	<i>Chalinolobus gouldii</i>		P	9
	Little Forest Bat	<i>Vespadelus vulturnus</i>		P	6
HT2 - Lot 373	White-striped Freetail-Bat	<i>Austronomus australis</i>		P	1
	East-coast Freetail-bat	<i>Micronomus norfolkensis</i>		V	2
	Little Bent-wing Bat	<i>Miniopterus australis</i>		V	6
HT3 – Lot 373	White-striped Freetail-Bat	<i>Austronomus australis</i>		P	8
	Eastern Bent-wing Bat	<i>Miniopterus schreibersii oceanensis</i>		V	4
	Gould's Wattled Bat	<i>Chalinolobus gouldii</i>		P	4
	Chocolate Wattled Bat	<i>Chalinolobus morio</i>		P	7
	Little Forest Bat	<i>Vespadelus vulturnus</i>		P	10
Total Calls Identified					67

Note: Species listed in **Bold Text** are listed as Threatened on either the EPBC Act 1999 or TSC Act 1995.

Harp Traps

No individuals were captured by harp trap on the landfill site, with 2 individuals of 2 separate species were captured on Lot 373. One individual Lesser Long-eared Bat *Nyctophilus geoffroyi* and one Little Forest Bat *Vespadelus vulturnus* were captured in November 2010. No bats were captured at sites HT1 (landfill site) or HT3 (Lot 373), but both sites were not considered optimal bat flyways, which may have resulted in absence of captures from these sites.

Spotlight Searches

No megachiropteran bats (flying-foxes) were observed foraging in the landfill site and larger study area during the nocturnal investigations. A number of individual Scribbly Gum trees were in flower during the survey in February 2011, but no individual flying-foxes were observed or heard foraging in the study area.

3.2.5 Reptiles and Amphibians

One reptile species Garden Skink *Lampropholis delicata* was recorded in the landfill site, and four additional species recorded in the adjacent bushland. Those species include Fence Skink *Cryptoblepharus virgatus*, Eastern Blue-tongue Skink *Tiliqua scincoides*, Red-bellied Black-snake *Pseudechis porphyriacus* and Black-bellied Snake *Hemiapsis signata*. A total of 22 reptile species have been recorded in the locality on the LMCC fauna database (LMCC, 2000) and OEH wildlife atlas (October 2011). Reptile habitat is overall good within the forested parts of the landfill site and larger study area, but the cleared open areas of the landfill site support very limited habitat. However, in areas where illegal dumping has occurred around the perimeter of the landfill site, and

stockpiles of green waste on the landfill site, provide refuge sites and foraging areas for reptiles. The list of reptile species recorded in the study area and locality is presented in **Appendix 2**.

There are several small sedimentation dams and leachate ponds in the landfill site which provide habitat for frogs. The drainage line along the un-named creek near Wilton Road support areas of ephemeral habitat for frogs, but would dry up during periods of low rainfall. Additional habitat for frogs on the landfill site include habitat trees which contain hollows utilised as sheltering sites for tree frogs.

3.3 Threatened Species

Two threatened flora and one threatened fauna were recorded on the landfill site during investigations in 2010 and 2011. Within locality (<5km radius), an additional 3 flora species and 28 fauna species have been recorded. The list of threatened species recorded on the landfill site and locality is presented below in **Table 10**.

Table 10. Summary of Threatened Species, Landfill Site and Locality.

Common Name	Scientific Name	Status		Record in Landfill Site	Locality Record
		EPBC	TSC		
Subject Site Records					
	<i>Grevillea parviflora ssp. parviflora</i>	V	V	+	+
Black-eyed Susan	<i>Tetratheca juncea</i>	V	V	+	+
Locality Records					
	<i>Acacia bynoeana</i>	V	V		Lot 373
Charmhaven Apple	<i>Angophora inopina</i>	V	V		Lot 373
	<i>Cryptostylis hunteriana</i>	V	V		+
Black Bittern	<i>Ixobrychus flavicollis</i>		V		+
Eastern Osprey	<i>Pandion cristatus</i>	M	V		+
Australian Pied Oystercatcher	<i>Haematopus longirostris</i>		E		+
Black-winged Stilt	<i>Himantopus himantopus</i>		V		+
Glossy Black-Cockatoo	<i>Calyptorhynchus lathami</i>		V		+
Gang-gang Cockatoo	<i>Callocephalon fimbriatum</i>		V		+
Little Lorikeet	<i>Glossopsitta pusilla</i>		V		+
Swift Parrot	<i>Lathamus discolor</i>	E	E		+
Turquoise Parrot	<i>Neophema pulchella</i>		V		+
Powerful Owl	<i>Ninox strenua</i>		V		+
Sooty Owl	<i>Tyto tenebrosa</i>		V		+
Masked Owl	<i>Tyto novaehollandiae</i>		V		+
Regent Honeyeater	<i>Anthochaera phrygia</i>	E M	CE		+
Varied Sittella	<i>Daphoenositta chrysoptera</i>		V		Lot 373
Scarlet Robin	<i>Petroica multicolor</i>		V		+
Spotted-tail Quoll	<i>Dasyurus maculatus</i>	V	V		+
Koala	<i>Phascolarctos cinereus</i>		V		+
Squirrel Glider	<i>Petaurus norfolcensis</i>		V		Lot 373
Grey-headed Flying-fox	<i>Pteropus poliocephalus</i>	V	V		+
East-coast Freetail-bat	<i>Micronomus norfolkensis</i>		V	+	Lot 373

Common Name	Scientific Name	Status		Record in Landfill Site	Locality Record
		EPBC	TSC		
Eastern Bent-wing Bat	<i>Miniopterus schreibersii oceanensis</i>		V		Lot 373
Little Bent-wing Bat	<i>Miniopterus australis</i>		V		Lot 373
Large-eared Pied Bat	<i>Chalinolobus dwyeri</i>	V	V		+
Eastern False Pipistrelle	<i>Falsistellus tasmaniensis</i>		V		+
Greater Broad-nosed Bat	<i>Scoteanax rueppellii</i>		V		+
Southern Myotis	<i>Myotis macropus</i>		V		+
Eastern Cave Bat	<i>Vespadelus troughtoni</i>		V		+
Stephens Banded Snake	<i>Hoplocephalus stephensii</i>		V		+
Wallum Froglet	<i>Crinia tinnula</i>		V		+

+ - refers to record of threatened species in locality (<5km radius)

In addition to those threatened species recorded on the subject site following extensive surveys, and review of threatened species in the locality, the federal Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) requested additional threatened species be assessed in this report. Those species include Green and Golden Bell Frog, Littlejohn's Tree Frog, Giant Barred Frog, Large-eared Pied-bat, Brush-tailed Rock-wallaby, Long-nosed Potoroo, New Holland Mouse and Biconvex Paperbark.

For these additional threatened species, there are no recent records within 20km radius of the Awaba site and were therefore not considered. Additionally, for the Green and Golden Bell Frog, Littlejohns Tree Frog, Giant Barred Frog, Brush-tailed Rock-wallaby, Long-nosed Potoroo and New Holland Mouse, no habitat exists to suggest their likely occurrence. No evidence of Biconvex Paperbark was recorded despite the entire site being intensively sampled by foot traverses for other threatened plant species.

3.3.1 Threatened Flora

A full description of the threatened flora recorded in the landfill site is presented further in **Appendix 4**. Following in **Table 11** is a summary of the number of threatened plants recorded on the landfill site.

Table 11. Threatened Plant Counts, Lot 372.

Threatened Species	Lot 372 (Awaba Landfill)
<i>Grevillea parviflora ssp. parviflora</i>	280 plants
<i>Tetraloche juncea</i>	2,333 plants
TOTAL	2,613 plants
Area (ha)	9.2 ha

The location of threatened flora records on the landfill site (and adjoining site) is presented in **Figure 15** below.

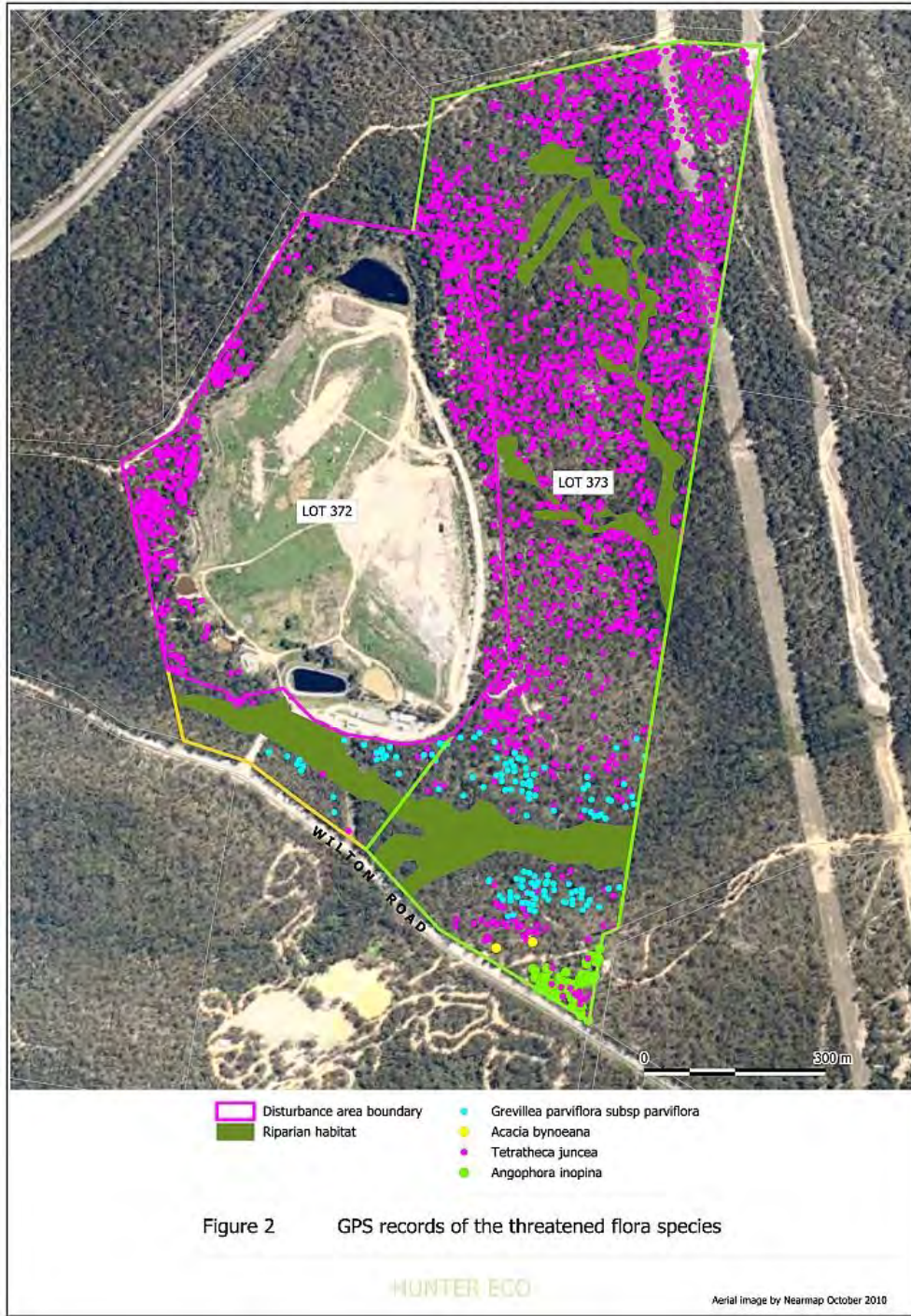


Figure 15. Location of Threatened Flora species, Awaba Landfill Investigation Area

(Map produced by Hunter ECO, October 2011)

3.3.1.1 *Grevillea parviflora* ssp. *parviflora*

The official taxonomic description of this species describes it as being a low shrub to 0.5 m tall with pure white flowers. The National Herbarium in Sydney has informally broadened this description by identifying plants as *Grevillea parviflora subsp parviflora* that have flowers ranging from white to pink. The majority of the plants recorded in the Awaba survey had small pure white flowers and so would be close to the type description other than that they were taller, up to 2 m. There was one small patch with pink flowers and another area where the plants had white flowers but distinctly broader leaves. There are scattered records for the species from throughout the immediate region in which the Awaba survey was situated. Within Lot 372, a total of 280 plants were located, all of which occur outside of the proposed disturbance area.

3.3.1.2 *Tetratheca juncea*

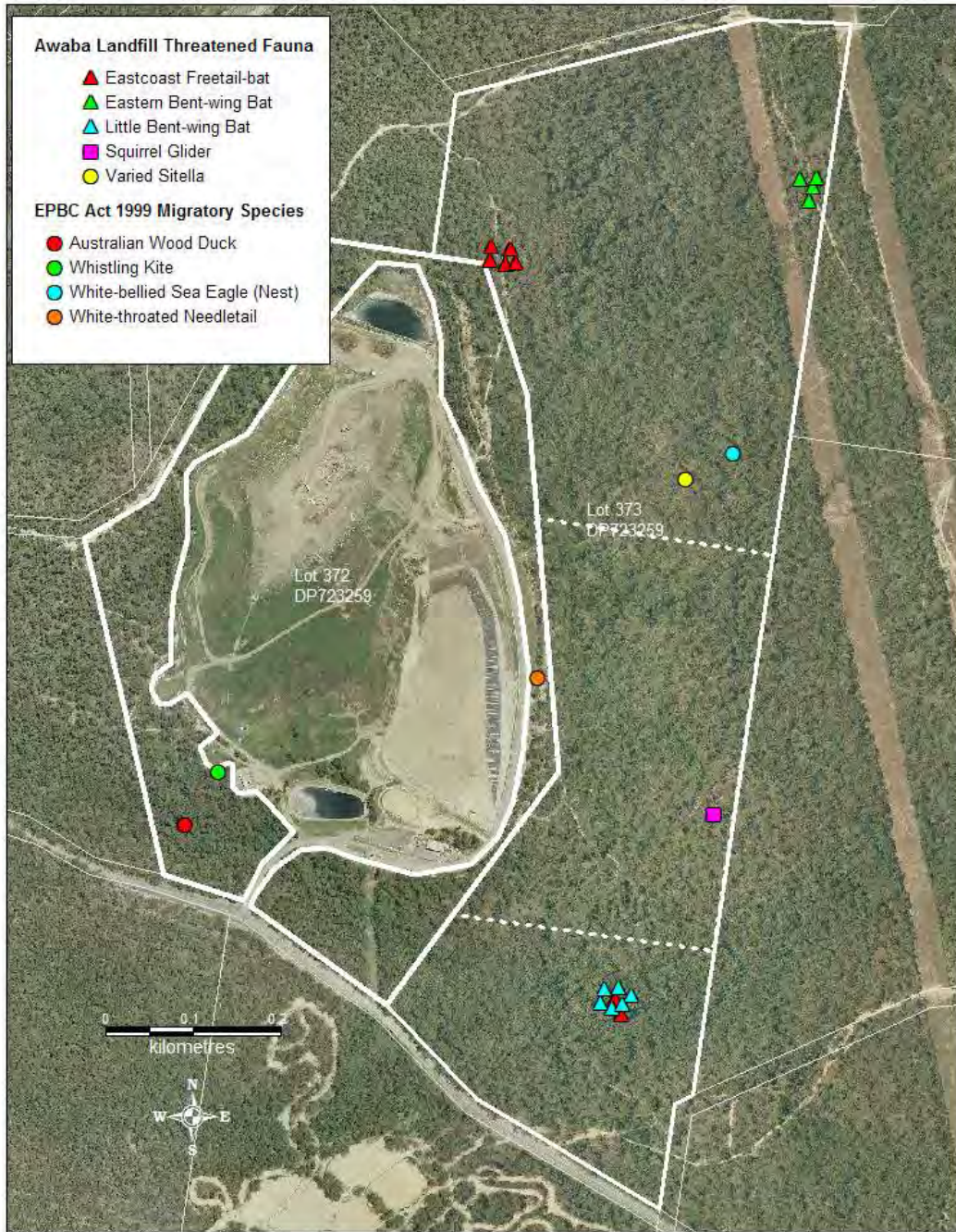
Overall there was an extraordinary density of *Tetratheca juncea* in Lots 372. Adjusting for the unsuitable habitat in the riparian and cleared areas, there were 340 clumps per hectare. This compares with a regional mean density of just under 40 clumps per hectare derived from 13 similar studies covering a total of 174 hectares (C. Driscoll unpublished). This survey result was probably around 98% of the total numbers present; it definitely was not an over-count. On several occasions it was necessary to walk back through areas that had previously been counted and invariably a small number of additional individual clumps were found. Within Lot 372, a total of 2,333 plants were located, of which 2,302 plants (or 98.6% of the Lot 372 population occur within the proposed disturbance area.

3.3.2 Threatened Birds

No threatened bird species were recorded in Lot 372 during this survey. However, the vulnerable Varied Sittella was recorded in the adjacent bushland and would likely forage on the landfill site as part of its larger foraging range. One bird species listed as Migratory under the EPBC Act 1999 was recorded adjacent to the landfill site, the White-bellied Sea Eagle. A nest was located in Lot 373 and individual birds were observed flying in proximity to the landfill site on several occasions.

3.3.3 Threatened Mammals

One threatened mammal species was recorded on Lot 372, the East-coast Freetail-bat. This species was recorded by echolocation calls at Site HT1, which was located on the northeastern boundary of the landfill site. Additional threatened mammal species recorded in the adjacent bushland include Squirrel Glider, Little Bent-wing Bat and Eastern Bent-wing Bat. These additional threatened fauna would utilise habitats on the landfill site as part of their ecological requirements. Additionally, the East-coast Freetail-bat and Squirrel Glider may utilise tree hollows occurring on the landfill site for roost and den sites. The location of threatened fauna species is presented below in **Figure 16**.



Study Area - Lot 372 (Awaba Landfill) and Lot 373 (Adjoining Area)

Map produced by Forest Fauna Surveys Pty Ltd
Base Aerial Photograph copyright LMCC
Aerial Photo Date: 2007

Figure 16. Location of Threatened Fauna species, Awaba Landfill

3.3.3 Threatened Species Not Recorded, but Potential to Occur

An assessment of the likelihood of additional threatened fauna species occurring on the landfill site is presented below in **Table 12**. The assessment is based on presence of suitable habitat within the landfill site to potentially support populations of threatened species not detected by fauna surveys to date.

Table 12. Potential Occurrence of Threatened Species on the Landfill Site.

Common Name	Presence of Suitable Habitat in Subject Site	Potential Occurrence On Lot 372
<i>Acacia bynoeana</i>	A small population of <i>Acacia bynoeana</i> is situated on Lot 373 just off Wilton Road. This area is subject to a lot of disturbance from illegal rubbish dumping and off-road access tracks. Under the current circumstances the viability of this population would have to be marginal. The next nearest known population is about 0.8 km south.	Low
<i>Angophora inopina</i>	A total of 66 plants were located in the south-eastern corner of the Lot 373 near Wilton Road. This group is the south western edge of a population that continues offsite to the east in a narrow band for about a kilometre.	Low
<i>Cryptostylis hunteriana</i>	There was a large area of potential habitat, mostly in the investigation area of Lot 373. However, no <i>Cryptostylis hunteriana</i> were found despite intensive survey effort. The OEH (2011) information for this species notes that it is often found in association with its congeners <i>Cryptostylis subulata</i> and <i>Cryptostylis erecta</i> . These associated species have distinctive leaves and there were only a few present (less than 10) on Lot 373.	Low
Black Bittern	No suitable habitat present	Low
Eastern Osprey	No suitable foraging habitat present. Potential for nest site but competition with White-bellied Sea Eagle may limit use of site	Low
Australian Pied Oystercatcher	No suitable habitat present	Low
Black-winged Stilt	No suitable habitat present	Low
Glossy Black-Cockatoo	Limited abundance of preferred foraging resources, <i>Allocasuarina</i> and <i>Casuarina</i> trees on landfill site, but may frequent the site as part of larger foraging range. Potential to use large to very large hollows for nesting, but limited foraging resources may limit nesting on subject site.	Low
Gang-gang Cockatoo	Could forage on cones and buds of eucalypt and non-eucalypt tree species. Limited number of records in the locality to suggest likely occurrence. More common in drier forests and woodlands in Watagan Ranges and Yengo / Wollemi National Parks.	Low
Little Lorikeet	Open forest and woodland within landfill site may provide foraging habitat. The Little Lorikeet is a wide ranging species that may occur in locality infrequently	Medium - High
Swift Parrot	Potentially could occur in landfill site foraging on lerps in open forest. Limited diversity of tree species with winter flowering.	Low
Turquoise Parrot	Preference for drier forests and woodlands with grasses. Most records concentrated in central and western Hunter Valley.	Low
Powerful Owl	Suitable foraging and nesting sites present in landfill site, preference for the moist creekline with dense understorey off Wilton Road for roost sites. No evidence noted based on searches for whitewash.	High
Sooty Owl	Potential foraging and nesting sites present in landfill site, preference	Low

Common Name	Presence of Suitable Habitat in Subject Site	Potential Occurrence On Lot 372
	for the moist creekline with dense canopy and understorey off Wilton Road. No evidence noted based on searches for whitewash and surveys for the species.	
Masked Owl	Suitable foraging and nesting sites present in landfill site, preference for drier Scribbly Gum forest with open understorey. No evidence noted based on searches for whitewash in proximity to suitable roost sites. Trapping surveys indicate abundance of foraging resources such as small mammals and bandicoots.	High
Regent Honeyeater	Potentially could occur in landfill site foraging on lerps in open forest. Limited diversity of tree species with winter flowering.	Low
Varied Sittella	Recorded foraging in Scribbly Gum Open Woodland in November 2010. Highly likely to forage in forest parts of the landfill site, particularly on rough-barked trees such as Brown Stringybark	High
Scarlet Robin	The species may frequent the forested parts of the landfill site and locality during seasonal movements. Considered an altitudinal migrant. More common in drier forests and woodlands than coastal locations.	Low
Spotted-tail Quoll	Suitable habitat present with ground logs and habitat trees for sheltering sites and presence of prey. Limited records in locality suggest occurs in very low abundance.	Low
Koala	Suitable food trees present in landfill site to suggest occurrence. Known to occur in the locality historically (1952 and 1970). No recent sightings to suggest local population persistence.	Low
Squirrel Glider	Suitable foraging and den sites present in landfill site, preference for drier Scribbly Gum forest with open understorey. The species was recorded on adjoining Lot 373 and would occur in forested parts of the landfill site.	High
Grey-headed Flying-fox	Highly likely to occur in forested parts of the landfill site during flowering of eucalypt and non-eucalypt tree species.	High
Little Bent-wing Bat and Eastern Bent-wing Bat	Recorded foraging on adjoining Lot 373 and would forage over the aerial open space and forested parts of the Awaba landfill site.	High
Large-eared Pied Bat	Potential foraging habitat present, although most records of the species associated with gorge or rock outcrop landscapes with caves, which it utilises as roost sites. No suitable roost habitat present on landfill site.	Low
Eastern False Pipistrelle	Potential foraging and roosting habitat (tree hollows) present on landfill site. The Eastern Falsistrelle is more commonly associated with moister forest types, particularly at higher altitude, although there are several records of the species in the locality.	Medium
Greater Broad-nosed Bat	Potential foraging and roosting habitat (tree hollows) present on landfill site.	High
Southern Myotis	No suitable foraging habitat present. May utilise tree hollows for roost sites.	Low
Eastern Cave Bat	Potential foraging habitat present, although most records of the species associated with gorge or rock outcrop landscapes with caves, which it utilises as roost sites. No suitable roost habitat present on landfill site.	Low
Stephen's Banded Snake	Potential foraging and roosting habitat present, although most records of the species associated with moist forest types.	Low
Wallum Froglet	No suitable habitat present on landfill site.	Low

Based on the assessment presented above in **Table 12**, it is considered likely that an additional 6 threatened species have a medium to high likelihood of occurrence on the subject site, in addition to the 3 threatened species recorded for this investigation. Accordingly, an assessment of the potential impact of the proposed expansion of the Awaba landfill operation on threatened species and their habitat has been prepared. The threatened species impact assessment follows the guidelines under the national *Environment Protection and Biodiversity Conservation Act 1999*, and the NSW *Environmental Planning and Assessment Act 1979*, as amended by the *Threatened Species Conservation Act 1995*. A summary of the assessment follows in **Section 3.4**, and the full impact assessment is presented in **Appendix 3** (fauna) and **Appendix 4** (flora).

3.4 Summary of Threatened Species Impact Assessment

Based on the impact assessment prepared in Appendix 3 and 4 of this report, following is a summary of the impact of the proposed action (expansion of the Awaba waste landfill). The landfill site presently supports approximately 12.0 hectares of remnant forest, and the proposal would seek to clear approximately 8.55 hectares (or 72.8%) of the remnant vegetation. A total of 2 threatened flora species and one threatened fauna species were recorded on the landfill site. In addition to those threatened species recorded on the landfill site an additional 6 fauna species were recorded in the locality and could occur on the landfill site. A summary of the impact assessment under *Environment Protection & Biodiversity Conservation Act 1999* legislation is presented below in **Table 13**.

Table 13 Summary of EPBC Act 1999 Impact Assessment on Threatened Species

Threatened Species	Occurrence	Summary of Impact Assessment
<i>Grevillea parviflora ssp. parviflora</i>	280 plants on Site	The plants are located outside of the proposed disturbance area and would not be directly impact by the action. Conclusion: No direct impact.
<i>Tetratheca juncea</i>	2,333 plants	The majority of these plants occur in the footprint of the proposed action and would be destroyed. Conclusion: Significant impact on site population but not local population..
Grey-headed Flying Fox	Locality Record	The proposed action would clear 8.55 hectares of foraging habitat. Conclusion: No significant impact on local population.
Large-eared Pied Bat	Locality Record	The proposed action would clear 8.55 hectares of foraging habitat. Conclusion: No significant impact on local population.
Listed Migratory Species	Recorded on Site	The proposed action would clear 8.55 hectares of foraging habitat. Conclusion: No significant impact on local population.

A summary of the impact assessment under *Environmental Planning & Assessment Act 1979* legislation (as amended by the *Threatened Species Conservation Act 1995*) is presented below in **Table 14**.

Table 14 Summary of TSC Act 1995 Impact Assessment on Threatened Species

Threatened Species	Occurrence	Summary of Impact Assessment
Threatened Species Recorded on Lot 372 Awaba waste landfill site		
<i>Grevillea parviflora</i> ssp. <i>parviflora</i>	280 plants on Site	The plants are located outside of the proposed disturbance area and would not be directly impact by the action. Conclusion: No direct impact.
<i>Tetradlea juncea</i>	2,333 plants	The majority of these plants (98.6%) occur in the footprint of the proposed action and would be destroyed. Conclusion: Significant impact on <u>site population</u> but would not significantly effect the local population.
East-coast Freetail-bat	Recorded on Site	The proposed action would clear 8.55 hectares of foraging habitat and loss of 18 potential roost trees. Conclusion: No significant impact on local population.
Threatened Species Recorded on Lot 373 Adjoining Site		
<i>Acacia bynoeana</i>	68 plants recorded on Lot 373	No plants occur located on the landfill site and would not be directly or indirectly impacted by the action. Conclusion: No direct impact.
<i>Angophora inopinata</i>	158 plants recorded on Lot 373	No plants occur located on the landfill site and would not be directly or indirectly impacted by the action. Conclusion: No direct impact.
<i>Cryptostylis hunteriana</i>	Locality Record	No plants were located on the landfill site and would not be directly or indirectly impacted by the action. Conclusion: No direct impact.
Varied Sittella	Recorded on Lot 373	The proposed action would clear 8.55 hectares of foraging habitat. Conclusion: No significant impact on local population.
Squirrel Glider	Recorded on Lot 373	The proposed action would clear 8.55 hectares of foraging habitat and loss of 18 potential roost trees. Conclusion: No significant impact on local population.
Eastern Bent-wing Bat	Recorded on Lot 373	The proposed action would clear 8.55 hectares of foraging habitat. Conclusion: No significant impact on local population.
Little Bent-wing Bat	Recorded on Lot 373	The proposed action would clear 8.55 hectares of foraging habitat. Conclusion: No significant impact on local population.
Little Lorikeet	Locality Record	The proposed action would clear 8.55 hectares of foraging habitat and loss of 18 potential roost trees. Conclusion: No significant impact on local population.
Powerful Owl	Locality Record	The proposed action would clear 8.55 hectares of foraging habitat and loss of 3 potential nest trees. Conclusion: No significant impact on local population.
Masked Owl	Locality Record	The proposed action would clear 8.55 hectares of foraging habitat and loss of 3 potential nest trees. Conclusion: No significant impact on local population.

Threatened Species	Occurrence	Summary of Impact Assessment
Grey-headed Flying Fox	Locality Record	The proposed action would clear 8.55 hectares of foraging habitat. Conclusion: No significant impact on local population.
Eastern False Pipistrelle	Locality Record	The proposed action would clear 8.55 hectares of foraging habitat and loss of 18 potential roost trees. Conclusion: No significant impact on local population.
Greater Broad-nosed Bat	Locality Record	The proposed action would clear 8.55 hectares of foraging habitat and loss of 18 potential roost trees. Conclusion: No significant impact on local population.

4.0 DISCUSSION

4.1 Vegetation Community Conservation Significance

None of five vegetation units described and mapped for Lot 372 equate to listed Threatened Ecological Communities in New South Wales (*TSC Act 1995*), or Nationally (*EPBC Act 1999*). The three sub-units of Unit 30 (30f, 30h, 30j) all fall within the Coastal Plains Smooth-barked Apple Woodland of NPWS (2000), and as amended for Lake Macquarie LGA (Bell & Driscoll 2010). Unit 31 is directly comparable to the Coastal Plains Scribbly Gum Woodland of NPWS (2000).

Unit 114 does not equate well with any of the NPWS (2000) vegetation communities, but has been recorded elsewhere in the western Lake Macquarie area (Bell & Driscoll 2010). This community does bear some resemblance to the Riparian Melaleuca Swamp Woodland (Unit 42 of NPWS 2000), which broadly fits within the Swamp Sclerophyll Forest on Coastal Floodplains EEC, but key differences can be found in floristic composition. Despite the presence of *Melaleuca linariifolia* and *Gahnia clarkei* as dominant components of Unit 114, it does not support *Eucalyptus robusta* in the canopy. *Melaleuca sieberi* as a characteristic small tree stratum, nor are any of the typical ground sedges present (*Lepyrodia scariosa*, *Empodisma minus*, *Schoenus brevifolius*, *Chorizandra cymbaria*), features of the NPWS-defined Unit 42. Instead, several other mesic species are present, including *Cyathea cooperi*, *Acmena smithii*, *Glochidion ferdinandi* var. *ferdinandi* and *Callicoma serratifolia*.

Based on current knowledge, Unit 114 (Red Mahogany-Paperbark Thicket) occupies very restricted distribution within the Lake Macquarie LGA. Although not included within any present TECs, efforts should be made to conserve lands supporting this community wherever possible. Vegetation Unit 114 – Red Mahogany – Paperbark Thicket occurs along the creekline between the current landfill operation and Wilton Road. The original proposed expansion of the Awaba landfill would have impacted on Unit 114 due to construction of sedimentation ponds and vehicle access roads proposed immediately adjacent to this community. However, a revision to the proposed expansion plan has removed this potential impact.

4.2 Threatened Species Impact Assessment

There are no *Acacia bynoeana* and *Angophora inopina* populations occurring in Lot 372 DP 723259, with the nearest known population located well away from the proposed expansion area. There would be no direct or indirect impact on these populations by the proposal. The population of *Grevillea parviflora subsp parviflora* on the landfill site (280 plants) occurs on the boundary of the expansion area and would not be impacted by the proposal. The proposed action on Lot 372 will reduce the size of the local *Tetratheca juncea* population, with a total of 2,302 plants disturbed by the proposed expansion.

For threatened fauna species, the extent of native vegetation / fauna habitat that would be cleared by the proposed expansion is 8.55 hectares. This area contains habitat attributes that may be utilised by up to 11 threatened species listed under national or state threatened species legislation. The landfill site area to be disturbed also provides habitat for a number of fauna species listed as Migratory under the national *EPBC Act 1999*. The potential removal of 8.55 hectares of habitat may result in the loss of the following:

- 31 habitat trees which provide an important habitat resource for tree hollow dependent threatened and protected fauna
- Foraging and sheltering habitat for threatened and protected fauna.

The federal department of environment (DSEWPaC) requested additional consideration of potential indirect and long term impacts to individuals of those threatened species that occur outside of the development footprint. Consideration of long term impacts can be assessed by comparison of the existing operation to current populations of threatened species. Populations of threatened species, particularly plants, occur within very close proximity to the boundary of the existing operation, which indicate limited direct or indirect impacts on those populations. For example, populations of *Tetratheca juncea* occur within 5 metres of the edge of the existing operation, which suggests edge effects are limited. For fauna populations, no obvious direct or indirect impacts were considered to operate.

The removal of existing vegetation for the proposed expansion will create a new boundary to the adjoining Lot 373. Based on evidence from the existing operation, it is likely that effects from the proposed operation will be restricted to an area less than 5 metres from the new site boundary. Additionally, improvements to water management and edge effects adopted for the new operation will ensure edge disturbances will be minimal. Where disturbance to native vegetation and fauna habitat has occurred distant to the site, such as dumping of domestic refuse in adjoining bushland, should be controlled by restrictions on access to motor vehicles.

An additional potential impact is introduction and establishment of Exotic Rust Fungi on plants of the Myrtaceae family, listed as a Key Threatening Process under the NSW Threatened Species Conservation Act 1995. This fungus has been detected on the Central Coast of NSW and could potentially spread to the City of Lake Macquarie. To avoid dispersal of this pathogen to other parts of the City, native vegetation mulched during the clearing process should be contained on site. Alternatively, during the clearing process, the vegetation is assessed for evidence of Exotic Rust Fungus and if cleared, allowed to be transported off site once mulched.

4.3 Biodiversity Offset Consideration

The “*maintain or improve*” principle means the result of an action should at least not result in a net loss of a species and its habitat, and preferably a net gain. This can be accomplished by setting aside in perpetuity parts of populations and habitat in a proportion of land and habitat that offsets the loss from the action. Historically this has been a fairly subjective process but Biobanking is now available and is being used as a tool to quantify offsets.

The removal of 8.55 hectares of remnant vegetation, including a population of *Tetratheca juncea* (2,302 plants) and habitat for threatened fauna species, can be offset by retention of approximately 3.6 hectares of native vegetation and habitat in an area along the southern boundary of the landfill site. This area is located between the existing facility and Wilton Road in the southern portion of the site. This area supports a population of 280 plants of *Grevillea parviflora ssp. parviflora* and 31 *Tetratheca juncea* plants. Whilst the retention of approximately 3.6 hectares of remnant vegetation in this location is unlikely to wholly offset the degree of plants removed by the proposed action (8.55 hectares), it would significantly contribute towards compensation for the proposed removal.

Additionally, as noted earlier, LMCC is currently undertaking compulsory acquisition of the adjoining property (Lot 373 DP723259). This property supports a very significant threatened plant population, and has the ability to offer a substantial offset to those plants proposed to be removed from the proposed expansion of the Awaba waste facility (removal of 8.55 hectares of remnant vegetation).

4.4 Landscape and Site Biodiversity Values

The threatened flora surveys reveal a very significant population abundance of *Tetratheca juncea* occurs on the landfill site. A total of 2,333 plants were recorded in remnant vegetation on the landfill site at a density which far exceeds previous known estimates. The landfill site is contiguous with an approximate area of 1,530 hectares of similar vegetation community, Coastal Plains Smooth-barked Apple Woodland or Coastal Plains Scribbly Gum Woodland communities (NPWS, 2000). The NPWS vegetation mapping shows that the aforementioned 1,530 ha of vegetation is almost entirely made up of these two communities and so may be suitable habitat for *Tetratheca juncea*. There is no suggestion that the extraordinary population density recorded in the Awaba waste site would continue unabated into this surrounding habitat, however based on the previously known density estimate of 40 clumps per hectare, the estimate of the local population is approaching 70,000 clumps. It is noted that a significant proportion of an additional 1,530 hectares occurs on land zoned 7(2) – Conservation Secondary with limited potential for future development (LMCC, 2004).

Under the current development plan for the Awaba site, there is very limited scope for conservation of remnant vegetation and habitat along the western, northern and eastern boundaries. The proposed loss of 8.55 hectares of habitat is offset by the extensive area of similar habitat in the locality (i.e. at least 1,530 hectares).

4.5 Conclusion

The impact assessment prepared for the proposed action, expansion of the Awaba waste facility, would not in itself have a significant impact on threatened species, or their habitat. This conclusion is based on the principle that whilst there would be a loss of individual threatened plants and habitat of fauna species, this loss is minimal in the context of the landscape environment, in which the landfill site is contiguous with >1,500 hectares of similar habitat. Additionally, taking into consideration that a significant proportion of the 1,500 hectares occurs on land zoned for conservation, with limited scope for future development, under the prevailing Local Environmental Plan.

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APPENDIX 1. Vegetation Community Analysis and Flora List

30f: Freemans Peppermint-Apple-Bloodwood Forest

Group 30f: Freemans Peppermint-Apple-Bloodwood Forest

Less than 2 samples in group (full species list provided)

Species	c/a
<i>Doryanthes excelsa</i>	5
<i>Corymbia gummifera</i>	4
<i>Pteridium esculentum</i>	3
<i>Angophora costata</i>	3
<i>Macrozamia reducta</i>	3
<i>Xanthorrhoea latifolia</i> subsp. <i>latifolia</i>	3
<i>Pandorea pandorana</i>	2
<i>Billardiera scandens</i>	2
<i>Blechnum cartilagineum</i>	2
<i>Polyscias sambucifolia</i> subsp. <i>sambucifolia</i>	2
<i>Ceratopetalum gummiferum</i>	2
<i>Eustrephus latifolius</i>	2
<i>Lomandra confertifolia</i> subsp. <i>pallida</i>	2
<i>Eucalyptus piperita</i>	2
<i>Gompholobium latifolium</i>	2
<i>Acacia myrtifolia</i>	2
<i>Eucalyptus umbra</i>	2
<i>Hibbertia dentata</i>	2
<i>Desmodium rhytidophyllum</i>	2
<i>Microlaena stipoides</i> var. <i>stipoides</i>	2
<i>Entolasia stricta</i>	2
<i>Acacia longifolia</i> subsp. <i>longifolia</i>	2
<i>Imperata cylindrica</i>	2
<i>Lomatia silaifolia</i>	2
<i>Calochlaena dubia</i>	2
<i>Themeda australis</i>	2
<i>Banksia serrata</i>	2
<i>Pseuderanthemum variabile</i>	2
<i>Allocasuarina littoralis</i>	1
<i>Dianella caerulea</i> var. <i>assera</i>	1
<i>Hardenbergia violacea</i>	1
<i>Banksia spinulosa</i> var. <i>collina</i>	1
<i>Scaevola ramosissima</i>	1
<i>Hibbertia obtusifolia</i>	1
<i>Glochidion ferdinandi</i> var. <i>ferdinandi</i>	1
<i>Bossiaea obcordata</i>	1
<i>Smilax glycyphylla</i>	1
<i>Persoonia levis</i>	1
<i>Leptospermum trinervium</i>	1

Group 30f: Freemans Peppermint-Apple-Bloodwood Forest
 Less than 2 samples in group (full species list provided)

<i>Hibbertia empetrifolia</i> subsp. <i>empetrifolia</i>	1
<i>Xylomelum pyriforme</i>	1

30h: Sugarloaf Lowlands Bloodwood-Apple Forest

Group 30h: Sugarloaf Lowlands Bloodwood-Apple Forest
 Average similarity: 61.74

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
<i>Eucalyptus capitellata</i>	4	5.37	-	8.7	8.7
<i>Corymbia gummifera</i>	3	4.03	-	6.52	15.22
<i>Themeda australis</i>	3.5	4.03	-	6.52	21.74
<i>Xanthorrhoea latifolia</i> subsp. <i>latifolia</i>	3.5	4.03	-	6.52	28.26
<i>Angophora costata</i>	2	2.68	-	4.35	32.61
<i>Brunoniella australis</i>	2	2.68	-	4.35	36.96
<i>Entolasia stricta</i>	2	2.68	-	4.35	41.3
<i>Gompholobium latifolium</i>	2	2.68	-	4.35	45.65
<i>Imperata cylindrica</i>	2	2.68	-	4.35	50
<i>Lepidosperma laterale</i>	2	2.68	-	4.35	54.35
<i>Lomandra obliqua</i>	2	2.68	-	4.35	58.7
<i>Panicum simile</i>	2	2.68	-	4.35	63.04
<i>Phyllanthus hirtellus</i>	2	2.68	-	4.35	67.39
<i>Podolobium ilicifolium</i>	2	2.68	-	4.35	71.74
<i>Acacia myrtifolia</i>	2	1.34	-	2.17	73.91
<i>Allocasuarina littoralis</i>	1	1.34	-	2.17	76.09
<i>Banksia spinulosa</i> var. <i>collina</i>	1.5	1.34	-	2.17	78.26
<i>Dianella caerulea</i> var. <i>assera</i>	1	1.34	-	2.17	80.43
<i>Dillwynia retorta</i>	1.5	1.34	-	2.17	82.61
<i>Doryphora excelsa</i>	2	1.34	-	2.17	84.78
<i>Epacris pulchella</i>	1.5	1.34	-	2.17	86.96
<i>Glycine clandestina</i>	1	1.34	-	2.17	89.13
<i>Hovea linearis</i>	1.5	1.34	-	2.17	91.3
<i>Leptospermum trinervium</i>	1.5	1.34	-	2.17	93.48
<i>Opercularia diphylla</i>	1.5	1.34	-	2.17	95.65
<i>Persoonia linearis</i>	1.5	1.34	-	2.17	97.83
<i>Pultenaea paleacea</i>	1	1.34	-	2.17	100

30j: Sugarloaf Lowlands Bloodwood-Apple-Scribbly Gum Forest

Group 30j: Sugarloaf Lowlands Bloodwood-Apple-Scribbly Gum Forest

Average similarity: 69.28

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
<i>Eucalyptus capitellata</i>	3	3.92	-	5.66	5.66
<i>Eucalyptus haemastoma</i>	3	3.92	-	5.66	11.32
<i>Ptilothrix deusta</i>	3.5	3.92	-	5.66	16.98
<i>Acacia brownii</i>	2	2.61	-	3.77	20.75
<i>Acacia myrtifolia</i>	2.5	2.61	-	3.77	24.53
<i>Angophora costata</i>	2.5	2.61	-	3.77	28.3
<i>Corymbia gummifera</i>	2.5	2.61	-	3.77	32.08
<i>Dillwynia retorta</i>	2.5	2.61	-	3.77	35.85
<i>Entolasia stricta</i>	2	2.61	-	3.77	39.62
<i>Epacris pulchella</i>	2	2.61	-	3.77	43.4
<i>Eucalyptus umbra</i>	2.5	2.61	-	3.77	47.17
<i>Isopogon anemonifolius</i>	2	2.61	-	3.77	50.94
<i>Lambertia formosa</i>	2.5	2.61	-	3.77	54.72
<i>Lepidosperma laterale</i>	2	2.61	-	3.77	58.49
<i>Lomandra glauca</i>	2	2.61	-	3.77	62.26
<i>Lomandra obliqua</i>	2	2.61	-	3.77	66.04
<i>Mirbelia rubiifolia</i>	2	2.61	-	3.77	69.81
<i>Podolobium ilicifolium</i>	2	2.61	-	3.77	73.58
<i>Pultenaea tuberculata</i>	2	2.61	-	3.77	77.36
<i>Themeda australis</i>	2.5	2.61	-	3.77	81.13
<i>Xanthorrhoea latifolia</i> subsp. <i>latifolia</i>	2	2.61	-	3.77	84.91
<i>Acacia longifolia</i> subsp. <i>longifolia</i>	1	1.31	-	1.89	86.79
<i>Allocasuarina littoralis</i>	1.5	1.31	-	1.89	88.68
<i>Astrotricha obovata</i>	1.5	1.31	-	1.89	90.57
<i>Banksia spinulosa</i> var. <i>collina</i>	1	1.31	-	1.89	92.45
<i>Hovea linearis</i>	1	1.31	-	1.89	94.34
<i>Leptospermum trinervium</i>	2.5	1.31	-	1.89	96.23
<i>Monotoca scoparia</i>	1	1.31	-	1.89	98.11
<i>Persoonia levis</i>	1	1.31	-	1.89	100

31: Coastal Plains Scribbly Gum Woodland

Group 31: Coastal Plains Scribbly Gum Woodland

Average similarity: 60.94

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
<i>Ptilothrix deusta</i>	4.67	5	3.13	8.21	8.21
<i>Eucalyptus haemastoma</i>	3	4.09	70.88	6.71	14.93
<i>Banksia oblongifolia</i>	2.67	3.19	3.87	5.23	20.16
<i>Corymbia gummifera</i>	2.67	3.18	3.97	5.23	25.38
<i>Xanthorrhoea latifolia subsp. latifolia</i>	2.67	3.18	3.97	5.23	30.61
<i>Cassylia glabella forma glabella</i>	2	2.73	70.88	4.48	35.09
<i>Entolasia stricta</i>	2.67	2.73	70.88	4.48	39.56
<i>Epacris pulchella</i>	2	2.73	70.88	4.48	44.04
<i>Leptospermum trinervium</i>	2	2.73	70.88	4.48	48.51
<i>Lindsaea linearis</i>	2	2.73	70.88	4.48	52.99
<i>Lomandra obliqua</i>	2	2.73	70.88	4.48	57.47
<i>Pultenaea tuberculata</i>	2	2.73	70.88	4.48	61.94
<i>Patersonia sericea</i>	1.67	1.82	2.25	2.99	64.94
<i>Dillwynia retorta</i>	2	1.82	2.29	2.99	67.92
<i>Goodenia heterophylla subsp. heterophylla</i>	1.67	1.82	2.29	2.99	70.91
<i>Lambertia formosa</i>	2	1.82	2.29	2.99	73.9
<i>Bossiaea stephensonii</i>	1.33	1.36	70.88	2.24	76.14
<i>Hakea laevipes subsp. laevipes</i>	1.33	1.36	70.88	2.24	78.37
<i>Isopogon anemonifolius</i>	1	1.36	70.88	2.24	80.61
<i>Melichrus procumbens</i>	1	1.36	70.88	2.24	82.85
<i>Persoonia levis</i>	1.33	1.36	70.88	2.24	85.09
<i>Leucopogon microphyllus var. microphyllus</i>	1.67	0.91	0.58	1.5	86.59
<i>Themeda australis</i>	1.33	0.89	0.58	1.47	88.06
<i>Billardiera scandens</i>	0.67	0.46	0.58	0.75	88.81
<i>Panicum simile</i>	1	0.46	0.58	0.75	89.56
<i>Thysanotus tuberosus subsp. tuberosus</i>	0.67	0.46	0.58	0.75	90.32
<i>Acacia myrtifolia</i>	1	0.46	0.58	0.75	91.07
<i>Allocasuarina littoralis</i>	0.67	0.46	0.58	0.75	91.82
<i>Daviesia mimosoides subsp. mimosoides</i>	1	0.46	0.58	0.75	92.57
<i>Lepidosperma laterale</i>	1	0.46	0.58	0.75	93.32
<i>Mirbelia rubiifolia</i>	1	0.46	0.58	0.75	94.07
<i>Pimelea linifolia subsp. linifolia</i>	0.67	0.46	0.58	0.75	94.81
<i>Platysace ericoides</i>	0.67	0.46	0.58	0.75	95.56
<i>Pultenaea paleacea</i>	0.67	0.46	0.58	0.75	96.31
<i>Schizaea bifida</i>	1	0.46	0.58	0.75	97.06
<i>Comesperma ericinum</i>	0.67	0.45	0.58	0.73	97.8
<i>Comesperma sphaerocarpum</i>	1	0.45	0.58	0.73	98.53
<i>Scaevola ramosissima</i>	0.67	0.45	0.58	0.73	99.27

114: Red Mahogany-Paperbark Thicket

Group 114: Red Mahogany-Paperbark Thicket

Average similarity: 60.81

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
<i>Gahnia clarkei</i>	5.25	9.87	10.92	16.23	16.23
<i>Melaleuca linariifolia</i>	4.5	7.9	10.92	12.99	29.22
<i>Calochlaena dubia</i>	3.25	5.25	3.12	8.63	37.85
<i>Callicoma serratifolia</i>	2.75	4.95	3.97	8.14	45.99
<i>Eucalyptus piperita</i>	2.75	4.9	4.94	8.06	54.06
<i>Eucalyptus resinifera subsp. resinifera</i>	3	4.88	5.63	8.03	62.09
<i>Glochidion ferdinandi var. ferdinandi</i>	2.5	4.26	5.9	7	69.09
<i>Adiantum aethiopicum</i>	2	3.95	10.92	6.49	75.58
<i>Oplismenus imbecillus</i>	2	3.95	10.92	6.49	82.08
<i>Dioscorea transversa</i>	1.5	2.26	3.71	3.72	85.8
<i>Hypolepis muelleri</i>	1.25	1.43	0.79	2.36	88.15
<i>Acmena smithii</i>	1.5	0.94	0.91	1.54	89.69
<i>Smilax australis</i>	0.75	0.94	0.91	1.54	91.23
<i>Acacia irrorata var. irrorata</i>	1.5	0.87	0.41	1.43	92.66
<i>Angophora costata</i>	1.5	0.87	0.41	1.43	94.09
<i>Cyathea cooperi</i>	1.25	0.75	0.41	1.23	95.32
<i>Carex longebrachiata</i>	0.5	0.35	0.41	0.57	95.89
<i>Eustrephus latifolius</i>	0.5	0.35	0.41	0.57	96.46
<i>Callistemon salignus</i>	0.5	0.34	0.41	0.55	97.02
<i>Parsonsia straminea</i>	0.75	0.34	0.41	0.55	97.57
<i>Entolasia marginata</i>	0.75	0.32	0.41	0.52	98.09
<i>Glycine clandestina</i>	0.75	0.29	0.41	0.48	98.57
<i>Hibbertia dentata</i>	0.5	0.29	0.41	0.48	99.05

Family	Genus & Species	Common Name
Acanthaceae	<i>Brunoniella australis</i>	Blue Trumpet
	<i>Pseuderanthemum variabile</i>	Pastel Flower
Adiantaceae	<i>Adiantum aethiopicum</i>	Common Maidenhair
	<i>Adiantum hispidulum</i>	Rough Maidenhair
	<i>Cheilanthes sieberi subsp. sieberi</i>	Rock Fern
Anthericaceae	<i>Thysanotus tuberosus subsp. tuberosus</i>	
	<i>Tricoryne elatior</i>	Yellow Autumn-lily
Apiaceae	<i>Platysace ericoides</i>	
	<i>Platysace linearifolia</i>	
	<i>Xanthosia tridentata</i>	Rock Xanthosia
Apocynaceae	<i>Parsonsia straminea</i>	Common Silkpod
Araceae	<i>Gymnostachys anceps</i>	Settler's Twine
Araliaceae	<i>Astrotricha obovata</i>	
	<i>Polyscias sambucifolia subsp. sambucifolia</i>	
Arecaceae	<i>Livistona australis</i>	Cabbage Palm
Asparagaceae	<i>Asparagus aethiopicus</i> *	Asparagus Fern
Asteraceae	<i>Ageratina adenophora</i> *	Crofton Weed
	<i>Bidens pilosa</i> *	Cobbler's Pegs
	<i>Chrysanthemoides monilifera subsp. rotundata</i> *	Bitou Bush
	<i>Senecio spp.</i>	Groundsel, Fireweed
Bignoniaceae	<i>Pandorea pandorana</i>	Wonga Wonga Vine
Blechnaceae	<i>Blechnum cartilagineum</i>	Gristle Fern
Casuarinaceae	<i>Allocasuarina littoralis</i>	Black She-Oak
	<i>Allocasuarina torulosa</i>	Forest Oak
Commelinaceae	<i>Tradescantia fluminensis</i> *	Wandering Jew
Convolvulaceae	<i>Dichondra repens</i>	Kidney Weed
	<i>Polymeria calycina</i>	

Family	Genus & Species	Common Name
Cunoniaceae	<i>Callicoma serratifolia</i>	Black Wattle
	<i>Ceratopetalum gummiferum</i>	Christmas Bush
Cyatheaceae	<i>Cyathea cooperi</i>	Straw Treefern
Cyperaceae	<i>Carex longebrachiata</i>	
	<i>Cyperus eragrostis</i> *	Umbrella Sedge
	<i>Gahnia clarkei</i>	Tall Saw-sedge
	<i>Gahnia melanocarpa</i>	Black Fruit Saw-sedge
	<i>Gahnia radula</i>	
	<i>Lepidosperma concavum</i>	
	<i>Lepidosperma laterale</i>	Variable Sword-sedge
	<i>Ptilothrix deusta</i>	
Dennstaedtiaceae	<i>Hypolepis muelleri</i>	Harsh Ground Fern
	<i>Pteridium esculentum</i>	Bracken
Dicksoniaceae	<i>Calochlaena dubia</i>	Rainbow Fern
Dilleniaceae	<i>Hibbertia dentata</i>	Twining Guinea Flower
	<i>Hibbertia empetrifolia</i> subsp. <i>empetrifolia</i>	
	<i>Hibbertia obtusifolia</i>	Hoary Guinea Flower
Dioscoreaceae	<i>Dioscorea transversa</i>	Native Yam
Doryanthaceae	<i>Doryanthes excelsa</i>	Gynea Lily
Elaeocarpaceae	<i>Elaeocarpus reticulatus</i>	Blueberry Ash
	<i>Tetradlea juncea</i> TSC	Black-eyed Susan
	<i>Tetradlea thymifolia</i>	Black-eyed Susan
Ericaceae	<i>Epacris pulchella</i>	Wallum Heath
	<i>Leucopogon lanceolatus</i> var. <i>lanceolatus</i>	
	<i>Leucopogon microphyllus</i> var. <i>microphyllus</i>	
	<i>Melichrus procumbens</i>	Jam Tarts
	<i>Monotoca scoparia</i>	
Fabaceae (Faboideae)	<i>Bossiaea heterophylla</i>	Variable Bossiaea
	<i>Bossiaea obcordata</i>	Spiny Bossiaea

Family	Genus & Species	Common Name
	<i>Bossiaea stephensonii</i>	
	<i>Daviesia mimosoides</i> subsp. <i>mimosoides</i>	
	<i>Daviesia squarrosa</i>	
	<i>Daviesia ulicifolia</i> subsp. <i>ulicifolia</i>	
	<i>Desmodium rhytidophyllum</i>	
	<i>Dillwynia retorta</i>	
	<i>Glycine clandestina</i>	Twining glycine
	<i>Gompholobium latifolium</i>	Golden Glory Pea
	<i>Gompholobium pinnatum</i>	Pinnate Wedge Pea
	<i>Hardenbergia violacea</i>	False Sarsaparilla
	<i>Hovea linearis</i>	
	<i>Kennedia rubicunda</i>	Dusky Coral Pea
	<i>Mirbelia rubiifolia</i>	Heathy Mirbelia
	<i>Platylobium formosum</i> subsp. <i>parviflorum</i>	
	<i>Podolobium ilicifolium</i>	Prickly Shaggy Pea
	<i>Pultenaea daphnoides</i>	Large-leaf Bush-pea
	<i>Pultenaea euchila</i>	
	<i>Pultenaea paleacea</i>	
	<i>Pultenaea tuberculata</i>	
	<i>Sphaerolobium minus</i>	
Fabaceae (Mimosoideae)	<i>Acacia brownii</i>	Heath Wattle
	<i>Acacia bynoeana</i> TSC	Bynoe's Wattle
	<i>Acacia irrorata</i> subsp. <i>irrorata</i>	Green Wattle
	<i>Acacia longifolia</i> subsp. <i>longifolia</i>	Sydney Golden Wattle
	<i>Acacia myrtifolia</i>	Red-stemmed Wattle
	<i>Acacia podalyriifolia</i> *	Queensland Silver Wattle
	<i>Acacia suaveolens</i>	Sweet Wattle
	<i>Acacia terminalis</i> subsp. <i>longiaxialis</i>	
Goodeniaceae	<i>Dampiera stricta</i>	
	<i>Goodenia bellidifolia</i> subsp. <i>bellidifolia</i>	
	<i>Goodenia hederacea</i> subsp. <i>hederacea</i>	
	<i>Goodenia heterophylla</i> subsp. <i>heterophylla</i>	
	<i>Scaevola ramosissima</i>	Purple Fan-flower
Haloragaceae	<i>Gonocarpus tetragynus</i>	Poverty Raspwort
Iridaceae	<i>Patersonia glabrata</i>	Leafy Purple-flag
	<i>Patersonia sericea</i>	Silky Purple-Flag

Family	Genus & Species	Common Name
Lamiaceae	<i>Prostanthera incisa</i>	Cut-leaved Mint-bush
Lauraceae	<i>Cassythia glabella</i> f. <i>glabella</i>	
	<i>Cinnamomum camphora</i> *	Camphor Laurel
Lindsaeaceae	<i>Lindsaea linearis</i>	Screw Fern
	<i>Lindsaea microphylla</i>	Lacy Wedge Fern
Loganiaceae	<i>Logania albiflora</i>	
	<i>Logania pusilla</i>	
Lomandraceae	<i>Lomandra confertifolia</i> subsp. <i>pallida</i>	Matrush
	<i>Lomandra filiformis</i> subsp. <i>filiformis</i>	
	<i>Lomandra glauca</i>	Pale Mat-rush
	<i>Lomandra longifolia</i>	Spiny-headed Mat-rush
	<i>Lomandra multiflora</i> subsp. <i>multiflora</i>	Many-flowered Mat-rush
	<i>Lomandra obliqua</i>	
Luzuriagaceae	<i>Eustrephus latifolius</i>	Wombat Berry
Menispermaceae	<i>Stephania japonica</i> var. <i>discolor</i>	Snake Vine
Myrtaceae	<i>Acmena smithii</i>	Lilly Pilly
	<i>Angophora costata</i>	Sydney Red Gum
	<i>Angophora inopina</i> TSC	Charmhaven Apple
	<i>Callistemon salignus</i>	Willow Bottlebrush
	<i>Corymbia gummifera</i>	Red Bloodwood
	<i>Eucalyptus beyeriana</i>	
	<i>Eucalyptus capitellata</i>	Brown Stringybark
	<i>Eucalyptus haemastoma</i>	Broad-leaved Scribbly Gum
	<i>Eucalyptus piperita</i>	Sydney Peppermint
	<i>Eucalyptus punctata</i>	Grey Gum
	<i>Eucalyptus resinifera</i> subsp. <i>resinifera</i>	
	<i>Eucalyptus umbra</i>	Broad-leaved White Mahogany
	<i>Leptospermum polygalifolium</i> subsp. <i>cismontanum</i>	
	<i>Leptospermum trinervium</i>	Slender Tea-tree
	<i>Melaleuca armillaris</i> subsp. <i>armillaris</i> *	Bracelet Honey-myrtle
	<i>Melaleuca linariifolia</i>	Flax-leaved Paperbark
	<i>Melaleuca sieberi</i>	
Oleaceae	<i>Ligustrum sinense</i> *	Small-leaved Privet

Family	Genus & Species	Common Name
	<i>Notelaea longifolia f. longifolia</i>	
Orchidaceae	<i>Calochilus robertsonii</i>	Purplish Beard Orchid
	<i>Calochilus spp.</i>	
	<i>Cryptostylis subulata</i>	Large Tongue Orchid
	<i>Cymbidium suave</i>	Snake Orchid
	<i>Microtis parviflora</i>	Slender Onion Orchid
	<i>Microtis unifolia</i>	Common Onion Orchid
Phormiaceae	<i>Dianella caerulea var. assera</i>	
Phyllanthaceae	<i>Glochidion ferdinandi var. ferdinandi</i>	Cheese Tree
	<i>Phyllanthus hirtellus</i>	Thyme Spurge
Pittosporaceae	<i>Billardiera scandens</i>	Hairy Apple Berry
Poaceae	<i>Anisopogon avenaceus</i>	Oat Speargrass
	<i>Aristida vagans</i>	Threeawn Speargrass
	<i>Aristida warburgii</i>	
	<i>Austrostipa pubescens</i>	
	<i>Digitaria diffusa</i>	Open Summer-grass
	<i>Entolasia marginata</i>	Bordered Panic
	<i>Entolasia stricta</i>	Wiry Panic
	<i>Imperata cylindrica</i>	Blady Grass
	<i>Joycea pallida</i>	Silvertop Wallaby Grass
	<i>Microlaena stipoides var. stipoides</i>	Weeping Grass
	<i>Oplismenus imbecillis</i>	
	<i>Panicum simile</i>	Two-colour Panic
	<i>Paspalum urvillei *</i>	Vasey Grass
	<i>Poa affinis</i>	
	<i>Setaria parviflora *</i>	
	<i>Themeda australis</i>	Kangaroo Grass
Polygalaceae	<i>Comesperma ericinum</i>	Pyramid Flower
	<i>Comesperma sphaerocarpum</i>	
Proteaceae	<i>Banksia oblongifolia</i>	Fern-leaved Banksia
	<i>Banksia serrata</i>	Old-man Banksia
	<i>Banksia spinulosa var. collina</i>	
	<i>Grevillea parviflora subsp. parviflora TSC</i>	Small-flower Grevillea
	<i>Grevillea sericea subsp. sericea</i>	

Family	Genus & Species	Common Name
	<i>Hakea bakeriana</i>	
	<i>Hakea laevipes</i> subsp. <i>laevipes</i>	
	<i>Isopogon anemonifolius</i>	Broad-leaf Drumsticks
	<i>Lambertia formosa</i>	Mountain Devil
	<i>Lomatia silaifolia</i>	Crinkle Bush
	<i>Persoonia lanceolata</i>	Lance Leaf Geebung
	<i>Persoonia levis</i>	Broad-leaved Geebung
	<i>Persoonia linearis</i>	Narrow-leaved Geebung
	<i>Petrophile pulchella</i>	Conesticks
	<i>Xylomelum pyriforme</i>	Woody Pear
Rosaceae	<i>Rubus fruticosus</i> sp. agg. *	Blackberry complex
	<i>Rubus moluccanus</i> var. <i>trilobus</i>	Molucca Bramble
Rubiaceae	<i>Opercularia diphylla</i>	Stinkweed
Santalaceae	<i>Exocarpos cupressiformis</i>	Cherry Ballart
Sapindaceae	<i>Dodonaea triquetra</i>	Large-leaf Hop-bush
Schizaeaceae	<i>Schizaea bifida</i>	Forked Comb Fern
Smilacaceae	<i>Smilax australis</i>	Lawyer Vine
	<i>Smilax glyciophylla</i>	Sweet Sarsparilla
Solanaceae	<i>Solanum mauritianum</i> *	Wild Tobacco Bush
Stackhousiaceae	<i>Stackhousia nuda</i>	
Thymelaeaceae	<i>Pimelea linifolia</i> subsp. <i>linifolia</i>	
Verbenaceae	<i>Lantana camara</i> *	Lantana
	<i>Verbena bonariensis</i> *	Purpletop
Violaceae	<i>Hybanthus monopetalus</i>	Slender Violet-bush
	<i>Viola hederacea</i>	Ivy-leaved Violet
Xanthorrhoeaceae	<i>Xanthorrhoea latifolia</i> subsp. <i>latifolia</i>	
	<i>Xanthorrhoea macronema</i>	
	<i>Xanthorrhoea resinosa</i>	

Family	Genus & Species	Common Name
Zamiaceae	<i>Macrozamia reducta</i>	

* = weed or non-endemic species

TSC = listed on NSW *Threatened Species Conservation Act 1995*

APPENDIX 2. Fauna Records

Common Name	FAMILY / Scientific Name	Status			Subject Site Records				Locality Records		
		EP&BC	TSC	Jamba / Camba	FA1	FA2	FA3	Opportunistic	OEH 2011	LMCC 2000	SWC 1995
BIRDS											
PHASIANIDAE											
Brown Quail	<i>Coturnix ypsilophora</i>								+	+	
ANATIDAE											
Musk Duck	<i>Biziura lobata</i>	M							+	+	
Australian Wood Duck	<i>Chenonetta jubata</i>	M			2				+	+	+
* Mallard	* <i>Anas platyrhynchos</i>									+	
Pacific Black Duck	<i>Anas superciliosa</i>	M							+	+	
Australasian Shoveller	<i>Anas rhynchotis</i>	M								+	
Grey Teal	<i>Anas gracilis</i>	M							+	+	
Chestnut Teal	<i>Anas castanea</i>	M							+	+	
Pink-eared Duck	<i>Malacorhynchus membranaceus</i>	M								+	
Hardhead	<i>Aythya australis</i>	M								+	
PODICIPEDIDAE											
Hoary-headed Grebe	<i>Poliiocephalus poliocephalus</i>										+
Australian Grebe	<i>Tachybaptus novaehollandiae</i>										+
ANHINGIDAE											
Australian Darter	<i>Anhinga melanogaster</i>								+	+	
PHALACROCORACIDAE											
Little Pied Cormorant	<i>Phalacrocorax melanoleucos</i>								+	+	
Pied Cormorant	<i>Phalacrocorax varius</i>								+	+	
Little Black Cormorant	<i>Phalacrocorax sulcirostris</i>								+	+	
Great Cormorant	<i>Phalacrocorax carbo</i>								+	+	
PELECANIDAE											
Australian Pelican	<i>Pelecanus conspicillatus</i>							overhead	+	+	

Common Name	FAMILY / Scientific Name	Status			Subject Site Records				Locality Records		
		EP&BC	TSC	Jamba / Camba	FA1	FA2	FA3	Opportunistic	OEH 2011	LMCC 2000	SWC 1995
ARDEIDAE											
White-faced Heron	<i>Egretta novaehollandiae</i>								+	+	
Little Egret	<i>Egretta garzetta</i>								+	+	
Eastern Reef Egret	<i>Egretta sacra</i>	M		C						+	
White-necked Heron	<i>Ardea pacifica</i>								+		
Great Egret	<i>Ardea alba</i>	M		J					+	+	
Intermediate Egret	<i>Ardea intermedia</i>								+	+	
Cattle Egret	<i>Ardea ibis</i>	M		J					+	+	
Striated Heron	<i>Ardea striata</i>								+	+	
Nankeen Night Heron	<i>Nycticorax caledonicus</i>								+	+	
Black Bittern	<i>Ixobrychus flavicollis</i>		V						+		
PLATALEIDAE											
Australian White Ibis	<i>Threskiornis molucca</i>							Overhead	+	+	+
Straw-necked Ibis	<i>Threskiornis spinicollis</i>									+	
Royal Spoonbill	<i>Platalea regia</i>								+	+	
ACCIPITRIDAE											
Eastern Osprey	<i>Pandion cristatus</i>	M	V						+	+	
Pacific Baza	<i>Aviceda subcristata</i>	M							+	+	
Black-shouldered Kite	<i>Elanus axillaris</i>	M							+	+	+
Whistling Kite	<i>Haliastur sphenurus</i>	M			1			overhead	+	+	+
Brahminy Kite	<i>Haliastur indus</i>	M								+	
White-bellied Sea-eagle	<i>Haliaeetus leucogaster</i>	M		C		2		Nest located	+	+	+
Brown Goshawk	<i>Accipiter fasciatus</i>	M							+	+	
Grey Goshawk	<i>Accipiter novaehollandiae</i>	M							+	+	
Collared Sparrowhawk	<i>Accipiter cirrhocephalus</i>	M							+	+	
Wedge-tailed Eagle	<i>Aquila audax</i>	M						Overhead	+	+	+
FALCONIDAE											
Brown Falcon	<i>Falco berigora</i>	M							+	+	
Peregrine Falcon	<i>Falco peregrinus</i>	M							+	+	

Common Name	FAMILY / Scientific Name	Status			Subject Site Records				Locality Records		
		EP&BC	TSC	Jamba / Camba	FA1	FA2	FA3	Opportunistic	OEH 2011	LMCC 2000	SWC 1995
Nankeen Kestrel	<i>Falco cenchroides</i>	M							+	+	+
RALLIDAE											
Purple Swamphen	<i>Porphyrio porphyrio</i>								+	+	
Dusky Moorhen	<i>Gallinula tenebrosa</i>								+	+	
TURNICIDAE											
Painted Button Quail	<i>Turnix varia</i>								+	+	+
SCOLOPACIDAE											
Latham's Snipe	<i>Gallinago hardwickii</i>	M		J					+	+	
Common Sandpiper	<i>Actitis hypoleucos</i>	M		J					+		
HAEMATOPODIDAE											
Australian Pied Oystercatcher	<i>Haematopus longirostris</i>		E	E					+		
RECURVIROSTRIDAE											
Black-winged Stilt	<i>Himantopus himantopus</i>	M	V						+	+	
CHARADRIIDAE											
Black-fronted Dotterel	<i>Euseyornis melanops</i>	M							+	+	
Masked Lapwing	<i>Vanellus miles</i>	M							+	+	
LARIDAE											
Silver Gull	<i>Larus novaehollandiae</i>				overhead			overhead	+	+	
Caspian Tern	<i>Sterna caspia</i>			J						+	
Crested Tern	<i>Sterna bergii</i>								+	+	
Common Tern	<i>Sterna hirundo</i>	M		J						+	
COLUMBIDAE											
* Rock Dove	* <i>Columba livia</i>								+	+	+
White-headed Pigeon	<i>Columba leucomela</i>								+	+	
* Spotted Turtle-dove	* <i>Streptopelia chinensis</i>								+	+	
Brown Cuckoo-dove	<i>Macropygia amboinenses</i>									+	
Emerald Dove	<i>Chalcophaps indica</i>	M							+	+	
Common Bronzewing	<i>Phaps chalcoptera</i>							1	+	+	
Crested Pigeon	<i>Ocyphaps lophotes</i>							4	+	+	+

Common Name	FAMILY / Scientific Name	Status			Subject Site Records				Locality Records			
		EP&BC	TSC	Jamba / Camba	FA1	FA2	FA3	Opportunistic	OEH 2011	LMCC 2000	SWC 1995	
Peaceful Dove	<i>Geopelia striata</i>									+	+	
Wonga Pigeon	<i>Leucosarcia melanoleuca</i>									+		
Topknot Pigeon	<i>Lopholaimus antarcticus</i>								+	+		
CACATUIDAE												
Glossy Black-Cockatoo	<i>Calyptorhynchus lathami</i>		V							+	+	+
Yellow-tailed Black Cockatoo	<i>Calyptorhynchus funereus</i>									+	+	
Gang-gang Cockatoo	<i>Callocephalon fimbriatum</i>		V								+	
Galah	<i>Cacatua roseicapilla</i>							overhead	+	+	+	
Long-billed Corella	<i>Cacatua tenuirostris</i>								+	+		
Little Corella	<i>Cacatua sanguinea</i>								+	+		
Sulphur-crested Cockatoo	<i>Cacatua galerita</i>					5		Overhead	+	+		
PSITTACIDAE												
Rainbow Lorikeet	<i>Trichoglossus haematodus</i>							Overhead	+	+	+	
Scaly-breasted Lorikeet	<i>Trichoglossus chlorolepidotus</i>								+	+		
Musk Lorikeet	<i>Glossopsitta concinna</i>								+	+		
Little Lorikeet	<i>Glossopsitta pusilla</i>		V						+	+		
Australian King Parrot	<i>Alisterus scapularis</i>						2		+	+	+	
Crimson Rosella	<i>Platycerus elegans</i>								+	+		
Eastern Rosella	<i>Platycerus eximius</i>				2		6	Powerline easement	+	+	+	
Swift Parrot	<i>Lathamus discolor</i>	E	E						+			
Turquoise Parrot	<i>Neophema pulchella</i>		V						+	+		
CUCULIDAE												
Pallid Cuckoo	<i>Cuculus pallidus</i>								+	+		
Brush Cuckoo	<i>Cacomantis variolosus</i>								+	+		
Fan-tailed Cuckoo	<i>Cacomantis flabelliformis</i>					1			+	+	+	
Horsfield's Bronze-Cuckoo	<i>Chrysococcyx basalis</i>								+	+		
Shining Bronze-Cuckoo	<i>Chrysococcyx lucidus</i>								+	+		
Common Koel	<i>Eudynamis scolopacea</i>								+	+		

Common Name	FAMILY / Scientific Name	Status			Subject Site Records				Locality Records		
		EP&BC	TSC	Jamba / Camba	FA1	FA2	FA3	Opportunistic	OEH 2011	LMCC 2000	SWC 1995
Channel-billed Cuckoo	<i>Scythrops novaehollandiae</i>							Heard call	+		
CENTROPODIDAE											
Pheasant Coucal	<i>Centropus phasianinus</i>						1	Heard call	+	+	
STRIGIDAE											
Powerful Owl	<i>Ninox strenua</i>		V						+	+	+
Southern Boobook	<i>Ninox novaeseelandiae</i>								+	+	
TYTONIDAE											
Sooty Owl	<i>Tyto tenebricosa</i>		V						+		
Masked Owl	<i>Tyto novaehollandiae</i>		V						+	+	+
Barn Owl	<i>Tyto alba</i>								+	+	
PODARGIDAE											
Tawny Frogmouth	<i>Podargus strigoides</i>					Spot			+	+	+
CAPRIMULGIDAE											
White-throated Nightjar	<i>Eurostopodus mystacalis</i>								+	+	
AEGOTHELIDAE											
Australian Owlet-Nightjar	<i>Aegotheles cristatus</i>				1	1	1	Heard call	+	+	+
APODIDAE											
White-throated Needletail	<i>Hirundapus caudacutus</i>	M		J				Overhead	+	+	
Fork-tailed Swift	<i>Apus pacificus</i>	M		J					+	+	
ALCEDINIDAE											
Azure Kingfisher	<i>Alcedo azurea</i>								+	+	
HALCYONIDAE											
Laughing Kookaburra	<i>Dacelo novaeguineae</i>				2	4	5		+	+	+
Sacred Kingfisher	<i>Todiramphus sancta</i>				2			Heard call		+	+
MEROPIIDAE											
Rainbow Bee-eater	<i>Merops ornatus</i>	M		J					+	+	
CORACIIDAE											
Dollarbird	<i>Eurystomus orientalis</i>				1		2	Overhead	+	+	
MENURIDAE											

Common Name	FAMILY / Scientific Name	Status			Subject Site Records				Locality Records		
		EP&BC	TSC	Jamba / Camba	FA1	FA2	FA3	Opportunistic	OEH 2011	LMCC 2000	SWC 1995
Superb Lyrebird	<i>Menura novaehollandiae</i>									+	
CLIMACTERIDAE											
White-throated Treecreeper	<i>Climacteris leucophaea</i>				1	1	2		+	+	+
MALURIDAE											
Superb Fairy-wren	<i>Malurus cyaneus</i>				4	3	6	+	+	+	+
Variegated Fairy-wren	<i>Malurus lamberti</i>					4		+	+	+	+
Southern Emu-wren	<i>Stipiturus malachurus</i>					3		Observed	+	+	
PARDALOTIDAE											
Spotted Pardalote	<i>Pardalotus punctatus</i>				2	2	1	Heard call	+	+	+
Striated Pardalote	<i>Pardalotus striatus</i>								+	+	+
Rock Warbler	<i>Origma solitaria</i>									+	
White-browed Scrubwren	<i>Sericornis frontalis</i>						2			+	+
Chestnut-rumped Heathwren	<i>Hylacola pyrrhopygia</i>								+	+	
Weebill	<i>Smicromis brevirostris</i>								+	+	
Brown Gerygone	<i>Gerygone mouki</i>								+	+	
Mangrove Gerygone	<i>Gerygone laevigaster</i>								+	+	
White-throated Gerygone	<i>Gerygone olivacea</i>				1	1	1	Heard call	+	+	
Brown Thornbill	<i>Acanthiza pusilla</i>								+	+	+
Buff-rumped Thornbill	<i>Acanthiza reguloides</i>				6				+	+	+
Yellow-rumped Thornbill	<i>Acanthiza chrysorrhoa</i>									+	+
Yellow Thornbill	<i>Acanthiza nana</i>								+	+	+
Striated Thornbill	<i>Acanthiza lineata</i>								+	+	+
MELIPHAGIDAE											
Red Wattlebird	<i>Anthochaera carunculata</i>								+	+	
Little Wattlebird	<i>Anthochaera chrysoptera</i>								+		
Striped Honeyeater	<i>Plectorhyncha lanceolata</i>				1			Heard call	+	+	
Noisy Friarbird	<i>Philemon corniculatus</i>							Heard call	+	+	+
Little Friarbird	<i>Philemon citreogularis</i>								+		
Regent Honeyeater	<i>Anthochaera phrygia</i>	E M	CE						+		

Common Name	FAMILY / Scientific Name	Status			Subject Site Records				Locality Records		
		EP&BC	TSC	Jamba / Camba	FA1	FA2	FA3	Opportunistic	OEH 2011	LMCC 2000	SWC 1995
Bell Miner	<i>Manorina melanophrys</i>								+	+	
Noisy Miner	<i>Manorina melanocephala</i>				10+		3	10+	+	+	+
Lewin's Honeyeater	<i>Meliphaga lewinii</i>				2		2		+	+	+
Yellow-faced Honeyeater	<i>Lichenostomus chrysops</i>				10+	10+	10+		+	+	+
White-eared Honeyeater	<i>Lichenostomus leucotis</i>									+	
Fuscous Honeyeater	<i>Lichenostomus fuscus</i>								+		
White-plumed Honeyeater	<i>Lichenostomus penicillatus</i>								+		
Brown-headed Honeyeater	<i>Melithreptus brevirostris</i>				5		8		+	+	+
White-throated Honeyeater	<i>Melithreptus albogularis</i>									+	
White-naped Honeyeater	<i>Melithreptus lunatus</i>								+	+	+
Brown Honeyeater	<i>Lichmera indistincta</i>								+	+	
New Holland Honeyeater	<i>Phylidonyris novaehollandiae</i>									+	+
White-cheeked Honeyeater	<i>Phylidonyris nigra</i>						10+		+	+	+
Tawny-crowned Honeyeater	<i>Phylidonyris melanops</i>								+	+	
Eastern Spinebill	<i>Acanthorhynchus tenuirostris</i>						2	+	+	+	+
Scarlet Honeyeater	<i>Myzomela sanguinolenta</i>				1		2	Heard call	+	+	
PETROICIDAE											
Jacky Winter	<i>Microeca fascinans</i>								+	+	+
Scarlet Robin	<i>Petroica multicolor</i>		V						+	+	
Red-capped Robin	<i>Petroica goodenovii</i>								+	+	
Rose Robin	<i>Petroica rosea</i>								+	+	
Eastern Yellow Robin	<i>Eopsaltria australis</i>						1	Heard call	+	+	+
CINCLOSOMATIDAE											
Eastern Whipbird	<i>Psophodes olivaceus</i>						2		+	+	+
Spotted Quail Thrush	<i>Cinclosoma punctatum</i>								+	+	+
NEOSITTIDAE											
Varied Sitella	<i>Daphoenositta chrysoptera</i>		V		10+				+	+	+
PACHYCEPHALIDAE											
Crested Shrike-tit	<i>Falcunculus frontatus</i>								+	+	

Common Name	FAMILY / Scientific Name	Status			Subject Site Records				Locality Records		
		EP&BC	TSC	Jamba / Camba	FA1	FA2	FA3	Opportunistic	OEH 2011	LMCC 2000	SWC 1995
Golden Whistler	<i>Pachycephala pectoralis</i>					2	2	Heard call	+	+	+
Rufous Whistler	<i>Pachycephala rufiventris</i>								+	+	
Grey Shrike-thrush	<i>Colluricincla harmonica</i>							Heard call	+	+	+
DICRURIDAE											
Black-faced Monarch	<i>Monarcha melanopsis</i>	M							+	+	
Leaden Flycatcher	<i>Myiagra rubecula</i>								+	+	
Satin Flycatcher	<i>Myiagra cyanoleuca</i>	M								+	
Magpie-Lark	<i>Grallina cyanoleuca</i>							Observed in tip	+	+	+
Rufous Fantail	<i>Rhipidura rufifrons</i>	M								+	
Grey Fantail	<i>Rhipidura fuliginosa</i>				2	2	2	Observed	+	+	+
Willie Wagtail	<i>Rhipidura leucophrys</i>					2			+	+	+
Spangled Drongo	<i>Dicrurus bracteatus</i>									+	
CAMPEPHAGIDAE											
Black-faced Cuckoo-shrike	<i>Coracina novaehollandiae</i>				4			Observed	+	+	+
White-bellied Cuckoo-shrike	<i>Coracina papuensis</i>								+	+	
Cicadabird	<i>Coracina tenuirostris</i>								+	+	
ORIOLIDAE											
Olive-backed Oriole	<i>Oriolus sagittatus</i>				1	1	1	Observed	+	+	
Figbird	<i>Sphecotheres viridis</i>								+	+	
ARTAMIDAE											
White-browed Woodswallow	<i>Artamus superciliosus</i>									+	
Dusky Woodswallow	<i>Artamus cyanopterus</i>								+	+	+
Grey Butcherbird	<i>Cracticus torquatus</i>					1	1	Heard call	+	+	
Pied Butcherbird	<i>Cracticus nigrogularis</i>								+	+	+
Australian Magpie	<i>Gymnorhina tibicen</i>				2	2	2		+	+	+
Pied Currawong	<i>Strepera graculina</i>				1			Observed	+	+	+
CORVIDAE											
Australian Raven	<i>Corvus coronoides</i>				10+	10+	4	Observed	+	+	+

Common Name	FAMILY / Scientific Name	Status			Subject Site Records				Locality Records		
		EP&BC	TSC	Jamba / Camba	FA1	FA2	FA3	Opportunistic	OEH 2011	LMCC 2000	SWC 1995
CORCORACIDAE											
White-winged Chough	<i>Corcorax melanorhamphos</i>								+	+	
PTILONORHYNCHIDAE											
Satin Bowerbird	<i>Ptilinorhynchus violaceus</i>						3		+	+	+
MOTACILLIDAE											
Richard's Pipit	<i>Anthus novaeseelandiae</i>							Landfill area		+	+
PASSERIDAE											
* House Sparrow	* <i>Passer domesticus</i>								+	+	
Double-barred Finch	<i>Taeniophygia bichenovii</i>								+	+	
Red-browed Firetail	<i>Neochmia temporalis</i>				10+	10+	10+		+	+	+
Chestnut-breasted Mannikin	<i>Lonchura castaneothorax</i>									+	
DICAEIDAE											
Mistletoebird	<i>Dicaeum hirundinaceum</i>				1		2	Heard call	+	+	+
HIRUNDINIDAE											
Welcome Swallow	<i>Hirundo neoxena</i>								+	+	+
Tree Martin	<i>Hirundo nigricans</i>								+	+	
SYLVIIDAE											
Clamorous Reed Warbler	<i>Acrocephalus stentoreus</i>								+	+	
Little Grassbird	<i>Megalurus gramineus</i>								+	+	
Golden-headed Cisticola	<i>Cisticola exilis</i>							Landfill area			
ZOSTEROPIDAE											
Silvereye	<i>Zosterops lateralis</i>						5		+	+	+
STURNIDAE											
* Common Starling	* <i>Sturnus vulgaris</i>								+	+	
* Common Myna	* <i>Acridotheres tristis</i>								+	+	
MAMMALS											
TACHYGLOSSIDAE											
Short-beaked Echidna	<i>Tachyglossus aculeatus</i>								+		
DASYURIDAE											

Common Name	FAMILY / Scientific Name	Status			Subject Site Records				Locality Records		
		EP&BC	TSC	Jamba / Camba	FA1	FA2	FA3	Opportunistic	OEH 2011	LMCC 2000	SWC 1995
Brown Antechinus	<i>Antechinus stuartii</i>				3 trap	2 trap	4 trap		+	+	+
Spotted-tailed Quoll	<i>Dasyurus maculatus</i>	V	V						+	+	+
Common Dunnart	<i>Smithopsis murina</i>								+	+	
PERAMELIDAE											
Northern Brown Bandicoot	<i>Isodon macrourus</i>				1 trap			Diggings	+	+	+
Long-nosed Bandicoot	<i>Perameles nasuta</i>								+	+	+
PHASCOLARCTIDAE											
Koala	<i>Phascolarctos cinereus</i>		V						+		
PETAURIDAE											
Sugar Glider	<i>Petaurus breviceps</i>								+	+	+
Squirrel Glider	<i>Petaurus norfolcensis</i>		V			1 spot			+	+	+
PSEUDOCHEIRIDAE											
Greater Glider	<i>Petauroides volans</i>									+	
Common Ringtail Possum	<i>Pseudocheirus peregrinus</i>						2 spot	Dreys observed	+	+	+
ACROBATIDAE											
Feather-tail Glider	<i>Acrobates pygmaeus</i>						1 spot		+	+	
PHALANGERIDAE											
Mountain Brushtail Possum	<i>Trichosurus caninus</i>								+	+	
Common Brushtail Possum	<i>Trichosurus vulpecula</i>				1 cage trap				+	+	+
MACROPODIDAE											
Eastern Grey Kangaroo	<i>Macropus giganteus</i>								+	+	
Red-necked Wallaby	<i>Macropus rufogriseus</i>								+	+	+
Swamp Wallaby	<i>Wallabia bicolor</i>						Observe		+	+	+
PTEROPODIDAE											
Grey-headed Flying-fox	<i>Pteropus poliocephalus</i>		V						+	+	
RHINOLOPHIDAE											
Eastern Horseshoe-bat	<i>Rhinolophus megaphyllus</i>				Call					+	
MOLOSSIDAE											

Common Name	FAMILY / Scientific Name	Status			Subject Site Records				Locality Records		
		EP&BC	TSC	Jamba / Camba	FA1	FA2	FA3	Opportunistic	OEH 2011	LMCC 2000	SWC 1995
East-coast Freetail-bat	<i>Micronomus norfolkensis</i>		✓			Prob	Prob		+	+	
White-striped Freetail-bat	<i>Austronomus australis</i>				Heard	Heard	Heard	Heard	+	+	+
VESPERTILIONIDAE											
Little Bent-wing Bat	<i>Miniopterus australis</i>		✓			Definite			+	+	
Eastern Bent-wing Bat	<i>Miniopterus schreibersii oceanensis</i>		✓				Definite		+	+	
Lesser Long-eared Bat	<i>Nyctophilus geoffroyi</i>					1 – HT2				+	
Large-eared Pied Bat	<i>Chalinolobus dwyeri</i>	✓	✓							+	
Gould's Wattled Bat	<i>Chalinolobus gouldii</i>				Definite		Definite		+	+	
Chocolate Wattled Bat	<i>Chalinolobus morio</i>						Prob		+	+	
Eastern Falsistrelle	<i>Falsistrellus tasmaniensis</i>		✓						+		
Southern Myotis	<i>Myotis macropus</i>		✓							+	
Greater Broad-nosed Bat	<i>Scoteanax rueppellii</i>		✓						+	+	
Eastern Broad-nosed Bat	<i>Scotorepens orion</i>									+	
Large Forest Bat	<i>Vespadelus darlingtoni</i>								+	+	
Eastern Forest Bat	<i>Vespadelus pumilus</i>								+		
Eastern Cave Bat	<i>Vespadelus troughtoni</i>		✓						+		
Little Forest Bat	<i>Vespadelus vulturnus</i>				Prob	1 – HT2	Prob		+	+	
MURIDAE											
Water Rat	<i>Hydromys chrysogaster</i>									+	
Fawn-footed Melomys	<i>Melomys cervinipes</i>									+	
* House Mouse	* <i>Mus musculus</i>								+	+	
Bush Rat	<i>Rattus fuscipes</i>								+	+	+
Swamp Rat	<i>Rattus lutreolus</i>				1 trap		1 trap		+	+	+
* Black Rat	* <i>Rattus rattus</i>					1 trap			+	+	
CANIDAE											
* Dog	* <i>Canis familiaris</i>								+		
* Fox	* <i>Vulpes vulpes</i>								+	+	
FELIDAE											
* Cat (feral)	* <i>Felis catus</i>								+		

Common Name	FAMILY / Scientific Name	Status			Subject Site Records				Locality Records		
		EP&BC	TSC	Jamba / Camba	FA1	FA2	FA3	Opportunistic	OEH 2011	LMCC 2000	SWC 1995
LEPORIDAE											
* Brown Hare	* <i>Lepus capensis</i>								+	+	
* Rabbit	* <i>Oryctolagus cuniculus</i>				Scat	Scat	Scat	Scats			
EQUIDAE											
* Horse	* <i>Equus caballus</i>								+	+	+
REPTILES											
CHELONIA											
Green Turtle	<i>Chelonia mydas</i>	V	V						+		
CHELIDAE											
Long-necked Tortoise	<i>Chelodina longicollis</i>								+	+	
AGAMIDAE											
Jacky Lizard	<i>Amphibolurus muricatus</i>								+	+	
Southern Angle-headed Dragon	<i>Hypsilurus spinipes</i>									+	
Eastern Water Dragon	<i>Physignathus lesueurii</i>									+	
Bearded Dragon	<i>Pogona barbata</i>									+	
VARANIDAE											
Lace Monitor	<i>Varanus varius</i>								+	+	
SCINCIDAE											
Striped Skink	<i>Ctenotus robustus</i>								+	+	
Copper-tailed Skink	<i>Ctenotus taeniolatus</i>								+	+	
Fence Skink	<i>Cryptoblepharus virgatus</i>							Observed			
Eastern Water Skink	<i>Eulamprus quoyii</i>								+	+	
Garden Skink	<i>Lampropholis delicata</i>				+	+	+	+	+	+	+
Garden Skink	<i>Lampropholis guichenoti</i>								+		
Three-toed Skink	<i>Saiphos equalis</i>								+	+	
Weasel Skink	<i>Saproscinus mustelina</i>								+		
Eastern Blue-tongued Lizard	<i>Tiliqua scincoides</i>							Landfill area	+	+	
BOIDAE											
Diamond Python	<i>Morelia spilota ssp. spilota</i>									+	

Common Name	FAMILY / Scientific Name	Status			Subject Site Records				Locality Records			
		EP&BC	TSC	Jamba / Camba	FA1	FA2	FA3	Opportunistic	OEH 2011	LMCC 2000	SWC 1995	
ELAPIDAE												
Golden Crowned Snake	<i>Cacophis squamulosus</i>										+	
Yellow-faced Whip Snake	<i>Demansia psammophis</i>										+	
Red-naped Snake	<i>Furina diadema</i>										+	
Black-bellied Snake	<i>Hemiaspis signata</i>					1 obs					+	
Red-bellied Black Snake	<i>Pseudechis porphyriacus</i>					1 obs			+	+	+	
Eastern Brown Snake	<i>Pseudonaja textilis</i>								+			
AMPHIBIANS												
MYOBATRACHIDAE												
Common Eastern Froglet	<i>Crinia signifera</i>							Heard call	+	+	+	
Wallum Froglet	<i>Crinia tinnula</i>		V						+			
Ornate Burrowing Frog	<i>Limnodynastes ornatus</i>										+	
Brown-striped Frog	<i>Limnodynastes peronii</i>								+	+		
Spotted Grass Frog	<i>Limnodynastes tasmaniensis</i>								+			
Brown Toadlet	<i>Pseudophryne bibronii</i>								+	+		
Red-backed Toadlet	<i>Pseudophryne coriacea</i>				Observe			In creek	+	+	+	
Dusky Toadlet	<i>Uperoleia fusca</i>								+			
Smooth Toadlet	<i>Uperoleia laevigata</i>								+	+		
HYLIDAE												
Bleating Tree Frog	<i>Litoria dentata</i>								+			
Eastern Dwarf Tree Frog	<i>Litoria fallax</i>								+	+		
Freycinet's Frog	<i>Litoria freycineti</i>								+			
Broad Palmed Frog	<i>Litoria latopalmata</i>							Heard call	+	+	+	
Peron's Tree Frog	<i>Litoria peronii</i>								+	+		
Tyler's Tree Frog	<i>Litoria tyleri</i>								+	+		

APPENDIX 3 Threatened Species Impact Assessment - Fauna

A summary discussion on the potential impact of the proposed activity (expansion of the existing Awaba Landfill facility) is presented below. The impact assessment was prepared following the guidelines specified in the national *Environment Protection & Biodiversity Conservation Act 1999* and NSW *Threatened Species Conservation Act 1995*.

The scope of this study was to conduct flora and fauna investigations within Lot 372 (landfill site) and identify and assess potential ecological constraints associated with the proposed action. The flora and fauna investigation sought to identify the presence of protected and threatened species. Threatened species are those listed on Schedules One and Two of the national *Environment Protection and Biodiversity Conservation Act 1999*, and also Schedules One to Four of the NSW *Threatened Species Conservation Act 1995*.

The assessment of potential or actual effect of the proposal under the *EPBC Act 1999* requires consideration of several Matters of National Significance. In addition, the proposal also requires consideration of impact under s.5A of the NSW *Environmental Planning and Assessment Act 1979* (as amended by the *Threatened Species Conservation Act 1995*).

Following from the review of studies in the locality, coupled with habitat assessment and flora / fauna surveys for threatened species within the landfill study area, a number of threatened species were identified and several additional species were also considered likely to occur. These threatened species were identified for consideration with regard to likely future outcome of the expansion works at the Awaba landfill site.

A3.1 Environment Protection and Biodiversity Conservation Act 1999

This Act requires the Commonwealth Environment Minister's approval for an Action that will have or is likely to have a detrimental / adverse impact(s) on a Matter of National Environmental Significance or on Commonwealth land unless the action is exempt. Matters of National Environmental Significance currently include World Heritage properties, Ramsar Wetlands of international importance, Listed threatened species and communities, Listed migratory species, Nuclear Actions, Commonwealth marine environment, and other matters prescribed by the Regulations.

Significant Impact Guidelines (DEHWA, 2009) have been prepared in order to decide whether an action is likely to have a significant impact, it is necessary to take into account the nature and magnitude of potential impacts. In determining the nature and magnitude of an action's impact, it is important to consider matters including:

- lead to a long-term decrease in the size of an important population of a species,
- reduce the area of occupancy of an important population,
- fragment an existing important population into two or more populations,
- adversely affect habitat critical to the survival of a species,
- disrupt the breeding cycle of an important population,
- modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline,
- result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat,

- introduce disease that may cause the species to decline, or
- interfere substantially with the recovery of the species.

Additionally, consideration of all on-site and off-site impacts, all direct and indirect impacts, the frequency and duration of the action, the total impact which can be attributed to that action over the entire geographic area affected, and over time, the sensitivity of the receiving environment, and the degree of confidence with which the impacts of the action are known and understood.

The Act provides that the Minister must, in deciding whether an action is likely to have a significant impact on a matter of national environmental significance, take account of the precautionary principle. Accordingly, the fact that there is a lack of scientific certainty about the potential impacts of an action will not itself justify a decision that the action is not likely to have a significant impact on a matter of national environmental significance.

Matters of National Environmental Significance relevant to the landfill site and study area at Awaba include **Listed threatened species** and **Listed migratory species**. No World Heritage properties, Ramsar Wetlands, Commonwealth Marine Areas, Nuclear Actions or other matters apply to the study area or the nominated action.

A3.1.1 Listed Threatened Species

Two threatened flora species were recorded on the landfill site during this investigation. No evidence of the 3 additional threatened plants known to occur in the locality was recorded on Lot 372 during the intensive surveys for this report. The impact assessment for Listed Threatened Plants is prepared in **Appendix 4** of this report.

No listed fauna species on the *EPBC Act 1999* were recorded in the landfill site during this investigation, but one threatened fauna species was identified as likely to occur, the Grey-headed Flying-fox. An additional threatened fauna species, the Large-eared Pied Bat *Chalinolobus dwyeri* has been recorded in the locality and may utilise the site as foraging areas. The assessment guidelines on impact significance were applied to the Grey-headed Flying-fox and Large-eared Pied Bat and presented below.

Under the significant impact guidelines, the definition of an 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

- key source populations either for breeding or dispersal,
- populations that are necessary for maintaining genetic diversity, and/or
- populations that are near the limit of the species range.

A3.1.1.1 Grey-headed Flying-fox *Pteropus poliocephalus*

Criteria One. *An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will lead to a long-term decrease in the size of an important population of a species.*

The Grey-headed Flying-fox was not recorded within the landfill site during surveys for this report, but the species is considered highly likely to utilise the forested parts of the landfill site as a component of its extensive foraging range. The population of Grey-headed Flying-fox that utilise habitats within the landfill site cannot be considered as an important population in itself. However, it can be considered to be part of a larger "important population" that comprises genetically similar individuals. The nomadic nature of this species suggests that the population visiting the landfill site utilise a much greater area to gain sufficient foraging resources throughout the year. The

loss of approximately 8.55 hectares of foraging habitat is not considered to result in long-term decrease in population size of an important population.

Criteria Two. *An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will reduce the area of occupancy of an important population.*

No populations of the species occupy the landfill site on a permanent basis. The proposed removal of 8.55 hectares of foraging habitat for the Grey-headed Flying-fox is unlikely to reduce the area of occupancy for the local population of the species.

Criteria Three. *An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will fragment an existing important population into two or more populations.*

Actions relating to the proposed expansion of the Awaba landfill operation will not fragment an existing important population of the Grey-headed Flying-fox into two or more sub-populations.

Criteria Four. *An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will adversely affect habitat critical to the survival of a species.*

The landfill site does not support a breeding and roosting camp of the species, and supports only a small component of the overall foraging habitat requirements of the local population of the Grey-headed Flying-fox. The draft national recovery plan for the Grey-headed Flying-fox indicates foraging habitat that meets at least one of the following criteria can be explicitly identified as habitat critical to survival, or essential habitat, for Grey-headed Flying-foxes. Natural foraging habitat that is:

1. productive during winter and spring, when food bottlenecks have been identified;
2. known to support populations of > 30,000 individuals within an area of 50 km radius (the maximum foraging distance of an adult)
3. productive during the final weeks of gestation, and during the weeks of birth, lactation and conception (September to May)
4. productive during the final stages of fruit development and ripening in commercial crops affected by Grey-headed Flying-foxes (months vary between regions)
5. known to support a continuously occupied camp.

Points 1 and 3 above from the draft national Recovery Plan would qualify the landfill site as either "critical" or "essential" foraging habitat for the Grey-headed Flying-fox, due to flowering of eucalypt and angophora tree species during the period September to May. Within the context of the normal foraging range of an individual Grey-headed Flying-fox (average 20km per night, DECCW, 2009), the proposed action will not result in a significant reduction in foraging habitat, and is therefore unlikely to constitute a significant impact.

The largest known camps of the Grey-headed Flying-fox within a 50km radius of the Awaba facility include Wambina Nature Reserve and Jilliby Conservation Area on the Central Coast and Blackbutt Reserve near Newcastle. None of these camps are known to support populations of > 30,000 individuals. Points 4 and 5 do not apply to the Awaba landfill site.

Criteria Five. *An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will disrupt the breeding cycle of an important population.*

The Grey-headed Flying-fox breeds in large maternity camps. No breeding camps occur within the landfill site, with the nearest known breeding camps located at Blackbutt Reserve in Newcastle, and Wambina Nature Reserve and Jilliby State Conservation Area within 50km radius.

Criteria Six. *An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.*

The likely extent of habitat modification associated with proposed Awaba landfill expansion is clearing of 8.55 hectares of remnant forest. There would be a net loss of foraging habitat by the proposed action. Therefore, the proposed action to remove the availability of habitat for the species, but this is unlikely to result in a decline in the important population.

Criteria Seven. *An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat.*

Whilst a proportion of the landfill area supports infestations of invasive species such as Lantana and Bitou Bush, these invasive species would not impact significantly upon the habitat of the Grey-headed Flying-fox.

Criteria Eight. *An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will introduce disease that may cause the species to decline.*

The proposed expansion of the Awaba waste facility is unlikely to introduce disease that may significantly impact on an important population of the Grey-headed Flying-fox.

Action Nine. *An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to interfere substantially with the recovery of the species.*

The loss of 8.55 hectares of remnant forest by the proposed expansion of the Awaba waste facility is unlikely to substantially interfere with the recovery of the Grey-headed Flying-fox.

Summary

The proposed action (expansion of the Awaba waste facility) is unlikely to impact (either directly or indirectly) on an important population of the Grey-headed Flying-fox. No camps of the species were located within, or in immediate vicinity of the landfill site. The species would likely forage within the landfill site during flowering of *Eucalyptus*, *Corymbia* and *Angophora* tree species, and possibly ripe fruits of rainforest trees along the smaller creeklines for a period of the year when this resource is available, but requires extensive areas of adjoining habitat to support their requirements on an annual basis.

A3.1.1.2 Large-eared Pied Bat *Chalinolobus dwyeri*

Criteria One. *An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will lead to a long-term decrease in the size of an important population of a species.*

The Large-eared Pied Bat was not detected within the landfill site by surveys for this species. However, the species may utilise the aerial space above the forested parts of the landfill site as a component of its larger foraging range. The population of Large-eared Pied Bat that utilise habitats within the landfill site cannot be considered as an important population in itself. However, it can be considered to be part of a larger "important population" that comprises genetically similar individuals. The Large-eared Pied Bat roosts in caves or similar structures which are absent for the Awaba landfill site, so no roost habitat would be disturbed. Individuals that may visit the landfill site would comprise a small component of a much larger foraging area. The loss of approximately 8.55 hectares of foraging habitat is not considered to result in long-term decrease in population size of an important population.

Criteria Two. *An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will reduce the area of occupancy of an important population.*

No roost sites suitable for the Large-eared Pied Bat occur on the site. The proposed removal of 8.55 hectares of foraging habitat for the Large-eared Pied Bat is unlikely to reduce the area of occupancy for the local population of the species.

Criteria Three. *An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will fragment an existing important population into two or more populations.*

Actions relating to the proposed expansion of the Awaba landfill operation will not fragment an existing important population of the Large-eared Pied Bat into two or more sub-populations.

Criteria Four. *An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will adversely affect habitat critical to the survival of a species.*

The landfill site does not support roosting habitat for the species, and supports only a small component of the overall foraging habitat requirements of the local population of the Large-eared Pied Bat. Within the context of the normal foraging range of an individual Large-eared Pied Bat, the proposed action will not result in a significant reduction in foraging habitat, and is therefore unlikely to constitute a significant impact.

Criteria Five. *An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will disrupt the breeding cycle of an important population.*

The Large-eared Pied Bat breeds in caves or similar structures. No breeding habitat occurs within the landfill site.

Criteria Six. *An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.*

The likely extent of habitat modification associated with proposed Awaba landfill expansion is clearing of 8.55 hectares of remnant forest. There would be a net loss of foraging habitat by the proposed action. Therefore, the proposed action to remove the availability of habitat for the species, but this is unlikely to result in a decline in the important population.

Criteria Seven. An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat.

Whilst a proportion of the landfill area supports infestations of invasive species such as Lantana and Bitou Bush, these invasive species would not impact significantly upon the habitat of the Large-eared Pied Bat.

Criteria Eight. An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will introduce disease that may cause the species to decline.

The proposed expansion of the Awaba waste facility is unlikely to introduce disease that may significantly impact on an important population of the Large-eared Pied Bat.

Action Nine. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to interfere substantially with the recovery of the species.

The loss of 8.55 hectares of remnant forest by the proposed expansion of the Awaba waste facility is unlikely to substantially interfere with the recovery of the Large-eared Pied Bat.

Summary

The proposed action (expansion of the Awaba waste facility) is unlikely to impact (either directly or indirectly) on an important population of the Large-eared Pied Bat.

A3.1.2 Listed Migratory Species

The List of Migratory Species on the *Environment Protection and Biodiversity Conservation Act 1999* that occur, or that could potentially occur within the Awaba landfill facility is presented below in **Table 15**.

Table 15 Listed Migratory Species recorded in Locality (5km radius).

FAMILY / Scientific Name	Common Name	Suitable Habitat in Lot 372
ARDEIDAE		
<i>Egretta sacra</i>	Eastern Reef Egret	No habitat present
<i>Egretta alba</i>	Great Egret	No habitat present
<i>Ardea ibis</i>	Cattle Egret	No habitat present
ACCIPITRIDAE		
<i>Pandion cristatus</i>	Eastern Opsrey	No habitat present
<i>Haliaeetus leucogaster</i>	White-bellied Sea-eagle	open forest / nest tree present
SCOLOPACIDAE		
<i>Gallinago hardwickii</i>	Latham's Snipe	No habitat present
<i>Actitis hypoleucos</i>	Common Sandpiper	No habitat present
LARIDAE		
<i>Sterna hirundo</i>	Common Tern	No habitat present
APODIDAE		
<i>Hirundapus caudacutus</i>	White-throated Needletail	aerial space
MEROPIDAE		

FAMILY / Scientific Name	Common Name	Suitable Habitat in Lot 372
<i>Merops ornatus</i>	Rainbow Bee-eater	open forest / woodland
MELIPHAGIDAE		
<i>Xanthomyza phrygia</i>	Regent Honeyeater	open forest / woodland
DICRURIDAE		
<i>Monarcha melanopsis</i>	Black-faced Monarch	Riparian forest
<i>Myiagracyanoleuca</i>	Satin Flycatcher	Riparian forest
<i>Rhipidura rufifrons</i>	Rufous Fantail	Riparian forest

The assessment guidelines on significance for migratory species was applied to each of the species listed above in **Table 15** and is presented below. An area of 'important habitat' for a migratory species is:

- a. habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species, and/or
- b. habitat that is of critical importance to the species at particular life-cycle stages, and/or
- c. habitat utilised by a migratory species which is at the limit of the species range, and/or
- d. habitat within an area where the species is declining.

Criteria One. *An action has, will have, or is likely to have a significant impact on a migratory species if it does, will, or is likely to substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat of the migratory species.*

The proposed action to clear approximately 8.55 hectares of remnant forest will not substantially modify, destroy or isolate an area of important habitat of each of the migratory species listed above. The habitat to be cleared is continuous with a much larger forest fragment in excess of 1,000 hectares, such that removal of 8.55 hectares will not substantially modify or destroy an area of important habitat for migratory species listed above.

Criteria Two. *An action has, will have, or is likely to have a significant impact on a migratory species if it does, will, or is likely to result in invasive species that is harmful to the migratory species becoming established in an area of important habitat of the migratory species.*

Whilst a proportion of the landfill area supports infestations of invasive species such as Lantana and Bitou Bush, the area to be impacted would not be deemed important habitat such that the invasive species would significantly impact or harm the listed migratory species.

Criteria Three. *An action has, will have, or is likely to have a significant impact on a migratory species if it does, will, or is likely to seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of the species.*

The proposed action would not seriously disrupt the lifecycles of migratory species listed above. Very few of the migratory species listed would actually breed in the proposed landfill expansion area. The loss of 8.55 hectares of habitat is not considered to significantly impact upon the feeding and migration / resting behaviour of those species.

A3.2 Environmental Planning & Assessment Act 1979

Any activity likely to have a significant effect on threatened species, populations and ecological communities, or their habitat, will require assessment under section 5A (“the seven part test”) of the *Environmental Planning and Assessment Act 1979* (as amended by the *Threatened Species Conservation Act 1995*). As indicated below in **Table 16**, two threatened plant species and one threatened fauna species were recorded on the landfill site. An additional 3 threatened flora and 10 threatened fauna species have recorded in the locality and also require assessment.

Table 16. Threatened Species Identified for Impact Assessment.

Common Name	Scientific Name	Habitat Present	Occurrence on Lot 372
SITE RECORDS			
	<i>Grevillea parviflora ssp. parviflora</i>	Yes	Recorded on Site
Black-eyed Susan	<i>Tetraloche juncea</i>	Yes	Recorded on Site
East-coast Freetail-bat	<i>Micronomus norfolkensis</i>	Yes	Recorded on Site
LOCALITY RECORDS			
Common Name	Scientific Name	Habitat Present	Potential Occurrence on Lot 372
	<i>Acacia bynoeana</i>	Yes	Low
Charmhaven Apple	<i>Angophora inopinata</i>	Yes	Low
	<i>Cryptostylis hunteriana</i>	Yes	Low
Varied Sittella	<i>Daphoenositta chrysoptera</i>	Yes	Recorded on Lot 373
Squirrel Glider	<i>Petaurus norfolcensis</i>	Yes	Recorded on Lot 373
Little Lorikeet	<i>Glossopsitta pusilla</i>	Yes	High
Powerful Owl	<i>Ninox strenua</i>	Yes	High
Masked Owl	<i>Tyto novaehollandiae</i>	Yes	High
Grey-headed Flying-fox	<i>Pteropus poliocephalus</i>	Yes	High
Little Bent-wing Bat	<i>Miniopterus australis</i>	Yes	Recorded on Lot 373
Large-eared Pied Bat	<i>Chalinolobus dwyeri</i>	Yes	Low
Eastern Bent-wing Bat	<i>Miniopterus schreibersii oceanensis</i>	Yes	Recorded on Lot 373
Eastern Falsistrelle	<i>Falsistrellus tasmaniensis</i>	Yes	Medium
Greater Broad-nosed Bat	<i>Scoteanax rueppellii</i>	Yes	Medium

Following is an assessment of the potential impact of the proposed action (clearing of 8.55 hectares of remnant forest for expansion of the existing Awaba waste facility) on the threatened species listed above in **Table 17**.

A3.2.1 Threatened Flora

The assessment for threatened flora species is presented in this report in **Appendix 4**.

A3.2.2. Threatened Fauna

A3.2.2.1 Varied Sittella

The Varied Sittella was not recorded in the landfill site during this investigation. The species is also known from the locality and may frequent the landfill site as part of its larger foraging range. There are breeding records of

the species in the Lower Hunter Valley (HBOC, 2009), with several records of the Varied Sitella on the LMCC fauna database (2000) and OEH Wildlife Atlas (October 2011). The landfill site contains suitable areas of foraging habitat for the species.

- (a) *in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,*

Actions likely to adversely effect the life cycle of the Varied Sitella are:

- (1) loss of foraging habitat (remnant forest) and
- (2) decline in habitat cover and quality.

The clearing of 8.55 hectares of foraging habitat is unlikely to significantly effect the abundance of this resource within the local range of the species, although will contribute to incremental loss of habitat for the species. The proposed clearing of 8.55 hectares of remnant forest is not considered to significantly effect the life cycle of a local population of the Varied Sitella, such that a viable local population is likely to be placed at risk of extinction.

- (b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,*

The Varied Sitella local population is not listed as an endangered population. No further assessment of part (b) is required.

- (c) *in the case of an endangered ecological community, whether the action proposed:*
- (i) *is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*
 - (ii) *is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,*

The Varied Sitella local population is not an endangered ecological community. No further assessment of part (c) is required.

- (d) *in relation to the habitat of a threatened species, population or ecological community:*
- (i) *the extent to which habitat is likely to be removed or modified as a result of the action proposed, and*
 - (ii) *whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and*
 - (iii) *the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,*

- (i). The extent of foraging habitat to be removed or modified by the proposed action is approximately 8.55 hectares.
- (ii) The existing habitat in the landfill site is continuous with extensive areas of similar forest within the locality. Clearing of 8.55 hectares of forest within the landfill site for the proposed Awaba waste expansion will not result in fragmentation of habitat or isolation from adjoining areas. Significant

movement and dispersal vegetated corridors occur between the landfill site and adjoining forested remnants.

- (iii) Components of the habitat presently existing on the landfill site would comprise "important habitat" for the threatened Varied Sitella local population. The area identified for potential loss is 8.55 hectares of foraging habitat for the species. The loss of this foraging habitat is unlikely to effect the long term survival of the local Varied Sitella population.
- (e) *whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),*

At present, no habitat critical to the survival of the Varied Sitella is declared under the *TSC Act 1995* (or its amendments).

- (f) *whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,*

There is no recovery plan, threat abatement plan or priority action statement (PAS) prepared specific for the Varied Sitella.

- (g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.*

Expansion of the proposed Awaba waste facility will constitute a Key Threatening Process by the following action;

- (1) Clearing of Native Vegetation

The proposed clearing of 8.55 hectares of remnant forest would result in loss of foraging habitat for the species, and potentially the loss of nesting sites for the Varied Sitella. The species builds a cup shaped nest high in the canopy of living trees which is used repeatedly over several years. The proposed Action would constitute a key threatening process to the species.

A3.2.2.2 Squirrel Glider

The Squirrel Glider was not recorded within the landfill site during this investigation, but was recorded on the adjoining Lot 373 and is known from a number of locations in the locality during previous fauna surveys. The remnant native vegetation occurring on the subject site would comprise a proportion of the home range of a local population of the species.

- (a) *in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,*

Factors likely to disrupt the life cycle of the Squirrel Glider is clearing of foraging resources, fragmentation of habitat, isolation of populations and removal of den trees as roost and breeding sites.

Foraging

Within the Wyong Shire, Smith (2002) rated the foraging habitat of the Squirrel Glider based on the vegetation assemblages. Within the landfill site, the vegetation community 30f: Freeman's Peppermint – Apple – Bloodwood Forest (2.73 ha) and 30j: Sugarloaf Lowlands Bloodwood – Apple - Scribbly Gum Forest (5.28 ha) would support moderate densities of gliders per hectare.

Breeding

The Squirrel Glider is dependent upon mature trees with hollows to provide shelter and breeding sites. Within the landfill site, the average density of habitat trees suitable for the Squirrel Glider is low, with an average of only 2.0 habitat trees per hectare (25 potential habitat trees in 12.5 hectares of remnant forest). The proposed action would result in a loss of potential or actual den sites for the species.

Fragmentation

The vegetation within the landfill site is presently continuous with more extensive areas of remnant vegetation to the west, north, south and east. Gaps in tree canopy cover exist between the landfill site and adjoining forest due to small access tracks. The proposed action will result in the clearing of foraging habitat and loss of potential den sites for the species. However, the extent of habitat to be removed (8.55 ha) is limited compared to the extent of adjoining suitable habitat in the locality (in excess of 1,500 hectares). The loss of habitat on the land fill site is therefore unlikely to adversely effect the life cycle of a viable local population of the Squirrel Glider.

- (b) *in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised;*

The Squirrel Glider local population in Awaba is not listed as an endangered population in NSW under the *TSC Act 1995*.

- (c) *in the case of an endangered ecological community, whether the action proposed:*
- (i) *is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*
 - (ii) *is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,*

The Squirrel Glider local population is not an endangered ecological community. No further assessment of part (c) is required.

- (d) *in relation to the habitat of a threatened species, population or ecological community:*
- (i) *the extent to which habitat is likely to be removed or modified as a result of the action proposed, and*
 - (ii) *whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and*
 - (iii) *the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,*
- (i). The extent of habitat to be removed or modified by the proposed action is 8.55 hectares.
 - (ii) The existing habitat in the landfill site is continuous with extensive areas of forest within the locality. Clearing of 8.55 hectares of forest within the landfill site will not result in fragmentation of habitat or isolation from adjoining areas.

(iii) Components of the habitat presently existing on the landfill site would comprise "important habitat" for the threatened Squirrel Glider local population. The area identified for loss of 8.55 hectares of remnant vegetation comprise foraging and sheltering habitat for the species. The extent of habitat to be cleared in comparison to the extent existing in the locality, is unlikely to effect the long term survival of the local Squirrel Glider population.

(e) *whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),*

No critical habitat for the Squirrel Glider is currently listed on the TSC Act 1995.

(f) *whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,*

No recovery plan or threat abatement plan has been prepared for the Squirrel Glider. However, OEH has prepared Priority Action Statements (PAS) to promote the recovery of the Squirrel Glider, and the abatement of key threatening processes in New South Wales. The Priorities Action Statement identifies a number of broad strategies to help the Squirrel Glider recover in New South Wales. Two priority actions applicable to the proposed Action are presented below:

- (1) Ensure the largest hollow bearing trees (including dead trees) are given highest priority for retention in PVP assessments and other environmental planning instruments, or other land assessment tools.
- (2) Delineate boundaries of populations to identify the extent to which populations are interconnected (to determine propensity to move across cleared land).

Given the extent of suitable habitat contiguous with the landfill site, it is not considered strategies outlined in the PAS are required to be implemented which will assist with recovery of the species in NSW.

(g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.*

Key threatening processes relevant to the proposed action include;

- (1) Loss of hollow-bearing trees.
- (2) Clearing of Native Vegetation.

The proposed clearing of 8.55 hectares would result in the loss of up to 18 habitat trees identified as potential den sites for the Squirrel Glider, and also loss of foraging habitat for the species. Both of the above actions would constitute a key threatening process to the species.

A3.2.2.3 East-coast Freetail-bat

The East-coast Freetail Bat has been recorded on the boundary of the landfill site, but also in the locality based on surveys conducted on adjoining land and records held on the OEH fauna atlas and LMCC Fauna database (current to October 2011).

- (a) *in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,*

Actions likely to adversely effect the life cycle of the East-coast Freetail-bat are:

- (1) loss of foraging habitat (remnant forests and woodlands),
- (2) clearing of habitat trees utilised as roost and breeding sites

The clearing of 8.55 hectares of foraging habitat (tree canopy and associated aerial insects) will result in a net reduction of this resource within the landfill site and locality. Additionally, the clearing of 8.55 hectares of habitat may result in a reduction of potential roost and breeding sites for the species. The proposed clearing of habitat (in comparison to the extent of suitable habitat in the locality) is unlikely to effect the life cycle of a local population of the East-coast Freetail-bat.

- (b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,*

The threatened East-coast Freetail-bat is not listed as an endangered population. No further assessment of part (b) is required.

- (c) *in the case of an endangered ecological community, whether the action proposed:*
- (i) *is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*
 - (ii) *is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,*

The East-coast Freetail-bat is not an endangered ecological community. No further assessment of part (c) is required.

- (d) *in relation to the habitat of a threatened species, population or ecological community:*
- (i) *the extent to which habitat is likely to be removed or modified as a result of the action proposed, and*
 - (ii) *whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and*
 - (iii) *the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,*

- (i). The extent of potential habitat to be removed by the proposed action is approximately 8.55 hectares of foraging habitat and loss of approximately 18 habitat trees as potential (or actual) roost sites.
- (ii). The habitat within the landfill site is presently continuous with adjoining areas of similar forest within the locality. Clearing of potential roosting habitat by the proposal will not result in fragmentation of habitat or isolation from adjoining areas.
- (iii). The habitats on the landfill site may comprise "important habitat" for the East-coast Freetail-bat. Whilst it may support roost sites for the local population, the extent of habitat identified for expansion of the Awaba facility is unlikely to be considered significant in comparison to the extent of similar habitats in

the locality. The loss of this habitat is unlikely to effect the long term survival of the local population of the East-coast Freetail-bat.

- (e) *whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),*

At present, no habitat critical to the survival of East-coast Freetail-bat is declared under the TSC Act 1995, or its subsequent amendments.

- (f) *whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,*

The Office of Environment and Heritage has prepared Priority Action Statements (PAS) to promote the recovery of threatened bats and the abatement of key threatening processes in New South Wales. The Priorities Action Statement identifies a number of broad strategies to help threatened bats recover in New South Wales. With regard to the East-coast Freetail-bat, a summary of priority actions applicable to the proposed Action is presented below:

- (1) Identify areas of private land that contain high densities of large hollow-bearing trees as areas of high conservation value (HCV) planning instruments and land management negotiations e.g. LEP, CAPs, PVPs.
- (2) Identify important foraging range and key habitat components for this species.
- (3) Identify the effects of fragmentation in a range of fragmented landscapes e.g. cleared landscapes. For example genetic isolation, movement and persistence across a range of fragment sizes.
- (4) Promote the conservation of these HCV private land areas using measures such as incentive funding to landholders, off-setting and biobanking, acquisition for reserve establishment or other means.

Response

- (1) With regard to the Awaba landfill site, 7 of the 25 habitat trees identified as suitable for microbats will be retained outside of the development footprint.
- (2) The landfill site presently supports 12.0 hectares of foraging habitat and 25 habitat trees potentially suitable for the East-coast Freetail-bat, but the extent of similar habitat in the locality is in excess of 1,500 hectares.
- (3) The extent of forest and woodland in the locality is presently continuous with the landfill site, with only minor gaps in canopy cover for roads and infrastructure such as powerline easements. However, for highly mobile species such as microchiropteran bats, this is unlikely to impact upon their movements within the locality.
- (4) The landfill site has conservation value at the minor scale, but at the landscape scale comprises a small component of a much larger HCV private land. Additionally, an area of 3.6 hectares of remnant forest will be conserved on the landfill site as habitat for the species.

In summary, the proposed Action will not significantly conflict with the objectives or actions of recovery plans for threatened East-coast Freetail-bat.

- (g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.*

Key threatening processes relevant to the proposal expansion of the Awaba landfill site include;

- (1) Loss of hollow-bearing trees.
- (2) Clearing of Native Vegetation.

The proposed clearing of 8.55 hectares of remnant vegetation would result in the loss of foraging habitat and up to 18 habitat trees identified as potential roost or breeding sites for the East-coast Freetail-bat. Both of the above actions would constitute a key threatening process to the species.

A3.2.2.4 Eastern Bent-wing Bat, Little Bent-wing Bat and Large-eared Pied Bat

The Eastern Bent-wing Bat, Little Bent-wing Bat and Large-eared Pied Bat were not recorded on the landfill site, but have been recorded in the locality (OEH fauna atlas – October 2011 and LMCC Fauna database, 2000). The Eastern Bent-wing Bat, Little Bent-wing Bat and Large-eared Pied Bat roost in caves or similar structures and forage over aerial spaces for flying insects. No roost habitat exists on the landfill site for each species.

- (a) *in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,*

Actions likely to adversely effect the life cycle of the Eastern Bent-wing Bat, Little Bent-wing Bat and Large-eared Pied Bat include:

- (1) Clearing of native vegetation which provides foraging resources for both species,
- (2) disturbance to roost sites (caves)
- (3) impact of urban lighting which can draw flying insects away from areas of remnant vegetation into urban areas.

The proposed action will result in loss of 8.55 hectares of remnant vegetation as foraging habitat for the Eastern Bent-wing Bat, Little Bent-wing Bat and Large-eared Pied Bat. Each species forages widely for their dietary requirements and the loss of 8.55 hectares of remnant native vegetation is unlikely to have an adverse effect on a component of the life-cycle of each species such that a viable local population is likely to be placed at risk of extinction.

- (b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,*

The threatened Eastern Bent-wing Bat, Little Bent-wing Bat and Large-eared Pied Bat are not listed as an endangered population. No further assessment of part (b) is required.

- (c) *in the case of an endangered ecological community, whether the action proposed:*
- (i) *is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*
 - (ii) *is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,*

The Eastern Bent-wing Bat, Little Bent-wing Bat and Large-eared Pied Bat are not an endangered ecological community. No further assessment of part (c) is required.

- (d) *in relation to the habitat of a threatened species, population or ecological community:*
- (i) *the extent to which habitat is likely to be removed or modified as a result of the action proposed, and*
 - (ii) *whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and*
 - (iii) *the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,*

- (i). The extent of potential habitat to be removed by the proposed action is 8.55 hectares of foraging habitat.
- (ii) The habitat within the subject site is presently continuous with adjoining areas of similar forest within the locality. Each species can readily traverse open areas of limited habitat value (i.e. aerial space above the landfill site). Expansion of the landfill site will not result in fragmentation of habitat.
- (iii) The extent of habitat identified for further development is unlikely to be considered significant for the Eastern Bent-wing Bat, Little Bent-wing Bat and Large-eared Pied Bat, due to the extensive area of similar habitat in the locality. The loss of habitat for the proposed expansion is unlikely to effect the long term survival of the local population of the Eastern Bent-wing Bat, Little Bent-wing Bat and Large-eared Pied Bat.

- (e) *whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),*

At present, no habitat critical to the survival of the Eastern Bent-wing Bat, Little Bent-wing Bat and Large-eared Pied Bat is declared under the TSC Act 1995, or its subsequent amendments.

- (f) *whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,*

The Office of Environment and Heritage has prepared Priority Action Statements (PAS) to promote the recovery of threatened bats and the abatement of key threatening processes in New South Wales. The Priorities Action Statement identifies a number of broad strategies to help threatened bats recover in New South Wales. With regard to the Eastern Bent-wing Bat, Little Bent-wing Bat and Large-eared Pied Bat, a summary of priority actions applicable to the proposed Action is presented below:

- (1) Identify important foraging range and key habitat components for this species.
- (2) Identify the effects of fragmentation in a range of fragmented landscapes e.g. cleared landscapes. For example genetic isolation, movement and persistence across a range of fragment sizes.
- (3) Promote the conservation of these HCV private land areas using measures such as incentive funding to landholders, off-setting and biobanking, acquisition for reserve establishment or other means.

Response

- (1) With regard to the Awaba landfill site, the retention of 3.6 hectares of remnant vegetation in proximity to Wilton Road would retain foraging habitat for both bat species.

-
- (2) The forested areas within the landfill site and locality are presently contiguous with limited fragmentation by cleared gaps. Where gaps occur in the landscape, for highly mobile species such as microchiropteran bats, this is unlikely to impact upon their movements in the landfill site and locality.
 - (3) The landfill site has conservation value at the minor scale, but at the landscape scale comprises a small component of a much larger HCV private land.

In summary, the proposed Action will not significantly conflict with the objectives or actions of recovery plans for threatened Eastern Bent-wing Bat, Little Bent-wing Bat and Large-eared Pied Bat.

- (g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.*

The proposed clearing of 8.55 hectares of remnant forest would result in loss of potential foraging habitat for each species. The above action would constitute a key threatening process to each species.

A3.2.2.5 Little Lorikeet

The Little Lorikeet was not recorded in the landfill site during this investigation, but is known to occur in the locality based on published records. The species is likely to frequent the remnant forested areas of the landfill site as part of its extensive foraging range. There are breeding records of the species in the Hunter Valley (HBOC, 2009), with the nearest known record at Quorrobolong and Kurri Kurri. No breeding records are known for the City of Lake Macquarie to suggest the landfill site supports breeding habitat. There are a number of records of the Little Lorikeet on the LMCC fauna database and OEH atlas to suggest that it may frequent the study area, even if on an infrequent basis.

- (a) *in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,*

Actions likely to adversely effect the life cycle of the Little Lorikeet include:

- (1) loss of foraging habitat (remnant forest) and,
- (2) loss of breeding sites (mature trees with hollows)

The clearing of 8.55 hectares of remnant forest for the proposed expansion of the Awaba waste facility will reduce the extent of foraging habitat available in the locality. However, the remnant vegetation and fauna habitat presently existing on the landfill site is continuous with an extensive forest fragment in excess of 1,500 hectares. The loss of 8.55 hectares of habitat will not significantly effect the life cycle of a local population of the Little Lorikeet such that a viable local population is likely to be placed at risk of extinction.

- (b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,*

The Little Lorikeet local population is not listed as endangered populations. No further assessment of part (b) is required.

- (c) *in the case of an endangered ecological community, whether the action proposed:*
- (i) *is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*
 - (ii) *is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,*

The Little Lorikeet local population is not an endangered ecological community. No further assessment of part (c) is required.

- (d) *in relation to the habitat of a threatened species, population or ecological community:*
- (i) *the extent to which habitat is likely to be removed or modified as a result of the action proposed, and*
 - (ii) *whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and*
 - (iii) *the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,*

- (i). The proposed action to clear 8.55 hectares of remnant vegetation on the Awaba landfill site will remove or modify habitat for the Little Lorikeet.
- (ii). The existing habitat on the landfill site is continuous with an extensive area of remnant forest in the locality (> 1,500 hectares). The proposed action will not result in significant fragmentation of habitat or isolation from adjoining areas.
- (iii). Components of the habitat presently existing on the landfill site would not comprise "important habitat" for the Little Lorikeet local population, but would contribute to the much larger extent of habitat in the locality. The area identified for removal for the proposed expansion will not result in loss of important habitat for the species.

- (e) *whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),*

At present, no habitat critical to the survival of the Little Lorikeet is declared under the *TSC Act 1995* (or its amendments).

- (f) *whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,*

There is no recovery plan or threat abatement plan prepared for the Little Lorikeet. However, recovery actions that can assist in conservation of the species include:

- Retain large old trees, especially those that are hollow-bearing
- Ensure recruitment of trees into the mature age class so that there is not a lag period of decades between the death of old trees and hollow formation in younger trees.
- Protect large flowering eucalyptus trees throughout the habitats frequented by this species. Manage remnant woodlands and forest for recovery of old-growth characteristics.
- Where natural tree recruitment is inadequate, replant local species to maintain foraging habitat and breeding sites.

- Reduce the abundance of feral Honeybees and limit the exploitation of nectar by domestic bees where resources are spatially or temporally sparse (e.g. in years of drought).

With regard to the proposed action to clear approximately 8.55 hectares of remnant forest, the proposed action would not be consistent with some of the objectives of the recommended recovery actions.

(g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.*

The proposed action to clear 8.55 hectares of remnant vegetation on Lot 372 will constitute several Key Threatening Processes;

- (1) Clearing of Native Vegetation
- (2) Loss of hollow bearing trees (as potential nesting sites)

The proposed clearing of 8.55 hectares of remnant forest would result in loss of foraging habitat for the species. There are no known breeding records of the Little Lorikeet within the City of Lake Macquarie (HBOC, 2009). However, the habitat trees that would be cleared by the proposed action may be considered potential nesting sites for the species.

A3.2.2.6 Large Forest Owls – Powerful Owl and Masked Owl

(a) *in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,*

Actions likely to adversely effect the life cycle of the Masked Owl and Powerful Owl are:

- (1) loss of foraging habitat (remnant forest) and,
- (2) disturbance or loss of roost and breeding sites

For the Powerful Owl and Masked Owl, no confirmed roost or nest sites were identified within the landfill site. However, a total of 4 habitat trees on Lot 372 were identified as potentially suitable for large forest owls (refer to **Figure 17** below). The Powerful Owl roosts in dense sheltered gullies which occur outside the proposed disturbance area at the Awaba landfill. For the Powerful Owl, the proposed Awaba waste facility expansion would also result in loss of 8.55 hectares of foraging habitat, and possibly 3 of the 4 potential habitat trees suitable as nest trees.

The Masked Owl roosts in large tree hollows, of which 4 were identified as suitable within the landfill site. Potentially 3 trees would be removed as part of the expansion of the Awaba landfill. . Development of Lot 372 would result in loss of 8.55 hectares of foraging habitat for the Masked Owl, and 3 roost trees that are potentially suitable for the species.

The loss of remnant forest and potential nest / roost tree is not considered to significantly effect the life cycle of a local population of the Powerful Owl and Masked Owl such that a viable local population is likely to be placed at risk of extinction.



Figure 17 Location of Potential Large Forest Owl Roost / Nest Trees

(b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,*

The threatened Powerful Owl and Masked Owl populations in the City of Lake Macquarie are not listed as endangered populations. No further assessment of part (b) is required.

(c) *in the case of an endangered ecological community, whether the action proposed:*

- (i) *is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*
- (ii) *is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,*

The Powerful Owl and Masked Owl local population are not an endangered ecological community. No further assessment of part (c) is required.

- (d) *in relation to the habitat of a threatened species, population or ecological community:*
 - (i) *the extent to which habitat is likely to be removed or modified as a result of the action proposed, and*
 - (ii) *whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and*
 - (iii) *the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,*
- (i). The extent of habitat to be removed or modified by the proposed action is 8.55 hectares and possibly 3 nest / roost tree.
- (ii) The existing habitat in the larger study area is continuous with other areas of forest within the locality. Clearing of 8.55 hectares of forest within the landfill site will not result in fragmentation of habitat or isolation from adjoining areas.
- (iii) Components of the habitat presently existing on the subject site would comprise "important habitat" for the threatened Powerful Owl and Masked Owl local population. The loss of this foraging habitat is unlikely to effect the long term survival of the local Powerful Owl and Masked Owl population.
- (e) *whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),*

At present, no habitat critical to the survival of the Powerful Owl and Masked Owl is declared under the TSC Act 1995 (or its amendments).

- (f) *whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,*

Conservation protocols for Powerful Owl and Masked Owl roost and nest trees on private land are specified in the Recovery plan for Large Forest Owls in NSW (DEC, 2006). Management of owls and their habitat on privately-owned lands in NSW ranges from non-existent to application of the principles and practices which apply on public forest lands. Few attempts have been made to date to coordinate owl conservation efforts over multiple holdings of private land. Examples of conservation protocols applied on development sites include the protection of nest and roost sites, patches of habitat and prey bases (DEC, 2006).

For the Awaba landfill area, four potential nest and or roost trees were identified. Three trees are located within the footprint of the proposed action and likely to be cleared. The remaining roost tree is located in the riparian zone of an un-named creek would not be disturbed by the current proposal. The application of recommended buffer zones (50 metres) around the potential roost and nest trees that may be cleared would require significant modification to the proposed waste expansion footprint. It is recommended more detailed investigations be undertaken of the potential roost / nest trees prior to any modification of the proposed expansion.

- (g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.*

Key threatening processes relevant to the proposal include;

- (1) Clearing of Native Vegetation
- (2) Loss of hollow bearing trees.

The proposed clearing of 8.55 hectares of remnant forest would result in loss of foraging habitat for the species, and potentially loss of 3 roost trees suitable as nest and roost sites. The proposed Action would constitute a key threatening process to the species.

A3.2.2.7 Grey-headed Flying-fox

- (a) *in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,*

Actions likely to adversely effect the life cycle of the Grey-headed Flying-fox are:

- (1) loss of foraging habitat (remnant forest) and,
- (2) disturbance to roost and breeding sites

The clearing of up to 8.55 hectares of foraging habitat is unlikely to significantly effect the abundance of this resource within the home range of the local population (25 - 50km radius). The proposed clearing of 8.55 hectares of remnant forest is not considered to significantly effect the life cycle of a local population of the Grey-headed Flying-fox, such that a viable local population is likely to be placed at risk of extinction. There would be no disturbance to roost and or breeding sites by the proposed activity.

- (b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,*

The threatened Grey-headed Flying-fox population in the City of Lake Macquarie and the lower Hunter Region is not listed as an endangered population. No further assessment of part (b) is required.

- (c) *in the case of an endangered ecological community, whether the action proposed:*
- (i) *is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*
 - (ii) *is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,*

The Grey-headed Flying-fox local population is not an endangered ecological community. No further assessment of part (c) is required.

- (d) *in relation to the habitat of a threatened species, population or ecological community:*
- (i) *the extent to which habitat is likely to be removed or modified as a result of the action proposed, and*
 - (ii) *whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and*
 - (iii) *the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,*

- (i). The extent of habitat to be removed by the proposed action is 8.55 hectares.
- (ii) The existing habitat in the study area is continuous with other areas of forest within the locality. Clearing of 8.55 hectares of forest within the landfill site will not result in fragmentation of habitat or isolation from adjoining areas.
- (iii) The habitat presently existing on the landfill site would comprise a component of "important habitat" for the threatened Grey-headed Flying-fox local population. However, the loss of 8.55 hectares is unlikely to be considered significant in comparison to the extent of similar foraging resources in the locality or City. The loss of this habitat is unlikely to effect the long term survival of the local Grey-headed Flying-fox population.

- (e) *whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),*

At present, no habitat critical to the survival of the Grey-headed Flying-fox is declared under the TSC Act 1995 (or its amendments).

- (f) *whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,*

The Office of Environment and Heritage has prepared a Recovery Plan for the Grey-headed Flying-fox, and the abatement of key threatening processes in New South Wales. The Recovery Plan identifies a number of broad strategies to help threatened bats recover in New South Wales. However, the proposed Action of clearing of foraging habitat is not consistent with the objectives or actions specified in the recovery plan for the Grey-headed Flying-fox.

- (g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.*

Key threatening processes relevant to the proposal include;

- (1) Clearing of Native Vegetation.

The proposed clearing of 8.55 hectares of remnant forest would result in loss of foraging habitat for the species. The proposed Action would constitute a key threatening process to the species.

A3.2.2.8 Eastern Falsistrelle / Greater Broad-nosed Bat

Two species of microchiropteran bats with similar habitat requirements and closely resembling echolocation calls have been recorded in the locality and could potentially occur on the landfill site. Each of these species would utilise the aerial space above the subject site for foraging purposes, but also may utilise tree hollows for roost and nest sites.

- (a) *in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,*

Actions likely to adversely effect the life cycle of the Eastern Falsistrelle and Greater Broad-nosed Bat include:

- loss of foraging habitat (remnant forests and woodlands),
- clearing of habitat trees utilised as roost and breeding sites

The clearing of remnant forest for the proposed expansion of the Awaba waste facility (8.55 hectares) will reduce the abundance of foraging resources (insects) associated with this habitat. Additionally, the clearing of 18 potential habitat trees which may support roost sites for tree hollow dependent bats, is unlikely to have an adverse effect on the viability of a local population. Within the wider study area and locality, this resource is relatively abundant in stands of remnant forest and woodland. The proposed action is unlikely to have an adverse effect on the life cycle of Eastern Falsistrelle and Greater Broad-nosed Bat local population.

- (b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,*

The threatened Eastern Falsistrelle and Greater Broad-nosed Bat are not listed as an endangered population. No further assessment of part (b) is required.

- (c) *in the case of an endangered ecological community, whether the action proposed:*
- (i) *is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*
 - (ii) *is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,*

The Eastern Falsistrelle and Greater Broad-nosed Bat are not an endangered ecological community. No further assessment of part (c) is required.

- (d) *in relation to the habitat of a threatened species, population or ecological community:*
- (i) *the extent to which habitat is likely to be removed or modified as a result of the action proposed, and*
 - (ii) *whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and*
 - (iii) *the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,*

- (i). The extent of habitat to be removed by the proposed action is up to 8.55 hectares in area and loss of 18 habitat trees as potential roost sites.
 - (ii) The existing remnant forest on the landfill site is continuous with extensive areas of similar forest within the locality. Clearing of habitat for the proposal will not result in fragmentation of habitat or isolation from adjoining areas.
 - (iii) The habitats existing within the landfill site would comprise a component of important habitat for the threatened Eastern Falsistrelle and Greater Broad-nosed Bat local population. However, whilst it may constitute foraging habitat and potential roost sites for the local population, this is unlikely to be considered significant in area in comparison to the extent of similar habitat in the locality. The loss of this habitat is unlikely to effect the long term survival of Eastern Falsistrelle and Greater Broad-nosed Bat in the locality.
- (e) *whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),*

At present, no habitat critical to the survival of Eastern Falsistrelle and Greater Broad-nosed Bat is declared under the TSC Act 1995, or its amendments.

- (f) *whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,*

The Office of Environment and Heritage has prepared Priority Action Statements (PAS) to promote the recovery of threatened bats and the abatement of key threatening processes in New South Wales. The Priorities Action Statement identifies a number of broad strategies to help threatened bats recover in New South Wales. With regard to the Eastern Falsistrelle and Greater Broad-nosed Bat, a summary of priority actions applicable to the proposed Action is presented below:

- (1) Identify areas of private land that contain high densities of large hollow-bearing trees as areas of high conservation value (HCV) planning instruments and land management negotiations e.g. LEP, CAPs, PVPs.
- (2) Identify important foraging range and key habitat components for this species.
- (3) Identify the effects of fragmentation in a range of fragmented landscapes e.g. cleared landscapes. For example genetic isolation, movement and persistence across a range of fragment sizes.
- (4) Promote the conservation of these HCV private land areas using measures such as incentive funding to landholders, off-setting and biobanking, acquisition for reserve establishment or other means.

Response

- (1) The land identified for the proposed waste expansion supports low density of hollow bearing trees, approximately 2.0 per hectare (low abundance).
- (2) The landfill site supports foraging habitat and key habitat components for each of the species, but this is not considered significant in relation to the extent of similar habitat in the locality.
- (3) The forested areas within the landfill site and locality are not significantly fragmented by cleared canopy gaps. Where such gaps exist, they mainly comprise major and minor roads, powerline easements, coal mines and limited urban areas. However, for highly mobile species such as microchiropteran bats, this is unlikely to impact upon their movements in the study area and locality.
- (4) The landfill site has conservation value at the minor scale, but at the landscape scale comprises a small component of a much larger higher conservation public and private land.

In summary, the proposed Action will not conflict with the objectives or actions of recovery plans for threatened microchiropteran bats.

- (g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.*

Key threatening processes relevant to the proposal expansion of the Awaba landfill site include;

- (1) Loss of hollow-bearing trees.
- (2) Clearing of Native Vegetation.

The proposed clearing of 8.55 hectares of remnant vegetation would result in the loss of foraging habitat and up to 18 habitat trees identified as potential roost or breeding sites for the Eastern Falsistrelle and Greater Broad-nosed Bat. Both of the above actions would constitute a key threatening process to the species.

APPENDIX 4 Threatened Species Impact Assessment - Flora

Awaba Waste Facility Threatened Flora Survey

A report prepared by Hunter Eco for Lake Macquarie City Council



Awaba Waste Facility Threatened Flora Survey

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Awaba Waste Facility Threatened Flora Survey

1 Introduction

This report documents the results of a detailed population count survey for threatened flora species occurring in remnant vegetation on land used by the Lake Macquarie City Council Awaba Waste Facility (AWF) and also adjoining land proposed for habitat and species loss offset.

The NSW *Environment Protection and Assessment Act 1979* (EP&A Act) requires that a 7-part test, as detailed in the NSW *Threatened Species Conservation Act 1995* (TSC Act), should be applied in order to determine whether a proposed development would have a significant impact on a threatened species, population or ecological community. The 7-part test was applied to the threatened flora species recorded in the proposed disturbance areas.

The Commonwealth *Environment Protection & Biodiversity Conservation Act 1999* (EPBC Act) provides a list of Matters of National Environmental Significance one of which is species and communities listed as threatened under the Act. Significant impact criteria are provided for determining whether an action would have a significant impact on any listed threatened species or community. The impact criteria were applied to the threatened flora species recorded in the disturbance areas. If it is determined that a significant impact could occur then approval from the Commonwealth Environment Minister must be sought by way of a referral process.

2 Target species

The survey was directed at flora species listed as threatened in the schedules of the NSW *Threatened Species Conservation Act 1995* (TSC Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). A search of data from the Atlas of NSW Wildlife within a 5 km radius of the Awaba site found five species possibly occurring (**Table 1**). The habitat descriptions are summarised from the threatened species profiles found in DECCW (2010).

Table 1 Threatened flora species possibly occurring in the Awaba survey areas

Species	Status	Survey restrictions	Habitat
<i>Acacia bynoeana</i>	Endangered	Small cryptic low-growing, spreading sub-shrub. Can be found at any time of year but requires very careful searching.	In the immediate region, this species is generally found in Scribbly Gum woodland.
<i>Angophora inopina</i>	Vulnerable	Small to medium tree, often multi-stemmed, lignotuberous. Can be found at any time of the year.	In the immediate region, this species is found in Scribbly Gum or Brown Stringybark woodland/forest.
<i>Cryptostylis hunteriana</i>	Vulnerable	A leafless ground orchid that can only be found when flowering. Sufficiently distinctive that it can be found when flowering from November – January.	Scribbly Gum, Red Bloodwood woodland/forest.
<i>Grevillea parviflora</i> subsp <i>parviflora</i>	Vulnerable	A small shrub from 30 cm to 2 m tall. Can be found at any time of the year.	Sandy or light clay soils in a variety of vegetation.
<i>Tetratheca juncea</i>	Vulnerable	A generally leafless, fine-stemmed clonal plant. Virtually invisible when not in flower. Flowers September – January.	Mostly Scribbly Gum and Smooth-barked Apple communities.

These five species are also listed as vulnerable in the EPBC Act.

3 Surveyed areas

The survey was conducted in two main areas (**Figure 1**): the vegetated margins of the current AWF (Lot 372 DP 723259) within which is the area for a proposed expansion of the facility; and Lot 373 DP 723259 adjoining the eastern boundary of the AWF property. A creek runs through the southern end of both properties and a buffer was placed on the north side of that creek in the AWF property.

Figure 1 also shows the survey coverage as a record of the tracks from the GPS.



4 Methods

The survey method was to walk the entire area in systematic transects close enough so that the majority of the survey area was seen. The separation of the transects was varied depending on visibility and the density of the target species being encountered.

A handheld GPS attached to an external antenna (for better satellite reception under canopy) was used to record species occurrences. The GPS resolution was between +/- 4 – 6 metres so each GPS waypoint became a record of the number of individuals within about a 4 m radius of the location. To avoid double counting, a small piece of flagging tape was dropped on each counted individual and a strip of flagging tape marked the waypoint location.

Because of its clonal plant structure it is not always possible to identify a single *Tetratheca juncea* plant. The method used here describes a single clump as being separate from the adjoining clump by 30 cm or more (Payne et al. 2002).

5 Results

The survey was conducted over 22 days between 30 September 2010 and 16 December 2010. This period covered the flowering of both *Tetratheca juncea* and *Cryptostylis hunteriana*. **Figure 2** shows the GPS species records overlaid on the main property boundaries and the areas of interest within. It should be emphasised that the species GPS points can each represent multiple counts of individuals. **Table 2** shows the numbers of individuals in each search area subdivision.

Table 2 The numbers of each species in each search area subdivision

Area	Area (ha)	<i>Acacia bynoeana</i>	<i>Angophora inopina</i>	<i>Grevillea parviflora</i> subsp <i>parviflora</i>	<i>Tetratheca juncea</i>
Lot 372 expansion	8.55	-	-	-	2302
Lot 372 remnant	5.6	-	-	280	31
Lot 373	39.7	68	158	797	12489
Totals	54.0	68	158	1077	14822

The GPS points in **Figure 2** only convey a general idea of the distribution of each species. A model of the relative density of the populations across the surveyed area

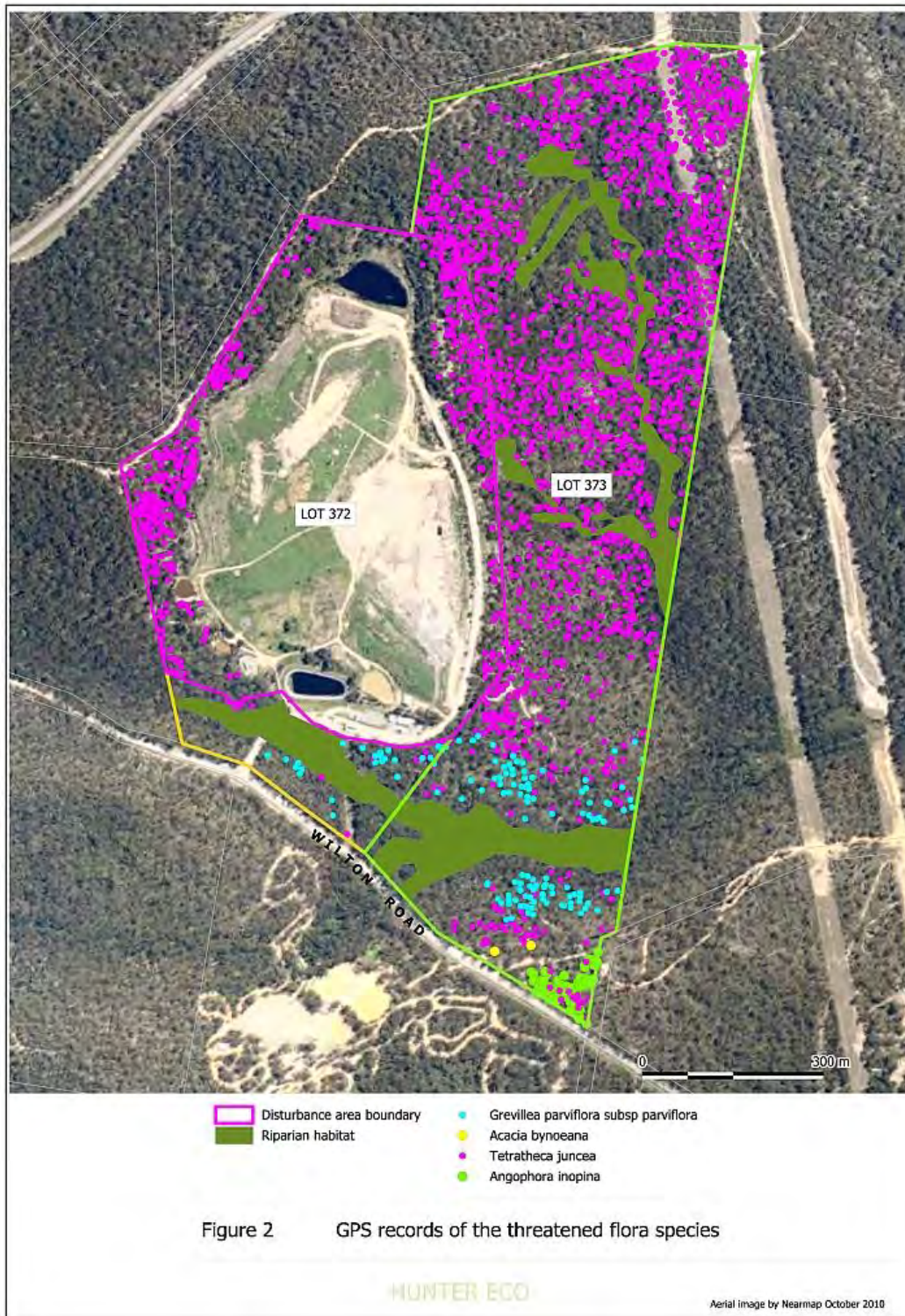
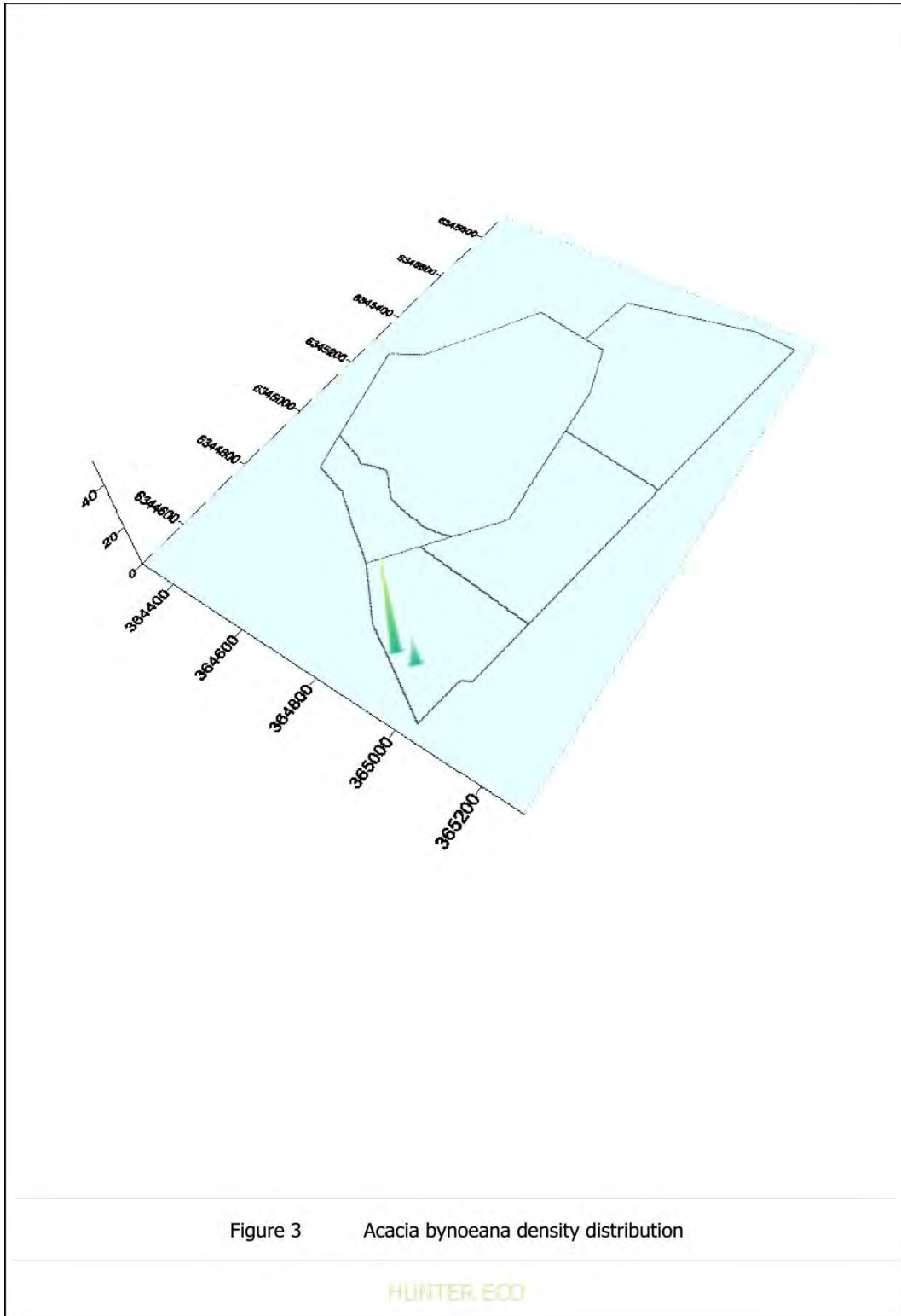
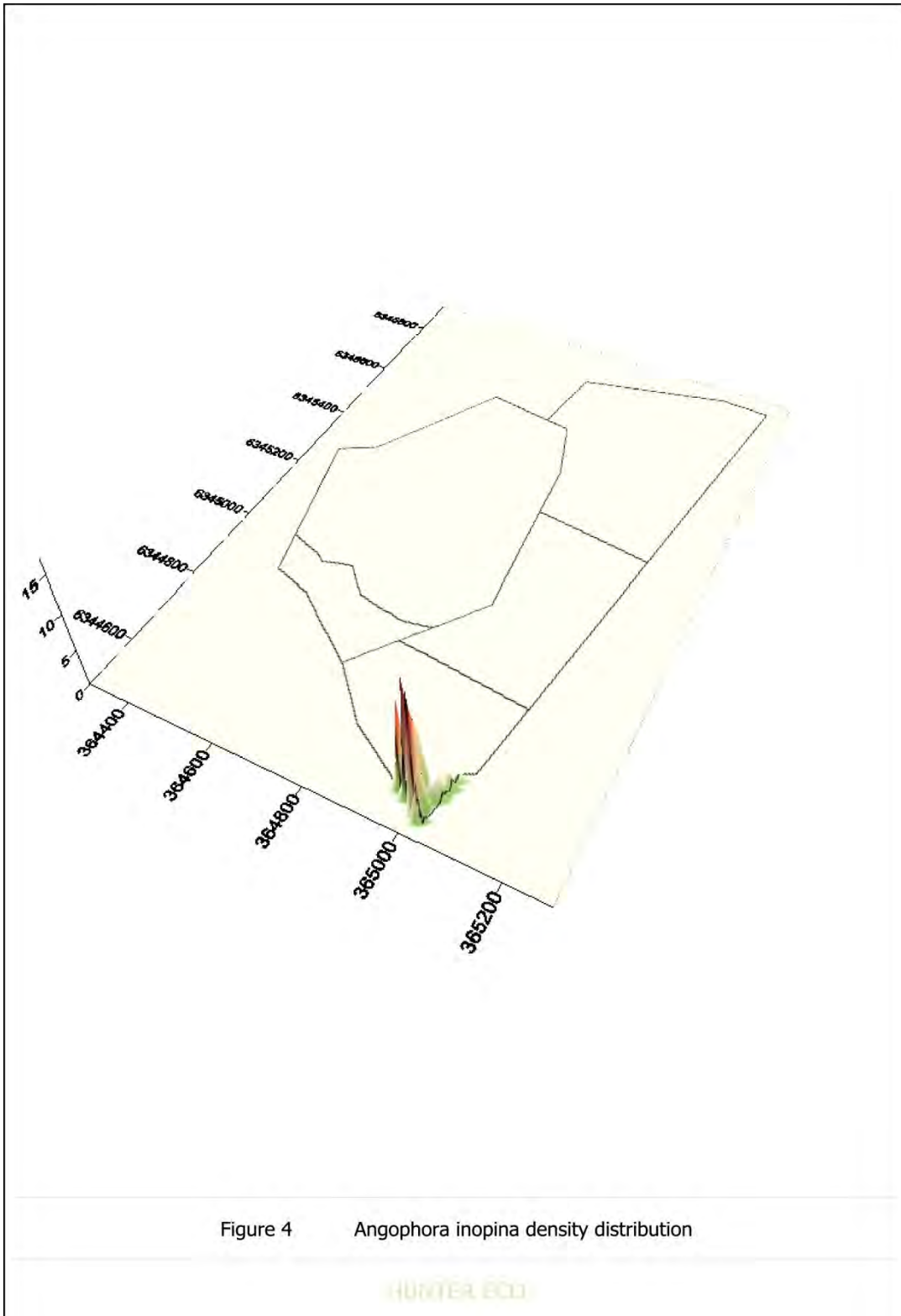


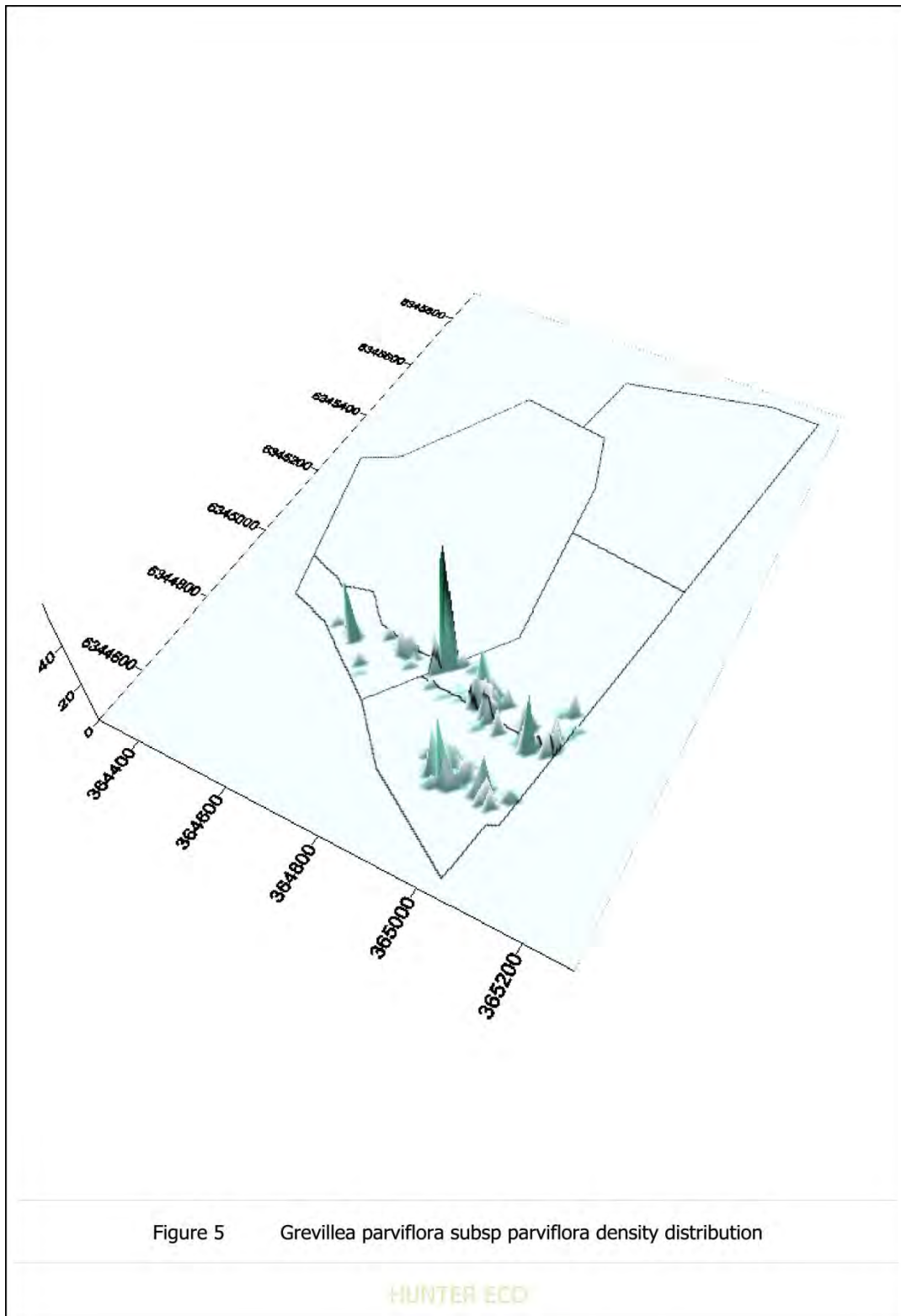
Figure 2 GPS records of the threatened flora species

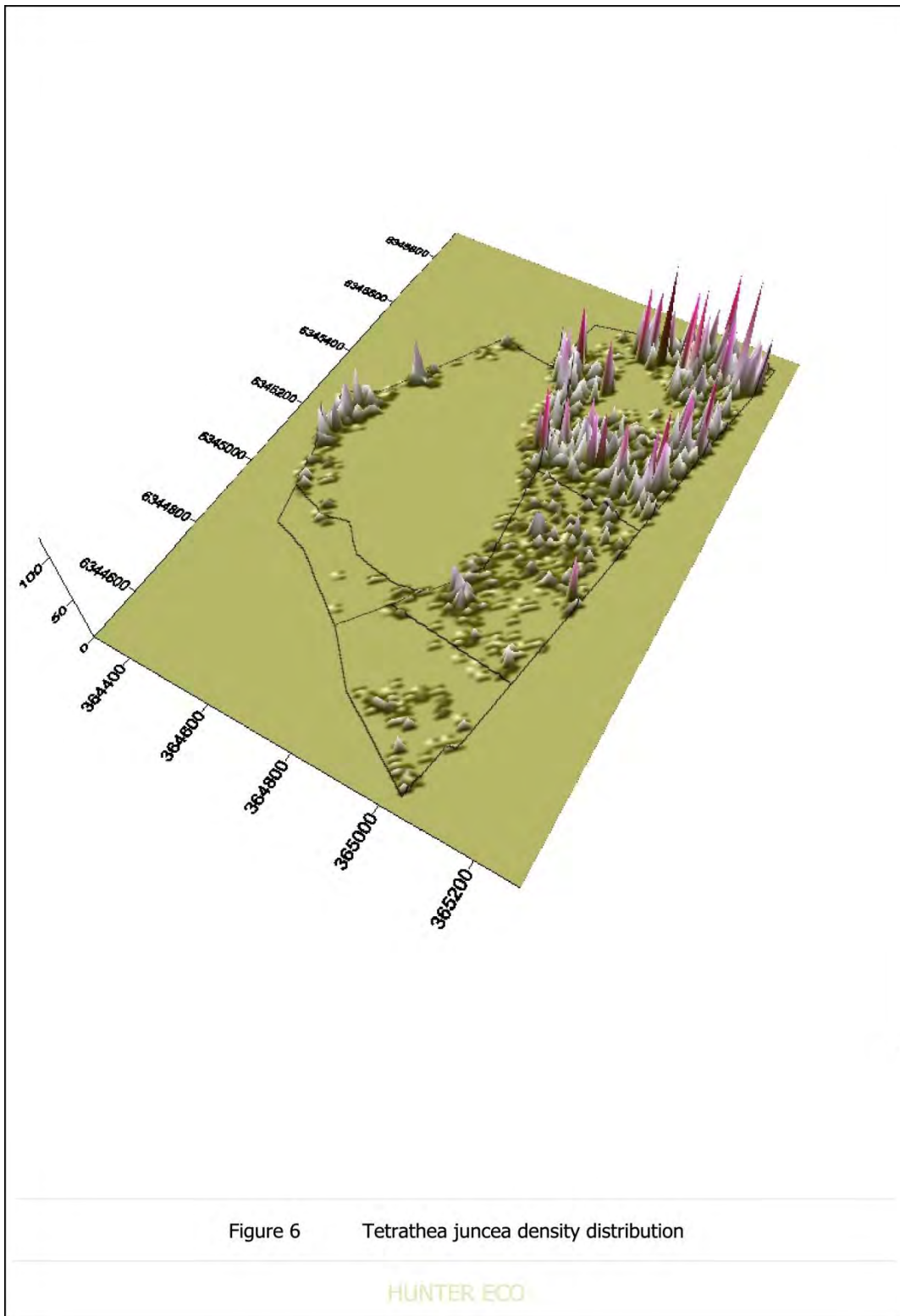
was prepared based on a 10x10 m grid with the cells being populated with the actual numbers of individuals recorded within each grid cell. The cell size was chosen as being about the resolution of the GPS records. A surface was prepared where the number of individuals in each cell was represented as the height of the cell in relation to the surrounding area. This surface was then displayed as a 3D image (**Figures 3 – 6**) with the vertical scale indicating the density in a grid cell.

The level of flowering in *Tetratheca juncea* was determined by sampling clumps across the survey area and throughout the survey period. The overall flowering was 82% of the total of flowers and buds.









5.1 *Acacia bynoeana*

A small population situated just off Wilton Road in an area that has been subject to a lot of disturbance from illegal rubbish dumping and off-road access tracks being forced around installed access barriers and illegally dumped rubbish. Recently constructed barriers should enhance the prospects of survival for this small population. The next nearest known population is about 0.8 km south.

5.2 *Angophora inopina*

The numbers shown are tree stems from 66 plants. This group is the south western edge of a population that continues offsite to the east in a narrow band for about a kilometre.

5.3 *Cryptostylis hunteriana*

There was a large area of potential habitat, mostly in Lot 373, however no *Cryptostylis hunteriana* were found. The DECCW (2010) information for this species notes that it is often found in association with its congeners *Cryptostylis subulata* and *Cryptostylis erecta*. These associated species have distinctive leaves and there were only a few present; not counted but certainly less than 10.

5.4 *Grevillea parviflora* subsp *parviflora*

The official taxonomic description of this species describes it as being a low shrub to 0.5 m tall with pure white flowers. The National Herbarium in Sydney has informally broadened this description by identifying plants as *Grevillea parviflora* subsp *parviflora* that have flowers ranging from white to pink. The majority of the plants recorded in the Awaba survey had small pure white flowers and so would be close to the type description other than that they were taller, up to 2 m. There was one small patch with pink flowers and another area where the plants had white flowers but distinctly broader leaves.

There are scattered records for the species from throughout the immediate region in which the Awaba survey was situated.

5.5 *Tetratheca juncea*

Overall there was an extraordinary amount of *Tetratheca juncea* in the surveyed area. Adjusting for the clearly unsuitable habitat in the riparian areas, there was 340

clumps per hectare. This compares with a regional mean density of just under 40 clumps per hectare derived from 13 similar studies covering a total of 174 hectares (C. Driscoll unpublished). Interestingly there was a high density growing and flowering in the recently slashed powerline easement that cuts through the north east of **Lot 373**.

This survey result was probably around 98% of the total numbers present; it definitely was not an over-count. On several occasions it was necessary to walk back through areas that had previously been counted and invariably a small number of additional individual clumps were found.

6 Planning issues

The *Acacia bynoeana* and *Angophora inopina* populations are located in Lot 373 well away from the proposed expansion area in Lot 372. *Grevillea parviflora* subsp *parviflora* is located in both Lots, however none would be disturbed by the proposed expansion in Lot 372. This leaves *Tetratheca juncea* as the primary threatened flora issue.

6.1 *Tetratheca juncea*

The clearing of the proposed expansion area in **Lot 372** would result in the loss of 2302 plants or 15.5% of the population recorded within the overall survey area.

Appendix 1 provides the NSW 7-part test and **Appendix 2** the Commonwealth significant impact test for *Tetratheca juncea*.

6.1.1 Regional context

Data from the NSW Wildlife Atlas shows that the species once occurred in a narrow 200 km coastal strip from Sydney to Bulahdelah (**Figure 7**). The Sydney population is long extinct and the species now occurs in a 120 km long and 30 km wide coastal strip from Wyong to Bulahdelah. Prior to this survey, there were two records of the species from the AWF survey area with the nearest being about 1 km to the east and north.

7 Impact assessment results

The available biological and ecological information for *Tetratheca juncea* can be applied in the NSW 7-part test to argue that the proposed loss would not have a significant impact on the species as a whole.

The results of the Commonwealth test was that there would be an impact on an important population and the test does not provide for quantifying that impact. Therefore it would be necessary to make a referral under the EPBC Act to the Commonwealth Environment Minister.



8 Amelioration measures

There is little that could be done to significantly reduce the loss of *Tetratheca juncea* because it is so widespread and dense.

The *improve or maintain* principle means that the net result of an action should at least not result in a net loss of a species and its habitat and preferably a net gain. This can be accomplished by setting aside *in perpetuity* parts of populations and habitat in a proportion that offsets the loss from the action. Historically this has been a fairly subjective process but Biobanking is now available and is being used as a tool to quantify offsets.

The first place to look for offsets would be in **Lot 373** and based on the known population numbers there would be just under a 5:1 offset for *Tetratheca juncea*.

In addition to species offsets there would also be ecosystem offsets required for offsetting the loss of fauna habitat. **Lot 373** would provide around a 6:1 habitat offset for the loss of the habitat in the expansion of **Lot 372**.

Biobanking offset requirements can be determined by using the Credit Calculator without needing to formally register the sites. In addition to data compiled from a GIS, the Credit Calculator requires inputs from field plot data collected as prescribed in the Biobanking Methodology. The Credit Calculator would be run on **Lot 372** as a Development site and on the undisturbed remnant in **Lot 372** and on **Lot 373** as a Biobanking site. Collecting the input data and running the Credit Calculator was beyond the scope of this report.

Both lots are zoned 9 – Natural Resources which does not appear to be an exempt zoning under the NSW *Native Vegetation Act 2003* (NV Act). The NV Act has its own offset rules determined through the PVP Developer tool. Referral to the Hunter - Central Rivers Catchment Management Authority would be needed to determine these requirements.

9 Conclusion

A large amount of *Tetratheca juncea* is present in the proposed **Lot 372** disturbance area and this would require referral to the Commonwealth Environment Minister.

Offsets will be required in order to meet the *maintain or improve* principle and **Lot 373** appears to offer substantial offset scope.

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11 Appendix 1 *Tetratheca juncea* 7-part test

(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

The local population is defined as the group of individuals within and beyond the subject site, between which cross pollination could reasonably be assumed to be occurring. Pollination in *Tetratheca juncea* was confirmed by Driscoll (2003) reporting two native bee species captured collecting pollen from flowers.

The high density of the plants within the surveyed area means that the entire 14820 clumps would be one population. Clearly this population would not stop at the surveyed property boundaries and in most areas plants could be seen to be continuing into the adjoining habitat.

A GIS analysis shows that the subject site is located in 530 ha of continuous vegetation which is connected across local roads to another 1000 ha. Driscoll (2003) showed that the majority of records for *Tetratheca juncea* were from Coastal Plains Smooth-barked Apple Woodland or Coastal Plains Scribbly Gum Woodland communities as classified in NPWS (2000). The NPWS (2000) vegetation map shows that the aforementioned 1530 ha of vegetation is almost entirely made up of these two communities and so would be suitable habitat for *Tetratheca juncea*.

There are NSW Atlas records within all of this habitat and each Atlas record is only indicative of presence as illustrated by there being only 2 records in the area of the AWF survey where 14 820 were subsequently recorded. There is no suggestion that the extraordinary population density recorded in the AWF survey would continue unabated into this surrounding habitat, however there could be the average 40 clumps/hectare (see section 5.5 above) with the population approaching 70 000 clumps.

When established, *Tetratheca juncea* appears to be very hardy as evidenced by there being 738 clumps in the closely slashed powerline easement that runs through the north western corner of the survey area. The species is clonal and appears to be long-lived. The loss of up to 2302 clumps and the associated habitat from the immediate population of 14820 and the much wider population would not place a viable local population at risk of extinction.

(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,

No endangered population of this species has been listed.

(c) in the case of an endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

Not applicable

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

Not applicable

(d) in relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

A maximum of 8.55 ha of habitat would be lost in the proposed **Lot 372** expansion area.

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

Isolation in this context for this species means genetic isolation whereby any gaps are sufficiently large that pollinators cannot cross. The clearing in **Lot 372** would not fragment or isolate the remainder of the local population.

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,

Because of the clonal nature of the species the loss of habitat would not impact on the survival of the species present in the remaining habitat.

(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),

No critical habitat was present.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,

No recovery plan has been prepared for the species however there are several priority actions listed as the recovery strategy for the species:

- Determine the key threats to the species and develop recovery actions to address these.
- Reassess the status of the species in the light of further surveys, monitoring and research on reproductive biology.
- Prepare and implement site-specific management plans for important populations on private and public land which address key threats to the species.
- Determine a suitable fire regime and incorporate this information into relevant plans of management on public and private lands.
- Prepare species profile and EIA guidelines as well as survey methodology to promote consistency of approach to assessments.
- Undertake weed control activities as appropriate using approved bush regeneration methods at priority sites on private and public land.
- Seek to increase the level of legislative protection for the species on private land through appropriate land-use planning mechanisms and negotiating conservation agreements particularly large populations and those at the limits of distribution.
- Maintain or rehabilitate areas which provide connectivity within and between populations.
- Monitor population numbers and habitat condition of key populations.
- Investigate population dynamics and genetic diversity within and between populations.
- Undertake research on the reproductive biology of the species.
- Undertake a review of the extent and distribution of the species as well as the type of tenures on which it occurs.

(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

Four Key Threatening Processes (KTP) could be relevant to this proposal:

- Clearing of Native Vegetation
- Invasion, establishment and spread of *Lantana camara*
- Invasion of native plant communities by *Chrysanthemoides monilifera* (Bitou bush and boneseed)
- Invasion of native plant communities by exotic perennial grasses

The only proposed action that would directly invoke a KTP would be native vegetation clearing, resulting in the loss of about 2300 clumps of *Tetratheca juncea*. The impact of this loss has been discussed in test (a) above.

The remaining KTP listed above involve the potential for the spread of various weed species into habitat surrounding areas that were cleared as part of the proposed action. The spread of weeds into native habitat containing *Tetratheca juncea* has the potential to result in further loss of the species through excessive competition. The impact of these KTP can be ameliorated by the implementation of a site-specific weed management plan.

12 Appendix 2 *Tetratheca juncea* significant impact test

Commonwealth EPBC Act Vulnerable species Significant impact criteria

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

- **lead to a long-term decrease in the size of an important population of a species;**

An important population is described as one that is a key source population for breeding or dispersal, necessary for maintaining genetic diversity or populations near the limit of a species range. *Tetratheca juncea* is not at the limits of its range at the AWF survey area.

The high density of the plants within the surveyed area means that the entire 14820 clumps would be one population. Clearly this population would not stop at the surveyed property boundaries and in most areas plants could be seen to be continuing into the adjoining habitat.

A GIS analysis shows that the subject site is located in 530 ha of continuous vegetation which is connected across local roads to another 1000 ha. Driscoll (2003) showed that the majority of records for *Tetratheca juncea* were from Coastal Plains Smooth-barked Apple Woodland or Coastal Plains Scribbly Gum Woodland communities as classified in NPWS (2000). The NPWS (2000) vegetation map shows that the aforementioned 1530 ha of vegetation is almost entirely made up of these two communities and so would be suitable habitat for *Tetratheca juncea*.

There are NSW Atlas records within all of this habitat and recall that each Atlas record is only indicative of presence as illustrated by there being only 2 records in the area of the AWF survey where 14 820 were recorded. There is no suggestion that the extraordinary population density recorded in the AWF survey would continue unabated into this surrounding habitat, however there could be the average 40 clumps/hectare (see section 5.5 above) with the population approaching 70 000 clumps.

The *Tetratheca juncea* plants recorded in the AWF survey area would be part of an important population. The loss of up to 2302 clumps and the associated habitat from the immediate population of 14820 and the much wider population would result in a long-term reduction in this important population.

- **reduce the area of occupancy of an important population;**

The loss of up to 8.55 ha in **Lot 372** and would reduce the area of an important population.

- **fragment an existing important population into two or more populations;**

The clearing of habitat in **Lot 372** would not fragment the important population.

- **adversely affect habitat critical to the survival of a species;**

The loss of up to 2302 clumps and the associated loss of habitat would not be critical to the survival of the species. The normal biological processes in the larger remainder of the population would be unaffected.

- **disrupt the breeding cycle of an important population;**

The breeding cycle consisting of vegetation spread and seed production and dispersal in the larger remainder of the important population would not be disrupted by the loss of nearly 2302 clumps and the associated habitat loss.

- **modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;**

There would be no impact on the surrounding habitat that would result from the AWF expansion actions.

- **result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;**

Left unchecked it is possible that invasive species could become established at the edges of disturbance areas. However a weed management plan properly implemented would control this.

- **introduce disease that may cause the species to decline; or**

There was no evidence of disease in any of the *Tetradlea juncea* clumps surveyed, even those within a few meters of the current AWF working areas. There is no reason to think that the impact of the proposed expansion areas in this regard would be any different.

- **interfere substantially with the recovery of the species.**

The loss of up to 2302 clumps would not be in the spirit of any recovery actions for the species. However this would not be a substantial loss being a small proportion of the overall population that these clumps are contained within.

APPENDIX 5. Curriculum Vitae of Authors

CURRICULUM VITAE: MICHAEL MURRAY

ACADEMIC QUALIFICATIONS:	Bachelor of Science (Hons), University of Newcastle, 1990.
	Pathology Technicians Certificate Tighes Hill Technical College, 1985.
LICENCE	NPWS Scientific Licence S10736 Animal Research Authority 01/1108 DG's Animal Care & Ethics Committee 01/1108
May 1995 - present	Established FOREST FAUNA SURVEYS (Incorporated 1998).

PROFESSIONAL EXPERIENCE

Extensive experience in undertaking detailed fauna surveys. Has undertaken many studies in the range of environments within the Newcastle/Lake Macquarie area, Hunter Valley, Sydney Basin, Western Slops and Plains, NE NSW, and riverine and mallee areas of Western Division of NSW.

MONITORING PROJECTS

October 1995 - present **Mt Owen Complex (including Glendell Mine)** – involved in long term wildlife monitoring project for Mt Owen Complex open cut coal mine in the central Hunter Valley. This work includes the establishment and monitoring of procedures, and formulation of amelioration measures for the maintenance and enhancement of habitat for protected and threatened fauna species. In particular, the threatened Squirrel Glider, woodland birds and microchiropteran bat species.

October 2008 –present **Mangoola Coal Mine** - commenced wildlife monitoring project for Mangoola Coal Open Cut Coal Mine in the upper Hunter Valley. This work follows similar monitoring procedures to the Mt Owen Complex for the maintenance and enhancement of habitat for protected and threatened fauna species.

March 2009 – present **Integra Coal** – commenced monitoring for protected and threatened fauna species following procedures specified in the Threatened Species Management Plan for Integra Coal Open Cut, Singleton. Target threatened species include Grey-crowned Babbler and Brushtailed Phascogale.

June 2008 – present **Bulahdelah Bypass** - commenced specific monitoring for the threatened Squirrel Glider following procedures specified in the Squirrel Glider Management Plan for Bulahdelah Bypass. Monitoring encompasses trapping, spotlight, nestbox and radiotracking monitoring of a population of the Squirrel Glider in proximity to the future bypass.

FAUNA SURVEYS

Michael has undertaken numerous fauna investigations for fauna and species impact statements, environmental impact statements, environmental assessments and strategic planning studies. These surveys have ranged from small individual allotment environmental assessments through to landscape level surveys. Examples of landscape level surveys include:

2009. DECC – Wyrribalong National Park

A fauna inventory was undertaken of Wyrribalong National Park at Wyong. Survey was conducted to document all fauna groups compared to previous surveys conducted in 1993.

2008. DECC – Tuggerah Nature Reserve

A fauna inventory was undertaken of the newly acquired Tuggerah Nature Reserve at Wyong. Survey was conducted to document all fauna groups in a 202 hectare area

CURRICULUM VITAE: MICHAEL MURRAY

2005-2007 Wyong Employment Zone (WEZ).

A full fauna inventory, land use strategy and biodiversity certification application was prepared for the Wyong Employment Zone on the Central Coast. Total study area is 750 hectares.

2005-2007 Munmorah State Conservation Area, Lake Macquarie SCA.

A small mammal survey was conducted over three years for native small mammals and the impact of fire on small mammal populations and their responses.

2006 Large Forest Owl Habitat Tree Mapping, Koombahtoo Land Rezoning, Morisset.

Survey undertaken to survey and document nest and roost trees for large forest owls (Powerful Owl, Masked Owl and Sooty Owl) in a large land holding at Morisset (940 hectares) in the City of Lake Macquarie.

2005. Department of Defence:

The Vertebrate Fauna of Singleton Training Area, Hunter Valley (13,752 hectares)

The Vertebrate Fauna of Beecroft Weapons Range, Jervis Bay (4,200 hectares)

The Vertebrate Fauna of HMAS Albatross, HMAS Cresswell and JBRF, Jervis Bay (610 hectares).

September 1998 Specialist Team Member (Large Forest Owls Survey)

NPWS CRA Sydney Region (Comprehensive Regional Assessments) undertook targeted threatened large forest owl surveys in the Central Coast (Gosford City Council reserves), Strickland, Ourimbah, MacPherson, Wyong, Olney, Watagan, Heaton, Awaba, Corrabare, Cessnock and Yango State Forests, Singleton Army Base, Manobolai Nature Reserve.

February 1997 - March 1998 Specialist Team Member (Mammals and Nocturnal Birds) for the NSW National

Parks and Wildlife Service Sydney Zone CRA (Comprehensive Regional Assessments) undertaking regional fauna surveys. Areas targetted include Wollemi N.P., Yengo N.P., Goulburn River N.P., Blue Mountains N.P., Illawarra Water Catchment, Newnes S.F., Gardens of Stone N.P., Wallaroo and Medowie S.F.

June 1995 to April 1996 CONSULTANT BIOLOGIST - TUNRA (The University of Newcastle Research Associates Ltd)

1994 - June 1995 ENVIRONMENTAL SCIENTIST
ERM Mitchell McCotter

October - November 1994 FBN BAT SURVEYS

Assistant to FBN Bat Surveys in bat survey for fauna impact statement, State Forests of New South Wales, Western Division.

1992 - July 1994 PROJECT OFFICER
SWC CONSULTANCY

1991 - 1992 RESEARCH OFFICER
SHORTLAND WETLANDS CENTRE

COMPETENCY

Michael is very competent in all aspects of fauna surveys including species identification of birds, mammals (including microchiropteran bats), reptiles and amphibians. Michael also has extensive GIS experience. Michael has prepared reports for:

- impact assessments,
- species impact statements,
- ecological management plans,
- threatened species management plans,

CURRICULUM VITAE: MICHAEL MURRAY

- ecological monitoring,
- biodiversity certifications
- local environmental studies,
- flora and fauna survey guidelines and
- fauna inventory studies.

EXAMPLES OF PUBLICATIONS:

Research Projects

- Murray, M. (1990) The re-introduction of the Magpie Goose *Anseranas semipalmata* to the Shortland Wetlands. BSc (Hons) thesis, Department of Biological Sciences, University of Newcastle.
- Murray, M. and Winning, G. (1992). *Flight behaviour and collision mortality of waterbird species into 330kV electricity transmission lines adjacent to the Shortland Wetlands*. Report to Pacific Power by the Shortland Wetlands Centre.
- Winning, G. and Murray, M. (1992). *NSW Important Wetlands - the First Chapter*. Recommended important wetlands in NSW, in support of the Directory of Important Wetlands in Australia. Report to NSW Department of Water Resources.
- Murray, M. (1993). *Review of Literature on High Country Wetlands of New South Wales and Victoria*. Report to Australian Nature Conservation Agency by Shortland Wetlands Centre.
- Murray, M. (1996) *Eleebana Local Squirrel Glider Study*. Report to Lake Macquarie City Council by SWC Consultancy.
- Murray, M. (1999) *Characterisation of Habitats and Distribution of Large Forest Owls in the City of Lake Macquarie*. Report to Lake Macquarie City Council.

Published Papers

- Kavanagh, R.P. and Murray, M. (1996). Home range, habitat and behaviour of the Masked Owl (*Tyto novaehollandiae*) near Newcastle, New South Wales. *Emu*. **96**, 157-170
- Smith, A.P. and Murray, M. (2003). Habitat requirements of the squirrel glider (*Petaurus norfolcensis*) and associated possums and gliders on the New South Wales central coast. *Wildlife Research* **30**, 291-301.

Major Fauna Surveys

- Murray, M., Mahony, M. and Hoye, G. (1995). *Pinney Beach Fauna Study*. Report to Lake Macquarie City Council.
- Hoye, G., Murray, M. and Mahony, M. (1996) *Mount Owen Coal Mine Wildlife Management Pilot Study*. Report to HLA-Envirosciences by Fly By Night Bat Surveys Pty Ltd and TUNRA Ltd.
- Hoye, G., Murray, M., Mahony, M. and Clulow, J. (1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007) *Mount Owen Coal Mine Wildlife Management - Annual Report(s)*. Report by Fly By Night Bat Surveys Pty Ltd, Forest Fauna Surveys P/L and TUNRA Ltd.
- Smith, A.P. (2000). *Wyong Sub-regional Squirrel Glider Study*. Report to Wyong Shire Council.
- Murray, M. (2001) *Salt Ash Air Weapons Range - Fauna and Habitat Assessment*. Report to URS Pty Ltd and Department of Defence.
- Bell, S.A.J. and Murray, M. (2001). *The ecological significance of Bow Wow Creek Gorge, Mulbring, lower Hunter Valley, New South Wales: a nationally significant site*. Report to Cessnock City Council by Eastcoast Flora Survey and Forest Fauna Surveys Pty Ltd.
- Thomson, C. and Murray, M. (2005). *The Vertebrate Fauna of Singleton Training Area, Hunter Valley, New South Wales*. Report to Department of Defence by Sinclair Knight Merz and Forest Fauna Surveys Pty Ltd.
- Thomson, C. and Murray, M. (2005). *The Vertebrate Fauna of Beecroft Weapons Range, Jervis Bay, New South Wales*. Report to Department of Defence by Sinclair Knight Merz and Forest Fauna Surveys Pty Ltd.
- Thomson, C. and Murray, M. (2005). *The Vertebrate Fauna of HMAS Albatross, HMAS Cresswell and JBRF, Jervis Bay, New South Wales*. Report to Department of Defence by Sinclair Knight Merz and Forest Fauna Surveys Pty Ltd.

Species Impact Statement

- Murray, M., Maryott-Brown, K. and Hoye, G. (1996) *Species Impact Statement, SRA Land, Glendale*. Report to Lake Macquarie City Council by Forest Fauna Surveys, in association with EcoPro P/L and Fly By Night Bat Surveys P/L.

CURRICULUM VITAE: MICHAEL MURRAY

- Murray, M., Hoyer, G., Mahony, M. and Clulow, J. (2003). *Mt Owen Operations Species Impact Statement*. Prepared for Umwelt (Australia) Pty Ltd on behalf of Mt Owen Mine by Forest Fauna Surveys Pty Ltd, Fly By Night Bat Surveys P/L and TUNRA Ltd.
- Bell, S.A.J. and Murray, M. (2004). *Warnervale Business Park Species Impact Statement. Stage 1*. Prepared for Wyong Shire Council by Eastcoast Flora Survey and Forest Fauna Surveys Pty Ltd.
- Murray, M. (2005). *Fern Bay Estate Squirrel Glider Study*. Prepared for ERM Australia Pty Limited.

Planning Documents

- Murray, M., Maryott-Brown, K. and Hoyer, G. (1997) *Flora and Fauna Survey Guidelines*. Report to Lake Macquarie City Council by Forest Fauna Surveys, Fly By Night Bat Surveys P/L and EcoPro P/L.
- Murray, M., Bell, S.A.J., Hoyer, G. (2001) *Flora and Fauna Survey Guidelines v.2*. Report to Lake Macquarie City Council by Forest Fauna Surveys P/L, Eastcoast Flora Survey and Fly By Night Bat Surveys P/L.
- Murray, M., Bell, S.A.J., Hoyer, G. (2002) *Flora and Fauna Survey Guidelines. Lower Hunter and Central Coast*. Report to Lower Hunter and Central Coast Regional Environment Management Strategy (LHCCREMS) by Forest Fauna Surveys P/L, Eastcoast Flora Survey and Fly By Night Bat Surveys P/L.
- Smith, A.P., Watson, G. and Murray, M. (2002) *Fauna Habitat Modelling and Wildlife Linkages in Wyong Shire*. Austeco, Armidale, 2350.
- Murray, M. and Bell, S.A.J. (2005). *Wyong Employment Zone Ecological Study*. Report to Wyong Shire Council.
- Murray, M. and Bell, S.A.J. (2007). *Ecological Investigations and Biocertification Application, Wyong Employment Zone, Warnervale Business Park, Warnervale Airport Lands, Precincts 11 & 13 and Precinct 14*. Report to Wyong Shire Council.
- Murray, M. (2008). *Wyong Corridor Strategy, Wyong Shire*. Report to Wyong Shire.

CONTACT DETAILS

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March 2012

PRECISE

Stephen has been involved in native vegetation survey, classification and mapping in the Greater Sydney and Hunter Regions since 1990. During this time, he has undertaken comprehensive surveys for the National Parks and Wildlife Service in over 30 conservation reserves, and has been contracted to the DECC as Senior Botanist and Team Leader for several large scale regional projects within the Sydney Basin. Under contract to local Councils, Stephen has co-ordinated and completed LGA-wide vegetation classification and mapping projects for Wyong, Gosford, Cessnock, Pittwater and Lake Macquarie (current) LGAs, and has assisted in similar mapping projects for Blue Mountains LGA. Stephen has also undertaken several studies on Endangered Ecological Communities and threatened plant species, and published some of these in the scientific literature.

Stephen represented the Ecological Society of Australia on the Hunter Regional Vegetation Committee, is a member of the Hunter Threatened Flora Recovery Team, and a founding member of the Hunter Rare Plants Committee, a sub-committee of the Hunter Region Botanic Gardens. Stephen is also finalizing his PhD studies through the University of Newcastle on improving recognition, identification and classification of restricted and significant vegetation communities, such as Endangered Ecological Communities (EECs).

Stephen has published several scientific papers on various aspects of the vegetation of the Sydney Basin, including classifications of vegetation within conservation reserves, threatened and rare plant species, and the description of new plant species. Stephen has also completed over 3500 standard full floristic sampling plots within the Sydney Basin, which are stored and used in classification analyses for many projects. Other skills include extensive multivariate data analysis experience, and GIS mapping.

QUALIFICATIONS

Bachelor of Science, 1990
Bachelor of Science (Honours), 1991
PhD Candidate (Plant Sciences Group, University of Newcastle) - submission March 2012

"Defining and mapping rare vegetation communities: Improving techniques to assist land-use planning and conservation"

EMPLOYMENT HISTORY

Eastcoast Flora Survey	Consultant Botanist (Principal)	Oct. 1996 - Present
Ecotone Ecological Consultants Pty Ltd	Manager - Flora Studies	Jan. 1996 - Oct. 1996
Private Ecological Consultant	Sole trader	Jan. 1991 - Dec. 1995
NSW National Parks and Wildlife Service	Project Officer	Sept. 1993 - Jan. 1994
University of Newcastle, Geography Dept.	Field Tutor (Scientific)	July 1993 - Aug. 1993
NSW National Parks and Wildlife Service	Project Officer	Jan. 1993 - June 1993
University of NSW, School of Biol. Sciences	Research Assistant (Bird ecology)	Sept. 1992 - Jan. 1993
NSW National Parks and Wildlife Service	Technical Officer (Scientific)	Jan. 1992 - June 1992
RZ Mines (Newcastle)	Environmental Research Officer	Oct. 1990 - Dec. 1991
Wayne Perry & Associates P/L	Environmental Officer (Casual)	June 1990 - Oct. 1990

RESEARCH INTERESTS

- Vegetation classification and mapping, at local and regional scales
- Population ecology and habitat of rare and threatened plants
- Rare vegetation communities
- Vegetation on sand bodies
- Classification of hanging swamps
- Taxonomy and significance of Hunter Region plants

SIGNIFICANT POSITIONS/ CONSULTANCIES

- **Vegetation survey, classification and mapping of the Singleton Army Training Area**, a project for the Department of Defence (2011-12).
- **Attribution of endemic Hunter Region vegetation communities into the NSW Vegetation Classification & Assessment (NSW VCA Database)**, a project for the Hunter-Central Rivers CMA & the Royal Botanic Gardens and Domain Trust (2011).
-
- Consultant Botanist for **Revised Classification and Mapping of Wollemi National Park**, a project for DECC (2008-present).
- Consultant Botanist for **Native Vegetation of the Putty Valley**, a project for DECC & Hawkesbury-Nepean Catchment Management Authority (2007-2008).
- Consultant Botanist for **Native Vegetation of the Northern Hawkesbury LGA**, a project for DECC & Hawkesbury-Nepean Catchment Management Authority (2007-2008).
- Consultant Botanist for **Native Vegetation of Yengo and Parr Reserves and Surrounds**, a project for Department of Environment & Climate Change (2006-2007).
- **Review of Central Coast Vegetation Communities** for DECC bioregional conservation assessments (2007).
- Member of Steering Committee (and co-supervisor of Newcastle University Honours student) for the CCCEN NSW Wetland Action Grants-funded project on "**Biodiversity assessment and conservation of hanging swamps on the Central Coast Plateau, NSW**" (2004).
- Founding member of *Hunter Region Botanic Gardens'* **Hunter Region Rare Plants Committee** (2000-present).
- Consultant botanist for **Vegetation survey and analysis of Warragamba Special Area and Lake Burragorang catchment (incorporating Blue Mountains, Kanangra-Boyd & Nattai National Parks, and**

Yerranderie, Burragorang & Nattai SRA's) for NPWS and the Sydney Catchment Authority (2001-2002).

- Consultant Botanist/ Vegetation Mapping Consultant (Hunter Region) for **NPWS CRA Lower North East (south of the Hunter)**. 1998-1999.
- Consultant Botanist/ Vegetation Mapping Consultant for **Lower Hunter & Central Coast Regional Environmental Management Strategy** for NPWS CRA Unit & Department of Urban Affairs & Planning. 1998-1999.

MEMBERSHIP OF EXPERT PANELS

- Member of Hunter-Central Rivers CMA's **Hunter Vegetation and the NSWVCA** Expert Panel (2009)
- Member of Port Stephens Shire Council **Conservation Assessment Database** Expert Panel (2009)
- Member of **DECC Climate Change & Biodiversity Impacts** Expert Panel (2008)
- Member of **Hunter-Central Rivers CMA** Vegetation Classification Expert Panel (2008)
- Ecological Expert for the **HotSpots Fire Project**, Hawkesbury Pilot Program (2007)
- Member (Technical Advisor) of **Hunter Valley Threatened Flora Recovery Team** (2006-7)
- Member of **Kurri Sands Swamp Woodland EEC Recovery Team** (2005)
- Member of **CMA Expert Panel** advising the Hunter-Central Rivers Catchment Management Authority on Regionally Significant Vegetation (2005)
- Member of **DIPNR Expert Panel** advising the Hunter Regional Vegetation Committee on High Conservation Value vegetation (2003)
- *Ecological Society of Australia* representative on the **Hunter Regional Vegetation Committee** (2001-2003)
- Member of *Environment Australia's* **Expert Panel for the Lower North-east CRA division** (1998)

CONFERENCE & WORKSHOP PRESENTATIONS

- Coastal Groundwater Dependent Ecosystems Workshop, 3rd – 4th September 2009, South West Rocks, NSW (Geoscience Australia): “**Surveying, classifying and mapping vegetation on the Tomago Sandbeds**”.
- Vegetation Management and Biodiversity Conservation in the Hunter Region, May 2000, Singleton, NSW (Hunter Environment Lobby Inc.): “**An evaluation of vegetation survey and threatened plant species listings in the Hunter Region**”

AWARDS

- UDIA NSW Award for Excellence (Professional Consultancy) 2003 for the *Thornton-Killingworth Sub-regional Conservation & Development Strategy*.

PUBLICATIONS (PEER REVIEWED)

Bell, S.A.J. & Nicolle, D. (in press) *Eucalyptus expressa* (Myrtaceae): a new and distinctive species from the sandstone ranges north-west of Sydney, New South Wales. *Telopea*

- Bell, S.A.J. & Stables, M. (in press) Floristic variability, distribution and an extension of range for the endangered Pittwater Spotted Gum Forest, Central Coast, New South Wales. *Cunninghamia*
- DeLacey, C., Bell, S., Chamberlain, S., & Bossard, K. (submitted) Prediction of and realised habitat for a cryptic plant species: the Leafless Tongue Orchid *Cryptostylis hunteriana* Nicholls. *Cunninghamia*
- DeLacey, C., Bell, S., & Chamberlain, S. (submitted) Habitat of the Leafless Tongue Orchid *Cryptostylis hunteriana* Nicholls throughout its known Australian distribution. *The Orchadian*
- Bell, S.A.J. (2009) Vegetation and floristics of Columbey National Park, lower Hunter Valley, New South Wales. *Cunninghamia* 11(2): 241-275.
- Bell, S.A.J. (2008) Rare or threatened vascular plant species of Wollemi National Park, central eastern New South Wales. *Cunninghamia* 10(3): 331-371.
- Bell, S., Branwhite, B., & Driscoll, C. (2005) *Thelymitra 'adorata'* (Orchidaceae): population size and habitat of a highly restricted terrestrial orchid from the Central Coast of New South Wales. *The Orchadian* 15(1): 6-10.
- Bell, S.A.J. (2004) Distribution and habitat of the vulnerable tree species, *Angophora inopina* (Myrtaceae), on the Central Coast of New South Wales. *Cunninghamia* 8(4): 477-484.
- Bell, S.A.J. (2004). Vegetation of Werakata National Park, Hunter Valley, New South Wales. *Cunninghamia* 8(3): 331-347.
- Bell, S.A.J. & Copeland, L.M. (2004) *Commersonia rosea* (Malvaceae s.l.: Lasiopetaleae): a new, rare fire-ephemeral species from the upper Hunter Valley, New South Wales. *Telopea* 10(2): 581-587.
- Bell, S.A.J. (2002) Habitat of the endangered *Hibbertia procumbens* (Labill.) DC (Dilleniaceae) from the Central Coast of New South Wales. *Victorian Naturalist* 119(2): 69-74.
- Bell, S.A.J. (2001) Notes on population size and habitat of the vulnerable *Cryptostylis hunteriana* Nicholls (Orchidaceae) from the Central Coast of New South Wales. *Cunninghamia* 7(2): 195-204.
- Bell, S.A.J. (2001). Notes on the distribution and conservation status of some restricted plant species from sandstone environments of the upper Hunter Valley, New South Wales. *Cunninghamia* 7(1): 77-88.
- Bell, S. (2000) An evaluation of vegetation survey and threatened plant species listings in the Hunter Region. Pp. 19-34 **IN *Vegetation Management and Biodiversity Conservation in the Hunter Region - Where to from here ?*** Ed. by M.Fallding. Proceedings of the Public Workshop. Hunter Environment Lobby. Singleton, 12 May 2000.

PUBLICATIONS (OTHERS)

- Bell, S.A.J. (2010) Defining and mapping an endangered ecological community within Lake Macquarie Local Government Area, New South Wales. *Australasian Plant Conservation* 18(3): 18-19.
- Bell, S., Peake, T. & Driscoll, C. (2007) Dealing with taxonomic uncertainty in Weeping Myall *Acacia pendula* from the Hunter catchment, New South Wales. *Australasian Plant Conservation*. 16(1): 14-15.
- Bell, S. & Driscoll, C. (2005) New records of the endangered *Hibbertia procumbens* from the Central Coast of NSW. *Australasian Plant Conservation* 13(4): 24-25.
- Bell, S.A.J., Parsons, J., & Meldrum, R. (2005) Towards the protection and management of hanging swamps on the Somersby Plateau, Central Coast, New South Wales. *Australasian Plant Conservation* 13(3): 10-11.
- Bell, S. (2003) Another new and highly restricted mallee from the Hunter Valley, *Eucalyptus castrensis*. *Hunter Flora* 11: 2.
- Peake, T., Bell, S., Tame, T., Simpson, J., & Curran, T. (2003) *The Hunter Rare Plants Database: Identification and listing of regionally significant flora for the Hunter Region, New South Wales*. Poster Presentation at the **Ecological Society of Australia Annual Conference 2003**, Armidale NSW.
- Peake, T., Bell, S., Tame, T., Simpson, J., & Curran, T. (2002) *Warkworth Sands Woodland – An Endangered Ecological Community: Distribution, Ecological Significance and Conservation Status*. **Hunter Region Botanic Gardens Technical Paper** [www.huntergardens.org.au/]

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Qualifications

BSc (Lond)
PhD candidate, thesis submitted - "*The ecology of reproduction and propagation in a rare plant, Tetradlea juncea.*"
Plant Sciences Group
School of Environmental and Life Sciences
University of Newcastle

Employment History

Mar 2007 –	Independent environmental consultant trading as HUNTER ECO and HUNTER BIOBANKING ASSESSMENTS.
Jan 2001 – Mar 2007:	Senior Environmental Biologist with EcoBiological.
1983 – 2000	Part-time environmental consultant.
1977 – 1983	Environmental assessments for the Electricity Commission of NSW through TUNRA along with work towards MSc (Newcastle).
1976 – 1977	Commenced working towards MSc (Biology, Newcastle) Topic: The reproductive biology and ecology of the Sugar Glider (<i>Petaurus breviceps</i>).
1967 – 1975	Researcher and Deputy Director Australasian Food Research Laboratories (a division of Sanitarium).

Professional Associations

Australian Network for Plant Conservation
BirdLife Australia
Ecological Society of Australia
Royal Zoological Society of New South Wales

Licenses

NPWS Scientific Licence S10565
NSW BioBanking Assessor Licence 0011

Skills Summary

ECOLOGY & BIOLOGY

Primary areas of expertise are in the fields of botany and vegetation ecology but I did start my career as a fauna person so have a good knowledge of birds and mammals and a fair knowledge of amphibians and reptiles. Current and past projects and research involve the following:

- Vegetation community classification and mapping
- Phylogenetic analysis using cladistics
- Threatened flora species monitoring
- Translocation of threatened plant species
- Population density assessment of rare plants
- Rare plant breeding systems
- Pollinator-plant interactions

GIS and Data Analysis

In association with the ecological consultancy and research work, a comprehensive range of skills has been acquired in spatial data management, analysis and presentation using various Geographical Information Systems (GIS). Main programs used are Manifold System, Surfer, Global Mapper, IntelliCAD, Primer, Minitab, SPSS and several vector and raster handling programs. Capabilities include:

- Georeferencing of aerial images
- Development of digital terrain models
- Visual fields analysis
- Hydrology
- Topography
- Spatial data management and analysis
- Presentation maps

LEGISLATION

Familiar with the relevant requirements of the following:

Commonwealth

Environment Protection & Biodiversity Conservation Act 1995

Environment Protection and Biodiversity Conservation Regulations 2000

JAMBA, CAMBA & RoKAMBA migratory bird agreements

NSW

Environmental Planning and Assessment Act 1979

Native Vegetation Act 2003

National Parks and Wildlife Act 1974

Threatened Species Conservation Act 1995

Threatened Species Conservation Amendment Act 2002

Threatened Species Conservation Amendment (Biodiversity Banking) Act 2006

Water Management Act 2000

Relevant State Environment Planning Policies.

Local Government requirements.

Projects

The following describe the range of work conducted:

- Review of Environmental Factors.
- Ecological constraints assessment.
- Threatened species assessment.
- BioBanking assessment.
- Preparation of ecological management and monitoring plans for various extractive industries.
- Implementation of ecological management and monitoring plans.
- Targeted threatened plant surveys and density assessment.
- Approved by NSW Department of Planning as an independent specialist auditor of mining ecological management and monitoring.

Clients include:

- Extractive industries such as coal mining, sand mining and quarrying.
- Resource exploration companies.
- Land developers.
- State, Local and Commonwealth Government.

Geographic Area

The majority of my work is in the Hunter Valley, Central Coast and Lower North Coast of NSW but also includes botany and vegetation assessment across the western Cape, Gulf Country, Central and south western Queensland.



Additions to Awaba Waste Management Facility

Appendix J

Sewer Pipeline Flora and Fauna Report




FLORA & FAUNA ASSESSMENT

**Proposed pipeline from Awaba Waste Disposal
Facility to Rathmines SPS**

August 2012

DOCUMENT CONTROL

Business Unit	Niche Environment and Heritage, Central Coast/Hunter Valley		
Project No.	1128		
Document Description	Flora and fauna assessment for a pipeline between the Awaba Waste Disposal Facility and Rathmines SPS		
	Name	Signed	Date
Supervising Manager(s)	Rhidian Harrington		26 August 2012

Person managing this document	Person(s) writing this document
Rhidian Harrington	Rhidian Harrington and Tom O'Sullivan

External Review	Name
	Sarah Fitzsimons (Cardno)

Document Status	Date
Rev3	26 August 2012

Prepared for:	Organisation
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Front Cover Photograph: *Tetratheca juncea* on Dorrington Road, Rathmines

EXECUTIVE SUMMARY

This ecological assessment has been carried out to satisfy the requirements of Part 3A of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Lake Macquarie City Council proposes to construct an approximately 3.4 km long pipeline from the Awaba SPS (which will be constructed on Lot 372) to the Rathmines SPS. The proposed pipeline would be placed beneath the existing road formation within Lot 372 and the access road to Rathmines SPS. The remainder of the pipeline would be placed within a 3 m wide easement immediately adjacent to Wilton, Wangi and Dorrington Roads, Awaba (herein referred as the 'subject site').

A habitat-based terrestrial assessment of the 'study area' was conducted on Friday, 21 October 2011. The assessment included the recording of dominant plant cover within the subject site and a generalised assessment of the vegetation type within the broader study area. Notes were taken on the broad vegetation type, condition and floristic composition.

Three species of threatened plant (*Tetratheca juncea*, *Grevillea parviflora* ssp. *parviflora* and *Angophora inopina*) were recorded within or near the margins of study area during the assessment. No Endangered Ecological Communities (EECs) were recorded within the study area, although the Swamp Oak Forest EEC was noted adjacent to the access road to the Rathmines SPS.

Animal species were recorded opportunistically during the floristic assessment. No threatened fauna were recorded during the assessment.

Assessment of Impact under Part 3A (NSW)

The proposal would remove approximately one hectare of mostly modified vegetation within existing road reserves. The proposed construction method, location and narrow width of the proposed footprint would limit the impact to areas of conservation value as much as possible, however minor residual impacts may occur to some components of adjacent vegetation.

The action is unlikely to lead to the direct removal of any of the threatened plant species referred to above or important habitat components for any other threatened species, such as tree hollows.

Assessment of Impact under the EPBC Act (Commonwealth)

No species or EECs listed under the EPBC Act would be affected by the proposed development.

State Environmental Planning Policy No. 44 - Koala Habitat Protection

State Environmental Planning Policy (SEPP) No. 44 was considered in this assessment. While the trees to be removed within the subject site may constitute potential Koala habitat, these trees are not core Koala habitat and therefore a Koala Management Plan is not considered to be necessary.

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1 INTRODUCTION

1.1 Background

Lake Macquarie City Council (LMCC) is proposing to expand the Awaba Waste Disposal Facility (Lot 372, DP 723259) at Wilton Road, Awaba, and thereby extend its operational life span by at least two decades (Figure 1). The proposal includes additional landfill cells, new detention ponds, access roads, weighbridge, building upgrades and a new sewerage pump station (SPS). The expansion would remove 7.2 hectares of native vegetation (Forest Fauna Surveys et al, October 2011). An additional ecological assessment was undertaken within the adjoining block (Lot 373, DP 723259), also by Forest Fauna Surveys et al (April 2011), to evaluate its potential offset value.

As part of the proposed Awaba Waste Facility expansion LMCC also proposes to construct a 3.4 km transfer pipeline from the proposed Awaba SPS to the existing Rathmines SPS. The following report provides an assessment of the potential impacts associated with the construction of that pipeline and forms an addendum to the Forest Fauna Survey (2011a) report.

1.2 Definitions

The following definitions are taken from the *Threatened Species Assessment Guidelines: The Assessment of Significance* (DECC, 2007) and have been adopted for this assessment.

Subject Site: the area to be directly affected by the proposal.

Study Area: includes the subject site and any additional area that may be affected by the proposal.

Direct Impacts: those that directly affect the habitat and/or individual plants and animals and cannot be avoided or mitigated.

Indirect Impacts: those that affect species, populations or ecological communities in a manner other than through direct loss or disturbance. These can usually be avoided or mitigated.

Local Population: the population of a particular species that occurs in the study area.

Locality: the area within 10 km of the study area.

Local Occurrence: refers to the distribution of an ecological community within the study area.

1.3 Legislative Context

The assessment of this project has been carried out for approval under Part 3A of the NSW EP&A Act. The NSW *Threatened Species Conservation Act* (TSC Act) 1995 and Commonwealth *Environment Protection and Biodiversity Conservation Act* (EPBC Act) 1999 have been considered in relation to threatened flora and fauna.

Other legislation that is relevant to the conservation of biodiversity includes the *Native Vegetation Act (NV Act) 2003*, the *National Parks and Wildlife Act (NPW Act) 1974*, *State Environmental Planning Policy No.44 (SEPP 44) Koala Habitat Protection*.

1.4 The Proposal (Subject Site) and the Study Area

The layout of the proposal within the study area is illustrated in Figure 2. The proposed work would include the construction of a new SPS within the Awaba Waste Facility and the excavation (trenching) and laying of a 3.4 km pipeline. The construction footprint would be confined to a 3 metre wide band within existing road corridors. In lieu of a construction plan the following outline of the proposed development was provided to Niche prior to the field assessment:

Awaba SPS

- The construction of an SPS (10 x 10 metre footprint) within the Awaba Waste Facility. The SPS would be located north of the proposed sediment basins (the impact area has been assessed by Forest Fauna Surveys et al, October 2011);

Pipeline alignment

- From the Awaba SPS (within Lot 372) the pipeline would be aligned within the existing access road corridor and placed beneath the road formation.
- The pipeline would then proceed along the north side of Wilton Road within 3 m of the outer edge of the road formation (Figure 3);
- A trenchless crossing would be used under Wangi Road, with launch pits located on the northwest corner of Wilton and Wangi Roads and another located directly opposite on the east side of Wangi Road. Each pit would have a disturbance footprint of 3 x 2 m that require a 5 m set back from the edge of the road formation (Figure 3);
- The pipeline would proceed along the eastern side of Wangi Road and turn left along the northern side of Dorrington Road. The construction footprint would be restricted to a 3 m wide area from the edge of the road formation (Figure 4);
- The pipeline would then turn north off Dorrington Road via an existing unsealed access road to the Rathmines SPS. The pipeline would be located within the existing road formation along the access track.

Generalised construction methods, specifications and impact

The dimensions of the proposed trench, creek crossing and pipeline diameter were not made available to Niche at the time of writing, though it is assumed that the open trench and subsequent overburden would be placed to the side of the trench within the 3 m wide subject site. The overburden would be returned to the trench after the pipeline has been laid and subsequently revegetated. Excess overburden, if generated, would be removed from the site.

The location for the storage of plant and equipment and pipe lay-down have not been specified.

For a detailed description and justification of the project and construction refer to Sections 5.2 and 2.2 of the Environmental Assessment Report by Cardno, respectively.

The proposal would remove approximately 1 hectare (ha) of mostly modified groundcover vegetation within the proposed 3 m wide construction easement (subject site). It is assumed that up to 10 mature trees would require either removal, trimming (to provide access for machinery) or sustain damage to their root systems as a result of trenching works.

A considerable proportion of the groundcover within the subject site contained road base, bare ground, post roadwork grass seeding (i.e. intersection of Wangi and Dorrington Roads) and various other exotic grass and forb species. Most of the groundcover vegetation within the subject site is regularly maintained (with the exception of steeper batters on the eastern corner of Wangi/Dorrington Road intersection and creek and drainage crossings).

1.5 Approach of this Assessment

The primary aims of this ecological assessment are to describe the ecological values of the site, identify ecological constraints, assess the impacts of the proposal against the assessment guidelines under Part 3A and demonstrate that the proposal and its associated amelioration measures will improve/maintain outcomes for biodiversity.

These aims would be met through the following approach:

- Undertake a background review of relevant literature and a review of relevant databases;
- Undertake a targeted survey for individuals or habitat for threatened plant species that are known or are considered to have the potential to occur within the study area;
- Describe the ecological values of the study area;
- Quantify and describe the ecological impacts of the proposed action;
- Assess the significance of the impacts of the proposal for threatened species in accordance with the EP&A Act and the EPBC Act; and,
- Provide recommendations to avoid, mitigate and offset impacts of the proposal.

1.6 Limitations of this Assessment

The field survey was undertaken as a habitat based assessment and did not include more detailed techniques such as plot-based sampling (flora), trapping or spotlighting (fauna).

Habitat assessments are an efficient method of assessing impacts from developments as they do not require individual species to be surveyed for, only the habitats on a site. Habitat assessments are a more conservative method of fauna and flora impact assessment

as a species is assumed to be present if its habitat is present. The alternative is to conduct extensive trapping surveys, and if a species is not detected, assume it is not present. Numerous threatened animal (and plant) species are cryptic or difficult to detect and failure to capture them through surveys (no matter how extensive) still does not indicate with certainty that they are absent from a study area. Using a habitat-based assessment means that all species that could potentially occur on a site are assessed for potential impacts.

2 NATIVE VEGETATION

2.1 Methodology - Native Vegetation

Review of Existing Vegetation Mapping

The review informed the development of a list of native vegetation types and Endangered Ecological Communities (EECs) known or likely to occur within the study area and immediate surrounds.

The key source of native vegetation data was from NPWS (2000) and *Flora and Fauna Investigations: Awaba Landfill adjoining area, Lot 373 DP 723259* (Forest Fauna Surveys et al, April 2011). The findings of the review are contained in Section 2.2 below.

Field Survey

Two field ecologists walked the entire length of the proposed pipeline route on Friday 21 October 2011. Vegetation maps from NPWS (2000) and Forest Fauna Surveys et al (October 2011 and April 2011) were examined prior to the fieldwork to assist in determining the occurrence and spatial array of broad vegetation types within the study area and in the immediate surrounds. A rapid assessment based on broad vegetation structure and floristic composition was used during the field assessment to validate (or refute) previous mapped vegetation types.

Floristic plots, Braun-Blanquet cover-abundance scores and multi-variate analyses were not used in this assessment.

Vegetation Resilience and Condition Assessment

As a result of previous road, drainage and other infrastructure works most of the subject site exhibits considerable soil disturbance and vegetation modification. The area immediately beyond the subject site is representative of moderate to high quality native bushland, the exception being the Toronto Country Club Golf Course and transecting electrical easements.

Offsetting Methodology

The proposed pipeline considered in this report would remove less than 0.1 ha of remnant non-EEC native vegetation and up to 10 mature trees. Whilst three threatened plant species (*Tetradlea juncea*, *Grevillea parviflora* subsp. *parviflora* and *Angophora inopina*) and one EEC (Swamp Oak Forest: 40 and 41) are in close proximity to the subject site none will be directly affected by the current proposal and are unlikely to be negatively affected by the current proposal. By confining the development footprint to a 3 m wide easement within mostly modified roadside vegetation, the threat to local threatened species and EECs is low and it is considered unnecessary and impractical to proceed with any offset prescription for this phase of the development (substantial offsets will already be required for the Awaba Waste Facility expansion*).

* Biobanking offsets for the clearing of 7.2 ha of remnant native vegetation and the loss of 2,302 *Tetratheca juncea* plants for expansion of the Awaba Waste Facility (Lot 372 DP 723259) (see Forest Fauna Surveys et al, October 2011) are yet to be fully calculated.

2.2 Results - Native Vegetation

Existing vegetation mapping of the region (NPWS 2000) shows six vegetation communities occurring within or abutting the study area. An additional three vegetation community categories (derivatives of previously named communities ([MU30 and possibly MU31]) identified in NPWS 2000) were also reported north of Wilton Road in Lots 372 and 373 (in Forest Fauna Surveys et al, October 2011; April 2011).

- Swamp Oak-Rushland Forest (40);
- Swamp Oak-Sedge Forest (41);
- *Red Mahogany-Paperbark Thicket (114);
- Foreshore Redgum-Rough-barked Apple Forest (38);
- Narrabeen Alluvial Sedge Woodland (42);
- Coastal Plains Smooth-barked Apple Woodland (30);
- *Coastal Plains Scribbly Gum Woodland (31);
- *Freemans Peppermint-Apple-Bloodwood Forest (30f);
- *Sugarloaf Lowland Bloodwood-Apple-Scribbly Gum Forest (30j); and,
- Exotic vegetation.

Three additional communities occurred in close proximity to the study area, these are:

- *Peppermint-Black Wattle Riparian Forest (11c);
- Swamp Mahogany-Paperbark Thicket (37); and,
- *Sugarloaf Lowlands Bloodwood-Apple Forest (30h).

* indicates vegetation communities that were identified within Lot 372 and Lot 373 by Forest Fauna Surveys et al (October 2011; April 2011) and which broadly equate with the regional classification presented in NPWS (2000), but have been expanded upon to accommodate new communities and finer scale resolution of existing community descriptions, see Figure 5.

Approximately 1 hectare of mostly highly modified vegetation would be removed during the construction of the proposed pipeline. Minor components of Coastal Plains Smooth-barked Apple Woodland (30) and its derivatives (30j, 30f); Coastal Plains Scribbly Gum Woodland (31) and lesser components of Red Mahogany-Paperbark Thicket (114) and Foreshore Redgum-Rough-barked Apple Forest (38) would also be affected, though the loss would be small, less than 0.1 ha. Other communities including Swamp Oak-Rushland Forest and Swamp Oak-Sedge Forest (40 and 41, respectively) EEC and Swamp Mahogany-Paperbark

Forest (37), while in the immediate vicinity of the access road to the Rathmines SPS, would not be affected.

2.1 Occurrence of each Vegetation Community across the Study Area

Access Road to Rathmines SPS

Vegetation types observed within the study area along the access road to Rathmines SPS were: 30, 31, 37, 40 and highly modified roadside groundcovers.

Dorrington Road

Vegetation types observed within the study area along the northern side of Dorrington Road were: 30, 31, 42 and moderate to highly modified roadside groundcovers.

Wangi Road

Vegetation types observed within the study area along the eastern side of Wangi Road were: 30, 38, 42, 40 and highly modified roadside groundcover vegetation, particularly on the earth batter at the Wangi Road and Dorrington Road intersection.

Wilton Road

Vegetation types observed within the study area along the northern side of Wilton Road were: 30, 30f, 30j, 31, 42 and highly modified roadside groundcover vegetation.

3 FLORA

3.1 Methodology - Flora

Literature and Database Review

The literature and database review informed the scope of the assessment with respect to affected species in Section 5 of this report. Database searches were conducted in October 2011.

The following were used in preparing this review:

- OEH Atlas of NSW Wildlife.
- SEWPaC protected matters search tool.
- Local flora and fauna reports (Forest Fauna Surveys et al October 2011; April 2011).

Threatened Flora: Likelihood of Occurrence

Appendix C lists the threatened flora within the locality (10 km radius) that were determined from records on the Atlas of NSW Wildlife and from the EPBC Act Protected Matters Search environmental reporting tool. The list of affected species is determined from this analysis.

Five categories for 'likelihood' are used to determine the final list of potentially affected species to be considered in the impact assessment. Affected species considered in any impact assessment are those species in the 'Known' or 'High' categories. This measure of 'likelihood' considers known records, presence or absence of important habitat features on the subject site, results of the field surveys and professional judgement. The categories are outlined in Table 1 below.

Table 1: Likelihood of occurrence criteria - threatened flora

Likelihood rating	Criteria
Known	the species was observed within the subject site or study area
High	it is likely that a species inhabits or utilises habitat within the study area
Moderate	potential habitat for a species exists within the study area. Adequate field survey would determine if there is a 'high' or 'low' likelihood of occurrence for the species within the study area
Low	it is unlikely that the species inhabits the study area – due to poor habitat quality , soil disturbance or absence of local or regional records
None	habitats within the study area are unsuitable for the species

Field Survey

Targeted searches to locate threatened plants were undertaken on Friday the 19th of October 2011 and consisted of walking the entire study area over an eight hour period . Where a threatened plant cluster or population was found, more extensive searches were

undertaken in the immediate area and, where necessary, total population counts and/or estimates of dispersal were made. Each position was recorded on a hand-held GPS.

3.2 Results - Flora

A total of 176 plant species were recorded from the study area, which included 69 introduced species (39%) (Appendix A). Three species of threatened plant: *Tetratheca juncea* (in MU 30 and 31); *Grevillea parviflora* subsp. *parviflora* (in MU 30f) and *Angophora inopina* (MU 31) (each listed as vulnerable on both the TSC Act and EPBC Act), were recorded within or in close proximity to the study area during the field assessment (Figure 6). None were observed within the subject site.

Subject Threatened Flora

A total of 17 subject threatened plant species listed on the TSC and/or EPBC Acts, or their habitats, have been previously recorded within 10 km of the study area (Appendix C).

In addition to the three species known to occur within the study area, two additional species (*Cryptostylis hunteriana* and *Acacia bynoeana*) were considered to have a low or moderate likelihood of occurring within the study area (Table 2).

Affected Threatened Flora

Less than 0.1 hectares of variable quality native vegetation would be removed by this proposal (see Section 2.2, above). The remainder of the subject site, approximately 0.9 ha, exhibited high levels of soil disturbance and extensive exotic herb cover and had a low potential to contain threatened species.

There was no evidence of these species occurring in similar, though structurally modified, vegetation (totalling 0.1 ha) within the subject site following extensive searches, and any further assessment on these species is not considered warranted.

We do note however, that *Cryptostylis hunteriana* flowers between November and February and it is most unlikely that it would have flowered during this assessment and therefore would not have been detected. The species has only been recorded twice within 10 km of the study area and was not recorded by Forest Fauna Surveys et al (October 2011; April 2011) during previous flowering periods. While the occurrence of *C. hunteriana* within the study area cannot be completely dismissed it is considered a low possibility.

Table 2. Affected Threatened Flora

Species	TSC Act	EPBC Act	Likelihood of Occurrence	Potential Impact on Sp. or habitat
<i>Acacia bynoeana</i>	E	V	Moderate	Negligible
<i>Angophora inopina</i>	V	V	Known	Negligible
<i>Cryptostylis hunteriana</i>	V	V	Low-Moderate	Negligible
<i>Grevillea parviflora</i> subsp. <i>parviflora</i>	V	V	Known	Negligible
<i>Tetratheca juncea</i>	V	V	Known	Negligible

4 FAUNA

4.1 Methodology - Fauna

Literature and Database Review

The literature and database review informed the development of the assessment of affected threatened fauna in Section 5.2. Database searches were conducted in October 2011.

The following were used in preparing this review:

- OEH Atlas of NSW Wildlife.
- SEWPaC protected matters search tool.
- Birds Australia database.
- Local flora and fauna reports (Forest Fauna Surveys et al October 2011; April 2011).

Fauna Likelihood of Occurrence

Appendix D lists the subject threatened fauna within the locality (10 km radius), which were determined from records on the Atlas of NSW Wildlife and the EPBC Act Protected Matters Search environmental reporting tool.

In a similar way to threatened flora (see Table 2 above), five categories for ‘likelihood’ are used to determine the final list of potentially affected species to be considered in the impact assessment. Affected species considered in any impact assessment are those species in the ‘Known’ or ‘High’ categories. This measure of ‘likelihood’ considers known records, presence or absence of important habitat features on the subject site, results of the field surveys and professional judgement. The categories are outlined in Table 3 below.

Table 3: Likelihood of occurrence criteria - threatened fauna

Likelihood rating	Criteria
Known	the species was observed within the study area
High	it is likely that a species inhabits or utilises habitat within the study area
Moderate	potential habitat for a species occurs on the site and the species may occasionally utilise that habitat. Species unlikely to be dependent on the habitat present within the study area
Low	it is unlikely that the species inhabits the study area. If present at the site the species would likely be a transient visitor. The site offers no exceptional habitat feature for which the species would rely on for its ongoing local existence
None	the habitat within the study area is unsuitable for the species

Field Assessment

The field assessment effort for fauna was considered commensurate to the size and condition of the subject site and comprised a habitat-based assessment and incidental fauna observations (including tracks, scats and other traces). The field survey was conducted on Friday, 21 October 2011 and conditions were warm and sunny. Weather on the day of the survey and in the week preceding it is provided in Table 4.

Table 4. Prevailing weather

Date	Minimum temperature (°C)	Maximum temperature (°C)	Rainfall (mm)	9am wind direction	9am wind speed (km/h)	3pm wind direction	3pm wind speed (km/h)
15/10/2011	13.8	25.5	0	N	2	ENE	11
16/10/2011	11.9	25.1	0	SW	7	SE	11
17/10/2011	11.4	18.6	1.2	S	4	SE	11
18/10/2011	9	20.4	0	WSW	6	NE	7
19/10/2011	5.9	21.7	0		Calm	E	13
20/10/2011	6.3	25.6	0	N	4	ESE	15
21/10/2011 (survey)	8.8	29.5	0		Calm	E	13

4.2 Results - Fauna

Thirty-one animal species were recorded during the field assessment.

Fauna Habitat

Fauna habitats with the subject site are limited to essentially native and non-native herbaceous groundcovers with occasional low shrubs, particularly along Wilton Rd. Reed and sedge vegetation occurred at creek crossings on Wangi and Wilton Road. Although hollow-bearing trees occurred within the study area, none were observed within the subject site.

Herbaceous groundcover is coincident with the exotic vegetation identified in Section 2. This community also occurs within surrounding parts as a treeless vegetation community, such as within the nearby Toronto Country Club and power easements.

Forested areas adjoining the study area are likely to provide a wide variety of sheltering habitat (in the form of hollows or nesting opportunities) and a range of food resource for both threatened and common native fauna. A qualitative assessment of this habitat was not conducted for this assessment. For the purposes of this assessment it has been assumed that all trees within the development footprint would be at least trimmed, have roots affected or some removed by the proposed trenching and construction works.

No hollow-bearing trees would be removed as a result of the proposed pipeline construction.

The availability of habitat for the affected threatened fauna identified in Table 5 is therefore very limited within the development footprint.

Subject Threatened Fauna

A total of 57 subject threatened fauna (excluding marine mammals and reptiles) listed on the TSC and/or EPBC Acts, or their habitats, have previously been recorded within 10 km of the study area (Appendix D). After considering the habitat requirements of these species and their potential to occur within the study area a total of 13 species were considered to have a low or moderate likelihood of occurring within the study area (Table 4).

Affected Threatened Fauna

Less than 0.1 ha of poor-moderate quality native vegetation would be affected by this proposal, as indicated in Section 3.2 above, and up to 10 mature non-hollow-bearing trees, would be either trimmed, sustain root damage or be felled. No hollow-bearing trees would be removed.

The impact on these 13 threatened animal species and their potential habitats as a result of the current proposed development is considered negligible, especially given that the pipeline would be covered over, allowing regeneration of the vegetation (Table 5). Therefore, no threatened animal species are likely to be disadvantaged.

Table 5. Affected Threatened Fauna

Species	TSC Act	EPBC Act	Likelihood of Occurrence	Potential Impact on Sp. or habitat
Birds				
Glossy Black-Cockatoo - <i>Calyptorhynchus lathami</i>	V	-	Low-Moderate	Negligible
Little Lorikeet - <i>Glossopsitta pusilla</i>	V	-	Low-Moderate	Negligible
Masked Owl - <i>Tyto novaehollandiae</i>	V	-	Moderate	Negligible
Powerful Owl - <i>Ninox strenua</i>	V	-	Moderate	Negligible
Scarlet Robin - <i>Petroica multicolour</i>	V	-	Low-Moderate	Negligible
Varied Sittella - <i>Daphoenositta chrysoptera</i>	V	-	Moderate	Negligible
Mammals				
Eastern Bentwing-bat - <i>Miniopterus schreibersii oceanensis</i>	V	-	Moderate	Negligible
Eastern Freetail Bat - <i>Mormopterus norfolkensis</i>	V	-	Moderate	Negligible
Greater Broad-nosed Bat - <i>Scoteanax rueppellii</i>	V	-	Moderate	Negligible
Grey-headed Flying-fox - <i>Pteropus poliocephalus</i>	V	V	Moderate	Negligible
Little Bentwing-bat - <i>Miniopterus australis</i>	V	-	Moderate	Negligible
Squirrel Glider - <i>Petaurus norfolcensis</i>	V	-	Moderate	Negligible
Yellow-bellied Sheathtail Bat - <i>Saccolaimus flaviventris</i>	V	-	Moderate	Negligible

Affected Threatened and Migratory Fauna

A total of 16 migratory fauna listed on the EPBC Act, or their habitats, have previously been recorded within 10 km of the study area (Appendix D). After considering the habitat requirements of these species and their potential to occur within the study area a total of two species were considered to have a likelihood of occurring within the study area (Table 6).

The impact on these two migratory species and their potential habitats as a result of the current proposed development is considered negligible, especially given that the pipeline would be covered over, allowing regeneration of the vegetation (Table 6). Therefore, no migratory species are likely to be disadvantaged.

Table 6. Affected Migratory Fauna

Species	TSC Act	EPBC Act	Likelihood of Occurrence	Potential Impact on Sp. or habitat
Birds				
Satin Flycatcher - <i>Myiagra cyanoleuca</i>	-	M	Moderate	Negligible
White-bellied Sea-eagle - <i>Haliaeetus leucogaster</i>	-	M	Known	Negligible

5 IMPACT ASSESSMENT

5.1 Predicted Impacts

Direct Impacts of the proposal include:

- Unavoidable removal of less than 0.1 ha of moderate quality native vegetation;
- Removal of 0.9 ha of mostly exotic herbaceous groundcover vegetation; and
- Removal of up to 10 mature trees (including *Casuarina glauca*, *Allocasuarina torulosa*, *Angophora costata*, *Eucalyptus haemastoma* and *E. umbra*).

Indirect impacts of the proposal will largely be mitigated by the on-site Environmental Management Plan (EMP) and some actions within the Vegetation Management Plan (VMP), but may include:

- the establishment of new weeds and increased dispersal of weeds and disease;
- short-term increase in human activity during the construction phase; and
- short-term potential trap posed by the pipe-line trench.

Indirect impacts from vegetation disturbance can also include edge effects, which extend into the retained vegetation from the formation of a 'new' edge of the vegetation. The current proposal is contained along existing vegetation edges and will not result in additional edge effects to native vegetation.

5.2 Assessment under Part 3A of the EP&A Act

Endangered Ecological Communities

No EECs would be directly affected by the proposed construction works.

Flora

Three threatened plant species were recorded within the study area (*Tetratheca juncea* and *Grevillea parviflora* subsp. *parviflora* and *Angophora inopina*). Given the extent of the current field assessment, the generally poor vegetation condition (resulting from former road works and roadside vegetation maintenance), none of these species is considered likely to occur on the subject site. Consequently, no threatened plants are likely to be negatively affected species under the current development proposal (Section 3.2). Further consideration of the impact on threatened flora is therefore considered unnecessary.

Fauna

Developments can impact upon fauna in a number of ways. The significance of an impact will be greatest if any of the following situations occur:

- Death or injury of individuals;
- Loss or disturbance of limiting foraging resources; or

- Loss or disturbance of limiting breeding resources.

Limiting resources are those that are important for a particular species survival. For example, animals that only feed on certain types of plants (i.e. Glossy Black Cockatoo dietary preference for *Allocasuarina* sp. seed cones) or only breed in certain habitats (i.e. deep water pools in flowing creeks).

The scale of the proposal is very small, and the potential for loss of limiting habitat for threatened species is low.

No threatened fauna were recorded during the field surveys, although the study area retains limiting breeding resources for some hollow dependent fauna.

A total of 13 threatened animal species are considered to have a moderate likelihood of occurrence within the study area though none of their habitat requirements would be affected by the proposal.

Consequently, impact assessments under the guidelines for Part 3A are not relevant under the current development proposal.

Apart from the loss of 0.1 ha of moderate quality vegetation and up to 10 mature trees, it is highly unlikely that the proposal would result in the loss of limiting foraging or breeding resources or the death or injury of individuals. Thus potential for impacts to threatened animal species is highly limited given the scope and extent of the proposed works. Further, offsetting the vegetation disturbance on the subject site is considered unnecessary.

Part 3A Key Thresholds

The Guidelines for threatened species assessment under Part 3A of the EP&A Act state that development applications must contain a justification based upon the listed key thresholds (DEC & DPI 2005):

- Whether or not the proposal, including actions to avoid or mitigate impacts or compensate to prevent unavoidable impacts, will maintain or improve biodiversity values.
- Whether or not the proposal is likely to reduce the long-term viability of a local population of a threatened species, population or ecological community.
- Whether or not the proposal is likely to accelerate the extinction of a threatened species, population or ecological community or place it at risk of extinction.
- Whether or not the proposal will affect critical habitat.

These key thresholds are addressed in Table 7.

Table 7. Assessment of Key Thresholds under Part 3A of the EP& A Act.

Threatened Biota	Maintain or improve biodiversity values.	Reduction in the long-term viability of a local population of the species, population or ecological community.	Accelerate extinction of the species, population or ecological community	Will critical habitat be affected?
Threatened Flora				
	Likely to maintain biodiversity values	Unlikely to reduce long term viability	Unlikely	No
Threatened Fauna				
	Likely to maintain biodiversity values	Unlikely to reduce long term viability	Unlikely	No
Endangered Ecological Communities				
<i>Swamp Oak Forest</i>	Likely to maintain biodiversity values	Unlikely to reduce long term viability	Unlikely	No

5.3 Assessment of Significance under the EPBC Act

Endangered Ecological Communities

No EEC would be affected by the proposed development.

Flora

Three threatened plant species were recorded within the study area (*Tetradlea juncea* and *Grevillea parviflora* subsp. *parviflora* and *Angophora inopina*). Given the confined nature of the subject site, the extent of the current field assessment and the generally poor vegetation condition (resulting from previous soil disturbances, road and culvert construction and roadside vegetation maintenance), none of these species is considered likely to occur on the subject site. Consequently, no threatened plants are likely to be affected species under the current development proposal (Section 3.2). Further consideration of threatened flora is therefore considered unnecessary.

Fauna

No threatened fauna listed on the EPBC Act were recorded and none are likely to be negatively affected by the proposed development.

A Referral to SEWPaC is not considered necessary for this proposal.

5.4 State Environmental Planning Policy No. 44 - Koala Habitat Protection

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

- (a) by requiring the preparation of plans of management before development consent can be granted in relation to areas of core Koala habitat, and
- (b) by encouraging the identification of areas of core Koala habitat, and
- (c) by encouraging the inclusion of areas of core Koala habitat in environment protection zones.

A number of criteria in the SEPP are to be considered during an assessment of potential Koala habitat. These criteria are set out and assessed below.

1. Does the policy apply? Does the subject land occur in an LGA identified in Schedule 1?

The subject site occurs in the Lake Macquarie LGA, which is listed under Schedule 1 of the SEPP.

2. Is the landholding to which the DA applies greater than 1 hectare in area?

Yes.

3. Is the land potential Koala habitat? Does the site contain areas of native vegetation where the trees of types listed in Schedule 2 constitute at least 15% of the total number of trees in the upper or lower strata of the tree component?

The subject site contains *Eucalyptus haemastoma*, which is listed as a Koala feed tree on Schedule 2 of the SEPP. Within the subject site this species would **not** represent 15% or more of the total number of trees in the upper or lower strata.

4. Is the land core Koala habitat?

Under the SEPP **core Koala habitat** means an area of land with a resident population of Koalas, evidenced by attributes such as breeding females (that is, females with young) and recent sightings of and historical records of a population.

The subject site does not contain a resident population of Koalas. The subject site contains few mature trees that would provide habitat for the Koala and which may be removed by the proposal.

Further, there are no recent sightings to suggest a presence of a Koala population within the locality.

The trees on the subject site mostly occur as overhang branches with little to no shrub cover. No more than 10 mature trees are to be removed along the entire length of the proposed pipeline.

The subject site does not contain core Koala habitat.

Conclusion

The subject site contains neither a viable population of Koalas nor core habitat for them as defined by SEPP 44. A plan of management for this species is not considered necessary.

6 AMELIORATION MEASURES

6.1 Avoid and Mitigate

There are only minor actions that may be required to avoid and mitigate impacts of the proposed works, these are:

1. Adjust the pipeline alignment to avoid mature trees;
2. Implementation of a Construction Environmental Management Plan; and
3. Reduce soil and vegetation disturbance at creek crossings.

The following measures are also recommended to further reduce potential impacts to native vegetation, fauna habitats and animals species:

1. Retain any felled trees or limbs on the site;
2. Barrier tape (flagging tape) should be used to demarcate the limits to vegetation clearing on the site and to identify and exclude areas containing threatened plant species from any inadvertent activity. The presence of this tape should be made obvious to the clearing contractor prior to the commencement of works;
3. Consider using a proportion of endemic grass seed mixes for post-construction revegetation;
4. Identify weed risks and minimise any assisted dispersal of noxious species, such as Blackberry, through the study area.

6.2 Offsetting

Offsetting for the proposed pipeline construction is not considered necessary.

7 CONCLUSION

7.1 Part 3A (NSW)

In considering the proposed extent and work activities associated with the proposed action it is unlikely that any threatened flora, as listed on the TSC Act, would be impacted by the proposal. However, up to 10 mature trees are likely to be affected through branch trimming, root damage and/or tree removal. While hollow-bearing trees were observed within the study area none would be removed. No threatened animal species' are likely to be negatively affected by the proposed works.

The proposal will lead to the removal of approximately 1 ha of mostly modified habitat that has been previously affected by previous road and culvert construction, exotic grass seeding and regular vegetation maintenance within the road reserve (including less than 0.1 ha of moderate quality native vegetation). The Swamp Oak Forest EEC located near the Rathmines SPS would not be affected by the proposed action.

The proposed works would not negatively affect any other intact native vegetation component. In this situation there is no requirement to provide an offset through the application of the Biobanking Calculator, which is based on the principle of maintain or improve.

The proposal therefore satisfies the 'maintain or improve' requirement of Part 3A.

7.2 EPBC Act (Commonwealth)

No matter of national environmental significance would be affected by the proposed action and, therefore, a referral to SEWPaC is not required.

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FIGURES

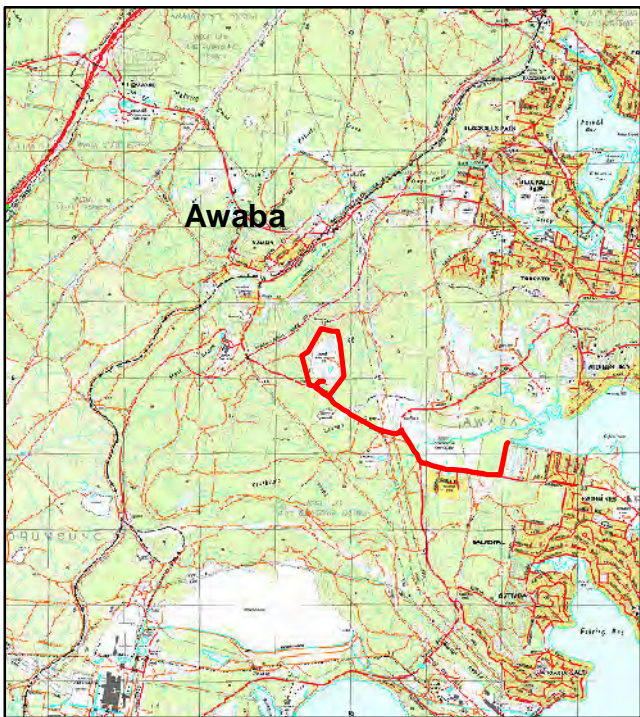
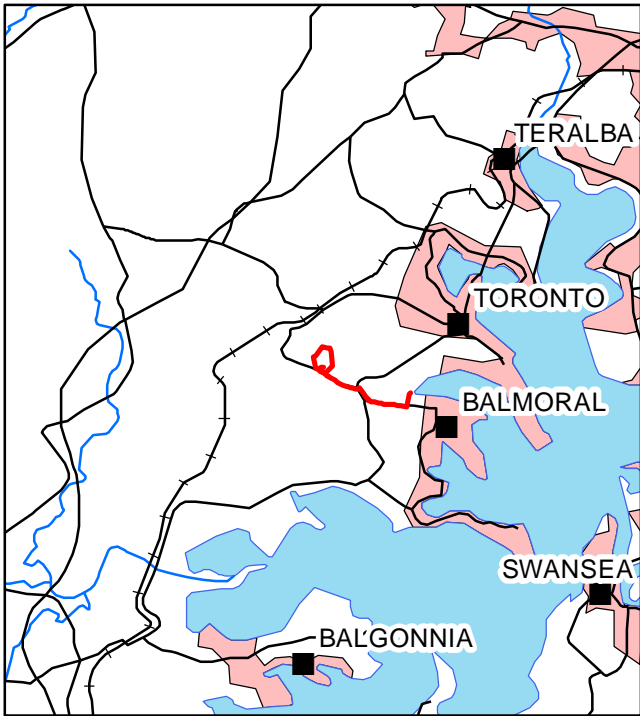


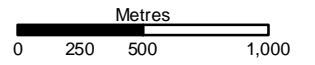
Figure 1: Location Map

1128 Awaba Waste Facility Pipeline

Drawn by: RJ
Project Mgr: RH

Date: 31/10/2011

- Pipeline
- Lot 372



Horizontal Datum
MGA Zone 56





Figure 2: Site Map - Overview

1128 Awaba Waste Facility Pipeline

Drawn by: RJ
Project Mgr: RH

Date: 02/11/2011

-  Pipeline
-  Awaba Tip Site

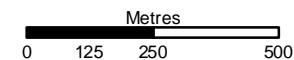




Figure 3: Site Map -
Wilton Road Section

1128 Awaba Waste
Facility Pipeline

Drawn by: RJ
Project Mgr: RH

Date: 02/11/2011

-  Pipeline
-  Awaba Tip Site

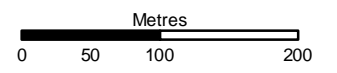




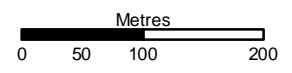
Figure 4: Site Map - Wangi-Dorrington Road Section

1128 Awaba Waste Facility Pipeline

Drawn by: RJ
Project Mgr: RH

Date: 02/11/2011

- Pipeline
- Awaba Tip Site





Lots 372 & 373 Vegetation

- 114 - Red Mahogany-Paperbark Thicket
- 11c - Peppermint-Black Wattle Riparian Forest
- 30f - Freemans Peppermint-Apple-Bloodwood Forest
- 30h - Sugarloaf Lowlands Bloodwood-Apple Forest
- 30j - Sugarloaf Lowlands Bloodwood-Apple-Scribbly Gum Forest
- 31 - Coastal Plains Scribbly Gum Woodland
- C - Cleared
- D - Dam
- I - Infrastructure
- Xs - Disturbed: Regrowth

LMCC Vegetation

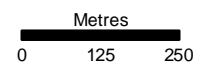
- 11, Coastal Sheltered Apple-Peppermint Forest
- 15, Coastal Foothills Spotted Gum - Ironbark Forest
- 30, Coastal Plains Smooth-barked Apple Woodland
- 31, Coastal Plains Scribbly Gum Woodland
- 31g, Scribbly Gum Open Woodland
- 37, Swamp Mahogany - Paperbark Forest
- 38, Foreshore Redgum-Rough-barked Apple Forest
- 40, Swamp Oak - Rushland Forest
- 41, Swamp Oak Sedge Forest
- 42, Narrabeen Alluvial Sedge Woodland
- 43a, Estuarine Paperbark Scrub Forest
- 47, Mangrove - Estuarine Complex
- 47a, Saltmarsh
- 9, Coastal Ranges Open Forest
- H,
- LM07,
- Water,
- Xs, Disturbed - Regrowth

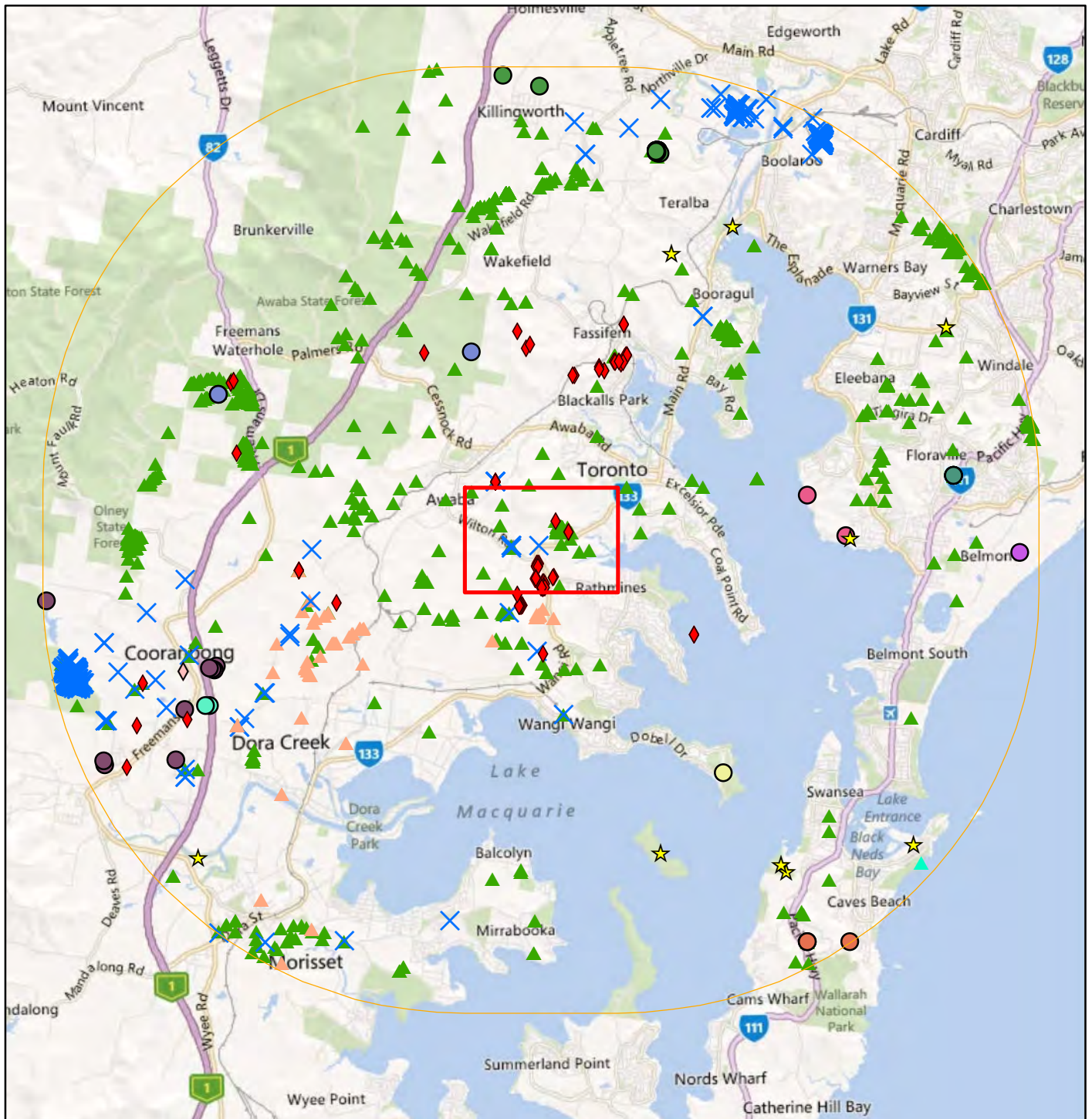
Figure 5: Vegetation

1128 Awaba Waste Facility Pipeline

Drawn by: RJ
Project Mgr: RH

Date: 26/08/2012

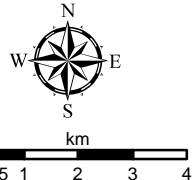


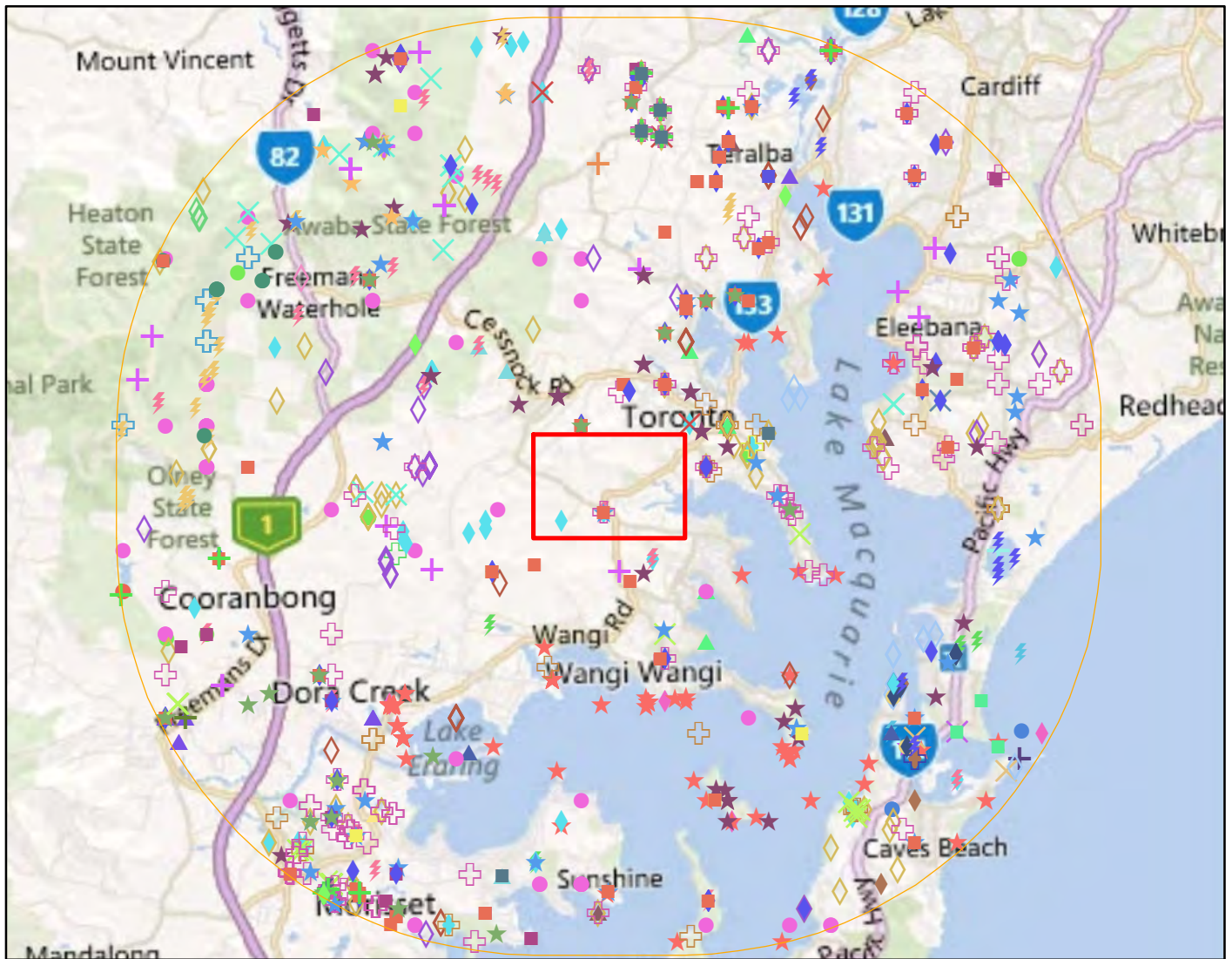


- | | | |
|----------------------------------|---|-------------------------------|
| Study Area | <i>Corybas dowlingii</i> | <i>Melaleuca biconvexa</i> |
| 10km Search | <i>Cryptostylis hunteriana</i> | <i>Senecio spathulatus</i> |
| Threatened Flora | <i>Cynanchum elegans</i> | <i>Syzygium paniculatum</i> |
| <i>Acacia bynoeana</i> | <i>Diuris praecox</i> | <i>Tetratheca glandulosa</i> |
| <i>Angophora inopina</i> | <i>Grevillea parviflora</i> | <i>Tetratheca juncea</i> |
| <i>Callistemon linearifolius</i> | <i>Grevillea parviflora subsp. parviflora</i> | <i>Zannichellia palustris</i> |
| <i>Chamaesyce psammogeton</i> | <i>Maudia triglochinos</i> | |

Figure 6: Threatened flora previously found within 10km of the Study Area
1128 Awaba Waste Facility Pipeline

Drawn by: RJ
Project Mgr: RH
Date: 1/08/2012





Study Area	Gang-gang Cockatoo	Loggerhead Turtle	Spotted Harrier
10km Search	Giant Barred Frog	Long-nosed Potoroo	Spotted-tailed Quoll
Threatened Fauna	Glossy Black-Cockatoo	Masked Owl	Square-tailed Kite
Barking Owl	Golden-tipped Bat	Osprey	Squirrel Glider
Black Bittern	Great Knot	Pied Oystercatcher	Stephens' Banded Snake
Black-necked Stork	Greater Broad-nosed Bat	Powerful Owl	Stuttering Frog
Blue-billed Duck	Greater Sand-plover	Red Goshawk	Swift Parrot
Brown Treecreeper	Green Turtle	Red-crowned Toadlet	Terek Sandpiper
Bush Stone-curlew	Grey-headed Flying-fox	Regent Honeyeater	Turquoise Parrot
Comb-crested Jacana	Koala	Scarlet Robin	Varied Sittella
Dugong	Large-eared Pied Bat	Shy Albatross	Wallum Froglet
Eastern Bentwing-bat	Lesser Sand-plover	Sooty Owl	Wandering Albatross
Eastern Cave Bat	Little Bentwing-bat	Sooty Oystercatcher	White-fronted Chat
Eastern False Pipistrelle	Little Eagle	Southern Giant Petrel	Yellow-bellied Glider
Eastern Freetail-bat	Little Lorikeet	Southern Myotis	Yellow-bellied Sheathtail-bat
Flesh-footed Shearwater	Little Tern	Speckled Warbler	

Figure 7: Threatened fauna previously found within 10km of the Study Area
1128 Awaba Waste Facility Pipeline

Drawn by: RJ
Project Mgr: RH
Date: 1/08/2012

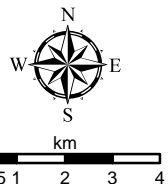


Figure 8: Habitat trees and threatened flora recorded within the study area

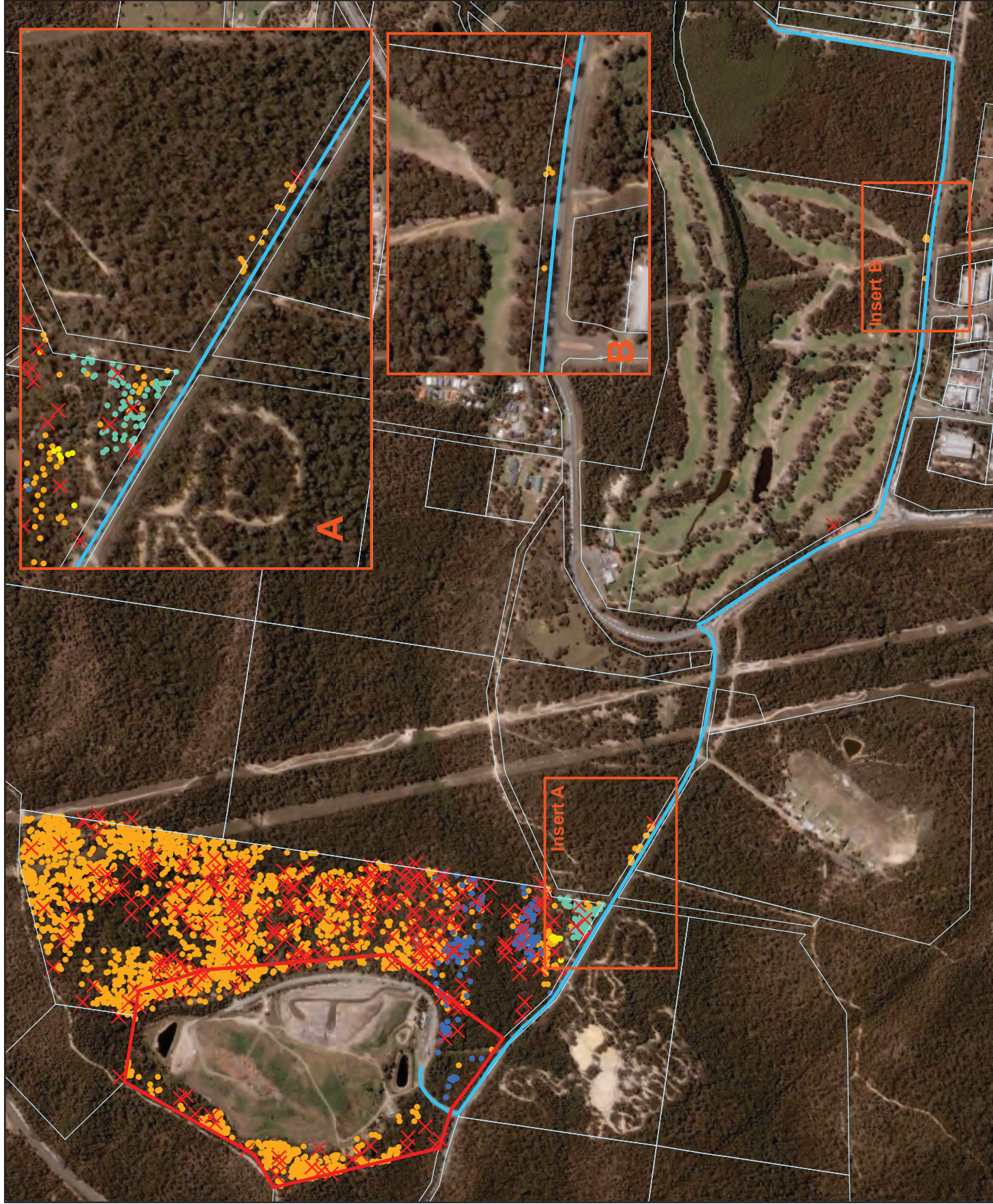
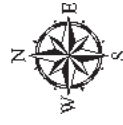
1128 Awaba Waste Facility Pipeline

Drawn by: RJ

Project Mgr: RH

Date: 07/11/2011

- Awaba Tip Site
- Pipeline
- X Habitat trees
- *Acacia bynoeana*
- *Angophora inopina*
- *Grevillea parviflora*
- *Tetratheca juncea*



APPENDICIES

Appendix A: Flora Recorded from the Study Area

Relative abundance Key; U = uncommon, Mc = moderately common, C = common

Status Key; V = vulnerable on either the TSC Act or EPBC Act, nw = noxious weed, e = exotic

Location Key; 1 = Rathmines SPS access track, 2 = Dorrington Road, 3 = Wangi Road, 4 = Wilton Road

Family	Scientific Name	Common Name	Status	Location			
				1	2	3	4
Adiantaceae	<i>Adiantum aethiopicum</i>	Common Maidenhair Fern		u	u	mc	
Anthericaceae	<i>Arthropodium ? minus</i>	Small Vanilla Lily			u		
	<i>Laxmannia gracilis</i>	Slender Wire Lily					u
	<i>Tricoryne elatior</i>	Yellow Autumn-lily			u	u	u
Apiaceae	* <i>Cyclospermum leptophyllum</i>	Slender Celery	e	mc	mc		u
	<i>Centella asiatica</i>	Indian Pennywort			u		u
	<i>Hydrocotyle laxiflora</i>	Stinking Pennywort				u	
Apocynaceae	* <i>Araujia sericifera</i> (syn. <i>A. hortorum</i>)	Moth Vine	nw		u		
	<i>Parsonsia straminea</i>	Common Silkpod		u			
Asteraceae	* <i>Ageratina adenophora</i>	Crofton Weed	nw			mc	u
	* <i>Bidens pilosa</i>	Cobblers Pegs				mc	mc
	* <i>Chrysanthemoides monilifera</i> subsp. <i>rotundata</i>	Bitou Bush	nw	u			u
	* <i>Cirsium vulgare</i>	Spear Thistle	nw		u	mc	
	* <i>Conyza bonariensis</i>	Flaxleaf Fleabane	e	mc	u	c	u
	* <i>Erigeron karvinskianus</i>	Seaside Daisy	e				u
	* <i>Foeniculum vulgare</i>	Fennel	e			u	u
* <i>Gamochoeta ? americana</i>	Cudweed	e	u	u		u	
* <i>Hypochoeris radicata</i>	Flatweed	e	mc	u	mc		

Family	Scientific Name	Common Name	Status				
				1	2	3	4
	<i>*Senecio madagascariensis</i>	Fireweed	nw	mc		mc	u
	<i>*Sonchus oleraceus</i>	Common Sowthistle	e	u	u	u	u
	<i>*Taraxacum officinale</i>	Dandelion	e		c	u	
	<i>Brachyscome</i> sp.						u
	<i>Cassinia aculeata</i>	Dolly Bush			u		
	<i>Cymbonotus lawsonianus</i>	Austral Bears-ear			u		u
	<i>Euchiton ? involucratus</i>	Star Cudweed		u		mc	
Caryophyllaceae	<i>*Cerastium glomeratum</i>	Mouse-ear Chickweed	e	u	mc		
	<i>*Petrohragia nanteuilii</i>	Proliferous Pink	e			u	u
Casuarinaceae	<i>Allocasuarina littoralis</i>	Black She-oak		u			
	<i>Allocasuarina torulosa</i>	Forest Oak		u	u	u	u
	<i>Casuarina glauca</i>	Swamp Oak		u			
Colchicaceae	<i>Burchardia umbellata</i>	Milkmaids		u	u		
Convolvulaceae	<i>Convolvulus erubescens</i>	Blushing Bindweed					u
	<i>Dichondra repens</i>	Kidney Weed			u	u	
Cyperaceae	<i>*Cyperus eragrostis</i>	Umbrella Sedge	e	u		u	u
	<i>Gahnia ? clarkei</i>	Tall Saw-sedge				u	
	<i>Lepidosperma laterale</i>	Variable Sword-sedge			u		
	<i>Schoenus</i> sp.				u	u	
Dennstaedtiaceae	<i>Pteridium esculentum</i>	Bracken		u	mc	mc	mc
Dilleniaceae	<i>Hibbertia diffusa</i>	Wedge Guinea Flower			u		
	<i>Hibbertia obtusifolia</i>	Grey Guinea-flower					u
Doryanthaceae	<i>Doryanthes excelsa</i>	Gynea Lily					u

Family	Scientific Name	Common Name	Status				
				1	2	3	4
Elaeocarpaceae	<i>Tetradlea juncea</i>	Black-eyed Susan	V TSC & EPBC Acts		?		?
Ericaceae (Stypheloidiaea)	<i>Epacris pulchella</i>	Wallum Heath			u		u
Euphorbiaceae	* <i>Ricinus communis</i>	Castor Oil Plant	nw	u			
Fabaceae (Caesalpinideae)	* <i>Senna pendula</i>		nw		u	mc	
Fabaceae (Faboideae)	* <i>Melilotus indicus</i>	Hexham Scent	e			u	
	* <i>Tephrosia ? grandiflora</i>		e	mc	mc	u	
	* <i>Trifolium angustifolium</i>	Narrow-leaved Clover	e			u	
	* <i>Trifolium campestre</i>	Hop Clover	e	u	mc	mc	mc
	* <i>Trifolium pratense</i>	Red Clover	e		u		mc
	* <i>Trifolium repens</i>	White Clover	e	mc	mc	c	mc
	* <i>Trifolium sp.</i>	a clover	e	u			
	* <i>Trifolium subterraneum</i>	Subterranean Clover	e	mc	mc		mc
	* <i>Vicia sativa subsp. nigra</i>	Vetch	e	mc	u	mc	u
	<i>Bossiaea obcordata</i>	Spiny Bossiaea					u
	<i>Daviesia ulicifolia</i>	Gorse Bitter-pea			u		
	<i>Dillwynia retorta</i>				u		u
	<i>Glycine clandestina</i>	Twining Glycine		u	u	u	u
	<i>Gompholobium latifolium</i>	Golden Glory Pea					u
	<i>Hardenbergia violacea</i>	False Sarsaparilla		u	u		
	<i>Hovea linearis</i>	Hovea		u			u
	<i>Kennedia rubicunda</i>	Dusky Coral Pea		u		u	u
	<i>Mirbelia rubiifolia</i>	Heathy Mirbelia					u

Family	Scientific Name	Common Name	Status			
			1	2	3	4
	<i>Podolobium ilicifolium</i>	Prickly Shaggy Pea				u
	<i>Pultenaea daphnoides</i>	Large-leaf Bush-pea		u		
	<i>Pultenaea villosa</i>	Hairy Bush-pea		u	u	u
Fabaceae (Mimosoideae)	<i>Acacia brownii</i>	Heath Wattle	u			
	<i>Acacia falcata</i>		u	u		
	<i>Acacia falciformis</i>	Broad-leaved Hickory		u		u
	<i>Acacia irrorata</i>	Green Wattle		u		u
	<i>Acacia longifolia</i> subsp. <i>longifolia</i>	Sydney Golden Wattle	u	u	u	mc
	<i>Acacia myrtifolia</i>	Red-stemmed Wattle		u		
	<i>Acacia terminalis</i> subsp. <i>longiaxialis</i>	Sunshine Wattle	u	u	u	u
	Gentianaceae	* <i>Centaurium erythraea</i>	Common Centaury			
* <i>Centaurium tenuiflorum</i>			u			
Geraniaceae	<i>Geranium solanderi</i>	Native Geranium				u
Goodeniaceae	<i>Dampiera sylvestris</i>				u	
	<i>Goodenia hederacea</i>	Ivy Goodenia		u		
	<i>Scaevola aemula</i>	Fairy Fanflower		u		u
Haloragaceae	<i>Gonocarpus tetragynus</i>	Common Raspwort		u		
Iridaceae	* <i>Iris</i> sp.		e			u
Iridaceae	* <i>Sisyrinchium iridifolium</i>	Blue Pigroot	e	u		
Iridaceae	<i>Patersonia sericea</i>	Silky Purple-flag				u
Juncaceae	<i>Juncus</i> sp.			u	u	
Lauraceae	<i>Cassytha glabella</i>	Devil's Twine		u	u	u
Liliaceae	* <i>Lilium formosanum</i>	Formosan Lily	e	u	mc	u

Family	Scientific Name	Common Name	Status			
			1	2	3	4
Lindsaeaceae	<i>Linseaea linearis</i>	Scrw Fern		u	u	u
Lobeliaceae	<i>Pratia purpurascens</i>	Whiteroot	u	mc	u	
Lomandraceae	<i>Lomandra longifolia</i>	Spiny-headed Mat-rush		u	u	
	<i>Lomandra multiflora</i> ssp. <i>multiflora</i>	Many-flowered Mat-rush	u			
	<i>Lomandra obliqua</i>			u	u	u
Luzuriagaceae	<i>Geitonoplesium cymosum</i>	Scrambling Lily		u	mc	
Lythraceae	<i>Lythrum hyssopifolia</i>	Hyssop Loosestrife	u			
Malvaceae	* <i>Sida rhombifolia</i>	Paddy's Lucerne			mc	
Myrtaceae	<i>Angophora costata</i>	Sydney Red Gum	u	mc	u	u
	<i>Angophora inopina</i>	Charmhaven Apple				u
	<i>Corymbia gummifera</i>	Red Bloodwood	u	u	u	u
	<i>Eucalyptus haemastoma</i>	Broad-leaved Scribbly Gum	u	u	u	u
	<i>Eucalyptus robusta</i>	Swamp Mahogany	u		u	
	<i>Eucalyptus umbra</i>	Broad-leaved White Mahogany				u
	<i>Leptospermum laevigatum</i>	Coast Teatree		u		
	<i>Leptospermum polygalifolium</i>					u
	<i>Leptospermum</i> sp.				u	u
	<i>Melaleuca linariifolia</i>	Flax-leaved Paperbark	u	mc	u	
	<i>Melaleuca styphelioides</i>	Prickly-leaved Tea Tree	u			
Orchidaceae	<i>Caladenia</i> sp.			u		
	<i>Calochilus ? paludosus</i>	Red-beard Orchid		u		
	<i>Microtis unifolia</i>	Common Onion Orchid		u	u	
	<i>Thelmitra ? pauciflora</i>	Slender Sun Orchid		u		u

Family	Scientific Name	Common Name	Status	1	2	3	4
Phormiaceae	<i>Dianella caerulea</i>	Blue Flax-lily		u	mc	mc	u
Phyllanthaceae	<i>Glochidion ferdinandi</i> var. <i>ferdinandi</i>	Cheese Tree					u
Pittosporaceae	<i>Billardiera scandens</i>	Hairy Apple Berry		u	u		u
	<i>Bursaria spinosa</i>	Blackthorn		u			
	<i>Pittosporum undulatum</i>	Sweet Pittosporum		u	u	u	
Plantaginaceae	* <i>Plantago ? myosuroides</i>		e	u		u	
	* <i>Plantago lanceolata</i>	Lamb's Tongues	e	mc	c	c	mc
Poaceae	* <i>Agrostis</i> sp.	Bent Grass					u
	* <i>Aira</i> sp.	Hairgrass	e	u	u		
	* <i>Andropogon virginicus</i>	Whiskey Grass	e	mc	mc	u	mc
	* <i>Anthoxanthum odoratum</i>	Sweet Vernal Grass	e		mc		u
	* <i>Avena barbata</i>	Bearded Oats	e				u
	* <i>Briza maxima</i>	Quaking Grass	e	mc	mc	mc	mc
	* <i>Briza minor</i>	Shivery Grass	e	mc	mc		mc
	* <i>Briza subaristata</i>		e	mc	mc	mc	mc
	* <i>Bromus catharticus</i>	Prairie Grass	e		mc	mc	mc
	* <i>Bromus</i> sp.	a broome					u
	* <i>Chloris gayana</i>	Rhodes Grass	e	mc		c	
	* <i>Dactylis glomerata</i>	Cocksfoot	e		mc		
	* <i>Ehrharta erecta</i>	Panic Veldtgrass	e			mc	u
	* <i>Eragrostis</i> sp.		e			u	u
* <i>Holcus lanatus</i>	Yorkshire Fog	e		u		u	
* <i>Hyparrhenia rufa</i> supsp. <i>altissima</i>		e		u			

Family	Scientific Name	Common Name	Status	1	2	3	4
	<i>*Lolium perenne</i>	Perennial Ryegrass	e		mc	c	
	<i>*Panicum capillare</i>	Witchgrass	e	mc			u
	<i>*Paspalum dilatatum</i>	Paspalum	e			c	
	<i>*Pennisetum clandestinum</i>	Kikuyu	e		mc		
	<i>*Poa annua</i>	Winter Grass	e	u	u		
	<i>*Setaria</i> sp.		e		u	mc	
	<i>*Sporobolus ? africanus</i>	Parramatta Grass	e				u
	<i>*Stenotaphrum secundatum</i>	Buffalo Grass	e			c	
	<i>*Vulpia myuros</i>	Rat's Tail Fesque	e			u	
	<i>Austrodanthonia</i> sp.	a wallaby grass			u		
	<i>Austrostipa</i> sp.	A speargrass			u		
	<i>Cymbopogon refractus</i>	Barbed Wire Grass				mc	u
	<i>Cynodon dactylon</i>	Common Couch		c	mc	mc	mc
	<i>Dichelachne crinita</i>	Longhair Plumegrass		u			
	<i>Dichelachne</i> sp.	Plumegrass			u		
	<i>Echinopogon caespitosus</i>	Bushy Hedgehog Grass			u		
	<i>Entolasia stricta</i>	Wiry Panic					u
	<i>Imperata cylindrica</i>	Blady Grass		mc	mc	c	c
	<i>Lachnagrostis ? filiformis</i>	Common Blown-grass		u			
	<i>Microlaena stipoides</i> var. <i>stipoides</i>	Weeping Grass			u		
	<i>Oplismenus imbecillis</i>	Australian Basket Grass			u	u	
	<i>Panicum simile</i>	Two-colour Panic		u			
	<i>Phragmies australis</i>	Common Reed				u	
	<i>Poa</i> sp. (small)					u	

Family	Scientific Name	Common Name	Status	Status			
				1	2	3	4
	<i>Themeda australis</i>	Kangaroo Grass		u	u	u	u
Polygalaceae	* <i>Polygala virgata</i>	Broom Milkwort	e				u
	<i>Comesperma ericinum</i>	Pyramid Flower				u	
Primulaceae	* <i>Anagallis arvensis</i>	Scarlet/Blue Pimpernel	e	mc	mc	u	mc
Proteaceae	<i>Banksia serrata</i>	Old-man Banksia			u		
	<i>Banksia spinulosa</i>						u
	<i>Grevillea linearifolia</i>	Linear-leaf Grevillea			u		
	<i>Grevillea parviflora</i> subsp. <i>parviflora</i>	Small-flower Grevillea	V TSC & EPBC Acts				u
	<i>Lambertia formosa</i>	Mountain Devil			u		mc
	<i>Persoonia levis</i>	Broad-leaved Geebung					u
Rosaceae	* <i>Rubus fruticosus</i>	Blackberry complex	nw	u		mc	u
Rubiaceae	* <i>Richardia ? humistrata</i>		e	u	mc		mc
Santalaceae	<i>Exocarpos cupressiformis</i>	Cherry Ballart			u		
Sapindaceae	<i>Dodonaea triquetra</i>	Large-leaf Hop-bush		u	u	mc	u
Solanaceae	* <i>Solanum mauritianum</i>	Wild Tobacco Bush	e			u	
	* <i>Solanum nigrum</i>	Black-berry Nightshade	e			u	
Thymelaeaceae	<i>Pimelea linifolia</i> subsp. <i>linifolia</i>	Slender Rice-flower			u		u
Verbenaceae	* <i>Lantana camara</i>	Lantana	nw	u	mc	u	u
	* <i>Verbena bonariensis</i>	Purpletop	e	c	mc	u	mc
Xanthorrhoeaceae	<i>Xanthorrhoea</i> sp.				u	u	

Appendix B: Fauna Recorded from the Study Area

Species
Australian Magpie
Australian Raven
Black-faced Cuckoo-shrike
Brown Thornbill
Crested Pigeon
Crimson Rosella
Dollarbird
Eastern Rosella
Eastern Whipbird
Eastern Yellow Robin
Fan-tailed Cuckoo
Garden Skink
Goshawk
Grey Fantail
Grey Shrike-thrush
Laughing Kookaburra
Noisy Miner
pie'd Butcherbird
Pied Currawong
Rainbow Lorikeet
Red-browed Finch
Rufous Whistler
Sacred Kingfisher
Spotted Pardolate
Striated Pardolate
Sulphur-crested Cockatoo
Superb Fairywren
White-bellied Sea Eagle
Yellow Thornbill
Yellow-faced Honeyeater
Yellow-throated Gerygone

Appendix C: Threatened Flora Likelihood of Occurrence

Scientific Name	Common Name	TSC Act	EPBC Act	Distribution and Habitat	Likelihood of occurrence within Subject Site	Likelihood of occurrence within Study Area
<i>Acacia bynoeana</i>	Bynoe's Wattle	E	V	<i>Acacia bynoeana</i> is found in central eastern NSW, from the Hunter District (Morisset) south to the Southern Highlands and west to the Blue Mountains. It has recently been found in the Colymea and Parma Creek areas west of Nowra. Not considered further as there would be negligible impact this species preferred habitat.	Low	Moderate. Known in area north of Wilton Rd.
<i>Angophora inopina</i>	Charmhaven Apple	V	V	<i>Angophora inopina</i> is endemic to the Central Coast region of NSW, the known northern limit is near Karuah where a disjunct population occurs; to the south populations extend from Toronto to Charmhaven with the main population occurring between Charmhaven and Morisset. There is an unconfirmed record of the species near Bulahdelah. Approximately 1,250 ha of occupied habitat has been mapped in the Wyong - south Lake Macquarie area. Not considered further as there would be no loss of individual plants and only negligible impact on this species preferred habitat.	Low	Known. Occurs in area north of Wilton Rd, NW of the Wilton Rd and Wangi Rd intersection
<i>Callistemon linearifolius</i>	Netted Bottle Brush	V	-	This shrub is up to 3-4 m tall, with linear (long and narrow) to linear-lanceolate (lance shaped) leaves. Recorded from the Georges River to Hawkesbury River in the Sydney area, and north to the Nelson Bay area of NSW. Recorded in 2000 at Coalcliff in the northern Illawarra. Grows in dry sclerophyll forest on the coast and adjacent ranges. Flowers spring – summer.	Low	Low
<i>Chamaesyce psammogeton</i>	Sand Spurge	E	-	Sand Spurge is a herb that forms mats to 1 m across. Sand Spurge is found sparsely along the coast from south of Jervis Bay (at Currarong, Culburra and Seven Mile Beach National Park) to Queensland (and Lord Howe Island). Populations have been recorded in Wamberal Lagoon Nature Reserve, Myall Lakes National Park and Bundjalung National Park. Grows on fore-dunes and exposed headlands, often with Spinifex (<i>Spinifex sericeus</i>). Flowering occurs in summer.	Low	Low

Scientific Name	Common Name	TSC Act	EPBC Act	Distribution and Habitat	Likelihood of occurrence within Subject Site	Likelihood of occurrence within Study Area
<i>Corybas dowlingii</i>	Red Helmet Orchid	E	-	<i>Corybas dowlingii</i> is a tuberous orchid species which grows in clonal colonies. The species is restricted to NSW where it is currently known from 4 localities including Port Stephens (2 localities), Bulahdelah and Freemans Waterhole south-west of Newcastle. LGAs known to contain plants of <i>Corybas dowlingii</i> include Great Lakes, Port Stephens, Newcastle and Lake Macquarie. Sheltered areas such as gullies and southerly slopes in tall open forest on well-drained gravelly soil at elevations of 10-200 m.	Low	Low
<i>Cryptostylis hunteriana</i>	Leafless Tongue Orchid	V	V	<i>Cryptostylis hunteriana</i> has been recorded from as far north as Gibraltar Range National Park south into Victoria around the coast as far as Orbost. It is known historically from a number of localities on the NSW south coast and has been observed in recent years at many sites between Batemans Bay and Nowra (although it is uncommon at all sites). Also recorded at Nelson Bay, Wye, Washpool National Park, Nowendoc State Forest, Ku-Ring-Gai Chase National Park, Ben Boyd National Park. Not considered further as there would be negligible impact to this species preferred habitat.	Low	Low to Moderate. Only one known local record about 8.5 km SW of the study area
<i>Cynanchum elegans</i>	White-flowered Wax Plant	E	E	<i>Cynanchum elegans</i> is recorded from rainforest gullies scrub and scree slopes from the Gloucester district to the Wollongong area and inland to Mt Dangar. ROTAP: 3ECi	Low	Low
<i>Diuruis praecox</i>	Rough Double-tail	V	V	A terrestrial herb (orchid) with two or three linear leaves. Occurs between Ourimbah and Nelson Bay. Grows on hills and slopes of near-coastal districts in open forests, which have a grassy to fairly dense understorey. Exists as subterranean tubers most of the year and produces leaves and flowering stems in winter.	Low	Low

Scientific Name	Common Name	TSC Act	EPBC Act	Distribution and Habitat	Likelihood of occurrence within Subject Site	Likelihood of occurrence within Study Area
<i>Grevillea parviflora</i> subsp. <i>parviflora</i>	Small-flower Grevillea	V	V	<i>Grevillea parviflora</i> subsp. <i>parviflora</i> is sporadically distributed throughout the Sydney Basin with the main occurrence centered around Picton, Appin and Bargo (and possibly further south to the Moss Vale area). Separate populations are also known further north from Putty to Wyong and Lake Macquarie on the Central Coast and Cessnock and Kurri Kurri in the Lower Hunter. This species grows in sandy or light clay soils usually over thin shales. It occurs in a range of vegetation types from heath and shrubby woodland to open forest and is found over a range of altitudes from flat, low-lying areas to upper slopes and ridge crests. It often occurs in open, slightly disturbed sites such as along tracks. Plants are capable of suckering from a rootstock and most populations demonstrate a degree of vegetative spread, particularly after disturbance such as fire. Not considered further as there would be no loss of individual plants and only negligible impact on this species preferred habitat.	Low. Not observed within subject site	Known. One plant observed at one location north of Wilton Rd within <i>Freemans Peppermint-Apple-Bloodwood Forest</i>
<i>Maundia triglochinooides</i>		V	-	<i>Maundia triglochinooides</i> occurs in permanent swamps and wetlands and is restricted to Central and North coasts NSW and extending into southern Queensland. The current southern limit is Wyong; former sites around Sydney are either non-existent or highly modified. Grows in swamps, creeks or shallow freshwater 30 - 60 cm deep on heavy clay, low nutrients.	None	Low
<i>Melaleuca biconvexa</i>	Biconvex Paperbark	V	V	<i>Melaleuca biconvexa</i> is endemic to NSW, with scattered and dispersed populations found in the Jervis Bay area in the south and the Gosford-Wyong area in the north. <i>Melaleuca biconvexa</i> generally grows in damp places, often near streams or low-lying areas on alluvial soils of low slopes or sheltered aspects. Its flowering occurs over a 3-4 week period in September and October and resprouts following fire.	None	Low
<i>Senecio spathulatus</i>	Coastal Groundsel	E	-	A low-growing smooth-stemmed daisy, often forming hummocks to 30 cm tall. Coast Groundsel grows on primary dunes in Nadgee Nature Reserve (Cape Howe) and between Kurnell in Sydney and Myall Lakes National Park (with a possible occurrence at Cudmirrah).	None	None

Scientific Name	Common Name	TSC Act	EPBC Act	Distribution and Habitat	Likelihood of occurrence within Subject Site	Likelihood of occurrence within Study Area
<i>Syzygium paniculatum</i>	Magenta Lilly Pilly	V	V	<i>Syzygium paniculatum</i> is endemic to NSW and is distributed from Bulahdelah in the north to Conjola in the south. On the Central Coast this species is found in rainforest remnants on gravel, sands, silts or clays	None	Low
<i>Tetratheca glandulosa</i>		V	V	Small, spreading shrub which grows 20 - 50cm in height. NSW populations behave as annuals, dying back completely every summer. Restricted to the following LGAS: Baulkham Hills, Gosford, Hawkesbury, Hornsby, Ku-ring-gai, Pittwater, Ryde, Warringah, and Wyong. Vegetation structure varies from heaths and scrub to woodlands/open woodlands, and open forest. Vegetation communities correspond broadly to Benson & Howell's Sydney Sandstone Ridgetop Woodland. Common woodland tree species include: <i>Corymbia gummifera</i> , <i>C. eximia</i> , <i>Eucalyptus haemastoma</i> , <i>E. punctata</i> , <i>E. racemosa</i> , and/or <i>E. sparsifolia</i> , with an understorey dominated by species from the families Proteaceae, Fabaceae, and Epacridaceae.	None	None
<i>Tetratheca juncea</i>	Black-eyed Susan	V	V	<i>Tetratheca juncea</i> is confined to the northern portion of the Sydney Basin bioregion and the southern portion of the North Coast bioregion in the local government areas of Wyong, Lake Macquarie, Newcastle, Port Stephens, Great Lakes and Cessnock. Usually found in low open forest/woodland with a mixed shrub understorey and grassy groundcover. Not considered further as there would be no loss of individual plants and only negligible impact on this species preferred habitat.	Low. Not observed within subject site during the flowering period for this species	Known. Observed along Wilton Rd (numerous locations) and Dorrington Rd (2 locations). All clumps occurred within 5 m of the road pavement.
<i>Zannichellia palustris</i>		E	-	A submerged aquatic plant that grows in fresh or slightly saline stationary or slowly flowing water. NSW populations behave as annuals, dying back completely every summer. In NSW, known only from the lower Hunter.	Low	Low

Appendix D: Threatened Fauna Likelihood of Occurrence

Common Name	Scientific Name	TSC Act	EPBC Act	Distribution and Habitat	Likelihood of occurrence within the Study Area
Frogs					
Giant Barred Frog	<i>Mixophyes iteratus</i>	E	E	In the mid-east of NSW, the species is currently only known from five populations in the Watagan Mountain area (White 2000). Occurs in uplands and lowlands in rainforest and wet sclerophyll forest, including farmland. Many sites where the Southern Barred Frog is known to occur are the lower reaches of streams which have been affected by major disturbances such as clearing, timber harvesting and urban development in their headwaters.	Low
Red-crowned Toadlet	<i>Pseudophryne australis</i>	V	-	Occurs on wetter ridge tops and upper slopes of sandstone formations on which the predominant vegetation is dry open forests and heaths. This species typically breeds within small ephemeral creeks that feed into larger semi-perennial streams. After rain these creeks are characterised by a series of shallow pools lined by dense grasses, ferns and low shrubs (Thumm, 1997).	None
Stuttering Frog	<i>Mixophyes balbus</i>	E	V	This species is usually associated with mountain streams, wet mountain forests and rainforests (Barker et al, 1995). It rarely wanders very far from the banks of permanent forest streams, although it will forage on nearby forest floors. Eggs are deposited in leaf litter on the banks of streams and are washed into the water during heavy rains (Barker et al, 1995).	Low
Wallum Froglet	<i>Crinia tinnula</i>	V	-	Wallum Froglets are found only in acid paperbark swamps and sedge swamps of the coastal 'wallum' country Barker et al, 1995.	Low
Reptiles					
Stephens' Banded Snake	<i>Hoplocephalus stephensii</i>	V	-	Stephens' Banded Snake's distribution is on the coast and ranges from Southern Queensland to Gosford in NSW where it occurs in rainforest and eucalypt forests and rocky areas up to 950 m in altitude. Stephens' Banded Snake is nocturnal, and shelters between loose bark and tree trunks, amongst vines, or in hollow trunks limbs, rock crevices or under slabs during the day. At night it hunts frogs, lizards, birds and small mammals.	Low

Common Name	Scientific Name	TSC Act	EPBC Act	Distribution and Habitat	Likelihood of occurrence within the Study Area
Birds					
Barking Owl	<i>Ninox connivens</i>	V	-	Generally found in open forests, woodlands, swamp woodlands and dense scrub. Can also be found in the foothills and timber along watercourses in otherwise open country (Pizzey, 1997).	Low
Black Bittern	<i>Ixobrychus flavicollis</i>	V	-	Usually found on coastal plains below 200 m. Often found along timbered watercourses, in wetlands with fringing trees and shrub vegetation. The sites where they occur are characterized by dense waterside vegetation (NPWS 1999a).	Low
Black-necked Stork	<i>Ephippiorhynchus asiaticus</i>	E	-	In Australia, Black-necked Storks are widespread in coastal and subcoastal northern and eastern Australia, south to central-eastern NSW and with vagrants recorded at scattered sites well away from the coast (for example, near Moree, north-east of Hay and in Victoria). Black-necked Storks are mainly found on shallow, permanent, freshwater terrestrial wetlands, and surrounding marginal vegetation, including swamps, floodplains, watercourses and billabongs, freshwater meadows, wet heathland, farm dams and shallow floodwaters, as well as extending into adjacent grasslands, paddocks and open savannah woodlands. They also forage within or around estuaries and along intertidal shorelines, such as saltmarshes, mudflats and sandflats, and mangrove vegetation.	None
Blue-billed Duck	<i>Oxyura australis</i>	V		The Blue-billed Duck is endemic to south-eastern and south-western Australia. It is widespread in NSW, but most common in the southern Murray-Darling Basin area. Birds disperse during the breeding season to deep swamps up to 300 km away. It is generally only during summer or in drier years that they are seen in coastal areas. The Blue-billed Duck prefers deep water in large permanent wetlands and swamps with dense aquatic vegetation. The species is completely aquatic, swimming low in the water along the edge of dense cover. It will fly if disturbed, but prefers to dive if approached.	None
Brown Treecreeper	<i>Climacteris picumnus victoriae</i>	V		Found in eucalypt woodlands (including Box-Gum Woodland) and dry open forest of the inland slopes and plains inland of the Great Dividing Range; mainly inhabits woodlands dominated by stringybarks or other rough-barked eucalypts, usually with an open grassy understorey, sometimes with one or more shrub species; also found in mallee and River Red Gum (<i>Eucalyptus camaldulensis</i>) Forest bordering wetlands with an open understorey of acacias, saltbush, lignum, cumbungi and grasses.	Low
Bush Stone-curlew	<i>Burhinus grallarius</i>	E		The Bush Stone-curlew is found throughout Australia except for the central southern coast and inland, the far south-east corner, and Tasmania. Nocturnal and inhabits open forests and woodlands with a sparse grassy groundlayer and fallen timber. Nests on ground.	Low

Common Name	Scientific Name	TSC Act	EPBC Act	Distribution and Habitat	Likelihood of occurrence within the Study Area
Cattle Egret	<i>Ardea ibis</i>	-	M	Occurs in tropical and temperate grasslands, wooded lands and terrestrial wetlands (Marchant, 1990).	Low
Comb-crested Jacana	<i>Irediparra gallinacea</i>	V	-	Inhabits permanent wetlands with a good surface cover of floating vegetation, especially water-lilies.	None
Flesh-footed Shearwater	<i>Puffinus crueipes</i>	V	-	Marine species. Ranges throughout the Pacific and Indian Oceans. There are two main breeding areas in the world: one in the South West Pacific includes Lord Howe Island and New Zealand; the other along the coast of Western Australia.	None
Fork-tailed Swift	<i>Apus pacificus</i>	-	M	The Fork-tailed Swift is almost exclusively aerial, flying from less than 1 m to at least 300 m above ground and probably much higher.	Low
Gang-gang Cockatoo	<i>Callocephalon fimbriatum</i>	V	-	In summer, occupies tall montane forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests (Higgins 1999). Also occur in subalpine Snow Gum woodland and occasionally in temperate or regenerating forest (Forshaw 1981). In winter, occurs at lower altitudes in drier, more open eucalypt forests and woodlands, particularly in box-ironbark assemblages, or in dry forest in coastal areas (Shields 1992). It requires tree hollows in which to breed (Gibbons and Lindenmeyer 1997).	Low
Glossy Black-Cockatoo	<i>Calyptorhynchus lathami</i>	V	-	Inhabits forest with low nutrients, characteristically with key Allocasuarina spp. Tends to prefer drier forest types (NPWS, 1999) with a middle stratum of Allocasuarina below Eucalyptus or Angophora. Often confined to remnant patches in hills and gullies (Higgins 1999). Breed in hollows stumps or limbs, either living or dead (Higgins and Davies 1996). Endangered population in the Riverina. Not considered further as there would be negligible impact on this species preferred habitat.	Low-Moderate
Great Egret	<i>Ardea alba</i>	-	M	Terrestrial wetlands, estuarine and littoral habitats and moist grasslands. Inland, prefer permanent water bodies on floodplains; shallows of deep permanent lakes (either open or vegetated), semi-permanent swamps with tall emergent vegetation and herb dominated seasonal swamps with abundant aquatic flora. Also regularly use saline habitats including mangrove forests, estuarine mudflats, salt marshes, bare salt pans, shallows of salt lakes, salt fields and offshore reefs. Breeding requires wetlands with fringing trees in which to build nests including mangrove forest, freshwater lakes or swamps and rivers (Marchant, 1990).	Low

Common Name	Scientific Name	TSC Act	EPBC Act	Distribution and Habitat	Likelihood of occurrence within the Study Area
Great Knot	<i>Calidris tenuirostris</i>	V	-	In NSW, the species has been recorded at scattered sites along the coast to about Narooma. It has also been observed inland at Tullakool, Armidale, Gilgandra and Griffith (DECC undated). Occurs within sheltered, coastal habitats containing large, intertidal mudflats or sandflats, including inlets, bays, harbours, estuaries and lagoons. Often recorded on sandy beaches with mudflats nearby, sandy spits and islets and sometimes on exposed reefs or rock platforms (DECC undated).	None
Greater Sand-plover	<i>Charadrius leschenaultii</i>	V	M	Migratory. Does not breed in Australia. The Greater Sand Plover breeds in central Asia from Armenia to Mongolia, moving further south for winter. Almost entirely restricted to coastal areas in NSW, occurring mainly on sheltered sandy, shelly or muddy beaches or estuaries with large intertidal mudflats or sandbanks.	None
Lesser Sand-plover	<i>Charadrius mongolus</i>	V	M	Migratory. Does not breed in Australia. The Lesser Sand Plover breeds in central and north eastern Asia, migrating further south for winter. Almost entirely coastal in NSW, favouring the beaches of sheltered bays, harbours and estuaries with large intertidal sandflats or mudflats; occasionally occurs on sandy beaches, coral reefs and rock platforms.	None
Little Eagle	<i>Hieraaetus morphnoides</i>	V	-	Most abundant in lightly timbered areas with open areas nearby. Often recorded foraging in grasslands, crops, treeless dune fields, and recently logged areas. May nest in farmland, woodland and forest in tall trees (Marchant and Higgins 1993).	Low
Little Lorikeet	<i>Glossopsitta pusilla</i>	V	-	Distributed in forests and woodlands from the coast to the western slopes of the Great Dividing Range in NSW, extending westwards to the vicinity of Albury, Parkes, Dubbo and Narrabri. Mostly occur in dry, open eucalypt forests and woodlands. They feed primarily on nectar and pollen in the tree canopy. Nest hollows are located at heights of between 2 m and 15 m, mostly in living, smooth-barked eucalypts. Most breeding records come from the western slopes (NSW Scientific Committee 2008). Not considered further as there would be negligible impact on this species preferred habitat.	Low-Moderate
Little Tern	<i>Sterna albifrons</i>	E	M	The Little Tern is a small, slender, migratory or partly migratory seabird. Migrating from eastern Asia, the Little Tern is found on the north, east and south-east Australian coasts. It breeds in spring and summer along the entire east coast from Tasmania to northern Queensland, and is seen until May, with only occasional birds seen in winter months. Almost exclusively coastal, preferring sheltered environments; however may occur several kilometres from the sea in harbours, inlets and rivers (with occasional offshore islands or coral cay records).	None

Common Name	Scientific Name	TSC Act	EPBC Act	Distribution and Habitat	Likelihood of occurrence within the Study Area
Masked Owl	<i>Tyto novaehollandiae</i>	V		Inhabits a diverse range of wooded habitat that provide tall or dense mature trees with hollows suitable for nesting and roosting (Higgins, 1999). Mostly recorded in open forest and woodlands adjacent to cleared lands. Nest in hollows, in trunks and in near vertical spouts or large trees, usually living but sometimes dead (Higgins, 1999). Nest hollows are usually located within dense forests or woodlands (Gibbons and Lindenmeyer, 1997). Masked owls prey upon hollow-dependent arboreal marsupials, but terrestrial mammals make up the largest proportion of the diet (Gibbons, 1997, Higgins, 1999). Not considered further as there would be negligible impact on this species preferred habitat.	Moderate
Osprey	<i>Pandion haliaetus</i>	V	-	Ospreys are found right around the Australian coast line, except for Victoria and Tasmania. They are common around the northern coast, especially on rocky shorelines, islands and reefs. The species is uncommon to rare or absent from closely settled parts of south-eastern Australia. Favour coastal areas, especially the mouths of large rivers, lagoons and lakes. Feed on fish over clear, open water.	Low
Pied Oystercatcher	<i>Haematopus longirostris</i>	E	-	The species is distributed around the entire Australian coastline. In NSW the species is thinly scattered along the entire coast, with fewer than 200 breeding pairs estimated to occur in the State. Favours intertidal flats of inlets and bays, open beaches and sandbanks. Forages on exposed sand, mud and rock at low tide, for molluscs, worms, crabs and small fish. The chisel-like bill is used to pry open or break into shells of oysters and other shellfish.	None
Powerful Owl	<i>Ninox strenua</i>	V		Occupies wet and dry eucalypt forests and rainforests. Can occupy both un-logged and lightly logged forests as well as undisturbed forests where it usually roosts on the limbs of dense trees in gully areas. It is most commonly recorded within Red Turpentine in tall open forests and Black She-oak within open forests (Debus, 1994). Large mature trees with hollows at least 0.5 m deep are required for nesting (Garnett, 1992). Tree hollows are particularly important for the Powerful Owl because a large proportion of the diet is made up of hollow-dependent arboreal marsupials (Gibbons, 1997). Nest trees for this species are usually emergent with a diameter at breast height of at least 100 cm (Gibbons, 1997). Not considered further as there would be negligible impact on this species preferred habitat.	Moderate
Rainbow Bee-eater	<i>Merops ornatus</i>	-	M	Usually occurs in open or lightly timbered areas, often near water (Higgins, 1999).	Low

Common Name	Scientific Name	TSC Act	EPBC Act	Distribution and Habitat	Likelihood of occurrence within the Study Area
Red Goshawk	<i>Erythroriorchis radiatus</i>	CE	E	The species is very rare in NSW, extending south to about 30°S, with most records north of this, in the Clarence River Catchment, and a few around the lower Richmond and Tweed Rivers. Formerly, it was at least occasionally reported as far south as Port Stephens. Red Goshawks usually hunt from concealed or, less often, exposed perches, but also fly close above or through forest or woodland searching for prey. They often hunt from perches early in the morning and late in the day and tend to hunt more on the wing at other times of the day.	Low
Regent Honeyeater	<i>Xanthomyza phrygia</i>	E1	E, M	A semi-nomadic species occurring in temperate eucalypt woodlands and open forests. Most records are from box-ironbark eucalypt forest associations and wet lowland coastal forests (NPWS, 1999) (Pizzey, 1997).	Low
Rufous Fantail	<i>Rhipidura rufifrons</i>	-	M	Migratory species that prefers dense, moist undergrowth of tropical rainforests and scrubs. During migration it can stray into gardens and more open areas (Pizzey, 1997).	Low
Satin Flycatcher	<i>Myiagra cyanoleuca</i>	-	M	The Satin Flycatcher is found along the east coast of Australia from far northern Queensland to Tasmania, including south-eastern South Australia. Found in tall forests, preferring wetter habitats such as heavily forested gullies, but not rainforests. Not considered further as there would be negligible impact on this species preferred habitat.	Moderate
Scarlet Robin	<i>Petroica multicolor</i>	V	-	The Scarlet Robin's range includes all state capitals. Occurs in forests, woodlands; and heavier vegetation when breeding. During autumn and winter occurs in more open and Cleared areas. It has dispersive or locally migratory seasonal movements. Is conspicuous in open and suburban habitats (Morcombe 2003). Not considered further as there would be negligible impact on this species preferred habitat.	Low-Moderate
Shy Albatross	<i>Thalassarche cauta</i>	V	V, M	Pleagic species. And inhabits sub-antarctic and sub-tropical marine waters, spending the majority of its time at sea. In Australian waters, the Shy Albatross occurs along the east coast from Stradbroke Island in Queensland along the entire south coast of the continent to Carnarvon in Western Australia. Although uncommon north of Sydney, the species is commonly recorded off southeast NSW, particularly between July and November, and has been recorded in Ben Boyd National Park.	None
Sooty owl	<i>Tyto tenebricosa</i>	V	-	Often found in tall old-growth forests, including temperate and subtropical rainforests. In NSW mostly found on escarpments with a mean altitude <500 m. Nests and roosts in hollows of tall emergent trees, mainly eucalypts (Higgins 1999) often located in gullies (Gibbons and Lindenmayer 1997). Nests have been located in trees 125 to 161 centimetres in diameter (Gibbons and Lindenmayer 1997).	Low

Common Name	Scientific Name	TSC Act	EPBC Act	Distribution and Habitat	Likelihood of occurrence within the Study Area
Sooty Oystercatcher	<i>Haematopus fuliginosus</i>	V	-	Sooty Oystercatchers are found around the entire Australian coast, including offshore islands, being most common in Bass Strait. Small numbers of the species are evenly distributed along the NSW coast. Favours rocky headlands, rocky shelves, exposed reefs with rock pools, beaches and muddy estuaries.	None
Southern Giant Petrel	<i>Macronectes giganteus</i>	E	E, M	Pelagic species. The Southern Giant Petrel has a circumpolar pelagic range from Antarctica to approximately 20° S and is a common visitor off the coast of NSW. Over summer, the species nests in small colonies amongst open vegetation on Antarctic and subantarctic islands, including Macquarie and Heard Islands and in Australian Antarctic territory.	None
Speckled Warbler	<i>Pyrholaemus sagittatus</i>	V	-	The Speckled Warbler lives in a wide range of Eucalyptus dominated communities that have a grassy understorey, often on rocky ridges or in gullies. Typical habitat would include scattered native tussock grasses, a sparse shrub layer, some eucalypt regrowth and an open canopy.	Low
Spotted Harrier	<i>Circus assimilis</i>	V	-	The Spotted Harrier occurs throughout the Australian mainland, except in densely forested or wooded habitats of the coast, escarpment and ranges, and rarely in Tasmania. Individuals disperse widely in NSW and comprise a single population. Occurs in grassy open woodland including acacia and mallee remnants, inland riparian woodland, grassland and shrub steppe. It is found most commonly in native grassland, but also occurs in agricultural land, foraging over open habitats including edges of inland wetlands.	Low
Square-tailed Kite	<i>Lophoictina isura</i>	V	-	The Square-tailed Kite ranges along coastal and subcoastal areas from south-western to northern Australia, Queensland, NSW and Victoria. Scattered though widespread records in NSW indicate that the species is a regular resident in the north, north-east and along the major west-flowing river systems. It is a summer breeding migrant to the south-east, including the NSW south coast, arriving in September and leaving by March. Occurs in a variety of timbered habitats including dry woodlands and open forests. Shows a particular preference for timbered watercourses.	Low
Swift Parrot	<i>Lathamus discolor</i>	E1	E, M	The Swift Parrot occurs in woodlands and forests of NSW from May to August, where it feeds on eucalypt nectar, pollen and associated insects (Forshaw, 1981). The Swift Parrot is dependent on flowering resources across a wide range of habitats in its wintering grounds in NSW (Shields, 1992). This species is migratory, breeding in Tasmania and also nomadic, moving about in response to changing food availability (Pizzey, 1997).	Low

Common Name	Scientific Name	TSC Act	EPBC Act	Distribution and Habitat	Likelihood of occurrence within the Study Area
Terek Sandpiper	<i>Xenus cinereus</i>	V	-	A rare migrant to the eastern and southern Australian coasts, being most common in northern Australia, and extending its distribution south to the NSW coast in the east. In Australia, has been recorded on coastal mudflats, lagoons, creeks and estuaries. Favours mudbanks and sandbanks located near mangroves, but may also be observed on rocky pools and reefs, and occasionally up to 10 km inland around brackish pools	None
Turquoise Parrot	<i>Neophema pulchella</i>	V	-	Occurs in open woodlands and eucalypt forests with a ground cover of grasses and under storey of low shrubs (Morris, 1980). Generally found in the foothills of the Great Divide, including steep rocky ridges and gullies (Higgins, 1999). Nest in hollow-bearing trees, either dead or alive; also in hollows in tree stumps. Prefer to breed in open grassy forests and woodlands, and gullies that are moist (Higgins, 1999).	Low
Varied Sittella	<i>Daphoenositta chrysoptera</i>	V	-	Inhabits wide variety of dry eucalypt forests and woodlands, usually with either shrubby under storey or grassy ground cover or both, in all climatic zones of Australia (Higgins and Peter 2002). Usually in areas with rough-barked trees, such as stringybarks or ironbarks, but also in paperbarks or mature Eucalypts with hollows. Not considered further as there would be negligible impact on this species preferred habitat.	Moderate
Wandering Albatross	<i>Diomedea exulans</i>	E	V, M	Pelagic species. Visits Australian waters extending from Fremantle, Western Australia, across the southern water to the Whitsunday Islands in Queensland between June and September. It has been recorded along the length of the NSW coast. At other times birds roam the southern oceans and commonly follow fishing vessels for several days. Breeds on a number of islands just north of the Antarctic Circle: South Georgia Island (belonging to the UK), Prince Edward and Marion Islands (South Africa), Crozet and Kerguelen Islands (French Southern Territories) and Macquarie Island (Australia).	None
White-bellied Sea-eagle	<i>Haliaeetus leucogaster</i>	-	M	A migratory species that is resident to Australia. Found in terrestrial and coastal wetlands; favouring deep freshwater swamps, lakes and reservoirs; shallow coastal lagoons and salt marshes (English, 2001). Not considered further as there would be negligible impact on this species preferred habitat.	Known. Observed along XX
White-fronted Chat	<i>Epthianura albifrons</i>	V	-	The White-fronted Chat is an endemic Australian passerine bird. In NSW, it occurs mostly in the southern half of the state, in damp open habitats along the coast, and near waterways in the western part of the state. Along the coastline, it is found predominantly in saltmarsh vegetation but also in open grasslands and sometimes in low shrubs bordering wetland areas. Gregarious species, usually found foraging on bare or grassy ground in wetland areas, singly or in pairs. They are insectivorous, feedin mainly on flies and beetles caught from or close to the ground.	Low

Common Name	Scientific Name	TSC Act	EPBC Act	Distribution and Habitat	Likelihood of occurrence within the Study Area
White-throated Needletail	<i>Hirundapus caudacutus</i>	-	M	An aerial species found in feeding concentrations over cities, hilltops and timbered ranges (Pizzey, 1997).	Low
Mammals					
Eastern Bentwing-bat	<i>Miniopterus schreibersii oceanensis</i>	V	-	Broad range of habitats including rainforest, wet and dry sclerophyll forest, paperbark forest and open grasslands. Roost in caves and man made habitats and under road culverts (Strahan, 1995). Not considered further as there would be negligible impact on this species preferred habitat.	Moderate
Eastern Cave Bat	<i>Vespadelus trougtoni</i>	V	-	The Eastern Cave Bat is found in a broad band on both sides of the Great Dividing Range from Cape York to Kempsey, with records from the New England Tablelands and the upper north coast of NSW. Cave-roosting species that is usually found in dry open forest and woodland, near cliffs or rocky overhangs; has been recorded roosting in disused mine workings, occasionally in colonies of up to 500 individuals (DECCW, 2005).	Low
Eastern False Pipistrelle	<i>Falsistrellus tasmaniensis</i>	V	-	Inhabit sclerophyll forests, preferring wet habitats where trees are more than 20 m high (Churchill, 1998). Two observations have been made of roosts in stem holes of living eucalypts (Phillips, 1995). There is debate about whether or not this species moves to lower altitudes during winter, or whether they remain sedentary but enter torpor (Menkhorst, 1995). This species also appears to be highly mobile and records showing movements of up to 12 km between roosting and foraging sites (Menkhorst, 1995).	Low
Eastern Freetail Bat	<i>Mormopterus norfolkensis</i>	V	-	Most records are from dry eucalypt forests and woodlands to the east of the Great Dividing Range. Appears to roost in trees, but little is known of this species' habits (Allison, 1995 Churchill, 1998). Not considered further as there would be negligible impact on this species preferred habitat.	Moderate
Golden-tipped Bat	<i>Kerivoula papuensis</i>	V	-	Distributed along the east coast of Australia in scattered locations from Cape York Peninsula in Queensland to Bega in southern NSW. Found in rainforest and adjacent sclerophyll forest. Roost in abandoned hanging Yellow-throated Scrubwren and Brown Gerygone nests located in rainforest gullies on small first- and second-order streams.	None

Common Name	Scientific Name	TSC Act	EPBC Act	Distribution and Habitat	Likelihood of occurrence within the Study Area
Greater Broad-nosed Bat	<i>Scoteanax rueppellii</i>	V	-	Prefer moist gullies in mature coastal forests and rainforests, between the Great Dividing Range and the coast. They are only found at low altitudes below 500 m (Churchill, 1998). In dense environments they utilise natural and human-made opening in the forest for flight paths. Creeks and small rivers are favoured foraging habitat (Hoye, 1995). This species roosts in hollow tree trunks and branches (Churchill, 1998). Not considered further as there would be negligible impact on this species preferred habitat.	Moderate
Grey-headed Flying-fox	<i>Pteropus poliocephalus</i>	V	V	This species is a canopy-feeding frugivore and nectarivore of rainforests, open forests, woodlands, melaleuca swamps and banksia woodlands. Bats commute daily to foraging areas, usually within 15 km of the day roost (Tidemann 1995) although some individuals may travel up to 70 km (Augee 1999). Not considered further as there would be negligible impact on this species preferred habitat.	Moderate
Koala	<i>Phascolarctos cinereus</i>	V	-	Inhabits eucalypt forests and woodlands. The suitability of these forests for habitation depends on the size and species of trees present, soil nutrients, climate and rainfall (Reed 1990).	Low
Large-eared Pied Bat	<i>Chalinolobus dwyeri</i>	V	V	Located in a variety of drier habitats, including the dry sclerophyll forests and woodlands to the east and west of the Great Dividing Range (Hoye 1995). Can also be found on the edges of rainforests and in wet sclerophyll forests (Churchill 1998). This species roosts in caves and mines in groups of between 3 and 37 individuals (Churchill 1998).	Low
Little Bent-wing Bat	<i>Miniopterus australis</i>	V	-	Coastal north-eastern NSW and eastern Queensland (Churchill 2008). Little Bent-wing Bat is an insectivorous bat that roost in caves, in old mines, in tunnels, under bridges, or in similar structures. They breed in large aggregations in a small number of known caves and may travel 100s km from feeding home ranges to breeding sites (Law 1996; Wilson 1982). Little Bent-wing Bat has a preference for moist eucalypt forest, rainforest or dense coastal banksia scrub where it forages below the canopy for insects. Not considered further as there would be negligible impact on this species preferred habitat.	Moderate
Long-nosed Potoroo,	<i>Potorous tridactylus</i>	V	-	Inhabits coastal heath and wet and dry sclerophyll forests. Generally found in areas with rainfall greater than 760 mm. Requires relatively thick ground cover where the soil is light and sandy (Johnston, 1995).	Low
Southern Myotis	<i>Myotis macropus (adversus)</i>	V	-	Occurs in most habitat types as long as they are near permanent water bodies, including streams, lakes and reservoirs. Commonly roost in caves, but can also roost in tree hollows, under bridges and in mines (Richards, 1995 Churchill, 1998).	Low

Common Name	Scientific Name	TSC Act	EPBC Act	Distribution and Habitat	Likelihood of occurrence within the Study Area
Spotted-tailed Quoll	<i>Dasyurus maculatus maculatus</i>	V	E	Uses a range of habitats including sclerophyll forests and woodlands, coastal heathlands and rainforests (Dickman 1992). Habitat requirements include suitable den sites, including hollow logs, rock crevices and caves, an abundance of food and an area of intact vegetation in which to forage (Edgar 1995).	Low
Squirrel Glider	<i>Petaurus norfolcensis</i>	V		Generally occurs in dry sclerophyll forests and woodlands but is absent from dense coastal ranges in the southern part of its range (Suckling, 1995). Requires abundant hollow bearing trees and a mix of eucalypts, banksias and acacias (Quin, 1995). There is only limited information available on den tree use by Squirrel gliders, but it has been observed using both living and dead trees as well as hollow stumps (Gibbons, 1997). Within a suitable vegetation community at least one species should flower heavily in winter and one species of eucalypt should be smooth barked (Menkhorst, 1988). Endangered population in the Wagga Wagga LGA. Not considered further as there would be negligible impact on this species preferred habitat.	Moderate
Yellow-bellied Glider	<i>Petaurus australis</i>	V	-	Occur in tall mature eucalypt forest generally in areas with high rainfall and nutrient rich soils. Forest type preferences vary with latitude and elevation; mixed coastal forests to dry escarpment forests in the north; moist coastal gullies and creek flats to tall montane forests in the south. Found along the eastern coast to the western slopes of the Great Dividing Range, from southern Queensland to Victoria.	None
Yellow-bellied Sheathtail-bat	<i>Saccolaimus flaviventris</i>	V	-	The Yellow-bellied Sheathtail-bat is a wide-ranging species found across northern and eastern Australia. In the most southerly part of its range - most of Victoria, south-western NSW and adjacent South Australia - it is a rare visitor in late summer and autumn. There are scattered records of this species across the New England Tablelands and North West Slopes. Roosts singly or in groups of up to six, in tree hollows and buildings; in treeless areas they are known to use mammal burrows. Flies above forested canopy. Not considered further as there would be negligible impact on this species preferred habitat.	Moderate

Appendix E: CVs of staff involved in field surveys



<p>Professional Memberships</p>	<ul style="list-style-type: none"> • Environmental Institute of Australia and New Zealand (EIANZ) • Ecological Consultants Association of NSW - council member • Birds Australia • Birds Australia Southern NSW and ACT (BASNA) - committee member • Ecological Society of Australia 																		
<p>Qualifications</p>	<ul style="list-style-type: none"> • Bachelor of Science (Honours) - James Cook University • Masters of Science (Zoology) - University of the Witwatersrand • Doctor of Philosophy (Zoology) - University of Melbourne • BioBanking Assessors Course - Ryde TAFE 																		
<p>Employment History</p>	<table border="0"> <tr> <td>2009-present</td> <td>Director/Senior Ecologist, Niche Environment and Heritage Pty Ltd</td> </tr> <tr> <td>2003-09</td> <td>Manager/Senior Ecologist, Biosis Research Pty. Ltd.</td> </tr> <tr> <td>2002-03</td> <td>Project Officer, Black-eared Miner Recovery Team, La Trobe University</td> </tr> <tr> <td>2002</td> <td>Scientific Writer, Institute for Land and Food Resources, University of Melbourne</td> </tr> <tr> <td>2000-01</td> <td>Zoologist/Project Manager, Melbourne Enterprises International Ltd</td> </tr> <tr> <td>1998-2002</td> <td>Research Assistant/Demonstrator, University of Melbourne</td> </tr> <tr> <td>1995-96</td> <td>Research Assistant, Botswana National Parks</td> </tr> <tr> <td>1993-95</td> <td>Lecturer/Demonstrator, University of the Witwatersrand, South Africa</td> </tr> <tr> <td>1992</td> <td>Research Assistant, Australian Centre for Tropical and Freshwater Research, James Cook University</td> </tr> </table>	2009-present	Director/Senior Ecologist, Niche Environment and Heritage Pty Ltd	2003-09	Manager/Senior Ecologist, Biosis Research Pty. Ltd.	2002-03	Project Officer, Black-eared Miner Recovery Team, La Trobe University	2002	Scientific Writer, Institute for Land and Food Resources, University of Melbourne	2000-01	Zoologist/Project Manager, Melbourne Enterprises International Ltd	1998-2002	Research Assistant/Demonstrator, University of Melbourne	1995-96	Research Assistant, Botswana National Parks	1993-95	Lecturer/Demonstrator, University of the Witwatersrand, South Africa	1992	Research Assistant, Australian Centre for Tropical and Freshwater Research, James Cook University
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<p>Career Overview</p>	<p>Rhidian has been a professional ecological consultant for over seven years, but has over 15 years experience in teaching and practicing terrestrial wildlife ecology. He has experience in flora and fauna survey, Biobanking and offset design and project management for environmental approvals projects. Rhidian has conducted ecological work throughout Australia (NSW, Victoria, Queensland, South Australia and the Northern Territory) as well as overseas in southern Africa and Pakistan. He has been the senior scientist and project manager on a number of major investigations, including environmental assessments, management plans and mitigation design, particularly for major linear developments. He is experienced in the application of state and federal legislation which relates to the conservation of threatened species and communities, and related planning instruments.</p> <p>As the project manager for both large and small projects, Rhidian has been required to develop methodology, co-ordinate multi disciplined field teams, prepare reports incorporating results from several disciplines and maintain effective communication with the client and various regulatory and/or public authorities. Rhidian has acted as an expert witness in the NSW Land and Environment Court. Rhidian is an accredited Biobanking assessor.</p>																		
<p>Professional Vision</p>	<p>To significantly contribute to the sustainable management of Australia's natural resources and promote a greater awareness and understanding of the unique natural history of this country. To balance community growth and development with ecological conservation by ensuring all development projects adhere to the principals of Ecologically Sustainable Development. By helping clients identify issues of high ecological value I hope to not only facilitate the conservation and management of these values but also facilitate efficient project delivery.</p>																		
<p>Skills</p>	<ul style="list-style-type: none"> • Ecological surveys, assessment and monitoring • BioBanking Assessments • Project management • Environmental approvals • Expert witness and peer review • Government agency consultation and advocacy • Impact minimisation (mitigation) 																		

Key achievements/ flagship projects

F3 to Branxton Link, 2003-09*

For over six years Rhidian managed the ecological components of this 40 km dual carriageway freeway project, including targeted flora and fauna surveys, impact assessment, mitigation design, offsets, environmental management plans and a Referral. There were numerous and significant ecological issues on this project and Rhidian worked closely with the RTA engineers during the design phase to minimise any impacts. Rhidian was also required to complete an Environmental Assessment and Species Impact Assessment for the associated electricity adjustments for this project.

Pacific Highway Upgrade: Tintenbar to Ewingsdale, 2004-09*

Rhidian managed the ecological components of this 16 km dual carriageway freeway project, including constraints assessment, vegetation mapping, targeted flora and fauna surveys, route option assessment, mitigation design and impact assessment. Liaison with commonwealth and state agencies was a key element of Rhidian's work on this project.

Pacific Highway Upgrade: Woodburn to Ballina, 2006-08*

Rhidian managed the ecological components of this 32 km dual carriageway freeway project, including targeted flora and fauna surveys, route option assessment, mitigation design and impact assessment. Liaison with DECCW and DPI was a key element of Rhidian's work on this project.

Other major road projects that Rhidian has project managed

Oxley Highway Upgrade; Species Impact Statement, 2004-06*

Pacific Highway Upgrade: Moorland to Herons Creek; Environmental Assessment, 2004-06*

Pacific Highway Upgrade: F3 to Raymond Terrace; Environmental Assessment, 2004-06*

Pacific Highway Upgrade: Ballina Bypass modifications; Environmental Assessment, 2007-08*

Hunter Expressway (formerly F3 to Branxton); Environmental Monitoring, 2009-11

Princes Highway Upgrade: Tomerong Bypass, 2011

Linear Infrastructure Mitigation panel, 2007*

Rhidian provided expert advice at a workshop for developing mitigation measures for linear infrastructure for the Department of the Environment, Water, Heritage and the Arts. Completed at Biosis Research for the RTA.

Darling Anabranh Pipeline and Environmental Flows, 2003-2004*

Rhidian managed the terrestrial and aquatic ecological components of this project, including targeted flora and fauna surveys, habitat mapping and impact assessment. The project required both an Environmental Assessment and a Species Impact Assessment.

Mining projects in which Rhidian has provided significant input

Dendrobium Colliery; Ecological Monitoring, REFs and SISs, 2003-09*

West Cliff Coal Wash Emplacement Area; Species Impact Statement, 2006-07*

Elouera Colliery Mine Site Rehabilitation; Species Impact Statement, 2006-07*

Northern Exploration Drilling Area (Weipa); Environmental Assessment, 2005*

Khirthar National Park (Pakistan); Baseline Environmental Study, 2000-01

Property Development

West Wallsend: SIS and offset negotiations for 375 lots, 2009-11

Edgeworth: Biobanking calculations and negotiations for rezoning application, 2010-11

Brimbin: Environmental Assessment and Biobanking Calculations, 2010-11

Curriculum Vitae of Thomas O'Sullivan

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LICENCES & TICKETS	<ul style="list-style-type: none"> ‣ CLASS ONE DRIVER'S LICENCE ‣ OH&S GENERAL INDUCTION FOR CONSTRUCTION WORK (WHITE CARD) ‣ NPWS SCIENTIFIC LICENCE: No.SL100455 ‣ ANIMAL RESEARCH AUTHORITY UNDER THE <i>ANIMAL RESEARCH ACT 1985</i> ‣ SENIOR FIRST AID CERTIFICATE ‣ BRONZE MEDALLION
NATIONALITY	AUSTRALIAN
FAMILY	PARTNER (BERNADETTE) & CHILDREN (BEN & EMMA)

EDUCATION

Tertiary Qualifications

1998-2001 (incomplete)	MASTER OF WILDLIFE MANAGEMENT <i>Macquarie University</i> Graduate School of the Environment
1994	ENVIRONMENTAL MANAGEMENT CERTIFICATE <i>OTEN College of TAFE</i> Subjects covered: Wildlife Management & Environmental Studies.
1992	BACHELOR OF ARTS <i>University of New England</i> Majors: Zoology/Physical Geography
1989-90	GRADUATE DIPLOMA IN VISUAL DISABILITY & MOBILITY Royal Guide Dog Association/Monash University

Secondary Qualifications

1981	HIGHER SCHOOL CERTIFICATE <i>Liverpool College of TAFE</i>
------	--

Further Education & Training

2010	BRONZE MEDALLION <i>Coogee Surf Lifesaving Club</i>
2009	SENIOR FIRST AID CERTIFICATE <i>St John's Ambulance Service, Deakin ACT</i>
2007	GRASSLAND AND GRASSY WOODLAND FIELD WORKSHOP <i>An ANPC Plant Conservation Training Program</i>
2004	TRANSLOCATION OF THREATENED AUSTRALIAN PLANTS <i>An ANPC Plant Conservation Training Program</i>
2002	CONSERVATION OF ECOLOGICAL COMMUNITIES <i>An ANPC Plant Conservation Training Program</i>
2000	INTRODUCTION TO ArcView GIS <i>ESRI Australia</i>
1999	TECHNIQUES IN THE CAPTURE AND HANDLING OF KOALAS <i>Taronga Zoo</i>
1999	INTRODUCTION TO ArcView <i>NSW National Parks and Wildlife Service</i>

1997	FROG AND BAT IDENTIFICATION AND SURVEY COURSE <i>NSW State Forests, Research Division</i>
1995	MICROSOFT WORD 6 for WINDOWS. EXCEL 4 - Spreadsheets and Database.
1993	WORD PERFECT 5.1
1992	COMMUNICATION SKILLS <i>Eastern Suburbs Evening College</i>

EMPLOYMENT HISTORY

2010 -	BLUE GUM ECOLOGICAL CONSULTING <i>Owner/Manager</i>
2005 - 2009	BIOSIS RESEARCH PTY LTD <i>Canberra Regional Office Manager</i>
2000 - 2005	BIOSIS RESEARCH PTY LTD <i>Project Manager (Ecologist) - Sydney Office</i>
1995 - 2000	AUSTRALIAN MUSEUM BUSINESS SERVICE (AMBS Consulting) <i>Project Officer and Project Manager (Ecologist)</i>
1995 & 1996	SSROC (SOUTHERN SYDNEY REGIONAL ORGANISATION OF COUNCILS). <i>Contract work - Compilation of air quality data for SoE reporting</i>

VOLUNTARY WORK

2010 -	WAVERLEY COUNCIL <i>Environmental Sustainability Advisory Committee</i>
2006/2007	GREENING AUSTRALIA <i>Rehabilitation of Mt Stromlo and Uriarra areas, ACT</i>
2003	BIRDS AUSTRALIA <i>Bird surveys of the Botany Wetlands</i>
1993-4	TARONGA ZOO <i>Research Assistant</i>
1993	ENVIRONMENTAL DEFENDERS OFFICE, SYDNEY <i>Office Assistant</i>
1989	RSPCA animal shelter, Yagoona. <i>Animal care assistant</i>

SUMMARY OF EXPERTISE

I have more than 17 years experience in ecological impact and conservation value assessments in many parts of NSW and ACT. My work has covered many bioregions from western NSW to the coast, which has exposed me to a wide range of vegetation types: including chenopod shrublands, mallee, grassland and grassy woodlands of the western plains and tablelands, alpine herbfields and fens and coastal forests. I have undertaken in excess of 200 ecological consulting projects and have conducted sampling for a wide range of plant and animal taxonomic groups. Other routine tasks include: literature reviews; project design and management, field surveys (including multi-species sampling and cross-seasonal studies), report preparation and mapping.

Between 2005 – 2009 I was responsible for the establishment and management of the Canberra regional office of Biosis Research Pty. Ltd. Duties included: staff and project timetabling; preparation and analysis of monthly office finances and performance statements; project management; marketing; preparation of project submissions; participation in quarterly company-wide planning and operational meetings; OH&S; staff performance reviews; and attending to other day to day business matters.

PROFESSIONAL EXPERIENCE**EXPERT TESTIMONY/PREPARATION OF EVIDENCE**

- Expert testimony and the preparation of a 'Statement of Evidence' in relation to Species Impact Statement for War Veterans Village Extension, Narrabeen. Cox Richardson P/L. NSW Land and Environment Court, March 1998.
- Preparation of a 'Statement of Evidence' for damage to Red-crowned Toadlet Habitat at Somersby, Gosford. NSW National Parks and Wildlife Service, July 1998.
- Assistance in the preparation of Affidavit for an injunction hearing for the release of tailings dam water into surrounding bushland at Timbarra Gold Mine, northern NSW. Malerah/Wahlbul N.T. Claimants. NSW Land and Environment Court, July 2000.

CONSULTING PROJECTS

The following list provides a sample of the projects in which I have been directly involved.

- Sub-consultant** Monitoring surveys for threatened grassland reptiles: Grassland Earless Dragon *Tympanocryptis pinguicolla* and Striped Legless Lizard *Delma impar*, Majura Valley ACT (2012 for SMEC)
- Sub-consultant** Vegetation monitoring for the Murrumbidgee River Googong Dam revegetation project, ACT and NSW (2012 for Bulk Water Alliance, ACTEW)
- Sub-consultant** Fauna surveys within mallee communities in western NSW. This included pit-fall trapping for ground-dwelling reptiles and small mammals, and timed bird surveys (2012 for the Australian Museum Business Services)
- Sub-consultant** Systematic targeted surveys for Golden Sun Moth *Synemon plana* at Crace Nature Reserve and Goorooyaroo Nature Reserve, ACT (2011 for ACT Government: Dept of Conservation, Planning and Research)
- Sub-consultant** Flora and fauna assessment for a proposed pipeline from Lot 372 DP 723259 to Rathmines SPS, Awaba NSW (2011 for Niche Environment and Heritage)
- Sub-consultant** Flora and fauna assessment Athllon Drive, ACT (2011 for J. Easthope & Associates / ACTPLA)
- Sub-consultant** Flora and fauna impact assessment HMAS Harman, ACT (2011 for Rudd's Engineering / Department of Defence)
- Sub-consultant** Bird surveys and habitat assessments within mallee communities in western NSW (2011 for Australian Museum Business Services)
- Sub-consultant** Supplementary vegetation condition assessment for the Murrumbidgee River to Googong Dam Water Transfer Project CEMP (2011 for Eco Logical Australia)
- Sub-consultant** Upper Murrumbidgee Catchment vegetation sampling surveys (2010-11 for NSW Department of Climate Change and Water)
- Sub-consultant** Review of Golden Sun Moth *Synemon plana* report and referral advice (2010 for Biosis Research / Village Building Co.)
- Sub-consultant** Roadside tree and vegetation condition assessment of the Lachlan Valley Way (2010 for Manidis Roberts / RTA)
- Project Manager** Roadside vegetation & habitat assessment - Bobeyan Road (2010 for Cooma-Monaro Shire Council)
- Project Manager** Roadside vegetation & habitat assessment - Badja Road (2010 for Cooma-Monaro Shire Council)
- Sub-consultant** Targeted threatened plant surveys (*Swainsona recta*) for the Murrumbidgee River to Googong Dam Water Transfer Project (2010 Eco Logical Australia)
- Project Manager** Terrestrial ecological impact assessment Enlarged Cotter Dam (2008-2009 for Bulk Water Alliance Joint Venture (ACTEW))
- Project Manager** Systematic surveys and monitoring for Golden Sun Moth at West Macgregor, ACT (2009 for Village Building Co. Ltd)
- Project Manager** Terrestrial flora and fauna impact assessment for the Murrumbidgee River to Googong Dam Water Transfer Project (2008-2009 for Bulk Water Alliance Joint Venture (ACTEW))
- Project Manager** Rapid road-side vegetation assessment and mapping trial within the Cooma-Monaro Shire (2008-2009 for Cooma-Monaro Shire Council)

- Project Manager** Targeted reptile trapping at West Macgregor, ACT (2008 for Village Building Co. Ltd)
- Project Manager** Systematic monitoring surveys for the Golden Sun Moth *Synemon plana* at Canberra Airport (2008 for Canberra International Airport)
- Project Manager** Monitoring studies for grassland reptiles for the Tralee access roads (2008 for Queanbeyan City Council)
- Project Manager** Terrestrial ecological of Block 1502 of the proposed National Zoo extension (2007 for Campbell Dion Pty Ltd)
- Project Manager** Molonglo Ecological Impact Review (2006 for ACT Planning and Land Authority)
- Project Manager** Ecological risk assessment for the 'triple bottom line' reporting for the proposed Lower Molonglo pond options (2006 for ACT Planning and Land Authority)
- Project Manager** Terrestrial ecological impact assessment for the proposed 360 kV transmission line for the Taralga Windfarm (2005 for SKM)
- Project Manager** Terrestrial and aquatic flora and fauna surveys for the proposed Pacific Highway upgrade:F3 to Raymond Terrace (2004 for Maunsell Australia Pty Ltd)
- Project Manager** Habitat assessment for emergency water supply options Goulburn (2004 for NSW Department of Commerce)
- Project Manager** Terrestrial flora and fauna assessment for the new water source options project Canberra (2004 for ACTEW Corporation)
- Project Officer** Targeted flora and fauna surveys for the F3 to Branxton Freeway (2003-4 for Roads and Traffic Authority of NSW)
- Project Officer** Targeted surveys for *Litoria brevipalmata* for the Pacific Highway upgrade: Moorelands to Herons Creek (2004 for Roads and Traffic Authority of NSW)
- Project Officer** Targeted waterbird surveys for the proposed changed flow regime within the Darling Anabranche (2003 for NSW Department of Infrastructure, Planning and Natural Resources)
- Project Manager** Targeted flora and fauna surveys for threatened species at 'Poplars' and 'Tralee', Queanbeyan (2002-3 for Queanbeyan City Council)
- Project Manager** Vegetation assessment of the Holsworthy Military Area (2002 for GHD and Department of Defence)
- Project Manager** Assessment of natural habitats and endangered ecological communities at Matraville (2002 for Sydney Ports Corporation)
- Project Manager** Flora and fauna assessment, Palm Beach (2002 for Gordon and Valich)
- Project Manager** Independent assessment of the ecological values of Kurnell Peninsula (2002 for Environment Australia)
- Project Officer** Targeted frog surveys in the upper Hunter (2002 for Roads and Traffic Authority of NSW)
- Project Manager** Assessment of public school redevelopment, Killara (2002 for Department of Public Works and Services)
- Project Manager** Assessment of Green and Golden Bell Frog *Litoria aurea* habitat at Greenacre. (2002 for Goodman Fielder)
- Project Manager** Habitat assessment for proposed rezoning Wahroonga 2002 for Urbis
- Project Manager** Flora and fauna assessment and eight part test for *Acacia pubescens*, Yennora (2002 for Prime Constructions)
- Project Officer** Dendrobium flora and fauna assessment, Illawarra Coal (2000-1 for BHP Billiton)
- Project Officer** Kurri Sand Swamp Woodland recovery assessment (2001 for NSW Roads and Traffic Authority and National Parks and Wildlife Service)
- Project Manager** Review of Environmental Factors for water pipeline maintenance: Cascades to Leura, Blue Mountains (2001 Sydney Catchment Authority)
- Project Manager** Assessment of the terrestrial, aquatic and cultural heritage for the Bate Bay Management Plan (2001 for Patterson Britton)
- Project Manager** Assessment of the natural and cultural heritage of Cooks Cove (2001 for Hassell Pty Ltd)
- Project Manager** Assessment of the distribution and abundance of *Dillwynia tenuifolia*, Londonderry (2001 for Penrith City Council)
- Project Manager** Review of Eight Part Test assessments Rouse Hill (2001 for DPWS)

- Project Manager** Terrestrial Flora and Fauna Survey and Habitat Assessment for the Proposed pump station upgrade, Hornsby (2001 for GHD)
- Project Manager** Assessment of potential Long-nosed Bandicoot *Peramales nasuta* habitat at Manly (2000)
- Project Manager** Assessment of rock outcrop habitat, Blakehurst (2000)
- Project Manager** Investigation of the movements of arboreal marsupials in relation to roads and overpass structures. (2000 for Roads and Traffic Authority of NSW)
- Project Manager** Assessment of flora and fauna habitats at 'Devils Pinch' north of Armidale. (2000 for GHD and Roads and Traffic Authority of NSW)
- Project Manager** Assessment of Bridge Refurbishment at Lycester Creek, Lismore (2000 for GHD)
- Project Manager** Assessment of Little Grassbird *Megalurus gramineus* habitat (2000 for Murrumbidgee Council)
- Project Officer** Biodiversity benchmarking survey of the Coleambally Irrigation Area and the development of management guidelines for threatened flora and fauna (1999-2000 for Coleambally Irrigation Corporation)
- Project Manager** Baseline Flora and Fauna Study for the Stage 2 Development Area 24a, Parklea (1999 for Rouse Hill Infrastructure Consortium)
- Project Manager** Ecological Assessment of Balmoral Park Creek and Surrounding Bushland, Mosman (1999 for Mosman Municipal Council)
- Project Manager** Interim Vertebrate Fauna Habitat Assessment; Duffys Forest (1999 for K. M. Harkness and Co)
- Project Manager** Terrestrial Flora and Fauna Survey and Habitat Assessment for the Proposed Water Treatment Plant at Sunset Strip, NSW (1999 for Department of Public Works and Services)
- Project Manager** Targeted Surveys for the Land Snail *Meridolum corneovirens* and Green and Golden Bell Frog *Litoria aurea* at Rouse Hill (1999 for Rouse Hill Infrastructure Consortium)
- Project Manager** Assessment of Fauna Underpasses at Two Culverts and Tree Identifications Rouse Hill (1999 for Rouse Hill Infrastructure Consortium)
- Project Manager** Flora and Fauna Habitat Assessment for the RHC Stage 2: Water, Sewerage and Drainage Infrastructure Works (1999 for Rouse Hill Infrastructure Consortium)
- Project Manager** Vertebrate Fauna Survey Middle Head and Georges Head, Sydney Harbour National Park (1999 for Root Projects Australia)
- Project Manager** Flora and Fauna Habitat Assessment of the Proposed Exclusion Fenceline Easement: Canyon Colliery near Bell (1999 for Kinhill Pty Ltd and Earth Sanctuaries)
- Project Officer** Survey of mammals, birds and herpetofauna and preparation of management plans for flora and fauna at Singleton, Albury-Wodonga and Kapooka Military Areas (1998 for Department of Defence)
- Project Officer** Targeted Flora and Fauna Investigation of the Wilton to Newcastle Gas Pipeline Easement (1998 for AGL)
- Project Officer** Redrafting of Flora and Fauna sections for the Sewerage Overflow Licensing Project EIS (1998 for Sydney Water)
- Project Officer** Fauna assessment of Goat Island (1998 Sydney Harbour National Park. NSW National Parks and Wildlife Service)
- Project Manager** Flora and Fauna Habitat Assessment for the Proposed Storage Tunnel (1997 for Sydney Water)
- Project Manager** Flora & Fauna Habitat Assessment for proposed access track & geological investigation at Bulli (1997 for Roads and Traffic Authority of NSW)
- Project Manager** Species Assessment of the Somersby Industrial Park (1997 for Gosford City Council)
- Project Officer** Species Impact Statement for War Veterans Village Extension, Narrabeen (1997 for Cox Richardson P/L)
- Project Officer** Monitoring of populations of the Green and Golden Bell Frog (*Litoria aurea*) at Homebush Bay (1996-1998 Olympic Coordination Authority)
- Project Officer** Species Impact Statement for Grosvenor Street, Wahroonga (1996 for Chanrich Properties)
- Project Officer** Habitat Assessment Tumberumba (1996 for Department of Public Works and Services)
- Project Officer** Habitat Assessment, Helensburgh (1996 for Walker Engineering)

Project Officer Hawkesbury-Nepean Catchment Biodiversity Study (1996 for NSW National Parks and Wildlife Service)

Project Officer Surveys of mammals, birds and herpetofauna for proposed Camden Haven High School at North Haven (1996 for Department of Education)

Project Officer Fauna Impact Statements for proposed forestry operations in the Urbenville Management Area and Gloucester/Chichester Management Area (1995 for State Forests)

INSURANCES

Professional Indemnity Insurance

AJC (UK) Ltd. (Lloyds of London)

Policy No: F101754

Cover: \$10,000,000

Excess: \$10,000.00

Period: 01/07/2011 - 01/07/2012

Public Liability Insurance

QBE Insurance (Australia) Limited

Policy No: 140A624360BPK

Cover: \$20,000,000

Period: 01/07/2011 - 01/07/2012

COMPUTER SKILLS

Proficient skills in the use of various Microsoft software packages, including Word, Excel and Access. Competent user of GIS software including *MapInfo* Professional and *ArcView*.

INTERESTS

Most of my off-work time is spent with family and friends. I enjoy travelling vacations; camping; and participating in ocean swimming events; attending concerts, cinema and sporting events and occasional volunteering. I also read as widely as possible and try to keep up with contemporary social and environmental issues.

ASSOCIATIONS

- Environmental Institute of Australia and New Zealand (EIANZ)
- Australian Network for Plant Conservation
- World Wildlife Fund for Nature
- Canberra Ornithologists Group

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Additions to Awaba Waste Management Facility

Appendix K

Biodiversity Offset Report




LOT 372 - AWABA LANDFILL SITE

Offsetting Assessment Report

August 2012

DOCUMENT CONTROL

Business Unit	Niche Environment and Heritage, Central Coast/Hunter		
Project No.	1230		
Document Description	Awaba Landfill Site - Offset Report		
	Name	Signed	Date
Supervising Manager(s)	Rhidian Harrington		27 August 2012

Person managing this document	Person(s) writing this document
Rhidian Harrington	Nathan Smith

External Review	Mr Chris Holloway: Senior Environmental Scientist, Cardno, Level 3, 910 Pacific Highway, Gordon, NSW 2072 Mr David Lovell, Lake Macquarie City Council
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Document Status	Date
Rev 5	27 August 2012

Prepared for:	Organisation
Mr Kester Boardman	Cardno, Level 3, 910 Pacific Highway, Gordon NSW 2072

Front Cover Photograph: *Tetratheca juncea*

EXECUTIVE SUMMARY

Niche Environment and Heritage Pty Ltd (Niche) was commissioned by Cardno to conduct an offsetting assessment to determine the requirements for the proposed Awaba Waste Disposal Facility extension project at Lot 372 (DP 723259), Awaba. The proposed development is being carried out under Part 3A of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) and is subject to a consent being granted by the Minister. The impacts of the development were assessed in Forest Fauna et al (2011a) as unavoidable residual impacts and therefore required the development proposal to be offset.

For the purposes of estimating the offsetting requirement for the project, Niche utilised the *BioBanking Assessment Methodology (BBAM, DECCW 2009)*. The offsetting report describes the following scenarios which were run in the BioBanking Credit Calculator Version 2.0:

- ❑ Development Site - part of Lot 372, (DP 723259);
 - 7.2 hectare impact on native vegetation. The whole of the development area covers 8.55 hectares (Forest Fauna et al 2011a), 1.35 hectares of which is non-assessable land under the *BBAM*,
 - Removal of 2,302 *Tetratheca juncea* individuals (threatened species),
- ❑ Proposed Awaba BioBank Site (Offset Site) - part of Lots 372 and 373 (DP 723259);
 - In-perpetuity conservation and management of 34.36 hectares of native vegetation,
 - In-perpetuity conservation and management of 11,632 *Tetratheca juncea* individuals, and
 - In-perpetuity conservation and management of additional known populations of the threatened plant species *Acacia bynoeana*, *Angophora inopina* and *Grevillea parviflora* subsp. *parviflora*.

Niche conducted the assessments of both the Development Site (Lot 372) and the proposed BioBank Site (part of Lot 372 and part of Lot 373) using data from previous on-site threatened flora and fauna field surveys conducted by Forest Fauna et al (2011a and 2011b) and from BioBanking plot data collected by Niche.

LMCC have committed to following the BioBanking pathway for the approval of this development and thus retiring the required types and numbers of Biodiversity Credits in order to offset the proposal.

The result of the BioBanking assessment of the Lot 372 Development Site was that 392 Ecosystem Credits and 33,853 *Tetratheca juncea* Species Credits were required to offset the Lot 372 proposal. No other threatened flora or fauna require the retirement of Species Credits.

The proposed Awaba BioBank Site would generate 180 Ecosystem Credits in total, including 153 Ecosystem Credits of the two vegetation types impacted on Lot 372. Therefore, a further 239 Ecosystem Credits (392 less 153) of the required vegetation types will need to be sourced in order to offset the proposed development. LMCC have committed to the sourcing of these credits and will retire Ecosystem Credits from secured offsets prior to the commencement of works on-site.

In terms of Species Credits the proposed Awaba BioBank Site generates the following:

- ❑ 408 *Acacia bynoeana* credits (conservation of 68 individuals);
- ❑ 948 *Angophora inopina* credits (conservation of 158 individuals);
- ❑ 5,292 *Grevillea parviflora* subsp. *parviflora* credits (conservation of 882 individuals); and
- ❑ 69,792 *Tetratheca juncea* credits (conservation of 11,632 individuals).

It is therefore possible for the Lot 372 development to achieve an improve or maintain outcome for *Tetratheca juncea* through the retirement of Species Credits, with an excess of 35,939 Species Credits (69,792 less 33,853) available for future purposes. Species Credits for *Acacia bynoeana*, *Angophora inopina* and *Grevillea parviflora* subsp. *parviflora* would also be retained for future use by LMCC.

Recommendations

The following recommendations have been made in anticipation of Conditions of Consent from the Department of Planning and Infrastructure (DoPI) and a Statement of Commitments from LMCC:

1. Finalise the BioBanking Statement for the Lot 372 Development Site and the BioBanking Agreement for the proposed Awaba BioBank Site;
2. LMCC will secure an offset site in addition to the proposed Awaba BioBank Site in order to retire the required credits. Such a site will be secured prior to works commencing on the development site;
3. As a component of finalising the BioBank Agreement at both BioBank Sites, LMCC will provide DoPI with BioBank Site Management Plans that commit the proposed offsets to in-perpetuity management and a fund deposit

calculated on this basis. The required management actions will be determined in consultation with OEH; and

4. Upon establishment of the Awaba BioBank Site and additional BioBank Site, 392 Ecosystem Credits of the required vegetation types and 33,853 *Tetratheca juncea* Species Credits, will be retired within the BioBanking Scheme.

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1 INTRODUCTION

1.1 Background

Niche Environment and Heritage Pty Ltd (Niche) was commissioned by Cardno to conduct an offsetting assessment to determine the requirements for the proposed Awaba Waste Facility extension project at Lot 372 (DP 723259), Awaba. The Awaba Waste Facility is operated by Lake Macquarie City Council (LMCC) but Council do not currently own the site.

The proposed development is being carried out under Part 3A of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) and is subject to a consent being granted by the Minister. Development proposals in NSW (under Part 3A or otherwise) are subject to the 'Improve or Maintain' principle in respect to impacts on threatened biodiversity as listed on the NSW *Threatened Species Conservation Act 1995* (TSC Act). Under this principle, all residual impacts (after avoidance and mitigation measure) are subject to in-perpetuity offsetting under improve or maintain management.

The total impact of the project amounts to the removal of 7.2 hectares of native vegetation. None of this native vegetation is aligned to either a national or state listed endangered ecological community (EEC), however the threatened plant *Tetratheca juncea* will be impacted by the proposal. These impacts were assessed in Forest Fauna et al (2011a) as unavoidable residual impacts and therefore required the development proposal to be offset.

For the purposes of estimating the offsetting requirement for the project, Niche utilised the *BioBanking Assessment Methodology (BBAM, DECCW 2009)*. The results of a BioBanking Assessment are expressed as the number of biodiversity credits required to be retired by a Development Site and the number of credits generated and available for retirement at a BioBank site.

The *BBAM* was initially utilised as a guide to calculate the offset requirement for the Lot 372 Development Site. However, as a result of the adequacy review of the initial EA from Planning and also OEH, and from discussions between Niche, Cardno and LMCC, it was decided that the BioBanking pathway would be pursued as the mechanism for approval in this instance. As such, this report does not constitute a full BioBanking Assessment Report for the purposes of accompanying the application for a BioBanking Statement. The report summarises the assessment of the Development Site (Lot 372) and the proposed Awaba BioBank Site to date, such that a commitment to the retirement of the required types and number of Biodiversity Credits can be made. Such a commitment by LMCC will be provided in a Statement of Commitments, prior to works commencing on Lot 372.

The full BioBanking Assessment Reports for both the Development Site and proposed Awaba BioBank Site will be provided to the OEH BioBanking Team upon finalisation.

Nathan Smith (Botanist) supervised all assessments and the use of the BioBanking Credit Calculator and Dr Rhidian Harrington (Director and Senior Ecologist) provided additional expertise and review. Both Nathan and Rhidian are Accredited BioBanking Assessors and their respective CVs are provided in Appendix E.

1.2 Definitions and Abbreviations

Biodiversity Credits - Ecosystem and Species Credits collectively, as defined under the BioBanking Scheme.

BBAM - BioBanking Assessment Methodology.

EEC - Endangered Ecological Community

EP&A Act - *NSW Environmental Planning and Assessment Act 1979*

EPBC Act - *Commonwealth Environment Protection and Biodiversity Conservation Act 1999*

OEH - NSW Office of Environment and Heritage (previously DECCW)

TSC Act - *NSW Threatened Species Conservation Act 1995*

1.3 Purpose of this Report

This report describes the following scenarios as run in the BioBanking Credit Calculator Version 2.0 since the commencement of the assessment in June 2011, and considers comments provided in the adequacy review of the previous EA submitted to Planning and relates to the areas represented in Figure 2:

- Development Site - part of Lot 372, (DP 723259); and
- Proposed Awaba BioBank Site (Offset Site) - part of Lots 372 and 373 (DP 723259).

Additional scenarios for a proposed Lot 373 Development Site (the proposed Awaba Waste Treatment Facility, AWTF) and a Lot 371 Offset Site, were also investigated, however these were conducted in order to provide LMCC with information for the purposes of planning advice and will not be mentioned further in this report. LMCC is currently undertaking investigations to secure the additional offset lands that will be required to satisfy the Ecosystem Credit shortfall and, as such, the Biobanking Assessment of such a site cannot be provided here.

1.4 Objectives of this Assessment

The specific objectives of this assessment are to provide:

- ❑ An assessment of the Biodiversity Credit requirement of the proposed development utilising the *BioBanking Assessment Methodology and Credit Calculator Operational Manual* (DECC 2009a);
- ❑ An assessment of the Biodiversity Credits created by the proposed Awaba BioBank Site, also in accordance with the *BBAM*; and
- ❑ Based on the BioBanking Credit Calculator results for the Development and Offset Sites, outline the suitability of retiring Biodiversity Credits for the impacts on Lot 372.

1.5 Description of the study area

A full description of the study area is contained in Forest Fauna et al (2011a and 2011b). The location of the study area in a regional context is provided in Figure 1.

The Lot 372 Development Site and the proposed Awaba BioBank Site are illustrated in Figure 2. Figure 2 also illustrates the future Alternative Waste Treatment Facility (AWTF) within the confines of Lot 373. The potential impacts of the AWTF site on biodiversity are subject to a separate development application and are not assessed in this report.

Forest Fauna et al (2011a) nominates an area of 8.55 hectares that will be impacted by the development area. Niche Environment and Heritage used GIS to clip the vegetation, as mapped by East Coast Flora Surveys within the Forest Fauna report, to the development area. The resultant vegetation calculations are provided in Table 2 and amount to 7.2 hectares of native vegetation that must be offset as Ecosystem Credits. The remaining 1.35 hectares is not required to be offset under the *BBAM* as it does not meet the required condition thresholds (e.g., existing cleared lands, access roads or areas dominated by exotic vegetation).

1.6 Limitations

Whilst this assessment does not constitute a BioBanking Assessment Report for the purposes of establishing a BioBank Statement or Agreement, it has been provided on the assumption that an application for such a Statement (Development Site) and the associated Agreement (BioBank Site) will be submitted to the OEH BioBanking Team for approval prior to works commencing on the Lot 372 site. This will be provided within the Statement of Commitments that accompanies the EA.

Given the respective sizes of the Development Site and the proposed Awaba BioBank Site, and the volume of BioBanking site attribute data used in the assessment, it is anticipated that the credit calculations are an adequate indication of the Biodiversity Credits required to offset the development of Lot 372 and of the number of Biodiversity Credits generated on the proposed Awaba BioBank Site.

2 SURVEY METHODOLOGY AND RESULTS

2.1 Previous Surveys

Two previous ecological assessments relevant to Lots 372 and 373 have been conducted by Forest Fauna et al (2011a and 2011b). The following summarises the key findings of these reports in relation to the offsetting of the impacts for Lot 372.

2.2 Vegetation Mapping and Alignment

Appendix A contains an alignment and summary of the native vegetation within the study area from Forest Fauna (2011a and 2011b). The vegetation types mapped by Forest Fauna were derived from site-specific surveys conducted by Stephen Bell and his subsequent floristic analysis. Niche have not altered this mapping at all, except to convert (Appendix A and Figure 5), as close as is possible the Forest Fauna vegetation types to Revised Biometric Vegetation Types (RBVTs) which are required in NSW for use in the *BBAM* and Credit Calculator. It is not possible to conduct BioBanking credit calculations without such a conversion.

Appendix B lists the BioBanking plot data that has been collected by Niche within the study area. The locations of these plots are represented in Figure 6. The number of plots required by the *BBAM* has been satisfied.

2.3 Lot 372 Impacts on Biodiversity

These surveys concluded that approximately 7.2 hectares of native vegetation and 2,302 *Tetratheca juncea* individuals would be removed by the Lot 372 development proposal. No other threatened species would be impacted by the proposal.

2.4 The Awaba BioBank Site

The proposed Awaba BioBank Site is comprised of part of Lot 372 and part of Lot 373 and amounts to a total of 34.36 hectares of native vegetation of which 29.22 hectares is comprised of the two vegetation types that must be offset for the development of Lot 372. The local populations of the following threatened plants is contained within the proposed BioBank Site:

- ❑ 68 *Acacia bynoeana* individuals;
- ❑ 158 *Angophora inopina* individuals;
- ❑ 882 *Grevillea parviflora* subsp. *parviflora* individuals; and
- ❑ 11,632 *Tetratheca juncea* individuals.

3 BIOBANKING ASSESSMENT - LOT 372 DEVELOPMENT SITE

This section outlines each of the required steps and the assumptions made to produce the Lot 372 Development Site Credit Report (Appendix C).

3.1 Landscape Assessment Circles and Connectivity Assessment

A single 1000 ha Assessment Circle and a 100 ha circle was used to assess the impact of proposals on the surrounding vegetation cover at a landscape and local scale (Figure 4). The 100 ha circle was centred on the area of greatest change. The entries at are shown in Table 1.

Table 1. Lot 372 Landscape Assessment

Stage/Item	Entry	
Opening Page		
CMA	Hunter/Central Rivers	
Mitchell Landscape	Gosford - Cooranbong Coastal Slopes	
Assessment Circles		
Assessment Circle Number/Name	A	
CMA Subregion	Wyang	
	Before development	After development
% Native Vegetation Cover in 1000ha Circle	81-90%	81-90 %
% Native Vegetation Cover in 100ha Circle	71-80%	61-70%
Connectivity Width	>500m	>500m
Over-storey Connectivity Condition	Over-storey condition: PFC at BM	Over-storey condition: PFC at BM
Mid-storey or ground cover Connectivity Condition	PFC of mid-storey/ground cover at BM	PFC of mid-storey/ground cover at BM

The amount of vegetation within the 1,000 hectare and 100 hectare assessment circles for both the Development Sites and the Offset Sites was assessed by using ArcMAP to clip areas of non vegetated land in the aerial photography from those clearly vegetated within each Circle. As a result of the proposal, vegetation cover dropped from approximately 855 hectares to 848 hectares within the 1000 hectare Circle (85.5 per cent to 84.8 per cent) and from approximately 76 hectares to 69 hectares within the 100 hectare Circle (76 per cent to 69 per cent).

The connectivity assessment was conducted for the proposal using the technique outlined in the *Operational Manual* (DECC 2009). The following aspects were considered:

- ❑ The width of the current and future connecting link; and
- ❑ The condition of the current and future connecting link (over-storey and mid-storey/ground cover).

The main connecting link through Lot 372 can be considered to be to either the north or the south of the development proposal and is connected to vegetation with a connectivity width of more than 500 metres. The Landscape Value was calculated at 12.50.

3.2 Vegetation Zones

Two vegetation Zones were defined within the Lot 372 development site (Figure 6). These are in Moderate to Good BioBanking condition. Table 2 includes the total figures for each Vegetation Zone within the study area. Revised Biometric Vegetation Types were used to define each vegetation zone.

Table 2. Vegetation Zones on the Lot 372 Development Site

Vegetation Zone	RBVT	Keith Formation	Area (ha)	Patch Size (ha)	Adjacent Remnant Area (ha)
HU621_Moderate/Good	Smooth-barked Apple - Red Bloodwood open forest on coastal plains on the Central Coast, Sydney Basin	Dry sclerophyll forests (shrubby sub-formation)	2.16	501.00	501.00
HU610_Moderate/Good	Scribbly Gum - Red Bloodwood heathy woodland on the coastal plains of the Central Coast, Sydney Basin		5.04	501.00	501.00
Total Native Vegetation requiring offsetting			7.20		
Land not requiring offsets (e.g., cleared or exotic areas)			1.35		
TOTAL Development Area			8.55		

3.3 Geographic and Habitat Features

The geographic and habitat features for threatened species at Step 2 of the Credit Calculator for the Lot 372 Development Site is presented in Table 3.

Table 3. Lot 372 Geographic and Habitat Questions

Common name	Scientific name	Feature	Potential Habitat
Grey-headed Flying-fox (Breeding)	<i>Pteropus poliocephalus</i>	Land within 40 m of rainforest, coastal scrub, riparian or estuarine communities	No
Little Bentwing-bat (Breeding)	<i>Miniopterus australis</i>	Land containing caves or similar structures	No
Eastern Bentwing-bat (Breeding)	<i>Miniopterus schreibersii oceanensis</i>	Land containing caves or similar structures	No
Large-footed Myotis (Breeding)	<i>Myotis macropus</i> (formally <i>Myotis adversus</i>)	Hollow-bearing trees, bridges, caves or artificial structures within 200 m of riparian zone	No
Large-eared Pied Bat (Breeding)	<i>Chalinolobus dwyeri</i>	Land containing escarpments, cliffs, caves, deep crevices, old mine shafts or tunnels	No
Large-eared Pied Bat	<i>Chalinolobus dwyeri</i>	Land containing escarpments, cliffs, caves, deep crevices, old mine shafts or tunnels	No
Heath Wrinklewort	<i>Rutidosia heterogama</i>	Heath on sandy soils, or moist areas in open forest	Yes
Giant Burrowing Frog	<i>Heleioporus australiacus</i>	Land within 40 m of heath, woodland or forest with sandy or friable soils	Yes
Pale-headed Snake	<i>Hoplocephalus bitorquatus</i>	Land within 40 m of watercourses, containing hollow-bearing trees, loose bark and/or fallen timber	No
Broad-headed Snake	<i>Hoplocephalus bungaroides</i>	Land within 50 m of sandstone escarpments with hollow-bearing trees, rock crevices or flat sandstone rocks on exposed cliff edges	Yes
Osprey	<i>Pandion haliaetus</i>	Land within 40 m of fresh/brackish/saline waters of larger rivers or creeks; estuaries, coastal lagoons, lakes and/or inshore marine waters	No
Brush-tailed Rock-wallaby	<i>Petrogale penicillata</i>	Land within 1 km of rock outcrops or cliffines	Yes
Common Planigale	<i>Planigale maculata</i>	Rainforest, eucalypt forest, heathland, marshland, grassland or rocky areas	Yes
Green-thighed Frog	<i>Litoria brevipalmata</i>	Land within 100 m of semi-permanent or ephemeral ponds or depressions containing leaf litter	Yes
Maundia triglochinos	<i>Maundia triglochinos</i>	Swamps or shallow fresh water on clay	No
<i>Eucalyptus oblonga</i> (Narrow-leaved Stringybark) population at Bateau Bay	<i>Eucalyptus oblonga</i> - endangered population	Land within Bateau Bay in Wyong CMA subregion	No
Caladenia porphyrea	<i>Caladenia porphyrea</i>	Grows in coastal sclerophyll forest on sandy soils.	Yes
Charmhaven Apple	<i>Angophora inopina</i>	Land within 5 km of Wallaroo Nature Reserve in Upper Hunter CMA subregion	No

3.4 Assess for Identified Populations

No 'identified populations' as defined by the BioBanking Methodology are relevant to the Development Site.

3.5 Undertake Site Survey

This component outlines the threatened species that are not predicted within the Ecosystem Credits on the site. The list is for those threatened species that would require retirement of Species Credits if present on the Development Site or, could earn Species Credits if present on the Offset Site. The results of Step 4 for both the Development Sites is provided below.

Common Name	Scientific Name
Bynoe's Wattle	<i>Acacia bynoeana</i>
Thick-leaf Star-hair	<i>Astrotricha crassifolia</i>
Caladenia porphyrea	<i>Caladenia porphyrea</i>
Netted Bottlebrush	<i>Callistemon linearifolius</i>
Gang-gang Cockatoo	<i>Callocephalon fimbriatum</i>
Leafless Tongue Orchid	<i>Cryptostylis hunteriana</i>
Rough Double Tail	<i>Diuris praecox</i>
Camfield's Stringybark	<i>Eucalyptus camfieldii</i>
Variable Midge Orchid	<i>Genoplesium insignis</i>
Small-flower Grevillea	<i>Grevillea parviflora</i> subsp. <i>parviflora</i>
Giant Burrowing Frog	<i>Heleioporus australiacus</i>
Little Eagle	<i>Hieraaetus morphnoides</i>
Broad-headed Snake	<i>Hoplocephalus bungaroides</i>
Green-thighed Frog	<i>Litoria brevipalmata</i>
Square-tailed Kite	<i>Lophoictinia isura</i>
Grove's Paperbark	<i>Melaleuca groveana</i>
CommonName	ScientificName
Brush-tailed Rock-wallaby	<i>Petrogale penicillata</i>
Brush-tailed Phascogale	<i>Phascogale tapoatafa</i>
Common Planigale	<i>Planigale maculata</i>
Cut-leaf Mint-bush	<i>Prostanthera askania</i>
Eastern Chestnut Mouse	<i>Pseudomys gracilicaudatus</i>
Heath Wrinklewort	<i>Rutidosia heterogama</i>
Tetradlea glandulosa	<i>Tetradlea glandulosa</i>
Black-eyed Susan	<i>Tetradlea juncea</i>

3.6 Site Survey Data

The BioBanking Methodology requires field survey to be undertaken on-site to accurately calculate credits. The field survey consisted of:

- Ecosystem Credits - 50 x 20 metre plots/transects to sample vegetation zones (mandatory on BioBank sites); and

- Species Credits - Targeted threatened species survey for threatened species identified by the credit calculator.

3.6.1 Plots

On Lot 372 a total of 5 plots were required, all of which were conducted (Table 4).

Table 4. Plots completed by vegetation type - Development Sites

Vegetation Zone	RBVT	Area (ha)	Plots Required	Plots Completed
HU621_Moderate/Good	Smooth-barked Apple - Red Bloodwood open forest on coastal plains on the Central Coast, Sydney Basin	2.16	2	2
HU610_Moderate/Good	Scribbly Gum - Red Bloodwood heathy woodland on the coastal plains of the Central Coast, Sydney Basin	5.04	3	3

Plots were supervised by Nathan Smith and Rhidian Harrington, Accredited BioBanking Assessors. Plot data has been provided in Appendix B for each of the sites mapped in Figure 6.

3.6.2 Management Zone Attribute Scores

A single Management Zone was selected per Threatened Species Sub-zone.

The default decrease in site score allowed by the Calculator was accepted for all management zones within the Lot 372 Development Site.

3.6.3 Threatened Species Survey Results

The number of *Tetratheca juncea* individuals, the only threatened species affected by the proposal was entered. 2,302 individuals must be offset (Forest Fauna et al 2011a).

3.7 BioBanking Credit Calculations

The BioBanking Credit Report for the Lot 372 Development Site is provided in Appendix C and summarised below.

3.7.1 Ecosystem Credits

A summary of the Ecosystem Credits required to be retired by the Lot 372 Development Site is provided in Table 5.

Table 5. Lot 372 Development Site Credit Calculations

Vegetation Zone Name	RBVT	Area	Ecosystem Credits Required
HU610_Moderate/Good	Scribbly Gum - Red Bloodwood heathy woodland on the coastal plains of the Central Coast, Sydney Basin	5.04	260
HU621_Moderate/Good	Smooth-barked Apple - Red Bloodwood open forest on coastal plains on the Central Coast, Sydney Basin	2.16	132

3.7.2 Species Credits

As stated in the Credit Report for the Lot 372 Development Site (Appendix C), 33,853 *Tetratheca juncea* Species Credits are required to offset the impact of removing 2,302 individuals.

4 BIOBANKING ASSESSMENT - PROPOSED AWABA BIOBANK SITE

This section outlines each of the required steps and the assumptions made to produce the proposed Awaba BioBank Site Credit Report (Appendix D).

4.1 Landscape Assessment Circles and Connectivity Assessment

The Landscape Assessment Circle and Connectivity Assessment for the proposed Awaba BioBank Site is shown in Table 6.

Table 6. Landscape assessment for proposed Awaba BioBank Site

Stage/Item	Entry	
Opening Page		
CMA	Hunter/Central Rivers	
Mitchell Landscape	Gosford - Cooranbong Coastal Slopes	
Step 1a - Assessment Circles		
Assessment Circle Number/Name	A	
CMA Subregion	Wyang	
	Before development	After development
% Native Vegetation Cover in 1000ha Circle	81-90%	81-90 %
% Native Vegetation Cover in 100ha Circle	61-70%	61-70%
Connectivity Width	100m – 500 m	100m – 500m
Over-storey Connectivity Condition	Over-storey condition: PFC at BM	Over-storey condition: PFC at BM
Mid-storey or ground cover Connectivity Condition	PFC of mid-storey/ground cover at BM	PFC of mid-storey/ground cover at BM

The amount of vegetation within the 1,000 hectare and 100 hectare assessment circles for both the Development Sites and the Offset Sites was assessed by using ArcMAP to clip areas of non tree-covered land in the aerial photography from those clearly vegetated within each Circle. As a result of this analysis, approximately 842 hectares of native vegetation tree cover was present within the 1000 hectare Circle (84.2 per cent) and 63 hectares in the 100 hectare Circle (63 per cent). It is not anticipated that native vegetation cover within each of the Circles will increase through management of the BioBank Site.

The connectivity assessment was conducted for the proposal using the technique outlined in the Operational Manual (DECC 2009). The following aspects were considered:

- The width of the current and future connecting link;

- The condition of the current and future connecting link (over-storey and mid-storey/ground cover).

The main connecting link through the proposed Awaba BioBank Site is considered to exist across the northern portion of Lot 373 and into the Adjacent Remnant Area. At this location, the link is between 100 and 500 metres wide and is not likely to be increased through the management of the BioBank Site as it exists largely off-site.

The Landscape Value was calculated at 12.00.

4.2 Vegetation Zones

Four Vegetation Zones were defined within the proposed Awaba BioBank Site (Figure 6). These were all in Moderate to Good BioBanking condition. Table 7 includes the total figures for each Vegetation Zone within the study area. Revised Biometric Vegetation Types were used to define each vegetation zone.

Table 7. Vegetation Zones on the proposed Awaba BioBank Site

Vegetation Zone	Condition	RBVT	Keith Formation	Area (ha)	Patch Size (ha)	Adjacent Remnant Area (ha)
4	HU508_Moderate/Good	Blackbutt - Pink Bloodwood shrubby open forest of the coastal lowlands of the North Coast	Wet Sclerophyll Forests (shrubby sub-formation)	4.85	501.00	501.00
3	HU610_Moderate/Good	Scribbly Gum - Red Bloodwood heathy woodland on the coastal plains of the Central Coast, Sydney Basin		10.01	501.00	501.00
2	HU621_Moderate/Good	Smooth-barked Apple - Red Bloodwood open forest on coastal plains on the Central Coast, Sydney Basin	Dry sclerophyll forests (shrubby sub-formation)	19.21	501.00	501.00
1	HU622_Moderate/Good	Smooth-barked Apple - Sydney Peppermint - Turpentine heathy open forest on plateau areas of the southern Central Coast, Sydney Basin		0.29	501.00	501.00

4.3 Geographic and Habitat Features

The geographic and habitat features for the proposed Awaba BioBank Site are presented in Table 8.

Table 8. Proposed Awaba BioBank Site Geographic and Habitat Questions

Common name	Scientific name	Feature	Potential Habitat (Y/N)
Grey-headed Flying-fox (Breeding)	<i>Pteropus poliocephalus</i>	Land within 40 m of rainforest, coastal scrub, riparian or estuarine communities	N
Biconvex Paperbark	<i>Melaleuca biconvexa</i>	Swamps, swamp margins or creek edges	N
Little Bentwing-bat (Breeding)	<i>Miniopterus australis</i>	Land containing caves or similar structures	N
Eastern Bentwing-bat (Breeding)	<i>Miniopterus schreibersii oceanensis</i>	Land containing caves or similar structures	N
Stuttering Barred Frog	<i>Mixophyes balbus</i>	Rainforest or tall open wet forest with understorey and/or leaf litter and within 100 m of streams	N
Giant Barred Frog	<i>Mixophyes iteratus</i>	Land below 1000 m in altitude and within 40 m of rainforest or eucalypt forest with deep leaf litter	Y
Large-footed Myotis (Breeding)	<i>Myotis macropus</i> (formally <i>Myotis adversus</i>)	Hollow-bearing trees, bridges, caves or artificial structures within 200 m of riparian zone	N
Large-eared Pied Bat (Breeding)	<i>Chalinolobus dwyeri</i>	Land containing escarpments, cliffs, caves, deep crevices, old mine shafts or tunnels	N
Large-eared Pied Bat	<i>Chalinolobus dwyeri</i>	Land containing escarpments, cliffs, caves, deep crevices, old mine shafts or tunnels	N
Pale-headed Snake	<i>Hoplocephalus bitorquatus</i>	Land within 40 m of watercourses, containing hollow-bearing trees, loose bark and/or fallen timber	N
Osprey	<i>Pandion haliaetus</i>	Land within 40 m of fresh/brackish/saline waters of larger rivers or creeks; estuaries, coastal lagoons, lakes and/or inshore marine waters	N
Common Planigale	<i>Planigale maculata</i>	Rainforest, eucalypt forest, heathland, marshland, grassland or rocky areas	Y
Green-thighed Frog	<i>Litoria brevipalmata</i>	Land within 100 m of semi-permanent or ephemeral ponds or depressions containing leaf litter	Y
Red Helmet Orchid	<i>Corybas dowlingii</i>	Sheltered areas such as gullies and southerly slopes in tall open forest on well-drained gravelly soil at elevations of 10-200 m	Y
Charmhaven Apple	<i>Angophora inopina</i>	Land within 5 km of Wallaroo Nature Reserve in Upper Hunter CMA subregion	N
Heath Wrinklewort	<i>Rutidosis heterogama</i>	Heath on sandy soils, or moist areas in open forest	Y
Giant Burrowing Frog	<i>Heleioporus australiacus</i>	Land within 40 m of heath, woodland or forest with sandy or friable soils	Y
Broad-headed Snake	<i>Hoplocephalus bungaroides</i>	Land within 50 m of sandstone escarpments with hollow-bearing trees, rock crevices or flat sandstone rocks on exposed cliff edges	Y
Brush-tailed Rock-wallaby	<i>Petrogale penicillata</i>	Land within 1 km of rock outcrops or cliffines	Y
<i>Maundia triglochinosoides</i>	<i>Maundia triglochinosoides</i>	Swamps or shallow fresh water on clay	N
<i>Eucalyptus oblonga</i> (Narrow-leaved Stringybark) population at Bateau Bay	<i>Eucalyptus oblonga</i> - endangered population	Land within Bateau Bay in Wyong CMA subregion	N
Caladenia porphyrea	<i>Caladenia porphyrea</i>	Grows in coastal sclerophyll forest on sandy soils.	N
Rosenberg's Goanna	<i>Varanus rosenbergi</i>	Land within 250 m of termite mounds or rock outcrops	Y

Common name	Scientific name	Feature	Potential Habitat (Y/N)
Eastern Cave Bat (Breeding)	<i>Vespadelus troughtoni</i>	Land containing escarpments, cliffs, caves, deep crevices, old mine shafts or tunnels	Y
Somersby Mintbush	<i>Prostanthera junonis</i>	Land containing Somersby or Sydney Town soil landscapes	N
Red-crowned Toadlet	<i>Pseudophryne australis</i>	Heath or eucalypt forest on sandstone with a build-up of litter or other debris and containing, or within 40 m of, ephemeral or intermittent drainage lines	Y
Green and Golden Bell Frog	<i>Litoria aurea</i>	Land within 100 m of emergent aquatic or riparian vegetation	N
Littlejohn's Tree Frog	<i>Litoria littlejohni</i>	Land within 100 m of permanent rocky streams with thick fringing vegetation	N
Wallum Froglet	<i>Crinia tinnula</i>	Land within 40 m of swamps, wet or dry heaths or sedge grasslands	N
Comb-crested Jacana	<i>Irediparra gallinacea</i>	Land within 40 m of permanent wetlands with a good surface cover of floating vegetation	N
Black Bittern	<i>Ixobrychus flavicollis</i>	Land within 40 m of freshwater and estuarine wetlands, in areas of permanent water and dense vegetation or emergent aquatic vegetation	N
Black-necked Stork	<i>Ephippiorhynchus asiaticus</i>	Land within 40 m of freshwater or saline wetlands (e.g. saltmarsh, mangroves, mudflats, swamps, billabongs, floodplains, watercourse pools, wet heathland and/or farm dams)	N
<i>Eucalyptus parramattensis</i> subsp. <i>decadens</i>	<i>Eucalyptus parramattensis</i> subsp. <i>decadens</i>	Land within northern section of sub-region, associated with poorly drained sand deposits within 10km radius of Kurri Kurri in Wyong CMA subregion	N

4.4 Assess for Identified Populations

No 'identified populations' as defined by the BioBanking Methodology are relevant to the Offset Site.

4.5 Undertake Site Survey

This component outlines the threatened species that are not predicted within the Ecosystem Credits on the site. The list is for those threatened species that could earn Species Credits if present on the proposed Awaba BioBank Site. The results for the proposed Awaba BioBank Site are provided below.

Common Name	Scientific Name
Bynoe's Wattle	<i>Acacia bynoeana</i>
Thick-leaf Star-hair	<i>Astrotricha crassifolia</i>
Caladenia porphyrea	<i>Caladenia porphyrea</i>
Netted Bottlebrush	<i>Callistemon linearifolius</i>
Gang-gang Cockatoo	<i>Callocephalon fimbriatum</i>
Red Helmet Orchid	<i>Corybas dowlingii</i>
Leafless Tongue Orchid	<i>Cryptostylis hunteriana</i>

Common Name	Scientific Name
Rough Double Tail	<i>Diuris praecox</i>
Camfield's Stringybark	<i>Eucalyptus camfieldii</i>
Variable Midge Orchid	<i>Genoplesium insignis</i>
Small-flower Grevillea	<i>Grevillea parviflora</i> subsp. <i>parviflora</i>
Giant Burrowing Frog	<i>Heleioporus australiacus</i>
Little Eagle	<i>Hieraaetus morphnoides</i>
Pale-headed Snake	<i>Hoplocephalus bitorquatus</i>
Green-thighed Frog	<i>Litoria brevipalmata</i>
Square-tailed Kite	<i>Lophoictinia isura</i>
Parma Wallaby	<i>Macropus parma</i>
Grove's Paperbark	<i>Melaleuca groveana</i>
Giant Barred Frog	<i>Mixophyes iteratus</i>
Brush-tailed Rock-wallaby	<i>Petrogale penicillata</i>
Brush-tailed Phascogale	<i>Phascogale tapoatafa</i>
Common Planigale	<i>Planigale maculata</i>
Cut-leaf Mint-bush	<i>Prostanthera askania</i>
Eastern Chestnut Mouse	<i>Pseudomys gracilicaudatus</i>
Heath Wrinklewort	<i>Rutidosis heterogama</i>
<i>Tetralthea glandulosa</i>	<i>Tetralthea glandulosa</i>
Black-eyed Susan	<i>Tetralthea juncea</i>

4.6 Site Survey Data

The *BBAM* requires field survey to be undertaken on-site to accurately calculate credits. The field survey consisted of:

- Ecosystem Credits - 50 x 20 metre plots/transects to sample vegetation zones (mandatory on BioBank sites); and
- Species Credits - Targeted threatened species survey for threatened species identified by the credit calculator.

4.6.1 Plots

BioBanking Plot data was collected by Niche for nine of the ten attributes, as near as possible to the sites of the Forest Fauna (2011a and 2011b) floristic plots, and the score for the tenth attribute, Native Plant Species Richness, was derived from the original Forest Fauna floristic plots. Plot data has been provided in Appendix B for each of the sites mapped in Figure 6.

4.6.2 Management Zone Attribute Scores

A single Management Zone was selected per Threatened Species Sub-zone.

The default increase in site score allowed by the Calculator was accepted for all management zones within the proposed Awaba BioBank Site.

4.6.3 Threatened Species Survey Results

Four threatened species were detected on the proposed Awaba BioBank Site:

- 68 *Acacia bynoeana* individuals;
- 158 *Angophora inopina* individuals;
- 882 *Grevillea parviflora* subsp. *parviflora* individuals; and
- 11,632 *Tetratheca juncea* individuals.

4.7 BioBanking Credit Calculations

The BioBanking Credit Report for the proposed Awaba BioBank Site is provided in Appendix D and summarised below.

4.7.1 Ecosystem Credits

A summary of the credits created by the proposed Awaba BioBank Site is provided in Table 9.

Table 9. Proposed Awaba BioBank Site Ecosystem Credit Calculations

Vegetation Zone	RBVT	Area (ha)	Ecosystem Credits Created
HU508_Moderate/Good	Blackbutt - Pink Bloodwood shrubby open forest of the coastal lowlands of the North Coast	4.85	25
HU610_Moderate/Good	Scribbly Gum - Red Bloodwood heathy woodland on the coastal plains of the Central Coast, Sydney Basin	10.01	67
HU621_Moderate/Good	Smooth-barked Apple - Red Bloodwood open forest on coastal plains on the Central Coast, Sydney Basin	19.21	86
HU622_Moderate/Good	Smooth-barked Apple - Sydney Peppermint - Turpentine heathy open forest on plateaux areas of the southern Central Coast, Sydney Basin	0.29	2

4.7.2 Species Credits

A summary of the Species Credits created by the proposed Awaba BioBank Site is provided in Table 10.

Table 10. Proposed Awaba BioBank Site Species Credit Calculations

<i>Species</i>	Individuals conserved	Species Credits Created
<i>Acacia bynoeana</i>	68	408
<i>Angophora inopina</i>	158	948
<i>Grevillea parviflora</i> subsp. <i>parviflora</i>	882	5,292
<i>Tetratheca juncea</i>	11,632	69,792

5 OFFSETTING LOT 372

5.1 Ecosystem Credits

The total amount of native vegetation available on Lots 372 and 373 for offsetting is 34.36 hectares (Table 11). Of this, the amount of like-for-like vegetation types available to offset the Lot 372 Development Site is 29.22 hectares.

Table 11 shows the Ecosystem Credits required for each vegetation community impacted by the Lot 372 Development Site and the credits generated on the proposed Awaba BioBank Site. Note that the main RBVTs impacted by either proposal, HU610 and HU621, are considered to be similar types and therefore Ecosystem Credits of each of these types are considered like-for-like.

The proposed Awaba BioBank Site can provide up to 153 Ecosystem Credits of the 392 required to offset the Lot 372 development. Therefore, the Awaba BioBank Site cannot, in itself, provide sufficient Ecosystem Credits in order to achieve an improve or maintain outcome for biodiversity. The shortfall of 239 Ecosystem Credits will be sourced and retired from an alternative location prior to the commencement of works on the development site. LMCC have commenced investigations of appropriate properties.

Table 11. Ecosystem Credits

Development Site (Lot 372)			
RBVT	TOTAL Credits Required	Area (ha)	Combined* Credits Required
HU610: Scribbly Gum - Red Bloodwood	260	5.04	392 (7.2 ha)
HU621: Smooth-barked Apple - Bloodwood	132	2.16	
<i>TOTAL</i>	392	7.2	
BioBank Site (Lots 372 and 373)			
RBVT	TOTAL Credits Created	Area (ha)	Combined* Credits Created
HU508: Blackbutt - Pink Bloodwood	25	4.85	153 (29.22 ha)
HU610: Scribbly Gum - Red Bloodwood	67	10.01	
HU621: Smooth-barked Apple - Red Bloodwood	86	19.21	
HU622: Smooth-barked Apple - Sydney Peppermint - Turpentine	2	0.29	
<i>TOTAL</i>	180	34.36	

* NOTE: HU_610 and HU_621 credits are inter-changeable types

5.2 Species Credits

Table 12 illustrates the Species Credit requirements for the offsetting of the Lot 372 Development Site and also the Species Credits created on the proposed Offset Sites. The loss of 2,302 *Tetratheca juncea* individuals on Lot 372 requires 33,853 Species Credits to be retired. The proposed Awaba BioBank Site results in 69,792 *Tetratheca juncea* Species Credits being created for the 11,632 individuals present. Therefore, the offsetting scenario presented is considered to “improve or maintain” biodiversity values for *T. juncea* through the retirement of Species Credits. Excess Species Credits may be utilised for future LMCC developments or sold to other developers.

Furthermore, the proposed Awaba BioBank Site generates additional Species Credit value for *Acacia bynoeana*, *Angophora inopina* and *Grevillea parviflora* subsp. *parviflora* which may be utilised to offset other LMCC developments or be sold to other developers.

Table 12. Species Credits

Development Site (Lot 372)		
Species	Individuals Lost	Credits Required
<i>Tetratheca juncea</i>	2,302	33,853
Offset Sites (part of Lots 372 and 373)		
Species	Individuals Present	Credits Created
<i>Acacia bynoeana</i>	68	408
<i>Angophora inopina</i>	158	948
<i>Grevillea parviflora</i> subsp. <i>parviflora</i>	882	5,292
<i>Tetratheca juncea</i>	11,632	69,792

5.3 Additional Biodiversity Values

A number of additional biodiversity values of high conservation significance would be enhanced by the establishment of the Awaba BioBank Site. In particular, this includes the in-perpetuity conservation of three additional threatened flora populations (*Acacia bynoeana*, *Angophora inopina* and *Grevillea parviflora* subsp. *parviflora*) and known and potential habitat for a variety of threatened fauna species. Furthermore the condition of the bushland present is very good and would require minimal, on-going, maintenance-level management.

6 RECOMMENDATIONS

The following recommendations have been made in anticipation of Conditions of Consent from the Department of Planning and Infrastructure (DoPI) and a Statement of Commitments from LMCC:

1. Finalise the BioBanking Statement for the Lot 372 Development Site and the BioBanking Agreement for the proposed Awaba BioBank Site;
2. LMCC will secure an offset site in addition to the proposed Awaba BioBank Site in order to retire the required Ecosystem Credits. Such a site will be secured prior to works commencing on the development site;
3. As a component of finalising the BioBank Agreement at both BioBank Sites, LMCC will provide DoPI with a BioBank Site Management Plan that commits the proposed Awaba BioBank Site to in-perpetuity management and a fund deposit calculated on this basis. The required management actions will be determined in consultation with OEH; and
4. Upon establishment of the Awaba BioBank Site and additional BioBank site, 392 Ecosystem Credits of the required vegetation types and 33,853 *Tetratheca juncea* Species Credits, will be retired within the BioBanking Scheme.

7 CONCLUSION

This report has examined the offsetting requirements as calculated by the BioBanking Credit Calculator, for the proposed development of part of Lot 372 (DP 723259), Awaba. The remainder of Lot 372 and a portion of the adjacent Lot 373 will form the proposed Awaba BioBank Site, from which Ecosystem and Species Credits will be retired. Whilst the proposed Awaba BioBank Site, generates sufficient Species Credits to offset impacts to *Tetratheca juncea*, additional Ecosystem Credits will be sourced from an alternative BioBank Site in order to satisfy the number of Ecosystem Credits required. The additional BioBank Site will be secured, and the subsequent required Ecosystem Credits retired, prior to the commencement of works on Lot 372. LMCC is currently investigating additional lands that may satisfy these requirements.

Surplus Biodiversity Credits created on any proposed BioBank Site may be used to offset additional future developments by LMCC or sold to third parties.

Any proposed BioBank Sites will be managed into perpetuity and registered on the Title of the land, thus securing the offsets.

REFERENCES

Department of Environment and Conservation (DEC) (2005b). Threatened Species Profiles for threatened species, endangered populations and endangered ecological communities listed under the NSW Threatened Species Conservation Act 1999. New South Wales Department of Environment and Conservation (DEC). Sydney, Australia, 2005. Online profiles found at http://threatenedspecies.environment.nsw.gov.au/tsprofile/browse_allspecies.aspx

DECCW (2008) Vegetation Types Database. Website: <http://www.environment.nsw.gov.au/BioBanking/VegTypeDatabase.htm>

DECCW (2009). *BioBanking Assessment Methodology and Credit Calculator Operational Manual*.

Forest Fauna Surveys Pty Ltd, Hunter ECO & Eastcoast Flora Survey (2011), *Flora And Fauna Investigations Awaba Landfill Lot 372 DP 723259*, March 2011, Report To Lake Macquarie City Council. Cited as Forest Fauna et al (2011a).

Forest Fauna Surveys Pty Ltd, Hunter ECO & Eastcoast Flora Survey (2011), *Flora And Fauna Investigations Awaba Landfill Adjoining Area Lot 373 DP 723259*, 5 April 2011, Report To Lake Macquarie City Council. Cited as Forest Fauna et al (2011b).

FIGURES

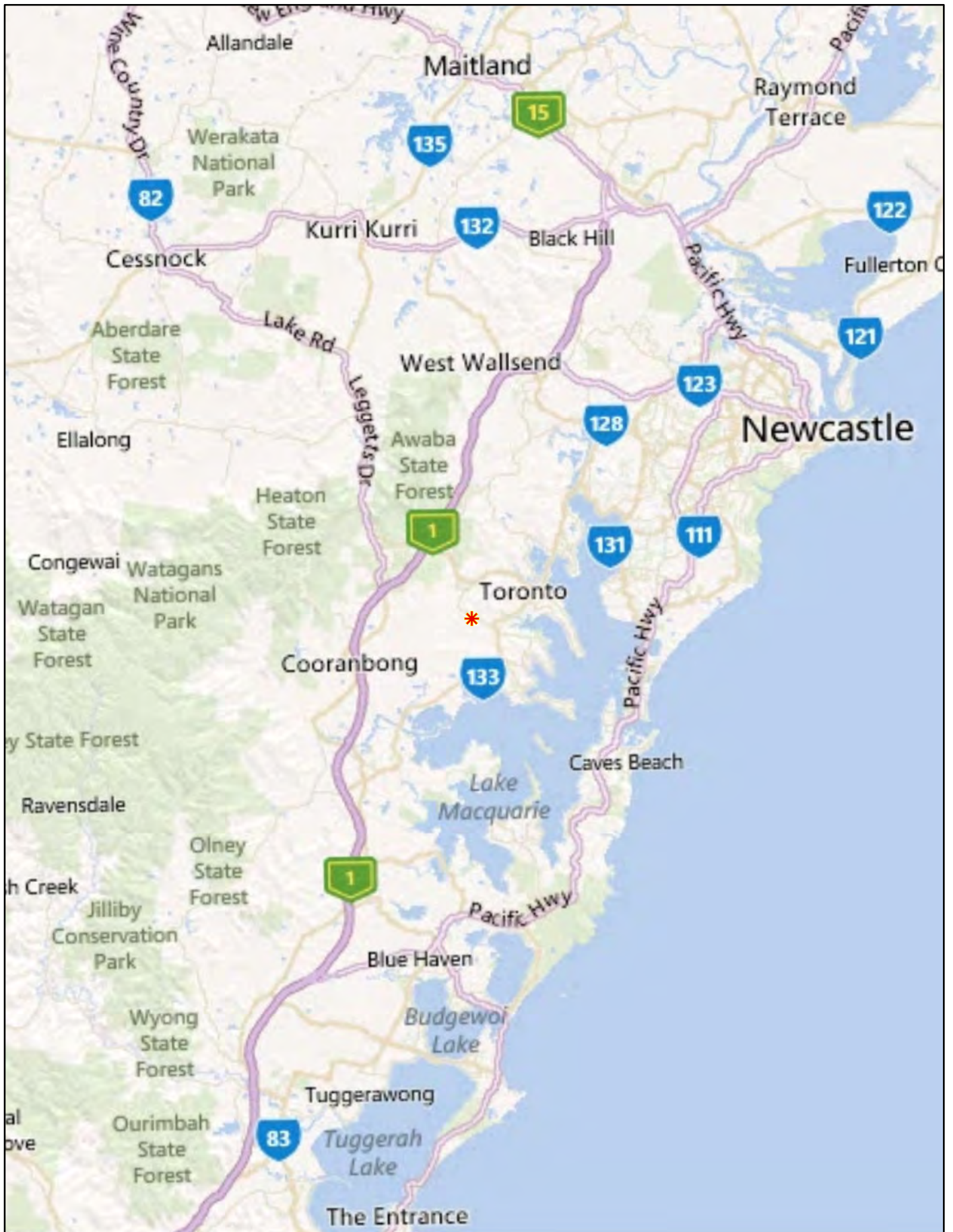


Figure 1: Location of the study area in a regional context

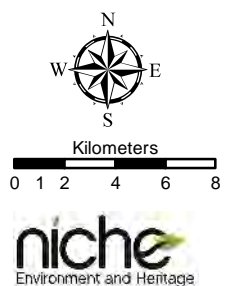
1230 Awaba Landfill BioBanking Assessment

Drawn by: NS

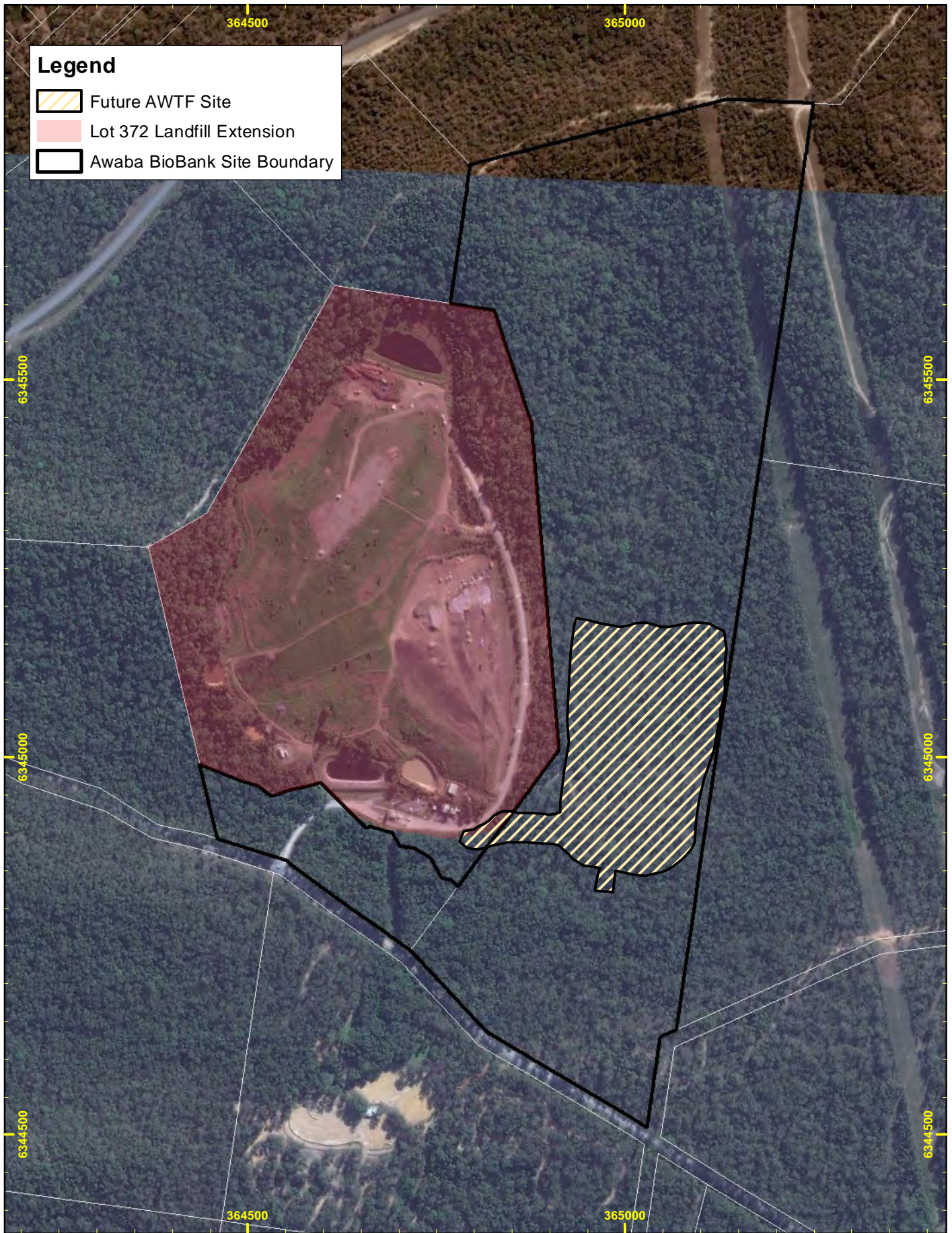
Project Mgr: NS

Date: 21/08/2012

* Awaba landfill site



niche
Environment and Heritage



Legend

- Future AWTF Site
- Lot 372 Landfill Extension
- Awaba BioBank Site Boundary

Figure 2: Awaba Development and Biobank Sites

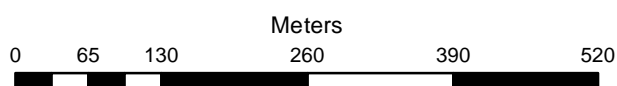
1230 Awaba Landfill Extension BioBanking

Drawn by: NS

Project Mgr: NS

Date: 21/08/2012

Imagery: (c) 2010 Microsoft and its data suppliers



Horizontal Datum: GDA 1994 MGA Zone 56





Figure 3: Mitchell Landscapes, CMA and CMA Sub-region
1230 Awaba Lot 372 Landfill BioBanking

- Lot 372 Landfill Extension
- Future AWTF Site
- BioBank Site Boundary
- Mitchell Landscape



Drawn by: NS

Date: 22/08/2012

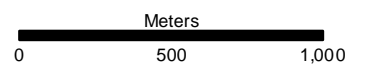









Figure 4: Assessment circle configuration and connectivity assessment

1230 Awaba Landfill BioBanking

Drawn by: NS

Project Mgr: RH

Date: 26/08/2012

-  100 ha Circle
-  1,000 ha Circle
-  Lot 372 Development Area
-  BioBank Site boundary
-  Future AWTF site

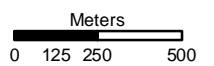




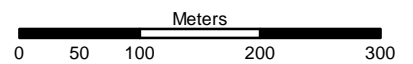
Figure 5: Vegetation Types of the study area (Forest Fauna et al 2011a and 2011b)
1230 Awaba Lot 372 Landfill BioBanking

-  Forest Fauna floristic plots
-  Lot 372 Landfill Extension
-  Future AWTF Site
-  BioBank Site Boundary
- Forest Fauna Vegetation Types**
-  114 - Red Mahogany-Paperbark Thicket
-  11c - Peppermint-Black Wattle Riparian Forest
-  30f - Freemans Peppermint-Apple-Bloodwood Forest
-  30j - Sugarloaf Lowlands Bloodwood-Apple-Scrubby Gum Forest



Drawn by: NS

Date: 21/08/2012



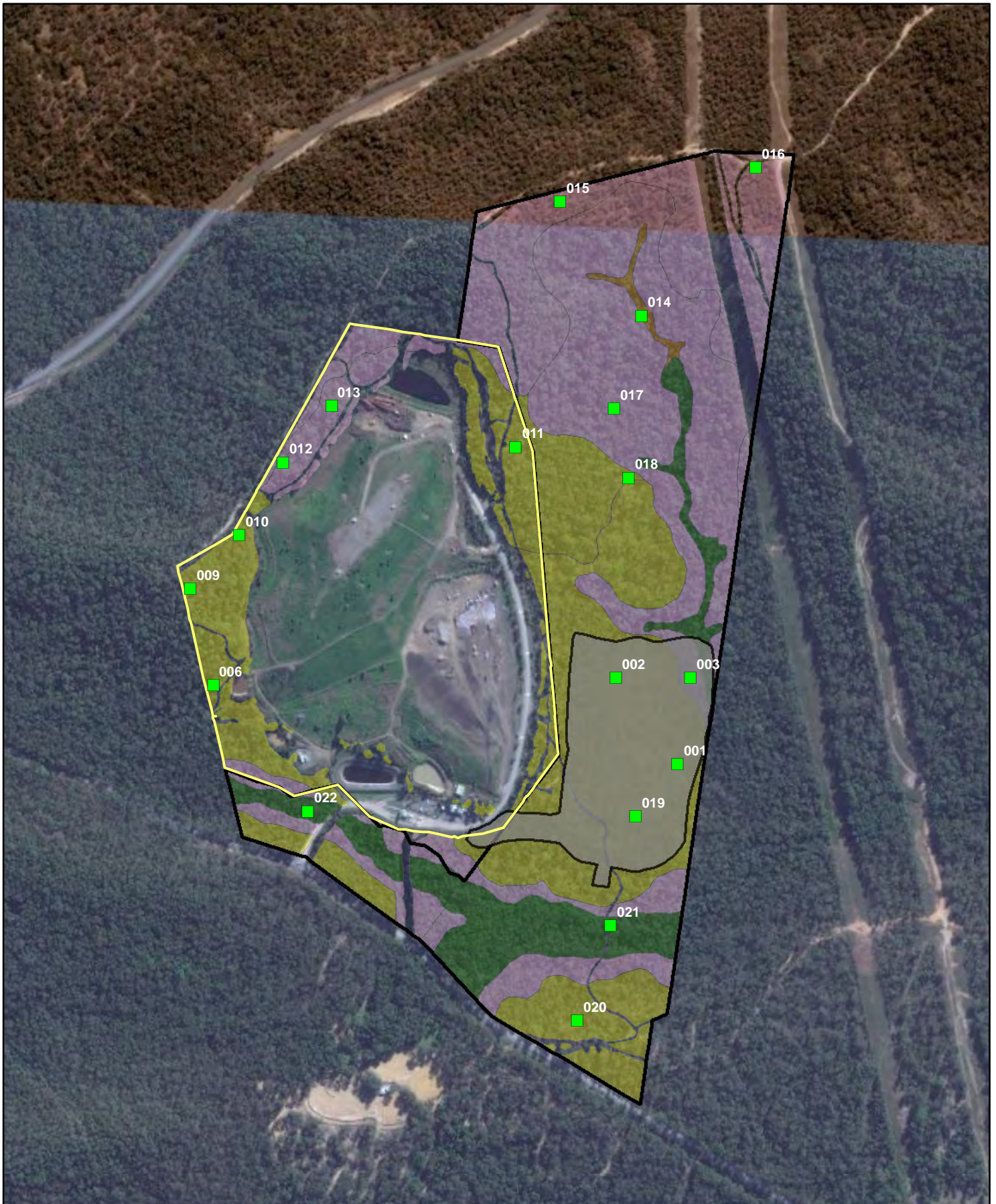


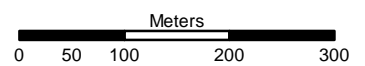
Figure 6: Revised Biometric Vegetation Types of the study area
1230 Awaba Lot 372 Landfill BioBanking

- Biobanking Plots
 - Lot 372 Landfill Extension
 - Future AWTF Site
 - BioBank Site Boundary
- Revised Biometric Vegetation Types**
- HU_508, Blackbutt - Pink Bloodwood
 - HU_610, Scribbly Gum - Red Bloodwood
 - HU_621, Smooth-barked Apple - Red Bloodwood
 - HU_622, Smooth-barked Apple - Sydney Peppermint - Turpentine



Drawn by: NS

Date: 21/08/2012



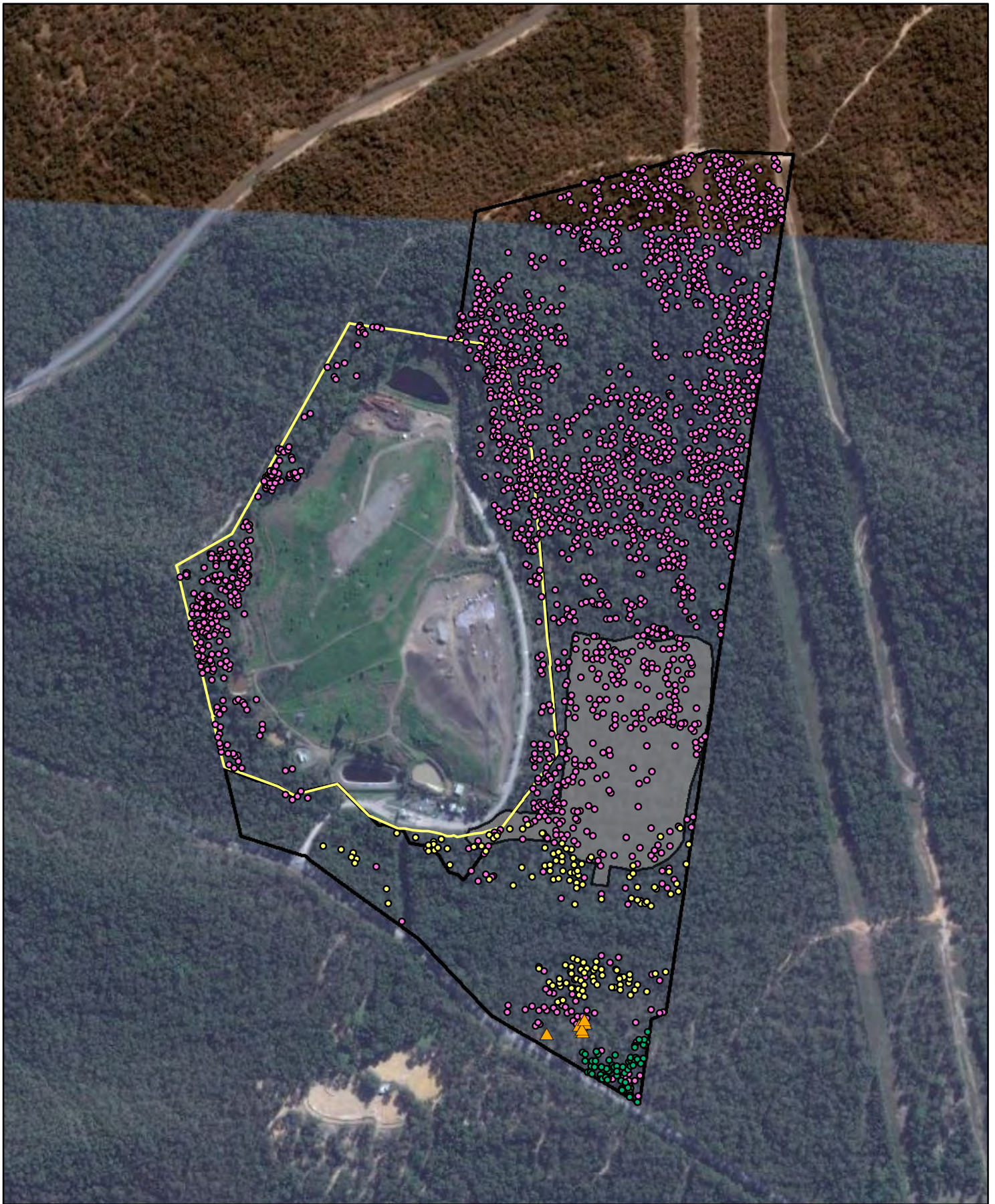


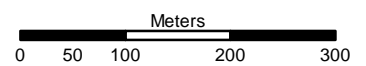
Figure 7: Threatened flora within the study area
1230 Awaba Lot 372 Landfill BioBanking

- ▲ Acacia bynoeana
- Angophora inopina
- Grevillea parviflora subsp. parviflora
- Tetratheca juncea
- Lot 372 Landfill Extension
- Future AWTF Site
- BioBank Site Boundary



Drawn by: NS

Date: 22/08/2012



APPENDICIES

Appendix A: Alignment of the native vegetation of the study area from Forest Fauna et al (2011a 2011b) with Revised Biometric Vegetation Types (BioBanking types).

Forest Fauna Veg Code	Forest Fauna Veg Type*	EEC	RBVT Code	RBVT**	Keith Formation	Keith Class
11c	Peppermint-Blackwattle Riparian Forest	Not an EEC	HU622	Smooth-barked Apple - Sydney Peppermint - Turpentine heathy open forest on plateau areas of the southern Central Coast, Sydney Basin		
30f	Freemans Peppermint-Apple-Bloodwood Forest	Not an EEC	HU621	Smooth-barked Apple - Red Bloodwood open forest on coastal plains on the Central Coast, Sydney Basin	Dry Sclerophyll Forests (shrubby subformation)	Sydney Coastal Dry Sclerophyll Forests
30h	Sugarloaf Lowlands Bloodwood-Apple Forest	Not an EEC				
30j	Sugarloaf Lowlands Bloodwood-Apple-Scribbly Gum Forest	Not an EEC	HU610	Scribbly Gum - Red Bloodwood heathy woodland on the coastal plains of the Central Coast, Sydney Basin		
31	Coastal Plains Scribbly Gum Woodland	Not an EEC				
114	Red Mahogany-Paperbark Thicket	Not an EEC	HU508	Blackbutt - Pink Bloodwood shrubby open forest of the coastal lowlands of the North Coast	Wet Sclerophyll Forests (shrubby subformation)	North Coast Wet Sclerophyll Forests

*Refer to Figure 5.

** Refer to Figure 6.

Appendix B: Awaba BioBanking plot data (Lots 372 and 373)

Site	BVT	Plot Number*	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	Easting**	Northing	Zone
Future AWTF	HU_610	001	29	4	4	16	56	100	0	5	1	7	365082	6344996	56
Future AWTF	HU_610	002	28	1	2	4	42	82	0	4	1	21	364994	6345120	56
Future AWTF	HU_610	019	38	26	1	54	42	94	0	8	1	10	365022	6344922	56
Future AWTF	HU_621	003	41	30.2	8	92	78	94	0	4	1	83	365100	6345120	56
Lot 372 Landfill	HU_610	006	38	34.5	2	88	16	30	0	0	1	25	364419	6345109	56
Lot 372 Landfill	HU_610	009	38	23	4.5	62	34	76	0	3	1	12	364386	6345247	56
Lot 372 Landfill	HU_610	010	39	11	7	50	42	70	0	4	1	43	364456	6345324	56
Lot 372 Landfill	HU_610	011	40	19.5	11.5	54	92	86	0	4	1	8	364851	6345450	56
Lot 372 Landfill	HU_621	012	42	22	37	52	16	78	0	3	1	33	364519	6345428	56
Lot 372 Landfill	HU_621	013	41	29	23.5	76	16	74	0	5	1	20	364588	6345508	56
Lot 372 Offset	HU_508	022	19	20	36	2	0	88	3	2	1	30	364554	6344930	56
Lot 373 Offset	HU_508	021	27	40	30	40	10	65	10	4	1	20	364987	6344766	56
Lot 373 Offset	HU_610	018	42	15	7.5	34	60	98	0	6	1	36	365012	6345405	56
Lot 373 Offset	HU_610	020	44	20	14.5	54	70	94	0	1	1	27	364939	6344630	56
Lot 373 Offset	HU_621	015	40	32	2.5	86	40	56	0	6	1	11	364914	6345800	56
Lot 373 Offset	HU_621	016	44	28	18	72	38	82	0	6	1	19	365194	6345849	56
Lot 373 Offset	HU_621	017	42	35	12.5	46	46	76	0	5	1	35	364991	6345505	56
Lot 373 Offset	HU_622	014	38	40	40	25	10	75	0	4	1	20	365031	6345637	56

*Refer to Figure 6.

** GDA 94.



Appendix C: Lot 372 Development Site Credit Report

BioBanking credit report

This report identifies the number and type of credits required at a DEVELOPMENT SITE.

Date of report: 30/04/2012

Time: 4:20:29AM

Tool version: 2.0

Development details

Proposal ID: 0047/2012/0122D
Proposal name: Lot 372 Awaba Landfill Expansion
Proposal address: 60 Wilton Road Awaba NSW 2283

Proponent name: Lake Macquarie City Council
Proponent address: Box 1906 HRMC NSW 2310
Proponent phone: 0249210333

Assessor name: Nathan Smith
Assessor address: 9/10 Bentley Street BALGOWLAH NSW 2093
Assessor phone: 0458 000 590
Assessor accreditation: 0047

Improving or maintaining biodiversity

An application for a red flag determination is required for the following red flag areas

Red flag	Reason
----------	--------

The application for a red flag determination should address the criteria set out in the BioBanking Assessment Methodology. Please note that a biobanking statement cannot be issued unless the determination is approved.

Additional information required for approval:

- Change to percent cleared for a vegetation type/s
- Use of local benchmark
- Change negligible loss
- Expert report
- Predicted threatened species not on site
- Change threatened species response to gain (Tg value)

Ecosystem credits summary

Vegetation type	Area (ha)	Credits required	Red flag
Smooth-barked Apple - Red Bloodwood open forest on coastal plains on the Central Coast, Sydney Basin	2.16	132	No
Scribbly Gum - Red Bloodwood heathy woodland on the coastal plains of the Central Coast, Sydney Basin	5.04	260	No
Total	7.20	392	

Credit profiles

1. Scribbly Gum - Red Bloodwood heathy woodland on the coastal plains of the Central Coast, Sydney Basin, (HU610)

Number of ecosystem credits required	260
CMA sub-region	Wyang
Minimum percent native vegetation cover class	>70%
Minimum adjacent remnant area class	>100 ha

Offset options - vegetation types	Offset options - CMA sub-regions
Scribbly Gum - Red Bloodwood heathy woodland on the coastal plains of the Central Coast, Sydney Basin, (HU610)	Wyang Stanthorpe Plateau

2. Smooth-barked Apple - Red Bloodwood open forest on coastal plains on the Central Coast, Sydney Basin, (HU621)

Number of ecosystem credits required	132
CMA sub-region	Wyang
Minimum percent native vegetation cover class	>70%
Minimum adjacent remnant area class	>100 ha

Offset options - vegetation types	Offset options - CMA sub-regions
Smooth-barked Apple - Red Bloodwood open forest on coastal plains on the Central Coast, Sydney Basin, (HU621)	Wyang Stanthorpe Plateau
Scribbly Gum - Red Bloodwood heathy woodland on the coastal plains of the Central Coast, Sydney Basin, (HU610)	

Species credits

Common name	Scientific name	Extent of impact	Number of species credits required
Black-eyed Susan	Tetratheca juncea	2,302.00	33,853

BioBanking credit report

This report identifies the number and type of credits required at a BIOBANK SITE.

Date of report: 22/08/2012

Time: 3:09:48PM

Tool version: 2.0

Biobank details

Proposal ID: 0047/2012/0124B

Proposal name: Awaba BioBank Site, Lots 372 and 373 Offset Areas

Proposal address: Wilton Road Awaba NSW 2283

Proponent name: Lake Macquarie City Council

Proponent address: Box 1906 HRMC NSW 2283

Proponent phone: 0249210333

Assessor name: Nathan Smith

Assessor address: 9/10 Bentley Street BALGOWLAH NSW 2093

Assessor phone: 0458 000 590

Assessor accreditation: 0047

Additional information required for approval:

- Use of local benchmark
- Expert report
- Change threatened species response to gain (Tg value)

Appendix E: CVs of staff involved in assessment



<p>Professional Memberships</p>	<ul style="list-style-type: none"> • Environmental Institute of Australia and New Zealand (EIANZ) • Ecological Consultants Association of NSW - council member • Birds Australia • Birds Australia Southern NSW and ACT (BASNA) - committee member • Ecological Society of Australia 																		
<p>Qualifications</p>	<ul style="list-style-type: none"> • Bachelor of Science (Honours) - James Cook University • Masters of Science (Zoology) - University of the Witwatersrand • Doctor of Philosophy (Zoology) - University of Melbourne • BioBanking Assessors Course - Ryde TAFE 																		
<p>Employment History</p>	<table border="0"> <tr> <td>2009-present</td> <td>Director/Senior Ecologist, Niche Environment and Heritage Pty Ltd</td> </tr> <tr> <td>2003-09</td> <td>Manager/Senior Ecologist, Biosis Research Pty. Ltd.</td> </tr> <tr> <td>2002-03</td> <td>Project Officer, Black-eared Miner Recovery Team, La Trobe University</td> </tr> <tr> <td>2002</td> <td>Scientific Writer, Institute for Land and Food Resources, University of Melbourne</td> </tr> <tr> <td>2000-01</td> <td>Zoologist/Project Manager, Melbourne Enterprises International Ltd</td> </tr> <tr> <td>1998-2002</td> <td>Research Assistant/Demonstrator, University of Melbourne</td> </tr> <tr> <td>1995-96</td> <td>Research Assistant, Botswana National Parks</td> </tr> <tr> <td>1993-95</td> <td>Lecturer/Demonstrator, University of the Witwatersrand, South Africa</td> </tr> <tr> <td>1992</td> <td>Research Assistant, Australian Centre for Tropical and Freshwater Research, James Cook University</td> </tr> </table>	2009-present	Director/Senior Ecologist, Niche Environment and Heritage Pty Ltd	2003-09	Manager/Senior Ecologist, Biosis Research Pty. Ltd.	2002-03	Project Officer, Black-eared Miner Recovery Team, La Trobe University	2002	Scientific Writer, Institute for Land and Food Resources, University of Melbourne	2000-01	Zoologist/Project Manager, Melbourne Enterprises International Ltd	1998-2002	Research Assistant/Demonstrator, University of Melbourne	1995-96	Research Assistant, Botswana National Parks	1993-95	Lecturer/Demonstrator, University of the Witwatersrand, South Africa	1992	Research Assistant, Australian Centre for Tropical and Freshwater Research, James Cook University
2009-present	Director/Senior Ecologist, Niche Environment and Heritage Pty Ltd																		
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1995-96	Research Assistant, Botswana National Parks																		
1993-95	Lecturer/Demonstrator, University of the Witwatersrand, South Africa																		
1992	Research Assistant, Australian Centre for Tropical and Freshwater Research, James Cook University																		
<p>Career Overview</p>	<p>Rhidian has been a professional ecological consultant for over seven years, but has over 15 years experience in teaching and practicing terrestrial wildlife ecology. He has experience in flora and fauna survey, Biobanking and offset design and project management for environmental approvals projects. Rhidian has conducted ecological work throughout Australia (NSW, Victoria, Queensland, South Australia and the Northern Territory) as well as overseas in southern Africa and Pakistan. He has been the senior scientist and project manager on a number of major investigations, including environmental assessments, management plans and mitigation design, particularly for major linear developments. He is experienced in the application of state and federal legislation which relates to the conservation of threatened species and communities, and related planning instruments.</p> <p>As the project manager for both large and small projects, Rhidian has been required to develop methodology, co-ordinate multi disciplined field teams, prepare reports incorporating results from several disciplines and maintain effective communication with the client and various regulatory and/or public authorities. Rhidian has acted as an expert witness in the NSW Land and Environment Court. Rhidian is an accredited Biobanking assessor.</p>																		
<p>Professional Vision</p>	<p>To significantly contribute to the sustainable management of Australia's natural resources and promote a greater awareness and understanding of the unique natural history of this country. To balance community growth and development with ecological conservation by ensuring all development projects adhere to the principals of Ecologically Sustainable Development. By helping clients identify issues of high ecological value I hope to not only facilitate the conservation and management of these values but also facilitate efficient project delivery.</p>																		
<p>Skills</p>	<ul style="list-style-type: none"> • Ecological surveys, assessment and monitoring • BioBanking Assessments • Project management • Environmental approvals • Expert witness and peer review • Government agency consultation and advocacy • Impact minimisation (mitigation) 																		

Key achievements/ flagship projects

F3 to Branxton Link, 2003-09*

For over six years Rhidian managed the ecological components of this 40 km dual carriageway freeway project, including targeted flora and fauna surveys, impact assessment, mitigation design, offsets, environmental management plans and a Referral. There were numerous and significant ecological issues on this project and Rhidian worked closely with the RTA engineers during the design phase to minimise any impacts. Rhidian was also required to complete an Environmental Assessment and Species Impact Assessment for the associated electricity adjustments for this project.

Pacific Highway Upgrade: Tintenbar to Ewingsdale, 2004-09*

Rhidian managed the ecological components of this 16 km dual carriageway freeway project, including constraints assessment, vegetation mapping, targeted flora and fauna surveys, route option assessment, mitigation design and impact assessment. Liaison with commonwealth and state agencies was a key element of Rhidian's work on this project.

Pacific Highway Upgrade: Woodburn to Ballina, 2006-08*

Rhidian managed the ecological components of this 32 km dual carriageway freeway project, including targeted flora and fauna surveys, route option assessment, mitigation design and impact assessment. Liaison with DECCW and DPI was a key element of Rhidian's work on this project.

Other major road projects that Rhidian has project managed

Oxley Highway Upgrade; Species Impact Statement, 2004-06*

Pacific Highway Upgrade: Moorland to Herons Creek; Environmental Assessment, 2004-06*

Pacific Highway Upgrade: F3 to Raymond Terrace; Environmental Assessment, 2004-06*

Pacific Highway Upgrade: Ballina Bypass modifications; Environmental Assessment, 2007-08*

Hunter Expressway (formerly F3 to Branxton); Environmental Monitoring, 2009-11

Princes Highway Upgrade: Tomerong Bypass, 2011

Linear Infrastructure Mitigation panel, 2007*

Rhidian provided expert advice at a workshop for developing mitigation measures for linear infrastructure for the Department of the Environment, Water, Heritage and the Arts. Completed at Biosis Research for the RTA.

Darling Anabranh Pipeline and Environmental Flows, 2003-2004*

Rhidian managed the terrestrial and aquatic ecological components of this project, including targeted flora and fauna surveys, habitat mapping and impact assessment. The project required both an Environmental Assessment and a Species Impact Assessment.

Mining projects in which Rhidian has provided significant input

Dendrobium Colliery; Ecological Monitoring, REFs and SISs, 2003-09*

West Cliff Coal Wash Emplacement Area; Species Impact Statement, 2006-07*

Elouera Colliery Mine Site Rehabilitation; Species Impact Statement, 2006-07*

Northern Exploration Drilling Area (Weipa); Environmental Assessment, 2005*

Khirthar National Park (Pakistan); Baseline Environmental Study, 2000-01

Property Development

West Wallsend: SIS and offset negotiations for 375 lots, 2009-11

Edgeworth: Biobanking calculations and negotiations for rezoning application, 2010-11

Brimbin: Environmental Assessment and Biobanking Calculations, 2010-11



Professional Memberships	<ul style="list-style-type: none"> • Ecological Society of Australia • Ecological Consultants Association of NSW 																
Qualifications	<ul style="list-style-type: none"> • Bachelor of Science (Resource & Environmental Management) - Macquarie University • Certificate IV Bushland Regeneration - School of Horticulture, Northern Sydney TAFE • Accredited BioBanking Assessor - Ryde TAFE • Statement of Attainment, Spatial Information Systems - Sydney Institute of Technology 																
Employment History	<table border="0"> <tr> <td>2010-present</td> <td>Senior Botanist, Niche Environment and Heritage Pty Ltd.</td> </tr> <tr> <td>2009-2010</td> <td>Senior Biodiversity Officer, Warringah Council.</td> </tr> <tr> <td>2008-2009</td> <td>Ecologist, Eco Logical Australia.</td> </tr> <tr> <td>2003-2008</td> <td>Botanist, Biosis Research Pty. Ltd.</td> </tr> <tr> <td>2001-2003</td> <td>Project Manager/Supervisor, Toolijooa Environmental Restoration</td> </tr> <tr> <td>1998-2002</td> <td>Project Manager/Supervisor, Australian Bushland Restoration</td> </tr> <tr> <td>1996-1998</td> <td>Bush Regeneration Supervisor, Agserv Pty Ltd</td> </tr> <tr> <td>1996</td> <td>Soil Lab Technician, Australian Soil Testing</td> </tr> </table>	2010-present	Senior Botanist, Niche Environment and Heritage Pty Ltd.	2009-2010	Senior Biodiversity Officer, Warringah Council.	2008-2009	Ecologist, Eco Logical Australia.	2003-2008	Botanist, Biosis Research Pty. Ltd.	2001-2003	Project Manager/Supervisor, Toolijooa Environmental Restoration	1998-2002	Project Manager/Supervisor, Australian Bushland Restoration	1996-1998	Bush Regeneration Supervisor, Agserv Pty Ltd	1996	Soil Lab Technician, Australian Soil Testing
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Career Overview	<p>Nathan has 13 years experience in the fields of natural area management and ecological consulting. Nathan has managed bush regeneration and mine site rehabilitation projects, vegetation management plans, ecological monitoring surveys, vegetation surveys and mapping, opportunities and constraints assessments, terrestrial and aquatic ecological assessments, reviews of environmental factors and impact assessments. He has managed large projects at both the State and Commonwealth level of assessment including Species Impact Statements, Referrals and Part 3A assessments. A key strength of Nathan's is his exposure to a diverse range of environments involving remote area ecological survey and assessment. In particular he has carried out and managed ecological surveys in Western Cape York, North-eastern NSW, the NSW Central Coast, the Illawarra and Sydney Catchment Area, NSW Western Slopes and Plains, the New England Tableland and also Victoria. In particular, Nathan is experienced in ecological assessment of subsidence related impacts due to long wall mining.</p> <p>As a project manager, Nathan is skilled in developing scopes of work for ecological assessments and restoration plans, client liaison, resource allocation, scheduling, cost estimation, report writing, technical review and staff supervision. Importantly, Nathan has a well-rounded capability in applying the DECC survey guidelines and Biobanking Methodology within budgetary and time constraints. He has also been involved in several high profile and controversial projects requiring sensitivity towards various stakeholders.</p>																
Professional Vision	<p>To respond innovatively to the challenge of facilitating net positive outcomes for Australia's unique biodiversity and ecosystems in a climate of development and resource use pressure. My hope is to illustrate to industry and the broader community that cost-effective sustainable outcomes are achievable through effective planning and re-direction of resources to on-ground biodiversity management.</p>																
Skills	<ul style="list-style-type: none"> • Environmental Impact Assessment (NSW, Qld, Commonwealth) • Habitat restoration and mine site rehabilitation • Biobanking and offsetting • Vegetation management • Ecological survey, monitoring and analysis • Habitat condition assessment • Vegetation survey and mapping • Project management and delivery • Stakeholder liaison, training and technical advice to government, NGO, volunteer and private organisations • Report writing and technical review • Staff supervision and training • Management of the integration of cultural heritage and aquatic ecology in assessments 																

Key achievements/ flagship projects

Sapphire Wind Farm Part 3A and Biobanking Ecological Assessment, Kings Plain NSW.

Project Manager and Ecologist - Ecological Survey Design, Vegetation Mapping and Validation, Flora Quadrats, Threatened Flora Random Meanders, Diurnal Bird Surveys, AnaBat, Spotlighting, Call Playback and Fauna Habitat Assessment. Nathan is an accredited Biobanking Assessor and utilised the Biobanking Assessment Methodology under Part 3A to calculate suitable offsets and credit requirements.

Vickery Coal Mine Part 4.1 (SSD) Ecological and Biobanking Assessment, Gunnedah NSW.

Lead botanist and Biobanking assessor for 1,500 ha open cut coal mine in the Gunnedah basin.

Hunter Valley Operations (Southern Project) Part 4.1 (SSD) Vegetation Mapping and Ecological and Biobanking Assessment, Warkworth NSW.

Lead botanist and Biobanking assessor for open cut coal mine in the Hunter Valley.

Tasman Mine Extension Referral to SEWPac, Seahampton NSW.

Project manager and author for a Referral for an underground coal mine in the lower Hunter Valley.

Brownlow Hill Biobanking Assessment, Brownlow Hill NSW.

Botanist and Accredited Biobanking Assessor - Biometric Vegetation Mapping, Survey Design, Site Management Plan and Costing of Management Actions, Biobank Report, Credit Calculations and Pricing.

Monitoring of Native Vegetation Condition and Pastures: Kestrel Mine Longwall Surface Monitoring Program.

Botanist and Management of Field Survey - Native vegetation survey and condition assessment including on-going recommendations for vegetation management, monitoring of pastures utilising remote techniques and biomass collection.

Baseline Ecological and Cultural Heritage Assessment of the Northern Exploration Drilling Area (Musgrave), Weipa Region, QLD.

Ecologist - Ecological Survey Design, Manager of Field Surveys, Vegetation Mapping and Validation, Flora Quadrats, Threatened Flora Random Meanders, Diurnal Bird Surveys, Herpetological Surveys.

Targeted Surveys and Impact Assessment for the Proposed Pacific Highway Upgrade: Woodburn to Ballina, North Coast NSW.

Field Survey Manager and Botanist - Survey Design, Vegetation Mapping and Validation, Flora Quadrats, Threatened Flora Random Meanders, opportunistic fauna observations.

Ecological Monitoring of Subsidence Related Impacts for the Dendrobium Coal Mine (Areas 1 and 2) within the Lake Cordeaux Catchment, Cordeaux Catchment Area NSW.

Botanist - Survey Design, Manager of Field Surveys, Vegetation Mapping and Validation, Flora Monitoring Quadrats.

Rehabilitation of Disused Surface Infrastructure Sites. Corrimal Number 2 Shaft and Pump Site, Port Kembla Number 2, Nebo 1 and 2 Shaft Site, Wongawilli Shaft Site.

Project Manager - Vegetation Mapping and Condition Assessment, Development of Rehabilitation Plan.

Dendrobium Coal Mine Area 2 Ventilation Shaft Site Vegetation Management Plan Cordeaux Catchment Area NSW.

Field Survey Manager - Vegetation Mapping and Condition Assessment, Development of Rehabilitation Plan.

REF's and Impact Assessments for Vegetation Clearing Associated with Geotechnical Investigations in the Cordeaux and Avon Catchments, Wollondilly and Illawarra districts NSW. Avondale Colliery, Gujarat No.1 Colliery, Dendrobium Mine Areas 1, 2 and 3, Appin Colliery. **

Field Survey Manager and Botanist - Ecological Survey Design, Coordination of Field Surveys (Cultural and Natural), Vegetation Mapping and Validation, Threatened Flora Random Meanders.

Pre and Post Mining Ecological and Cultural Heritage Assessments of Subsidence Impacts due to Longwall Mining, Wollondilly and Illawarra districts NSW. Elouera Colliery, Dendrobium Mine, West Cliff Colliery.

Field Survey Manager and Botanist - Ecological Survey Design, Manager of Field Surveys, Vegetation Mapping and Validation, Threatened Flora Random Meanders.

Entrance Road Duplication Terrestrial and Aquatic Ecological Impact Assessment, Central Coast NSW.

Field Survey Manager and Botanist - Ecological Survey Design, Manager of Field Surveys, Vegetation Mapping and Validation, Threatened Flora Random Meanders, management of Tree Survey.

Species Impact Statement for the Proposed Area 3 West Cliff Coal Wash Emplacement, Appin NSW.

Field Survey Manager and Botanist - Botanical Survey Design, Vegetation Mapping and Validation, Flora Quadrats, Threatened Flora Random Meanders.

Species Impact Statement and EPBC Referral for the Proposed National Highway Link F3 to Branxton, the Associated Electricity Adjustments and Other Infrastructure, Lower Hunter region, NSW.

Field Survey Manager and Botanist - Survey Design, Vegetation Mapping and Validation, Flora Quadrats, Threatened Flora Random Meanders.