KINGS FOREST

STAGE 1 PROJECT APPLICATION

PRECINCT 2, 3, 4, 6, 7, 8, 9, 10 & 11
THREATENED SPECIES
MANAGEMENT PLAN

JUNE 2011

A REPORT PREPARED FOR PROJECT 28 PTY LTD
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1 INTRODUCTION

1.1 Background

The NSW Minister for Planning approved a Concept Plan for the proposed residential community at Kings Forest on the 19th August 2010. The approved documents included a Revised Threatened Species Management Plan (LandPartners 2009), which proposed the principles upon which the management of Threatened species at the Kings Forest site would be based.

Subsequently, the Director General issued modified Environmental Assessment Requirements (DGR’s) on the 22nd December 2010. James Warren & Associates (JWA) were engaged by Project 28 Pty Ltd to complete a Kings Forest Stage 1 Project Application Threatened Species Management Plan (TSMP) for Precincts 2 - 4 & 6 - 11 in accordance with requirements of 9.4 of these DGR’s and Clause C2 of the modified Concept Approval.

1.2 Proposed Development

1.2.1 Kings Forest Stage 1 Project Application

The Kings Forest site consists of 872 hectares of land located at Cudgen between Bogangar to the south-east and Kingscliff to the north in Northern New South Wales (NSW). The approved concept plan for the Kings Forest site is shown in FIGURE 1.

The scope of the Stage 1 Project Application works is as follows:

- Construction of the entrance road to the site and associated intersection works on Tweed Coast Road.
- Alignment and construction details of two lanes of Kings Forest Parkway, from Tweed Coast Road via Precincts 2, 3, 4 and 5 through to the roundabout in the western part of the site from which access to the southern part of the site is to be gained.
- Alignment and construction details for the civil works of the two proposed roads through the east-west SEPP 14 area to access the southern part of the site.
- Rural retail development in Precinct 1 to the east of Tweed Coast Road.
- Subdivision and construction of residential Precinct 5.
- Bulk earthworks across the site in Precincts 2, 3, 4, 6, 7, 8, 9, 10, 11, 12, 13 & 14.

The scope of works is illustrated in FIGURE 2.

1.2.2 Precincts 2 - 4 & 6 - 11

This TSMP has been prepared for the proposed bulk earthworks in Precincts 2, 3, 4, 6, 7, 8, 9, 10 & 11 (FIGURE 2).
Tweed Coast Road
Kingsford
ST Parkway

50m Ecological Buffer
Proposed Zone Substation (Subject to Country Energy final approval)
Private Open Space
Golf Course Area (Encompassing ecological buffers where indicated)
Private Open Space Including Lake
Start School Site

LEGEND
- Town Centre / Neighbourhood Centre
- Residential
- Community Facilities / Education
- Employment Land
- Structured Open Space (Active)
  (Passive open space to council standards, location subject to urban design)
- Environmental Protection Area to be Dedicated to Council or NPWS
- 50m Ecological Buffer
  (Includes APZs & Roads where approved)
- Proposed Zone Substation
  (Subject to Country Energy final approval)
- Private Open Space
- Golf Course Area
  (Encompassing ecological buffers where indicated)
- Structured Open Space (Passive open space to council standards, location subject to urban design)
- Active Environmental Protection Area to be Dedicated to Council or NPWS

SOURCE: MPS Architects
SCALE: 1:20 000 @ A3
PROJECT: Kings Forest: Stage 1 Project Application
Precincts 2-4 & 6-11 - Threatened Species MP
Melaleuca Drive, Duranbah, NSW
Shire of Tweed

CONCEPT PLAN
FIGURE 1
PREPARED: BW
DATE: 24 June 2011
FILE: N97017_TSMP_Concept.cdr
1.3 Aim & Objectives

The aim of this TSMP is to provide guidelines, strategies and methods for the management of the Threatened flora and fauna species recorded within the vicinity of Precincts 2, 3, 4, 6, 7, 8, 9, 10 & 11, such that species continue to persist and reproduce.

Specific objectives of the Precinct 2-4 & 6-11 TSMP include:

- provide a summary of the threatened flora and fauna species occurring within the vicinity of Precincts 2, 3, 4, 6, 7, 8, 9, 10 & 11;
- provide a profile for each threatened species occurring which includes:
  - a list of overall threats to the species;
  - potential threats from bulk earthworks within Precincts 2, 3, 4, 6, 7, 8, 9, 10 & 11;
  - recovery strategies for the species including details of Approved Recovery Plans and/or Priority Actions;
- devise management strategies to be implemented including:
  - strategies for the protection of threatened species during the bulk earthworks activities;
  - weed control measures specific to areas containing listed threatened flora and fauna;
  - guidelines for the control of human and animal access to areas containing threatened species; and
  - strategies for the embellishment of threatened species habitat through revegetation works and/or the creation of compensatory habitat areas where required.

1.4 Plan Requirements

As discussed above, this TSMP has been prepared in accordance with DGR 9.4 which states:

“Updates are to be provided, where relevant, for the various management plans for koalas, vegetation, threatened species, feral animals weeds, the buffers, and the golf course providing where relevant details on timelines for implementation of recommended works including maintenance periods and measurable performance and completion criteria. Each plan is to consider all other plans for the site to ensure that management strategies do not conflict and that each plan can be implemented without negatively impacting on the objectives of another.”
This TSMP has also been prepared to comply with Clause C2 of the modified Concept Approval as follows:

**Threatened Species Management Plan**

“Each Threatened Species Management Plan update is to provide further details on specific habitat management measures to safeguard existing populations of the two threatened Wallum frog species that occur within the Environmental Protection zones, Ecological buffers and the golf course. These measures are to be determined with reference to contemporary scientific literature and current best practice.”

**1.5 Relationship to other Management Plans**

Additional to this TSMP, the following Management Plans relevant to Precincts 2, 3, 4, 6, 7, 8, 9, 10 & 11 have been prepared for the Stage 1 Project Application, and should be read in conjunction with this TSMP:

- Kings Forest Stage 1 Project Application: Precinct 2, 3, 4, 6, 7, 8, 9, 10 & 11 Vegetation Management Plan (Precinct 2-4 & 6-11 VMP) (JWA 2011b);
- Kings Forest Stage 1 Project Application: Precinct 2, 3, 4, 6, 7, 8, 9, 10 & 11 Buffer Management Plan (Precinct 2-4 & 6-11 BMP) (JWA 2011c); and
- Kings Forest Stage 1 Project Application: Precinct 2, 3, 4, 6, 7, 8, 9, 10 & 11 Weed Management Plan (Precinct 2-4 & 6-11 WMP) (JWA 2011d).

A Kings Forest Stage 1 Project Application Feral Animal Management Plan (Stage 1 FAMP) (JWA 2011e) has also been prepared for the entire Kings Forest site and is therefore relevant to Precincts 2, 3, 4, 6, 7, 8, 9, 10 & 11.

Furthermore, a Kings Forest Stage 1 Project Application Koala Plan of Management (Stage 1 KPoM) (JWA 2011a) has been prepared for the entire Kings Forest site and is therefore relevant to Precincts 2, 3, 4, 6, 7, 8, 9, 10 & 11.

This TSMP should also be read in conjunction with the Site Based Management Plan (Gilbert & Sutherland 2011a) which details further protection measures for Threatened species during the following phases of development across the entire Kings Forest site:

1. Bulk earthworks
2. Landform stabilisation
3. Civil construction
4. On maintenance
5. Operational
2 SUMMARY OF SIGNIFICANT VALUES

2.1 Background

Kings Forest has been comprehensively studied. A summary of the significant values relevant to this TSMP are provided in the following sections.

2.2 Endangered Ecological Communities

Three (3) Endangered Ecological Communities (EEC’s)\(^1\) occur within the vicinity of Precincts 2, 3, 4, 6, 7, 8, 9, 10 & 11 (FIGURE 3):

- Swamp sclerophyll forest on coastal floodplain;
- Freshwater wetlands; and
- Subtropical coastal floodplain forest.

2.3 Threatened Species

3.2.3 Flora

One (1) Threatened flora species was recorded from Precincts 2, 3, 4, 6, 7, 8, 9, 10 & 11 - the Square-stemmed Spike rush (*Eleocharis tetraquetra*), has historically been recorded in the western portion of Kings Forest (FIGURE 4).

3.2.4 Fauna

Ten (10) Threatened fauna species have been recorded (FIGURES 5 & 6), or are considered to occur over time within the area subject to this VMP. These species are as follows:

- Wallum froglet (*Crinia tinnula*)
- Olongburra frog (*Litoria olongburensis*)
- Osprey (*Pandion haliaetus*)
- Grass Owl (*Tyto capensis*)
- Masked Owl (*Tyto novaehollandiae*)
- Glossy black cockatoo (*Calyptorhynchus lathami*)
- Black bittern (*Ixobrychus flavidus*)
- Grey Headed Flying fox (*Pteropus poliocephalus*)
- Koala (*Phascolarctos cinereus*)
- Yellow-bellied sheathtail bat (*Saccolaimus flaviventris*).

\(^{1}\) As listed within schedules of the TSC Act (1995).
2.4 SEPP 14 Wetlands

SEPP 14 - Coastal Wetlands are mapped over large areas of the Kings Forest site. These wetlands are protected by State Environmental Planning Policy No. 14 - Coastal Wetlands (SEPP 14). **FIGURE 7** shows the SEPP 14 wetlands relevant to this VMP.

2.5 Cudgen Nature Reserve

Cudgen Nature Reserve occurs immediately adjacent to the eastern and southern boundaries of the Kings Forest site (**FIGURE 8**).
3 THREATS, RECOVERY STRATEGIES AND MANAGEMENT ACTIONS

3.1 Introduction

The existing and potential threats, recovery strategies and management actions for all listed threatened species that occur within the area subject to this TSMP are discussed below. For each listed species, management actions are based on those set out in the Revised Threatened Species Management Plan (LandPartners 2009) which accompanied the Concept Plan Application, the Draft or Approved Recovery Plan and the Priority Action Statement.

3.2 Threatened flora species

3.2.1 Square-stemmed spike rush

3.2.1.1 Threats

The Australian Koala Foundation (AKF) (2005) recorded a colony of Square-stemmed spike rush (*Eleocharis tetraquetra*) in the far west of the site in association with vegetation described as “Hillside Seepage Swamp” (FIGURE 4). This part of the site is almost exclusively dominated by mature Slash Pine within exotic grassland dominated by Broad-leaved paspalum with little native vegetation.

Two (2) small constructed dams and a natural soak located in the area of the site where this species was previously recorded (AKF 2005) were inspected during the preparation of this TSMP. The inspection included searches of the edges of the two (2) dams and the entire natural soak area. These areas were intensively searched by one (1) scientist looking for the distinguishable slender four-angled stem and broad spikelet of this species. A total of three (3) hours was spent on the survey.

No specimens of Square-stemmed spike rush were observed, although the related *Eleocharis acuta* was relatively common at both sites, along with *Cyperus exaltatus*, *Persicaria strigosa*, *P. decipiens*, *Schoenoplectus mucronatus* and *Leersia hexandra*.

Previous surveys by LandPartners (2009) also failed to locate this species. The natural soak was relatively dry at the time of the recent site visit, and during the LandPartners searches, and it may be that this species only establishes in wetter conditions.

The site locations and surrounds are grazed by cattle, while the soak occurs within exotic grasslands (*Setaria sphacelata*, *Paspalum dilatatum*), with occasional Billygoat weed (*Adenophora houstonianum*) also occurring.

Threats to these colonies of Square-stemmed spike rush include:

- Slashing for routine maintenance;
- Grazing, trampling and disturbance by cattle; and
- Changes to drainage and hydrological regimes.
3.2.1.2 Recovery of the species

The Recovery Plan for the Square-stemmed spike rush lists the following specific objectives:

- Protect and maintain wild populations and their habitat from human-induced threatening processes;
- Determine the location, condition and extent of known populations;
- Determine if any further populations exist, and provide suitable protection for those populations and their habitat;
- Improve the knowledge of the ecology and biology of the species;
- Ensure that known populations achieve long-term viability; and
- Establish representative ex situ populations in gardens or other suitable locations.

Specific management objectives have been recommended for the separate populations of this species. Management objectives of relevance include:

- Ensure that ‘on-ground’ managers, field staff and other contractors who may be required to enter the area be aware of the location of *E. tetraquetra* by marking the site;
- Ensure that site management actions such as the use of herbicides or machinery do not have an adverse impact upon *E. tetraquetra*;
- Minimise the alteration of existing drainage patterns;
- Control exotic weeds which invade *E. tetraquetra* habitat;
- Identify any potential or perceived threats to *E. tetraquetra* and its habitat; and
- Monitor the population annually.

3.2.1.3 Management Actions

The Approved Recovery Plan for the species (NPWS 1999) notes that the culms of Square-stemmed spike rush have been observed to die and decay following annual flowering and fruiting, with the plant difficult to detect when there is no inflorescence or fruiting bodies present (generally in the cooler months between April and October). However, most recent surveys for the species were completed during January.

The following management actions will benefit *E. tetraquetra* on site:

1. Despite this species not having been recorded on the site since 2005, the area where this species was recorded will be retained within an Environmental Protection Zone.

2. Retained habitat areas will be buffered from the bulk earthworks. Buffers are to consist of a minimum 30m inner zone vegetated in accordance with the Precinct 2-4 & 6-11 Vegetation Management Plan (JWA 2011b) and Precinct 2-4 & 6-11 Buffer Management Plan (JWA 2011c), and a maximum 20m outer zone containing roads, footpaths and cycle ways, an asset protection zone (APZ), stormwater management and passive recreation areas.
3. A monitoring program has been devised to monitor the presence of this species (SECTION 4). Furthermore, monitoring programs are included within the Precinct 2-4 & 6-11 VMP (2011a) and Precinct 2-4 & 6-11 WMP (2011c) to ensure suitable habitat remains viable.

3.3 Threatened fauna species

3.3.1 Black bittern

3.3.1.1 Threats

There are two (2) records of the Black bittern at the Kings Forest site within proposed Environmental Protection Zones (FIGURE 6).

Potential threats to this species are as follows:

- Clearing of riparian vegetation;
- Predation by foxes and feral cats on eggs and juveniles; and
- Grazing and trampling of riparian vegetation by stock.

No habitat suitable for this species will be cleared during bulk earthworks within Precincts 2-4 & 6-11. However, foxes and feral cats have been recorded on the site and may threaten the wellbeing and/or survival of this species.

3.3.1.2 Recovery of the species

No recovery plan exists for this species however a Priority Action Statement (PAS) has been prepared. The following list of recovery strategies are relevant:

- In areas of suitable breeding habitat, seek to retain and manage riparian vegetation; and
- Enhance knowledge of the breeding locations of this species. Survey suitable habitat e.g. vegetated wetlands during the breeding season. Investigate habitat usage particularly in Swamp Oak Forest.

3.3.1.3 Management Actions

Although the Black bittern was sighted outside of Precincts 2-4 & 6-11 and within Environmental Protection Zones, the species will benefit from the extensive rehabilitation works planned for Precincts 2-4 & 6-11 (in accordance with the Precinct 2-4 & 6-11 VMP).

The following management actions will also benefit the Black bittern:

1. Quality habitat will be created for the Black bittern with the completion of constructed wetlands/detention basins. In addition to the creation of new habitat, extensive areas currently weed infested and supporting pine plantations will be rehabilitated to extend forage areas (in accordance with the Precinct 2-4 & 6-11 VMP).
2. The Stage 1 FAMP (JWA 2011e) will ensure predators such as the Red fox are controlled in areas of known habitat.

3. A monitoring program has been devised to monitor the presence of this species within the vicinity of Precincts 1 & 5 (SECTION 4). Furthermore, monitoring programs are included within the Precinct 2-4 & 6-11 VMP (2011a) and Precinct 2-4 & 6-11 WMP (2011c) to ensure suitable habitat remains viable.

3.3.2 Glossy black cockatoo

3.3.2.1 Threats

The Glossy black cockatoo has been recorded in the southern portion of the Kings Forest site (FIGURE 6). The species inhabits open forest and woodlands in which stands of she-oak species, particularly Black She-oak (*Allocasuarina littoralis*), Forest She-oak (*A. torulosa*) or Drooping She-oak (*A. verticillata*) occur. Suitable habitat is considered to occur in the vicinity of Precincts 2-4 & 6-11.

Potential threats to this species are as follows:

- Reduction of suitable habitat through clearing for bulk earthworks;
- Loss of tree hollows;
- Excessively frequent fire which reduces the abundance and recovery of she-oaks and also may destroy nest trees; and
- Illegal bird smuggling and egg-collecting.

No extensive areas of suitable habitat for this species will be cleared for during bulk earthworks within Precincts 2-4 & 6-11. However, general vegetation clearing, potentially including some scattered Black she-oak (*Allocasuarina littoralis*) or Forest she-oak (*A. torulosa*) may have a minor impact on food resources for the Glossy black cockatoo.

3.3.2.2 Recovery of the species

No recovery plan exists for this species, however a Priority Action Statement has been prepared. The following list of recovery strategies is derived from the PAS and includes strategies that are relevant to the proposed bulk earthworks within Precincts 2-4 & 6-11:

- Increase landholder and public awareness and interest in Glossy Black Cockatoo conservation and habitat management;
- Utilise the Glossy Black Cockatoo as a flagship threatened species for woodland and forest conservation education and awareness programs;
- Encourage the restoration of foraging habitat that has been cleared or degraded by previous impacts;
- Continue existing monitoring programs and encourage other community groups to develop a monitoring program of local populations; and
- Identify and map key breeding and foraging habitat.
3.3.1.3 Management Actions

The Glossy black cockatoo will benefit from the extensive rehabilitation works planned in accordance with the Precinct 2-4 & 6-11 VMP (JWA 2011b). The species inhabits open forest and woodlands containing Allocasuarina spp. (i.e. Black she-oak or Forest She-oak). The proposed enhancement plantings will include the preferred feed tree species.

The following management actions will also benefit the Glossy black cockatoo:

1. Habitat for the Glossy black cockatoo will be created by including Black she-oak and Forest she-oak in enhancement plantings. Planting of these species will be undertaken in the rehabilitation areas within the environmental protection zones in accordance with the Precinct 2-4 & 6-11 VMP (2011a).

2. A monitoring program has been devised to monitor the presence of this species within the vicinity of Precincts 2-4 & 6-11 (SECTION 4). Furthermore, monitoring programs are included within the Precinct 2-4 & 6-11 VMP (2011a) and Precinct 2-4 & 6-11 WMP (2011c) to ensure suitable habitat remains viable.

3.3.3 Grass Owl

3.3.3.1 Threats

There are numerous recorded sightings of the Grass owl on the Kings Forest site (FIGURE 6). While Grass owls have been recorded within rank grassland within Environmental Protection Zones, they have also been recorded within urban zoned areas of the Kings Forest site, and are likely to forage widely.

Potential threats to this species from proposed bulk earthworks within Precincts 2-4 & 6-11 include:

- Fragmentation and loss of habitat;
- Alteration of habitat from weed invasion, colonisation by woody heathland species;
- Injury/death from vehicle strike;
- Fire;
- Human disturbance;
- Injury/death from domestic animals;
- Increased risk of fire;
- Disturbance from light spill from houses and roads; and
- Use of second-generation (single-dose) rodenticides based on brodifacoum (e.g. Talon).

3.3.3.2 Recovery of the species

No recovery plan exists for the Grass owl, however a Priority Action Statement has been prepared. The following list of recovery strategies is derived from the PAS and includes strategies that are relevant to the proposed bulk earthworks within Precincts 2-4 & 6-11:
• Secure sympathetic management of the Grass Owl, particularly in regard to minimising secondary poisoning from pesticides such as brodifacoum based rodenticides.
• Control pest animals throughout the species range where nesting is known or strongly suspected.
• Where Grass Owl records occur on private land encourage landholders to undertake management to conserve and actively manage habitat.
• Compile and assess opportunistically gathered records of the species in NSW toward developing a model of distribution, habitat use and management.

3.3.3.3 Management actions

1. The existence of this threatened species must be considered in the development of any Fire Management Plan (i.e. fire should be excluded from the areas of potential habitat);
2. The existence of the Grass owl must be considered in the development of any program using pesticides and herbicides for weed and/or mosquito and/or feral animal control).
3. The Stage 1 FAMP (JWA 2011e) will ensure predators such as the Red fox are controlled in areas of known habitat.
4. A monitoring program has been devised to monitor the presence of this species within the vicinity of Precincts 2-4 & 6-11 (SECTION 4). Furthermore, monitoring programs are included within the Precinct 2-4 & 6-11 VMP (2011a) and Precinct 2-4 & 6-11 WMP (2011c) to ensure suitable habitat remains viable.

3.3.4 Grey-headed Flying-fox

3.3.4.1 Threats

The Grey-headed flying-fox has been recorded on the Kings Forest site (FIGURE 6) and will likely utilise the entire Kings Forest site on a seasonal basis (i.e. when feed trees such as Swamp Mahogany, Swamp Box, Scribbly Gum, Broad-leaved Paperbark, Figs etc are flowering).

Potential threats to this species are as follows:

• Loss of foraging habitat;
• Disturbance of roosting sites;
• Unregulated shooting; and
• Electrocution on powerlines.

Large areas or forage resources are retained within Environmental Protection Zones, and the bulk earthworks will result in a very minor reduction of resources for this species.
3.3.4.2 Recovery of the species
The following list of recovery strategies are derived from the Draft Recovery Plan and the PAS, and includes strategies that are relevant to the proposed bulk earthworks within Precincts 2-4 & 6-11:

- Provide educational resources to improve public attitudes toward Grey-headed Flying-foxes.
- Develop materials for public education & provide them to land managers & local community groups working with controversial flying-fox camps, highlighting species status, reasons for being in urban areas, reasons for decline etc.
- Conduct periodic range-wide assessments of the population size of Grey-headed Flying-foxes to monitor population trends.
- Enhance and sustain the vegetation of camps critical to the survival of Grey-headed Flying-foxes.
- Protect and enhance priority foraging habitat for Grey-headed Flying-foxes, for example through management plans, local environmental plans and development assessments, and through volunteer conservation programs for privately owned land.
- Protect roosting habitat critical to the survival of Grey-headed Flying-foxes, for example through management plans, local environmental plans and development assessments, and through volunteer conservation programs for privately owned land.
- Increase the extent and viability of foraging habitat for Grey-headed Flying-foxes that is productive during winter and spring (generally times of food shortage), including habitat restoration/rehabilitation works.

3.3.4.3 Management actions
Although there are no camp sites within Kings Forest, the Grey-headed flying-fox forages widely, (i.e. up to 50km from camps) and is likely to benefit from the extensive rehabilitation works planned in accordance with the Precinct 2-4 & 6-11 VMP (JWA 2011b).

The Grey headed flying fox is a canopy-feeding frugivore, blossom-eater and nectarivore of rainforests, open forests, woodlands, Melaleuca swamps and Banksia woodlands. The restored wet and dry heath communities and other rehabilitated areas within the Environmental Protection zone will provide a potential forage resource for this species.

Bulk earthworks within Precincts 2-4 & 6-11 are likely to result in very few impacts to the Grey-headed flying-fox. The species is known to be adaptable to foraging in close proximity to urban environments, and the majority of suitable habitat for the species is well-buffered from urban encroachment. The following management actions will benefit the Grey-headed flying-fox:

1. Forage areas, for the Grey headed flying fox, will be created by including feed trees such as Swamp Mahogany, Swamp Box, Scribbly Gum, Broad-leaved Paperbark and Figs in the enhancement planting programme.

2. A monitoring program has been devised to monitor the presence of this species within the vicinity of Precincts 2-4 & 6-11 (SECTION 4).
Furthermore, monitoring programs are included within the Precinct 2-4 & 6-11 VMP (2011a) and Precinct 2-4 & 6-11 WMP (2011c) to ensure suitable habitat remains viable.

3.3.5 Koala

A Kings Forest Stage 1 Koala Plan of Management (JWA 2011a) has been prepared and contains a detailed assessment of the potential threats and issues relating to the recovery of the species. Numerous management actions are recommended within the KPoM which should be read in conjunction with this TSMP.

3.3.6 Masked Owl

3.3.6.1 Threats

Masked Owls are likely to forage widely over the Kings Forest site as the mosaic of vegetation types provides habitat for a variety of prey species.

Potential threats to this species are as follows:

- Loss of mature hollow-bearing trees and changes to forest and woodland structure, which leads to fewer such trees in the future.
- Clearing of habitat for grazing, agriculture, forestry or other development.
- A combination of grazing and regular burning is a threat, through the effects on the quality of ground cover for mammal prey, particularly in open, grassy forests.
- Secondary poisoning from rodenticides.
- Being hit by vehicles.

Some small areas of habitat (e.g. grassland and heathland) for potential prey species for the Masked owl (e.g. Black Rat, Bush Rat and Swamp Rat) will be lost during bulk earthworks within Precincts 2-4 & 6-11. However, retention of large areas within Environmental Protection Zones will continue to provide a variety of forage environments for Masked owls.

Masked Owls may also be at risk from use of second-generation (single-dose) rodenticides used for management of rodents.

3.3.6.2 Recovery of the species

An approved Recovery Plans has been prepared for the Masked Owl (as part of the ‘Recovery Plan for the Large Forest Owls’). The Recovery Plan lists the following relevant proposed recovery objectives:

- Encourage private landholders to undertake management options to conserve and/or actively manage forest owl habitat.
- Ensure the impacts on large forest owls and their habitats are adequately assessed during planning and environmental assessment processes.
- Minimise further loss and fragmentation of habitat by protection and more informed management of significant owl habitat (including protection of individual nest sites).
• To raise awareness of the conservation requirements of the three large forest owls amongst the broader community, to involve the community in owl conservation efforts and in so doing increase the information base about owl habitats and biology.

3.3.6.3 Management Actions
The Masked owl lives as monogamous, sedentary life-long pairs in large permanent home ranges (i.e. 500 to 1000 hectares). They cover dry eucalypt forests and woodlands from sea level to 1100 m and hunt along the edges of forests, including road sides. Their diet will typically include tree-dwelling and ground mammals, especially rats.

The following management actions will benefit the Masked owl:

1. Hunting grounds consisting of habitat for small mammals will be created through proposed revegetation works. In addition to the creation of new habitat, extensive areas currently weed infested and supporting pine plantations will be rehabilitated to extend forage areas in accordance with the Precinct 2-4 & 6-11 VMP (2011a) and Precinct 2-4 & 6-11 WMP (2011c).

2. The existence of the Masked owl must be considered in the development of any program using pesticides and herbicides for weed and/or mosquito and/or feral animal control.

3. A monitoring program has been devised to monitor the presence of this species within the vicinity of Precincts 2-4 & 6-11 (SECTION 4). Furthermore, monitoring programs are included within the Precinct 2-4 & 6-11 (2011a) and Precinct 2-4 & 6-11 WMP (2011c) to ensure suitable habitat remains viable.

3.3.7 Wallum froglet & Wallum sedge frog (Acid frogs)

3.3.7.1 Background
Wallum froglets have been recorded in association with constructed drainage lines within the proposed bulk earthworks area as well as inhabiting depressions formed during Slash pine stump removal (FIGURE 5). Low lying wet heath and drainage line communities and adjacent areas prone to frequent inundation, within adjacent EPZ’s, are considered to provide core habitat for this species (FIGURE 9).

Many of the Wallum froglet records within the Kings Forest site occur in forage habitat (i.e. land inundated after heavy rain) rather than core habitat.

Wallum sedge frogs have been recorded in association with two constructed dams in the southern portion of the Kings Forest site (FIGURE 5). Potential habitat is also considered to occur in the vicinity of Precinct 2-4 & 6-11.

3.3.7.2 Threats
Potential threats to these species from bulk earthworks within Precincts 2-4 & 6-11 include:
• Loss of habitat from habitat removal and fragmentation;
• Changes in hydrology;
• Water pollution;
• Injury/death from vehicle strike; and
• Contamination of habitat by herbicides, pesticides and fertiliser as part of landscaping maintenance.

3.3.7.3 Recovery of the species
An approved Recovery Plan has been prepared for the Wallum froglet and the Wallum sedge frog (as part of the ‘National recovery plan for the wallum sedgefrog and other wallum-dependent frog species’ [Meyer et al. 2006]). The Recovery Plan lists the following relevant proposed recovery objectives:

• Identify and assess essential habitat.
• Protect wallum frog populations and manage habitat.
• Acquire information on threats to inform management.
• Engage stakeholders and the broader community in recovery of wallum frog species.
• Rehabilitate degraded wallum frog habitat.
• Monitor frog numbers and distribution.

3.3.7.4 Management Actions
Long-term management of these species will be tied to the maintenance of existing suitable habitat within EPZ’s and the creation of additional compensatory habitat areas within EPZ’s and ecological buffers to offset unavoidable losses of habitat. Maintenance of hydrology (particularly acidity), stormwater and run-off (including herbicides, pesticides, fuel etc.) in constructed habitat areas is critical in determining whether these areas are capable of supporting the species in the long term.

The following management actions have considered the appropriate objectives of the National Recovery Plan:

1. Compensatory habitat areas will be created within EPZ’s and ecological buffers and will include core breeding habitat and forage habitat areas. Constructed ponds for the Wallum froglet and Wallum sedge frog have been completed as part of the Tugun Bypass, with successful results. Details of the proposed Acid Frog Compensatory habitat strategy at Kings Forest are provided in APPENDIX 1.

2. Additionally, forage habitat will be created for the Acid frogs with the construction of bio-filtration swales within ecological buffers.

3. In addition to the creation of new habitat, extensive areas currently weed infested and supporting pine plantations will be rehabilitated to extend habitat areas in accordance with the Precinct 2-4 & 6-11 VMP (JWA 2011b) and Precinct 2-4 & 6-11 WMP (2011d).

4. A detailed water quality monitoring regime is included in the Overall Water Management Plan (Gilbert & Sutherland 2011b) and will ensure that significant impacts on Acid frog habitats are avoided.
5. The Stage 1 FAMP (JWA 2011e) will ensure Cane toads are controlled in areas of known habitat. Core habitat areas will densely planted with sedges etc. to deter Cane toads from entering these areas.

6. The existence of the Acid frogs must be considered in the development of any Fire Management Plan (i.e. fire should be excluded from swamps and areas immediately adjacent to Wallum froglet habitat).

7. To minimise the spread of the disease chytridiomycosis to and between habitats, all contractors undertaking work in both wetland construction and vegetation rehabilitation must follow the protocol set out within the publication *Hygiene protocol for the control of disease in frogs* (DECCW & NPWS 2008).

8. The existence of the Acid frogs must be considered in the development of any program using pesticides and herbicides for weed and/or mosquito and/or feral animal control).

9. A monitoring program has been devised to monitor the presence of these species within the vicinity of Precincts 2-4 & 6-11 (SECTION 4). Furthermore, monitoring programs are included within the Precinct 2-4 & 6-11 VMP (2011a) and Precinct 2-4 & 6-11 WMP (2011c) to ensure suitable habitat remains viable.

### 3.3.8 Yellow-bellied sheathtail bat

#### 3.3.8.1 Threats

The Yellow-bellied sheathtail bat roosts singly or in groups of up to six, in tree hollows and buildings. In treeless areas they are known to utilise mammal burrows. When foraging for insects, this species flies high and fast over the forest canopy, but lower in more open country. This species has been recorded in the Environmental Protection Zone in the southern of the Kings Forest site (FIGURE 6).

General threats to Yellow-bellied sheathtail bat include:

- Disturbance to roosting and summer breeding sites.
- Foraging habitats are being cleared for residential and agricultural developments, including clearing by residents within rural subdivisions.
- Loss of hollow-bearing trees; clearing and fragmentation of forest and woodland habitat.
- Pesticides and herbicides may reduce the availability of insects, or result in the accumulation of toxic residues in individuals’ fat stores.

Potential threats to Yellow-bellied sheathtail bat from the bulk earthworks within Precincts 2-4 & 6-11 include:

- Minor loss of foraging habitats;
- Potential loss of hollow-bearing trees; and
- The use of pesticides and herbicides which may reduce the availability of insects, or result in the accumulation of toxic residues in individuals’ fat stores.
3.3.8.2 Recovery of the species

No recovery plan exists for the Yellow-bellied sheathtail bat, however Priority Action Statements have been prepared. The following list of recovery strategies is derived from the PAS and includes strategies that are relevant to the proposed bulk earthworks within Precincts 2-4 & 6-11:

- Raise the awareness of local residents and golf course management/users about the presence of the species and provide information on how their management/use will affect the species' survival.
- Consult authorities when planning development/s to minimise impact/s on populations.
- Conduct searches for the species in suitable habitat in proposed development areas.
- Retain stands of native vegetation, especially those with hollow-bearing trees (including dead trees), and retain other structures containing bats.
- Retain a buffer of vegetation around roost sites in vegetated areas.
- Protect hollow-bearing trees for breeding sites, including those on farmland; younger mature trees should also be retained to provide replacements for the older trees as they die and fall over.
- Reduce the use of pesticides in the environment.
- Encourage regeneration and replanting of local flora species to maintain bat foraging habitat.
- Assess the site's importance to the species' survival, including linkages provided between ecological resources across the broader landscape.
- Mark known sites and potential habitat onto maps used for planned poison-spraying activities.

3.3.8.3 Management Actions

1. Quality habitat will be created for this species with the completion of restoration/rehabilitation works in accordance with the Precinct 2-4 & 6-11 VMP (2011a). In addition to the creation of new habitat, extensive areas currently weed infested and supporting pine plantations will be rehabilitated to extend forage areas in accordance with the Precinct 2-4 & 6-11 VMP (2011a) and Precinct 2-4 & 6-11 WMP (2011c).

2. The existence of the Yellow-bellied sheathtail bat must be considered in the development of any Fire Management Plan (i.e. fire should be excluded from suitable habitat).

3. The existence of the Yellow-bellied sheathtail bat must be considered in the development of any program using pesticides and herbicides for weed and/or mosquito and/or feral animal control).

4. A monitoring program has been devised to monitor the presence of these species within the vicinity of Precincts 2-4 & 6-11 (SECTION 4). Furthermore, monitoring programs are included within the Precinct 2-4 & 6-11 VMP (2011a) and Precinct 2-4 & 6-11 WMP (2011c) to ensure suitable habitat remains viable.
4 Monitoring and Reporting

4.1 Background

A well-designed monitoring program will allow project managers to detect results months, years, or decades following implementation of a plan. This section outlines the monitoring requirements for the area subject to this TSMP.

Populations of Threatened flora & fauna within the EPZ’s will be monitored on an annual basis for a period of five (5) years.

4.2 Flora monitoring

All threatened plant species will be monitored as follows:

- Survival
- Height
- Flowering
- Fruiting
- Signs of natural recruitment
- Potential threats (i.e. weeds)

4.3 Fauna monitoring

A baseline survey will be completed prior to commencement of construction to determine species presence. The fauna surveys will target Threatened species recorded, or predicted to occur and will include the following methodology (where appropriate):

- Elliott trapping;
- Cage trapping;
- Pitfall trapping;
- Arboreal Elliott trapping;
- Spotlighting/stag watching;
- Call playback;
- Dawn & dusk bird surveys;
- Hair tubes; and
- Active searching.
4.4 Performance Criteria

The success of the TSMP will be regularly evaluated (i.e. as above). A number of criteria will indicate successful management of threatened species. The overall performance criteria for this plan are that:

- Management actions for each threatened species as listed within the TSMP are completed;
- All recorded threatened flora species survive and flourish during the proposed bulk earthworks;
- Where revegetation is proposed in accordance with this TSMP (i.e. buffer plantings, compensatory habitat etc.), survival of 95% of stems planted;
- Within revegetation areas, establishment of a 70% native ground cover after 2-3 years;
- Within revegetation areas, average percentage cover of 90% native ground cover at the 5th year;
- Within revegetation areas, noxious weeds are to be eradicated and environmental weeds less than 1% of the area;
- Within revegetation areas, maintenance of 100% of planted diversity;
- All appropriate exclusion fencing is in place and operational, and existing habitat to be retained for each threatened flora and fauna species remains unaffected; and
- Feral animal monitoring is completed in accordance with the FAMP (JWA 2011c).

4.5 Monitoring Reports

A report will be prepared after each annual survey period and will include the following:

- Results of the flora and fauna surveys;
- A comparison of results with previous years;
- Discussion regarding the absence of previous species/occurrence of new species;
- Any habitat maintenance recommendations (i.e. additional nest boxes etc.);
- Discussion regarding the occurrence of any weed/pest species;
- Recommendations for controlling weed/pest species (if required); and
- Performance against performance criteria (Section 4.4).
REFERENCES


APPENDIX 1 - ACID FROG COMPENSATORY HABITAT

1. Background

Two (2) Threatened species of ‘Acid fog’ have been recorded from the vicinity of Precincts 2-4 & 6-11 (FIGURE 6):

- Wallum froglet (*Crinia tinnula*); and
- Wallum sedge frog (*Litoria olongburensis*).

The Wallum froglet is listed as Vulnerable within schedules of the NSW Threatened Species Conservation Act (1995). Wallum froglets inhabit acid paperbark swamps and sedge swamps of the coastal ‘wallum’ country.

The Wallum sedge frog is listed as Vulnerable within schedules of the NSW Threatened Species Conservation Act (1995) and the Commonwealth Environment Protection & Biodiversity Conservation Act (1999).

Core habitat for Acid frog species within the vicinity of Precincts 2-4 & 6-11 is considered to be comprised of undisturbed and regenerating wet heathland (FIGURE 9, PLATE 1), whilst remaining habitats (i.e. adjoining areas of grassland and slashed areas) are considered to provide forage habitat when inundated during wet periods.

Wallum froglets in particular have been recorded in a number of locations within Precincts 2-4 & 6-11 particularly within constructed drainage line communities (PLATE 2). Whilst numerous records have occurred over a 10 year period in some areas of the site not mapped as core habitat, records of this species do not necessarily equate with breeding habitat. Breeding habitat must retain water for extended periods of time.

Furthermore, the Wallum froglet is known to move into adjacent habitats during rainfall events. During a study of the habitat and movements of the Wallum froglet by White & Pike (2006), froglets were often located away from breeding ponds in nearby heath and woodland and could be found up to 100m from a pond. Froglet movement between ponds and foraging sites nearby appeared to be directed by the occurrence of rainfall events.

The assessment of impacts on Acid frog habitat has considered the avoid, mitigate, offset approach as described in the Threatened Species Assessment Guidelines: The Assessment of Significance (DPI 2008). However, the proposed bulk earthworks within Precincts 2-4 & 6-11 will result in unavoidable impacts on some Core habitat areas. Core habitat in other areas of the site has been avoided and will be rehabilitated.
PLATE 1: Existing frog habitat (i.e. regenerating wet heath) within EPZ to the south of Precinct 2.

PLATE 2: Example of existing frog habitat within the development area (i.e. constructed drainage line with Precinct 5).
2. Literature Review

Few attempts to replicate or re-instate breeding areas for ‘Acid frogs’ have been undertaken and documented in Australia. It is well recognised however that the Wallum froglet will rapidly recolonise disturbed areas previously containing ‘Wallum’ vegetation. In these instances common attributes are shallow water bodies in sandy soils and of low pH and electrical conductivity (Ecosense Consulting Pty Ltd, 2005).

The creation of compensatory habitat was completed for ‘Acid frog’ species during the construction of the Tugun Bypass. The design requirements of the Tugun Bypass frog ponds were determined through consultation with a number of recognised authorities on ‘Acid frogs’.

A number of recommendations were provided by these experts based on observations made during field & laboratory work (Ecosense Consulting Pty Ltd, 2005):

- Ponds should be constructed in sandy substrates (which previously contained ‘Wallum’) with an underlying organic hardpan;
- Ponds should generally be shallow and constructed in areas of high groundwater;
- Water quality should exhibit the following characteristics:
  - pH <5 (as influenced by humic soils);
  - hardness < 100 p.p.m;
  - salinity < 350 uS.cm⁻¹;
- Ponds should be ephemeral to prevent habitation by fish but have a minimum hydro-period of 4-6 weeks for the Wallum froglet; and
- Pond fringes should be densely planted with emergent species to prevent predation by the Cane toad (Bufo marinus).

Four (4) frog ponds were constructed within compensatory habitat areas adjoining the Tugun Bypass. Both the Wallum froglet and the Wallum sedge frog (Litoria olongburensis) have been recorded within these constructed ponds. Furthermore, water treatment basins constructed around the bypass have had the added benefit of providing additional frog habitat. Wallum froglets have been recorded calling from several water treatment basins on numerous occasions during monitoring events (Pacific Alliance, 2010).
3. Kings Forest Proposal

It is proposed to create Core Acid frog habitat within Environmental Protection Zones (EPZ’s), ecological buffers and the golf course on the Kings Forest site (FIGURE 10). Areas requiring rehabilitation works within EPZ’s and buffers will be targeted for the creation of Core Acid Frog habitat. Site selection has also included consideration of the following:

- Proximity to existing Core habitat areas and Acid frog records (FIGURE 11);
- Distribution of suitable soils (i.e. Podsols) (FIGURE 12);
- Topography;
- Presence of Potential Acid Sulphate soils (FIGURE 13); and
- Existing vegetation values.

A typical section and plan view of the proposed compensatory acid frog habitat FIGURE 14. The compensatory core acid frog habitat will include:

- The creation of melon holes by either using an excavator bucket to form holes approximately 60cm deep by at least 1.8m long, or through the removal of Slash pine stumps which has been shown to create small breeding ponds elsewhere on the site (PLATE 3);
- These holes will be created to intercept the water table to ensure water is available for an extended period of time and allow for successful breeding;
- It would be expected that the water in these melon holes would evaporate during extended dry periods;
- ‘Tiles’ of suitable vegetation (i.e. from existing habitat areas to be removed) will be translocated to compensatory habitat areas. It is likely that some frogs will also be translocated with the tiles of vegetation;
- Additionally, dense plantings of Saw-sedge (Gahnia spp.), Curly sedge (Baloskion spp.) and Matrush (Lomandra spp.) will also occur around the margins of these melon holes (where required) to ensure almost complete coverage of the hole by the sedges;
- The narrow design of the melon holes, coupled with the dense planting of Saw-sedge, will assist in the prevention of mosquito breeding, protect tadpoles from predation and preclude the occurrence of Cane toads.

The compensatory habitat areas will be planted with a combination of Swamp sclerophyll (i.e. Swamp mahogany & Broad-leaved paperbark) and Wet heath species.
KINGS FOREST

STAGE 1 PROJECT APPLICATION

PRECINCT 12, 13 & 14
THREATENED SPECIES
MANAGEMENT PLAN

JUNE 2011

A REPORT PREPARED FOR PROJECT 28 PTY LTD
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1 INTRODUCTION

1.1 Background

The NSW Minister for Planning approved a Concept Plan for the proposed residential community at Kings Forest on the 19th August 2010. The approved documents included a Revised Threatened Species Management Plan (LandPartners 2009), which proposed the principles upon which the management of Threatened species at the Kings Forest site would be based.

Subsequently, the Director General issued modified Environmental Assessment Requirements (DGR’s) on the 22nd December 2010. James Warren & Associates (JWA) were engaged by Project 28 Pty Ltd to complete a Kings Forest Stage 1 Project Application Threatened Species Management Plan (TSMP) for Precincts 12, 13 & 14 in accordance with requirements of 9.4 of these DGR’s and Clause C2 of the modified Concept Approval.

1.2 Proposed Development

2.3.1 Kings Forest Stage 1 Project Application

The Kings Forest site consists of 872 hectares of land located at Cudgen between Bogangar to the south-east and Kingscliff to the north in Northern New South Wales (NSW). The concept plan for the Kings Forest site is shown in FIGURE 1.

The scope of the Stage 1 Project Application works is as follows:

- Construction of the entrance road to the site and associated intersection works on Tweed Coast Road.
- Alignment and construction details of two lanes of Kings Forest Parkway, from Tweed Coast Road via Precincts 2, 3, 4 and 5 through to the roundabout in the western part of the site from which access to the southern part of the site is to be gained.
- Alignment and construction details for the civil works of the two proposed roads through the east-west SEPP 14 area to access the southern part of the site.
- Rural retail development in Precinct 1 to the east of Tweed Coast Road.
- Subdivision and construction of residential Precinct 5.
- Bulk earthworks across the site in Precincts 2, 3, 4, 6, 7, 8, 9, 10, 11, 12, 13 & 14.

The scope of works is illustrated in FIGURE 2.
Tweed Coast Road
Kingsford

50m Ecological Buffer

Proposed Zone Substation
(Subject to Country Energy final approval)

Private Open Space

Golf Course Area (Encompassing ecological buffers where indicated)

Private Open Space Including Lake

50m Ecological Buffer
(Includes APZs & Roads where approved)

State School Site

Proposed Zone Substation
(Subject to Country Energy final approval)

Legend:
- Town Centre / Neighbourhood Centre
- Residential
- Community Facilities / Education
- Employment Land
- Structured Open Space (Active)
  (Passive open space to council standards, location subject to urban design)
- Environmental Open Space
  (To be Dedicated to Council or NPWS)
- Environmental Protection Area
  (To be Dedicated to Council or NPWS)
- 50m Ecological Buffer
  (Includes APZs & Roads where approved)
- Active Environmental Protection Area
  to be Dedicated to Council or NPWS
- State School Site
- Proposed Zone Substation
  (Subject to Country Energy final approval)
- Private Open Space
- Golf Course Area
  (Encompassing ecological buffers where indicated)
- Private Open Space Including Lake
- Precincts 12-14
- Kings Forest Boundary

Kings Forest Boundary

Source: MPS Architects

Ref: 2011-06-23 DA Set.pdf

Prepared: BW
File: N97017_TSMP_Concept.cdr

Date: 24 June 2011

JAMES WARREN & ASSOCIATES PTY LIMITED
Environmental Consultants

Shire of Tweed

CLIENT
PROJECT
PROJECT
Title
Source
Prepared
Date
File
STAGE 1
SCOPE OF WORKS

Kings Forest Stage 1 Project Application
Precincts 12-14 - Threatened Species Mgt Plan
Melaleuca Drive, Duranbah, NSW
Shire of Tweed
2.3.2 Precincts 12, 13 & 14

This TSMP has been prepared for the proposed bulk earthworks in Precincts 12, 13 & 14 (FIGURE 2).

1.3 Aim & Objectives

The aim of this TSMP is to provide guidelines, strategies and methods for the management of the Threatened flora and fauna species recorded within the vicinity of Precincts 12, 13 & 14 such that species continue to persist and reproduce.

Specific objectives of the Precinct 12, 13 & 14 TSMP include:

- provide a summary of the threatened flora and fauna species occurring within the vicinity of Precincts 12, 13 & 14;
- provide a profile for each threatened species occurring which includes:
  - a list of overall threats to the species;
  - potential threats from bulk earthworks within Precincts 12, 13 & 14;
  - recovery strategies for the species including details of Approved Recovery Plans and/or Priority Actions;
- devise management strategies to be implemented including:
  - strategies for the protection of threatened species during the bulk earthworks activities;
  - weed control measures specific to areas containing listed threatened flora and fauna;
  - guidelines for the control of human and animal access to areas containing threatened species; and
  - strategies for the embellishment of threatened species habitat through revegetation works and/or the creation of compensatory habitat areas where required.

1.4 Plan Requirements

As discussed above, this TSMP has been prepared in accordance with DGR 9.4 which states:

“Updates are to be provided, where relevant, for the various management plans for koalas, vegetation, threatened species, feral animals, weeds, the buffers, and the golf course providing where relevant details on timelines for implementation of recommended works including maintenance periods and measurable performance and completion criteria. Each plan is to consider all other plans for the site to ensure that management strategies do not conflict and that each plan can be implemented without negatively impacting on the objectives of another.”
This TSMP has also been prepared to comply with Clause C2 of the modified Concept Approval as follows:

**Threatened Species Management Plan**

“Each Threatened Species Management Plan update is to provide further details on specific habitat management measures to safeguard existing populations of the two threatened Wallum frog species that occur within the Environmental Protection zones, Ecological buffers and the golf course. These measures are to be determined with reference to contemporary scientific literature and current best practice.”

### 1.5 Relationship to other Management Plans

Additional to this TSMP, the following Management Plans relevant to Precincts 12, 13 & 14 have been prepared for the Stage 1 Project Application, and should be read in conjunction with this TSMP:

- Kings Forest Stage 1 Project Application: Precinct 12, 13 & 14 Vegetation Management Plan (JWA 2011a); and
- Kings Forest Stage 1 Project Application: Precinct 12, 13 & 14 Weed Management Plan (JWA 2011b).

A Kings Forest Stage 1 Project Application Feral Animal Management Plan (Stage 1 FAMP) (JWA 2011c) has also been prepared for the entire Kings Forest site and is therefore relevant to Precincts 12, 13 & 14.

Furthermore, a Kings Forest Stage 1 Project Application Koala Plan of Management (Stage 1 KPoM) (JWA 2011d) has been prepared for the entire Kings Forest site and is therefore relevant to Precincts 12, 13 & 14.

This TSMP should also be read in conjunction with the Site Based Management Plan (Gilbert & Sutherland 2011a) which details further protection measures for Threatened species during the following phases of development across the entire Kings Forest site:

1. Bulk earthworks
2. Landform stabilisation
3. Civil construction
4. On maintenance
5. Operational
2 SUMMARY OF SIGNIFICANT VALUES

2.1 Background

Kings Forest has been comprehensively studied. A summary of the significant values relevant to this TSMP are provided in the following sections.

2.2 Endangered Ecological Communities

Three (3) Endangered Ecological Communities (EEC’s)\(^1\) occur within the vicinity of Precincts 12, 13 & 14 (FIGURE 3):

- Swamp sclerophyll forest on coastal floodplain;
- Freshwater wetlands; and
- Subtropical coastal floodplain forest.

2.3 Threatened Species

2.3.3 Flora

One (1) Threatened flora species occurs within the vicinity of Precincts 12, 13 & 14 - the White yiel yiel (*Grevillea hilliana*) (FIGURE 4).

2.3.4 Fauna

Eleven (11) Threatened fauna species have been recorded (FIGURE 5), or are considered to be provided with potential habitat, within the vicinity of Precincts 12, 13 & 14. These species are as follows:

- Bush hen (*Amaurornis olivaceus*)
- Bush stone-curlew (*Burhinus grallarius*)
- Common planigale (*Planigale maculata*)
- Glossy black cockatoo (*Calyptorhynchus lathami*)
- Grass Owl (*Tyto capensis*)
- Grey Headed Flying fox (*Pteropus poliocephalus*)
- Koala (*Phascolarctos cinereus*)
- Masked Owl (*Tyto novaehollandiae*)
- Wallum sedge frog (*Litoria olongburensis*)
- Wallum froglet (*Crinia tinnula*)

\(^1\) As listed within schedules of the TSC Act (1995).
- Yellow-bellied sheathtail bat (*Saccolaimus flaviventris*)

### 2.4 SEPP 14 Wetlands

SEPP 14 - Coastal Wetlands are mapped over large areas of the Kings Forest site, including areas adjacent to Precincts 12, 13 & 14 (FIGURE 6). These wetlands are protected by State Environmental Planning Policy No. 14 - Coastal Wetlands (SEPP 14).

### 2.5 Cudgen Nature Reserve

Cudgen Nature Reserve occurs immediately adjacent to the eastern and southern boundaries of the Kings Forest site (FIGURE 7).
3 Threats, Recovery Strategies and Management Actions

3.1 Introduction

The existing and potential threats, recovery strategies and management actions for all listed species that occur within the vicinity of Precincts 12, 13 & 14 are discussed below. For the listed threatened species, management actions are based on those set out in the Revised Threatened Species Management Plan (LandPartners 2009) which accompanied the Concept Plan Application, the Draft or Approved Recovery Plan and the Priority Action Statement.

3.3 Threatened Flora Species

3.3.1 White yiel yiel

3.3.1.1 Threats

Two (2) stems of White yiel yiel (Grevillea hilliana) has been recorded in the western portion of Precinct 12 in an area of Camphor laurel dominated closed forest (FIGURE 4).

The surrounding vegetation is highly disturbed and degraded with typical weed species including Camphor laurel, Lantana, Mist Flower, Crofton Weed, Broad-leaved Paspalum and Cherry guava. It is likely that a mature parent tree occurs on adjacent land to the west.

Threats to these trees include competition from weeds and accidental damage/removal as part of clearing works or weed removal.

3.3.1.2 Recovery of the Species

There is no approved Recovery Plan for this species or a Priority Action Statement, however, the following actions are listed on the NSW threatened species web site (DECC 2005) as actions to be undertaken to recover the species.

- Buy plants only from licensed nurseries.
- Prevent weeds and garden plants from invading habitat.
- Protect remnant rainforest areas from development.
- Seek a permit from the DEC before collecting seed from wild plants.
- Report new occurrences to the DEC.

3.3.1.3 Management Actions

1. Prior to commencement of earthworks a search is to be completed to locate any other specimens of this species and propagate offspring that can then be used in rehabilitation works.

2. Prior to any rehabilitation works the White yiel yiel must be identified and clearly marked. A secure high visibility fence (i.e. star pickets and high
visibility mesh) should be constructed around both trees to limit disturbance.

3. No mechanical works are to be undertaken within 10m of the protected trees.

4. Weed control in the vicinity of these plants will be undertaken strictly adhering to the following strategies:
   a. Any personnel involved in restoration/weed control works in the vicinity of the trees should be made aware of the location of the trees.
   b. Areas immediately adjacent to the trees should be hand weeded.
   c. Vines and Lantana should be carefully removed by hand.
   d. Extreme care should be taken when spraying herbicides in the area to ensure drift does not adversely affect the trees.

5. The White yiel yiel occurs within land zoned for urban expansion. A 10m buffer of Rainforest species will be planted to protect the threatened plants. This area will be protected by covenant and ownership transferred to Tweed Shire Council.

6. The existence of the threatened species must be considered in the development of any Fire Management Plan (i.e. fire should be excluded from the area immediately adjacent to the trees).

7. A monitoring program has been devised to monitor the health and continued persistence of these trees and to search for and record any additional individuals of this species occurring within the vicinity of Precincts 12, 13 & 14 (SECTION 4). Furthermore, monitoring programs are included within the Precinct 12, 13 & 14 VMP (2011a) and Precinct 12, 13 & 14 WMP (2011b) to ensure suitable habitat remains viable.

### 3.4 Fauna

#### 3.4.1 Bush hen

##### 3.4.1.1 Threats

The Bush hen was recorded in rank sedges in the understorey of Swamp sclerophyll forest adjacent to the Cudgen Lake (Warren 2000) (FIGURE 5). The sighting was within the Environmental Protection Zone, an area which will be retained and rehabilitated. This species may also occur in forest growth and pastures around Precincts 12, 13 & 14 within close proximity to permanent water.

Potential threats to this species are as follows (DECC 2005):

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands.
- Loss of dense and rank understorey vegetation near streams and wetlands with clearing associated with urban and semi-rural developments.
• Clearing, filling and draining of wetlands for agricultural, residential and industrial development.
• Pollution of wetlands from agricultural, urban and industrial run-off, including herbicides and pesticides.
• Changes to wetlands caused by weed invasion, often associated with sedimentation or grazing.
• Predation by introduced, feral and domestic predators, particularly Red Foxes (*Vulpes vulpes*) and Cats.
• Destruction of habitat and predation by feral Pigs (*Sus scrofa*).

Potential threats to the species from bulk earthworks within Precincts 12, 13 & 14 include:

• Minor loss of habitat within low-lying pasture;
• Human disturbance to areas of forage habitat; and
• Disturbance from straying domestic dogs.

### 3.4.1.2 Recovery of the species

No recovery plan exists for this species, however a Priority Action Statement has been prepared. The following list of recovery strategies is derived from the PAS and includes strategies that are relevant to the proposed bulk earthworks within Precincts 12, 13 & 14:

• Increase community awareness regarding the biodiversity values of vegetated freshwater wetlands on floodplains in northern NSW through educational programs.
• Control pest species in conservation reserves and other areas of public land known to support Bush-hens.
• Reduce grazing and drainage of vegetated floodplain wetlands through the implementation of targeted programs such as landholder education, fencing of reserve boundaries, weed control programs and wetland restoration programs.
• Reduce nutrient runoff into freshwater wetlands known to be used by Bush-hens.
• Restore natural hydrological regimes to freshwater wetlands and maintain existing hydrological regimes; do not fill or drain wetlands; retain and protect native vegetation in and around wetlands and restore degraded wetlands.
• Ensure that Bush-hens are considered in the preparation of weed management plans. Specifically, it must be recognised that Bush-hens readily utilise thickets of exotic species, such as *Lantana camara*.
• Weed control programs must ensure that suitable roosting sites in the form of dense vegetation are retained or replaced with native plants that provide a similar structure.

### 3.4.1.3 Management Actions

The Bush hen will benefit from the extensive rehabilitation works planned in accordance with the Precinct 12, 13 & 14 VMP (2011a) and Precinct 12, 13 & 14
WMP (2011b) as well as the construction of artificial wetland storm water devices, weed control and enhancement planting within the golf course.

The following management actions will benefit the Bush hen:

1. Quality habitat will be created for the Bush hen within the golf course area (i.e. storm water control devices). In addition to the creation of new habitat, extensive areas currently weed infested and supporting pine plantations will be rehabilitated to extend forage areas in accordance with the Precinct 12, 13 & 14 VMP (2011a) and Precinct 12, 13 & 14 WMP (2011b).

2. The Stage 1 FAMP (JWA 2011c) will ensure predators such as the Red fox are controlled in areas of known habitat.

3. A monitoring program has been devised to monitor the presence of this species within the vicinity of Precincts 12, 13 & 14 (SECTION 4). Furthermore, monitoring programs are included within the Precinct 12, 13 & 14 VMP (2011a) and Precinct 12, 13 & 14 WMP (2011b) to ensure suitable habitat remains viable.

### 3.4.2 Bush stone-curlew

#### 3.4.2.1 Threats

A single record for the Bush Stone-curlew occurs in the south-eastern part of Kings Forest, adjacent to the proposed golf course and residential areas (Warren 2000) (FIGURE 5). The species usually inhabits open forests and woodlands with a sparse grassy ground layer and fallen timber.

Overall threats to this species are as follows (DECC 2005):

- Predation by foxes and cats.
- Trampling of eggs by cattle.
- Clearance of woodland habitat for agricultural and residential development.
- Modification and destruction of ground habitat through removal of litter and fallen timber, introduction of exotic pasture grasses, grazing and frequent fires.
- Disturbance in the vicinity of nest sites.

Potential threats to the species from bulk earthworks within Precincts 12, 13 & 14 include:

- Injury/death from vehicle strike;
- Injury/death from domestic animals;
- Loss of habitat (either directly as a result of development, or indirectly as habitat becomes unsuitable due to regrowth of heathland in identified habitat areas); and
- Human disturbance.
3.4.2.2 Recovery of the species

No recovery plan exists for this species however a Priority Action Statement has been prepared. The following list of recovery strategies is derived from the PAS and includes strategies that are relevant to the bulk earthworks within Precincts 12, 13 & 14.

- Keep domestic dogs and cats indoors at night.
- Desex domestic dogs and cats.
- Undertake fox and feral cat control programs.
- Assess the appropriateness of dog and cat ownership in new subdivisions.
- Remove cattle from paddocks containing nesting areas at least during breeding season or while eggs and chicks are in nest.
- Retain existing vegetation along roadsides, in paddocks and remnant stands of native trees.
- Retain dead timber on the ground in open woodland areas.
- Fence off suitable woodland habitats, particularly those with unimproved pasture and an intact native ground plant layer.
- Fence off nesting sites.
- Increase the size of existing remnants, planting trees and establishing buffer zones of unimproved uncultivated pasture around woodland remnants.
- Assess the importance of the site to the species' survival. Include the linkages the site provides for the species between ecological resources across the broader landscape.

3.4.2.3 Management Actions

The Bush stone curlew will benefit from the extensive rehabilitation works planned in accordance with the Precinct 12, 13 & 14 VMP (2011a) and Precinct 12, 13 & 14 WMP (2011b).

The following management actions will benefit the Bush stone-curlew:

1. Quality habitat will be created for the Bush stone-curlew within the golf course area (i.e. vegetated bio-retention basins, ecological regeneration zones and forest regeneration with the Golf course area). In addition to the creation of new habitat, extensive areas currently weed infested and supporting pine plantations will be rehabilitated to extend forage areas in accordance with the Precinct 12, 13 & 14 VMP (2011a) and Precinct 12, 13 & 14 WMP (2011b).

2. The existence of the Bush stone-curlew must be considered in the development of any program using pesticides and herbicides for weed and/or mosquito and/or feral animal control.

3. The Stage 1 FAMP (JWA 2011c) will ensure predators such as the Red fox are controlled in areas of known habitat.

4. The existence of this threatened species must be considered in the development of any Fire Management Plan (i.e. fire should be excluded from the areas of potential habitat);
5. A monitoring program has been devised to monitor the presence of this species within the vicinity of Precincts 12, 13 & 14 (SECTION 4). Furthermore, monitoring programs are included within the Precinct 12, 13 & 14 VMP (2011a) and Precinct 12, 13 & 14 WMP (2011b) to ensure suitable habitat remains viable.

3.4.3 Common planigale

3.4.3.1 Threats
A single record of the Common planigale occurs in the south-eastern portion of the Kings Forest site (FIGURE 5). Suitable habitat for this species is also considered to occur within the vicinity of Precincts 12, 13 & 14.

Overall threats to this species are as follows (DECC 2005):

- Predation by foxes, cats and cane toads.
- Loss and fragmentation of habitat through clearing for agriculture and development in coastal areas.
- Frequent burning and grazing that reduces ground cover such as hollow logs and bark.
- Disturbance of vegetation surrounding water bodies.

Potential threats to the species from development of Precincts 12, 13 & 14 include:

- loss of habitat;
- mortality from vehicles and domestic cats; and
- disturbance due to human activity.

3.4.3.2 Recovery of the species
No recovery plan exists for this species however a Priority Action Statement has been prepared. The following list of recovery strategies is derived from the PAS and includes strategies that are relevant to the bulk earthworks within Precincts 12, 13 & 14.

- Control foxes, feral cats and cane toads.
- Reduce the impact of burning to retain diverse understorey species and cover, such as hollow logs and bark.
- Maintain adequate ground cover, especially near water.
- Control cattle access to reduce grazing and trampling of waterside vegetation.
- Protect areas of habitat from clearing and development.

3.4.3.3 Management Actions
The Common planigale will benefit from the extensive rehabilitation works planned in accordance with the Precinct 12, 13 & 14 VMP (2011a) and Precinct 12, 13 & 14 WMP (2011b).
The following management actions will also benefit the Common planigale:

1. As cats will be prohibited from the site, risks to the Common planigale will be significantly reduced. Feral animal control in accordance with the Stage 1 FAMP (JWA 2011c) will ensure the any stray feral cats are appropriately controlled, while the Koala exclusion fences (JWA 2011d) will restrict domestic dogs as well as humans from entering habitat areas for the species.

2. Quality habitat will be created for the Common planigale within the golf course area (i.e. vegetated bio-retention basins, ecological regeneration zones and forest regeneration with the Golf course area). In addition to the creation of new habitat, extensive areas currently weed infested and supporting pine plantations will be rehabilitated to extend forage areas in accordance with the Precinct 12, 13 & 14 VMP (2011a) and Precinct 12, 13 & 14 WMP (2011b).

3. The existence of the Common planigale must be considered in the development of any program using pesticides and herbicides for weed and/or mosquito and/or feral animal control).

4. The existence of this threatened species must be considered in the development of any Fire Management Plan (i.e. fire should be excluded from the areas of potential habitat);

5. A monitoring program has been devised to monitor the presence of this species within the vicinity of Precincts 12, 13 & 14 (SECTION 4). Furthermore, monitoring programs are included within the Precinct 12, 13 & 14 VMP (2011a) and Precinct 12, 13 & 14 WMP (2011b) to ensure suitable habitat remains viable.

### 3.4.4 Glossy black cockatoo

#### 3.4.4.1 Threats

The Glossy black cockatoo has been recorded in the southern portion of the Kings Forest site (FIGURE 5). The species inhabits open forest and woodlands in which stands of she-oak species, particularly Black she-oak (*Allocasuarina littoralis*), Forest she-oak (*A. torulosa*) or Drooping she-oak (*A. verticillata*) occur.

Potential threats to this species are as follows:

- Reduction of suitable habitat through clearing for development.
- Loss of tree hollows.
- Excessively frequent fire which reduces the abundance and recovery of she-oaks and also may destroy nest trees.
- Illegal bird smuggling and egg-collecting.

No extensive areas of suitable habitat for this species will be cleared during bulk earthworks within Precincts 12, 13 & 14. However, general vegetation clearing, potentially including some scattered Black she-oak (*Allocasuarina littoralis*) or Forest she-oak (*A. torulosa*) may have a minor impact on food resources for the Glossy black cockatoo.
3.4.4.2 Recovery of the species

No recovery plan exists for this species however a Priority Action Statement has been prepared. The following list of recovery strategies is derived from the PAS and includes strategies that are relevant to the bulk earthworks within Precincts 12, 13 & 14.

- Increase landholder and public awareness and interest in Glossy Black Cockatoo conservation and habitat management.
- Utilise the Glossy Black Cockatoo as a flagship threatened species for woodland and forest conservation education and awareness programs.
- Encourage the restoration of foraging habitat that has been cleared or degraded by previous impacts.
- Continue existing monitoring programs and encourage other community groups to develop a monitoring program of local populations.
- Identify and map key breeding and foraging habitat.

3.4.4.3 Management Actions

The Glossy black cockatoo will benefit from the extensive rehabilitation works planned in accordance with the Precinct 12, 13 & 14 VMP (2011a) and Precinct 12, 13 & 14 WMP (2011b).

The following management actions will also benefit the Glossy black cockatoo:

1. Habitat for the Glossy black cockatoo will be created by including Black she-oak and Forest she-oak in enhancement plantings. Planting of these species will be undertaken both within the golf course landscaping and in the rehabilitation areas within the environmental protection zones in accordance with the Precinct 12, 13 & 14 VMP (2011a).

2. A monitoring program has been devised to monitor the presence of this species within the vicinity of Precincts 12, 13 & 14 (SECTION 4). Furthermore, monitoring programs are included within the Precinct 12, 13 & 14 VMP (2011a) and Precinct 12, 13 & 14 WMP (2011b) to ensure suitable habitat remains viable.

3.4.5 Grass Owl

3.4.5.1 Threats

There are four (4) recorded sightings of the Grass owl at Kings Forest (FIGURE 5). While Grass owls have been recorded within rank grassland within areas of Environmental Protection zoned vegetation, they have also been recorded within urban zoned areas of the Kings Forest site, and are likely to forage widely.

Potential threats to this species from proposed bulk earthworks within Precincts 12, 13 & 14 include:

- Fragmentation and loss of habitat;
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- Alteration of habitat from weed invasion, colonisation by woody heathland species;
- Injury/death from vehicle strike;
- Fire;
- Human disturbance;
- Injury/death from domestic animals;
- Increased risk of fire;
- Disturbance from light spill from houses and roads; and
- Use of second-generation (single-dose) rodenticides based on brodifacoum (e.g. Talon).

3.4.5.2 Recovery of the species

No recovery plan exists for the Grass owl however a Priority Action Statement has been prepared. The following list of recovery strategies is derived from the PAS and includes strategies that are relevant to the proposed bulk earthworks within Precincts 12, 13 & 14.

- Secure sympathetic management of the Grass Owl, particularly in regard to minimising secondary poisoning from pesticides such as brodifacoum based rodenticides.
- Control pest animals throughout the species range where nesting is known or strongly suspected.
- Where Grass Owl records occur on private land encourage landholders to undertake management to conserve and actively manage habitat.
- Compile and assess opportunistically gathered records of the species in NSW toward developing a model of distribution, habitat use and management.

3.4.5.3 Management actions

1. The existence of this threatened species must be considered in the development of any Fire Management Plan (i.e. fire should be excluded from the areas of potential habitat);
2. The existence of the Grass owl must be considered in the development of any program using pesticides and herbicides for weed and/or mosquito and/or feral animal control).
3. The Stage 1 FAMP (JWA 2011c) will ensure predators such as the Red fox are controlled in areas of known habitat.
4. A monitoring program has been devised to monitor the presence of this species within the vicinity of Precincts 12, 13 & 14 (SECTION 4). Furthermore, monitoring programs are included within the Precinct 12, 13 & 14 VMP (2011a) and Precinct 12, 13 & 14 WMP (2011b) to ensure suitable habitat remains viable.
3.4.6 Grey-headed Flying-fox

3.4.6.1 Threats

There is one (1) record of the Grey-headed flying fox to the south of the Kings Forest site (FIGURE 5). The Grey-headed flying-fox is considered likely to utilise the Kings Forest site on a seasonal basis (i.e. when feed trees such as Swamp Mahogany, Swamp Box, Scribbly Gum, Broad-leaved Paperbark, Figs etc. are flowering).

Large areas or forage resources are retained within Environmental Protection Zones, and the development of the site will result in a very minor reduction of resources for this species.

3.4.6.2 Recovery of the species

The following list of recovery strategies are derived from the Draft Recovery Plan and the PAS, and includes strategies that are relevant to the proposed bulk earthworks within Precincts 12, 13 & 14:

- Provide educational resources to improve public attitudes toward Grey-headed Flying-foxes.
- Develop materials for public education & provide them to land managers & local community groups working with controversial flying-fox camps, highlighting species status, reasons for being in urban areas, reasons for decline etc.
- Conduct periodic range-wide assessments of the population size of Grey-headed Flying-foxes to monitor population trends.
- Enhance and sustain the vegetation of camps critical to the survival of Grey-headed Flying-foxes.
- Protect and enhance priority foraging habitat for Grey-headed Flying-foxes, for example through management plans, local environmental plans and development assessments, and through volunteer conservation programs for privately owned land.
- Protect roosting habitat critical to the survival of Grey-headed Flying-foxes, for example through management plans, local environmental plans and development assessments, and through volunteer conservation programs for privately owned land.
- Increase the extent and viability of foraging habitat for Grey-headed Flying-foxes that is productive during winter and spring (generally times of food shortage), including habitat restoration/rehabilitation works.

3.4.6.3 Management actions

Although there are no camp sites within Kings Forest, the Grey-headed flying-fox forages widely, (i.e. up to 50km from camps) and is likely to benefit from the extensive rehabilitation works planned in accordance with the Precinct 12, 13 & 14 VMP (2011a) and Precinct 12, 13 & 14 WMP (2011b).

The Grey-headed flying-fox is a canopy-feeding frugivore, blossom-eater and nectarivore of rainforests, open forests, woodlands, Melaleuca swamps and Banksia.
woodlands. The restored wet and dry heath communities and other rehabilitated areas within the Environmental Protection zones will provide a potential forage resource for this species.

The following management actions will also benefit the Grey-headed flying-fox:

1. Forage areas for the Grey-headed flying-fox, will be created by including feed trees such as Swamp Mahogany, Swamp Box, Scribbly Gum, Broad-leaved Paperbark and Figs in the enhancement planting programme.

2. A monitoring program has been devised to monitor the presence of this species within the vicinity of Precincts 12, 13 & 14 (SECTION 4). Furthermore, monitoring programs are included within the Precinct 12, 13 & 14 VMP (2011a) and Precinct 12, 13 & 14 WMP (2011b) to ensure suitable habitat remains viable.

3.4.7 Koala

A Kings Forest Stage 1 Koala Plan of Management (JWA 2011a) has been prepared and contains a detailed assessment of the potential threats and issues relating to the recovery of the species. Numerous management actions are recommended within the KPoM which should be read in conjunction with this TSMP.

3.4.8 Masked Owl

3.4.8.1 Threats

There is one (1) record of the Masked owl to the north of Precincts 12, 13 & 14 within the Environmental Protection Zone (FIGURE 5). Masked Owls are likely to forage widely over the Kings Forest site as the mosaic of vegetation types provides habitat for a variety of prey species.

Potential threats to this species are as follows:

- Loss of mature hollow-bearing trees and changes to forest and woodland structure, which leads to fewer such trees in the future.
- Clearing of habitat for grazing, agriculture, forestry or other development.
- A combination of grazing and regular burning is a threat, through the effects on the quality of ground cover for mammal prey, particularly in open, grassy forests.
- Secondary poisoning from rodenticides.
- Being hit by vehicles.

Habitat (e.g. grassland and heathland) for potential prey species for the Masked owl (e.g. Black Rat, Bush Rat and Swamp Rat) will be lost during proposed bulk earthworks within Precincts 12, 13 & 14. However, retention of large areas within Environmental Protection Zones will continue to provide a variety of forage environments for Masked owls. Masked owls may also be at risk from use of second-generation (single-dose) rodenticides used for management of rodents.
3.4.8.2 Recovery of the species

An approved Recovery Plans has been prepared for the Masked Owl (as part of the ‘Recovery Plan for the Large Forest Owls’). The Recovery Plan lists the following proposed recovery objectives which are relevant to the proposed bulk earthworks:

- Encourage private landholders to undertake management options to conserve and/or actively manage forest owl habitat.
- Ensure the impacts on large forest owls and their habitats are adequately assessed during planning and environmental assessment processes.
- Minimise further loss and fragmentation of habitat by protection and more informed management of significant owl habitat (including protection of individual nest sites).
- To raise awareness of the conservation requirements of the three large forest owls amongst the broader community, to involve the community in owl conservation efforts and in so doing increase the information base about owl habitats and biology.

A Priority Action Statement (PAS) has also been prepared however none of the recovery strategies within the PAS are considered to be relevant to the proposed bulk earthworks with Precincts 12, 13 & 14.

3.4.8.3 Management Actions

The Masked Owl lives as monogamous, sedentary life-long pairs in large permanent home ranges (i.e. 500 to 1000 hectares). They cover dry eucalypt forests and woodlands from sea level to 1100 m and hunt along the edges of forests, including road sides. Their diet will typically include tree-dwelling and ground mammals, especially rats.

The following management actions will benefit the Masked owl:

1. Hunting grounds consisting of habitat for small mammals will be created within the golf course area. In addition to the creation of new habitat, extensive areas currently weed infested and supporting pine plantations will be rehabilitated to extend forage areas in accordance with the Precinct 12, 13 & 14 VMP (2011a) and Precinct 12, 13 & 14 WMP (2011b).

2. The existence of the Masked owl must be considered in the development of any program using pesticides and herbicides for weed and/or mosquito and/or feral animal control.

3. A monitoring program has been devised to monitor the presence of this species within the vicinity of Precincts 12, 13 & 14 (SECTION 4). Furthermore, monitoring programs are included within the Precinct 12, 13 & 14 VMP (2011a) and Precinct 12, 13 & 14 WMP (2011b) to ensure suitable habitat remains viable.
3.4.9 Wallum Froglet & Wallum sedge frog (Acid frogs)

3.4.9.1 Background

Wallum froglets have been recorded in association with constructed drainage lines within the proposed bulk earthworks area as well as inhabiting depressions formed during slash pine stump removal (FIGURE 5). Low-lying wet heath and drainage line communities and adjacent areas prone to frequent inundation, within adjacent EPZ’s, are considered to provide core habitat for this species (FIGURE 8).

Many of the Wallum froglet records within the Kings Forest site occur in forage habitat (i.e. land inundated after heavy rain) rather than core habitat.

Wallum sedge frogs have been recorded in association with two constructed dams in the southern portion of the Kings Forest site (FIGURE 5). Potential habitat is also considered to occur in the vicinity of Precinct 12, 13 & 14.

3.4.9.2 Threats

Potential threats to these species from bulk earthworks within Precincts 12, 13 & 14 include:

- Loss of habitat from habitat removal and fragmentation;
- Changes in hydrology;
- Water pollution;
- Injury/death from vehicle strike; and
- Contamination of habitat by herbicides, pesticides and fertiliser as part of landscaping maintenance.

3.4.9.3 Recovery of the species

An approved Recovery Plan has been prepared for the Wallum froglet and the Wallum sedge frog (as part of the ‘National recovery plan for the wallum sedgefrog and other wallum-dependent frog species’ [Meyer et al. 2006]). The Recovery Plan lists the following relevant proposed recovery objectives:

- Identify and assess essential habitat.
- Protect wallum frog populations and manage habitat.
- Acquire information on threats to inform management.
- Engage stakeholders and the broader community in recovery of wallum frog species.
- Rehabilitate degraded wallum frog habitat.
- Monitor frog numbers and distribution.

3.4.9.4 Management Actions

Long-term management of these species will be tied to the maintenance of existing suitable habitat within EPZ’s and the creation of additional compensatory habitat areas within EPZ’s and ecological buffers to offset unavoidable losses of habitat. Maintenance of hydrology (particularly acidity), stormwater and run-off (including
herbicides, pesticides, fuel etc.) in constructed habitat areas is critical in determining whether these areas are capable of supporting the species in the long term.

The following management actions have considered the appropriate objectives of the National Recovery Plan:

1. Compensatory habitat areas will be created within EPZ’s and ecological buffers and will include core breeding habitat and forage habitat areas. Constructed ponds for the Wallum froglet and Wallum sedge frog have been completed as part of the Tugun Bypass, with successful results. Details of the proposed Acid Frog Compensatory habitat strategy at Kings Forest are provided in **APPENDIX 1**.

2. Additionally, forage habitat will be created for the Acid frogs with the construction of bio-filtration swales within ecological buffers.

3. In addition to the creation of new habitat, extensive areas currently weed infested and supporting pine plantations will be rehabilitated to extend habitat areas in accordance with the Precinct 12, 13 & 14 VMP (JWA 2011b) and Precinct 12, 13 & 14 WMP (2011d).

4. A detailed water quality monitoring regime is included in the Overall Water Management Plan (Gilbert & Sutherland 2011b) and will ensure that significant impacts on Acid frog habitats are avoided.

5. The Stage 1 FAMP (JWA 2011e) will ensure Cane toads are controlled in areas of known habitat. Core habitat areas will densely planted with sedges etc. to deter Cane toads from entering these areas.

6. The existence of the Acid frogs must be considered in the development of any Fire Management Plan (i.e. fire should be excluded from swamps and areas immediately adjacent to Wallum froglet habitat).

7. To minimise the spread of the disease chytridiomycosis to and between habitats, all contractors undertaking work in both wetland construction and vegetation rehabilitation must follow the protocol set out within the publication *Hygiene protocol for the control of disease in frogs* (DECCW & NPWS 2008).

8. The existence of the Acid frogs must be considered in the development of any program using pesticides and herbicides for weed and/or mosquito and/or feral animal control.

9. A monitoring program has been devised to monitor the presence of these species within the vicinity of Precincts 12, 13 & 14 (SECTION 4). Furthermore, monitoring programs are included within the Precinct 12, 13 & 14 VMP (2011a) and Precinct 12, 13 & 14 WMP (2011c) to ensure suitable habitat remains viable.
3.4.10 Yellow-bellied sheathtail bat

3.4.10.1 Threats

The Yellow-bellied sheathtail bat roosts singly or in groups of up to six, in tree hollows and buildings. In treeless areas they are known to utilise mammal burrows. When foraging for insects this species flies high and fast over the forest canopy, but lower in more open country. This species has been recorded in the Environmental Protection Zone to the south of Precincts 12, 13 & 14.

General threats to Yellow-bellied sheathtail bat include:

- Disturbance to roosting and summer breeding sites.
- Foraging habitats are being cleared for residential and agricultural developments, including clearing by residents within rural subdivisions.
- Loss of hollow-bearing trees; clearing and fragmentation of forest and woodland habitat.
- Pesticides and herbicides may reduce the availability of insects, or result in the accumulation of toxic residues in individuals' fat stores.

Potential threats to Yellow-bellied sheathtail bat from the bulk earthworks within Precincts 12, 13 & 14 include:

- Minor loss of foraging habitats;
- Potential loss of hollow-bearing trees; and
- The use of pesticides and herbicides which may reduce the availability of insects, or result in the accumulation of toxic residues in individuals' fat stores.

3.4.10.2 Recovery of the species

No recovery plan exists for the Yellow-bellied sheathtail bat however a Priority Action Statement has been prepared. The following list of recovery strategies is derived from the PAS and includes strategies that are relevant to the proposed bulk earthworks within Precincts 12, 13 & 14:

- Raise the awareness of local residents and golf course management/users about the presence of the species and provide information on how their management/use will affect the species' survival.
- Consult authorities when planning development/s to minimise impact/s on populations.
- Conduct searches for the species in suitable habitat in proposed development areas.
- Retain stands of native vegetation, especially those with hollow-bearing trees (including dead trees), and retain other structures containing bats.
- Retain a buffer of vegetation around roost sites in vegetated areas.
- Protect hollow-bearing trees for breeding sites, including those on farmland; younger mature trees should also be retained to provide replacements for the older trees as they die and fall over.
- Reduce the use of pesticides in the environment.
- Encourage regeneration and replanting of local flora species to maintain bat foraging habitat.
- Assess the site’s importance to the species’ survival, including linkages provided between ecological resources across the broader landscape.
- Mark known sites and potential habitat onto maps used for planned poison-spraying activities.

3.4.10.3 Management Actions

1. Quality habitat will be created for this species with the completion of restoration/rehabilitation works (i.e. vegetated bio-retention basins, ecological regeneration zones and forest regeneration with the Golf course area). In addition to the creation of new habitat, extensive areas currently weed infested and supporting pine plantations will be rehabilitated to extend forage areas in accordance with the Precinct 12, 13 & 14 VMP (2011a) and Precinct 12, 13 & 14 WMP (2011b).

2. The existence of the Yellow-bellied sheahtail bat must be considered in the development of any Fire Management Plan (i.e. fire should be excluded from suitable habitat).

3. The existence of the Yellow bellied sheahtail bat must be considered in the development of any program using pesticides and herbicides for weed and/or mosquito and/or feral animal control.

4. A monitoring program has been devised to monitor the presence of these species within the vicinity of Precincts 12, 13 & 14 (SECTION 4). Furthermore, monitoring programs are included within the Precinct 12, 13 & 14 VMP (2011a) and Precinct 12, 13 & 14 WMP (2011b) to ensure suitable habitat remains viable.
4 MONITORING AND REPORTING

4.1 Background

A well-designed monitoring program will allow project managers to detect results months, years, or decades following implementation of a plan. This section outlines the monitoring requirements for the Precinct 12, 13 & 14 TSMP.

Populations of Threatened flora & fauna within the EPZ’s adjoining Precincts 12, 13 & 14 will be monitored on an annual basis for a period of five (5) years.

4.2 Flora monitoring

All threatened plant species will be monitored as follows:

- Survival
- Height
- Flowering
- Fruiting
- Signs of natural recruitment
- Potential threats (i.e. weeds)

4.3 Fauna monitoring

A baseline survey will be completed within the Precinct 12, 13 & 14 EPZ’s prior to commencement of construction to determine species presence. The fauna surveys will target Threatened species recorded, or predicted to occur, within the vicinity of Precincts 12, 13 & 14 and will include the following methodology (where appropriate):

- Elliott trapping;
- Cage trapping;
- Pitfall trapping;
- Arboreal Elliott trapping;
- Spotlighting/stag watching;
- Call playback;
- Dawn & dusk bird surveys;
- Hair tubes; and
- Active searching.
4.4 Performance Criteria

The success of the TSMP will be regularly evaluated (i.e. as above). A number of criteria will indicate successful management of threatened species. The overall performance criteria for this plan are:

- Management actions for each threatened species as listed within this TSMP are implemented;
- All recorded threatened flora species survive and flourish during the proposed bulk earthworks;
- Successful propagation and planting of additional White yiel yiel after 1-2 years;
- Where revegetation is proposed in accordance with this TSMP (i.e. buffer plantings, compensatory habitat etc.), survival of 95% of stems planted;
- Within revegetation areas, establishment of a 70% native ground cover after 2-3 years;
- Within revegetation areas, average percentage cover of 90% native ground cover at the 5th year;
- Within revegetation areas, noxious weeds are to be eradicated and environmental weeds less than 1% of the area;
- Within revegetation areas, maintenance of 100% of planted diversity;
- All appropriate exclusion fencing is in place and operational, and existing habitat to be retained for each threatened flora and fauna species remains unaffected; and
- Feral animal monitoring is completed in accordance with the FAMP (JWA 2011c).

4.5 Monitoring Reports

A report will be prepared after each annual survey period and will include the following:

- Results of the flora and fauna surveys;
- A comparison of results with previous years;
- Discussion regarding the absence of previous species/occurrence of new species;
- Any habitat maintenance recommendations (i.e. additional nest boxes etc.);
- Discussion regarding the occurrence of any weed/pest species;
- Recommendations for controlling weed/pest species (if required); and
- Performance against performance criteria (Section 4.4).
REFERENCES


APPENDIX 1 - ACID FROG COMPENSATORY HABITAT

1. Background

Two (2) Threatened species of ‘Acid fog’ have been recorded from the vicinity of Precincts 12, 13 & 14 (FIGURE 5):

- Wallum froglet (*Crinia tinnula*); and
- Wallum sedge frog (*Litoria olongburensis*).

The Wallum froglet is listed as Vulnerable within schedules of the NSW Threatened Species Conservation Act (1995). Wallum froglets inhabit acid paperbark swamps and sedge swamps of the coastal ‘wallum’ country.

The Wallum sedge frog is listed as Vulnerable within schedules of the NSW Threatened Species Conservation Act (1995) and the Commonwealth Environment Protection & Biodiversity Conservation Act (1999).

Core habitat for Acid frog species within the vicinity of Precincts 12, 13 & 14 is considered to be comprised of undisturbed and regenerating wet heathland and swamp sclerophyll forest communities (FIGURE 8, PLATE 1), whilst remaining habitats (i.e. adjoining areas of grassland and slashed areas) are considered to provide forage habitat when inundated during wet periods.

Wallum froglets in particular have been recorded in a number of locations within Precincts 12, 13 & 14 particularly within constructed drainage line communities (PLATE 2). Whilst numerous records have occurred over a 10 year period in some areas of the site not mapped as core habitat, records of this species do not necessarily equate with breeding habitat. Breeding habitat must retain water for extended periods of time.

Furthermore, the Wallum froglet is known to move into adjacent habitats during rainfall events. During a study of the habitat and movements of the Wallum froglet by White & Pike (2006), froglets were often located away from breeding ponds in nearby heath and woodland and could be found up to 100m from a pond. Froglet movement between ponds and foraging sites nearby appeared to be directed by the occurrence of rainfall events.

The assessment of impacts on Acid frog habitat has considered the avoid, mitigate, offset approach as described in the Threatened Species Assessment Guidelines: The Assessment of Significance (DPI 2008). However, the proposed bulk earthworks within Precincts 12, 13 & 14 will result in unavoidable impacts on some Core habitat areas. Core habitat in other areas of the site has been avoided and will be rehabilitated.
PLATE 1: Existing frog habitat (i.e. Swamp sclerophyll forest) within EPZ to the east of Precinct 14.

PLATE 2: Example of existing frog habitat within the development area (i.e. constructed drainage line with Precinct 5).
2. Literature Review

Few attempts to replicate or re-instate breeding areas for ‘Acid frogs’ have been undertaken and documented in Australia. It is well recognised however that the Wallum froglet will rapidly recolonise disturbed areas previously containing ‘Wallum’ vegetation. In these instances common attributes are shallow water bodies in sandy soils and of low pH and electrical conductivity (Ecosense Consulting Pty Ltd, 2005).

The creation of compensatory habitat was completed for ‘Acid frog’ species during the construction of the Tugun Bypass. The design requirements of the Tugun Bypass frog ponds were determined through consultation with a number of recognised authorities on ‘Acid frogs’.

A number of recommendations were provided by these experts based on observations made during field & laboratory work (Ecosense Consulting Pty Ltd, 2005):

- Ponds should be constructed in sandy substrates (which previously contained ‘Wallum’) with an underlying organic hardpan;
- Ponds should generally be shallow and constructed in areas of high groundwater;
- Water quality should exhibit the following characteristics:
  - pH <5 (as influenced by humic soils);
  - hardness < 100 p.p.m;
  - salinity < 350 uS.cm⁻¹;
- Ponds should be ephemeral to prevent habitation by fish but have a minimum hydro-period of 4-6 weeks for the Wallum froglet; and
- Pond fringes should be densely planted with emergent species to prevent predation by the Cane toad (*Bufo marinus*).

Four (4) frog ponds were constructed within compensatory habitat areas adjoining the Tugun Bypass. Both the Wallum froglet and the Wallum sedge frog (*Litoria olongburensis*) have been recorded within these constructed ponds. Furthermore, water treatment basins constructed around the bypass have had the added benefit of providing additional frog habitat. Wallum froglets have been recorded calling from several water treatment basins on numerous occasions during monitoring events (Pacific Alliance, 2010).
3. Kings Forest Proposal

It is proposed to create Core Acid frog habitat within Environmental Protection Zones (EPZ’s), ecological buffers and the golf course on the Kings Forest site (FIGURE 9). Areas requiring rehabilitation works within EPZ’s and buffers will be targeted for the creation of Core Acid Frog habitat. Site selection has also included consideration of the following:

- Proximity to existing Core habitat areas and Acid frog records (FIGURE 10);
- Distribution of suitable soils (i.e. Podsols) (FIGURE 11);
- Topography;
- Presence of Potential Acid Sulphate soils (FIGURE 12); and
- Existing vegetation values.

A typical section and plan view of the proposed compensatory acid frog habitat (FIGURE 13). The compensatory core acid frog habitat will include:

- The creation of melon holes by either using an excavator bucket to form holes approximately 60cm deep by at least 1.8m long, or through the removal of Slash pine stumps which has been shown to create small breeding ponds elsewhere on the site (PLATE 3);
- These holes will be created to intercept the water table to ensure water is available for an extended period of time and allow for successful breeding;
- It would be expected that the water in these melon holes would evaporate during extended dry periods;
- ‘Tiles’ of suitable vegetation (i.e. from existing habitat areas to be removed) will be translocated to compensatory habitat areas. It is likely that some frogs will also be translocated with the tiles of vegetation;
- Additionally, dense plantings of Saw-sedge (Gahnia spp.), Curly sedge (Baloskion spp.) and Matrush (Lomandra spp.) will also occur around the margins of these melon holes (where required) to ensure almost complete coverage of the hole by the sedges;
- The narrow design of the melon holes, coupled with the dense planting of Saw-sedge, will assist in the prevention of mosquito breeding, protect tadpoles from predation and preclude the occurrence of Cane toads.

The compensatory habitat areas will be planted with a combination of Swamp sclerophyll (i.e. Swamp mahogany & Broad-leaved paperbark) and Wet heath species.
ACID FROG COMPENSATORY HABITAT

TYPICAL ACID FROG
COMPENSATORY HABITAT LAYOUT

LEGEND
- Proposed Broad leaf paperbark
  - at 7m centres
- Proposed Swamp mahogany
  - at 7m centres (within identified Koala
    food tree planting areas only - refer to KPoM)
- Proposed melanhole (0.6x1.8m TYP.)
  surrounded by Saw sedges

ACID FROG COMPENSATORY HABITAT
CROSS-SECTION
Fourteen (14) suitable compensatory habitat areas have been identified on the Kings Forest site (FIGURE 10), covering a total area of approximately 59ha, and are described as follows:

- **Compensatory Habitat Area 1**
  - An area of approximately 1.44ha on the northern side of Depot Road in the north-eastern portion of the Kings Forest site (i.e. adjacent to Precinct 2);
  - Core habitat will be created through excavation of melon holes and subsequent assisted regeneration/revegetation works where necessary.

- **Compensatory Habitat Area 2**
  - An area of approximately 2.41ha on the southern side of Depot Road in the north-eastern portion of the Kings Forest site (i.e. adjacent to the northern portion of Precinct 5);
  - Adjacent to existing areas of Core habitat (FIGURE 11, PLATE 1);
  - This area is to be dedicated to NPWS for inclusion in the Cudgen Nature Reserve (FIGURE 10);
  - Core habitat will be created through a combination of excavation of melon holes and removal of existing mature Slash pine (PLATE 4), and subsequent assisted regeneration/revegetation works where necessary.
PLATE 4: Slash pine to be removed from Compensatory Habitat Area 2.

- **Compensatory Habitat Area 3**
  - An area of approximately 2.47ha on the northern side of Depot Road in the north-eastern portion of the Kings Forest site (i.e. adjacent to Precinct 3);
  - Adjacent to existing areas of Core habitat (**FIGURE 11**);
  - Core habitat will be created through excavation of melon holes and subsequent assisted regeneration/revegetation works where necessary.

- **Compensatory Habitat Area 4**
  - Areas totalling approximately 2.77ha within the inner ecological buffers to the south of Precinct 5 (**PLATES 5 & 6**);
  - Core habitat occurs within the adjacent SEPP 14 wetland;
  - Includes existing small areas of existing frog habitat. Wallum froglets were recorded within this Compensatory Habitat Area during recent site assessments;
  - Core habitat will be created through a combination of excavation of melon holes and removal of existing mature Slash pine (**PLATE 5**), and subsequent assisted regeneration/revegetation works where necessary.
PLATE 5: Compensatory Habitat Area 4.

PLATE 6: Compensatory Habitat Area 4 (existing frog habitat in centre of shot).
• **Compensatory Habitat Area 5**
  
  o An area of approximately 2.46ha in eastern portion of the Kings Forest site (i.e. south-east of Precinct 5) (PLATE 7);
  o Adjacent to existing areas of Core habitat (PLATE 8);
  o This area is to be dedicated to NPWS for inclusion in the Cudgen Nature Reserve (FIGURE 11);
  o Core habitat will be created through excavation of melon holes and subsequent assisted regeneration/revegetation works where necessary.

PLATE 7: Compensatory Habitat Area 5.
PLATE 8: Existing Core habitat area to the east of Compensatory Habitat Area 5.
• Compensatory Habitat Area 6
  o An area of approximately 2.76ha in eastern portion of the Kings Forest site (i.e. south-east of Precinct 5) (PLATE 9);
  o Adjacent to existing areas of Core habitat (PLATE 10);
  o Includes existing small areas subject to inundation (PLATE 11). Wallum froglets were recorded within this Compensatory Habitat Area during recent site assessments;
  o This area is to be dedicated to NPWS for inclusion in the Cudgen Nature Reserve (FIGURE 11);
  o Core habitat will be created through excavation of melon holes and subsequent assisted regeneration/revegetation works where necessary.

PLATE 9: Compensatory Habitat Area 6.
PLATE 10: Existing Core habitat area to the south of Compensatory Habitat Area 6.
PLATE 11: Small areas or inundation within Compensatory Habitat Area 6. Wallum froglets were recorded within these pools during recent site assessments.

- **Compensatory Habitat Area 7**
  - An area of approximately 4.51ha in eastern portion of the Kings Forest site (i.e. south-east of Precinct 5) (PLATE 12);
  - This area is to be dedicated to NPWS for inclusion in the Cudgen Nature Reserve (FIGURE 11);
  - Core habitat will be created through excavation of melon holes and subsequent assisted regeneration/revegetation works where necessary.
• **Compensatory Habitat Area 8**
  
  o An area of approximately 3.9ha in eastern portion of the Kings Forest site (i.e. east of Precinct 13) (PLATE 13);
  
  o Adjacent to existing areas of Core habitat (PLATE 14);
  
  o Includes existing small areas subject to inundation (PLATE 15). Wallum froglets were recorded within this Compensatory Habitat Area during recent site assessments;
  
  o This area is to be dedicated to NPWS for inclusion in the Cudgen Nature Reserve (FIGURE 11);
  
  o Core habitat will be created through excavation of melon holes and subsequent assisted regeneration/revegetation works where necessary.
PLATE 13: Compensatory Habitat Area 8.

PLATE 14: Existing Core habitat area to the east of Compensatory Habitat Area 8.
PLATE 15: Small areas or inundation within Compensatory Habitat Area 8. Wallum froglets were recorded within these pools during recent site assessments.

- **Compensatory Habitat Area 9**
  - An total area of approximately 6.9ha within the proposed Golf Course in the southern portion of the Kings Forest site (**FIGURE 15**);
  - Core habitat will be created through revegetation of bio-retention swales and aquifer recharge ponds.

- **Compensatory Habitat Area 10**
  - An area of approximately 1.15ha within the EPZ to the south of Precinct 14;
  - Core habitat will be created through excavation of melon holes and subsequent assisted regeneration/revegetation works where necessary.

- **Compensatory Habitat Area 11**
  - An area of approximately 5.63ha within the inner ecological buffers to the south of Precincts 6 & 7 (**PLATES 16 & 17**);
  - Adjacent to Core habitat within the adjacent SEPP 14 wetland (**PLATE 18**);
  - Includes existing small areas of frog habitat (**PLATE 19**). Wallum froglets were recorded within this Compensatory Habitat Area during recent site assessments;
- Core habitat will be created through excavation of melon holes and subsequent assisted regeneration/revegetation works where necessary.

PLATE 16: Compensatory Habitat Area 11.
PLATE 17: Compensatory Habitat Area 11.

PLATE 18: Existing Core habitat area within SEPP 14 wetland adjacent to Compensatory Habitat Area 11.
PLATE 19: Small area of existing frog habitat within Compensatory Habitat Area 11. Wallum froglets were recorded within these pools during recent site assessments.
- **Compensatory Habitat Area 12**
  - An area of approximately 13.96ha within the inner ecological buffers to the west of Precincts 9 & 10 and the east of Precinct 11;
  - Core habitat will be created through excavation of melon holes and subsequent assisted regeneration/revegetation works where necessary.

- **Compensatory Habitat Area 13**
  - An area of approximately 2.36ha within the inner ecological buffers to the east of Precincts 8 (PLATE 20);
  - Includes existing small areas of frog habitat. Wallum froglets were recorded within this Compensatory Habitat Area during recent site assessments;
  - Core habitat will be created through excavation of melon holes and subsequent assisted regeneration/revegetation works where necessary.

PLATE 20: Compensatory Habitat Area 13.
- **Compensatory Habitat Area 14**
  - An area of approximately 6.32ha within an EPZ to the west of Precinct 8;
  - Core habitat will be created through excavation of melon holes and subsequent assisted regeneration/revegetation works where necessary.

A comparison of the compensatory habitat proposed at Kings Forest with the design criteria of the Tugun Bypass frog ponds is provided in TABLE 1.

**TABLE 1**

**COMPARISON OF KINGS FOREST & TUGUN BYPASS COMPENSATORY HABITAT**

<table>
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<th>TUGUN BYPASS FROG PONDS</th>
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<td>Ponds should be constructed in sandy substrates (which previously contained ‘Wallum’) with an underlying organic hardpan;</td>
<td>The proposed compensatory habitat areas occur on a sandy substrate which historically contained ‘Wallum’ vegetation. This area likely comprises an underlying organic hardpan. If necessary, topsoil/organic material will be stockpiled during initial earthworks and used to line constructed frog habitat areas.</td>
</tr>
<tr>
<td>Ponds should generally be shallow and constructed in areas of high groundwater;</td>
<td>Constructed melon holes will be a maximum of approximately 60cm deep and will be created to intercept the water table.</td>
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| Water quality should exhibit the following characteristics:  
  - pH <5 (as influenced by humic soils);  
  - hardness < 100 p.p.m; and  
  - salinity < 350 uS.cm\(^{-1}\). | Core habitat will be designed and located in areas with similar water quality characteristics. |
| Ponds should be ephemeral to prevent habitation by fish but have a minimum hydro-period of 4-6 weeks for the Wallum froglet; and | Proposed melon holes will be constructed to ensure water is available for an extended period of time and allow for successful breeding. |
| Pond fringes should be densely planted with emergent species to prevent predation by the Cane toad (*Bufo marinus*). | Dense plantings of Saw-sedge (*Gahnia* spp.), Curly sedge (*Restio* spp.) and Matrush (*Lomandra* spp.) will occur around the margins of the melon holes. |
Further to the comparison above, which shows the similarities between the two compensatory habitat proposals, it is noted that the configuration of the frog ponds at the Tugun Bypass comprised a small number or larger ponds, whereas the Kings Forest proposal provides a larger number of small ponds (melon holes). This design feature has been incorporated to discourage the use of the ponds by Mosquitoes. As the Tugun Bypass ponds are not immediately adjacent to a residential area, this would not likely have been a design consideration.

A Wallum Froglet Compensatory Habitat Plan (WFCHP) will be completed to guide the construction of the frog habitat on completion of earthworks. The plan will be prepared in accordance with the National recovery plan for the wallum sedgefrog and other wallum-dependent frog species (Queensland Environmental Protection Agency 2006). The WFCHP will include (but not be limited to) the following:

- detailed frog pond design criteria;
- performance criteria;
- a detailed habitat and population monitoring program; and
- contingencies in the event that constructed habitats perform poorly.
**ACID FROG COMPENSATORY HABITAT CROSS-SECTION**

**TYPICAL ACID FROG COMPENSATORY HABITAT LAYOUT**

**LEGEND**
- Proposed Broad leaf paperbark - at 7m centres
- Proposed Swamp mahogany - at 7m centres (within identified Koala food tree planting areas only - refer to KPoM)
- Proposed melanhole (0.6x1.8m TYP.) surrounded by Saw sedges

**MELANHOLE (TYPICAL)**

**ACID FROG COMPENSATORY HABITAT CROSS-SECTION**

**TYPICAL WALLUM FROGLET HABITAT PLAN & SECTION**
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  - Core habitat will be created through excavation of melon holes and subsequent assisted regeneration/revegetation works where necessary.

- **Compensatory Habitat Area 2**
  - An area of approximately 2.41ha on the southern side of Depot Road in the north-eastern portion of the Kings Forest site (i.e. adjacent to the northern portion of Precinct 5);
  - Adjacent to existing areas of Core habitat (FIGURE 10, PLATE 1);
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PLATE 20: Compensatory Habitat Area 13.
Kings Forest (Stage 1) - Precinct 12, 13 & 14 Threatened Species Management Plan

- **Compensatory Habitat Area 14**
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A Wallum Froglet Compensatory Habitat Plan (WFCHP) will be completed to guide the construction of the frog habitat on completion of earthworks. The plan will be prepared in accordance with the National recovery plan for the wallum sedgefrog and other wallum-dependent frog species (Queensland Environmental Protection Agency 2006). The WFCHP will include (but not be limited to) the following:

- detailed frog pond design criteria;
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