22.0 THREATENED SPECIES MANAGEMENT PLAN, PRECINCTS 2 TO 4 AND 6 TO 11 – JAMES WARREN & ASSOCIATES, AUGUST 2012

Implementation and Summary Table

Action No	Action	Location (Reference to Map)	Purpose	Timing and Frequency	Responsibility	Performance Measure	Monitoring and Reporting	Further Details
Threatened Flora								
TSMP-1	Manage and protect potential habitat for threatened plant species (i.e. Weeding and Regeneration)	Within the vicinity of Precinct 2-4 & 6-11	To provide potential areas for the chance regeneration of threatened plant species	Six weeks after primary weeding, Six weeks after initial plant out, then 6 monthly until groundcovers are established, Annually thereafter until completion criteria met/ ongoing	Project 28 Pty Ltd - Site manager, Bush Regeneration Company	FPC assessment; Noxious and environmental weeds eradicated; and natural recruitment of native seedlings; species composition targets based on accepted benchmarks	Annual basis for a period of 5 years	See Precinct 2-4 & 6-11 VMP and WMP (JWA 2012)
TSMP-2	Make contractors aware of the location of threatened plant species and their need for protection and limited spray drift	Within the vicinity of Precinct 2-4 & 6-11	To protect threatened plant species from damage during construction and spray drift	Prior to construction phase/ ongoing	Project 28 Pty Ltd - Site manager	Threatened species maintained	Annual basis for a period of 5 years	See Precinct 2-4 & 6-11 VMP & WMP (JWA 2012)
TSMP-3	Monitoring program	Within the vicinity of Precinct 2-4 & 6-11	To search for and record any threatened plant species occurring	Baseline monitoring once project is approved; Annual basis for a period of 5 years	Bush Regeneration Company/ Suitably qualified ecologist	Noxious and environmental weeds eradicated; natural recruitment of native seedlings; no loss of threatened flora, propagating and replanted seedlings	Annual basis for a period of 5 years	See Section 22.3 (this document)

Action No	Action	Location (Reference to Map)	Purpose	Timing and Frequency	Responsibility	Performance Measure	Monitoring and Reporting	Further Details
Threatened Fauna								
TSMP- 4	Construction of compensatory habitat	Within the vicinity of Precinct 1 & 5	To increase amount/ availability of suitable habitat for threatened fauna across the site	During the construction phase of the development	Project 28 Pty Ltd- Site Manager	Compensatory habitat is constructed and utilised	Annual basis for a period of 5 years	See KPOM (JWA, 2012) and Appendix 1 (this document)
TSMP- 5	Rehabilitation of existing habitat	Within the vicinity of Precinct 1 & 5	Maintain current habitat and improve its condition	During the construction phase of the development/ ongoing	Project 28 Pty Ltd- Site Manager/ Bush Regeneration Company/ Suitably qualified ecologist	FPC assessment; Noxious and environmental weeds eradicated; and natural recruitment of native seedlings; species composition targets based on accepted benchmarks	Annual basis for a period of 5 years	See VMP & WMP (JWA 2012)
TSMP- 6	Control feral animals (predators) in areas of known habitat	Within the vicinity of Precinct 1 & 5	To prevent threats to threatened fauna	On detection of pest species until there is a successful capture or for a period considered reasonable for the expectation of success	Project 28 Pty Ltd- Site Manager	Feral animal monitoring is completed in accordance with the FAMP (JWA 2012).	All set traps regularly monitored and results of trapping reported on Annual basis for a period of 5 years	See FAMP 2012 (JWA 2012), Flora and Fauna Monitoring Report
TSMP- 7	Consider threatened species in Fire management	Within the vicinity of Precinct 1 & 5	To prevent injury to threatened fauna; To maintain integrity and suitability of current habitat	Ongoing	Project 28 Pty Ltd- Site Manager	No significant change in presence, range, numbers and/or abundance estimates from baseline data	Annual basis for a period of 5 years	See Bushfire risk assessment and management Plan (Bushfire Safe Australia, 2012).
TSMP- 8	Consider threatened species in the development of any program using pesticides, herbicides or rodenticides	Within the vicinity of Precinct 1 & 5	To prevent impacts on threatened bird and/or frog species	Once the project is approved, ongoing	Project 28 Pty Ltd- Site Manager	No significant change in presence, range, numbers and/or abundance estimates from baseline data	Annual basis for a period of 5 years	See WMP, FAMP (JWA 2012)

Action No	Action	Location (Reference to Map)	Purpose	Timing and Frequency	Responsibility	Performance Measure	Monitoring and Reporting	Further Details
TSMP- 9	Retain hollow bearing trees where possible or install compensatory habitat e.g. bat boxes, nest boxes	Within the vicinity of Precinct 1 & 5	To maintain current habitat, increase habitat of threatened fauna	During construction phase of the development, ongoing	Project 28 Pty Ltd- Site Manager, Bush Regeneration company, suitably qualified person	No significant change in presence, range, numbers and/or abundance estimates from baseline data	Annual basis for a period of 5 years	See WMP (JWA 2012)
TSMP- 10	Buffer habitat areas from the development	Within the vicinity of Precinct 1 & 5	Reduce risk of window strike, light and noise pollution.	During the construction and operational phases of the development	Project 28 Pty Ltd- Site Manager	No significant change in presence, range, numbers and/or abundance estimates from baseline data	Annual basis for a period of 5 years	See BMP (JWA 2012)
TSMP- 11	Contractors follow hygiene protocol for frogs and koalas,	Within the vicinity of Precinct 1 & 5	To prevent introduction and spread of diseases such as Chytridiomycosis or Chlamydia	Where necessary	Project 28 Pty Ltd- Site Manager	No significant change in presence, range, numbers and/or abundance estimates from baseline data	Annual basis for a period of 5 years	See KPoM
TSMP- 12	Monitoring program	Within the vicinity of Precinct 1 & 5	To monitor the presence of threatened fauna species; To ensure suitable habitat remains viable; To ensure habitat creation is successful	Baseline monitoring once project is approved; Annual basis for a period of 5 years	Suitably qualified ecologist	No significant change in presence, range, numbers and/or abundance estimates from baseline data	Annual basis for a period of 5 years	Overall Water Management Plan (Gilbert and Sutherland, July 2012); Flora and Fauna Monitoring Report (JWA 2012)

22.1 Introduction

22.1.1 Executive Summary

The Kings Forest Stage 1 Project Application No. MP 08_0194 was lodged in November 2011. The Application and Environmental Assessment Report was advertised from December 2011 to January 2012 following which 302 public submissions and 10 agency submissions were received.

As a result of the submissions, amendments to the project have been made. The amended project contains the following key elements (NB: these elements will be revised and updated as the amended project is finalised).

- Subdivision to create new lots for future development;
  - Bulk earthworks across the site;
  - Road works comprising:
    - construction of the entrance road into the site and associated intersection works on Tweed Coast Road;
    - alignment and construction of the proposed Kings Forest Parkway from Tweed Coast Road via Precincts 4 and 5 through to the western precincts; and
    - alignment and part construction of two proposed roads through SEPP 14 areas to access the southern precincts;
- Development of 2,036 m^2 of floor space for rural supplies development and access arrangements within Precinct 1;
- Construction of subdivision and infrastructure works along the Kings Forest Parkway and within Precincts 1 and 5;
- The Plan of Development for Precinct 5.

This revised Threatened Species Management Plan (TSMP) addresses the amendments to the project and the key issues raised in the submissions.

22.1.2 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 (**FIGURE 1, APPENDIX 3**), such that species continue to persist and reproduce. **FIGURE 2 (APPENDIX 3)** shows the final Scope of Works Plan for the Kings Forest site.

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.

22.1.3 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."

22.1.4 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 2012);
- 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 2012); 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 2012).

A Kings Forest Stage 1 Project Application Feral Animal Management Plan (Stage 1 FAMP) (JWA 2012) 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.

A Kings Forest Stage 1 Project Application Koala Plan of Management (Stage 1 KPoM) (JWA 2012) 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 Flora and Fauna Monitoring Report (FFMR) (JWA 2012) 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 Kings Forest Stage 1 Managament Plan) 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

22.2 Threats, Recovery Strategies and Management Actions

22.2.1 Introduction

The existing and potential threats, recovery strategies and management actions for all listed flora species, Endangered Ecological Communities (EECs) and fauna 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 for each species and the Priority Action Statement for each species.

22.2.2 Threatened flora, EECs and threatened fauna species to be considered in this TSMP

The threatened species and EECs that are known to occur within (or in the vicinity of) Precincts 2-4 & 6-11 are listed in **TABLE 1.**

TABLE 1
THREATENED SPECIES AND EECS TO BE CONSIDERED IN THIS TSMP

Scientific Name	Common Name
Threatened flora species	
Eleocharis quadrangulata	Square-stemmed spike rush
Endangered Ecological Communities (EECs)	
Swamp sclerophyll forest on coastal floodplains of the NSW North Coast	
Freshwater wetlands on coastal floodplains of the NSW North Coast	
Subtropical coastal floodplain forest of the NSW North Coast bioregion	
Threatened fauna species	
Ixobrychus flavicollis	Black bittern
Calyptorhynchus lathami	Glossy Black Cockatoo
Tyto longimembris	Grass owl
Pteropus poliocephalus	Grey-headed flying fox
Phascolarctos cinereus	Koala
Tyto novaehollandiae	Masked owl
Pandion haliaetus	Osprey
Crinia tinnula	Wallum froglet
Litoria olongburensis	Wallum sedge frog
Saccolaimus flaviventris	Yellow-bellied sheathtail bat

22.2.3 Threatened flora species

22.2.4 Square-stemmed spike rush

Background

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". 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. It is possible that the species was originally misidentified or that the species no longer exists on the Kings Forest site.

22.2.5 Endangered Ecological Communities

22.2.6 Background

Three (3) Endangered Ecological Communities (EEC's)[4] occur within the Subject site:

- Swamp sclerophyll forest on coastal floodplains of the NSW North Coast;
- Freshwater wetlands on coastal floodplains of the NSW North Coast; and
- Subtropical coastal floodplain forest of the NSW North Coast bioregion.

22.2.7 Threats

Potential threats to the EEC's are listed as follows:

- Clearing of vegetation;
- competition from weeds and native vines;
- fire and fire control methods;
- grazing; and
- disturbance by cattle.

22.2.8 Management Actions

The restoration, enhancement and management strategies for the EEC's are contained in the Vegetation Management Plan and include:

[4] As listed within schedules of the TSC Act (1995).

- Weed control;
- Regeneration/Revegetation;
- Pest Management; and
- Adaptive Management.

22.2.9 Threatened fauna species

22.2.10 Black bittern

Threats

There are two (2) records of the Black bittern: within the central Environmental Protection Zone, south of Precinct 5; and within the southern Environmental Protection Zone, south of Precinct 14 (**FIGURE 4, APPENDIX 3**).

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.

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 is 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.

Management Actions

Although the Black bittern was observed 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 2012) 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 22.3**). Furthermore, monitoring programs are included within the Precinct 2-4 & 6-11 VMP (2012) and Precinct 2-4 & 6-11 WMP (2012) to ensure suitable habitat remains viable.

22.2.11 Glossy black cockatoo

Threats

The Glossy black cockatoo has been recorded in the southern portion of the Kings Forest site **(FIGURE 4, APPENDIX 3)**. 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.

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.

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 2012). 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 (2012).
2. A monitoring program has been devised to monitor the presence of this species within the vicinity of Precincts 2-4 & 6-11 (**SECTION 22.3**). Furthermore, monitoring programs

are included within the Precinct 2-4 & 6-11 VMP (2012) and Precinct 2-4 & 6-11 WMP (2012) to ensure suitable habitat remains viable.

22.2.12 Grass Owl

Threats

There are numerous recorded sightings of the Grass owl on the Kings Forest site **(FIGURE 4, APPENDIX 3)**. 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).

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.

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 2012) 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 22.3**). Furthermore, monitoring programs are included within the Precinct 2-4 & 6-11 VMP (2012) and Precinct 2-4 & 6-11 WMP (2012) to ensure suitable habitat remains viable.

22.2.13 Grey-headed Flying-fox

Threats

The Grey-headed flying-fox has been recorded on the Kings Forest site **(FIGURE 4, APPENDIX 3)** 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.

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.

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 2012).

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 program.
2. A monitoring program has been devised to monitor the presence of this species within the vicinity of Precincts 2-4 & 6-11 (**SECTION 22.3**). Furthermore, monitoring programs are included within the Precinct 2-4 & 6-11 VMP (2012) and Precinct 2-4 & 6-11 WMP (2012) to ensure suitable habitat remains viable.

22.2.14 Koala

A Kings Forest Stage 1 Koala Plan of Management (JWA 2012) 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.

22.2.15 Masked Owl

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.

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.

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 (2012) and Precinct 2-4 & 6-11 WMP (2012).
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 22.3**). Furthermore, monitoring programs are included within the Precinct 2-4 & 6-11 (2012) and Precinct 2-4 & 6-11 WMP (2012) to ensure suitable habitat remains viable.

22.2.16 Osprey

Background

The Osprey has been recorded in the north-eastern portion of the Kings Forest site (**FIGURE 4, APPENDIX 3**). Ospreys require adequate supplies of fish, expanses of open water, tall trees for use as feeding bases, nest sites and vantage points. The preferred habitats are coastal lakes, rivers, estuaries, oceans and beaches. Offshore islands are utilised, and this species may range inland along large rivers, particularly in the northern part of the country. Extensive sheets of clear open water, fresh, brackish or saline are needed for fishing. Suitable habitat is considered to occur in the eastern portion of the site, in the vicinity of Cudgen Creek and Cudgen Lake.

Threats

Potential threats to this species are as follows:

- Reduction of suitable habitat (feeding, nesting and roosting) through clearing for bulk earthworks;
- Disturbance of nest sites by human activity;
- Pollution of foraging habitat

Recovery of the species

The NSW Office of Environment and Heritage has identified nine (9) priority actions to help recover this species:

1. Protect nest sites (usually large dead trees) and surrounding vegetation using appropriate buffer zones (suggest 100 metres). Preservation of the existing nest and structure is a priority and relocation should only be considered a last resort.
2. Work with managers of infrastructure to manage or translocate nests if site selection puts Osprey at risk.
3. Identify and protect regular feeding areas, perch (feeding) trees and nest material collection sites, particularly vegetation surrounding nest tree.
4. Consider direct and indirect impacts on the species and its habitat in planning processes including adequate field survey to identify nest tree, buffer protection zone, perch trees and feeding areas. Nesting season is from June to October.
5. Continue programs monitoring the breeding status of the species in NSW incorporating surveys of the number of active nest trees, breeding success at nests and protection of buffer zones and roost trees.
6. Undertake community awareness initiatives such as media campaigns, brochures and interpretive signs. These should cover issues such as the threat of discarding fish with fishing tackle attached, protection of potential and future nest trees.
7. Investigate the effectiveness of ameliorative management actions on the species including effectiveness of artificial nest structures.
8. Continue ecological research to determine whether availability of potential nest trees and/or food resources are limiting to the species as well as potential impacts of pesticides and polluntants on species breeding success.
9. Continue to consult with Aboriginal communities to determine cultural significance of the osprey.

Management Actions

The Osprey will benefit from the extensive rehabilitation works planned in accordance with the Precinct 1 & 5 VMP (JWA 2012) and the Precinct 12, 13 & 14 VMP (JWA 2012). The species utilises tall trees for nesting sites and vantage points. The proposed enhancement plantings will include tree species that are suitable for Osprey habitat.

The following management actions will also benefit the Osprey:

3. Habitat for the Osprey will be created through enhancement plantings. Planting will be undertaken in the rehabilitation areas within the environmental protection zones in accordance with the Precinct 1 & 5 VMP (JWA 2012) and the Precinct 12, 13 & 14 VMP (JWA 2012).
4. A monitoring program has been devised to monitor the presence of this species within the vicinity of Precincts 1 & 5. Furthermore, monitoring programs are included within the Precinct 1 & 5 VMP (2012) and Precinct 12, 13 & 14 VMP (JWA 2012) to ensure that suitable habitat remains viable.

22.2.17 Wallum froglet & Wallum sedge frog (Acid frogs)

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, APPENDIX 3**). 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 6, APPENDIX 3**).

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, APPENDIX 3**). Potential habitat is also considered to occur in the vicinity of Precinct 2-4 & 6-11.

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.

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.

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 (**APPENDIX 1**). Details of the proposed Acid Frog Compensatory habitat strategy at Kings Forest are also provided in **APPENDIX 1.**
2. 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 2012) and Precinct 2-4 & 6-11 WMP (2012).

3. A detailed water quality monitoring regime is included in the Overall Water Management Plan (Gilbert & Sutherland, July 2012) and will ensure that significant impacts on Acid frog habitats are avoided.
4. The Stage 1 FAMP (JWA 2012) 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.
5. 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).
6. 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).
7. 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).
8. A monitoring program has been devised to monitor the presence of these species within the vicinity of Precincts 2-4 & 6-11 (**SECTION 22.3**). Furthermore, monitoring programs are included within the Precinct 2-4 & 6-11 VMP (2012) and Precinct 2-4 & 6-11 WMP (2012) to ensure suitable habitat remains viable.

22.2.18 Yellow bellied sheathtail bat

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 4, APPENDIX 3**).

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.

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.

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 (2012). 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 (2012) and Precinct 2-4 & 6-11 WMP (2012).
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 22.3**). Furthermore, monitoring programs are included within the Precinct 2-4 & 6-11 VMP (2012) and Precinct 2-4 & 6-11 WMP (2012) to ensure suitable habitat remains viable.

22.3 Monitoring and Reporting

22.3.1 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 (also refer FFMR (JWA 2012)).

Populations of Threatened flora & fauna within the EPZ's will be monitored on an annual basis for a period of five (5) years or until the vegetation is self-sustaining (whichever is the earliest).

22.3.2 Flora monitoring

All threatened plant species will be monitored as follows:

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

22.3.3 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.

22.3.4 Performance Criteria

The success of the TSMP will be regularly evaluated by measurement of impacts and monitoring results. A number of criteria will indicate successful management of threatened species. The overall performance criteria for this plan are shown in **TABLE 2.**

TABLE 2
PERFORMANCE CRITERIA

Objectives	Target	Performance
Vegetation protection		
Manage and protect existing threatened plant species from site activities	No disturbance to existing threatened plant species	Protective and high visibility temporary fencing erected
	Protection from management activities	No detrimental impacts to existing threatened plant species from spraying/ weeding
	Fire management	No disturbance to existing threatened species from fire
Manage and protect Endangered Ecological Communities (EECs) from site activities	No disturbance to existing EECs on the Kings Forest site	Erect protective and high visibility temporary fencing
	Protection from management activities	No detrimental impacts to existing threatened plant species from spraying/ weeding
	Fire management	No disturbance to existing EECs from fire.
Manage and protect potential habitat for threatened plant species	No significant barriers to natural regeneration of threatened plant species	Weed control (Foliage Projective Cover (%) assessed using eye estimates or photo points)
	Enhance natural regeneration potential of threatened plant species	Revegetation occurring (Species composition targets, based on accepted benchmarks for the specific vegetation communities on the Kings Forest site, are met)
Maintain and increase presence of threatened plant species over time	Protection of naturally regenerating threatened flora species	Regular (annual) searches of any threatened plant species occurring on the site indicates the continued presence of threatened plant species
	Propagate seeds and/or cuttings from threatened plant species for use in rehabilitation plantings	Successful propagation and establishment of cuttings/ seedlings of threatened flora
Fauna Protection		
Manage and protect existing threatened fauna species from site activities	Exclude threatened species from potential impacts by way of exclusion fencing	No sightings of threatened fauna species within exclusion fencing
	No significant barriers for native fauna	Fauna demonstrated to be utilising road underpasses
	Buffer threatened species from potential impacts	No significant decrease in numbers, range or abundance estimates from baseline data resulting from site activities
Maintain and increase presence of threatened fauna species over time	Minimise predation of threatened fauna by feral animals	Feral animal control and monitoring is completed in accordance with the FAMP (JWA 2012). No threatened species decline as a result of feral animal predation
	Rehabilitation of existing habitat	Increased abundance of threatened fauna as a result of the rehabilitation of existing habitat
	Creation of compensatory habitat	Increased abundance of threatened fauna as a result of compensatory habitat creation

22.3.5 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 22.3.4).

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APPENDIX 1 – ACID FROG COMPENSATORY HABITAT

1. Background

Two (2) Threatened species of 'Acid fog' have been recorded from the vicinity of Precincts 1 & 5 (refer **SECTION 22.2.17** of the main body of this report):

- 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 1 & 5 is considered to be comprised of undisturbed and regenerating wet heathland (**APPENDIX 1 FIGURE 1, 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 1 & 5 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 development will result in unavoidable impacts on some Core habitat areas. Core habitat in other areas of the site have been avoided and will be rehabilitated.

PLATE 1: Existing frog habitat (i.e. regenerating wet heath) within EPZ to the east of Precinct 5.

PLATE 2: Existing frog habitat within the Precinct 5 development area (i.e. constructed drainage line).

2. Literature Review

Where it has been trialled, the creation of aquatic habitats has had a positive influence on securing and augmenting populations of some species of amphibians such as *Bufo calamita* (Denton et al. 1997), *Hyla arborea* (Berninhausen 1995; Meier 1995), *Triturus alpestrus* (Mikkelsen 1993), and *Andrias japonicas* (Tochimoto 1995). Few attempts to replicate or re-instate breeding areas for frog species, not least 'Acid frogs,' have been undertaken and documented in Australia. It is well recognised however that the Wallum froglet and to a lesser extent, the Wallum sedge frog will rapidly recolonise and breed in disturbed areas previously containing 'Wallum' vegetation (Hero et al. 2001; Ingram 2005). The construction of artificial habitat and breeding ponds for 'Acid frogs' is therefore considered feasible and likely to be successful (Ingram 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.' Recommendations were provided by these experts based on observations made during field & laboratory work (Ecosense Consulting Pty Ltd, 2005). For instance 'Acid frogs' were observed to utilise manmade ponds and drainage lines on the site for breeding. In these instances common attributes are shallow water bodies in sandy soils and of low pH and electrical conductivity (Ecosense Consulting Pty Ltd, 2005). A summary of observed habitat commonalities is as follows:

- 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 based on the above recommendations, the *Tugun Bypass Species Impact Statement* (2004) and Ingram (2005). The effectiveness of the compensatory frog ponds along the Tugun Bypass were assessed against Operational Environmental Management Plan performance criteria in the Environmental Impact Audit Report: Operations for the Tugun Bypass Project (Pacific Alliance, 2010).

Three of the four ponds consistently met the performance criteria for water quality and hydroperiod5. Wallum Froglet (*Crinia tinnula*) and Wallum Sedge Frog (*Litoria olongburensis*) abundances varied throughout the eight surveys conducted during the reporting period6. In

[5] **The performance criteria stipulated that for two of the 3 year monitoring period - 75% of the frog ponds should contain surface water for >10 weeks per annum and that 75% of these frog ponds will have water quality similar to pH and electrical conductivity parameters of pH <5 and EC <350 µS/cm.**

[6] **The performance criteria stipulated that 75% of the frog ponds should not contain Gambusia sp. and that 75% of the ponds should have an active calling of either Wallum Froglet (Crinia tinnula) and/or Wallum Sedge Frog (Litoria olongburensis) species during survey monitoring.**

general results for the compensatory ponds showed that although consistently present, threatened frog numbers were low, while a diverse range of other non-threatened frogs were present. *Gambusia* sp. (Mosquito fish) was recorded during one survey but following draining of the ponds, undertaken as a remediation measure, follow up surveys did not reveal the presence of *Gambusia* sp. Water treatment basins constructed around the Bypass had the added benefit of providing additional frog habitat. *Crinia tinnula* were recorded calling from several different water treatment basins on numerous occasions during regular 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 (**APPENDIX 1 FIGURE 2**). 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 (**APPENDIX 1 FIGURE 1**);
- Distribution of suitable soils (i.e. Podsols) (**APPENDIX 1 FIGURE 3**);
- Topography;
- Presence of Potential Acid Sulphate soils (**APPENDIX 1 FIGURE 4**); and
- Existing vegetation values.

A typical section and plan view of the proposed compensatory acid frog habitat is shown in **APPENDIX 1 FIGURE 5**. The compensatory core acid frog habitat is based on the Tugun Bypass compensatory habitat and will include the following design criteria:

a) 'above ground'

- 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**);
- '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;
- 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;
- Construction during a dry period (spring) leading to a pronounced rainfall period as to enable machinery to access the site with minimal damage and enhance the likelihood that transplanted vegetation would survive; and

- Be interspersed with existing breeding ponds, thereby increasing the interconnectivity of aquatic habitats.

(b) **'below ground'**

- Be created to a depth immediately above the organic hard pan layer to to a maximum depth of 60cm;
- Be created to intercept the water table to ensure water is available for an extended period of time and allow for successful breeding; and
- It would be expected that the water in these melon holes would evaporate during extended dry periods.

The compensatory habitat areas will be planted with a combination of Swamp sclerophyll (i.e. Swamp mahogany & Broad-leaved paperbark) and Wet heath species. On coastal sand plains, swamp forests form mosaics with wallum sand heaths, coastal heath swamps and coastal freshwater lagoons (Keith, 2004). This is a natural association of vegetation communities and habitat features that occurs across the Subject site. For example, a site assessment of a ~2.8 ha plot in Precinct 3 recorded confirmed 'Acid frog' habitat in the form of ephemeral pools, drainage lines and associated sedges, in association with Swamp Mahogany, Scribbly Gum, Paperbark and various heath species (See Appendix 4 KPOM (JWA 2012)).

Swamp sclerophyll species will be planted at 7 metre centres, with Broad leaved paperbark constituting 1/3 of species planted and Swamp mahogany 2/3 of species planted. In areas of known scribbly gum habitat, the proportion of swamp mahogany will be reduced to 1/3 and scribbly gum plantings will constitute 1/3 of tree species. The typical composition of the proposed wallum sedge frog habitat is given in **APPENDIX 1 FIGURE 5**. Heath understory will be naturally regenerated or revegetated depending on the soil seed bank and site specific conditions.

PLATE 3: Existing frog ponds on site created during Slash pine removal.

Fourteen (14) suitable compensatory habitat areas have been identified on the Kings Forest site (**APPENDIX 1 FIGURE 2**), covering a total area of approximately 48.77ha. For details of the works to be completed at each site see **FIGURES 10 & 10A – 10L (APPENDIX 2)** of the Precinct 1 & 5 BMP (JWA 2012) and **APPENDIX 2** of this TSMP. Compensatory habitat areas 1, 3, 11, 12, 13 & 14 are relevant to this TSMP and are described as follows:

Compensatory Habitat Area 1 (**FIGURE 10I BMP**, **APPENDIX 2** (JWA 2012))

- An area of approximately 0.78ha on the northern side of Depot Road in the north-eastern portion of the Kings Forest site (i.e. adjacent to Precinct 2) within the inner 30m of the Ecological buffer, consisting of:
    - Podosol soils; and
    - Exotic grassland dominated with heathland species and Regenerating wet/dry coastal heathland to shrubland vegetation communities.
- Core habitat will be created through excavation of melon holes and subsequent assisted regeneration/revegetation works:
    - Swamp sclerophyll (i.e. Swamp mahogany & Broad-leaved paperbark) and Wet heath species.

Compensatory Habitat Area 3 (**FIGURE 10I BMP, APPENDIX 2** (JWA 2012))

- An area of approximately 1.50ha on the northern side of Depot Road in the north-eastern portion of the Kings Forest site (i.e. adjacent to Precinct 3) within the inner 30m of the Ecological buffer that consists of;
    - Podosols; and is
    - Substantially cleared of native vegetation with regenerating wet/dry coastal heathland to shrubland.
- This area is adjacent to existing areas of Core habitat (**APPENDIX 1 FIGURE 1**);
- Core habitat will be created through excavation of melon holes and subsequent assisted regeneration/revegetation works where necessary:
    - Swamp sclerophyll (i.e. Swamp mahogany & Broad-leaved paperbark) and Wet heath species.

Compensatory Habitat Area 11 (**FIGURE 10B, C, E & F BMP, APPENDIX 2** (JWA 2012))

- An area of approximately 3.24ha within the inner ecological buffers to the south of Precincts 6 & 7 (**PLATES 16 & 17**) that consists of:
    - Podosols; Organosols and Potential acid sulphate soils; and
    - Broad-leaved paperbark closed forest to woodland.
- This area is adjacent to Core habitat within the adjacent SEPP 14 wetland (**PLATE 18**); and includes small areas of existing frog habitat (**PLATE 19**) that are to be dedicated to NPWS for inclusion in the Cudgen Nature Reserve (**APPENDIX FIGURE 2**);
- Core habitat will be created through excavation of melon holes and subsequent assisted regeneration/revegetation works where necessary.
    - Swamp sclerophyll (i.e. Swamp mahogany & Broad-leaved paperbark) and Wet heath species.

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 (**FIGURE 10 BMP, APPENDIX 2** (JWA 2012))

- An area of approximately 9.47ha within the inner ecological buffers to the west of Precincts 9 & 10 and the east of Precinct 11 that consists of:
    - Podosols; and
    - Ponds and fringing wetland, Broad-leaved paperbark closed forest to woodland, exotic pine plantations/ pine wildings, regenerating wet/dry coastal heathland to shrubland.
- Core habitat will be created through excavation of melon holes and subsequent assisted regeneration/revegetation works where necessary.
    - Swamp sclerophyll (i.e. Swamp mahogany & Broad-leaved paperbark) and Wet heath species.

Compensatory Habitat Area 13 (**FIGURE 10D BMP, APPENDIX 2** (JWA 2012))

- An area of approximately 1.17ha within the inner ecological buffers to the east of Precincts 8 (**PLATE 20**) that consists of:
    - Podosols and Organosols; and
    - Sedgeland/ rushland, regenerating wet/dry coastal heathland to shrubland, exotic grassland dominated with heathland species, regenerating broad-leaved paperbark closed forest to woodland & heathland species.
- This area includes 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 excavation of melon holes and subsequent assisted regeneration/revegetation works where necessary.
    - Swamp sclerophyll (i.e. Swamp mahogany & Broad-leaved paperbark) and Wet heath species.

PLATE 20: Compensatory Habitat Area 13.

Compensatory Habitat Area 14 (**FIGURE 10D BMP, APPENDIX 2** (JWA 2012))

- An area of approximately 6.32ha within an EPZ to the west of Precinct 8 that consists of:
    - Podosols; and is
    - Substantially cleared of native vegetation.
- Core habitat will be created through excavation of melon holes and subsequent assisted regeneration/revegetation works where necessary.
    - Swamp sclerophyll (i.e. Swamp mahogany & Broad-leaved paperbark) and Wet heath species.

The staging of Acid frog compensatory habitat works will generally be based on the sequence of bulk earthworks (**APPENDIX FIGURE 6**) as shown in **TABLE 1**.

TABLE 1
TSMP STAGING OF WORKS

Earthworks sequencing	Work areas
Stage 1	1 & 3
Stage 2, 4, 5 & 9	11
Stage 9	12, 13 & 14

A comparison of the compensatory habitat proposed at Kings Forest with the design criteria of the Tugun Bypass frog ponds is provided in **TABLE 2**.

TABLE 2
COMPARISON OF KINGS FOREST & TUGUN BYPASS COMPENSATORY HABITAT

TUGUN BYPASS FROG PONDS	PROPOSED KINGS FOREST COMPENSATORY HABITAT
Ponds should be constructed in sandy substrates (which previously contained 'Wallum') with an underlying organic hardpan;	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.
Ponds should generally be shallow and constructed in areas of high groundwater;	Constructed melon holes will be a maximum of approximately 60cm deep and will be created to intercept the water table.
Water quality should exhibit the following characteristics: o pH <5 (as influenced by humic soils); o hardness < 100 p.p.m; and o 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.

An 'Acid frog' Compensatory Habitat Plan (CHP) 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).

4. Performance criteria

- Ponds are to contain surface water for a period of >10 weeks per annum, for at least two of the three year monitoring periods,
- Waters within ponds are to have a pH <5 and an electrical conductivity <350 uS.cm-1
- ponds are to contain a margin of emergent macrophytes >200 mm thick
- ponds are not to contain fish

5. Monitoring Program

- Regular (quarterly) monitoring of wallum sites is needed to ascertain population trends for all wallum-dependent frog species and to determine whether habitat restoration has been effective species (Queensland Environmental Protection Agency 2006)
- Between April and August for the wallum froglet and between September and April for the Wallum sedge frog (Survey guidelines)
- During the survey the following activities shall also be undertaken:

    - Water quality monitoring for the parameters of pH and electrical conductivity
    - Recording of water depth and general environmental conditions.

6. Contingencies

- Ponds that contain fish shall be reduced in capacity and hydroperiod
- Restoration of macrophytes shall be undertaken where margins >200mm thick
- New ponds shall be constructed when the water quality of existing ponds exceeds the designated performance criteria for two of the tree year periods
- Ponds shall be increased in capacity, or their catchment areas increased where the hydroperiod does not accord with the required performance criteria.
- Consideration shall however be given to the seasonal conditions of those times.

LEGEND

- Acid Frog Core Habitat
- Wallum sedge frog
- Wallum froglet
- Precincts 2-4 & 6-11
- Kings Forest Boundary

0 500m
1 : 20 000

SOURCE: JWA Site Investigations

SCALE: 1 : 20 000 @ A3

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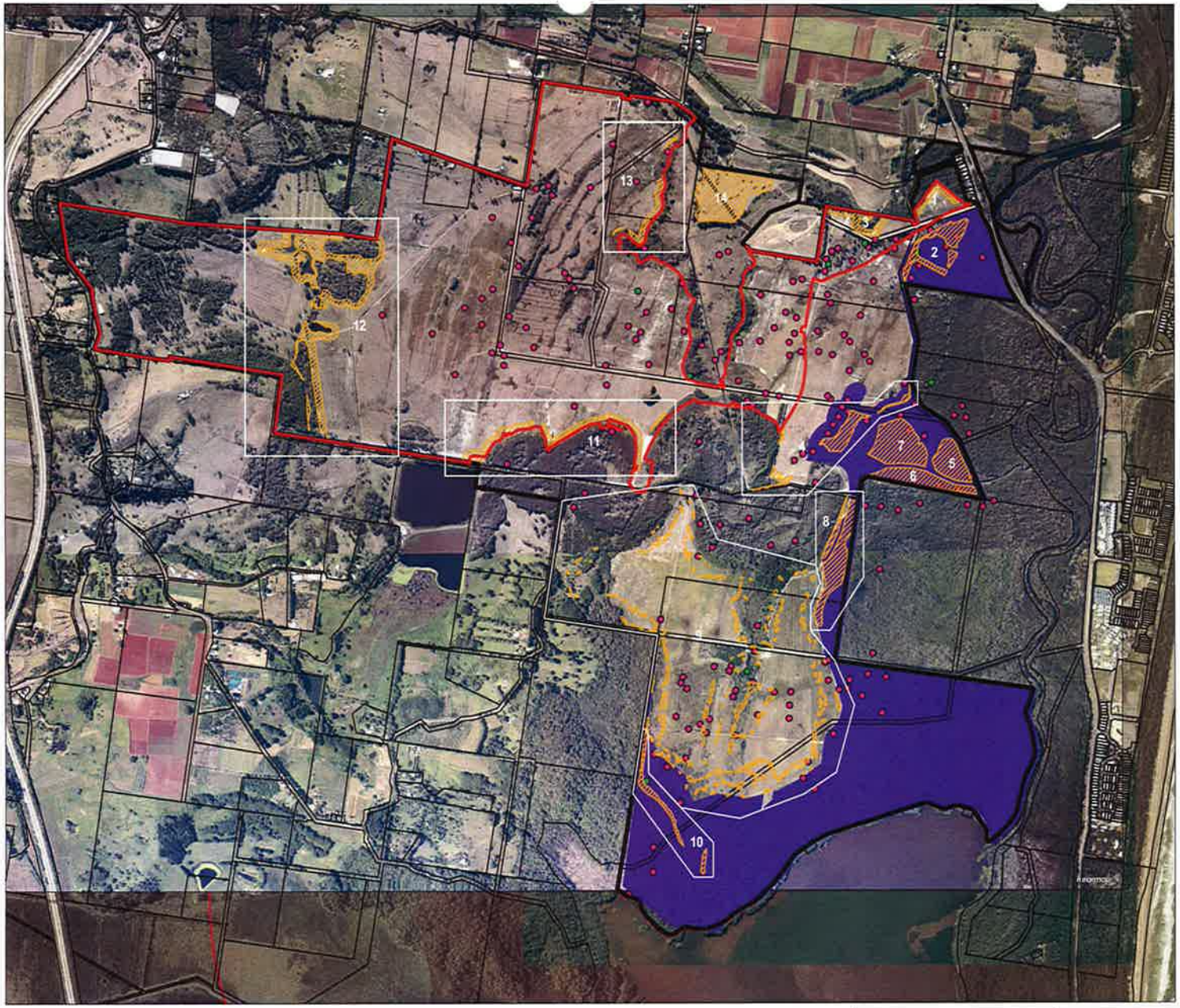
APPENDIX 1
FIGURE 1

PREPARED: BW
DATE: 20 August 2012
FILE: N97017_TSMP_Base.dwg

TITLE

ACID FROG
CORE HABITAT



LEGEND

- Acid Frog Compensatory Habitat
- Wallum sedge frog
- Wallum froglet
- Indicative Areas to be Dedicated to NPWS Conservation Offset (Nature Reserve Addition) Land (Approx Total Area 180ha) (150ha per concept plan condition C3, additional 30ha subject to agreement with NPWS)
- Precincts 2-4 & 6-11
- Kings Forest Boundary

Note: Final boundaries are subject to agreement with Deptartment of Planning & Infrastructure

0 500m
1 : 20 000

SOURCE: JWA Site Investigations

SCALE: 1 : 20 000 @ A3

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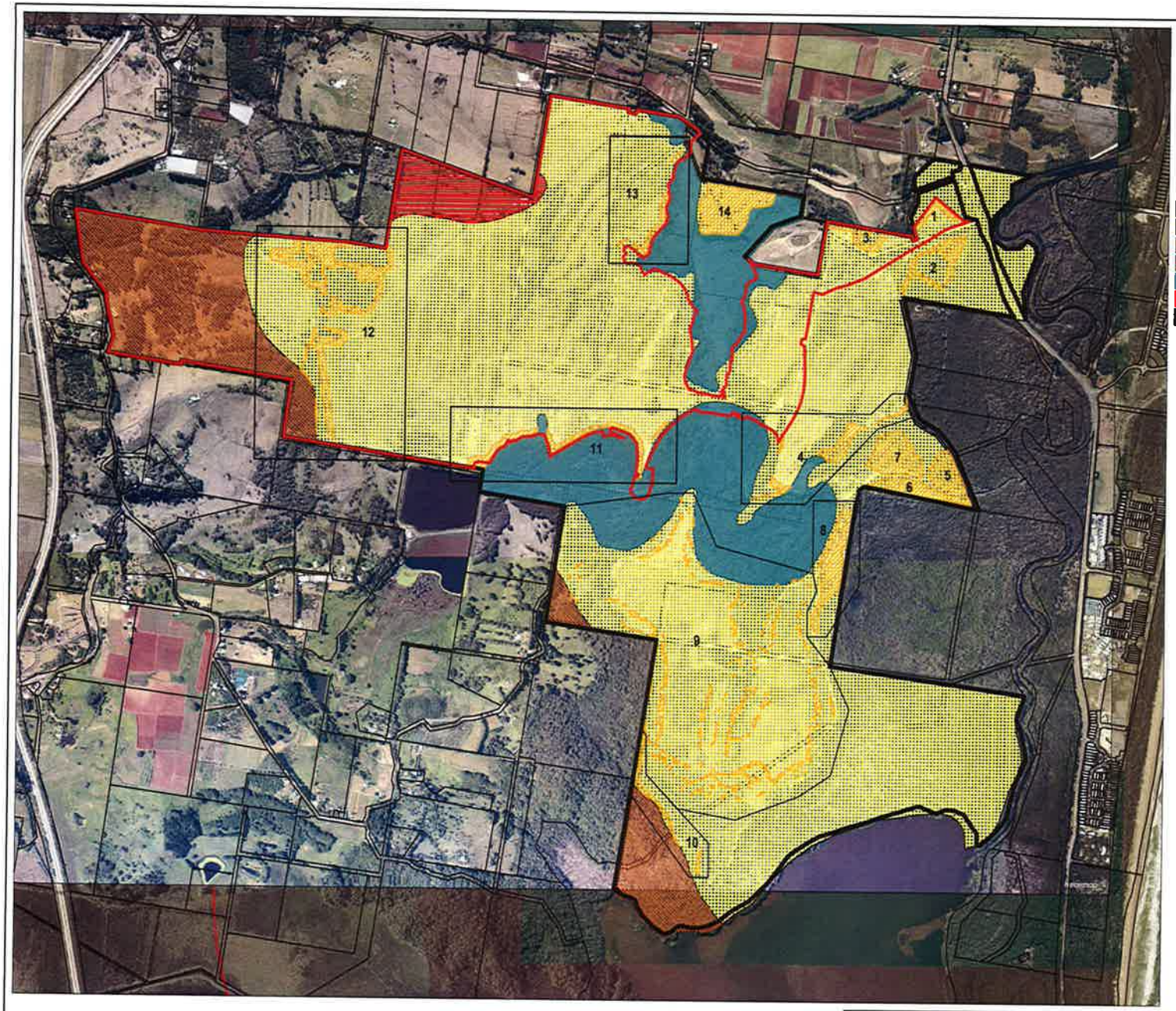
APPENDIX 1
FIGURE 2

PREPARED: BW
DATE: 28 August 2012
FILE: N97017_TSMP_Base.dwg

TITLE

ACID FROG COMPENSATORY HABITAT & RECORDS



LEGEND

- Acid Frog Compensatory Habitat
- Podosols
- Meta-Sediments consisting of Kandosols & Dermosols (Hydrosol at OBS4)
- Ferrosols
- Organosols
- Precincts 2-4 & 6-11
- Kings Forest Boundary

0 500m
1 : 20 000

SOURCE: JWA Site Investigations
Gilbert & Sutherland

SCALE: 1 : 20 000 @ A3

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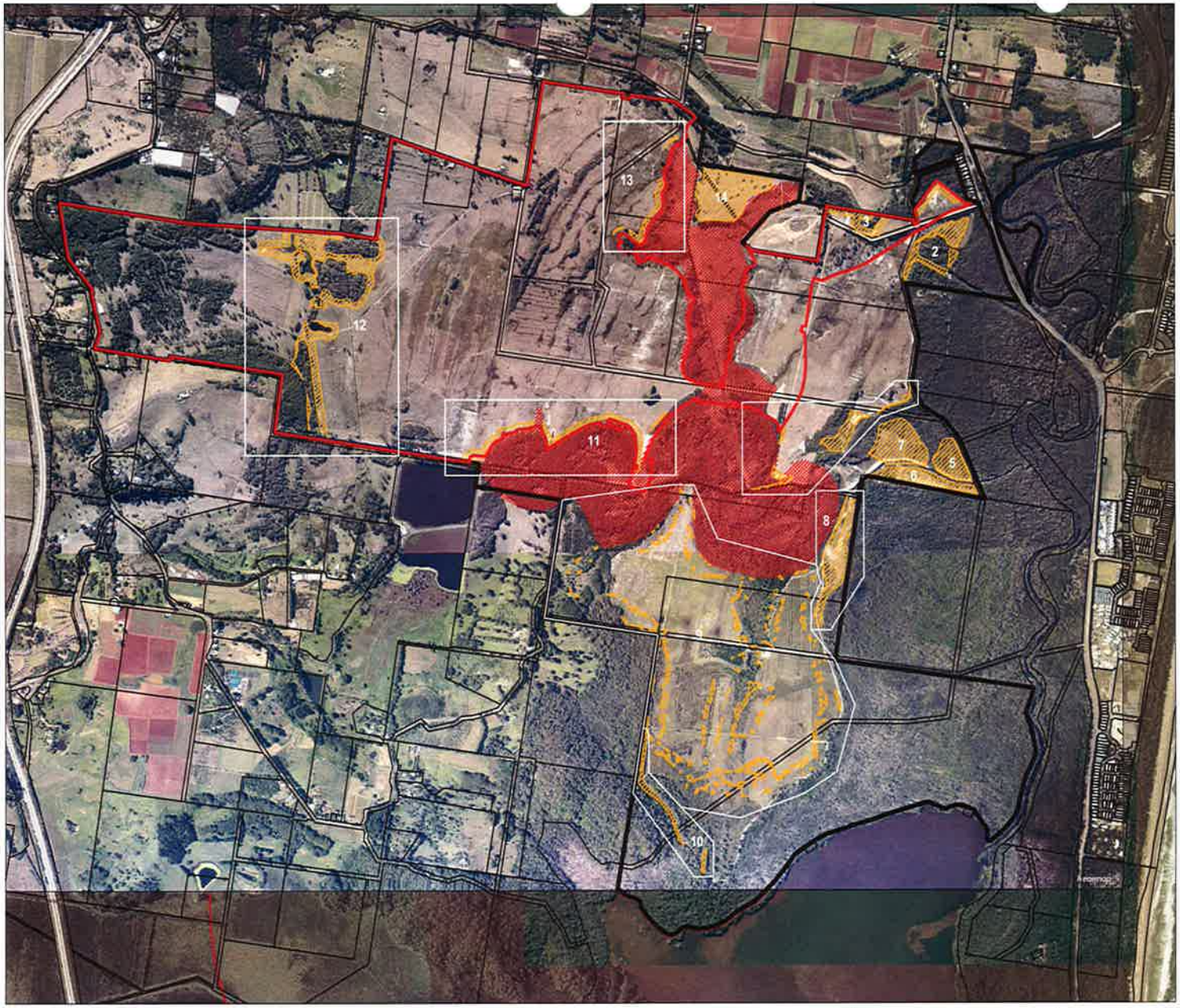
APPENDIX 1
FIGURE 3

PREPARED: BW
DATE: 20 August 2012
FILE: N97017_TSMP_Base.dwg

TITLE
ACID FROG COMPENSATORY HABITAT OVERLAID ON SOIL MAPPING



LEGEND

- Acid Frog Compensatory Habitat
- Potential Acid Sulphate Soils
- Precincts 2-4 & 6-11
- Kings Forest Boundary

0 500m
1 : 20 000

SOURCE: JWA Site Investigations
Gilbert & Sutherland

SCALE: 1 : 20 000 @ A3

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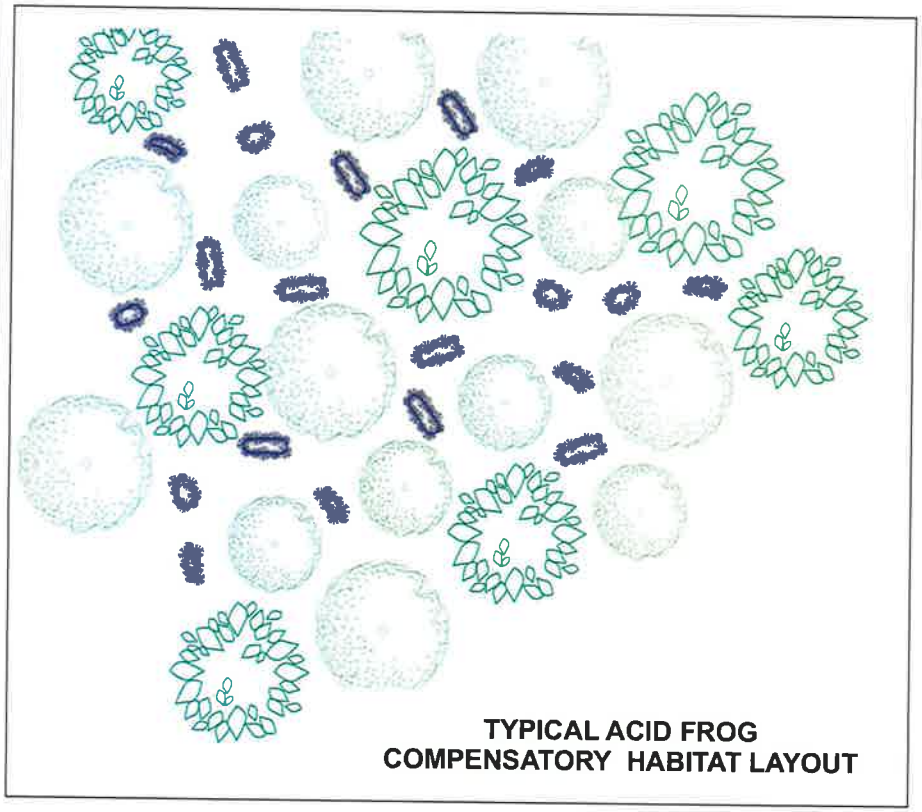
APPENDIX 1
FIGURE 4

PREPARED: BW
DATE: 20 August 2012
FILE: N97017_TSMP_Base.dwg

TITLE
ACID FROG COMPENSATORY HABITAT OVERLAID ON POTENTIAL ACID SULPHATE SOILS



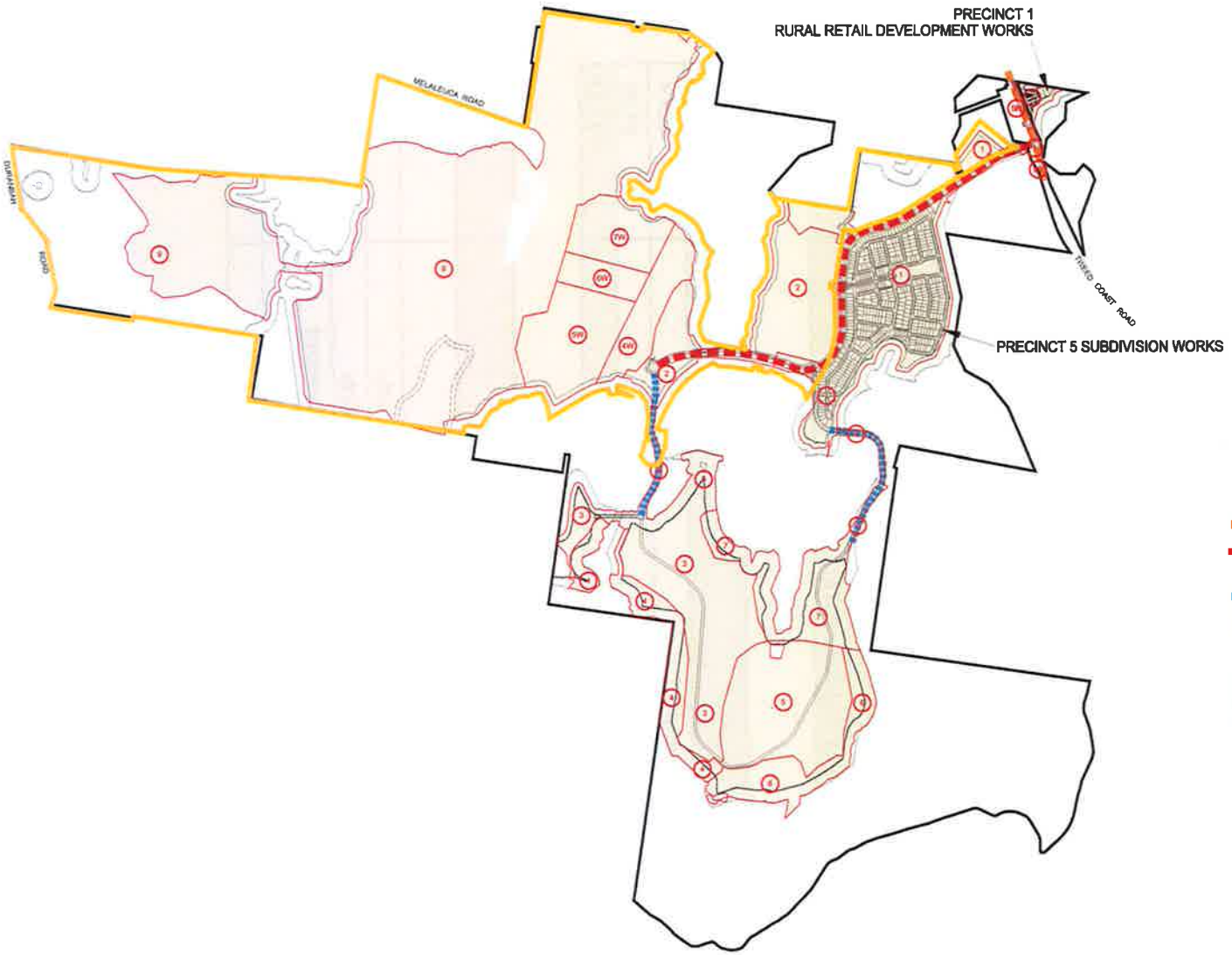
TYPICAL ACID FROG COMPENSATORY HABITAT LAYOUT

ACID FROG COMPENSATORY HABITAT CROSS-SECTION

LEGEND

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

SOURCE: JWA SCALE: Not to Scale JAMES WARREN & ASSOCIATES PTY LIMITED Environmental Consultants	CLIENT Project 28 Pty Ltd PROJECT Kings Forest Stage 1 Project Application Precincts 2-4 & 6-11 - Threatened Species MP Melaleuca Drive, Duranbah, NSW Shire of Tweed	**APPENDIX 1** **FIGURE 5** PREPARED: BW DATE: 20 August 2012 FILE:N97017_TSMP_frog habitat.cdr	TITLE **TYPICAL WALLUM FROGLET HABITAT PLAN & SECTION**



LEGEND

- Tweed Coast Road Intersection Works
- Kings Forest Parkway through to Western Precincts
- Roads through to Southern Precincts
- Indicative Bulk Earthworks Location (Refer to detailed engineering design by Mortons Urban Solutions)
- Earthworks Sequencing
- Precincts 2-4 & 6-11
- Kings Forest Boundary

0 500m
1 : 20 000

SOURCE: RPS (Ref: 113691-PSP-4a (SCOPE OF WORKS).jpeg); Mortons Urban Solutions (Ref: sequencing COLOUR.pdf)
SCALE: 1 : 20 000 @ A3
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APPENDIX 1
FIGURE 6
PREPARED: BW
DATE: 28 August 2012
FILE: N97017_TSMP_Scope.cdr

TITLE
SCOPE OF WORKS

APPENDIX 2 – COMPENSATORY HABITAT AREAS

TABLE 1

COMPENSATORY HABITAT AREA CALCULATIONS

Koala Food Tree Planting Areas	**Area (ha)**
Koala Food Tree Planting Areas - Site excluding golf course	60.48
Koala Food Tree Planting Areas - Golf course only	10.64
Koala Food Tree Planting Areas - TOTAL	**71.12**

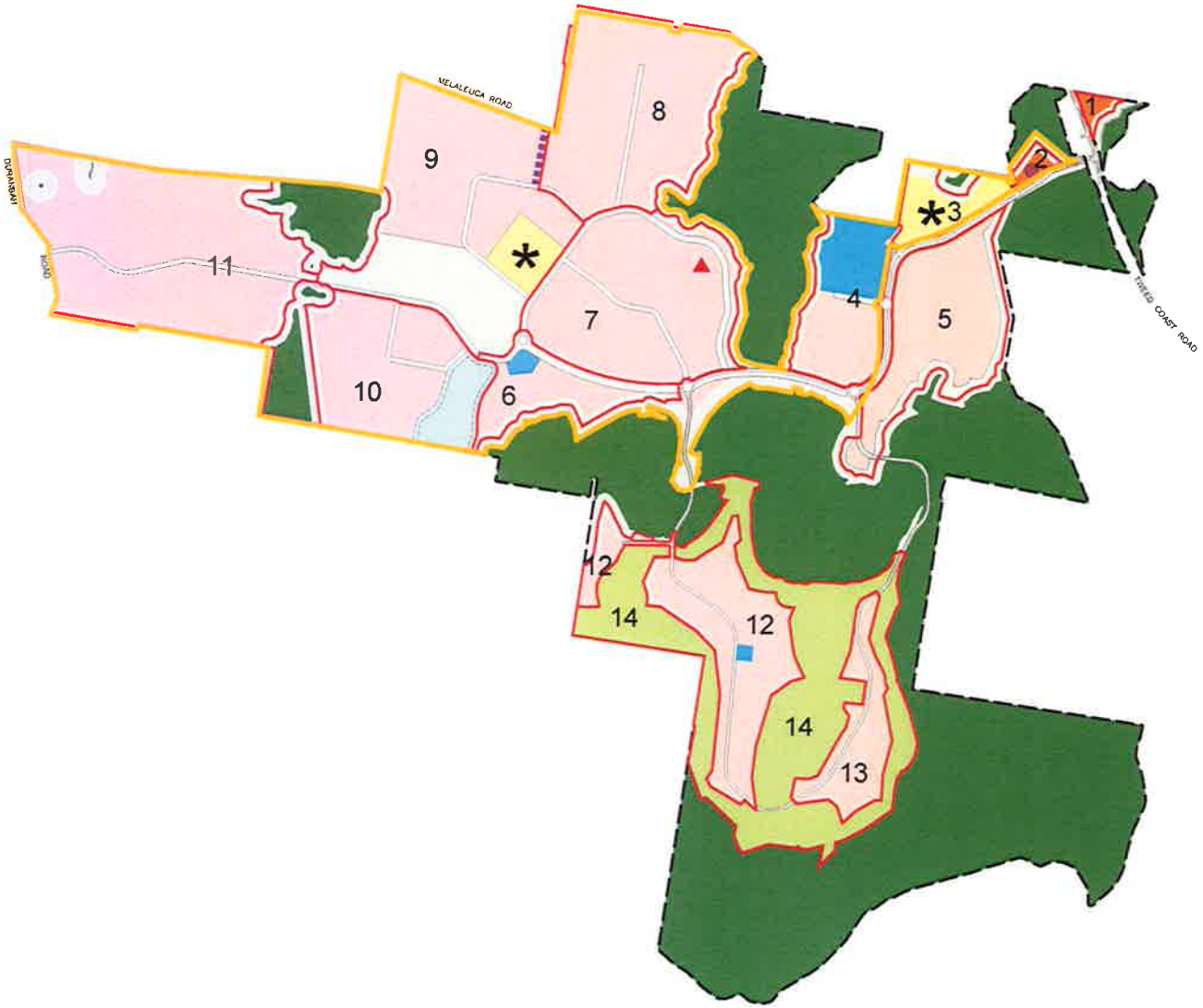
Wallum Sedge Frog Compensatory Habitat	**Area (ha)**
Wallum Sedge Frog Compensatory Habitat - Site excluding golf course	32.40
Wallum Sedge Frog Compensatory Habitat - Golf course only	6.90
Wallum Sedge Frog Compensatory Habitat - TOTAL	**39.30**

Wallum Froglet Compensatory Habitat	**Area (ha)**
Wallum Froglet Compensatory Habitat - Site	9.47
Wallum Froglet Compensatory Habitat - TOTAL	**9.47**

Heath Rehabilitation	**Area (ha)**
Heath to be Naturally Regenerated	42.19
Heath to be Revegetated	69.02
Heath Rehabilitation - TOTAL	**111.21**

Overlapping Areas	**Area (ha)**
Overlapping areas of Wallum Sedge Frog, Koala and Heath Compensatory Habtiat	40.24
Areas designated for Koala Compo Habtiat & Heath Reveg only	10.21
Areas designated for Koala Compo Habtiat & Heath Regen only	14.82
Areas designated for Koala Compensatory Habitat only (no overlap)	6.19
Areas designated for Heath Revegetation only (no overlap)	24.74
Areas designated for Heath Regeneration only (no overlap)	21.69

APPENDIX 3 – FIGURES



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 APZ's & roads where approved)
- State School Site
- Proposed Zone Substation
  (subject to Country Energy final approval)
- Potential Affordable Housing Location
- Potential Road Connection to Melaleuca Road

Private Open Space

- Golf Course Area
  (encompassing ecological buffers where indicated)
- Private Open Space including Lake
- Precinct Boundaries
- Precincts 2-4 & 6-11
- Kings Forest Boundary

0 500m
1 : 20 000

SOURCE: RPS (Ref: 113691-PSP-4a (PRECINCT PLAN).jpeg)
SCALE: 1 : 20 000 @ A3

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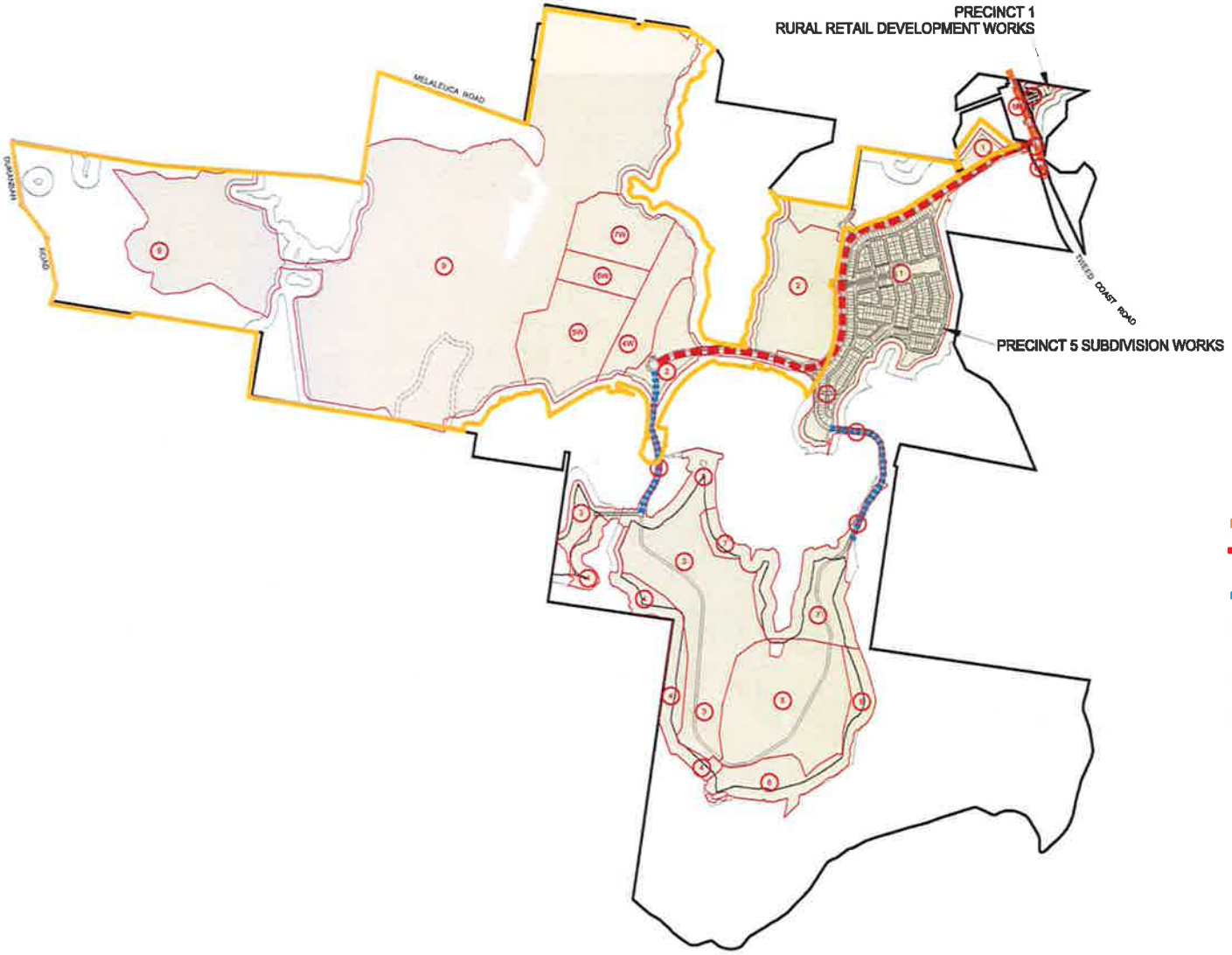
Shire of Tweed

FIGURE 1

PREPARED: BW
DATE: 27 August 2012
FILE: N97017_TSMP_Precincts.cdr

TITLE

PRECINCTS PLAN



LEGEND

- Tweed Coast Road Intersection Works
- Kings Forest Parkway through to Western Precincts
- Roads through to Southern Precincts
- Indicative Bulk Earthworks Location (Refer to detailed engineering design by Mortons Urban Solutions)
- Earthworks Sequencing
- Precincts 2-4 & 6-11
- Kings Forest Boundary

0 500m
1 : 20 000

SOURCE: RPS (Ref: 113691-PSP-4a (SCOPE OF WORKS).jpeg); Mortons Urban Solutions (Ref: sequencing COLOUR.pdf)
SCALE: 1 : 20 000 @ A3
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FIGURE 2

PREPARED: BW
DATE: 28 August 2012
FILE: N97017_TSMP_Scope.cdr

TITLE
SCOPE OF WORKS

LEGEND

- Green leaved rose walnut
- Southern swamp orchid
- Stinking laurel
- White laceflower
- White yiel yiel
- Precincts 2-4 & 6-11
- Kings Forest Boundary

0 500m
1 : 20 000

SOURCE: Landpartners - Threatened Flora; 2007 Aerial Photograph

SCALE: 1 : 20 000 @ A3

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FIGURE 3

PREPARED: BW
DATE: 20 August 2012
FILE: N97017_TSMP_Base.dwg

TITLE

THREATENED FLORA

LEGEND

- Black bittern
- Black-necked stork
- Bush hen
- Bush stone-curlew
- Glossy black cockatoo
- Grass owl
- Masked owl
- Osprey
- Common blossom bat
- Common planigale
- Grey-headed flying-fox
- Koala
- Yellow-bellied sheathtail bat
- Precincts 2-4 & 6-11
- Kings Forest Boundary

0 500m
1 : 20 000

SOURCE: Landpartners - Threatened Fauna - Birds & Mammals; 2007 Aerial Photograph

SCALE: 1 : 20 000 @ A3

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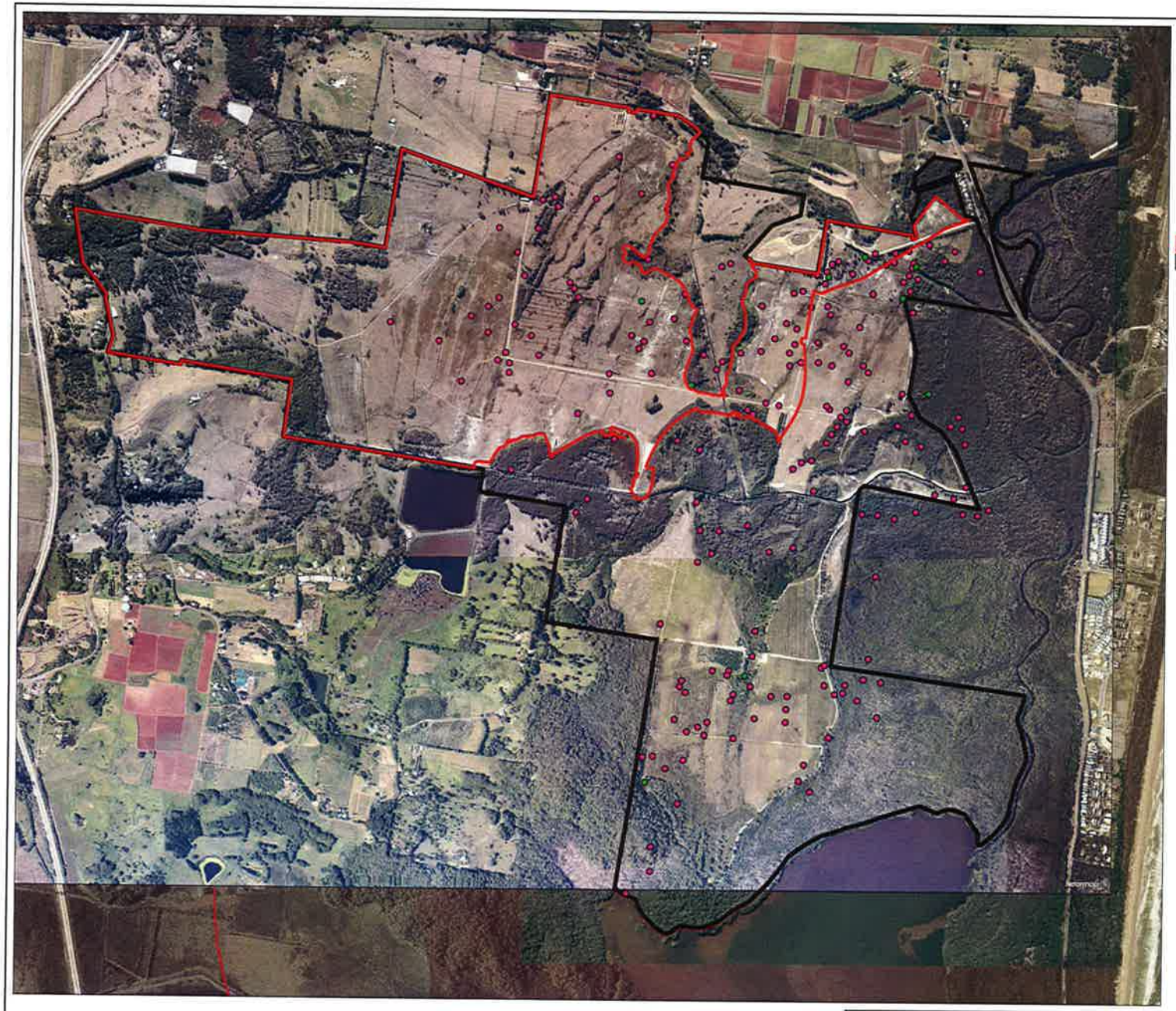
FIGURE 4

PREPARED: BW
DATE: 20 August 2012
FILE: N97017_TSMP_Base.dwg

TITLE

THREATENED FAUNA SPECIES - BIRDS & MAMMALS



LEGEND

- Wallum sedge frog
- Wallum froglet
- Precincts 2-4 & 6-11
- Kings Forest Boundary

0 500m
1 : 20 000

SOURCE: Landpartners - Threatened Fauna - Amphibians; 2007 Aerial Photograph

SCALE: 1 : 20 000 @ A3

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FIGURE 5

PREPARED: BW
DATE: 20 August 2012
FILE: N97017_TSMP_Base.dwg

TITLE

THREATENED FAUNA SPECIES - AMPHIBIANS

LEGEND

- Acid Frog Core Habitat
- Wallum sedge frog
- Wallum froglet
- Precincts 2-4 & 6-11
- Kings Forest Boundary

0 500m
1 : 20 000

SOURCE: JWA Site Investigations

SCALE: 1 : 20 000 @ A3

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FIGURE 6

PREPARED: BW
DATE: 20 August 2012
FILE: N97017_TSMP_Base.dwg

TITLE

ACID FROG
CORE HABITAT