Offsets Area Management Plan

Mt Emerald Wind Farm, Herberton Range, North Queensland

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Document Status

Version	Purpose of Document	Orig	Review	Review Date
1	Draft Offset Area Management Plan	M Jess	L Liessmann	28/09/2016
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Approval for Issue

Name	Signature	Date
Mellissa Jess		13/12/2016

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1.0 Introduction

RATCH-Australia Corporation Limited (RACL) proposed to develop the Mount Emerald Wind Farm (MEWF) project located southeast of Walkamin in north Queensland (**Figure 1**). The MEWF (Lot 7 SP235244) is approximately 2,422 ha in size and will include 53 wind turbines, associated access tracks and electrical infrastructure, feeding into the main electricity grid (Chalumbin-Woree transmission line).

The purpose of this Mt Emerald Offset Area Management Plan (OAMP) is to identify the management objectives and outcomes, and the actions necessary to fulfil a statutory requirement for the provision of an offset under an approval (EPBC 2011/6228) granted under the *Environment Protection and Biodiversity Conservation Act 1999* (Clth) (EPBC Act) to Mount Emerald Wind Farm Pty Ltd (MEWFPL). This Plan has been developed to meet both the EPBC Act and NCA Act requirements and also the requirements to secure the land under a voluntary agreement within relevant state legislation.

This Offset Area Management Plan replaces the MEWF Management Plan produced by CO_2 Australia (2013) for the MEWF Offset Area.

The purpose of this Offsets Area Management Plan (OAMP) is to provide:

- A map of the offset area, including GPS points;
- The type and location of values to be offset;
- The offset area management objectives and outcomes;
- Activities that will be undertaken to achieve the management objectives and outcomes and analysis of the risks to achieving the management objectives and outcomes;
- A monitoring and reporting program;
- Estimated time until the offset management objectives and outcomes will be achieved; and
- Identification of all registered interests including mortgages, leases, subleases, covenants, profit-a-prendre.

1.1 Regulatory Requirements

Conditions relevant to the preparation and implementation of the offset Area Management Plan are detailed in **Table 1** below.

Table 1 Location of specific EPBC Condition information within this document

EPBC Condition		Location
18.	To compensate for residual significant impacts to EPBC Act listed threatened species, the approval holder must provide environmental offsets that comply with the principles of the EPBC Act Environmental Offsets Policy.	Section 4
19.	The approval holder must prepare and submit an Offset Management Plan to the Minister for approval in writing. The Offset Management Plan must include:	
	a) details of the minimum offset areas proposed to compensate for the loss of habitat for EPBC Act listed threatened species from the wind farm site,	Section 4.6
	b) information about how the offset area/s provide connectivity with other relevant habitats and biodiversity corridors, including a map depicting the offset areas in relation to other habitats and biodiversity corridors;	Section 4.4
	c) a description of the management measures that will be implemented on the offset site for the protection and management of habitat for EPBC Act listed threatened species, including a discussion of how measures proposed are consistent with the measures in conservation advice, recovery plans and relevant threat abatement plans;	Section 4.4 and Table 12
	d) performance and completion criteria for evaluating the management of the offset area/s, and criteria for triggering remedial action (if necessary);	Table 12
	e) a program, including timelines to monitor and report on the effectiveness of these measures, and progress against the performance and completion criteria;	Table 12 Appendix I Appendix K
	f) a description of potential risks to the successful implementation of the plan, and a description of the contingency measures that would be implemented to mitigate against these risks;	Section 8 Table 11
	g) the proposed legal mechanism and timelines for securing the offset/s; and	Section 5
	h) a textual description and map to clearly define the location and boundaries of the offset area. This must be accompanied with the offset attributes and a shapefile.	Appendix A

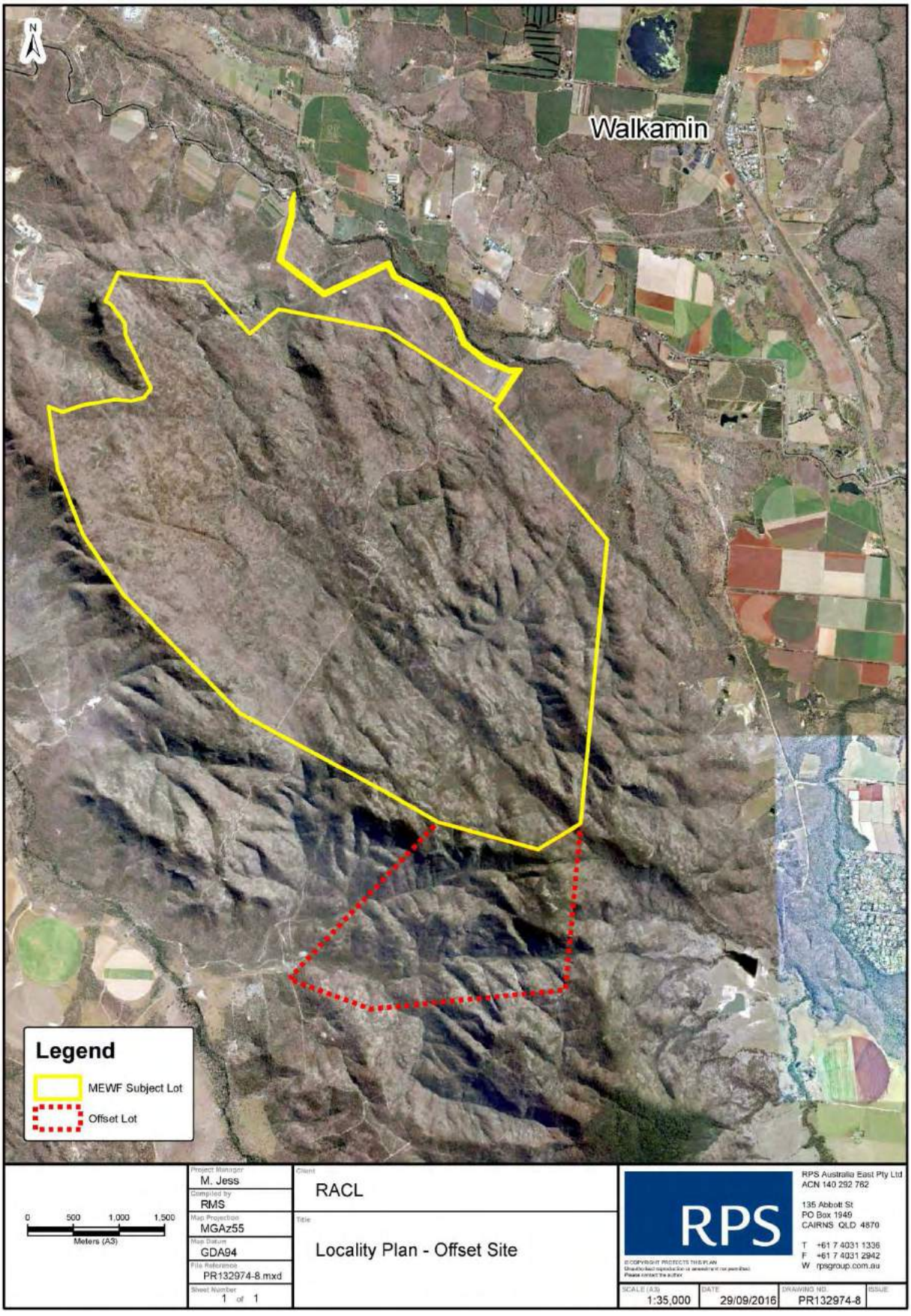


Figure 1 Locality Plan Offset Site

2.0 Summary Information

2.1 Departmental Reference Details

As a requirement of the EPBC Act approval 2011/6228, Mount Emerald Wind Farm Pty Ltd (MEWFPL) is required to finalise an offset to compensate for the clearing of habitat on the Mount Emerald Wind Farm (MEWF) Project Site. The departmental reference and assessment details for the offset area are outlined in **Table 2**.

Table 2 Referral Triggers, Reference and Assessment Details

EPBC Act Referral Trigger	Values Impacted/Requiring Offset
EPBC Act Approval 2011/6228	☒ Listed Threatened Species
Reference and Assessment Details Requiring Offset	
Departmental Ref. Number: EPBC 2011/6228	
Property Address: Lot 7 Springmount Road Arriga, Atherton Tablelands	
Real property description (Primary Lot on Plan/s): Lot 7 SP235224, Easements A, C & E in Lots 1, 2 & 3 on SP231871 and part of Lot 905	
Primary Local Government Area: Mareeba Shire Council	
Tenure: Freehold	
Offset ID: Lot 22 SP 210202	

2.2 Property and Ownership Details

The offset area is located at Lot 22 SP 210202 near Mutchilba within the Mareeba Shire Council Area. The lot tenure is freehold and the primary land use is vacant. The area fringes the Baldy Mountain Forest Reserve and the Herberton Range National Park via the Herberton Range (Queensland Government 2016). The town centre of Mareeba is situated approximately 18km to the north of the site, with the town of Atherton approximately 11.5km south-east of the site. Property Ownership and landholder details are outlined in **Table 3** and **Table 4** below.

Table 3 Offset Landholder details

Offset Landholder details	
Name of Registered Owner(s)/ Licensee(s) or Trustee(s)	**Peter and Carolyn Hinchcliffe**
Postal Address	**Po Box 190 Port Douglas QLD 4877**
Phone	**0409 985 214**
Facsimile	
Email Address	
Real Property Description	**Lot 22 SP210202**
Property Name	
Area of Property	**434.9 ha**
Local Government Area	**Mareeba Shire**
Tenure Type	**Freehold**

Table 4 Registered Interests

Parcel (Lot and Plan)	Type of Registered Interest	Registered Interest holder's name and contact details
Lot 22 SP210202	Purchase Option Agreement	**Contact details: Mount Emerald Wind Farm Pty Ltd** **Phone number:** 02 8913 9400 **Fax number:** 02 8913 9423

3.0 Threatened Flora Species

Four EPBC listed threatened plant species have now been confirmed to be present within the MEWF project footprint and could be impacted during construction, maintenance and decommissioning of the wind farm.

Grevillea glossadenia and *Homoranthus porteri* have previously been identified; however two new species have been added to the threatened species list:

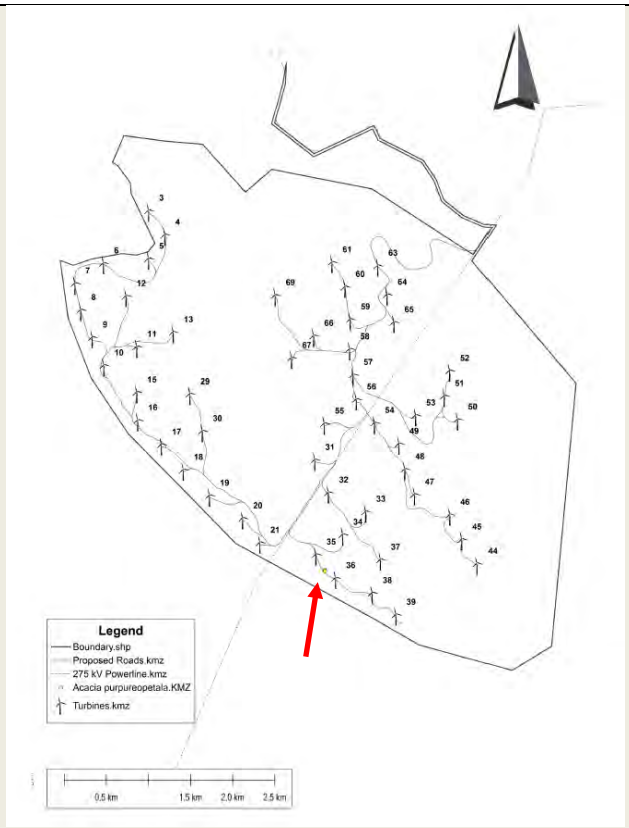
- ***Acacia purpureopetala*** (Purple-flowering Wattle) – Critically Endangered/Endangered (EPBC Act / NC Act); and
- ***Prostanthera clotteniana*** (Mint Bush) – Critically Endangered/Endangered (EPBC Act / NC Act).

These species have been assessed against the EPBC Act Offsets Assessment Guide and have also been field verified on the offsets site.

3.1 *Acacia purpureopetala*

The Purple-flowering Wattle *Acacia purpureopetala* is a prostrate shrub with a spreading habitat growing to approximately 50 cm high. Most plants are lower and usually attain a height of 20-35 cm. Older plants have a distinctive "rosette" pattern to the branches, where they tend to radiate outwards in a circular fashion and arch downwards. Mature plants may spread to a diameter of one metre or more.

Acacia purpureopetala is endemic to northern Queensland and has a restricted distribution with populations between Herberton and Irvinebank, Stannary Hills, and Silver Valley. The Mt Emerald Wind Farm site populations represent the most north-eastern distribution of the species, where it is found at only a single location between WTG's 35 and 36 (**Figure 2**).



Location of *Acacia purpureopetala* - Mt Emerald Wind Farm.

Acacia purpureopetala foliage and flowers. Photo SG

Acacia purpureopetala growth habit. Photo TDR

Acacia purpureopetala fruit pod. Photo SG

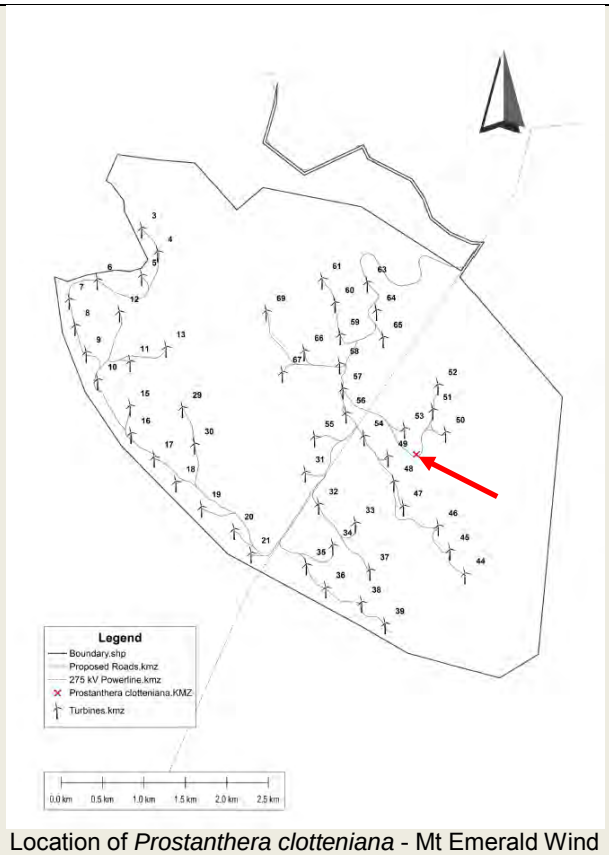
Acacia purpureopetala seedling. Photo SG

Figure 2 *Acacia purpureopetala* Location on MEWF

3.2 *Prostanthera clotteniana*

Prostanthera clotteniana grows in exposed rocky areas which are protected from hot fires. The species prefers the tops of steep rocky drop-offs with a southeast aspect. Associated species include *Pseudanthus ligulatus*, *Grevillea glossadenia*, *Eucalyptus lockyeri* and *Xanthorrhoea johnsonii*. There can be woodland of *Eucalyptus reducta* in gullies and on slopes in adjacent areas. Grasses include *Cleistochloa subjuncea*, *Cymbopogon obtectus* and *Themeda triandra*.

Prostanthera clotteniana is endemic to northern Queensland and is highly restricted. Populations are found near Ravenshoe, the Dinden State Forest to the north-east, and the single population of the Mt Emerald Wind Farm site. It has also been recorded from the Baal Gammon mine area near Watsonville, and at lower elevation around Oaky Creek. All populations are small. It is found in one location of few specimens on the eastern edge of the broad ridge south of WTG 53 (**Figure 3**).



Location of *Prostanthera clotteniana* - Mt Emerald Wind Farm.

Prostanthera clotteniana foliage and flowers. Photo SG

Prostanthera clotteniana growth habit. Photo SG

Prostanthera clotteniana flower and branches. Photo SG

Prostanthera clotteniana habitat. Photo SG

Figure 3 *Prostanthera clotteniana* Location on MEWF

3.3 Threatened Plants Management

Major threats to the survival of the conservation significant species include altered fire regimes, weed invasion, and physical clearing and modification of critical habitats.

MEWF Threatened Plants Management Plan (Gleed, 2016) details the distribution, habitat, ecology, conservation status, threats and management actions relating to threatened plant species occurring on the MEWF site. The Plan's overarching intent is to provide guidance to avoid or minimise adverse impacts to threatened plant species and their respective habitats listed under the *Queensland NC Act* and the *Commonwealth EPBC Act* and provides details where there are no recovery plans available for these restricted species.

4.0 Description of the Offset Management Area

4.1 Site Description

The Offset area is located within land described as Lot 22 SP210202, comprising approximately 434.9 ha (**Figure 4**). It is located immediately to the south west of the MEWF site. The site was considered in the original offsets assessment (CO2 Australia, 2013) which was inclusive of six segmented allotments however, MEWF have concluded after consultation with DEE and landowners, that a (whole) single lot offset under the ownership of MEWF was a more viable option.

The site is located within Mutchilba within the Mareeba Shire Council Area. The lot tenure is freehold and the primary land use is vacant. The area fringes the Baldy Mountain Forest Reserve and the Herberton Range National Park, via the Herberton Range (Queensland Government, 2016) (**Plate 1**).

Plate 1 Offset Site

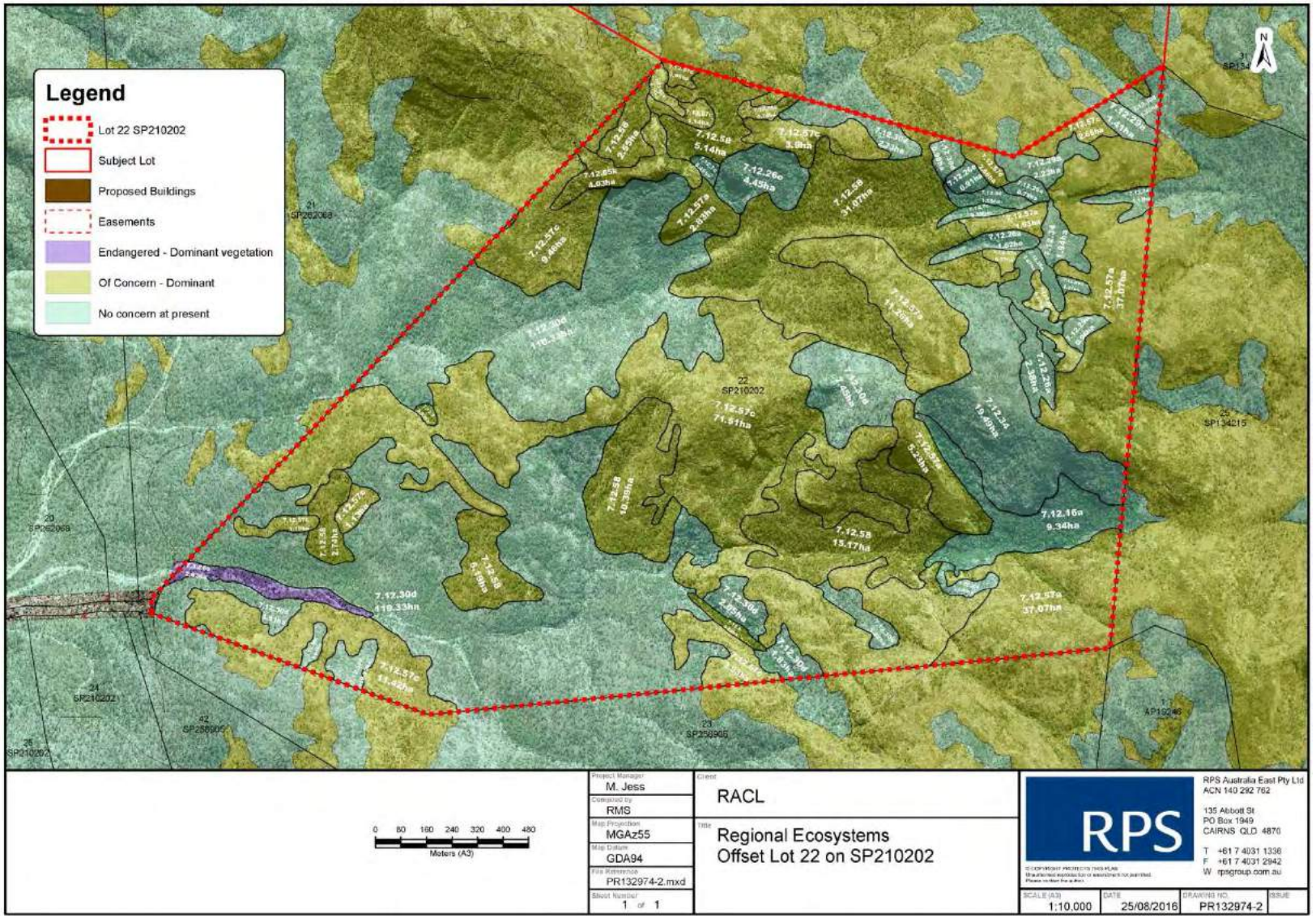


Figure 4 Regional Ecosystems on Offset Site

4.2 Environmental Values of the Offset Area

The offsets site is broadly within the wet tropics bioregion and is markedly rugged and steeply dissected; rendering the highest points as a series of narrow ridges and rocky knolls with steep drop-offs on adjacent slope faces.

The site is composed of nearly entirely remnant vegetation with approximately 192.89 ha consisting of Least Concern vegetation and the remaining 242 ha listed as Of Concern vegetation. An assessment of the common trees of the woodlands include Lemon-scented Gum (*Corymbia citriodora*), Yellow Stringybark Range Bloodwood (*C. abergiana*), Ironbark (*E. crebra*), Dead Finish (*E. cloeziana*), Cypress Pine (*Callitris intratropica*), Silver-leaf Ironbark (*E. shirleyi*), Orange Jacket (*C. leichhardtii*) which are all found on the gentler slopes.

Shrublands are characterised by many species, but typically include Sheoak (*Allocasuarina littoralis*), (*Xanthorrhoea johnsonii*), *Eucalyptus lockyeri*, Wattle (*Acacia aulacocarpa*), *Homoranthus porteri*, *Grevillea glossadenia*, and stunted forms of Range Bloodwood (*Corymbia abergiana*). Shrublands are generally found in relation to the ridge environment where thin rocky soils prevail. A feature of the montane heathland and shrublands at high elevation is the presence of rock pavements and areas of poorly vegetated rock outcrops. This particular habitat supports few large plant species because of the near-absence of soil or growth medium on their surfaces.

The steep rocky slopes, outcrops, cliffs, caves, and fallen logs and thick grasses offer plentiful habitat and refuge for both terrestrial and arboreal fauna species throughout the site.

4.3 Values to be Offset

The offset site is comprised of approximately 434.9 ha of high quality remnant habitat which sits adjacent to the MEWF project site. The offset requirements have been identified and are presented in **Table 5**.

Three threatened fauna species require offset and four threatened flora species.

Detailed offset area map/s identifying values, vegetation types (Regional Ecosystems) and GPS points are included in **Appendix A**.

Table 5 Environmental Values on Offset Site

Environmental Value	EBPC Act Status	NC Act Status
Fauna		
Northern Quoll (*Dasyurus hallucatus*)	E	E
Spectacled Flying-fox (*Pteropus conspicillatus*)	V	C
Bare-rumped Sheathtail Bat (*Saccolaimus Saccolaimus nudicluniatus*)	CE	CE
Flora		
Grevillea glossadenia	V	V
Homoranthus porteri	V	V
Acacia purpureopetala	CE	V
Prostanthera clotteniana	CE	E
Melaleuca uxorum	-	V
Plectranthus amoenus	-	V

4.3.1 *Nature Conservation Act* Listed Flora

An offset is not required for *Melaleuca uxorum* and *Plectranthus amoenus* (**Table 6**) as all reasonable avoidance and mitigation measures have been met for each of these species and there will be no 'significant residual impact' on these matters of State environmental significance.

Table 6 NCA Environmental Values on Offset Site

Environmental Value	EBPC Act Status	NC Act Status
Flora		
Melaleuca uxorum	-	V
Plectranthus amoenus	-	V

4.3.1.2 Avoidance

Complete avoidance of impacts to populations of highly threatened plants is considered as a priority. In terms of rarity on the wind farm site, *Melaleuca uxorum* and *Plectranthus amoenus* are rare species and are represented in the vicinity of proposed construction works by very small populations in isolated locations.

Sensible positioning of tracks which maintain an undisturbed, natural buffer from the populations of these species is recommended in the Threatened Plants Management Plan (Gleed, 2016), and Rehabilitation Plan (Gleed 2016) prepared for the wind farm.

4.3.1.3 Translocation

The requirement for re-establishing threatened plants assumes direct impacts to the species cannot be avoided, therefore this mitigation measure is required. A number of individuals of *Plectranthus amoenus* will be cleared during construction; whereby a selection of the cleared plants are candidates for translocation. This species is known to respond well to translocation (**Appendix B)**.

4.3.2 Regional Ecosystems

The offset site is mapped almost entirely as remnant vegetation (Regional Ecosystems - RE's), with a small area of non-remnant shown near the south-west corner at the end of Lemon Tree Drive.

The RE's mapped for the offset site are described in **Table 7** and shown on the mapping in **Figure 4**.

Table 7 Regional ecosystem present within the proposed offset site

RE	RE Description	VMA[1]	Bio.[2]	Area[3]
7.3.26a	*Casuarina cunninghamiana* (river oak) woodland to open forest on alluvium fringing streams. Occurs on channel benches, levees and terraces on deep loamy sands or sandy clay loams (often with loose surface gravel). (BVG1M: 16a). Vegetation communities in this regional ecosystem include: 7.3.26a: Riverine wetland or fringing riverine wetland. *Casuarina cunninghamiana*, *Eucalyptus tereticornis*, *Lophostemon suaveolens*, *Melaleuca leucadendra*, *M. fluviatilis*, *Buckinghamia celsissima*, *Mallotus philippensis* woodland and forest with an understorey of *Melaleuca viminalis* and *Bursaria tenuifolia*. Fringing forests of larger streams. (BVG1M: 16a) .	OC	E	2.63
7.12.7c	Simple to complex microphyll to notophyll vine forest, often with *Agathis robusta* (kauri pine) or *A. microstachya* (bull kauri). Granites and rhyolites of foothills and uplands, of the moist rainfall zone. (BVG1M: 5c). Vegetation communities in this regional ecosystem include: 7.12.7c: Simple notophyll semi-evergreen vine forest. Uplands of the dry rainfall zone. Rhyolite. (BVG1M: 5c) .	LC	NCP	1.24

RE	RE Description	VMA[1]	Bio.[2]	Area[3]
7.12.9	*Acacia celsa* (brown salwood) open forest to closed forest. Foothills, uplands and highlands on granites and rhyolites, of the very wet and wet rainfall zone. (BVG1M: 5d).	OC	OC	1.16
7.12.16a	Simple to complex notophyll vine forest, including small areas of *Araucaria bidwillii* (Bunya pine). Uplands and highlands on granites and rhyolites, of the cloudy wet to moist rainfall zones. (BVG1M: 6b). Vegetation communities in this regional ecosystem include: 7.12.16a: Simple notophyll vine forest (often with *Agathis microstachya*). Uplands of the cloudy wet to moist rainfall zones. Granite and rhyolite. (BVG1M: 6b) .	LC	NCP	9.34
7.12.26a	*Syncarpia glomulifera* (turpentine) +/- *Corymbia intermedia* (pink bloodwood) +/- *Allocasuarina* spp. (sheoaks) closed-forest to woodland, or *Lophostemon suaveolens* (swamp mahogany), *Allocasuarina littoralis* (black sheoak), *C. intermedia* shrubland, (or vine forest with these species as emergents). Exposed ridgelines or steep rocky slopes, on granite and rhyolite. 7.12.26a: *Syncarpia glomulifera*, *Allocasuarina torulosa* and/or *A. littoralis* open-forest and woodland. Uplands and highlands, often on steep slopes, of the wet rainfall zone. Granite and rhyolite. (BVG1M: 28e) .	LC	NCP	4.41
7.12.26e	*Syncarpia glomulifera* (turpentine) +/- *Corymbia intermedia* (pink bloodwood) +/- *Allocasuarina* spp. (sheoaks) closed forest to woodland, or *Lophostemon suaveolens* (swamp mahogany), *Allocasuarina littoralis (bl*ack sheoak), *C. intermedia* shrubland, (or vine forest with these species as emergents). Exposed ridgelines or steep rocky slopes, on granite and rhyolite. (BVG1M: 9d). Vegetation communities in this regional ecosystem include: 7.12.26e: *Syncarpia glomulifera* low open forest and low woodland. Uplands on steep rocky slopes, of the moist and dry rainfall zone. Granite and rhyolite. (BVG1M: 28e) .	LC	NCP	8.99
7.12.29a	*Corymbia intermedia* (pink bloodwood) and/or *Lophostemon suaveolens* (swamp mahogany) open forest to woodland +/- areas of *Allocasuarina littoralis* (black sheoak) and *A. torulosa* (forest sheoak). Uplands, on granite and rhyolite. (BVG1M: 9c). Vegetation communities in this regional ecosystem include: 7.12.29a: *Corymbia intermedia*, *Eucalyptus tereticornis*, *E. drepanophylla* open forest to low open forest and woodland with *Allocasuarina torulosa*, *A. littoralis*, *Lophostemon suaveolens*, *Acacia cincinnata*, *A. flavescens*, *Banksia aquilonia* and *Xanthorrhoea johnsonii*. Uplands, on granite and rhyolite. (BVG1M: 9c) .	LC	NCP	4.60
7.12.30d	*Corymbia citriodora* (lemon-scented gum) +/- *Eucalyptus portuensis* (white mahogany) woodland to open forest. Granite and rhyolite (often coarse-grained red earths and lithosols with much surface rock). (BVG1M: 10b). Vegetation communities in this regional ecosystem include: 7.12.30d: Open woodland to open forest (10-20m tall) mosaic with variable dominance, often including *Eucalyptus cloeziana*, *C. citriodora*, *E. portuensis*, *E. lockyeri*, *C. leichhardtii*, *E. atrata*, *E. pachycalyx*, *E. reducta*, *C. intermedia* and *E. shirleyi*. There is often a very sparse to mid-dense secondary tree layer of *C. abergiana* and/or *C. stockeri*. A very sparse to sparse tall shrub layer may be present and can include *Acacia flavescens*, *Persoonia falcata*, *Bursaria spinosa* subsp. *spinosa*, *Allocasuarina inophloia*, *Petalostigma pubescens* and *Grevillea glauca*. A sparse to dense lower shrub layer may include *Jacksonia thesioides*, *Acacia calyculata*, *Xanthorrhoea johnsonii* and *Grevillea glossadenia*. The ground layer may be dominated by species such as *Themeda triandra*, *Heteropogon triticeus*, *Mnesithea rottboellioides*, *Arundinella setosa*, *Cleistochloa subjuncea*, *Eriachne pallescens* var. *pallescens*, *Lepidosperma laterale* and *Xanthorrhoea johnsonii*. Rocky slopes on granite and rhyolite. (BVG1M: 9d).	LC	NCP	133.42
7.12.34	*Eucalyptus portuensis* (white mahogany) and/or *E. drepanophylla* (ironbark), +/- *C. intermedia* (pink bloodwood) +/- *C. citriodora* (lemon-scented gum), +/- *E. granitica* (granite ironbark) open woodland to open forest. Uplands on granite, of the dry rainfall zone. (BVG1M: 9d).	LC	NCP	23.76

RE	RE Description	VMA[1]	Bio.[2]	Area[3]
7.12.57a	Shrubland and low woodland mosaic with *Syncarpia glomulifera* (turpentine), *Corymbia abergiana* (range bloodwood), *Eucalyptus portuensis* (white mahogany), *Allocasuarina littoralis* (black sheoak) and *Xanthorrhoea johnsonii* (grasstree). Uplands and highlands on granite and rhyolite, of the moist and dry rainfall zones. (BVG1M: 9d). Vegetation communities in this regional ecosystem include: 7.12.57a: Shrubland and low woodland mosaic with *Syncarpia glomulifera*, *Corymbia abergiana*, *Eucalyptus portuensis*, *Allocasuarina littoralis* and *Xanthorrhoea johnsonii*. Uplands and highlands on granite and rhyolite, of the moist and dry rainfall zones. (BVG1M: 9d).	OC	OC	58.60
7.12.57c	Shrubland and low woodland mosaic with *Syncarpia glomulifera* (turpentine), *Corymbia abergiana* (range bloodwood), *Eucalyptus portuensis* (white mahogany), *Allocasuarina littoralis* (black sheoak) and *Xanthorrhoea johnsonii* (grasstree). Uplands and highlands on granite and rhyolite, of the moist and dry rainfall zones. (BVG1M: 9d). Vegetation communities in this regional ecosystem include: 7.12.57c: Shrubland/low woodland (1.5-9 m tall) mosaic with variable dominance, often including *Eucalyptus cloeziana*, *Corymbia abergiana*, *E. portuensis*, *E. reducta*, *E. lockyeri*, *C. leichhardtii*, *Callitris intratropica*, *E. atrata*, *E. pachycalyx*, *E. shirleyi*, *E. drepanophylla* and *Homoranthus porteri*, on rhyolite and granite. There is occasionally a very sparse to sparse secondary tree layer of *C. abergiana* and/or *C. stockeri*. A very sparse to sparse tall shrub layer may be present and can include *Persoonia falcata*, *Exocarpos cupressiformis* and *Melaleuca viridiflora* var. *viridiflora*. A sparse to dense lower shrub layer may include *Jacksonia thesioides*, *Acacia calyculata*, *Coelospermum reticulatum*, *Xanthorrhoea johnsonii*, *Acacia humifusa*, *Dodonaea lanceolata* var. *subsessilifolia*, *Grevillea dryandri* subsp. *dryandri*, *Grevillea glossadenia*, *Acacia umbellata* and Ericaceae spp. The ground layer may be dominated by species such as *Themeda triandra*, *Xanthorrhoea johnsonii*, *Eriachne pallescens* var. *pallescens*, *Cleistochloa subjuncea*, *Borya septentrionalis*, and *Eriachne* spp. Includes open rocky dominated by herbs and grasses. This RE includes areas of 7.12.65k (rocky areas with shrubby/herbaceous cover) which are too small to map. Rocky slopes on granite and rhyolite. (BVG1M: 9d).	OC	OC	107.32
7.12.58	*Eucalyptus reducta* woodland to open forest (6-18m tall). Common associated species include *E. granitica*, *Corymbia dimorpha*, *C. citriodora*, *E. cloeziana* and occasionally *C. intermedia*. There is often a sparse secondary tree layer of *C. abergiana* and/or *E. lockyeri*. There may be a very sparse tall shrub layer of species such as *Acacia flavescens*, *Persoonia falcata*, *Allocasuarina littoralis* and *Acacia simsii*, and a very sparse to dense lower shrub layer of *Acacia calyculata*, *Pultenaea millarii*, *Jacksonia thesioides*, *Grevillea glossadenia*, *Grevillea dryandri* subsp. *dryandri*, *Homoranthus porteri* and *Dodonaea lanceolata* var. *subsessilifolia*. The ground layer is often dominated by species such as *Themeda triandra*, *Eriachne* spp., *Cleistochloa subjuncea*, *Lomandra longifolia*, *Mnesithea rottboellioides*, *Xanthorrhoea johnsonii*, *Heteropogon triticeus* and *Coronidium newcastlianum*. Granite and rhyolite. (BVG1M: 9d).	OC	OC	72.45

RE	RE Description	VMA[1]	Bio.[2]	Area[3]
7.12.65k	Rock pavements or areas of skeletal soil, on granite and rhyolite, mostly of dry western or southern areas, often with shrublands to closed forests of *Acacia* spp. (wattles) and/or *Lophostemon suaveolens* (swamp mahogany) and/or *Allocasuarina littoralis* (black sheoak) and/or *Eucalyptus lockyeri* subsp. *exuta*. (BVG1M: 28e). 7.12.65k: Granite and rhyolite rock outcrop, of dry western areas, associated with shrublands to closed forests of *Acacia* spp. and/or *Lophostemon* spp. and/or *Allocasuarina* spp. In the Mount Emerald area, shrubs may include *Acacia umbellata*, *Melaleuca borealis*, *Homoranthus porteri*, *Leptospermum neglectum*, *Melaleuca recurva*, *Melaleuca uxorum*, *Grevillea glossadenia*, *Corymbia abergiana*, *Eucalyptus lockyeri*, *Sannantha angusta*, *Pseudanthus ligulatus* subsp. *ligulatus*, *Acacia aulacocarpa*, *Leptospermum amboinense*, *Xanthorrhoea johnsonii* and *Jacksonia thesioides*. Ground-cover species may include *Borya septentrionalis*, *Lepidosperma laterale*, *Eriachne* spp., *Cleistochloa subjuncea*, *Boronia occidentalis*, *Cheilanthes* spp., *Coronidium newcastlianum*, *Schizachyrium* spp., *Tripogon loliiformis*, *Gonocarpus acanthocarpus* and *Eragrostis* spp. Dry western areas. Granite and rhyolite. (BVG1M: 29b).	LC	OC	7.03
9.5.8	Woodland to open-woodland of *Eucalyptus cullenii* (Cullen's ironbark) and/or *E. leptophleba* (Molloy red box) +/- *Corymbia erythrophloia* (red bloodwood) +/- *Erythrophleum chlorostachys* (Cooktown ironwood). *Eucalyptus tardecidens* (box) may also occur as a subdominant in northern extent of this regional ecosystem. A sparse shrub layer includes *Petalostigma* spp., *Melaleuca* spp., *Grevillea* spp., *Alphitonia pomaderroides* and *Maytenus cunninghamii* (yellowberry bush). The sparse to dense ground layer is dominated by *Heteropogon contortus* (black speargrass) and *Sarga plumosum* (plume sorghum). Occurs on undulating plains in valleys in ranges on Tertiary/Quaternary soils overlying granite and metamorphic geologies. (BVG1M: 13a)	LC	NCP	0.01
9.5.9a	Woodland to open-woodland of *Corymbia clarksoniana* (Clarkson's bloodwood) and/or *Eucalyptus leptophleba* (Molloy red box) and/or *E. platyphylla*. A sparse to mid-dense shrub layer including *Melaleuca* spp., *Grevillea* spp., and *Planchonia careya* (cocky apple) can occur. The ground layer is dominated by *Themeda triandra* (kangaroo grass) and *Heteropogon* spp. Occurs on plains, undulating plains and outwash deposits and Tertiary to Quaternary locally consolidated high-level alluvium and colluvium. Major vegetation communities include: 9.5.9a: Woodland to open-woodland of *Corymbia clarksoniana* (Clarkson's bloodwood) +/- *Eucalyptus platyphylla* (poplar gum) +/- *E. leptophleba* (Molloy red box) +/- *C. tessellaris* (Moreton Bay ash) with a distinct to sparse sub-canopy layer often including *Melaleuca viridiflora* (broad-leaved paperbark), *Grevillea glauca* (bushman's clothes peg), *Petalostigma pubescens* (quinine) and *Alphitonia pomaderroides* (soapbush). An open to sparse shrub layer includes *Melaleuca* spp., *Persoonia falcata*, *Grevillea* spp. and *Petalostigma pubescens (*quinine). The sparse to mid-dense ground layer is dominated by *Themeda triandra* (kangaroo grass), *Aristida* spp., *Heteropogon contortus* (black speargrass), *H. triticeus* (giant speargrass), and *Sarga plumosum* (plume sorghum). Occurs on undulating plains. (BVG1M: 9e) .	LC	NCP	

RE	RE Description	VMA[1]	Bio.[2]	Area[3]
9.12.7a	Woodland to low open-woodland of Eucalyptus cullenii (Cullen's ironbark) +/- Erythrophleum chlorostachys (Cooktown ironwood) +/- C. leichhardtii (yellowjacket) +/- Corymbia erythrophloia (red bloodwood). The mid-layer is generally absent but a subcanopy and/or shrub layer can occur. The ground layer is sparse to dense and dominated by Heteropogon contortus (black speargrass) and Themeda triandra (kangaroo grass). Occurs on predominantly felsic volcanic rocks, on rolling to steep hills. Major vegetation communities include: 9.12.7a: Woodland to open-woodland of *Eucalyptus cullenii* (Cullen's ironbark) +/- *Corymbia erythrophloia* (red bloodwood) +/- *Erythrophleum chlorostachys* (Cooktown ironwood) +/- *C. dallachiana* (Dallachy's gum). An open to mid-dense subcanopy can occur and includes a variety of species. The shrub layer is absent to open and dominated by *Maytenus cunninghamii* (yellowberry bush), *Alphitonia pomaderroides* (soapbush), *Petalostigma* spp., and *Acacia* spp. The ground layer is sparse to dense and dominated by *Heteropogon contortus* (black speargrass), *H. triticeus* (giant speargrass), *Themeda triandra* (kangaroo grass) and *Sarga plumosum* (plume sorghum) with a *Xanthorrhoea* sp. (grasstree) occurring in some areas. Occurs on rhyolite hills. (BVG1M: 13a) .	LC	NCP	0.01
9.12.40	Low open-woodland to low woodland of *Melaleuca citrolens* (scrub teatree) +/- *Terminalia platyptera* (yellow-wood) +/- *Corymbia dallachiana* (Dallachy's gum) +/- *Erythrophleum chlorostachys* (Cooktown ironwood). The sparse shrub layer consists of *Petalostigma banksii* (smooth-leaved quinine), *M. citrolens* and *Gardenia vilhelmii* (breadfruit). The ground layer is frequently bare, with patches of short grasses including *Eriachne* spp., *Aristida* spp. and *Schizachyrium* spp. (firegrass). This community also occurs as short open-tussock grassland wooded with low trees and shrubs of *Melaleuca citrolens* +/- *Terminalia* spp. Occurs on gentle slopes, footslopes, rolling hills and colluvial low slopes. (BVG1M: 21b).	LC	NCP	
Non-rem	Non-remnant: modified land, roads, clearings and tracks.			0.08

[1] Status under Vegetation Management Act 1999: OC - Of Concern; LC - Least Concern.

[2] Biodiversity management status: E - Endangered; OC - Of Concern, NCP - No Concern at Present.

[3] Area - total area in hectares of RE type within offset site.

Conservation status of EVNT species: *Acacia purpureopetala* (CE - EPBC Act, V - NCA); *Grevillea glossadenia* (V- EPBC Act, V - NCA); *Homoranthus porteri* (V - EPBC Act, V - NCA); *Melaleuca uxorum* (E - NCA); *Plectranthus amoenus* (V - NCA); *Prostanthera albohirta* (CE - EBC Act, E - NCA); *Prostanthera clotteniana* (CE - EBC Act, E - NCA).

4.4 Habitat Connectivity

Regionally, the MEWF site forms the northern extent of the Herberton Range. The Wet Tropics bioregion section is contiguous with the Mount Emerald mountain range. The Wet Tropics section and the western ridge of the Einesleigh Uplands section are in near pristine condition. They hold very high values in terms of floristic diversity, landscape connectivity and undisturbed ecological function. The site forms important refuge areas for numerous species of flora and fauna, many of which are restricted to montane environments. The MEWF site joins to the Offsets site leading to the south to the Herberton Range State Forest (**Figure 1**). There, contiguous native vegetation exists to the south. This native vegetation is unbroken with the exception of occasional minor access tracks, providing habitat linkages throughout surrounding areas.

The project site is located in a landscape fragmented by farmland. However, both the project and offset sites' vegetation is widely untouched and well connected to surrounding habitat. This corridor extends into the Herberton State Forest providing both a wide corridor and protected habitat of high ecological value to matters of national significance.

The removal of habitat on the project site as a result of the MEWF project will remove some remnant vegetation, but will not create further fragmentation of the habitat at a wider landscape level. The project

is unlikely to isolate the site and habitat to the remaining vegetation community. Arboreal mammals, terrestrial mammals, reptiles and amphibians will still be able to move across the landscape, within similar remnant communities. Connectivity, identified in **Figure 5** to the offset area and State Forest adjacent to the site, will be maintained.

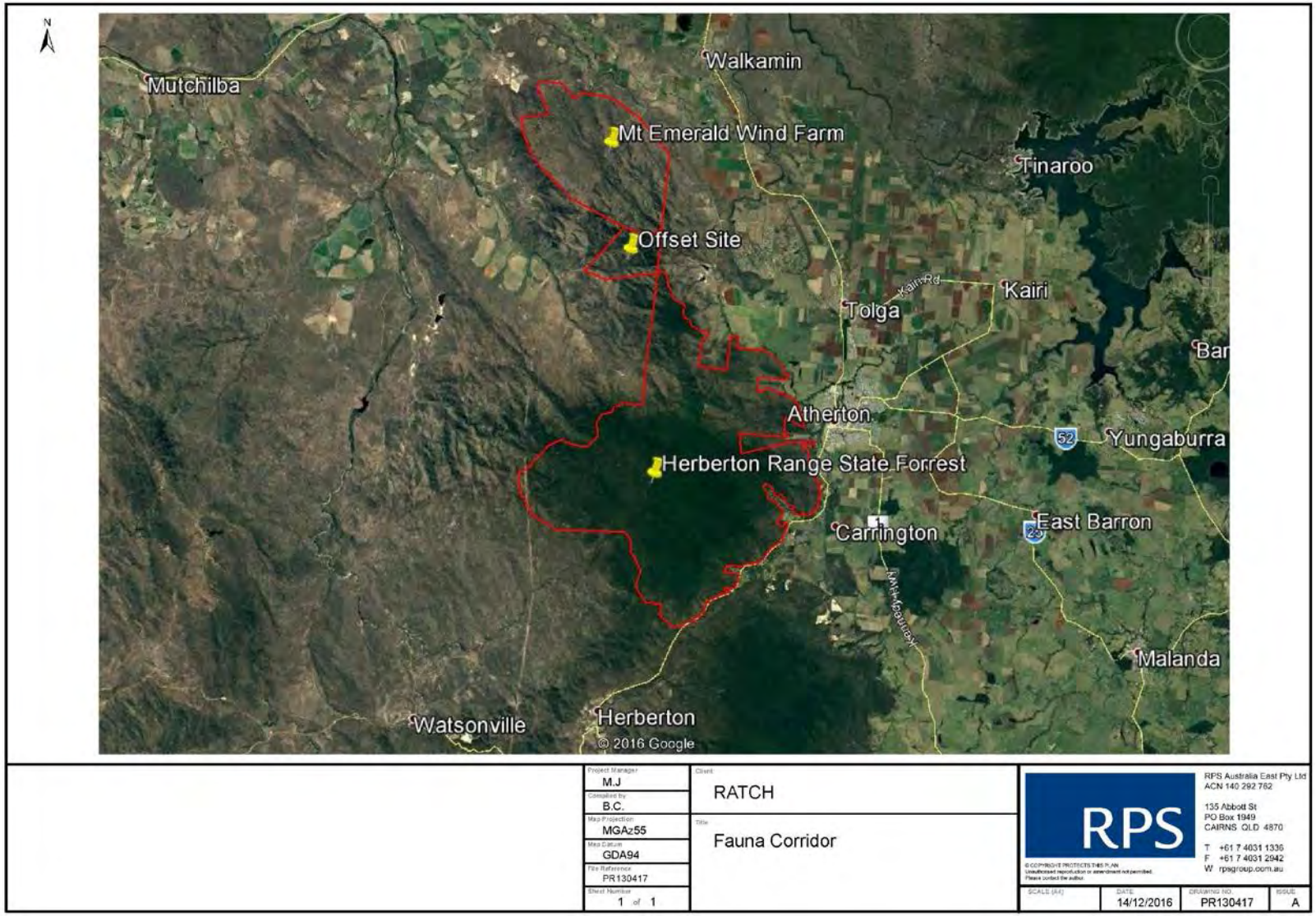


Figure 5 MEWF and Offset Site Biodiversity Corridor

4.4.1 Northern Quoll

Habitat modelling conducted by University of Sunshine Coast researchers for the project (Burnett et al, 2013) indicate that 72% of the predicted high and very highly suitable Northern Quoll habitat in FNQ is found within a 55 km buffer of the project site boundary. Rocky areas may provide refugia from fire and predation by feral cats and due to their water retaining attributes, they may support high floristic diversity and productivity and thus higher prey abundances than areas without rocky outcrops (Burnett, 1997; Hill & Ward, 2010).

Individuals of the Northern Quoll are known to utilise the entire MEWF and Offset site due the species ability to utilise a large variety of habitat structures for nesting and denning and to forage over several kilometres in a single night.

As an endangered species at the federal level there are guidelines for recovery, mitigation and conservation:

- National Recovery Plan for the Northern Quoll *Dasyurus hallucatus*;
- Threat abatement plan for predation by feral cats;
- Threat Abatement Plan for Predation by the European Red Fox.

The MEWF Pest Management Plan includes strategies to prevent undisturbed habitat throughout the project and offset site from being impacted by feral animals. An extensive corridor system will ensure habitat functionality and faunal movement is maintained to external boundaries and not confine individuals within or external to the site. The projects mitigation measures are consistent with the National Recovery Plan for the species.

4.4.2 Bare-rumped Sheathtail Bat

The Bare-rumped Sheathtail Bat *(Saccolaimus saccolaimus nudicluniatus)* has been recorded in a range of habitats including tropical woodland and tall open forests where it roosts in long, wide hollows in various eucalypts (*Eucalyptus platyphylla* and *Eucalyptus tetrodonta*) and in *Melaleuca leucadendra*. Consistent with the National Recovery Plan for Bare-rumped Sheathtail Bat the offset area ensures sufficient foraging area would be maintained, and connectivity will be maintained between riparian areas and external to the site. Therefore the project is not expected to interfere with the recovery of the species.

4.4.3 Spectacled Flying Fox

Essential roosting, breeding and mating habitat for Spectacled Flying-foxes includes rainforest, gallery forest, Melaleuca swamps, mangroves and eucalypt forest (DERM, 2010; Curtis and Dennis, 2012). Most camp sites are located within 6.5 km of rainforest (Richards, 1990); however at least one colony located at Mareeba is approximately 16 km from the nearest rainforest (Shilton *et al*., 2008). Ongoing satellite-telemetry tracking of Spectacled Flying-foxes by CSIRO researchers is assisting with the discovery of new roost sites (James Hammond, DotE, pers. comm., 16/10/13).

Potential roosting habitat is within areas that will be buffered from the impacts of the project development and as the species is very selective in camp preference for mangrove, vine forest, riparian gallery forest which occurs within the Tolga scrub and across the Wet Tropics. The proposed project will not interfere with the recovery of the species as it has no impact on foraging or roosting activities. Effective pest and weed management measures incorporated into the offset site are consistent with National recovery measures for the Spectacled Flying Fox in particular the species foraging distribution across the local and regional landscape.

4.4.4 Threatened Plants

The four species of threatened plants listed under the EPBC Act and found on the wind farm site: *Acacia purpureopetala, Grevillea glossadenia, Homoranthus porteri and Prostanthera clotteniana*, were positively identified in the field in the offset site. All were represented in healthy populations growing under remnant vegetation in original ecological condition to the type (see RE descriptions). Additionally, one of the two NCA listed species *Plectranthus amoanus* was also found in a healthy population on the offsets site.

With the exception of *G. glossadenia*, these species have specific habitat requirements, which explains their rareness in the wild. *G. glossadenia* tends to favour disturbance events, which can include mortality by fire that triggers mass germination of seeds, or substrate disturbance, where seed germination is in response to an altered edaphic condition. Hence, *G. glossadenia* is more widespread and can tolerate a range of habitat attributes and characteristics, which vary from wind-swept ridges to less exposed (but dry) woodlands along broader ridges.

Predicting suitable habitats for the listed threatened plants within the offset site poses a number of uncertainties and inconsistencies when measured against and compared to the supporting habitats on the wind farm site. Simply matching Regional Ecosystem types is inadequate and does not sufficiently detail the idiosyncrasies of threatened plant habitat. This is because obligate habitats are part of mosaic or complex of habitats nested amongst wider mapping units (RE's). The offset site nevertheless, is in pristine ecological condition with few incidences of notable human impact and influence. The absence of modification, isolation from human influence and rugged topography similar to that found on the wind farm are in many ways major determinants of "habitat suitability" for threatened plants, which should be able to persist in the landscape for several generations in the absence of gross disturbance and modification.

As with the predicted genetic dispersal between the population of Northern Quolls between the offset site and the wind farm, a similar ecological scenario is expected for threatened plants because of the functional, contiguous landscape connectivity and very low probability of future disturbance.

4.5 Field Verification

Targeted fauna surveys were conducted in the offsets site between 29 August – 13 September 2016.

4.5.1 Northern Quoll (*Dasyurus hallucatus*)

4.5.1.1 Methods

The most suitable method for determining the presence of Northern Quoll is by undertaking a Camera Trapping Survey.

The survey site spacing was based on research on optimal camera trap spacing for the Northern Quoll conducted by RPS at the Mt Emerald Wind Farm site, (RPS, 2014). A total of 18 camera traps (Reconyx visible flash units) were used for the camera trapping survey. At each survey site (**Appendix C**) a single camera trap was attached horizontally to the trunk of a tree with a 'dbh' (diameter at breast height) of at least 15 cm with a metal angle bracket, at ~1 m above the ground so the camera faced the ground. Directly beneath the camera, a bait holder, consisting of a Rain Harvesting™ PVC toilet vent pipe cap with a 50 mm PVC pipe insert, baited with two chicken necks, was affixed to the ground with a 30 cm, 5mm diameter tent peg.

Each camera was set at the medium-level trigger sensitivity. All loose vegetation (e.g. grass stalks, forbs and shrub branches) within the field of view of each camera were removed to minimize false triggers. Camera traps were active for a period of 14 days. Habitat assessments were conducted at each site.

4.5.1.2 Results

A total of 252 camera trap nights were conducted on the offsets site and all of the units captured images. Thirteen Northern Quolls were recorded during the camera trapping survey. In addition, 8 other fauna species were able to be positively identified from the images (2 reptiles, 6 mammals) with none of these species listed as threatened under the EPBC Act or Queensland NC Act.

Habitat was observed to be of high quality with large refugial areas of rocky outcrops and deep ravines and gullies suitable for denning with quality foraging and dispersal habitat available across the site in the form of rocky outcrops, hollows and fallen logs. Quoll scats were also located within creek beds and gullies in both low and high altitude aspects of the site.

4.5.2 Spectacled Flying Fox (*Pteropus conspicillatus*)

4.5.2.1 Methods

Diurnal searches for roosts and feeding signs were undertaken over a large proportion of the project site during the course of setting out camera traps for the targeted Northern Quoll survey over the 14 day period including the patches of evergreen to semi-evergreen notophyll vine forest on the project site.

The total number of spot-lighting transects as recommended by DotE (2014b) were unachievable given the harsh terrain (i.e. 5 hours per 50 ha/night = a total of 365 hrs of spotlighting) and location. Observers conducted a total of 30 hours spotlighting.

A botanical assessment of the presence of feed trees and the percentage currently flowering (during this survey) across the site was undertaken by a qualified botanist.

4.5.2.2 Results

No Spectacled Flying-foxes (SFF) were recorded during the survey. Foraging trees were located across the site however fewer than 5% were flowering during each site visit in August and September. Foraging habitat is available across the offset site and is considered in moderate to high quality.

The majority of the site was found to be suitable foraging habitat for the SFF, due to the high availability of pollen and blossom food sources including *Eucalyptus reducta, E. portuensis, E. tereticornis, E. crebra, E. shirleyi, E. cloeziana*, *Corymbia leichhardtii, C. clarksoniana, C. abergiana*, *Lophostemon grandiflorus, Melaleuca viridiflora* and *M. monantha.* These RE's included *7.12.57a. 7.12.34, 7,12.30d* (**Appendix D**).

In addition, the riparian habitats present in the deeply dissected rocky creek lines throughout the centre of the project site contain tree species that possess fruits known to be eaten by SFF, *e.g. Pleiogynium timorense* (Burdekin Plum).

4.5.3 Bare-rumped Sheathtail Bat (*Saccolaimus saccolaimus nudicluniatus*)

4.5.3.1 Methods

Four ultrasonic bat call detectors (Wildlife Acoustics SM2+BAT fitted with a SM-UX microphone) were placed across the site (**Appendix E**), to determine presence and species composition of bats within the Offset areas. The bat call detectors were programmed to turn on automatically at 6 pm each evening and record for a 12 hour period.

All call analysis was conducted by Kelly Matthews from Green Tape Solutions, Brisbane. Kelly is a recognised expert on bat call analysis and has an extensive library of reference calls from the FNQ

Bioregion. Survey limitations identified bat detectors failures preventing recording across the full site during the full fortnight duration. Functioning bat detectors identified large numbers of bat calls.

4.5.3.2 Results

A total of 56 detector nights of microchiropteran bat call surveys were conducted within the project site between August and September 2016 (**Appendix E**).

From the data set, 2244 bat calls were selected for call identification, with 2192 of these calls also analysed in full spectrum format to determine the presence of Saccolaimus species. Six microbat species were identified on site with an additional five species listed as potentially recorded on site. The Bare-rumped Sheathtail Bat (*Saccolaimus saccolaimus*) was most likely recorded on site (**Appendix E**) however the species could not be clearly identified due to the poor condition of the call, the similarity in call with sympatric species and overlap in their distribution (**Appendix F**). The presence of the species confirmed within 500m of the site and the available habitat being within exception ecological condition with high levels of natural integrity, it is highly likely the species would utilise the offset site for roosting and foraging activities.

Table 8 summarises the Call Analysis.

Table 8 Summary of Call Analysis

Species Scientific Name	EPBC	NC Act	Occurrence
Miniopterus australis	Least Concern	Least Concern	Definite
Miniopterus orianae oceanensis	Least Concern	Least Concern	Definite
Mormopterus eleryi	Least Concern	Least Concern	Definite
Myotis macropus	Least Concern	Least Concern	Probable
Nyctophilus sp ▪ *N. geoffroyi*, ▪ *N. gouldi* ▪ *N. bifax*	 Least Concern Least Concern Least Concern	 Least Concern Least Concern Least Concern	
Rhinolophus megaphyllus	Least Concern	Least Concern	Definite
Saccolaimus flaviventris	Least Concern	Least Concern	Probable
Saccolaimus saccolaimus	Critically Endangered	Endangered	Possible
Taphozous troughtoni	Least Concern	Least Concern	Possible
Vespadelus troughtoni	Least Concern	Least Concern	Definite
Vespadelus pumilus	Least Concern	Least Concern	Definite

4.5.4 *Grevillea glossadenia*

4.5.4.1 Methods

Survey methods conformed to the 'Flora survey guidelines – Protected Plants' for species listed under the *Nature Conservation Act 1992* (DEHP 2014), using the 'systematic transect search method'. This includes the presence of threatened flora identified under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) within suitable habitat areas.

When an Endangered, Vulnerable or Near Threatened (EVNT) plant species has been recorded during the transect search, the population extent and density was determined in order to quantify the potential impact.

Additionally, Vegetation communities discernible in the field were surveyed using Queensland CORVEG Database methods and the outline for recording quaternary type information as defined by the 'Methodology

for Survey and Mapping of Regional Ecosystems and Vegetation Communities in Queensland' (Nelder *et al*. 2012).

Any conservation significant species not previously recorded will form a voucher collection of plant specimens with specimens submitted to the Queensland Herbarium for formal identification where required.

4.5.4.2 Results

Grevillea glossadenia was positively identified in the field in the offset site. It was widespread mostly across the southern section of the property around Oaky Creek and mostly in woodland on lower hills. The species was represented in healthy populations growing under remnant vegetation in original ecological condition to the type (see RE 7.12.30d).

Grevillea glossadenia grows in rocky soils or on ridges in exposed conditions or on the edges of woodlands. It rarely grows under woodland cover. Associated plants included: *Eucalyptus lockyeri, E. mediocris, Corymbia abergiana, C. citriodora, Xanthorrhoea johnsonii* and the grasses *Themeda triandra* and *Cleistochloa subjuncea* along the dissected ridgetops to the eastern sections of the offsets site (**Appendix G**). The habitat and surrounding vegetation was of exceptionally high quality ecological condition.

4.5.5 *Homoranthus porteri*

4.5.5.1 Methods

As per **Section 4.5.4.1**.

4.5.5.2 Results

Homoranthus porteri was positively identified in the field in the offset site and primarily concentrated around the rocky, fire-protected zone of Oaky Creek and on rock shelves and platforms above gorges. The species was represented in healthy populations growing under remnant vegetation in original ecological condition to the type (see RE 7.12.30d). This species is found in habitats ranging from the fireproof niche environment of the rocky upper banks and slopes of Oaky Creek and its tributaries. The offset site nevertheless, is in pristine ecological condition with few incidences of notable human impact and influence. **Appendix G** provides a map of the species known distribution.

4.5.6 *Acacia purpureopetala*

4.5.6.1 Methods

As per **Section 4.5.4.1**.

4.5.6.2 Results

A healthy population of *Acacia purpureopetala* was located on the offset site near the southern boundary, however the species does remain rare across its distribution. *Acacia purpureopetala* is another enigmatic threatened plant, whose habitat cannot be prescriptively defined based on suitable habitat. In the offset site, the only possible determinant of habitat is the presence of Pumpkin Gum (*E. pachycalyx*). Even within a broader area of woodland dominated by *E. pachycalyx*, the population of *A. purpureopetala* occupies an area not much larger than 30 m x 15 m, and is not found elsewhere under the same woodland composition. The offset site nevertheless, is in pristine ecological condition with few incidences of notable human impact and influence. **Appendix G** provides a map of the species known distribution.

4.5.7 *Prostanthera clotteniana*

4.5.7.1 Methods

As per **Section 4.5.4.1**.

4.5.7.2 Results

Prostanthera clotteniana, was positively identified in the field in the offset site. Three populations were found in the vicinity of the southern side of Oaky Creek. Two of these are under *E. pachycalyx - C. intratropica* woodland, and the third on the top bank of Oaky Creek under *C. intratropica* with *H. porteri* and *G. glossadenia - E. pachycalyx* is absent at this site. The species represented in a healthy populations growing under remnant vegetation in original ecological condition to the type (RE 7.12.30d). *Prostanthera clotteniana* appear to be obligated to strict habitat conditions as with *Homoranthus porteri*, where protection from fire, or at least the intensity of fire, is afforded by the predominance of rock cover down slope or around the species' populations. These species are therefore found in habitats ranging from the fireproof niche environment of the rocky upper banks and slopes of Oaky Creek and its tributaries. *P. clotteniana* is difficult to predict a certain habitat preference, other than protection from fire. The species is constrained to small populations on the less dissected hills south of Oaky Creek. Despite extensive searches in apparently "suitable habitat" elsewhere, *P. clotteniana* remains cryptic and poorly represented. In comparison to the MEWF site, the species was better represented on the offset site.

4.6 Offset Availability against Offset Assessment Guide

The method used to measure and compare values between the impact area and the offset area has been identified in Section 3 of *CO2* Australia's *MEWF Offsets Assessments Guide* (2013) and has been used here to:

(1) Update the offset site; and

(2) Include a further two threatened flora species for offset assessment.

Table 9 provides the outcomes of the Offsets Assessments Guide results for seven threatened species. These results were developed in consultation with the CO2 Australia report *MEWF Offsets Assessment Guide* (2013) which considered the individual characteristics of each threatened species on the impact site and is therefore not detailed further here.

The values generated from the offsets assessment guide indicate the proposed offset is suitable to acquit the offset requirements of the project and the percentage of impact offset is over 100% for all values. **Sections 4.6.1 - 4.6.7** provide further information for each threatened species.

Table 9 Offsets Assessment Guide Results

Offset Assessment Guide Parameters	Northern Quoll	Spectacled Flying Fox	Bare-rumped Sheathtailed Bat	*Grevillea glossadenia*	*Homoranthus porteri*	*Acacia purpureopetala*	*Prostanthera clotteniana*
Size of impact area:	73 ha	73 ha	73 ha	0.399 ha	0.2 ha	0.0021 ha	0.01ha
Current Offset Area	434.9 ha	355.58 ha	404.04 ha	5 ha	1 ha	0.04 ha	0.045 ha
Quality of impact area:	8	3	7	7	7	7	7
Start quality of offset area:	9	4	9	10	10	10	10
Future quality with offset:	9	4	9	10	10	10	10
Future quality without offset:	7	3	7	7	7	7	7
Confidence in results:	80%	80%	80%	80%	80%	80%	80%
Risk of loss with offset:	3%	3%	3%	3%	3%	3%	3%
Risk of loss without offset:	5%	5%	5%	5%	5%	5%	5%
Confidence in results:	80%	80%	80%	80%	80%	80%	80%
Time over which loss is averted:	20 years	20 years	20 years	20 years	20 years	20 years	20 years
Time until ecological benefit:	Immediate	Immediate	Immediate	Immediate	Immediate	Immediate	Immediate
Minimum % of impact offset:	100%	100%	100%	100%	100%	100%	100%
Maximum % of impact offset:	121.64%	131.58%	129.15%	430.73%	171.86%	696.40%	156.70%

4.6.1 Northern Quoll

The proposed offset area has the potential to provide a conservation gain that maintains the populations of the regional Northern Quoll population. The proposed offset area is mapped as containing 434.9ha of potential foraging, denning and dispersal habitat (**Appendix H**) which was supported by evidence of Northern Quolls at camera traps at almost all identified locations across the site and evidence of scats within creeks and gullies at low and high altitude locations. The offset site has a strong connectivity to the project site, and provides a pathway link to the Baldy Mountain Forest Reserve, which facilitates dispersal between populations. Using the available habitat, further field verification and the new offset area against the offset

assessment guide RPS has been able to determine the offset site will fulfil its offsets compliance requirement. In addition the site is of high quality and therefore an immediate ecological benefit can occur.

4.6.2 Spectacled Flying Fox

The proposed offset area is mapped as containing 355.58 ha of available SFF foraging habitat (**Appendix D**). This habitat was field verified as moderate quality, some of which of higher quality than the project site due to the larger number of myrtaceous species. While SFF were not sighted during the field surveys there are records of the species utilising this site. Using the available habitat, further field verification and the new offset area against the offset assessment guide RPS has been able to determine the offset site will fulfil its offsets compliance requirement. In addition the site is of high quality and therefore an immediate ecological benefit can occur.

4.6.3 Bare-rumped Sheathtail Bat

Field Surveys verified approximately 404.04h of the proposed offset area contains suitable habitat for the potential roosting of the Bare-rumped Sheathtail (**Appendix F**). There is also strong connectivity between the offset site and the project site which facilitates dispersal between populations. Using the available habitat, further field verification and the new offset area against the offset assessment guide RPS has been able to determine the offset site will fulfil its offsets compliance requirement. In addition the site is of high quality and therefore an immediate ecological benefit can occur.

4.6.4 *Grevillea glossadenia*

The MEWF project is expected to impact on 0.399ha of *Grevillea glossadenia* or removal of up to 500 individuals (Gleed, *2016*). Field verification identified approximately 5 hectares of *G. glossadenia* present (**Appendix G**) on the offset site. The amount of suitable habitat capable of sustaining this species is much higher. Calculations against the Offset assessment guide determined the offset site will fulfil its offsets compliance requirement. In addition the site is of high quality and therefore an immediate ecological benefit can occur.

4.6.5 *Homoranthus porteri*

The MEWF project is expected to impact on approximately 0.20 ha of *Homoranthus porteri*. Field verification identified approximately 1 hectare of *H. porteri* present on the offset site. The amount of suitable habitat capable of sustaining this species is likely to be higher, although the (**Appendix G**) species is quite restricted and can be cryptic. Calculations against the Offset Assessment Guide determined the offset site will fulfil its offsets compliance requirement. In addition the site is of high quality and therefore an immediate ecological benefit can occur.

4.6.6 *Acacia purpureopetala*

The Mt Emerald Wind Farm site population of *Acacia purpureopetala* represent the most north-eastern distribution of the species, where it is found at only a single location and represents an area of .0021ha. Field verification identified an area of approximately 0.04ha on the offsets site. This does not eliminate the possibility or additional suitable habitat capable of sustaining this species. The distribution on the offsets site and available habitat area was determined to be of high quality (**Appendix G**). Calculations against the Offset Assessment Guide determined the offset site will fulfil its offsets compliance requirement. In addition the site is of high quality and therefore an immediate ecological benefit can occur.

4.6.7 *Prostanthera clotteniana*

Small populations of *Prostanthera clotteniana* were found in habitats ranging from the fireproof niche environment of the rocky upper banks and slopes of Oaky Creek and its tributaries on the offset site. In comparison the species was found in one location on the MEWF within an impact area of 0.010ha. Field verification identified an area of approximately 0.045ha on the offset site. This does not eliminate the possibility or additional suitable habitat capable of sustaining this species (**Appendix G**). Calculations against the Offset Assessment Guide determined the offset site will fulfil its offsets compliance requirement. In addition the site is of high quality and therefore an immediate ecological benefit can occur.

4.7 Summary of Field Verification

In summary the suitability of the MEWF Offset Site Lot 22 SP210202 has been assessed against the seven EPBC threatened species listed namely:

- Northern Quoll (*Dasyurus hallucatus*);
- Spectacled Flying-fox (*Pteropus conspicillatus*);
- Bare-rumped Sheathtail Bat (*Saccolamimus saccolaimus nudicluniatus*);
- *Grevillea glossadenia;*
- *Homoranthus porteri;*
- *Acacia purpureopetala; and*
- *Prostanthera clotteniana*.

The values generated from the Offsets Assessment Guide indicate the proposed offset is suitable to acquit the offset requirements of the project and the percentage of impact offset is over 100% for all values. The offset area provides for the long-term protection of habitat for the seven threatened species and through effective management and monitoring strategies, the habitat will be protected and maintained.

5.0 Securing the Offset

5.1 Offset Deed

The owners of the land have entered into a formal "Call Option to Purchase Property" agreement with MEWFPL. Under the contractual terms of this agreement the owners agree to sell the Property to MEWFPL should MEWFPL exercise its Call Option on the terms specified in the deed.

It is intended for Call Option to be exercised by MEWFPL upon the project reaching financial bankable status and confirmation from DEE on its suitability as an Offset Area. At this time the ownership of the Offset Area property will fall to MEWFPL, with the intention of remaining so until the completion of all operational activities at the site.

5.2 Securing the Offset Area

The offset area will be secured as a nature refuge, as recognised by the *Nature Conservation Act 1992* (Qld).

A nature refuge agreement acknowledges the commitment to protect the offset land with significant conservation value, while allowing compatible and sustainable land uses to continue.

A nature refuge agreement will be:

- Negotiated between EHP and the landholder, and provides a framework for sustainably managing a nature refuge and protecting its significant values;
- Tailored to suit the landholder's management needs;
- Able to be negotiated with owners of freehold land,
- Able to be negotiated over the whole of the property;
- Perpetual, registrable on title and binds successive owners or lessees of the land; and
- A draft Nature Refuge Agreement will be developed with the Queensland Government.

6.0 Offset Area Management

6.1 Objectives and Outcomes

The offset area provides for the long term protection of habitat for seven threatened species and through the implementation of adaptive management practices the quality of the habitat will be improved and maintained over time.

The offset area is to be protected in perpetuity through an appropriate mechanism as outlined in **Section 5.2**.

The management plan objectives and outcomes are to:

- Protect all vegetation within the offset area from future clearing;
- Protect all fauna within the offset area from introduced weeds and pests;
- Protect the site vegetation and fauna from un-prescribed burn and wildfire;
- Maintain the ecological condition of remnant of-concern and least concern vegetation within the Offset area where the BioCondition Class of 1 for each assessment unit does not change;
- Implement a Translocation Plan based on the criteria and guidelines detailed in the *Guidelines for the translocation of threatened plants in Australia* (Vallee *et al*, 2004) should be developed to identify MNES plant species appropriate for relocation as well as target and recipient sites.

7.0 Restrictions on the Use of the Offsets Area

The restrictions below (**Table 10**) will be implemented within the Offset Area Management Plan.

Table 10 Offsets Area Restrictions

Restriction	Implementation
Fire	Fire is to be, where possible, managed in the offset area by: (a) Maintaining firebreaks relative to the offset area; (b) Co-locating firebreaks with existing roads and fence lines on the property where possible; and (c) Utilising prescribed burning strategies as outlined in the *MEWF Bushfire Management and Emergency Evacuation Plan* (2016).
Pest Animal Management	Minimise the introduction of pest animals and control of existing populations of pest animals within the Offset Area in accordance with the *Biosecurity Act 2014.* The MEWF *Pest Management Plan* (2016) identifies strategies to protect and/or eradicate vertebrate pests from the Mt Emerald massif. Minimise the risk of invasion and spread of any invasive species within the Offset area in accordance with **Table 12 Management Actions**.
Weeds	Keep the introduction; establishment and spread of non-native weeds including Declared Pest Plants listed under the *Biosecurity Act 2014* to no more than 5% weed cover over the Offset Area. Control any existing infestations of non-native weeds including Declared Pest Plants under the *Biosecurity Act 2014* to ensure the non-native weeds do not cover more than 5% of the Offset Area. Minimise the spread of any non-native pasture species within the Offset Area in accordance with **Table 12 Management Actions**.
Access (including livestock)	The offset area will be fenced to restrict access. Access to the offset area will be for authorised personnel only.
Limited vehicle access and movements within the offset area	Vehicle movement will be limited to designated access tracks in the offset area to minimise impacts to the ecological communities and minimise erosion.

8.0 Analysis of Risks to Achieving Management Objectives and Outcomes

The following risk assessment (**Table 11**) has considered:

- Any real or potential risks associated with achieving the management objectives and outcomes;
- The actions taken to minimise those risks and;
- Any remedial action that will be undertaken if any of the risks occur.

Table 11 Risk Analysis

Number	Risk	Level of Risk (Extreme, High, Moderate or Low)	Proposed Actions to Minimise Risk	Proposed Remedial Actions if Risk occurs
1	Fire	Moderate	Maintain fire break, Manage fuel loads through controlled fire regime	Allow offset area to recover post fire with control of weeds. Rehabilitate and revegetate sensitive areas where necessary.
2	Pest Animals and Weeds	Moderate	Limit the introduction of pest and weed animals	Implement and/or increase control methods where required.
3	Grazing, Human Access	Low	Fence where required in accordance with this plan	Prevent access from neighbouring properties.

9.0 Management Measures

9.1 Management Actions

The following table (**Table 12**) identifies the actions which will be undertaken for the offset area, by whom, and the corrective actions for each management action.

Table 12 Offset area management, monitoring and reporting schedule

ACTION	UNDERTAKEN BY	DETAILS (LOCATION, METHOD, TIMING AND FREQUENCY)	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10	CORRECTIVE ACTIONS
Weed Management													
Weed distribution survey		Conduct biennial surveys to determine the occurrence and distribution of weeds. Map the extent and density of weed infestations with GIS.	✓		✓		✓		✓		✓		
Weed control plan	TBD	Implement MEWF Weed Management Plan (**Appendix I**) incorporating Offset Site attributes at the start of management and update as required based on the results of weed distribution surveys.	✓										
Active weed control	TBD	▪ Triggers for weed control include any new or unusual weed sightings should be reported immediately to allow for rapid control to occur to prevent outbreaks or new populations. Locations should then be added to a register of all known weed locations. ▪ Activate monitoring from incursions on adjacent MEWF site – additional management activities (**Appendix I**). ▪ Check and control priority weed and contain weed infestations. Keep the access road free of weeds, with particular attention to Grader Grass and any other tall grasses. Maintain a 2 m wide weed-free clear zone each side of access from Lemontree Drive. The weed-free clear zone should allow for 2 m clearance each side of the largest expected vehicle that will enter the site. ▪ Implement annual weed control measures to reduce the density and area of occupation in the offset area in accordance with the weed control plan. ▪ Weed control methods will be chosen based on the results of the weed control surveys to suit individual weed species. Weed control to include a combination of biological, mechanical and herbicide control methods.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	▪ Investigate alternative weed management regimes or techniques. ▪ Develop an updated weed management regime. ▪ Submit the proposed revised weed management program, as part of a revised Offset Area Management Plan, to the Department of the Environment and Energy. ▪ Implement the revised and approved plan. ▪
Short term monitoring of weeds	TBD	Monitoring of targeted weed infestations will be conducted as follow up after weed control events to ensure infestations have been sufficiently eradicated and to conduct re-control where required. Review Weed Management Plan: amend and adapt weed management practices as required throughout the duration of the construction and operational stages of the wind farm (**Appendix I**)	As required										
Weed prevention/hygiene	All approved visitors to the offset area	Practice Good Weed Management: Always work from the cleanest, weed-free areas towards contaminated areas. Prevent the movement of weed material from weed infested areas into the offset area. Ensure that all vehicles and equipment entering the offset area are clean and free of weed seed prior to entry.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Managing access by humans, livestock													
Fencing	TBD	The majority of the offset area is not accessible to livestock given its topography. Areas considered to be accessible would be fenced with a four strand barbed wire, stock proof fence.	✓										▪ Interim exclusion options will be used if fence construction or repairs are delayed. ▪ Conduct quarterly audits of the offset area until actions are completed as agreed
Fire management													
Bushfire Management and Emergency Evacuation Plan	TBD	MEWF Bushfire and Emergency Evacuation Plan (**Appendix J**) identifies a program of actions that will be utilised on the Offsets site.	✓										▪ Investigate alternative fire management regimes or techniques such as prescribed burning ▪ Develop updated fire management regime ▪ Submit the revised fire management regime to the Department of Environment for approval ▪ Implement revised and approved plan.
Firebreaks	TBD	▪ If appropriate, establish firebreaks around the perimeter of the offset ▪ area to prevent unplanned fires entering the offset area, ▪ Inspect firebreaks and maintain as required.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Fuel loads	TBD	▪ Monitor fuel loads during short term weed monitoring events and annual weed inspections ▪ Maintain fuel loads through annual weed control to include a combination of biological, mechanical and herbicide control.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	

ACTION	UNDERTAKEN BY	DETAILS (LOCATION, METHOD, TIMING AND FREQUENCY)	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10	CORRECTIVE ACTIONS
Pest management													
Pest animal control	TBD	▪ Refer to MEWF Pest Management Plan (**Appendix K**) and incorporate the adjoining offsets site. Record the incidental occurrence of pests at key locations on offset site. Identify if the pest has been observed on the site before, is breeding and occupies a small area. This population may be controlled. ▪ Triggers for pest control include incursion on adjacent MEWF site – additional monitor and management activities (**Appendix K**). ▪ Conduct an annual assessment of need for pest animal control measures. ▪ Measures to include live trapping or shooting. ▪ Control by baiting will not be undertaken.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	▪ Investigate reasons for poor pest animal control. ▪ Develop updated Pest Animal Plan. ▪ Submit the proposed revised pest animal management program, as part of a revised Offset Area Management Plan, to the Department of Environment and Energy for approval ▪ Implement the revised and approved plan
Translocation of threatened plants													
Translocation Management Plan	TBD	Refer to MEWF Translocation Management Plan (**Appendix B**) outlining specific management measures associated with the translocation of threatened plant species to the offset area.	✓										
Site preparation	TBD	Prior to planting, reduce ground cover within the planting site so as not to limit the establishment of any of the translocated species.	✓										
Planting	TBD	Undertake planting during a suitable time of year. General management measures for the translocated plants will include but not be limited to the following: ▪ Track each plant with a unique code and record a GPS location. ▪ Water each plant immediately after planting. ▪ Monitor predation by insects and apply insecticide onto the foliage if required. Any weeds occurring within the vicinity of translocated individuals will be hand removed whilst watering.	✓										▪ Replace dead plants in order to achieve the required number of individuals
Watering	TBD	Water translocated plants immediately after planting and every week for the first four weeks following translocation (if required).	✓										
Monitoring													
Photo monitoring	TBD	Establish four photo monitoring points within the offset area to enable a visual assessment of changes over time including the following: ▪ Mark photo monitoring points with flagging tape and the GPS points recorded. ▪ Take annual photographs in north, southeast and west directions. ▪ Maintain a record of the photographs, including GPS co-ordinates, date and time of each photograph, the direction in which the photograph was taken; and the height above the ground at which the photograph was taken.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	▪ Investigate reasons for why management actions are not achieving desired outcome ▪ Revise management strategies and implement as required
Opportunistic visual monitoring	TBD	Undertake visual monitoring opportunistically during the implementation of management actions to assess the following: ▪ the status of fencing in the offset area ▪ the status of weeds in the offset area ▪ areas of erosion and/or areas with high erosion potential ▪ firebreaks and fuel loads ▪ evidence of pest animals in the offset area (including feral cats and dogs).	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Fauna surveys	TBD	Targeted surveys will be undertaken annually in year 1 and year 2, then every two years. The fauna survey methodologies will be developed in consultation with DEE and will be consistent with Australian Government fauna survey guidelines. All surveys will be undertaken by a suitably qualified person (e.g. fauna ecologist). More detail regarding fauna surveys is provided in Section 1.2. Prior to undertaking the fauna monitoring program, ensure all necessary licenses relating to the capture of wildlife are current, including animal ethics approval and DEHP wildlife trapping permit. Prepare report on the statistical analysis of changes in species diversity and provide to DEE within three months of monitoring completion.	✓	✓		✓		✓		✓		✓	▪ Investigate reasons for low native species diversity ▪ Develop a program improve or manage fauna species diversity ▪ Submit the proposed management program, as part of a revised Offset Management Plan, to the DoEE for approval Implement the revised and approved plan

ACTION	UNDERTAKEN BY	DETAILS (LOCATION, METHOD, TIMING AND FREQUENCY)	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10	CORRECTIVE ACTIONS
Biocondition assessments	TBD	Two permanent transects for undertaking BioCondition assessment will be established and marked using flagged star pickets or other markers (See Eyre *et al*. 2011). Biennial BioCondition assessments will be undertaken in accordance with the BioCondition Methodology (version 2.1, Eyre *et al*. 2011).	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Monitoring of translocated threatened plant species populations	TBD	Monitor the translocated *Grevillea glossadenia, Prostanthera clotteniana, Acacia purpureopetala*,*Homoranthus porteri*, *Melaleuca uxorum* and *Plectrathus amoenus* populations in order to assess the success of the translocation program. Conduct monitoring monthly for the first 12 months and then quarterly for the next four years. Table 14 lists the parameters to be monitored and the performance criteria against which they will be assessed (**Appendix B**)	✓ Monthly	✓ Quarterly	✓ Quarterly	✓ Quarterly	✓ Quarterly						▪ Investigate reasons for why the translocation program is not achieving desired outcome. ▪ Revise the Translocation Management Plan and implement as required.
Reporting													
Annual report submitted to Department of the Environment and Energy (DEE)	TBD	Provide an annual report to DEE by 30 June. It will include: ▪ results of monitoring activities ▪ the outcomes of management actions including annual weed surveys and pest animal control ▪ a general description of climatic conditions and other factors that may impact the offset area (fires, drought, flood, etc.).	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	

(From RATCH Offset Management Plan, 2013)

9.2 Translocation and Propagation

A management action for threatened plants includes taking opportunities to remove a living plant from its natural habitat and planting it into a suitable recipient site, where there is a reasonable probability of it surviving and forming a healthy and functional population in the future. This process is called translocation and is an accepted impact mitigation technique used for threatened plants listed under the EPBC Act and the NC Act.

The translocation of living threatened plants requires a detailed and site-specific *Translocation Plan* (**Appendix B**) to be developed in order that a number of matters including the selection of suitable recipient sites; the technique of translocation; and a monitoring component are clearly defined. This Threatened Plants Management Plan is not a dedicated translocation plan; however, a brief summary of the predicted likelihood of successfully translocating the threatened plant species recorded from the Mt Emerald Wind Farm site is shown in **Table 13**.

Table 13 Predicted Success Rates for Translocating Threatened Plant Species

Species	Transplant/translocation	Stem/leaf cuttings	Seed propagation
Acacia purpureopetala (Purple-flowered Wattle)	Low. Adult plants could have underground perennating stems or other plant parts. Possible higher success rate transplanting seedlings. Plants (on Mt Emerald) have peculiar and very specific habitat requirements.	Low.	Low-moderate. Seeds germinate okay, but new seedlings are prone to fungal disease and difficult to grow on to more mature stages.
Grevillea glossadenia (no common name)	Adult plants - low. Seedlings - would need to select relatively fresh seedling material (post-fire germination event). Plants are likely to require mycorrhyzal inoculation from parent soil to improve success rates.	Low.	Moderate to high.
Homoranthus porteri (no common name)	Low. Insufficient knowledge of propagation. Plants have very specific habitat requirements.	Low - insufficient knowledge of propagation through cuttings, although other species of *Homoranthus* have been propagated using this method.	Insufficient knowledge to determine validity of this method.
Prostanthera clotteniana (Mint Bush)	Low for adult plants. Juvenile material may have higher rates of transplanting success. Insufficient knowledge to determine validity of this method.	Moderate, but would require specialised nursery set-up.	Insufficient knowledge to determine validity of this method.
Melaleuca uxorum (no common name)	Low. Natural regeneration appears to be from resprouting stems from adult plants. Seedlings not observed in wild - insufficient knowledge.	Low to moderate, although insufficient knowledge of propagation through cuttings.	Moderate to high. Fresh seed material would need to be collected.
Plectranthus amoenus (Plectranthus)	Moderate to high. Would need to have recipient site and dedicated process to increase success rates.	High. Plectranthus plants are likely to be successfully propagated through leaf or stem cuttings.	Insufficient knowledge, although other methods of propagation or transplanting are likely to prove successful and are a more valid means of horticultural reproduction.

(Gleed, 2016)

10.0 Monitoring and Reporting

10.1 Monitoring

Ongoing monitoring is required to ensure the offset area management plan achieves the objectives outlined above. Monitoring activities will be undertaken to assess how the offset site is progressing over time and inform ongoing management activities should additional management activities be required. **Table 12** also outlines the Monitoring and Reporting Schedule over a ten year time frame.

10.2 Procedures

10.2.1 Training Requirements

The effectiveness of the Offset Area Management Plan will depend on those responsible for its implementation. Those responsible must be familiar with the content and able to interpret and successfully implement the management actions of the Plan. The MEWF Site Manager will ensure relevant personnel are trained in the procedures of the OAMP and are capable of implementation.

Employees and contractors entering the Offset Area will have an induction which will cover:

- Procedures to reduce spreading weeds and pests;
- General fire awareness and response procedures;
- Vehicle access management; and
- Response procedures to mitigate impacts.

10.2.2 Roles and Responsibilities

Contractors undertaking site works must be instructed directly of the requirements of this plan. A copy of this OAMP is to be retained and displayed on site at all times during the life of the Offset program. The site manager should ensure all relevant contractual documents specify the OAMP as a responsibility.

10.3 Reporting

Reports will be submitted to the Department of the Environment and Energy by 30 June of each calendar year detailing the progress against the proposed management outcomes until the outcomes are achieved.

As a minimum each report will include:

- Departmental reference number;
- Name and contact details of landholder;
- Lot on plan property description and postal address;
- A general description of climatic conditions which may impact the offset area;
- Activities undertaken within each management action and the outcomes achieved;
- Schedule of management actions with progress section completed;
- Program of action for the next management period;
- Results of BioCondition assessments;
- Photo monitoring results;

- Progress towards the achievement of offset area objectives and outcomes;
- Problems, issues and impediments to achieving the objectives and outcomes of the management plan; and
- Adaptive management actions (e.g. adverse climatic conditions such as storm damage or flooding; bushfire; or pest species invasion).

11.0 Consent

Consent must be provided by the owner/s and signed off by the chief executive delegate.

SIGNED by delegate of the Chief Executive Officer (Department of Environment and Energy) to indicate approval of the Offset Area Management Plan.

Name:..... Signature.....

Witness name:.....Signature.....

Date:.....

SIGNED by being the current owner/s of the abovementioned property to indicate that the terms of this offset area management plan including responsibilities under the management plan, have been read, understood and accepted.

The landholder agrees that any non-compliance with the requirements of this Offset Area Management Plan shall constitute a breach of the terms and conditions of the legally binding mechanism entered into.

Name:..... Signature.....

Witness name:.....Signature.....

Date:.....

Name:..... Signature.....

Witness name:.....Signature.....

Date:.....

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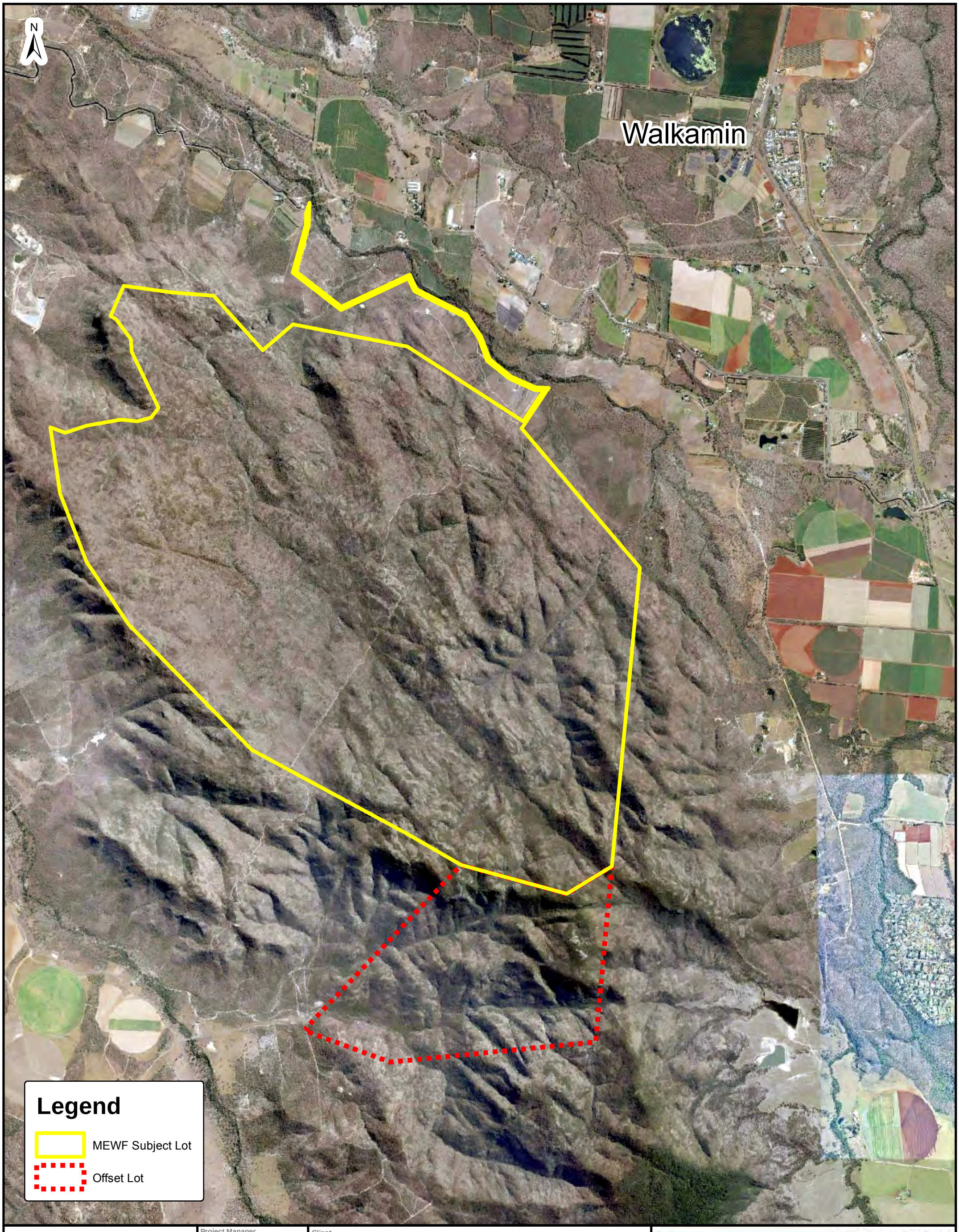
Appendix A

Offset Site Map Location and GPS Points

Coordinate	Latitude	Longitude
1	327665.28	8096419.29
2	329271.77	8098108.56
3	330368.63	8097807.76
4	330836.23	8098093.03
5	330668.16	8096268.77
6	328535.6	8096059.89
7	327665.43	8096379.33
8	327674.97	8096399.37



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Map Projection	MGAz55
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File Reference	PR132974-8.mxd
Sheet Number	1 of 1

Client: RACL

Title: Locality Plan - Offset Site

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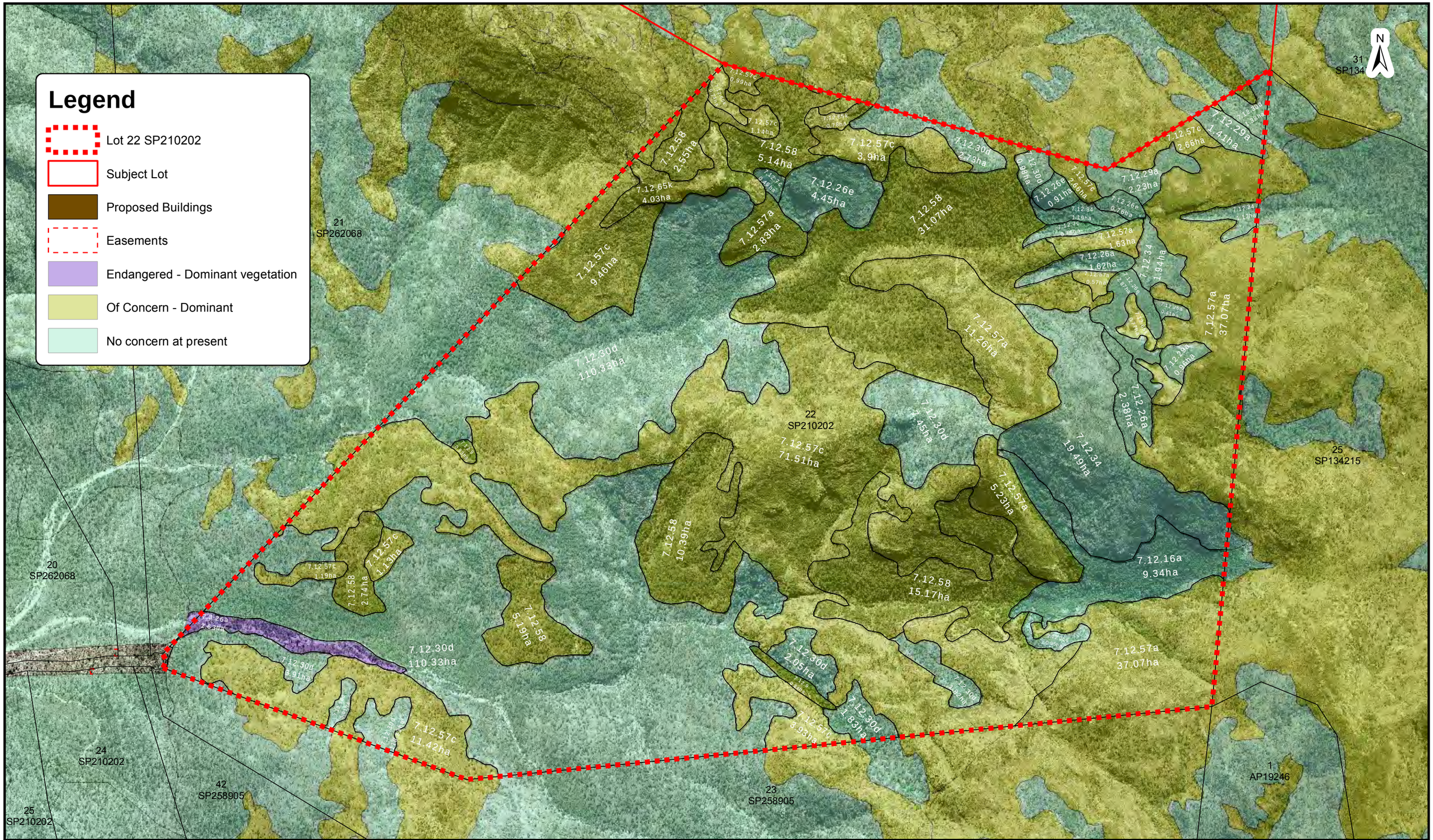

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Compiled by	RMS
Map Projection	MGAz55
Map Datum	GDA94
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Sheet Number	1 of 1

Client: RACL

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Appendix B

Translocation Plan

Translocation Plan for Threatened Plants

Mount Emerald Wind Farm

Report prepared for RPS Australia East for MEWFPL

December 2016
(Reference SG1615)

Translocation Plan for Threatened Plants

Mount Emerald Wind Farm

Report prepared for RPS Australia East on behalf of MEWFPL

Simon Gleed

12th December 2016

(Reference: SG1615)

Disclaimer

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Photo credits in this report: Simon Gleed

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Simon Gleed undertook the fieldwork and preparation of this document in accordance with specific instructions from RPS Australia East to whom this document is addressed. This report has been prepared using information and data supplied by RPS Australia East and other information sourced by the author.

The conclusions and recommendations contained in this document reflect the professional opinion of the author based on the data and information supplied and available at the time of the work. The author has used reasonable care and professional judgment in the interpretation and analysis of the data. The conclusions and recommendations must be considered within the agreed scope of work, and the methodology used to perform the work, both of which are outlined in this report.

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Simon Gleed	1 (electronic)	S. Gleed

CONTENTS

1.0 INTRODUCTION

1.1 Overview

The Mount Emerald Wind Farm site provides important habitat and refuge areas for threatened plants which are listed under Queensland and Commonwealth legislation. Six species of threatened plants are found on the site, and three of these species will be directly impacted by clearing for the construction of tracks and wind turbine generator (WTG) construction pads. The majority of vegetation clearing will take place during the construction phase of the project.

Virtually all the project site is in an undisturbed condition and subsequently holds high levels of natural and ecological integrity. At elevation where the wind farm infrastructure will be constructed, the project site supports large areas of remnant vegetation, with land disturbances limited to access tracks to the easement corridor associated with the 275 kV powerline infrastructure. The 275 kV powerline approximately divides the site into two quite distinct landforms: the southern section coinciding with the Wet Tropics bioregion and the northern section within the Einasleigh Uplands bioregion.

Construction of the Mt Emerald Wind Farm will result in a range of new impacts being introduced to the site. A prominent impact will be the creation of a road and cabling network, plus the Wind Turbine Generator (WTG) construction pads. Roads and access tracks are proposed to be cleared to a width of 10 m at the construction stage. Wider clearing will be required in some situations to allow for adequate manoeuvring space for large machinery and trucks. It is in, and adjacent to the clearing footprint where the threatened plants discussed in this Translocation Plan are found.

The Mount Emerald Wind Farm site is unique in many respects because of its high altitude position in the landscape and the special flora and vegetation values the dissected ridge country holds south of the 275 kV powerline in the Wet tropics bioregion section. The threatened plants found on the site are adapted to surviving in a harsh environment where water deficits, high daytime temperatures, wind shearing and exposure, low soil fertility and very thin soil cover contribute to conditions requiring specialised plant survival qualities. These factors render the practice of plant translocation difficult and challenging.

This Translocation Plan outlines a background to the ecological and habitat requirements of the threatened species found on the Mount Emerald Wind Farm, and provides guidelines for translocating and reproduction of these species into "recipient" translocation sites.

The plan is intended to be applied in conjunction with the Threatened Plants Management Plan and the Rehabilitation Plan - both of which have been specifically prepared with consideration and reference to the unique environmental and habitat characteristics of the Mount Emerald Wind Farm site.

1.2 Project Description

The Mount Emerald Wind Farm Pty Ltd (MEWFPL) proposes to construct and operate a wind farm located approximately 20 km SSW of Mareeba on the Atherton Tablelands in north Queensland at the northern extent of the Herberton Range mountainous area.

The nature of the project requires wind energy to be harnessed efficiently and effectively; therefore, WTG's will be located on high points throughout the project site. The northern half of the site has broad, rolling hills, with conspicuous dissected associations with ravines and gorges. The northern section contrasts with the land found south of the existing 275 kV powerline, where rugged and steeply dissected hills with precipitous rocky cliffs and outcrops form a landscape of narrow ridges and rocky knolls.

Slope faces in the southern section are steep and often benched with rock pavements. This is the characteristic landform which supports threatened plants on the wind farm site.

The wind farm will consist of 53 WTG's, which will be approximately 80-90 m high and with 55 m diameter rotor blades. The wind farm will provide energy to feed into the main electricity grid infrastructure currently provided by the 275 kV Chalumbin to Woree powerline.

WTG's will be connected to each other by a network of tracks, some of which will accommodate underground cabling. Other infrastructure and facilities to be constructed within the wind farm project site include a contractors site compound, a lay-down area, a substation, and an associated substation operation and management building. The location of the works and layout of the wind farm infrastructure are shown in **Figure 1**.

Above: rugged hills south of the 275 kV powerline on the Mount Emerald Wind Farm site host the highest proportion of threatened plants.

Above: blocks of rhyolite rock scattered over most rock pavements are the typical habitat of *Plectranthus amoenus* on the wind farm site.

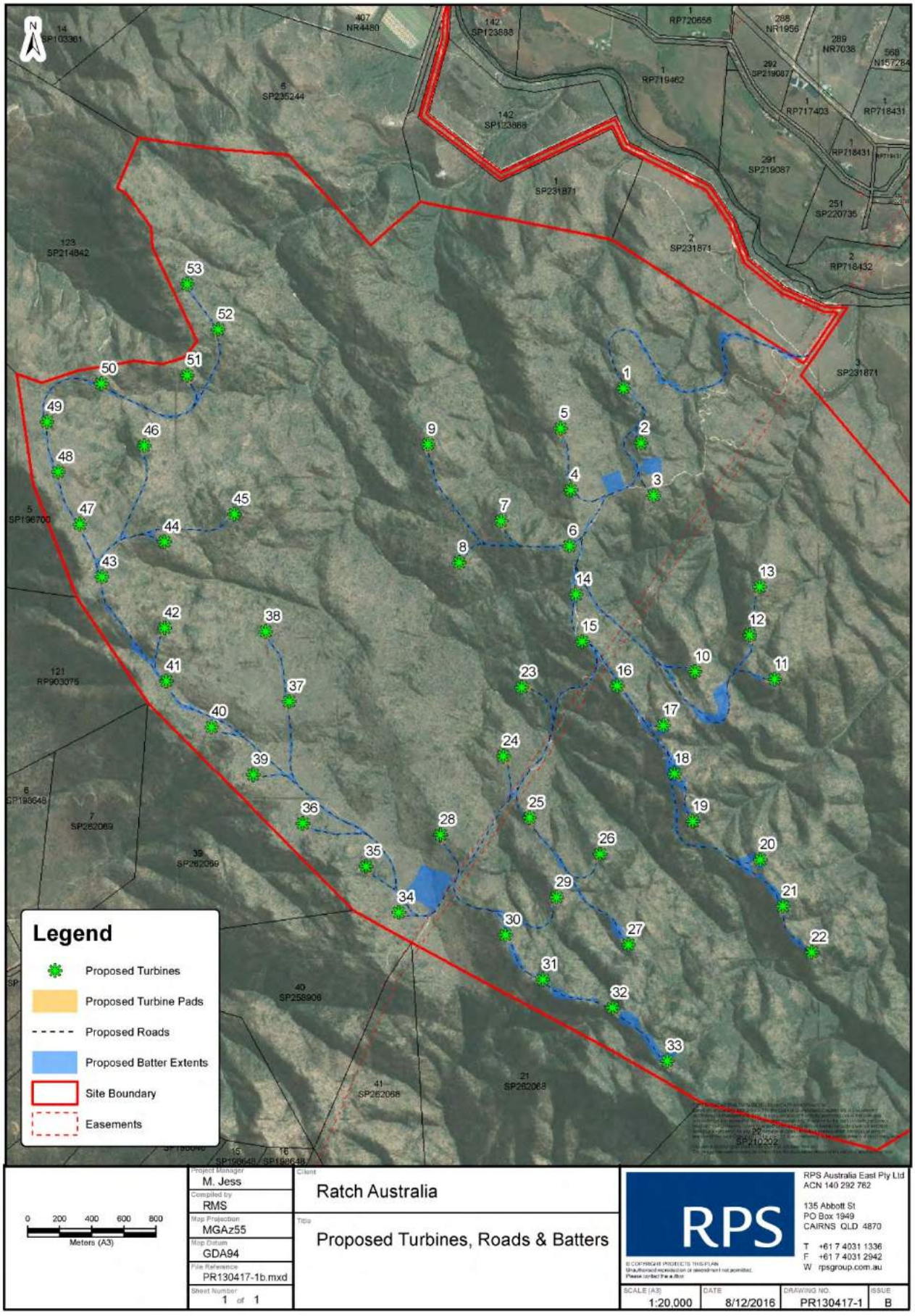


Figure 1. Layout of the Mount Emerald Wind Farm.

2.0 EXISTING ENVIRONMENT

The Mount Emerald Wind Farm site is located at the northern limit of the Herberton Range and immediately north of Mount Emerald. The landscape is characterised by steeply dissected hills, rocky terrain and areas of precipitous ravines and narrow ridges. The broad geology of the site is mapped as the Walsh Bluff Volcanics, which comprises fine-grained rhyolite.

2.1 Vegetation

The predominant vegetation cover over the project site is a mosaic of sclerophyll woodlands, shrublands and heathlands.

Woodlands: Common trees of the woodlands include Lemon-scented Gum (*Corymbia citriodora*), Yellow Stringybark (*Eucalyptus mediocris*), Range Bloodwood (*C. abergiana*), Ironbark (*E. drepanophylla*), Dead Finish (*E. cloeziana*), Cypress Pine (*Callitris intratropica*), Silver-leaf Ironbark (*E. shirleyi*), Orange Jacket (*C. leichhardtii*), White Stringybark (*E. reducta*), and *E. lockyeri*. The dominant grasses are usually Kangaroo Grass (*Themeda triandra*) and *Arundinella setosa*, with *Cleistochloa subjuncea* on very rocky soils at higher elevation on ridges and amongst rocky outcrops.

Woodlands are most frequent over broad slopes, flats and rolling hills with less dissected surfaces. Low, sparse woodlands and shrublands develop on ridges and in exposed conditions.

Woodlands in the centre of the site grow on relatively flat land where soil has a high clay content and in places, is slowly drained. These flat areas are often interspersed with sections of rock plates or pavements, and occasionally rocky outcrops with low relief. Typical trees of these woodlands include *Corymbia leichhardtii*, *Eucalyptus lockyeri* and *Callitris intratropica*. As the land ascends into gently rolling hills, trees such as *C. citriodora* (Lemon-scented Gum) and *E. cloeziana* (Dead Finish) become more frequent. The ground layer of these woodlands is dominated by Kangaroo Grass (*Themeda triandra*) and in some areas near watercourses, by *Pseudopogoantherum contortum*. The Grass Tree *Xanthorrhoea johnsonii* is usually well-represented and occasionally forms a secondary shrub layer. As the ground becomes drier in northern aspects of the site, Ironbark trees (*Eucalyptus drepanophylla*) become more common. Woodlands support the lowest proportion of threatened plants, where *Grevillea glossadenia* is virtually the only species which intergrades with the edges of this structural type.

Low woodlands and shrublands: Low woodlands and shrublands are characterised by many species, but typically include Sheoak (*Allocasuarina littoralis*), Grass Trees (*Xanthorrhoea johnsonii*), *Eucalyptus lockyeri*, Wattle (*Acacia aulacocarpa*), *Homoranthus porteri*, *Grevillea glossadenia*, and stunted forms of Range Bloodwood (*Corymbia abergiana*). Shrublands are generally found in relation to the ridge environment where thin rocky soils prevail. The endangered shrub *Melaleuca uxorum* is found on the boundary of this vegetation type with slightly taller woodlands, but is also found in association with the montane heathland and rock pavements described below.

Heathlands: Heathlands have a special and diverse group of plants which include species such as Broom Bush (*Jacksonia thesioides*), Grass Tree (*Xanthorrhoea johnsonii*), *Gompholobium nitidum*, wattles *Acacia calyculata* and *A. whitei*, grasses *Cleistochloa subjuncea*, Kangaroo Grass (*Themeda triandra*) and *Cymbopogon bombycinus*. Taller woody plants in this community include emergent stunted forms of *Eucalyptus lockyeri* and *E. mediocris*, shrubs such as *Grevillea glossadenia* and *Homoranthus porteri*; and compact shrublets such as *Cryptandra debilis*, *Mirbelia speciosa* subsp. *ringrosei*, *Pseudanthus ligulatus*, *Zieria whitei*, *Boronia occidentalis* and others.

The critically endangered *Acacia purpureopetala* and *Prostanthera clotteniana* grow in this vegetation type. It is referred to as montane heathland, because of its structure and reliance on high elevation aspects and very thin soils.

A feature of the montane heathland and shrublands at high elevation is the presence of rock pavements and areas of poorly vegetated rock outcrops. This particular habitat supports few tall plant species because of the near-absence of soil or growth medium on their surfaces. The soil that does develop is trapped in rock hollows, scoops and crevices between rock plates and boulders, and is developed from small plants such as lichens, mosses and the remains of rock ferns. This plant matter integrates with weathered rock material to form a soil that has the texture of peat, where in wetter times the absorbent nature of the medium is able to store water for longer periods.

Plants on rock pavements include the Resurrection Plant (*Borya septentrionalis*), *Pseudanthus ligulatus*, scattered shrubs of *Grevillea glossadenia*, *Plectranthus* species (including the threatened *P. amoenus*) and occasionally, sentinel specimens of Cypress Pine (*Callitris intratropica*). Grasses are sparsely represented and can include Five Minute Grass (*Tripogon loliiformis*), *Cymbopogon bombycinus* and *Eriachne humilis*. *Eriachne mucronata* is often found around the edges of rock pavements, with some pavements entirely covered by Firegrass (*Schizachyrium pachyarthron*).

2.2 Significance of the Ridge Environment and Key Plant Habitats

The high altitude ridges in the Wet Tropics bioregion section of the site south of the 275 kV powerline are sensitive environments that serve as critical habitats for plants and the poorly represented montane heathland and shrubland mosaic found mostly around 900 m ASL. Here the cloud base is a determinant of the moisture regime in relation to availability to plants and their exposure to extreme conditions.

The land south of the 275 kV powerline holds the highest levels of species diversity and endemism, where many species are restricted to and have adapted to the harsh environment of exposed high elevation points on ridges, rock pavements and areas of skeletal soil.

The montane habitat supports six species of plants which are listed as critically endangered, endangered and vulnerable under Queensland and Commonwealth legislation. Many other species, not listed under legislation, are restricted to the montane heathland along and on the edges of narrow ridges and rock pavements.

The rugged nature of the land with steep rocky slopes, bare rock pavements, outcrops and cliffs provides a unique environment for plants, and it is these characteristics which act as a refuge and reduces the effects of the severity and intensity of bush fires due to the low levels of flammable material such as grasses. Consequently, the conservation significant plants are found almost exclusively in fireproof habitats and niches.

The protection from fire afforded by rocks and low levels of flammable plant material is a critical attribute, which renders ridge tops and rock pavements significant habitats where many threatened plants are able to persist.

3.0 TRANSLOCATION PLAN

3.1 Background

Traditionally, plant translocation plans are compiled close to the event of removing the specimens/s from the ground (the disturbance site) and relocating them to a "recipient" site. A recipient site is selected beforehand so the opportunities for successful translocation are maximised (Vallee *et al*., 2004).

Following the physical activity of translocating, which generally involves re-planting the specimen or transferring regenerative plant material (e.g. the soil seed bank or root stock) into a suitably prepared site, monitoring of the translocation action is undertaken to assess success or otherwise.

This translocation plan has however, has been prepared well in advance of the actual translocation process because of the nature and scale of the Mount Emerald Wind Farm project. There are a number of important site-specific situations which will arise out the construction of the wind farm: one of the most important in regard to this plan, being the availability of near-ideal translocation recipient sites for threatened plants. This negates the requirement to search for surrogate *ex-situ* sites and investigate their potential suitability for hosting threatened plants, and therefore, all translocation activities will be to *in-situ* recipient sites.

3.2 Purpose of Translocation Plan

The purpose of this Translocation Plan is to facilitate the effective planning, implementation and evaluation of the translocation of threatened plants on the Mount Emerald Wind Farm site. The plan identifies which situations are appropriate for translocation; for example, when a threatened plant is required to be cleared and opportunities are identified where the specimen can be translocated.

3.3 Legislative Context

Plant translocation is an impact mitigation technique, which is required under both Queensland and Commonwealth legislation for the conservation of threatened plants on the Mount Emerald Wind Farm. In a legislative context, the process complies with requirements and conditions placed on the approval of the wind farm under the following legislation:

- *Nature Conservation Act 1992* (Queensland)
- *Environmental Offsets Act 2014* (Queensland)
- *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)

3.4 Plan Integration

The practice of translocating plants from the Mount Emerald Wind Farm is to be incorporated with the approaches used for landscape rehabilitation of the wind farm site. Because of the remoteness of the wind farm infrastructure setting, areas immediately adjacent to the disturbance footprint where threatened plants grow hold significant high levels of natural integrity, intactness and suitability (habitat-niche matching) for translocating and integrating a threatened plant enhancement initiative with the rehabilitation program.

The two key plans prepared for the Mount Emerald Wind Farm, which should be consulted in relation to the application of this Translocation Plan are:

- *Rehabilitation Plan & Guidelines - Mt Emerald Wind Farm* (Gleed, 2016a)
- *Threatened Plants Management Plan - Mt Emerald Wind Farm* (Gleed, 2016b)

Additional to the Mount Emerald Wind Farm site-specific plans listed above, a key plan with direct relevance to this translocation plan in terms of addressing the precept of no direct loss and no significant residual impact to threatened plant species (as defined under the NCA and EPBC Act) is the Mount Emerald Wind Farm Environmental Offsets Management Plan (RPS, 2016), plus the designated Offset Site, which is contiguous with the wind farm site. The Offset Area Management Plan has been prepared for and endorsed under the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

3.5 Threatened Plants of the Mount Emerald Wind Farm

The threatened plants, which are listed under Queensland's *Nature Conservation Act 1992* (NCA) and / or the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and which this translocation plan relates to are shown in **Table 1**. The table notes the approximate number of individuals of each species on the wind farm site. This estimation is arbitrary, and in some situations it is almost impossible to count individual plants when they grow in dense thickets, such as with *Homoranthus porteri*. The estimates are of populations which grow on and adjacent to the areas of land expected to be cleared for tracks and WTG construction pads. The estimates do not account for sections of the site where wind farm infrastructure is not proposed; and consequently, where no direct impacts will occur.

Table1. Status of threatened plants found on the Mount Emerald Wind Farm site.

Name	NCA status	EPBC Act status	Frequency on site	Approx. number of individuals on site
Acacia purpureopetala Purple-flowering Wattle	Endangered	Critically Endangered	Highly restricted and very rare	~18
Grevillea glossadenia No common name	Vulnerable	Vulnerable	Restricted and locally common	+800
Homoranthus porteri No common name	Vulnerable	Vulnerable	Restricted and locally common	+300
Melaleuca uxorum No common name	Endangered	Not listed	Highly restricted and very rare	~15
Plectranthus amoenus Plectranthus	Vulnerable	Not listed	Restricted and occasional	~50
Prostanthera clotteniana Mint Bush	Endangered	Critically Endangered	Highly restricted and very rare	~30

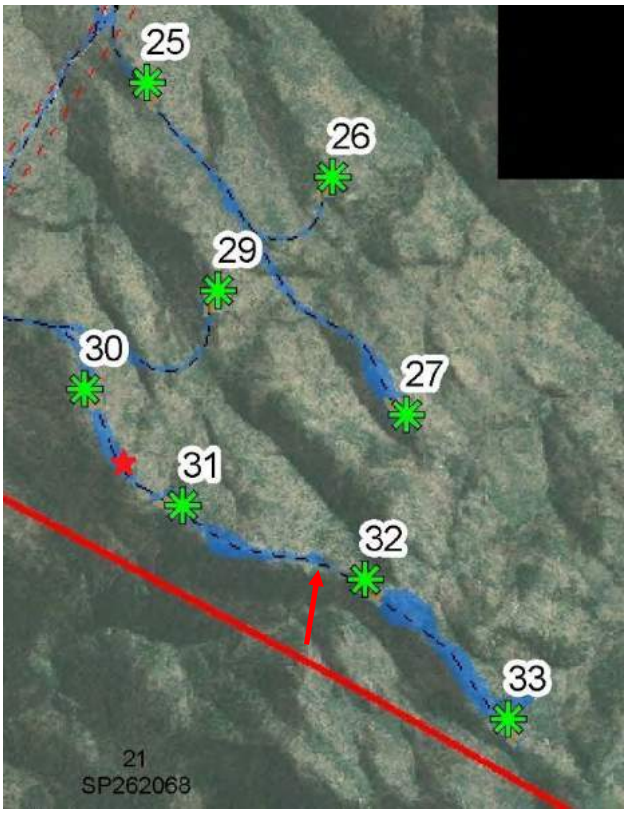
3.6 Location and Habitats of Threatened Plants

This plan is specific to the translocation of the threatened species listed in **Table 1** and the areas of land within the broader wind farm site where these are located. Because the wind farm takes advantage of high points within the landscape to locate WTG's, a majority of the infrastructure, and consequently, direct impacts to threatened plants will occur on ridges and the rocky knolls along the ridge lines.

The highest and most significant proportion of threatened plants are located on the narrow ridges and adjacent steep slopes south of the 275 kV powerline in the Wet Tropics bioregion section of the site. Scattered individuals of *Grevillea glossadenia*, an isolated population of *Homoranthus porteri* and the main population centre of *Plectranthus amoenus* are located to the north of the powerline in the section of the site which coincides with the Einasleigh Uplands bioregion - an area of less dissected hills.

The Threatened Plants Management Plan for the Mt Emerald Wind Farm (Gleed, 2016b) gives accurate details of the location of threatened plants; and detailed descriptions of the respective habitats and vegetation characteristics. The maps and habitat descriptions in **Table 2** are taken from the Threatened Plants Management Plan and should be used as a guide to the location of suitable recipient sites for translocation and enhancement planting during rehabilitation.

Table 2. Threatened plant species and their habitats and locations.

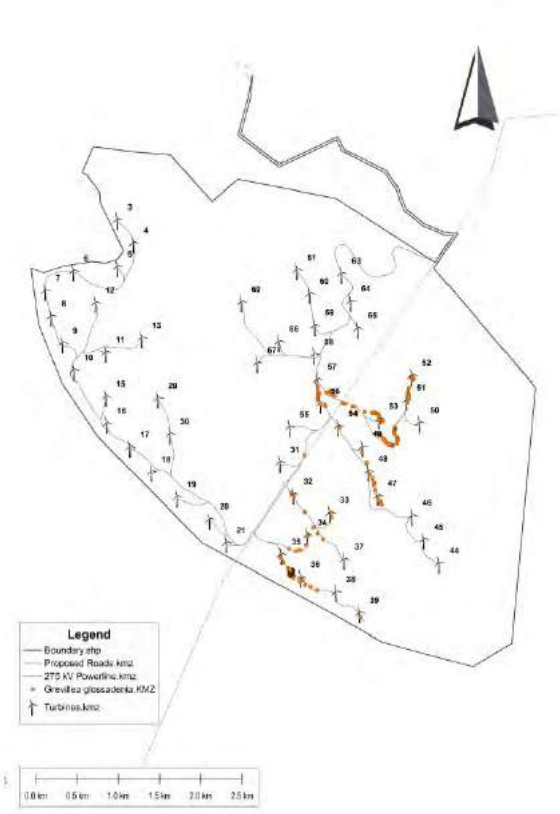
Species and habitat	Location map
***Acacia purpureopetala* (Purple-flowering Wattle)** **Location**: A single population of 18 plants grows on the wind farm site on the elevated ridge approximately midway between WTG 30 and 31. **Habitat**: The plants are very inconspicuous and are concealed under a low mixed thicket of *Homoranthus porteri* and *Acacia aulacocarpa*. Other plants around this population include *Pseudanthus ligulatus* and *Grevillea glossadenia*.  **Distinguishing characteristics**: The low-growing, almost prostrate habit with reddish stems that radiate in a circular fashion from the main stem, small grey-green phyllodes with a raised central vein, and pink-purple ball flowers. *Acacia purpureopetala* is the only wattle in Australia with pink or purple flowers. All other species of wattle in the region have white, cream or yellow flowers (in rods or balls).	 Location of *Acacia purpureopetala* - red star

***Grevillea glossadenia* (no common name - a Grevillea)**

Location: *Grevillea glossadenia* has a wide distribution across the southern parts of the wind farm site. The shrub is mainly found along ridges and can be seen along the edge of existing tracks near the 275 kV powerline.

Habitat: *Grevillea glossadenia* grows in rocky soils or on ridges in exposed conditions or on the edges of woodlands. It rarely grows under woodland cover. Associated plants can include: *Eucalyptus lockyeri*, *E. mediocris*, *Corymbia abergiana*, *C. citriodora*, *Xanthorrhoea johnsonii* and the grasses *Themeda triandra* and *Cleistochloa subjuncea*.

Distinguishing characteristics: A rounded or spindly shrub between 1 m and 1.6 m tall. Leaves have entire margins and are silvery below. Flowers conspicuously red-yellow-orange.



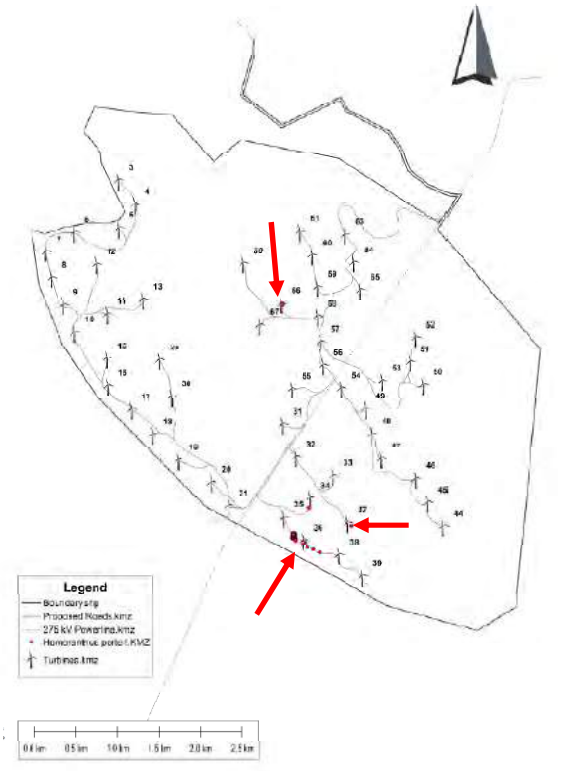
Location of *Grevillea glossadenia* - orange dots

***Homoranthus porteri* (no common name)**

Location: The largest and most important population of *Homoranthus porteri* is located along the ridge between WTG's 30 and 33. An outlier population occurs at WTG 7 on the edge of the large rock pavement.

Habitat: *Homoranthus porteri* grows on and around rock pavements and amongst wide areas of bare or poorly vegetated rocks mostly on ridges or above very steep rocky slopes. It is seldom found under trees of woodlands. Associated species include *Acacia aulacocarpa*, *Leptospermum amboinense*, *Pseudanthus ligulatus*, *Grevillea glossadenia* and *Eucalyptus lockyeri*.

Distinguishing characteristics: Rounded shrub with bright green foliage - forms thickets. The leaves are narrow and small. Flowers are pink and grow in pairs - they are pendulous. Another feature is its preference for growing on or around the edges of rock pavements or large areas of bare rock in crevices.



Location of *Homoranthus porteri* - red arrows

***Melaleuca uxorum* (no common name)**

Location: A single population is found on the eastern edge of the broad ridge just north of WTG 18 and just below the wind monitoring tower.

Habitat: *Melaleuca uxorum* grows on very rocky slopes and rock pavements and generally in exposed, wind-swept areas of ridges. Associated species include *Acacia aulacocarpa*, *A. calyculata*, *Pseudanthus ligulatus*, *Grevillea glossadenia*, *Eucalyptus lockyeri*, *E. mediocris*, and *Corymbia abergiana*. Grasses include *Cleistochloa subjuncea* and *Themeda triandra*. Grass trees (*Xanthorrhoea johnsonii*) are often present.

Distinguishing characteristics: A low, dense shrub with thicket habit. Leaves are small, almost rounded, decussate with a sharply pointed apex - shrubs are prickly to touch. May be obscured by other heath-like plants such as *Acacia calyculata* and *Jacksonia thesioides*.

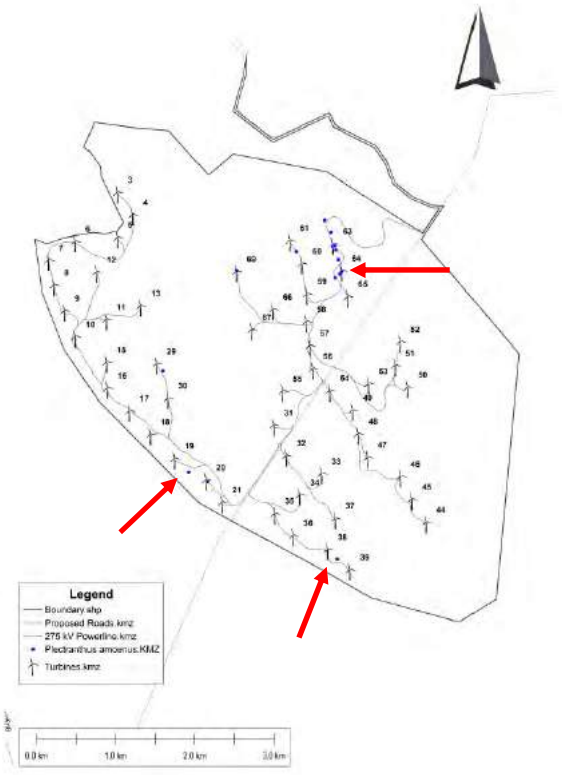
Location of *Melaleuca uxorum* - red arrow

***Plectranthus amoenus* (Plectranthus)**

Location: The largest populations are found north of the 275 kV powerline between WTG's 1 and 3. Isolated occurrences occur further south in the project area.

Habitat: *Plectranthus amoenus* grows almost exclusively on rock pavements and large areas of bare rock in accumulated pockets of soil and in crevices. The species has a strong association with the tree *Callitris intratropica* on the wind farm site. Associated species include the grass *Eragrostis schultzii* and the Cypress Pine *Callitris intratropica*.

Distinguishing characteristics: *Plectranthus amoenus* has a sparse open, semi-erect growth habit with only a few ascending stout, grey and fleshy stems. Flowers are blue-purple. The thick, soft and felt-like leaves are a feature of the species. Habitat-specific to almost bare rock pavements.



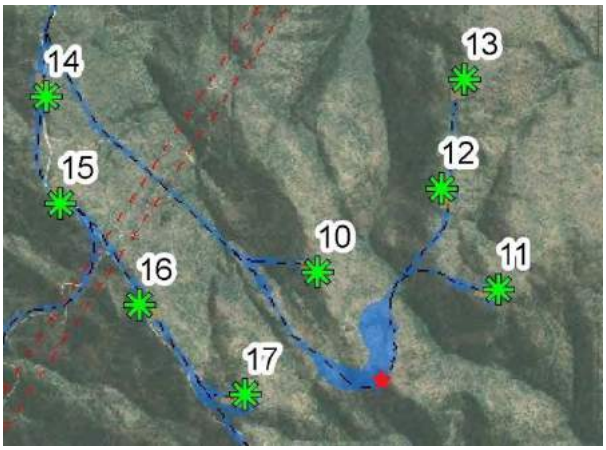
Location of *Plectranthus amoenus* - red arrows

***Prostanthera clotteniana* (Mint Bush)**

Location: A single population found on the eastern edge of the broad ridge south of WTG 10.

Habitat: *Prostanthera clotteniana* grows in exposed rocky areas that are protected from hot fires. The species prefers the tops of steep rocky drop-offs and with a southeast aspect. Associated species include *Pseudanthus ligulatus*, *Grevillea glossadenia*, *Eucalyptus lockyeri* and *Xanthorrhoea johnsonii*. There can be woodland of *Eucalyptus reducta* in gullies and on slopes in adjacent areas. Grasses include *Cleistochloa subjuncea*, *Cymbopogon bombycinus* and *Themeda triandra*.

Distinguishing characteristics: *Prostanthera clotteniana* is a low, open-branched erect shrub to 1 m. It has attractive white, lobed flowers. The grey branches with fine pale silky hairs is characteristic. When not in flower this species is difficult to identify quickly and looks superficially similar to the widespread shrub *Platysace valida*.



Location of *Prostanthera clotteniana* - red star

3.7 What is Translocation?

Translocation is the deliberate removal of a living plant or reproductive material such as root stock or even parts of the soil seed bank from where it originally and naturally grew. The plant or reproductive material is relocated to a suitable recipient site at which the specimen or material is replanted or positioned until it can survive or regenerate in the wild without further assistance or intervention (Vallee *et al*., 2004).

Not all plants can be successfully translocated; and therefore, notes and guidelines in this Translocation Plan also refer to techniques involving forms of propagation such as cuttings and germinating seeds. These are included as part of an overall enhancement program for conservation significant plants.

3.8 Threatened Plants Requiring Translocation

The threatened plant species listed in **Table 3** will be directly impacted by construction works and will require some form of translocation where there is a reasonable chance of the plants surviving; or an alternative method of reproducing the species as part of the translocation program.

Note: *Acacia purpureopetala*, *Melaleuca uxorum* and *Prostanthera clotteniana* will not be directly impacted and can be avoided and protected by the designated of a 30 m separation buffer zone of intact vegetation around the respective populations (see Threatened Plants Management Plan).

Table 3. Threatened plants requiring translocation.

Threatened Species	Direct Impact	Mitigation
Grevillea glossadenia (no common name)	Clearing of individuals for establishment of tracks and WTG pads.	Translocation: transplant seedlings, nursery propagation of seed, direct-seeding, brush matting, topsoil relocation.
Homoranthus porteri (no common name)	Clearing of thickets along narrow ridge for establishment of tracks. Clearing of individuals at WTG pad locations.	Translocation: topsoil relocation, brush matting. Trial nursery propagation of cuttings and seed germination. Potential to trial rootstock relocation - probably best under controlled conditions in short-term to test viability of method.
Plectranthus amoenus (Plectranthus)	Clearing of individuals on rock pavements for establishment of WTG pads. Isolated clearing of individual/s for track on narrow ridge.	Translocation: relocate whole individual plants onto adjacent, undisturbed rock pavement areas. Supplementary propagation from cuttings to incorporate into adjacent rehabilitation areas.

Alternative translocation methods should consider relocating fresh topsoil which holds the seed bank reserve; nursery propagation by cuttings or seed germination under controlled conditions; direct-seeding and brush matting as part of the rehabilitation program; or transplanting excavated rootstock of threatened species.

Transplanting rootstock material is likely to require ideal ground conditions, very quick translocation times, and regular maintenance - this method could be the least effective and less practicable approach to re-establishing threatened plants into a recipient site, and is probably better suited to short-term translocation trials under controlled conditions.

3.9 Ecological Considerations

3.9.1 *Plant survival: obligate seeders and resprouters*

Plant regeneration in sclerophyll communities (woodlands and heathlands) can occur in distinct forms. Some plants regenerate after fire for example, by producing new shoots from protected underground stems and roots - these are termed obligate resprouters. Another common mechanism for plant reproduction in the wild is where new generations are produced from seeds.

The seeds of some species are stored in the canopy and held temporarily in capsules or follicles (canopy seed bank), and others release seed which is then stored in the soil (soil seed bank). This groups of plants are termed obligate seeders. A third survival trait of post-fire survival in sclerophyll montane vegetation are plants which are termed facultative seeders. This group resprouts after fire as well as recruits heavily from seed.

Tropical montane heath - where the greatest proportion of threatened plants naturally occur on the wind farm - holds a high percentage of obligate seeders; therefore, the soil seed bank reserve is an important component of the ecosystem to consider when applying different translocation and rehabilitation methods.

3.9.2 *Effects of fire*

Short fire-cycles in heath ecosystems have a detrimental effect on the abundance and distribution of obligate seeders in heath vegetation (Price *et al*., 2003; Dyer *et al*., 2001; Vlok and Yeaton, 2000).

Clarke *et al*. (2009) suggest fire intervals of less than five years have a profound effect of killing resprouting juvenile plants and can have a detrimental effect on seed bank reserves in the soil. Therefore, fire should be excluded from all translocation and rehabilitation sites for a minimum of five years from the time of initial plant establishment.

The reproductive and survival traits of the conservation significant plants on the Mount Emerald Wind Farm Site are summarised in **Table 4**. The mechanisms for reproduction or survival have important relevance when considering how a particular species is best translocated, or which method is likely to result in the most successful translocation outcome.

Table 4. Post-fire survival traits of threatened plants on the Mount Emerald Wind Farm.

Name	Typical habitat	Post-fire survival
Acacia purpureopetala Purple-flowering Wattle	Rhyolite ridge with low, stunted shrubland and mixed thickets of Homoranthus porteri and *Acacia aulacocarpa* with *Pseudanthus ligulatus* and *Grevillea glossadenia*. Grasses are more or less absent.	Obligate seeder (?). May also reproduce/survive through resprouting from semi-underground perennating stems.
Grevillea glossadenia No common name	Edge of woodlands and on exposed hills and ridges. *Eucalyptus lockyeri* is usually an associated species.	Obligate seeder. Seeds germinate en masse after fire kills adult shrubs. Seed germination may also be triggered by soil disturbance.
Homoranthus porteri No common name	Typical habitat is on fire-protected rock pavements or very rocky sites with very sparse, short grass cover (*Tripogon loliiformis*, *Eriachne humilis*, *Aristida* sp).	Obligate seeder / facultative seeder (?).
Melaleuca uxorum No common name	Montane heathlands on vegetated rock pavements and stony ridges. Population described here is on edge of low, windswept woodland dominated by *Eucalyptus lockyeri*.	Obligate resprouter after fire with capacity to regenerate from seed in absence of fire event after seed release (facultative seeder).
Plectranthus amoenus Plectranthus	Rock pavements or their edges. Invariably grows on very shallow soil accumulated in crevices or surface scoops. Soil made up of weathered rhyolite, decomposing rock ferns (*Cheilanthes* spp.), mosses and lichens.	Not known. Possibly obligate seeder and semi-obligate resprouter from rhizomes. Fleshy stems and roots adapted for moisture storage and regeneration after above ground plant parts are desiccated.
Prostanthera clotteniana Mint Bush	Semi-fireproof niche on rocky soils usually above cliff faces and very rocky zones where effect of fire is limited by low fuel loads. Potentially with a south-east aspect (pers. comm. B. Wannan). Exposed ridge tops with stunted *Eucalyptus lockyeri*, *Xanthorrhoea johnsonii* and very sparse grass cover of *Themeda triandra* and *Cymbopogon bombycinus*.	Obligate seeder. Fire-sensitive - fire kills plants. Regeneration from soil seed bank. Excessive fire frequency and intensity will kill soil seed bank reserves and lead to population decline.

4.0 TRANSLOCATION OF THREATENED PLANTS

4.1 Avoidance of Direct Impacts

The requirement for re-establishing threatened plants assumes direct impacts to the species cannot be avoided, and consequently a number of individuals will be cleared during construction; whereby a selection of the cleared plants would be candidates for translocation.

Translocation, particularly the removal of living plant from their natural habitat, is to be considered as a last option.

Complete avoidance of impacts to populations of highly threatened plants is to be considered as a priority. In terms of rarity on the wind farm site, *Acacia purpureopetala*, *Melaleuca uxorum* and *Prostanthera clotteniana* are exceptionally rare species and are represented in the vicinity of proposed construction works by very small, single populations in isolated locations.

Sensible positioning of tracks which maintain an undisturbed, natural buffer of 30 m from the populations of *A. purpureopetala*, *M. uxorum* and *P. clotteniana* is recommended in the Threatened Plants Management Plan prepared for the wind farm.

4.2 Practicality of Translocation

Some threatened species may not respond well to translocation. There is a limited knowledge of the physiological growth requirements of plants from high elevation habitats such as heathland on the Mount Emerald Wind Farm.

Factors such as thin skeletal soils, low fertility, long periods of dry and exposure to wind and solar radiation contribute to a harsh environment not well-suited to re-planting recently disturbed plants.

Species such as *Homoranthus porteri*, *Melaleuca uxorum* and possibly *Acacia purpureopetala* have specialised roots systems which are adapted to harsh soil environments. *Prostanthera clotteniana* is sensitive to fire and relies on regeneration from seed. Hence, the species invariably grows in situations where surface rocks, cliff faces and ravines provide a partially fire-protected habitat. *Grevillea glossadenia* has been observed to have mass germination events following fire, where numerous seedlings of a similar age group (size) emerge around parent plants (obligate seeder).

This response to fire disturbance indicates the soil seed bank reserve is important for the regeneration of this species, and adult plants of *G. glossadenia* may not respond well to being translocated.

4.3 Translocation Methods

A range of methods for re-establishing each threatened species should be considered before translocating. For example, additional to translocating a plant, propagating from seeds is likely to result in more viable plant stock able to survive in the wild than a translocated specimen.

Seedling stock also has the benefit of being able to be incorporated into rehabilitation areas adjacent to the site where the translocated specimen originally grew. Other methods of propagation, such as cuttings should also be considered. A range of possible methods is summarised in **Table 5**.

Table 5. Outline of methods for re-establishing threatened plants.

Name	Frequency on site	Mitigation priority	Methods of re-establishment (if required)
Acacia purpureopetala Purple-flowering Wattle	Exceptionally rare	**1. Avoidance** 2. Re-establish	1. Propagate from seed. 2. Translocate seedlings. 3. Re-spread topsoil and finer grade rock spoil from disturbance site.
Grevillea glossadenia No common name	Very common	1. Re-establish	1. Translocate seedlings. 2. Propagate from seed. 3. Re-spread topsoil and finer grade rock spoil from disturbance site. 4. Brush-matting during rehabilitation.
Homoranthus porteri No common name	Locally common	1. Re-establish	1. Translocate seedlings and rootstock. 2. Re-spread topsoil and finer grade rock spoil from disturbance site. 3. Brush-matting during rehabilitation. 4. Propagate seed. 5. Propagate from cuttings.
Melaleuca uxorum No common name	Exceptionally rare	**1. Avoidance** 2. Re-establish	1. Propagate from seed. 2. Re-spread topsoil and finer grade rock spoil from disturbance site. 3. Brush-matting during rehabilitation. 4. Translocate rootstock.
Plectranthus amoenus Plectranthus	Locally common	1. Re-establish	1. Translocate adult and juvenile plants. 2. Propagate from cuttings (stem and root).
Prostanthera clotteniana Mint Bush	Exceptionally rare	**1. Avoidance** 2. Re-establish	1. Propagate from cuttings and seed. 2. Translocate seedlings and rootstock. 3. Re-spread topsoil and finer grade rock spoil from disturbance site. 4. Brush-matting during rehabilitation.

4.4 Selecting Recipient Translocation Sites

Translocation of threatened plants is likely to result in higher rates of survival if specimens are translocated into sites close to where they were originally growing. It is crucial to select a recipient translocation site with closely matched key environmental characteristics such as geology, landform, aspect, altitude and vegetation in order to maximise the chances of success. Therefore, it is easier and probably more practical to translocate plants directly into the undisturbed land adjacent to the clearing footprint, where most of the environmental features mentioned above are present.

4.5 Site Preparation

All translocation recipient sites have the potential to be remnant vegetation on undisturbed landforms and immediately adjacent to the disturbance footprint from where translocated specimens will be taken. This has significant advantages over selecting *ex-situ* recipient sites which may differ considerably in terms of habitat characteristics such as drainage, soil composition and mycorrhyzal activity, vegetation cover, elevation, aspect and exposure.

The key to site preparation, although minimal when selecting recipient sites with remnant vegetation cover over natural landforms is ecological feature matching and ensuring the natural features of the original site are replicated as closely as possible.

The soil medium is a critical aspect of translocation as well as rehabilitation. It is important to characterise the soil substrate at the original site where a translocation candidate originally grows and match the soil conditions and characteristics as closely as possible to the recipient translocation site. This will be crucial for species such as *Plectranthus amoenus*, which only grows naturally in thin pockets or crevices of accumulated peat-like soil on or around rock pavements. In this instance, adequate quantities of matched soil medium will need to be gathered or be available at the recipient site in order to receive translocated specimens of *P. amoenus*.

4.6 Timing of Translocation

It is difficult to give prescriptive timeframes for the translocation of plants because each translocation event will be linked to the time of site disturbance or prior to the disturbance event if adequate lead-in time is allocated.

Candidates for translocation will need to be identified prior to clearing tracks and WTG construction pads, and the most practical method of achieving this is by undertaking pre-clearance surveys ideally several weeks beforehand. Last minute, unplanned approaches to translocation will lead to less successful outcomes.

The success of actual plant translocation will also depend largely on the timing of removal of the plant from the original site and the time at which it is physically transferred to the recipient translocation site. This includes the time and prevailing weather conditions at the time of removal, plus the interval between taking a specimen from its natural location and transferring it to the recipient translocation site.

Times of heavy rainfall should be avoided due to obvious erosion issues; however, times of prolonged dry weather should also be avoided as no follow-up rain will be available to sustain the translocated specimens in the early establishment phase. In this regard, translocation of living plants during late March onwards to July might be considered an appropriate time. Observing the prevailing weather patterns will provide the most accurate means of determining appropriate timing, keeping in mind the necessity for longer-term soil moisture availability.

Potential translocation site for *Plectranthus amoenus* on rock pavement.

5.0 THREATENED SPECIES TRANSLOCATION

5.1 *Acacia purpureopetala* (Purple-flowering Wattle)

PRIORITY: Disturbance to the population of this species of approximately 18 plants should be avoided by a minimum 30 m buffer. The following propagation notes are intended as a guide for consideration of increasing the population size of *Acacia purpureopetala* adjacent to its natural location on the wind farm.

The primary method for propagating *Acacia purpureopetala*, like most wattles (Simmons, 1987) is from seed. Seed should be treated by pouring boiling water over the seeds placed in a bowl and leaving for 24 hours. The treated seeds are then sown into a sandy germinating mix (approximately 4 parts washed river sand to 1 part peat). If algae develops on the surface of the tray, reduce the quantity of peat.

A. purpureopetala seeds germinate reasonably successfully, but are susceptible to damping off by fungal disease (*Pythium* spp.), and are subsequently a difficult species to grow onto a seedling size suitable for planting out into recipient sites (S. De Ridder† pers. comm.).

Application of a preventative fungicide such as Previcur® (Propamocarb 600g/L) to reduce damping off is recommended as a pre-emergence and post-germination treatment; and should be used as part of an integrated approach to the protective hygiene environment of a plant nursery.

Planting treated seeds into a specifically prepared area of ground may prove successful and should be considered as a trial method. Given the very small area of occupancy of *A. purpureopetala* on the wind farm site, the only viable site which meets strict habitat similarities for trialling this method is located approximately half way along the ridge between WTG 30 and 31, where the species naturally occurs under a mixed thicket of *Homoranthus porteri* and *Acacia aulacocarpa*.

5.2 *Grevillea glossadenia* (no common name)

Grevillea glossadenia is an obligate seeder. After a fire event, the adult plants die and when conditions are suitable in the soil, seeds germinate. There is a tendency for mass germination of this species, where numerous seedlings of the same age group (judging by the height evenness of the juvenile plants) are commonly seen growing around fire-killed adult plants. Disturbance of soil may also be a trigger for seed germination of the species, and in some situations, many seedlings can be seen growing on turned over soil and rock spoil adjacent to tracks and where machinery has operated.

Grevillea glossadenia produces reasonable crops of seed and it is expected these should have moderate germination rates. Sked (1998) trialled a method of pre-germinating *G. glossadenia* seeds in plastic bags using peat moss as a germination medium and then sealing the bag. Success rates of 70% were achieved but only using a sample base of 10 seeds. With this method, seeds were initially nicked with a razor blade and allowed to germinate to the stage where the first roots emerge, at which time they are potted into a suitable container and grown-on in a controlled nursery environment.

Translocating seedlings from the wild is possible. Seedlings are likely to have a higher chance of translocation survival if taken when they are relatively small - approximately 5 cm tall (S. Gleed pers. obs.). The larger the seedling, the greater the root mass and hence the greater potential for root damage. Ten seedlings were collected in the field, wrapped in wet newspaper and stored in a zip-lock bag and then placed in a refrigerator overnight. The seedlings were transplanted into pots containing a proprietary potting mix three days after removal from the ground. Some natural residual leaf litter and soil matter from the collection site was mixed into the potting mix with the intention of transferring "native" soil bacteria and mycorrhiza fungus.

Although slow to stabilise, 4 seedlings survived and actively produced new, healthy leaf shoots. It is expected higher success rates could be achieved by adopting a quicker turnaround between field collection and transplanting. Collecting seedlings from the wild when the soil moisture is fully moist would also increase survival rates of translocated specimens.

Direct-seeding of *G. glossadenia* is a possibility with reasonable chances of establishment, given the species readily grows in some areas of track spoil, suggesting disturbance may be a factor in triggering seed germination. The seeds of *G. glossadenia* are of a size which appear to be amenable to broadcasting in multi-species seed mixes. For example, the species could be incorporated into mixed seed mixes which include *Acacia calyculata* - one of the commonest wattles growing in association with *G. glossadenia*. This seed mix would ideally be suited to application on track edges and around WTG pads.

5.3 *Homoranthus porteri* (no common name)

Homoranthus porteri is possibly an obligate seeder. It is invariably found growing on rock pavements and areas protected from fire by expanses of rock or in rocky scree slopes where flammable plant matter is limited (e.g. grasses are poorly represented due to absence of soil substrate).

The seed of *H. porteri* is probably difficult to collect, and if plants are encountered in flower and fruit during clearing, then opportunities should be taken to include cleared plant material as brush matting with the expectation that a least some seed matter could get included into a recipient translocation site.

Transfer of the soil seed bank from cleared ridge caps and rock pavement areas where tracks are proposed is another option worthy of trialling. Given the potential for the species to be an obligate seeder, the soil seed bank may hold important reserves of genetic material of the species which should be included in translocation efforts.

Reproduction of plants could be undertaken from cuttings grown in a controlled nursery environment, where the advanced cuttings are further planted out into translocation sites and rehabilitation areas adjacent to the original clearing zone.

5.4 *Melaleuca uxorum* (no common name)

PRIORITY: Disturbance to the population of this species of approximately 45 plants is to be avoided by a minimum 30 m buffer. The following propagation notes are intended as a guide for consideration of increasing the population size of *Melaleuca uxorum* adjacent to its natural location on the wind farm.

Melaleuca uxorum is likely to produce reasonable supplies of seed. The dry fruit capsules are tightly grouped on the upper branches and could easily be collected at the appropriate time and stored in paper bags until the seed is released. To maximise germination success, seed should be sown when it is fresh.

Seed could be germinated in trays and the seedlings potted-up then subsequently planted into recipient sites adjacent to the original population location; or the seed could be incorporated into direct-seeding mixes and applied to rehabilitation areas adjacent to the existing population.

5.5 *Plectranthus amoenus* (Plectranthus)

Plectranthus amoenus is a semi-succulent, partially erect plant, which has the potential to be successfully translocated. The propagation of this group of plants is regarded as being relatively easy; and possibly due to the stout, semi-fleshy stems which can store water and nutrients and allow the plant to survive periods of harsh climatic conditions such as drought and water deficit.

Plectranthus amoenus should be able to be successfully grown from stem or leaf cuttings, and possibly from the division of the roots. These are probably the most viable methods of reproducing the plant compared with growing from seed, as the seed of *Plectranthus* is small and difficult to collect.

Living plants of *P. amoenus* at most stages of growth (juvenile to adult) are likely to be successfully translocated as a whole plant. Selection of a recipient translocation site is important, as the species is almost entirely restricted to growing on rock pavements or around the base of these features. Because of this limited habitat resource, translocated specimens of *P. amoenus* are recommended to be translocated onto very similar rock features in the vicinity of the originally collection site. These plants are not suitable for transplanting into neighbouring woodlands of eucalypts or wattles.

The specific planting sites within the broader translocation site should be selected prior to removal of the specimen from the original location. The actual location where the translocated specimen is to be positioned must consider the general shallow nature of the soil, and therefore translocation sites in rock cracks and fissures as well as scoops on rock pavement surfaces are potentially suitable.

When translocating *P. amoenus*, the specimen should be carefully removed as an entire plant with as much of the soil medium taken with the plant as is available around the roots. Removal of the plant from its original location should ideally occur when the soil is moist. If no soil moisture is available at the time of translocation, then the whole plant and surrounding soil medium should be watered prior to removing the plant.

Hessian sacks which have been soaked in water are useful when moving a plant and its roots to a new site. The sack is used to wrap up and protect the root ball when the plant is in transit to the recipient translocation site. The aim is to prevent fine root hairs from drying out during the transfer.

If the recipient translocation site, which will be a rock pavement or similarly soilless site, has very limited supplies of "soil", then as much suitable soil medium where *P. amoenus* grows at the original site should be recovered and moved and placed at the recipient site in readiness for receiving the translocated specimens. Generally, this soil medium will have the texture and structure of peat. It is dark (almost black) and comprises decomposed rock ferns (*Cheilanthes* spp.), crustose and fructose lichens, mosses and weathered rhyolite particles and maybe some leaves. Following rain, this soil medium holds water and is spongy, but completely dries out after prolonged periods of dry.

The translocated specimen should be located in a similar surface feature (rock crack, fissure or scoop) as the original site. Translocated specimens of *Plectranthus* will need to be "stabilised" in the short-term and until an adequate root system has developed and keyed the plant into the new site. To assist with retaining the shallow soil medium and holding the specimen in place, it is recommended to place small rocks around and over the root ball. Small rocks can also be hand-placed around the translocation area to act as capture points to assist with the generation of soil over time.

Post-translocation management should include preventing weeds, particularly Praxelis (*Praxelis clematidea*), from establishing in the limited soil resources on rock pavements. Excessive colonisation of Praxelis will prevent natural recruitment of rock ferns and lichens, which in turn will reduce the integrity of a healthy soil environment.

The fleshy nature of *Plectranthus* plant stems and leaves renders this group susceptible to uptake of herbicide. Because native rock ferns, lichens and mosses are a critical component of the skeletal soil that develops in small capture points on rock pavements, the use of herbicide to control weeds is not

recommended as it would be almost impossible to avoid off-target application to the native plant component. Regular inspections of rock pavement translocation sites should be made and manual removal of herbaceous weeds such as Praxelis undertaken as part of the inspection.

5.6 *Prostanthera clotteniana* (Mint Bush)

PRIORITY: Disturbance to the population of this species of approximately 35 plants is to be avoided by a minimum 30 m buffer. The following propagation notes are intended as a guide for consideration of increasing the population size of *Prostanthera clotteniana* adjacent to its natural location on the wind farm.

Prostanthera clotteniana will possibly be a difficult species to propagate. Translocation of seedlings into containers and on-grown in a controlled nursery environment may prove more successful than translocation of seedlings directly into a recipient site.

Seed is apparently difficult to collect; however, when opportunities become available, attempts should be made to collect seed of the species from the sites' population. Given the rarity of this species, seed germination trials under controlled nursery conditions are recommended over applying the seed through direct-seeding.

The genus *Prostanthera* is known to be successfully propagated from cuttings (Australian Native Plants Society, 2006).

Prostanthera clotteniana has been grown from cuttings collected from the Baal Gammon mine site area between Herberton and Watsonville, and the resultant plants successfully established in an arboretum in New South Wales (written correspondence sighted from George Althofer† to James McDonald†).

If enhancement of the existing population of *P. clotteniana* on the wind farm site is to be considered, then propagation by cuttings in a nursery environment and subsequently planting out hardened cutting-grown plants into a recipient site adjacent to the current population of the species is likely to yield the most productive results.

Nursery propagated cutting of *Prostanthera clotteniana* in sandy, free-draining mix.

6.0 POST-TRANSLOCATION MAINTENANCE

6.1 Watering

Initial, early stage watering of individual translocated specimens may be required; but should only be undertaken when absolutely necessary. Translocated plants should be promoted to be able to cope and survive under extreme conditions of water shortage, high solar radiation and high daytime temperatures.

Incidences of plant mortality of translocated specimens could be attributable to a number of factors such as root desiccation, unsuccessful root development and keying into shallow substrates, or severe water shortage. One of the main factors is likely to be the link between mortality to the quantity and depth of soil around the roots. Each situation will need to be investigated and appropriate action taken as required.

6.2 Mulching

Introduced mulch (e.g. hay) from external sources is not permitted as part of the translocation program or rehabilitation works due to the risk of introducing disease and weeds into the site. If naturally occurring and suitable mulching products such as leaf litter, spongy soil or matted native grasses are available from the adjacent area being cleared and where the translocated specimen/s is being extracted, then these can be incorporated around the translocated specimen in the recipient site. If weeds are present in the original mulch product, then it is not be used.

Experimentation using exfoliated rock plates and small slabs of rhyolite around translocated plants (rock mulching) may prove to be useful in reducing evaporation of water and helping prolong the retention of limited soil moisture reserves. For recipient sites on rock pavements, it is critical to ensure the roots of the translocated specimens are sufficiently protected by a layer of naturally occurring soil medium, which has some capacity to retain water. If rock mulching is deemed suitable on a site-by-site basis, then it should be trialled wherever practicable.

6.3 Fertilising

It is not recommended to apply fertiliser at any stage of the translocation, as all the threatened plants on the Mount Emerald Wind Farm have adapted to extremely harsh environments depleted of soil fertility.

The use of slow release fertilisers for propagated plants under a controlled nursery environment is permitted. In the event that fertilising translocated plants is deemed an appropriate addition to the methodology to improve establishment rates and overall translocation success without detriment to the surrounding native environment and its flora, then the use of fertiliser may be permitted as an adaptive management approach.

6.4 Weed Control

If weeds are detected in the recipient translocation site, manual removal is recommended at the earliest possible stage after detection. Early detection and prevention of weeds as directed in the Mount Emerald Weed Management Plan (Gleed, 2016c) is the primary management measure. Care should be taken not to transfer weeds from the original site to the recipient translocation site.

If threatened plants are translocated into rehabilitation sites where limited herbicide application may be permitted according to the circumstances, then care should be exercised in avoiding off-target application where native pants regardless of conservation status are damaged or killed.

The herbaceous weed Praxelis (*Praxelis clematidea*) can become problematic around disturbed rocky soil on the wind farm site. This species - a daisy - readily establishes under suitable disturbed ground conditions because of its wind-dispersed seed. It is one of the few weeds, along with Red Natal Grass (*Melinis repens*) able to infiltrate remote remnant vegetation areas on the site.

Praxelis and Red Natal Grass pose a threat to the successful establishment and long-term health of populations of translocated *Plectranthus amoenus* plants. *P. amoenus*, because of its fleshy stems and leaves, is particularly susceptible to uptake of herbicides and therefore if this herbaceous plant is used as a translocation species in rehabilitation areas, manual removal of Praxelis and Red Natal Grass is recommended.

Praxelis (*Praxelis clematidea*) is a noxious weed which has the potential to quickly colonise disturbed rocky soil sites on the wind farm and adversely affect the success of translocation of threatened plants.

6.5 Fire Management

Fire must be excluded from the recipient translocation sites for a minimum of 5 years from the date of the original translocation event.

6.6 Plant Mortality

Plant mortality of translocated specimens is expected given the difficult growing conditions present in the high elevation areas of the wind farm site. If plant mortality is high for a particular threatened species, then the factors contributing to the decline should be investigated as part of the monitoring schedule.

Different approaches of ameliorative and supplementary translocation techniques should be considered for widespread mortality; or if the cause can be remedied, then corrective action taken accordingly (e.g. instigating an interim irrigation/watering schedule). Long-term amelioration is not recommend as successfully translocated plants should be able to survive and reproduce unassisted and without intervention.

7.0 TRANSLOCATION TRIALS

7.1 Translocation Trial Sites

Additional to selecting primary recipient translocation sites adjacent to the original disturbance footprint within the wind farm, it is recommended to set-up translocation trial plots close to permanent wind farm building facilities or nearby areas, so regular monitoring of trials can occur. Close-by access to utilities such as fresh water and electricity will facilitate applying different experimental approaches, but are not strategically essential.

Trial plots allow for a range of conditions and translocation methods to be monitored, which in the longer-term could yield useful and practical information in regard to the management and conservation of threatened plants on the wind farm site. Trials also facilitate the review of the techniques and practices used during translocation elsewhere on the site and can identify successful as well as unsuccessful methods.

Trial sites should be selected on the basis of physical features which are represented in threatened plant habitats. It may be difficult to find these exact features close to built infrastructure on the wind farm, and sites taking in ridge topography and similar geological characteristics may have to be chosen for trialling the translocation of some threatened plants.

Areas close to WTG 34 and also around the tall wind monitoring tower between WTG's 17 and 18 could be suitable translocation trial sites - the latter site particularly suited to experimental design for translocation or growing-on of seedlings of *Grevillea glossadenia*, *Melaleuca uxorum* and *Prostanthera clotteniana* (*M. uxorum* and *P. clotteniana* do not require physical translocation of *in-situ* living plants - these are to be avoided and protected).

All trial sites should be clearly and permanently demarcated with star pickets at their boundaries or corners. The features of each site should be recorded and should include detailed vegetation and floristic information, geological and landform descriptions, as well as spatial data such as location and altitude. It is important to record the 'baseline' condition of the site - whether the vegetation cover is remnant or modified, and its proximity to previously disturbed areas such as tracks or small clearings.

7.2 Translocation Trials

This is the experimental aspect of translocation and is not a substitute for timely and active translocation of impacted specimens which is to be carried out during the construction stage. Translocations trials should consider the issues and difficulties encountered during the active translocation process and take opportunities to trial methods that could otherwise be unachievable or impractical whilst construction is underway.

For example, earthworks during construction will expose large areas of ridge top and root mass of habitat-specific vegetation (montane heath and shrublands). In this situation there will be good opportunities to harvest exposed roots and plant stumps, store and protect them appropriately in the short-term, and then experiment with re-burial of rootstock into the trial site.

The example outlined above is one of many possibilities, and the practicalities and worth of trialling different translocation methods will become clearer as the wind farm project develops and the results of monitoring identify areas for further investigation or improvement.

Broad translocation concepts for consideration of trialling and experimentation can include but not limited to the following:

- Translocating topsoil and seed banks. Viability and soil storage times. Species germination.
- Direct-seeding: species selection, seed treatments and additives/carriers.
- Brush matting: seed release from harvested shrubs, partially burial or incorporation into uppermost soil horizon.
- Re-creating micro-habitats and niche environments for narrowly restricted and habitat specific species such as *Homoranthus porteri*, *Plectranthus amoenus* and *Acacia purpureopetala*. Can the development of lithosols and soil veneers be accelerated?
- Translocating rootstock, excavated stumps and underground plant parts.

Large-class sentinel Cypress Pine trees (*Callitris intratropica*) are not listed as conservation significant. They are however important trees in the wind farm landscape and are susceptible to fire. Cypress Pines typically grow on or around rock pavements - a fire-protected niche and the specific habitat for the threatened *Plectranthus amoenus* and other rare plants on the Mount Emerald Wind Farm site.

8.0 MONITORING

Successfully translocated plants are able to survive in the recipient site without assistance from irrigation, fertilising, or other human-derived maintenance events after they have become established. Other indicators of successful translocation and plant establishment are the production of flowers, fruits and consequently, new generations of plants originating from the translocated parent plants.

A specific monitoring plan is not proposed for this Translocation Plan because of the integration of this plan with other specifically prepared environmental plans for the Mount Emerald Wind Farm. To avoid duplication of data, it is recommended to undertake monitoring and associated periodic reporting in tandem and accordance with the monitoring protocols and guidelines prepared separately in the Threatened Plants Management Plan and the Rehabilitation Plan.

Key data and information which must be included and incorporated into the monitoring schedule for this plan and the associated Threatened Plants Management Plan and the Rehabilitation Plan are summarised in **Table 6**.

Note, some rehabilitation sites and adjacent areas of remnant intact vegetation will have similar data (coordinates, vegetation, etc). In this situation it is important to additionally record whether a translocation site is associated or adjacent to a rehabilitation site or threatened plant management site: hence, use the site identifier prefix of TR (translocation) for example in the site identifier name.

Table 6. Key monitoring data and information required to inform the Translocation Plan.

Parameter	Description
Location of translocation sites	GPS location of each translocation site: datum, GDA94, elevation, UTM coordinates. Note of GPS accuracy if atypically >±10 m.
Site ID	Unique and consecutively running site name (e.g. TR001, TR002, TR003 etc).
WTG ID	Nearest WTG.
Geology/topography	Description of topography and geological features including soil. For example, narrow ridge, rock pavement, peat-like soil only in rock crevices.
Vegetation description of recipient site	Detailed stratified vegetation description of all plant species in all layers.
Species translocated	Botanical name of threatened species, plus any non-threatened species which may have been translocated (e.g. Grevillea glossadenia, *Xanthorrhoea johnsonii*).
Origin of translocated specimens	GPS coordinates of the location/s where the specimens were originally growing. For grouped specimens such as a stand of *Grevillea glossadenia*, a central coordinate is sufficient.
Number of specimens translocated	The number of individuals translocated.
Methods of translocation	Method/s used for translocating each species, including additional ameliorative maintenance measures such as mulching and irrigation.
Growth stage and status of translocated specimen/s	What was translocated: seedlings (10 cm tall), whole adult plants, root stock. Were the translocated specimens flowering or fruiting at time of translocation? General health of specimens.
Date of translocation	The date of each translocation event.
Weather	Prevailing weather conditions at the time of translocation.
Names of person/s undertaking translocation	Names of person/s undertaking translocation.

Parameter	Description
Photographic monitoring	Photos taken of whole site, individuals (close-up) at time of translocation and every two weeks thereafter during the establishment stage. Once established and actively growing and producing new shoots or stem growth, then photograph periodically every 3 months.
Phenology	Record date of first new leaf flush event after translocation, production of flowers and fruits, and mortality (if applicable).
Mortality date	Record date of first incidence of mortality and consequent dates thereafter if further plant losses are observed.
Reason for mortality	Assessment of possible causes of mortality: disease, drought-water deficit, desiccation-sunburn, insect damage, eroded from site (washed out during rainfall), animal grubbing/rooting, fire etc.
Disturbance to translocation site and adjacent areas	Record type of disturbance and date. For example, fire, animal damage, vehicle damage, off-target herbicide application, insect damage, herbivory, disease.

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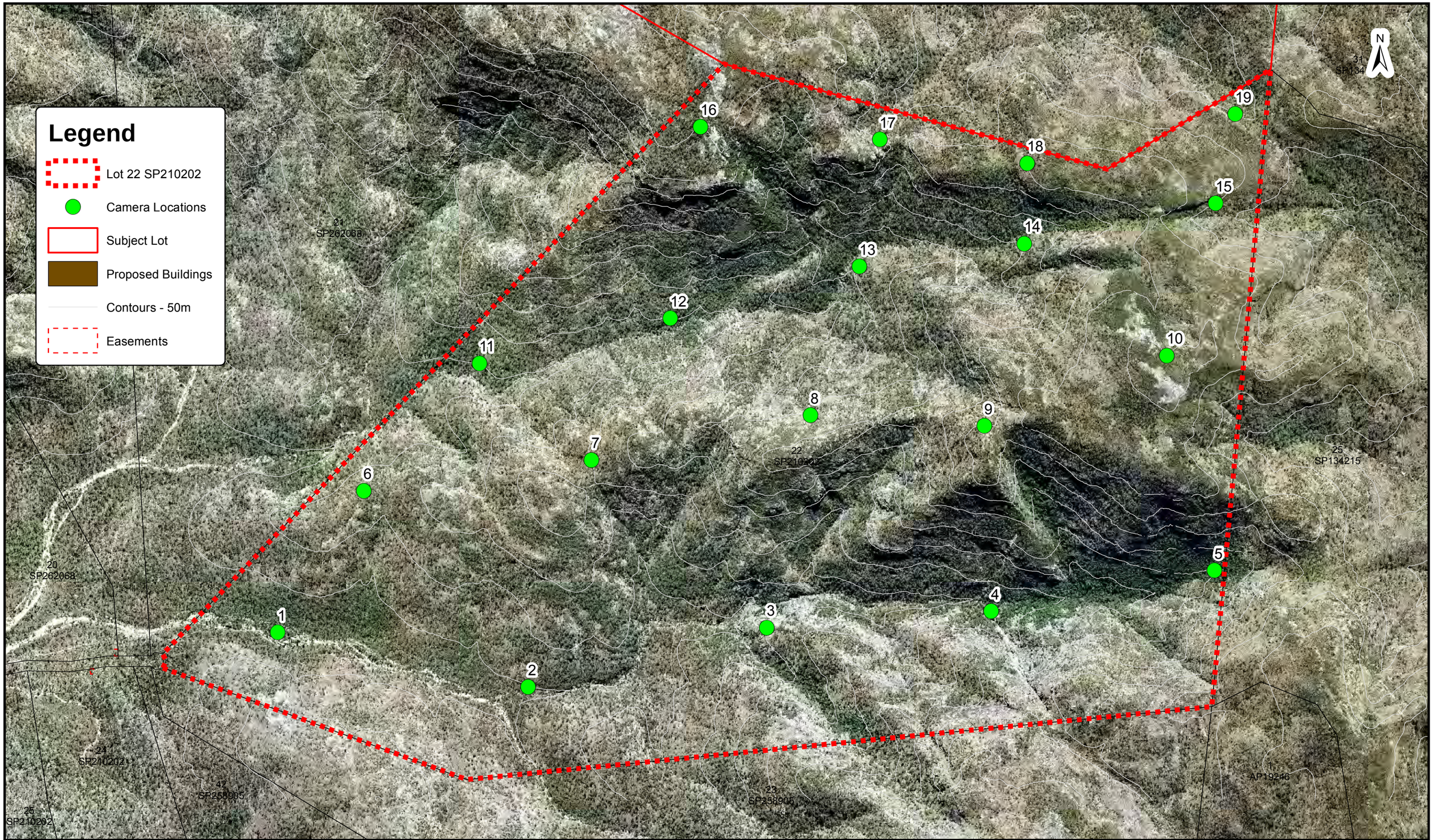
Appendix C

Quoll Survey Sites



0 80 160 240 320 400 480

Meters (A3)

Project Manager	M. Jess
Compiled by	RMS
Map Projection	MGAz55
Map Datum	GDA94
File Reference	PR132974-3.mxd
Sheet Number	1 of 1

Client: RACL

Title: Camera Trap Locations
Offset Lot 22 on SP210202

RPS Australia East Pty Ltd
ACN 140 292 762

135 Abbott St
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T +61 7 4031 1336
F +61 7 4031 2942
W rpsgroup.com.au

SCALE (A3)	DATE	DRAWING NO.	ISSUE
1:10,000	25/08/2016	PR132974-3	

Appendix D

Spectacled Flying-fox Potential Distribution

Legend

- Lot 22 SP210202
- Subject Lot
- Easements
- Endangered - Dominant vegetation
- Of Concern - Dominant
- No concern at present

N

21 SP262068

20 SP262068

22 SP210202

24 SP210202

25 SP210202

42 SP258905

23 SP258905

1 AP19246

25 SP134215

31 SP134

7.12.57c 7.12.57c 7.12.57c 7.12.57c 7.12.30d 7.12.30d 7.12.57c 7.12.57c 7.12.30d 7.12.29a 7.12.7c 7.12.26e 7.12.26e 7.12.29a 7.12.34 7.12.34 7.12.7c 7.12.57a 7.12.57a 7.12.26a 7.12.34 7.12.57c 7.12.57a 7.12.26e 7.12.26a 7.12.57a 7.12.30d 7.12.29a 7.12.26a 7.12.9 7.12.57c 7.12.30d 7.12.34 7.12.57a 7.12.16a 7.12.57c 7.12.57c 7.12.57c 7.3.26a 7.12.30d 7.12.30d 7.12.57c 7.12.30d 7.12.30d 7.12.30d 7.12.9 7.12.30d 7.12.30d 7.12.57c 7.12.57a

Total Lot Area: 434.9ha
Regional Ecosystems Area: 355.58ha
Remaining Area: 79.32ha

0 80 160 240 320 400 480
Meters (A3)

Project Manager	M. Jess
Compiled by	RMS
Map Projection	MGAz55
Map Datum	GDA94
File Reference	PR132974-5.mxd
Sheet Number	1 of 1

Client: RACL

Title: Regional Ecosystems
Potential Spectacled Flying Fox Habitat
Offset Lot 22 on SP210202

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SCALE (A3)	DATE	DRAWING NO.	ISSUE
1:10,000	27/09/2016	PR132974-5	

Appendix E

Acoustic Analysis Results

Green Tape Solutions

Quality, Integrity, Experience

Bat Call Analysis Report

Lot 22 Plan SP210202

Prepared for RPS Australia Pty Ltd

Prepared by:

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Client Manager: Kelly Matthews
Report Number: PR16088_BA_Ver2

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Document Records - Quality

DATE	6 October 2016
TITLE	Bat Analysis for the site at Mareeba Shire
AUTHOR/S	Kelly Matthews
REVIEW – QA	Adrian Cupitt
STATUS	Report_Version 1
FILED AS	PR16088_BA_Ver2

Table of Content

TABLES

FIGURES

1.0 Introduction

1.1 Background

An assessment on the likelihood of the presence of microbat species using four echolocation detectors (Songmeters SM2BAT) was conducted during an ecological survey at Lot 22 Plan SP210202. The site is located in Mutchilba, Mareeba Shire in Queensland.

1.2 Scope of Works

The specific scope of works for this report includes the following:

- Outline the methodology used to survey microbat species within the subject site;
- Analyse and provide an assessment of the likelihood of occurrence of threatened microbat species listed under State and Commonwealth legislation; and,
- Identify of local statutory considerations relevant to ecological aspects (relevant to bats) of the site.

2.0 Methodology

2.1 Capture

Data was collected over six nights from 30 August 2016 using four detectors (Songmeters SM2BAT). The original call files display Australian Eastern Standard Time. The majority of calls were considered to be of medium to good quality calls.

Data was received via an electronic transfer on 27th September 2016 and was analysed using Kaleidoscope Pro. In total, 2,244 call sequence files were received all of which 2,192 were marked as containing recognisable bat calls.

2.2 Call Identification

Call identification for this dataset was based on call keys and descriptions published for Queensland (Reinhold, 2001) and Northern Territory (PWCNT, 2002) with reference to descriptions for New South Wales (Pennay et al., 2004).

Species' identification was further refined using the probability of occurrence of each species based on their geographic distribution (Churchill, 2008, Van Dyck and Strahan, 2008). Species nomenclature used in this report follows Churchill (2008).

The reliability of identification is as follows:

- **Definite** - one or more calls where there is no doubt about the identification of the species;
- **Probable** - most likely to be the species named, low probability of confusion with species that use similar calls; and,
- **Possible -** call is comparable with the named species, with a moderate to high probability of confusion with species of similar calls.

2.3 Survey Limitations

The ability to detect call and accurately identify them to species level can vary greatly with the surrounding environment and the location of the echolocation device. The survey undertaken as part of this assessment only represents a ‘snapshot’ in time and therefore, may not provide a true indication of species presence at the site. Hence, this survey should not be regarded as conclusive evidence that certain protected microbats species do not occur at the site.

2.4 National Standard

The format and content of this report complies with the nationally accepted standards for the interpretation and reporting of Anabats and Songmeters data (Reardon, 2003), which is currently available from the Australasian Bat Society at www.ausbats.org.au.

3.0 Results

3.1 Total of Species Recorded

A total of 2,244 sequence files were submitted for bat analysis. A small proportion of these files (52) in this dataset contained background noise or resulted in poor quality calls that did not provide bat calls for analysis. While some call sequences were recognised as bat calls, the quality was not sufficient to assign species identification. These species have been recorded as "possible" in this report.

One ("010372") of the four SM2BAT detectors generated a large quantity of identifiable bat calls. The other three detectors apparently failed to record (presumably due to equipment malfunction rather than lack of bat activity). Sites represented, sampling dates and data extraction results are presented in **Table 1**.

A total of six (6) microbat species were definitely identified being present on site and an additional five (5) species were potentially recorded on site. One threatened species, *Saccolaimus saccolaimus,* listed under the *Nature Conservation Act 1992* as Endangered and under the *Environmental Protection and Biodiversity Act 1999* as Critically Endangered was probably recorded on site. This species could not be clearly identified due to the poor condition of the call, the similarity in call with sympatric species and overlap in their distribution. However, this species was recorded 500m away from the site and therefore, this species is considered highly likely to be present on site. A detailed assessment of the call recorded is provided in **Section 3.2.**

A summary of the species present on site is provided in **Table 1**.

Table 1: Summary of bat calls

Species	NC Act	EPBC Act	010372	010375	010379	010388
Miniopterus australis	Least Concern	Least Concern	Definite	N/A	N/A	N/A
Miniopterus orianae oceanensis	Least Concern	Least Concern	Definite	N/A	N/A	N/A
Mormopterus eleryi	Least Concern	Least Concern	Definite	N/A	N/A	N/A
Myotis macropus	Least Concern	Least Concern	Probable	N/A	N/A	N/A
Nyctophilus sp *- N. geoffroyi,* *- N. gouldi* *- N. bifax*	 Least Concern Least Concern Least Concern	 Least Concern Least Concern Least Concern	Probable	N/A	N/A	N/A
Rhinolophus megaphyllus	Least Concern	Least Concern	Definite	N/A	N/A	N/A
Saccolaimus flaviventris	Least Concern	Least Concern	Probable	N/A	N/A	N/A
Saccolaimus saccolaimus	Endangered	Critically Endangered	Possible	N/A	N/A	N/A
Taphozous troughtoni	Least Concern	Least Concern	Possible	N/A	N/A	N/A
Vespadelus troughtoni	Least Concern	Least Concern	Definite	N/A	N/A	N/A
Vespadelus pumilus	Least Concern	Least Concern	Definite	N/A	N/A	N/A

3.2 Analysis of the presence of *Saccolaimus saccolaimus*

The purpose of the bat survey was to identify the presence of *S. saccolaimus* on site. Characteristic call attributes of *S. saccolaimus* (PWCNT, 2002) include:

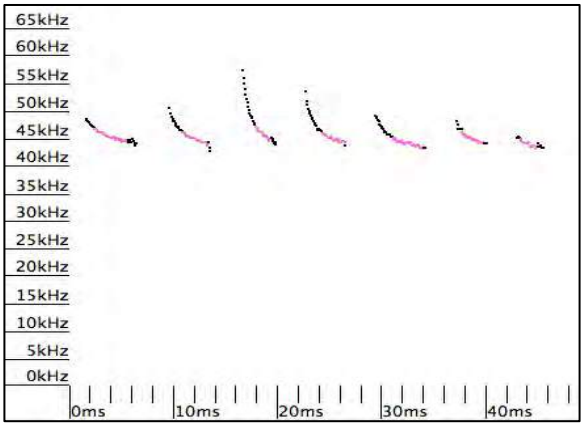
- A dominant harmonic with characteristic frequency around 22-25 kHz;
- At least 3 and up to five distinct harmonics at approximately 13 kHz intervals (1 below and up to 3 above the dominant harmonic); and
- Call pulses sometimes in "triplet" sets with pulse intervals of approximately 10-20ms between first and second pulses and 20-40ms between second and third pulses and an inter-triplet interval of about 80-100ms.

Only one sequence file was recorded that may be representative of *S. saccolaimus* and this call does not shown all the harmonic characteristics. Therefore, it was not possible to reliably separate this species from several sympatric species with similar call attributes (i.e. *T. troughtoni*). It is noted that *S. saccolaimus* was previously recorded 500m away from the site. Consequently, it is considered that *S. saccolaimus* is highly likely to occur on site.

3.3 Samples of Calls / Sequences Files

Samples of call extracted from the dataset for each species identified is provided in the following figures.

Figure 1: Definite *Miniopterus orianae oceanensis*

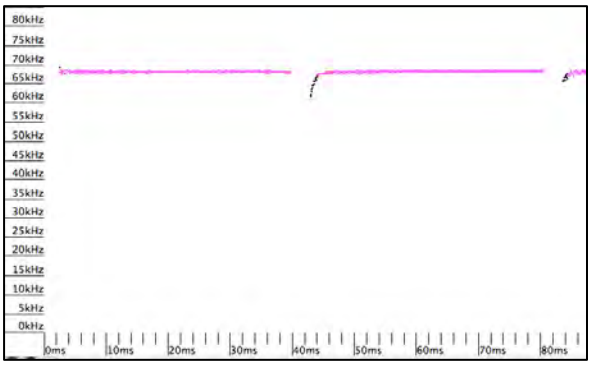


The species call is characterised by its relatively long curved pulse with a small down-sweeping tail and its frequency 43-47kHz (Reinhold, 2001).

Pulse shape and time between calls usually variable within a sequence.

This species had the second most number of calls recorded on site.

Figure 2: Definite *Rhinolophus megaphyllus*



The species call cannot be misidentified with any other species. Pulses have an up-sweeping initial section a perfectly flat, relatively long characteristic section and a down sweeping tail (Reinhold, 2001). Characteristic frequency ranges from 66 to 72 kHz.

Figure 3: Definite *Miniopterus australis*

This species displays a characteristic frequency between 54.5 – 64.5 kHz with a curved, usually down-sweeping tail (Pennay et al 2004). It overlaps in frequency with *Vespadelus pumilus* between 57 – 58 kHz but the latter exhibits curved up-sweeping tail.

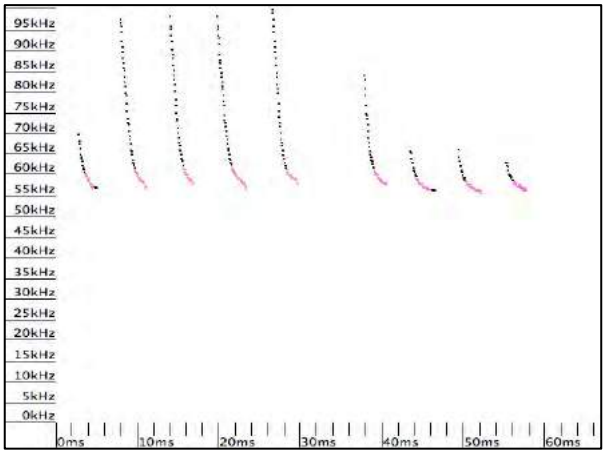


Figure 4: Probable *Vespadelus pumilus*

This species displays a characteristic frequency between 50 – 58 kHz and has a prominent up-sweeping tail (Pennay *et al*, 2004).

Calls of this species may be easily confused with *V. troughtoni,* unless the end frequency is higher than 54 kHz, which is representative of *V. pumilus*, as illustrated in the **Figure 4**.

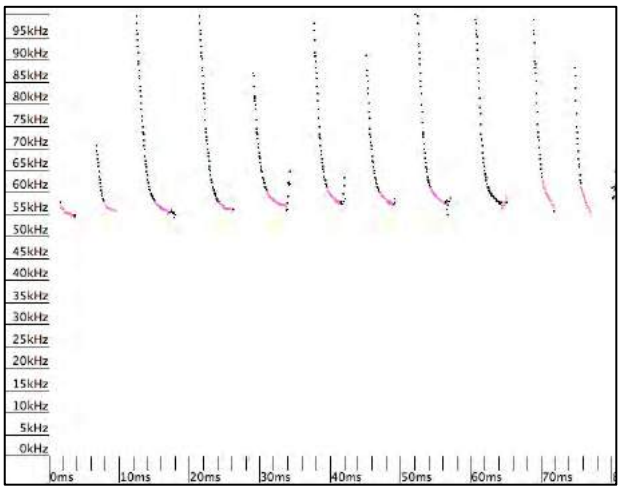


Figure 5: Definite *Nyctophilus sp.*

This species displays a near-vertical pulse, characteristic frequency between 80 and 35KHz (Pennay *et al*, 2004). The call of these species cannot be distinguished from each other.

There are four species of *Nyctophilus spp* occurring within the site area. *N. geoffroyi, N. gouldi* and *N. bifax*.

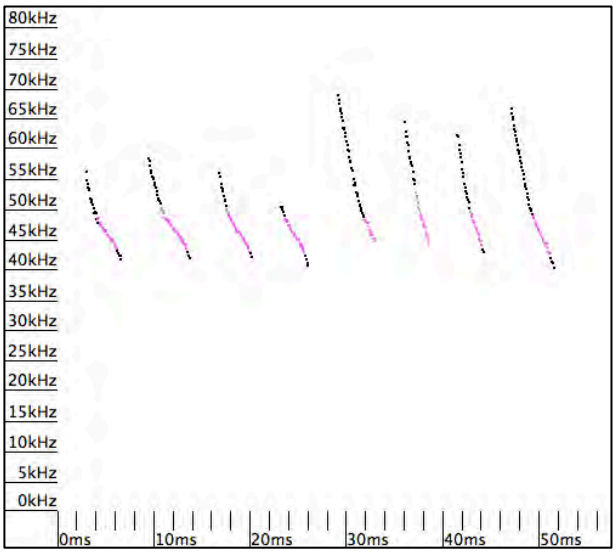
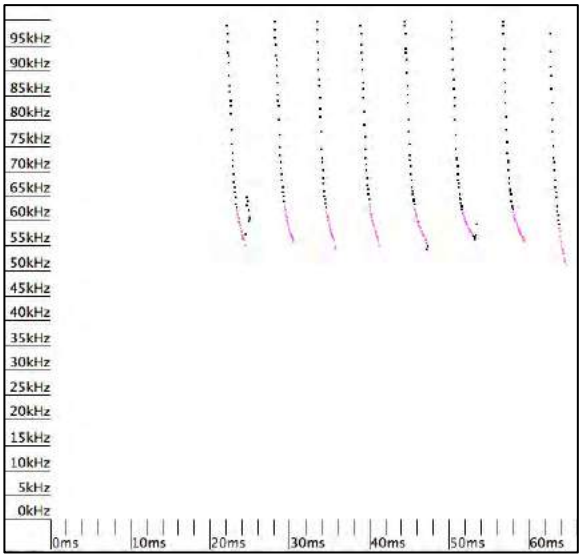


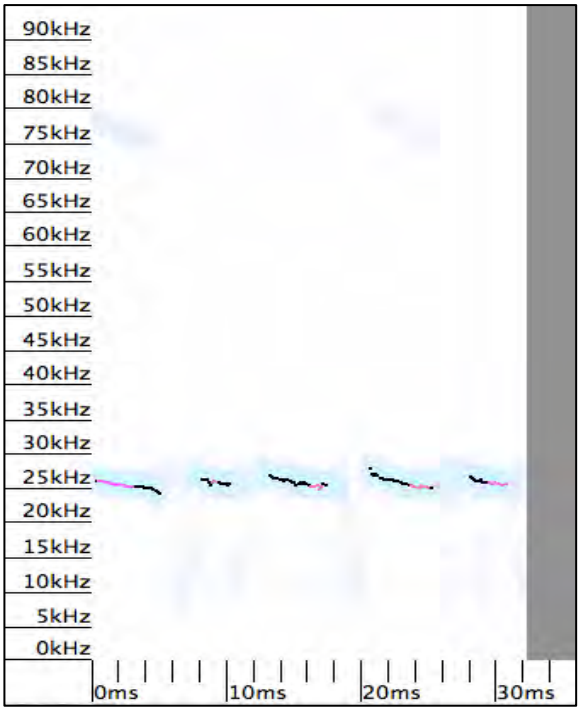
Figure 6: Probable *Myotis macropus*



Near-vertical pulse dropping to about 30 to 35-50kHz. *M. macropus* mostly have a pulse interval of less than 75ms and usually have one kink close to the middle so that the second part has a lesser slope than the first (Reinhold, 2001) as illustrated in **Figure 6**.

This call can be confused with *Nyctophilus sp* calls. The latest have usually a pulse interval greater than 95ms and are slightly more complicated structure with two kinks instead of one.

Figure 7: Possible *T. troughtoni / Saccolaimus saccolaimus*



Only one sequence file was recorded on site (20160903_204733) that may be representative of *Saccolaimus saccolaimus*.

Echolocation calls for *S. saccolaimus* have peak energy in the range 23-25kHz, similar to the frequency band of other large sheathtail bats in Australia. It is difficult to differentiate this species as its ranges overlap with the other S. spp.

Chaerephon jobensis has a similar characteristic frequency call as *S. flaviventris*; however, *Chaerephon jobensis* has often an infrequent sequence with pulse shape variable and inconsistent with abrupt changes in frequency. This cannot be seen in **Figure 7**.

T. troughtoni also produces a flat type call pulse at the same frequency as *S. saccolaimus*. It is typically long and straight or slightly curved and almost horizontal, similar to *S. saccolaimus.*

Figure 8: Probable *Saccolaimus falviventris*

This species displays a curved pulse, characteristic frequency between 17.5 to 22.5 kHz (Pennay *et al*, 2004). Dominant harmonics are between 18-20 kHz as illustrated in **Figure 8**.

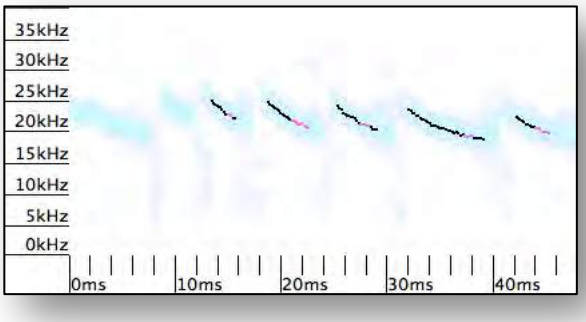


Figure 9: Definite *Vespadelus troughtoni*

This species displays a curved pulse, characteristic frequency between 48.5 to 55 kHz (Pennay *et al*, 2004). If the end frequency is lower than 51 kHz (**Figure 8**), then the call can be identified to *V. Troughtoni* and be differentiated from *V. pumilus*.

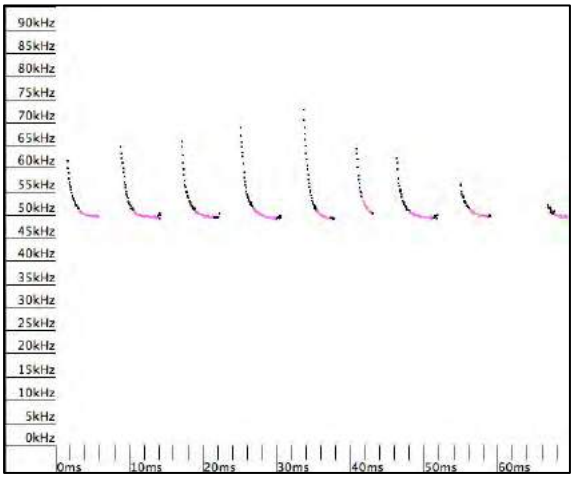
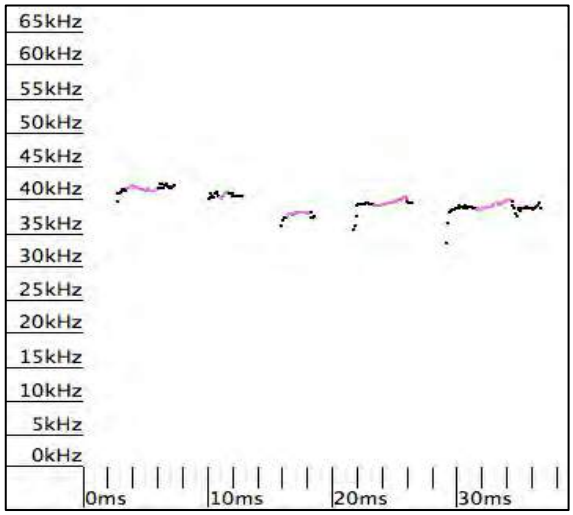


Figure 10: Definite *Mormopterus eleryi*

This species displays a distinctive flat pulses and has the highest mean characteristic frequency of all Australian's Mormopterus.



4.0 Conclusion

A total of 11 microbat species were detected occurring within the site. A total of six (6) microbat species were definitely identified being present on site and an additional five (5) species were potentially recorded on site.

The presence of *S. saccolaimus,* listed as Endangered under NC Act, and listed as Critically Endangered under EPBC Act, was analysed. Only one sequence file was identified as potentially representing *S. saccolaimus'* call. However, due to the lack of harmonics within the sequence, it was not possible to reliably separate this species from several sympatric species with similar call attributes (i.e. *T. troughtoni*). It is noted that the presence of *S. saccolaimus* was confirmed 500m away from the site. Consequently, it is considered that *S. saccolaimus* is highly likely to occur on site.

All bats identified on the site were expected to be present within the region. Bat activity levels at the site are considered to be similar compared to other surveys within similar areas in the surrounding region.

5.0 References

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Appendix F

Bare-rumped Sheathtail Bat Potential Distribution

Legend

- Lot 22 SP210202
- Subject Lot
- Easements
- Endangered - Dominant vegetation
- Of Concern - Dominant
- No concern at present

N

21 SP262068

22 SP210202

20 SP262068

24 SP210202

42 SP258905

25 SP210202

23 SP258905

1 AP19246

25 SP134215

31 SP134

7.12.57c 7.12.57c 7.12.57c 7.12.58 7.12.58 7.12.57c 7.12.30d 7.12.30d 7.12.57c 7.12.29a 7.12.30d 7.12.57c 7.12.29a 7.12.34 7.12.34 7.12.58 7.12.57a 7.12.57a 7.12.34 7.12.57a 7.12.57a 7.12.29a 7.12.30d 7.12.57a 7.12.58 7.12.30d 7.12.9 7.12.57c 7.12.34 7.12.58 7.12.57a 7.12.58 7.12.57c 7.12.57c 7.12.58 7.3.26a 7.12.30d 7.12.30d 7.12.57c 7.12.30d 7.12.30d 7.12.58 7.12.30d 7.12.57a 7.12.30d 7.12.9 7.12.30d 7.12.57c

Total Lot Area: 434.9ha
Regional Ecosystems Area: 404.04ha
Remaining Area: 30.86ha

0 80 160 240 320 400 480
Meters (A3)

Project Manager	M. Jess
Compiled by	RMS
Map Projection	MGAz55
Map Datum	GDA94
File Reference	PR132974-6.mxd
Sheet Number	1 of 1

Client: RACL

Title: Regional Ecosystems Potential Bare-rumped Sheathtailed Bat Habitat Offset Lot 22 on SP210202

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SCALE (A3)	DATE	DRAWING NO.	ISSUE
1:10,000	27/09/2016	PR132974-6	

Appendix G

Threatened Plant Species Distribution

Legend

EVNT Species

- Acacia purpureopetala
- Grevillea glossadenia
- Grevillea glossadenia, Acacia purpureopetala
- Grevillea glossadenia, Homoranthus porteri
- Grevillea glossadenia, Homoranthus porteri, Plectranthus amoenus
- Grevillea glossadenia, Homoranthus porteri, Prostanthera clotteniana
- Grevillea glossadenia, Prostanthera clotteniana
- Homoranthus porteri
- Melaleuca sylvana
- Plectranthus amoenus
- Prostanthera albohirta
- Offset Lot
- MEWF Lot

Regional Ecosystems

- Endangered - Dominant vegetation
- Of Concern - Dominant
- No concern at present

0 80 160 240 320 400 480
Meters (A3)

Project Manager	M. Jess
Compiled by	RMS
Map Projection	MGAz55
Map Datum	GDA94
File Reference	PR132974-7.mxd
Sheet Number	1 of 1

Client: RACL

Title: EVNT Species
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SCALE (A3)	DATE	DRAWING NO.	ISSUE
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Appendix H

Northern Quoll Potential Den and Foraging Areas

0 80 160 240 320 400 480

Meters (A3)

Project Manager	M. Jess
Compiled by	RMS
Map Projection	MGAz55
Map Datum	GDA94
File Reference	PR132974-4.mxd
Sheet Number	1 of 1

Client: RACL

Title: Possible Quoll Denning & Foraging Area - Offset Site

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Appendix I

Weed Management Plan

Weed Management Plan

Mt Emerald Wind Farm

2016 - 2020

Report prepared for RPS Australia East Pty Ltd for MEWFPL

September 2016

Weed Management Plan

2016 to 2020

Mt Emerald Wind Farm

Simon Gleed

9th September 2016

Report prepared for RPS Australia East Pty Ltd for MEWFPL

Disclaimer

Simon Gleed: sgleed@internode.on.net

Photo credits in this report: Simon Gleed

This document is confidential and its contents or parts thereof cannot be disclosed to any third party without the written approval of the author.

Simon Gleed undertook the fieldwork and preparation of this document in accordance with specific instructions from RPS Australia Asia Pacific (Cairns), to whom this document is addressed. This report has been prepared using information and data supplied by RPS Australia Asia Pacific (Cairns) and other information sourced by the author.

The conclusions and recommendations contained in this document reflect the professional opinion of the author based on the data and information supplied and available at the time of the work. The author has used reasonable care and professional judgment in the interpretation and analysis of the data. The conclusions and recommendations must be considered within the agreed scope of work, and the methodology used to perform the work, both of which are outlined in this report.

Document Status

Document Status	Author	Reviewer	Date of Issue
Draft Report	S. Gleed	M. Jess (RPS)	6th September 2016
Final Report	S. Gleed	T. Johannesen	9th September 2016

Distribution

Company	Copies	Contact Name
RPS	1 (electronic: PDF)	Via email to M. Jess
Simon Gleed	1 (electronic)	S. Gleed

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1.0 SUMMARY

The Mt Emerald Wind Farm site provides important habitat and refuge areas for threatened plants, animals and a majority of the project site is in an undisturbed ecological condition. The project area is covered by remnant vegetation, in which few if any weeds are present prior to the wind farm being constructed.

The areas of weed presence and large populations were in 2016 at the lowest elevation along the pre-disturbed Kippen Drive: the main entry and exit point into the Mt Emerald Wind Farm site. At higher elevation where the wind turbine generators (WTG's) and associated road and compound infrastructure are located, weeds are confined to the edges of the existing track network that provides access to the 275 kV powerline infrastructure which passes through the project area. Weeds are also found under a number of transmission towers.

Some weeds have entered the site elsewhere at higher elevation, such as around the 80 m wind monitoring tower, where increased vehicle access has resulted in some weed establishment . The wind monitoring tower area is amongst critical habitat for threatened plants and weeds have the potential to significantly degrade habitat integrity and values.

Major threats to the survival of threatened plants and animals and their habitats include altered fire regimes, weed invasion, and physical clearing and modification of habitat zones. The three impacts are interrelated.

The example of new weeds entering the project area at the wind monitoring tower highlights the crucial requirement to practice robust weed management in an environment that holds significant environmental values.

Changed fire ecology, for example modification to the landscape and habitats caused by unnaturally intense and hot fires, is identified as one of the major potential impacts to the long-term viability of the environment at the Mt Emerald Wind Farm site. One of the main determinants of fire impacts is an increase in fuel loads, which is typically caused by tall, bulky invasive grasses. Hence, the following list includes many species of this group of weeds.

Key weeds that are present along Kippen Drive or near the 275 kV powerline infrastructure that pose a high risk to the long-term quality and values of the wind farm site include:

- Grader Grass (*Themeda quadrivalvis*),
- Mission Grass (*Cenchrus polystachyum*),
- Thatch Grass (*Hyparrhenia rufa*),
- Signal Grass (*Urochloa decumbens*),
- Molasses Grass (*Melinis minutiflora*),
- Giant Rat's Tall Grass (*Sporobolus natalensis*) and other *Sporobolus* species,
- Rhodes Grass (*Chloris gayana*),
- Guinea Grass (*Megathyrsus maximus*),
- Lantana (*Lantana camara*),
- Hyptis (*Hyptis suaveolens*),
- Stinking Passionflower (*Passiflora foetida*) and
- Gambia Pea (*Crotalaria goreensis*).

This list is not exhaustive and many other weeds known from the surrounding region could be introduced into the site (e.g. Japanese Sunflower - *Tithonia diversifolia*).

This Weed Management Plan forms the framework and provides guidelines on how weeds will be managed on the Mt Emerald Wind Farm. The plan sets out the strategies and outcomes, and also considerations that are intended to form the basis on which day-to-day weed management decisions are made.

The Weed Management Plan was prepared in August 2016 and it is intended that the plan will have a life of 4 years between 2016 and 2020. The plan is to be reviewed and amended as necessary on an annual basis or earlier if particular events require an adaptive approach to weed management.

2.0 INTRODUCTION

2.1 Project Description

Mount Emerald Wind Farm Pty Ltd (MEWFPL) proposes to construct and operate a wind farm located approximately 20 km SSW of Mareeba on the Atherton Tablelands in north Queensland at the northern extent of the Herberton Range mountainous area.

The nature of the project requires wind energy to be harnessed efficiently and effectively therefore the WTG's are located on high points through the project site. The northern half of the site has broad, rolling hills, with dissected areas found in ravines and gorges; whereas the land to the south of the existing 275 kV powerline is markedly rugged and steeply dissected, rendering the highest points a series of narrow ridges and rocky knolls with steep drop-offs on adjacent slope faces. WTG's will be connected to each other by a network of tracks, some of which will accommodate underground cabling. A substation and contractors compound will be constructed within the wind farm site.

The primary access from Springmount Road to the wind farm will be along Kippen Drive at the base of the site. From the end of the flat section of Kippen Drive, the access will then ascend the hills into the wind farm site at elevation.

2.2 Project Components

The wind farm will consist of a maximum of 63 hollow tower wind turbine generators (WTG's), which will be approximately 80 m high and with 55 m diameter rotor blades. The wind farm will provide energy to feed into the main electricity grid infrastructure currently provided by the 275 kV Chalumbin to Woree powerline. The WTG's will be connected and linked by a series of access tracks and underground cabling.

Other infrastructure and facilities to be constructed within the wind farm project site include a contractors site compound, a lay-down area, a substation, and an associated substation operation and management building. The location of the works and layout of the wind farm infrastructure are shown in **Figure 1**.

2.3 Purpose and Objectives of Weed Management Plan

This Weed Management Plan describes the management measures and actions that apply to eliminating or reducing the impact of weeds in the Mt Emerald Wind Farm project site. The purpose of this Weed Management Plan is to reduce the impacts of weeds by achieving the following objectives:

- Significantly reduce and manage the dominant weed infestations along the proposed access route on Kippen Drive.
- Eliminate or control to negligible populations sizes the priority weeds within the WTG footprint area of the Mt Emerald Wind Farm site.
- Enhance and improve the quality of natural habitats within the wind farm site where identified.

The Plan's framework comprises: weed management objectives; management actions; performance indicators; monitoring; roles and responsibilities; and reporting requirements.

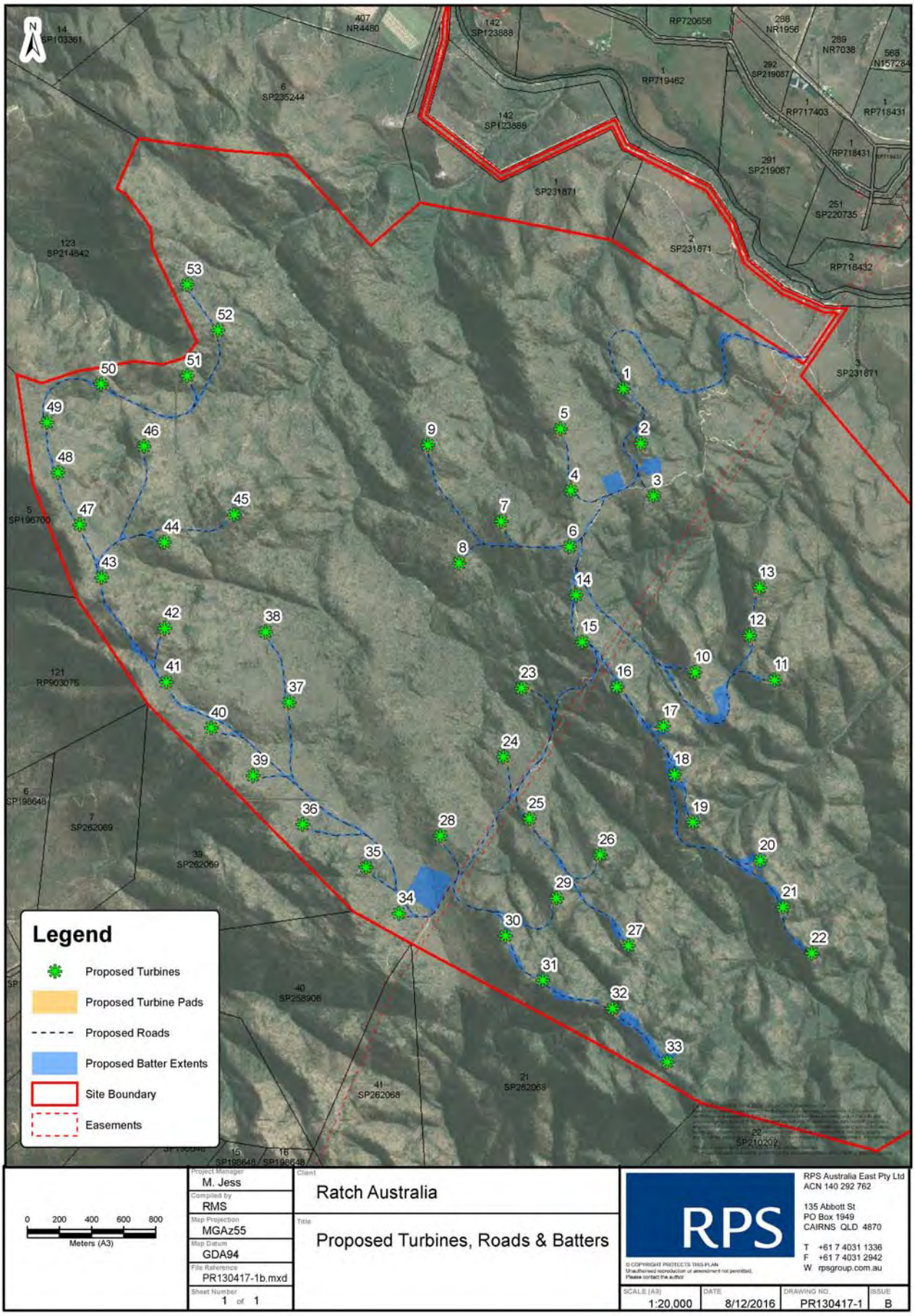

Figure 1. Layout of the Mt Emerald Wind Farm

2.4 Legislative Context

Invasive weeds are known to pose a significant threat to biodiversity and natural landscape function. As a result of the impacts weeds cause, including economic reasons, weeds are regulated at three government levels. For major infrastructure projects such as the Mt Emerald Wind Farm, weed priorities are established, which consider whether a species is listed (declared) under legislation, local law or under Australia-wide national plans; and importantly, at the project site-scale, whether a weed species poses a risk of causing environmental degradation to important habitats or sensitive areas.

2.4.1 *Land Protection (Pest and Stock Route Management) Act 2002* (Queensland)

Declaration of weeds under Queensland's *Land Protection (Pest and Stock Route Management) Act* 2002 (LP Act) imposes a legal responsibility for control by all landowners on land under their management. Declared weeds are given a status of class 1, class 2 or class 3. The descriptions and legal obligations for the declared weed classes are as follows:

A Class 1 weed is one that has the potential to become a very serious weed in Queensland in the future. All landholders are required by law to keep their land free of Class 1 weeds. It is a serious offence to introduce, keep, release or sell Class 1 weeds without a permit.

A Class 2 weed is one that has already spread over substantial areas of Queensland. By law, all landholders must attempt to keep their land free of Class 2 weeds and it is an offence to possess, sell or release these weeds without a permit.

A Class 3 weed is one that is commonly established in parts of Queensland. Landholders are not required to control a Class 3 declared pest plant on their land unless a pest control notice is issued by a local government because the weed is causing or has potential to cause an negative impact on an adjacent environmentally significant area. It is an offence to supply a Class 3 weed.

Weeds not declared under the LP Act may still be declared at a local government level under local laws (see Mareeba Shire Pest Management Plan).

Declared weeds found on or in the vicinity of the Mt Emerald Wind Farm site are listed in **Table 1** under the following section.

2.4.2 Mareeba Shire Pest Management Plan 2015 to 2020

The Mareeba Shire Council lists priority pest plants in its Mareeba Shire Pest Management Plan 2015 to 2020 (MSPMP). Priority weeds are given a ranking, where weeds with higher scores are a higher priority for control. The highest score that a priority weed can be scored is 45. The priority weeds occurring in or near the Mt Emerald Wind Farm site are listed and categorised in **Table 1**.

Table1. Priority weeds listed under local law, nationally and Queensland legislation.

Weed species	MSPMP Score	WONS	LP Act	On wind farm site?
Parthenium (*Parthenium hysterophorus*)	35.9	Yes	Class 2	No
Bellyache Bush (*Jatropha gossypifolia*)	35.0	Yes	Class 2	No
Rubber Vine (*Cryptostegia grandiflora*)	33.2	Yes	Class 2	No
Lantana (*Lantana camara*)	29.5	Yes	Class 3	**Yes**

Weed species	MSPMP Score	WONS	LP Act	On wind farm site?
Sicklepod (*Senna obtusifolia*)	27.0	No	Class 2	**Yes**
Giant Rat's Tail Grass (*Sporobolus natalensis*)	26.8	No	Class 2	**Yes**
American Rat's Tail Grass (*Sporobolus jacquemontii*)	-	No	Class 2	**Yes**
Cat's Claw Creeper (*Dolichandra unguis-cati*)	-	Yes	Class 3	No
Gamba Grass (*Andropogon gayanus*)	-	Yes	Class 2	No
Mother of Millions (*Bryophyllum* spp.)	-	No	Class 2	**Yes**
Asparagus Fern/Ground Asparagus (*Asparagus aethiopicus*)	-	Yes	Class 3	No
Captain Cook Tree / Yellow Oleander (*Cascabela thevetia*)	-	No	Class 3	No
Madeira Vine (*Anredera cordifolia*)	-	Yes	Class 3	No

The following extract from the Mareeba Shire Pest Management Plan relates to the legal requirement for landholders to control class 1 and 2 declared pest plants as regulated by the LP Act. The extract also refers to priority weeds species listed in the shire's pest management plan.

> "Where an infestation of a class 1 or 2 plant or animal or one identified in the "Priority Pest Plan" is identified by Council's Pest Management Officer, a notice under the Land Protection (Pest and Stock Route Management) Act or Local Law will be served to destroy all declared weeds on the property within seven (7) and twenty-one (21) days (or other length as required by the circumstance i.e. notices will give the landholder a reasonable and sufficient period of time for each particular circumstance to take the required action). Council hereby delegates the authority to serve notice to the Chief Executive Officer and Pest Management Officer generally under the Land Protection (Pest and Stock Route Management) Act and its Local Laws."

2.4.3 Weeds of National Significance

The Australian, state and territory governments have compiled a list of thirty-two *Weeds of National Significance* (WONS). Nomination of a weed for inclusion on the WONS list is based the species' invasiveness, impacts, the potential to spread, environmental and socio-economic values.

Two species from the WONS list occur in the Mt Emerald Wind Farm project site: the shrubs Lantana (*Lantana camara*) and Bellyache Bush (*Jatropha gossypifolia*). A small population of Lantana is found under a powerline tower, and one juvenile plant of Bellyache Bush was observed around the 80 m wind monitoring tower.

Seven other WONS terrestrial weed species that occur regionally or in the vicinity, but are not found in the wind farm site include: Gamba Grass (*Andropogon gayanus*), Rubber Vine (*Cryptostegia grandiflora*), Parthenium (*Parthenium hysterophorus*), Cat's Claw Vine (*Dolichandra unguis-cati*), Climbing Asparagus Fern (*Asparagus plumosus*), Ground Asparagus (*Asparagus aethiopicus*) and Madeira Vine (*Anredera cordifolia*).

3.0 WEED MANAGEMENT PLAN

3.1 Existing Environment and Current Weed Status

The following summary information regarding the existing environment, which has been described in detail in the EIS (Environmental Impact Statement), and the current status and distribution of weeds in the wind farm project area forms the baseline information needed to form the framework of the monitoring component of this Weed Management Plan. Reference should also be made to detailed documents that have been published about the environmental characteristics of the Mt Emerald Wind Farm site, such as the EIS and any relevant supporting reports.

3.1.1 Description of existing environment

The Mt Emerald Wind Farm site is characterised by steeply dissected hills, rocky terrain and areas of precipitous ridges and ravines. The broad geology of the site is mapped as the Walsh Bluff Volcanics, which comprises fine-grained rhyolite.

The predominant vegetation cover over the project site is a mosaic of sclerophyll woodland, shrubland and heathland. Weeds are virtually absent from remnant vegetation.

Common trees of the woodlands include Lemon-scented Gum (*Corymbia citriodora*), Yellow Stringybark (*Eucalyptus mediocris* - this species was referred to its former name in the EIS as *E. portuensis*), Range Bloodwood (*C. abergiana*), Ironbark (*E. crebra*) and Dead Finish (*E. cloeziana*) and Cypress Pine (*Callitris intratropica*), Silver-leaf Ironbark (*E. shirleyi*), Orange jacket (*C. leichhardtii*), White Stringybark (*E. reducta*), and *E. lockyeri.* The dominant grass is usually Kangaroo Grass (*Themeda triandra*). Woodlands are most frequent over broad slopes, flats and rolling hills

Shrublands are characterised by many species, but typically include Sheoak (*Allocasuarina littoralis*), (*Xanthorrhoea johnsonii*), *Eucalyptus lockyeri*, Wattle (*Acacia aulacocarpa*), *Homoranthus porteri*, *Grevillea glossadenia*, and stunted forms of Range Bloodwood (*Corymbia abergiana*). Shrubland is generally found in relation to the ridge environment where rocky soils prevail. The endangered shrub *Melaleuca uxorum* is found on the boundary of this vegetation type with taller woodlands. It is found elsewhere in association with the montane heathland and rock pavements described below.

Heathlands have a special and diverse group of plants which include species such as Broom (*Jacksonia thesioides*), Grass Tree (*Xanthorrhoea johnsonii*), *Gompholobium nitidum*, the wattles *Acacia calyculata* and *A. whitei*, the grass *Cleistochloa subjuncea*, emergent stunted forms of *Eucalyptus lockyeri*, *Grevillea glossadenia*, *Homoranthus porteri*, *Cryptandra debilis*, *Mirbelia speciosa* subsp. *ringrosei*, *Pseudanthus ligulatus*, *Zieria whitei*, *Boronia occidentalis* and others. The critically endangered *Acacia purpureopetala* and *Prostanthera clotteniana* grow in this vegetation type. It is referred to in the EIS as montane heathland, because of its reliance on high elevation aspects and very thin soils.

A feature of the montane heathland and shrublands at high elevation is the presence of rock pavements and areas of poorly vegetated rock outcrops. This particular habitat supports few large species because of the near-absence of soil or growth medium on their surfaces. The soil that does develop is trapped in rock hollows and scoops and crevices between rock plates and boulders. The soil is developed from small plants such as lichens, mosses and the remains of rock ferns (Cheilanthes spp.). These plant matter integrates with weathered rock material to form a soil that has the texture of peat, where in wetter times the absorbent nature of the medium is able to store water for longer periods.

Plants on rock pavements include the Resurrection Plant (*Borya septentrionalis*), *Pseudanthus ligulatus*, scattered shrubs of *Grevillea glossadenia*, *Plectranthus* species (including the threatened *P. amoenus*) and occasionally sentinel specimens of Cypress Pine (*Callitris intratropica*). Grasses are sparsely represented and can include Five Minute Grass (*Tripogon loliiformis*) and *Eriachne humilis*. *Eriachne mucronata* is often found around the edges of rock pavements. Some rock pavements are entirely covered by Firegrass (*Schizachyrium pachyarthron*).

Land surrounding Kippen Drive from Springmount Road to the low sections of the Herberton Range before the road ascends into the wind farm site is highly modified through long-term disturbance and farming. Consequently, this section of the project site carries the highest proportion of weeds and the most serious weeds. Grader Grass (*Themeda quadrivalvis*) is considerably problematic along this section of the access into the wind farm site. Grader Grass is also gradually entering higher sections of the site and has been introduced by recent machinery operations.

3.1.2 Significance ridge environment and key plant habitats

The high altitude ridges in the wet tropics bioregion section of the site (south of the 275 kV powerline) are sensitive environments that serve as important habitats for plants and the poorly represented montane heath and shrubland mosaic found around 900 m ASL. Here the cloud base is a determinant of the moisture regime in relation to plants and their exposure to extreme conditions.

The land south of the 275 kV powerline holds the highest levels of species diversity and endemism, where many species are restricted to and have adapted to the harsh environment of exposed high elevation points on ridges, rock pavements and areas of skeletal soil. This montane habitat supports six species of plants which are listed as critically endangered, endangered and vulnerable under Queensland and Commonwealth legislation. Many other species, not listed under legislation, are restricted to the montane heath along and on the edges of narrow ridge lines and rock pavement areas.

The rugged nature of the land with steep rocky slopes, bare rock pavements, outcrops and cliffs provides a unique environment for plants, and it is these characteristics which act as a refuge and reduces the effects of the severity and intensity of bush fires due to the low levels of flammable material such as grasses. Consequently, the conservation significant plants are found almost exclusively in fireproof habitats and niches. The protection from fire is a critical attribute, which renders most of the ridge tops and rock pavements as significant habitats where many threatened plants are able to persist.

3.2 Current Weed Status

Some weeds are established within the project footprint, and most probably as a result of construction of the 275 kV powerline and its associated track network. Some zones of the site have suffered longer term weed incursions as a result of grazing and regular vehicle movements at lower elevation, particularly along Kippen Drive.

The most significant manifestation of weed invasion is along and adjacent to both sides of the main access road into the site along Kippen Drive. In this section, loss of native woodlands through prior land clearing, plus road verge maintenance have resulted in large areas being infested and dominated by weedy grasses and shrubs including Grader Grass (*Themeda quadrivalvis*), Stylo (*Stylosanthes scabra* and other species), Hyptis (*Hyptis suaveolens*) and Stinking Passion Flower (*Passiflora foetida*). These are invasive weeds which pose a significant threat to the high quality environments higher up in the wind farm site if allow to establish.

Higher on the site, where traffic, machinery and human movement is less frequent, weed presence is found wherever land has been cleared and modified. Weeds observed on the site at higher elevation include Praxelis (*Praxelis clematidea*), Molasses Grass (*Melinis minutiflora*), Guinea Grass (*Megathyrsus maximus*), Thatch Grass (*Hyparrhenia rufa*) and Mission Grass (*Cenchrus polystachyum*). Occurrences of Giant Rat's Tail Grass (*Sporobolus natalensis*), American Rat's Tail Grass (*S. jacquemontii*) and Lantana (*Lantana camara*) are found in containable populations around the existing 275 kV powerline and towers.

An important baseline observation is that the invasive weeds listed above (with the exception of isolated occurrences of Praxelis) are absent from remnant vegetation areas. In this regard, ridges, rocky slopes and undisturbed land is in pristine condition and holds significantly high levels of natural integrity and condition.

3.3 Priority Weed Species on the Mt Emerald Wind Farm

For the purposes of this Weed Management Plan, priority weeds are the species that have been identified as posing the highest risk of causing environmental harm in a site-based context. Any declared weeds as listed under Queensland or National legislation, or local government laws will be managed accordingly.

3.3.1 Invasive weeds

Invasive weeds, including grasses and broadleaf plants, quickly adapt to disturbed environments and can rapidly outcompete native species and dominate a disturbed site. They spread quickly and are responsible for significant levels of environmental damage displacing native plants and habitats.

Weeds contribute to changed fire regimes, which negatively affect the structure, flora and habitat values of native vegetation. On the Mt Emerald Wind Farm site, invasive grasses and other weeds are a significant threat to the natural values of the project area. Invasive weeds place adverse and unnatural pressure on the integrity and function of the vegetation of all aspects of the wind farm site, and notably the function of threatened plant habitats. Tall weedy grasses and other lower growing introduced grasses are given priority status in this weed management plan for control and ongoing management.

Typical invasive weeds present on the Mt Emerald Wind Farm site include; Grader Grass, Thatch Grass, Guinea Grass, Molasses Grass, Signal Grass, Mission Grass, two species of Rat's Tail Grass and Lantana. The priority weeds on the site are listed in **Table 2** and reference should be made to the weed schedule in **Appendix A** for other weed management priorities.

Table 2. Priority weeds on the Mt Emerald Wind Farm site (listed in order of importance).

			MEWF Management Priority		
Weed	**LP Act**	**Threats**	**Kippen Drive**	**WTG site**	**Notes**
Grader Grass (*Themeda quadrivalvis*)	-	Invasive. Increases unnatural fire risk. Displaces ground flora.	Very High	Very High	Encroaching into WTG site on lower slopes.
Mission Grass (*Cenchrus polystachyum*)	-	Invasive. Increases unnatural fire risk. Displaces ground flora.	Very High	Very High	Main patches under 275 kV powerline in WTG site. Spot occurrences along Kippen Drive.
Giant Rat's Tail Grass (*Sporobolus natalensis*)	Class 2	Invasive and fire risk.	-	Very High	Under 275 kV powerline towers in WTG site.
Thatch Grass	-	Invasive and increase fire risk.	Very High	Very High	Only one incidence seen on

			MEWF Management Priority		
Weed	**LP Act**	**Threats**	**Kippen Drive**	**WTG site**	**Notes**
(*Hyparrhenia rufa)*					northern approach track into WTG site. Isolated along Kippen Drive. Control early.
American Rat's Tail Grass (*Sporobolus jacquemontii*)	Class 2	Invasive and fire risk.	Very High	Very High	Under 275 kV powerline towers in WTG site and along Kippen Drive.
Molasses Grass (*Melinis minutiflora*)	-	Invasive. Increases unnatural fire risk. Displaces ground flora.	Medium	Very High	Main area around watercourse crossing under powerline in WTG site.
Signal Grass (*Urochloa decumbens*)	-	Invasive. Increases unnatural fire risk. Displaces ground flora.	Medium	High	Only small areas in WTG site - control early.
Rhodes Grass (*Chloris gayana*)	-	Invasive, increases unnatural fire risk. Displaces native species.	High	-	Small patches along Kippen Drive.
Guinea Grass (*Megathyrsus maximus*)	-	Invasive. Increases unnatural fire risk. Displaces ground flora.	Medium	High	Isolated on WTG site. Along Kippen Drive. Control early.
Hyptis (*Hyptis suaveolens*)	-	Increases risk of hot fires. Invasive and lowers integrity.	High	High	Along Kippen Drive and encroaching up lower northern slopes.
Lantana (*Lantana camara*)	Class 3	Invasive. Increases unnatural fire risk. Displaces ground flora.	High	Very High	Isolated along Kipen Drive and under 275 kV powerline tower in WTG site.
Sicklepod (*Senna obtusifolia*)	Class 2	Invasive. Displaces native vegetation. Difficult to eradicate.	-	Very High	Isolated record at 80 m wind monitoring tower when first constructed. Not seen in 2016. Vigilance required.

NOTES

A hyphen (-) in the table indicates that the species has not been recorded at a location; or the species is not listed under the *Land Protection (Pest and Stock Route Management) Act 2002* (LP Act), Mareeba Shire Pest Management Plan (MSPMP) or WONS (Weeds of National Significance). If a species is indicated as not being observed at a location this does not infer that the species is absent - weed surveillance should update presence if a weed is a new detection.

LP Act: Declared weed status under the *Land Protection (Pest and Stock Route Management) Act 2002*.

MSPMP: Priority score under the Mareeba Shire Pest Management Plan.

WONS: Indicates if the species is listed as a Weed of National Significance.

Threats: Describes the main threats and potential impacts that the species could cause once established.

MEWF Management Priority: This is the site-specific Mt Emerald Wind Farm priority ranking for management of weeds. It is based on invasiveness, current population sizes, potential to affect fire ecology and whether a species is considered to impose a significant threat to sensitive environmental areas. Very High - requires to be managed as a priority; High - requires early intervention and management; Medium - requires to be managed on a regular basis; Low - requires to watched and managed if deemed problematic.

Kippen Drive: Refers to the flat, modified land that will be used as the primary access from Springmount Road to the base of the wind farm site.

WTG site: Refers to all the land in which the wind farm operational infrastructure will be located and begins at the base of the hill at the terminus of Kippen Drive and extends into all ridges and land at higher elevation where WTG's, access roads, cabling network, lay-down pads, substation and compound infrastructure will be located.

3.4 Potential Impacts of Weeds

The following impacts are relevant to the pre-construction, construction, operation and decommissioning stages of the Mt Emerald Wind Farm. The main triggers for weed invasion and outbreaks are:

- Disturbance of the natural ground surface. This provides good opportunities for weeds to occupy soil where no natural competition would otherwise exclude weeds. Disturbance or modification can be in the form of new excavation work; introduction of foreign soil material and roadbase; and trampled or flattened vegetation.
- Weeds being introduced into a site on machinery and vehicles; which often includes weed-contaminated soil and roadbase or construction materials.
- Repeated use of herbicide can modify a natural surface. Often one species of weed is killed by the herbicide, but another species of weeds replaces the former species. For example, Bluetop and Praxelis will often colonise areas that were once infested with noxious grasses.

Invasive weeds displace native plants and habitats by out-competing native plants for resources. Weeds prevent native seedling recruitment and retard germination of seed. They contribute to changed fire regimes, which affect the structure, flora composition and habitat values of native vegetation. On the Mt Emerald Wind Farm site, invasive grasses and other weeds pose a significant threat to the natural values of the project area.

The key impacts that weeds cause to natural environments are:

- **Changed fire regimes** through increased fuel loads (tall, dense grasses) and the generation of flammable fuel loads that burn hotter and more fiercely than native grasses.
- **Displacement of native plant species** by outcompeting smaller plants. For example, the critically endangered wattle *Acacia purpureopetala* (Purple-flowering Wattle) is found in the wind farm project footprint, and has a low growing habit which would quickly be smothered by invasive grasses.
- **Modification and degradation** of the quality of remnant habitats for flora and fauna. For example, on the wind farm site, many native species of flora and fauna rely on specialist habitats to survive: some species are only found on this site and in the local region.
- **Habitat destruction**: intense fire events destruct and incinerate hollow logs (important for wildlife); kill trees (nectar source for bats and birds); and destroy soil seed banks and the thin veneer of soil matter found around rock pavements.
- **Increased soil erosion**: widespread, unnaturally hot fires caused by weedy grasses can promote higher levels of soil erosion by burning out native grasses and patches of woody shrubs that protect the soil surface.
- **Pathogens and diseases** such as Phytophora root rot, scale insects, and fungal diseases can be introduced by weeds.
- **Expanding impacts**: large areas of weeds promote more weed growth and the scale of the problem increases and causes more widespread environmental impacts.

3.5 Weeds and Fire

Altered fire dynamics may occur as a result of increased fuel loads developing adjacent to newly cleared areas where weeds establish. A changed fire ecology can result in the elimination of certain native plant species or the promotion of different plant functional groups, and consequently, change the micro-habitats for species of flora and fauna.

Invasive grasses such as tall species like Grader Grass, Mission Grass, Thatch Grass, increase fuel loads and introduce unnatural fierce and intense fire events in sensitive habitats. Even a blanket covering of lower growing grasses such as Molasses Grass and Signal Grass carry very hot, unnatural fires.

The priority weeds identified within the wind farm project area and along the access road of Kippen Drive, which are considered to pose the highest threats to natural values are listed in the weed schedule for the Mt Emerald Wind Farm, are included at the end of this document.

3.6 Weed Dispersal and Sources of Contamination

Weeds are plants either not native to Australia, or species that grow outside of their natural range and become problematic. They are opportunistic and can quickly establish at disturbed sites, where for example, construction works break the natural ground surface. Once native ground covers such as grasses have been removed, a modified environment is available for weeds to quickly establish.

Weeds are dispersed and brought into previously weed-free areas by various means. Weeds can be "transported" by,

- wind dispersed seeds (daisies for example);
- animals in their fur;
- seed consumed by the animal;
- human activity.

Dispersal of weeds by humans is one of the main factors in how weeds become established at construction sites and around infrastructure such as roads, farms and powerline corridors. Examples of typical reasons why construction can lead to weeds being introduced are:

- Heavy machinery and vehicles carrying weed seed trapped in soil and mud on tyres and tracks and implements. For example, weeds can be transported by excavators, contractor light vehicles, graders, dozers, tractors, water trucks and even delivery trucks if they pass through weed contaminated roads and access points.
- Contractor vehicles such as slashing tractors pose a notable risk after working in weed infested areas. For example, a tractor slashing Grader Grass along Kippen Drive will invariably carry Grader Grass seed in the slasher and other tractor components. If allowed past an uncontrolled point to higher elevation into the site, the potential to spread the weed is high.
- Dozers, graders and any earthmoving machinery used for constructing and widening roads has a high risk of introducing new weeds into a site. For example, small turnout drains dozed within the hilly part of the wind farm site already have developing populations of Graders Grass.
- Road-base material, gravel and quarry aggregates are often a carrier of weed seed and consequently, new weed introductions.

- Vehicles and machinery that have travelled from high risk weed infected areas heighten the risk of weeds being introduced into a weed-free or low weed level sites.

3.7 Roles and Responsibilities

The Principal Contractor, contractors, sub-consultants and personnel have a responsibility to avoid and minimise the impact of weeds, which pose a threat to the condition and function of the natural landscape within the Mt Emerald Wind Farm site.

Weeds require considerable costs to eradicate and manage, particularly when infestations become large and widespread, at which stage they cannot be effectively controlled. Understanding the roles and responsibilities for good weed management helps reduce annual costs and increases management efficiency.

3.7.1 Principal contractor

The Principal Contractor of the Mt Emerald Wind Farm project is responsible for:

- Implementing and updating this Weed Management Plan.
- Designing, constructing and management of a weed washdown bay and machinery cleaning area.
- Prioritising weed management actions according to this Weed Management Plan.
- Identifying relevant weed species listed under the Queensland *Land Protection (Pest and Stock Route Management) Act 2002* and complying with the requirements for management of declared plant species.
- Identifying and directing weed management practices to the priority weed species according to this Weed Management Plan.
- Identifying appropriate site-specific training and induction materials and procedures required for weed management.
- Maintaining records of inductions and training given to contractors, sub-consultants and workers.
- Ensuring that contractors, sub-consultants and workers that use vehicles, machinery and equipment known to spread weeds undertake appropriate training.
- Investigating and taking corrective actions in relation to new records of weeds or weed population expansions being detected in the wind farm project area.
- Scheduled reporting, monitoring and maintenance of records relating to weed management in the wind farm project site.

3.7.2 Contractors, sub-consultants and personnel

Contractors, sub-consultants and personnel engaged in work practices that have the potential to transport or spread weeds into the wind farm site are responsible for:

- Fulfilling duties as directed by the Principal Contractor in relation to weed management.
- Identifying significant habitats for flora and fauna, and ensuring weed management work methods are of a standard that avoids or minimises harm to the natural environment.
- Undertaking site-specific weed management inductions and training before commencing work. All inductions must be signed off by the Principal Contractor after completion.
- Complying with the weed management requirements as directed by the Principal Contractor.

- Reporting to the Principal Contractor new weed species, and unusual or expanding weed populations.
- Requesting further advice and clarification from the Principal Contractor in relation to weed species identification, uncertainties and knowledge gaps before proceeding with the related weed management issue.
- Ensuring that the equipment and products used for weed management is legal, in safe working condition and meets current specifications and regulatory requirements.

3.8 Weed Management Actions

The following weed management actions (**Table 3**) are recommended for the early prevention of weed movement from the Kippen Drive area higher up into the wind farm site and to achieve the overall management objectives of the Weed Management Plan. Additional steps or actions may be required if considered necessary to address unexpected circumstances.

Table 3. Weed management actions and responsibilities.

	Weed Management Action	Responsibility
1	**Adopt** Weed Management Plan.	MEWFPL
2	**Implement** Weed Management Plan and follow weed management protocols and procedures.	Principal Contractor, Environment Officer, contractors and personnel.
3	**Machinery Washdown Bays**. Before heavy machinery commences work in the WTG site, construct a permanent machinery and vehicle washdown bay at the base of the wind farm site at the terminus of Kippen Drive. Implement operational procedures such as washdown log, signage and directional entry control points.	Principal Contractor
4	**Control Priority Weeds**: Before construction commences, control the following weeds inside the wind farm site (i.e. at elevation and around the 275 kV powerline and towers): Giant Rat's Tail Grass, American Rat's Tail Grass, Mission Grass, Molasses Grass, Signal Grass, Grader Grass, and Lantana. Check and control priority weeds found around the 80 m wind monitoring tower. Kippen Drive: slash, contain and control the entire length from the base of the wind farm site to Springmount Road.	Principal Contractor, contractors and personnel.
5	**Contain Weed Infestations**: Keep the access road free of weeds, with particular attention to Grader Grass and any other tall grasses. Maintain a 2 m wide weed-free clear zone each side of Kippen Drive. The weed-free clear zone should allow for 2 m clearance each side of the largest expected vehicle or machinery that will enter the site.	Principal Contractor, contractors and personnel.
6	**Before Construction of WTG Site**: At construction, establish machinery and vehicle washdown facility within the WTG site within the contractors compound or suitable area. This is to control and limit soil movement into the ridge country south of the 275 kV powerline (highly sensitive environment).	Principal Contractor
7	**Practice Good Weed Management**: Always work from the cleanest, weed-free areas towards contaminated areas.	Principal Contractor, contractors and personnel.
8	**Monitor**: monitor weeds throughout ALL stages of the wind farm.	Environmental Officer
9	**Review Weed Management Plan**: amend and adapt weed management practices as required throughout the duration of the construction and operational stages of the wind farm.	Environmental Officer, principal Contractor.

3.9 Principles of Weed Control and Management

It is recommended for the following weed management principles to apply to the Mt Emerald Wind Farm.

3.9.1 Weed prevention and early detection

Prevention of weed contamination and spread should be the first objective in weed management. Vigilance and early detection of weeds prevent small and new populations becoming problematic and uncontrollable. Any new or unusual weeds sightings should be reported immediately to allow for rapid control to occur to prevent outbreaks of new populations. Locations should then be added to a register of all known weeds locations.

Contractors and workers should be alerted to the presence and location of high priority weeds across the wind farm project area. This can be achieved through inductions and toolbox meetings.

Be vigilant of areas of weeds that have been controlled with herbicide as weeds quickly respond to changes in the soil condition and plant cover, and often a new species of weed will colonise a site treated with herbicide.

Roadbase, fill materials and sources of soil contamination should also be strictly monitored. Incidences of weed incursion or germination at newly prepared construction sites should be investigated immediately and corrective actions taken as a matter of priority.

3.9.2 Machinery washdown facility

For effective cleaning of potentially weed-contaminated vehicles and machinery it is important that the underside of the vehicle can be accessed with a high pressure water cleaner. A washdown bay with clear side access with a minimum height of 1.5 m between the lower side of vehicle and washdown base is preferred. Elevated washdown bays where the vehicle or machine stops on a grid allows users to direct high pressure cleaners to the areas of a vehicle where weed seed is most likely to adhere to the underside. High pressure cleaning and manual inspection should be completed for all accessible parts of the vehicle or machine.

The washdown bay base should be impervious and constructed with an adequate fall to allow for unimpeded drainage of washdown water and contaminated soil.

Washdown areas should be bunded to prevent overflow of washdown water and escape of contaminated soil and weed seed.

Washdown water should be drained, diverted and filtered into a suitably designed sediment trap that facilitates cleaning and disposal of seed-contaminated soil. Disposal of contaminated soil should be to a designated location, and not indiscriminately dumped at any location.

3.9.3 Prioritising weed management

Weed management is ongoing and must be performed throughout all stages of the Mt Emerald Wind Farm project: pre-construction, construction, operation and decommissioning.

All species of weeds on the wind farm site should be treated as undesirable and unwanted plants. Target control of priority weeds should be undertaken according to their ranking given in this Weed Management Plan. Reference should be made to the weed schedule in **Appendix A**. The distribution of weeds along Kippen Drive and in the WTG site is shown on the mapping in **Appendix B**.

Best results would be achieved by eradication of major weed infestations early in the project cycle, and application of progressive control measures throughout the life of the project.

The areas of the wind farm project that require urgent weed containment and control are along Kippen Drive and the lower slopes leading into the WTG site; and under or adjacent to the 275 kV powerline.

3.9.4 Managing the spread and introduction of weeds

Machinery work areas are to be minimised as much as possible and should be constrained to clearly defined and marked areas within the wind farm site. The creation of unplanned tracks, short-cuts, dump areas or random machinery movement should be treated as non-compliance.

Machinery is to be kept free of weed seed to prevent spreading weeds beyond infested areas. Use of the vehicle and machinery washdown facilities should be mandatory and records of each washdown should be kept and signed off.

Vehicles associated with the planning, surveying and construction phases of the project must be cleaned and inspected before entering the site. The number of vehicles accessing a particular section of construction during a single event should be limited to a practical minimum.

Do not use any introduced grasses, legumes or shrubs in revegetation or as soil stabilisation for erosion and sediment control in the WTG site and particularly not in environmentally sensitive areas south of the 275 kV powerline.

3.9.5 Weed control recommendations

Manually remove isolated specimens of weeds when first detected as part of the daily work routine (i.e. remove a clump of Mission Grass before it spreads).

It is important when managing priority invasive weeds such as Grader Grass to undertake mechanical (slashing) control measures before they seed. Where appropriate (i.e. along Kippen Drive. NOT in sensitive areas), the use of herbicide control over active weed growth is preferred; for example, new leaf growth of Grader Grass.

Consider all options to reduce herbicide use over time, and implement rehabilitation with native species. For example, invasive grasses along Kippen Drive could be slashed, controlled with herbicide over new growth and then the area revegetated to form thickets of native wattles as a replacement species.

Where clearing of vegetation is required, always work machinery from clean, weed-free areas and work towards weed infested areas. It is important weed seed is not carried back through reverse operation of machinery. For example, if an upgrade to Kippen Drive is required, it would be good practice to begin earthworks from the base of the wind farm site and work towards the Springmount Road intersection.

If excavated soil is required to be stockpiled from weed infected areas of the site, the soil should not be moved or stored in or near weed-free parts of the site.

A major source of new weed introductions into otherwise weed free areas is through the import and use of contaminated roadbase and fill materials. Roadbase and fill materials must be certified free of weeds as far as is practicable. It is strongly recommended suppliers' sources of these materials (from local quarries) are audited by the Environmental Officer. Serious weeds are imported into sites through contaminated quarry materials and include difficult to eradicate species such as Sicklepod and Siratro.

Weedy invasive grasses that generate higher than normal fuel loads or promote hot fires should not be allowed to establish. Considerably reduce the size or eliminate all populations of the following grasses within the WTG operational area of the project site: Mission Grass, Giant and American Rat's Tail Grass, Thatch Grass, Grader Grass, Guinea Grass, Molasses Grass and Signal Grass.

Contractors involved in weed control must be aware of the importance of the vegetation at higher elevations within the site, and should not apply herbicide in areas identified as environmentally sensitive. Appropriate training and inductions should be provided as part of the overall weed management strategy.

Weed control contractors and workers undertaking practical weed management should be suitably qualified in the areas of weed identification of target species and the appropriate level of control for each weed species. Workers must be able to apply the most appropriate control technique to any given weed situation.

The blanket application of herbicide in sensitive environmental areas is not advised or recommended. Off-target herbicide application is an unacceptable practice. The application of herbicides should be targeted, be specific to the weed, and should be kept to the minimum necessary to adequately control the weed.

The continuous use of herbicide around WTG footings or other concrete-soil interfaces should be avoided as permanent loss of plant cover often results in localised erosion of the exposed soil surface. It is recommended the establishment of low-growing forms of native grasses; for example, *Cleistochloa subjuncea* and Kangaroo Grass (*Themeda triandra*) and shrubs such as *Acacia calyculata*, *A. whitei* and *Jacksonia thesioides* and other native shrubs should always be promoted to expand into disturbed sites.

4.0 MONITORING, REVIEW AND TRAINING

4.1 Monitoring

Monitoring of weed populations, control methods, decreasing or increasing populations, problematic species and new detections should be continuous throughout all stages of the wind farm. It is the responsibility of the Principal Contractor and/or the Environmental Officer to ensure progressive records and observations of weed management are kept. The EIS describes in detail the baseline information relating to the condition of all parts of the wind farm site and recognises the weed-degraded Kippen Drive as a critical potential source of weed invasion into the relatively pristine high ridge country south of the 275 kV powerline.

The performance indicators outlined below are derived from the current condition of the wind farm site and are intended to be an important aspect of determining a successful approach to weed management on the Mt Emerald Wind Farm.

4.2 Performance Indicators

The following performance indicators will help identify that the most efficient and effective methods of weed management are being implemented throughout the construction and operational phases.

- Construction and operation of weed washdown bays. Vehicle and machinery washdown log records maintained, complete and signed off.
- Development of weed management training and induction material for contractors, sub-consultants and personnel.
- Weed management training and inductions delivered to contractors, sub-consultants and personnel.
- Ongoing weed surveillance, monitoring and reporting completed for entire wind farm site monthly or more frequently if deemed necessary throughout the construction phase, and every three months during the operational phase.
- New infestations of invasive, environmental and / or declared weeds do not occur across the wind farm site (including WTG sites, access roads and tracks, substation, maintenance facilities and construction compounds) either during or after the construction phase.
- Native flora expands into disturbed areas after construction.
- A net reduction in weed species and population sizes across the wind farm site.
- Eradication of Giant Rat's Tail Grass, Mission Grass, Molasses Grass, Grader Grass, Signal Grass and Lantana along the existing 275 kV powerline access tracks and within the WTG operational area.
- The Weed Management Plan is reviewed and amended annually or before if deemed necessary.
- Corrective actions are implemented methodically and diligently.

4.3 Review and Evaluation of the Weed Management Plan

The Mt Emerald Wind Farm Weed Management Plan has a currency life of four (4) years and is effective from 2016 to 2020. After this period a review of the plan will be undertaken. Updates, amendments and corrections to the plan will be made annually to reflect changes to weed statuses (new threats or decreases in threats) on the wind farm, changes to legislation, and other relevant amendments as deemed necessary.

It is the responsibility of the Principal Contractor and the Environmental Officer to undertake the review.

Changes, modifications and amendments to the plan may be required on an annual basis, or earlier if necessary. These changes should reflect improved management actions and reassess management priorities in terms of problematic weeds or new infestations.

4.4 Reporting and Recordkeeping

An annual Weed Management Plan Review report is to be compiled, which will report on the following:

- Records of vehicle and machinery washdowns will be required to be compiled for any facility established in relation to the site.
- Techniques and control methods and dates of weed management actions.
- Records of any new, expanding or problematic weeds.
- Records of weed-contaminated roadbase and construction materials brought into the site from external sources.
- Records of contractor non-compliance with weed management protocols.
- Recommendations for corrective actions, and if implemented prior to the annual report, the dates, types and effectiveness of the corrective actions.
- Development of a complaints recording system: dates, source of complaint and type of complaint.
- An annual weed audit and report by an independent monitoring botanist or suitably qualified person. Weeds are to be re-mapped.

4.5 Training

Staff and contractors of the Mt Emerald Wind Farm must be aware of the importance of high quality and efficient weed management.

Site-specific training and environmental awareness must be undertaken and delivered to all contractors prior to construction. New contractors who enter the project at later stages of the construction and operation of the wind farm will need to receive the same level of weed management training.

Training must be delivered as part of site induction and toolbox meetings, which should include the following components:

- An outline of why the Mt Emerald Wind Farm project site is important in a regional context; and what specific environmental values the site holds. For example, the site south of the 275 kV powerline is unique in respect to its high elevation, sensitive environment.
- Weed identification sheets or guides should be made available, and should be able to be accessed at any stage of the project.
- Training should identify the priority weeds species described in this Weed Management Plan for the Mt Emerald Wind Farm.
- Reporting procedures for informing the Environmental Officer of weed sightings, new populations or evidence of weed spread. A database of these records should be kept and regularly updated by the Environmental Officer.

5.0 PRIORITY WEED PROFILES

The following weed profiles are of the priority species identified as posing a significant threat because of their invasiveness, modification of natural fire ecology and potential to cause serious environmental impacts in the long-term.

Information regarding relevant control methods is available as a number of factsheets published by either the Queensland or Federal Government. It is recommended that these factsheets are kept on file and updated when necessary. All factsheets should be reviewed annually by the Environmental Officer.

	**Grader Grass** (*Themeda quadrivalvis*) A highly invasive grass, which often lines the sides of tracks and is introduced by machinery such as slashers and graders. The grass grows to over 1 m tall and is characteristically golden brown when the seed heads start to mature. This grass dominates both sides of Kippen Drive and is also steadily entering the site at higher elevation through increased frequency of vehicles and periodic grading of the track.
	**Mission Grass** (*Cenchrus polystachyum*) A highly invasive grass that can grow to 3 m tall. It significantly increases the risk of hot fires and displaces native vegetation.

	**Giant Rat's Tail Grass** (*Sporobolus natalensis*) - Class 2 A highly invasive grass and difficult to eradicate. grows to over 2 m tall and has a fine. narrow seed head. Increases fire risk and displaces native vegetation. Also similar to **American Rat's Tail Grass** (*Sporobolus jacquemontii*) - Class 2, which is a shorter grass to 75 cm tall and has the same degrading characteristics.
	**Thatch Grass** (*Hyparrhenia rufa*) Thatch grass can grow to 3 m tall. Because of its height, it creates an unnatural fire risk, which once established can facilitate hot wild fires. It is currently present as scattered plants along Kippen Drive and one or two incidences higher into the wind farm site.
	**Molasses Grass** (*Melinis minutiflora*) Molasses Grass forms very dense swards, which outcompete most native vegetation. The grass grows to about 1 m tall and poses a significant fire risk. It is established in linear patches along Kippen Drive and also just above the watercourse under the 275 kV powerline. It is identified by its "sticky" foliage, which also has a distinctive smell.

	**Signal Grass** (*Urochloa decumbens*) Signal grass is widespread in pastures, but is becoming increasingly problematic in woodlands where it displaces native vegetation and prevents native species from establishing. The grass forms dense patches to 60 cm tall or more. It creates an increased fire risk and once established under native woodland is difficult to eradicate.
	**Rhodes Grass** (*Chloris gayana*) This grass can grow to 2.5-3 m. It is a successful coloniser of disturbed land and when established becomes persistent in the landscape. It displaces native flora and heightens the risk of unnatural fires.
	**Guinea Grass** (*Megathyrsus maximus*) A tall invasive grasses that will favour marginally wetter conditions. It poses a high fire risk because of the size of the grass, and will easily outcompete native vegetation. Guinea Grass is presently only in small areas along Kippen Drive and one or two isolated occurrences at higher elevation.

	**Hyptis** (*Hyptis suaveolens*) An open branched, erect shrub that completely dries out during the dry season, at which time it increases the risk of unnaturally hot fires developing. It typically grows along the edges of tracks and some incursions are found on the lower slopes leading into the wind farm site. Its main occurrence is along Kippen Drive.
	**Stinking Passionflower** (*Passiflora foetida*) Stinking Passionflower is a sprawling vine which smothers native vegetation. It has tendrils which assist it to attach to other plants. It is often seen adjacent to roads and areas of frequent vehicle use. Some incursions are found on the lower northern slopes of the wind farm site and along Kippen Drive. It displaces native plants and lowers natural integrity.
	**Lantana** (*Lantana camara*) - Class 3 Lantana is a highly invasive dense, tangled shrub which can grow to 3 m tall. Its colourful flowers are a characteristic which makes it easy to identify. When established, Lantana forms thickets which can heighten fuel loads and cause unnaturally hot fires. The shrub also displaces native flora.

	**Red Natal Grass** (*Melinis repens*) This grass is not yet problematic in the wind farm site at elevation. It is often encountered as scattered individuals in woodland. But once established (as along Kippen Drive), it forms dense patches similar to that of Molasses Grass. It contributes to unnatural fires and displaces native vegetation when growing densely.
	**Sicklepod** (*Senna obtusifolia*) - Class 2 Sicklepod is an erect shrub that can grow to 2-3 m tall. When mature it forms dense stands which outcompete native vegetation. The species produces very hard-coated seeds which remain viable in the soil for several years, making this weed difficult to eradicate if allowed to establish.
	**Gambia Pea** (*Crotalaria goreensis*) Gambia Pea is an erect shrub growing to approximately 1 m tall. When established it forms dense thickets, which displace native vegetation. It produces hard-coated seeds (similar to Sicklepod), which remain viable in the soil for many years. Isolated patches are found on the northern slopes and along Kippen Drive.

APPENDIX A

WEED SCHEDULE - Mt Emerald Wind Farm (including Kippen Drive)

							MEWF Management Priority		
Species	**Common Name**	**Habit**	**LP Act**	**MSPMP**	**WONS**	**Threats**	**Kippen Drive**	**WTG site**	**Location**
Ageratum conyzoides	Bluetop	Forb	-	-	-	Flora displacement	Low	Low	Kippen Drive and remote ridge at south of site.
Bidens pilosa	Cobbler's Pegs	Forb	-	-	-	Flora displacement	Low	Medium	Kippen Drive and 80 m wind monitoring tower.
Bryophyllum sp.	Mother of Millions	Forb	Class 2	-	-	Invasive	-	High	Isolated population on remote access track at minor watercourse crossing.
Cenchrus polystachyum	Mission Grass	Grass	-	-	-	Fire; invasive	Very High	Very High	Scattered swards along Kippen Drive and under 275 kV power near watercourse crossing.
Chamaecrista rotundifolia	Wynn Cassia	Forb	-	-	-	Flora displacement	Low	Medium	Kippen Drive and isolated at 80 m wind monitoring tower.
Conyza sumatrensis	Tall Fleabane	Shrub	-	-	-	Flora displacement	Low	Medium	Kippen Drive and 80 m wind monitoring tower.
Chloris gayana	Rhodes Grass	Grass	-	-	-	Fire; invasive	High	-	Kippen Drive at watercourse.
Chloris virgata	Feathertop Rhodes Grass	Grass	-	-	-	Invasive	Medium	-	Along Kippen Drive.
Crassocephalum crepidioides	Thickhead	Forb	-	-	-	Flora displacement	Low	Low	Kippen Drive and very isolated occurrence along ridge.
Crotalaria goreensis	Gambia Pea	Shrub	-	-	-	Invasive	Medium	Medium	Along Kippen Drive and isolated incidences in remnant grassland at northern end of site.
Cynodon dactylon	Couch Grass	Grass	-	-	-	Lowers integrity	Low	-	Kippen Drive.
Dactyloctenium aegyptium	Egyptian Crowfoot Grass	Grass	-	-	-	Flora displacement	Low	High	Scattered along Kippen Drive and one occurrence at 80 m wind monitoring tower.
Eleusine indica	Crowfoot Grass	Grass	-	-	-	Flora displacement	Low	Low	Along Kippen Drive.
Hyparrhenia rufa	Thatch Grass	Grass	-	-	-	Fire; invasive	Very High	Very High	Scattered clumps along Kippen Drive and isolated on site. Presently not common.
Hyptis suaveolens	Hyptis	Shrub	-	-	-	Fire; invasive	High	High	Kippen Drive and expanding into site along lower slopes.
Lantana camara	Lantana	Shrub	Class 3	29.5	Yes	Fire; invasive	High	Very High	Isolated along Kippen Drive and only seen under 275 kV powerline tower.
Macroptilium atropurpureum	Siratro	Vine	-	-	-	Invasive	Medium	-	Along Kippen Drive.
Megathyrsus maximus	Guinea Grass	Grass	-	-	-	Fire; invasive	Medium	High	One clump on site and scattered along Kippen Drive on marginally wetter soil.
Melinis minutiflora	Molasses Grass	Grass	-	-	-	Fire; invasive	Medium	Very High	Along Kippen Drive, at watercourse crossing under 275 kV powerline and sporadic occurrences in remnant vegetation on northern and eastern slopes.
Melinis repens	Red Natal Grass	Grass	-	-	-	Low fire threat	Low	Medium	Scattered and diffuse over site; denser along Kippen Drive.
Mimosa pudica	Sensitive Weed	Subshrub	-	-	-	Habitat degrading	Low	-	Along Kippen Drive.
Mitracarpus hirtus	White Eye	Forb	-	-	-	Flora displacement	Low	Medium	Kippen Drive and 80 m wind monitoring tower.
Passiflora foetida	Stinking Passionflower	Vine	-	-	-	Invasive	Medium	High	Kippen Drive and scattered on northern slopes.
Praxelis clematidea	Praxelis	Forb	-	-	-	Flora displacement	Medium	High	Widespread as individual plants in remnant areas, but notably denser around disturbed ground.

							MEWF Management Priority		
Species	**Common Name**	**Habit**	**LP Act**	**MSPMP**	**WONS**	**Threats**	**Kippen Drive**	**WTG site**	**Location**
Richardia scabra	Richardia	Forb	-	-	-	Flora displacement	Low	Medium	Kippen Drive and 80 m wind monitoring tower.
Senna obtusifolia	Sicklepod	Shrub	Class 2	27.0	-	Invasive	-	Very High	80 m wind monitoring tower. Not present in August 2016.
Setaria pumila	Pigeon Grass	Grass	-	-	-	Fire; invasive	Medium	-	Scattered along Kippen Drive.
Sida cordifolia	Flannel Weed	Shrub	-	-	-	Habitat degrading	Low	Low	Kippen Drive and isolated occurrences on northern slopes.
Sporobolus jacquemontii	American Rat's Tail Grass	Grass	Class 2	-	-	Invasive	High	Very High	Kippen Drive. Isolated specimens under 275 kV powerline.
Sporobolus natalensis	Giant Rat's Tail Grass	Grass	Class 2	26.8	-	Invasive	-	Very High	Under 275 kV powerline towers.
Stachytarpheta cayennensis	Dark Blue Snakeweed	Shrub	-	-	-	Habitat degrading	Low	-	Along Kippen Drive.
Stachytarpheta jamaicensis	Pale Blue Snakeweed	Shrub	-	-	-	Habitat degrading	Low	-	Along Kippen Drive.
Stylosanthes humilis	Townsville Stylo	Shrub	-	-	-	Flora displacement	Low	Low	Kippen Drive and 80 m wind monitoring tower.
Stylosanthes scabra	Shrubby Stylo	Shrub	-	-	-	Flora displacement	Medium	Medium	Kippen Drive and advancing into site along lower slopes.
Themeda quadrivalvis	Grader Grass	Grass	-	-	-	Fire, invasive	Very High	Very High	Entire length of Kippen Drive and expanding into site along lower slopes. Also under 275 kV powerline.
Tridax procumbens	Tridax Daisy	Forb	-	-	-	Habitat degrading	Low	Low	Kippen Drive and 80 m wind monitoring tower.
Triumfetta rhomboidea	Chinese Burr	Shrub	-	-	-	Habitat degrading	Low	Medium	Kippen Drive and isolated occurrences on northern slopes.
Urochloa decumbens	Signal Grass	Grass	-	-	-	Fire, invasive	Medium	High	Along Kippen Drive and developing patches under 275 kV powerline near watercourse crossing.

NOTES

A hyphen (-) in the table indicates that the species has not been recorded at a location; or the species is not listed under the *Land Protection (Pest and Stock Route Management) Act 2002* (LP Act), Mareeba Shire Pest Management Plan (MSPMP) or WONS (Weeds of National Significance). If a species is indicated as not being observed at a location this does not infer that the species is absent - weed surveillance should update presence if a weed is a new detection.

LP Act: Declared weed status under the *Land Protection (Pest and Stock Route Management) Act 2002*.

MSPMP: Priority score under the Mareeba Shire Pest Management Plan.

WONS: Indicates if the species is listed as a Weed of National Significance.

Threats: Describes the main threats and potential impacts that the species could cause once established.

MEWF Management Priority: This is the site-specific Mt Emerald Wind Farm priority ranking for management of weeds. It is based on invasiveness, current population sizes, potential to affect fire ecology and whether a species is considered to impose a significant threat to sensitive environmental areas. **Very High** - requires to be managed as a priority; **High** - requires early intervention and management; **Medium** - requires to be managed on a regular basis; **Low** - requires to watched and managed if deemed problematic.

Kippen Drive: Refers to the flat, modified land that will be used as the primary access from Springmount Road to the base of the wind farm site.

WTG site: Refers to all the land in which the wind farm operational infrastructure will be located and begins at the base of the hill at the terminus of Kippen Drive and extends into all ridges and land at higher elevation where WTG's, access roads, cabling network, lay-down pads, substation and compound infrastructure will be located.

APPENDIX B

WEED DISTRIBUTION - Mt Emerald Wind Farm (including Kippen Drive)

Site	Weed 1	Weed 2	Weed 3	Weed 4	Weed 5
1	Grader Grass	Feathertop Rhodes Grass			
2	Grader Grass				
3	Grader Grass	Stylo	Praxelis	Sicklepod	
4	Grader Grass	Mission Grass	Passiflora foetida	Stylo	
5	Grader Grass	Mission Grass	Passiflora foetida	Stylo	
6	Grader Grass	Hyptis	Red Natal Grass	Stylo	
7	Grader Grass	Melinis repens	Stylo		
8	Grader Grass	Hyptis	Stylo		
9	Grader Grass	Hyptis	Stylo		
10	Grader Grass				
11	Grader Grass				
12	Grader Grass				
13	Grader Grass	Mission Grass	Stinking Passionflower	Stylo	Praxelis
14	Grader Grass				
15	Grader Grass				
16	Grader Grass				
17	Grader Grass	Thatch Grass			
18	Grader Grass	Thatch Grass			
19	Grader Grass				
20	Grader Grass				
21	Mission Grass				
22	Grader Grass	Mission Grass	Thatch Grass	Signal Grass	
23	Mission Grass				
24	Giant Rat's Tail Grass	Grader Grass			
25	Grader Grass	Signal Grass	Stylo		
26	Grader Grass				
27	Giant Rat's Tail Grass	Grader Grass	Stylo		
28	Molasses Grass	Giant Rat's Tail Grass			
29	Mother of Millions				
30	Grader Grass	Stinking Passionflower	Hyptis		
31	Gambia Pea	Stinking Passionflower			
32	Gambia Pea				
33	Grader Grass				
34	Grader Grass				
35	Chinese Burr				
36	Molasses Grass				
37	Mission Grass				
38	Mission Grass				
39	Thatch Grass				
40	Rhodes Grass				
41	Lantana				
42	American Rat's Tail Grass	Rhodes Grass	Pigeon Grass		
43	Thatch Grass				

Legend

- Weed Sites
- Proposed Turbines
- Proposed Roads
- Proposed Turbine Pads
- Proposed Batter Extents
- Site Boundary
- Easements

Substation

Substation O&M Building

N

0 200 400 600

Meters (A3)

Project Manager	M. Jess
Compiled by	RMS
Map Projection	MGAz55
Map Datum	GDA94
File Reference	PR130417-10a.mxd
Sheet Number	1 of 1

Client: Ratch Australia

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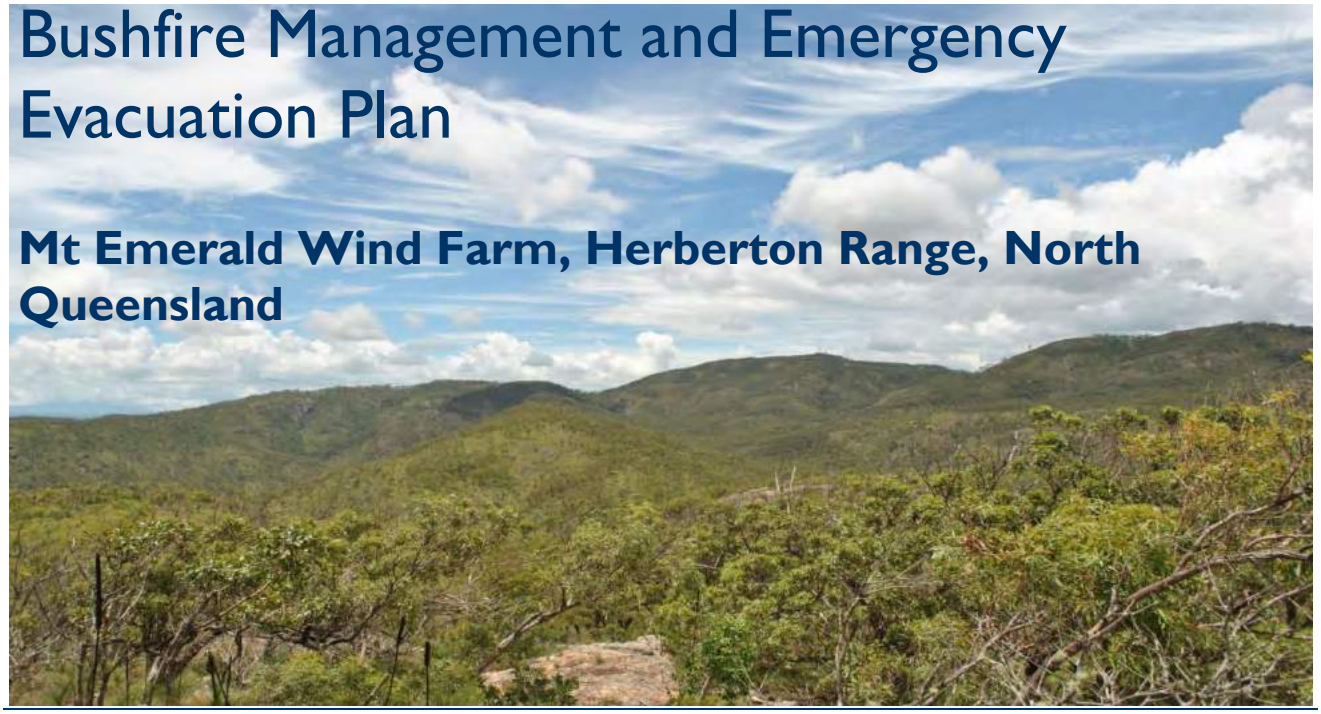
SCALE (A3)	DATE	DRAWING NO.	ISSUE
1:16,000	8/12/2016	PR130417-10	A

Appendix J

Bushfire Management and Emergency Evacuation Plan

Bushfire Management and Emergency Evacuation Plan

Mt Emerald Wind Farm, Herberton Range, North Queensland



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IMPORTANT NOTE

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In preparing this report we have made certain assumptions. We have assumed that all information and documents provided to us by the Client or as a result of a specific request or enquiry were complete, accurate and up-to-date. Where we have obtained information from a government register or database, we have assumed that the information is accurate. Where an assumption has been made, we have not made any independent investigations with respect to the matters the subject of that assumption. We are not aware of any reason why any of the assumptions are incorrect.

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Document Status

Version	Purpose of Document	Orig	Review	Review Date
1	Draft	BC	MJ	04/08/2016
2	Review	BC	TJ	15/08/2016
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Final	Final Report	MJ		08/12/2016

Approval for Issue

Name	Signature	Date
Mellissa Jess		08/12/2016

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1.0 Introduction

This Bushfire Management and Emergency Evacuation Response Plan (the plan) is prepared for RATCH Australia Corporation Limited (RACL) for construction and operational activities proposed to be carried out on the Mount Emerald Wind Farm (MEWF) site. The Plan is prepared in accordance with State Planning Policy 1/03 - *Mitigating the Adverse Impacts of Flood, Bushfire and Landslide* (SPP 1/03).

The project area comprises Lot 7 on SP235224, Easements A, C & E in Lots 1, 2 & 3 on SP231871 and part of Lot 905 on CP896501. The project involves the construction and operation of a wind farm located approximately 20 km SSW of Mareeba on the Atherton Tablelands in north Queensland. The project approval allows for the construction of up to 63 wind turbines, associated access tracks and an electricity substation that will feed into the main electricity grid (Powerlink's Chalumbin – Woree 275 kV transmission line).

Fires have the potential to impact upon flora, fauna, and infrastructure within the MEWF site. The fire risk varies throughout the study area dependent on topography. Bushfire danger season is typically from August to late October in north Queensland when the dry season is nearing its end and both temperatures and winds are on the increase. Fire is an important landscape function and should be managed in respect to vegetation and human safety.

The purpose of this Plan is to focus on preventing fires on the MEWF site and to be prepared should a bushfire be ignited or pass through the site.

1.1 The Project

The Mount Emerald Wind Farm (MEWF) is approved for the construction of up to 63 wind turbines on an elevated site approximately 20 km SSW of Mareeba on the Atherton Tablelands in north Queensland (**Figure 1**). The towers will be approx 80-90m high with approximately 55-60m blades, utilising 3.3-3.45 MW machines.

The site where the wind turbines, interconnecting tracks and associated infrastructure are to be established is on land formally described as Lot 7 on SP235224, which encompasses an area of 2,422ha. This land forms the terminus of the Herberton Range and is contiguous with Mount Emerald (proper) at its southern boundary. Virtually all the wind farm project area is covered by remnant and relatively undisturbed vegetation, where the only land modification is associated with the existing 275 kV transmission line infrastructure and its series of access tracks. Kippen Drive at the base of the site is severely degraded in most zones adjacent to the unsealed road, and weeds are conspicuous.

The wind farm site has been selected on the basis that it represents an excellent wind resource because of its elevated position and series of high ridges. The elevation range of the site is between 540m up to 1089m above sea level (ASL). The highest ridges south of the existing 275 kV transmission line hold the most significant value in terms of flora and represent an important tract of land with functional connectivity to other regional nodes of high biodiversity importance. Although land to the north of the transmission line (including the landmark of Walsh Bluff) possesses lower floristic diversity, it is recognised for its habitat value for the endangered Northern Quoll (which is also expected to occur south of the transmission line).

The wind farm project estimates to deliver up to 650,000 megawatt hours of renewable energy, which is predicted to meet the annual needs of approximately 75,000 North Queensland homes over a 20 year period.

The wind farm will be connected to the existing Chalumbin –Woree 275 kV transmission line via a substation, which is to be located within the site. The 275 kV transmission line infrastructure that traverses the site was established in 1998 and represents a pre-existing disturbance footprint which the proposed wind farm will take advantage of in order to minimise the area of new impacts to the environment.

From a constructability perspective the northern sector of the site has more undulating landforms and fewer dissected ridges. There also appears to be a higher proportion of former landscape disturbance in the northern sector and across the east-facing slopes on the Walkamin side.

1.2 Construction Details

Access to the site will be via Kennedy Highway, onto Hansen Drive and then into the site at a realigned Springmount Road - Kippen Drive intersection. Kippen Drive is currently unsealed. A series of access and interconnecting tracks will need to be constructed within the wind farm site, and will take advantage of existing transmission line infrastructure tracks wherever possible. A number of new tracks will need to be constructed to an initial cleared width of approximately 10m. The interconnecting tracks will form the routes for the inter-turbine underground cabling – expected to be buried in trenches at approximately 1m deep.

Each turbine construction pad is expected to occupy an area in the order of 40m (long) x 60m (wide). The substation and associated compound will be in the order of 200m x 200m or similar configuration and will be located close to the existing 275 kV transmission line which crosses the site.

Wind turbines will be "micro-sited" – a technique which involves selecting a position in the landscape where the, environmental, constructability and other impacts area considered and weighed up. As part of this procedure, comprehensive ground surveys will be undertaken of each site to ensure impacts to conservation significant species and other matters of importance are minimised or avoided.

A wind farm operations building will be constructed adjacent to the substation, which will house monitoring and communications equipment. Other associated internal infrastructure will include car parking areas, construction compound and machinery area. Depending on the outcomes of relevant approvals, a batching plant may be temporarily constructed within the site.

The Mount Emerald Wind Farm (MEWF) project has been broadly categorised into four phases: pre-construction, construction, operation and maintenance and decommissioning. Rehabilitation and impact mitigation will be actively practiced throughout these stages and will be informed by respective plans and strategic documents.

In preparing the Environmental Impact Statement (EIS), several specialist investigations were undertaken and accompanying technical reports prepared. These include the disciplines of flora, fauna, general environmental reporting and offsets plan; town planning; aeronautical assessment; transport and traffic assessment; shadow flicker, electromagnetic interference, and energy yield; geotechnical; visual and landscape aesthetics; noise mapping; cultural heritage; community consultation; and social and economic assessment.

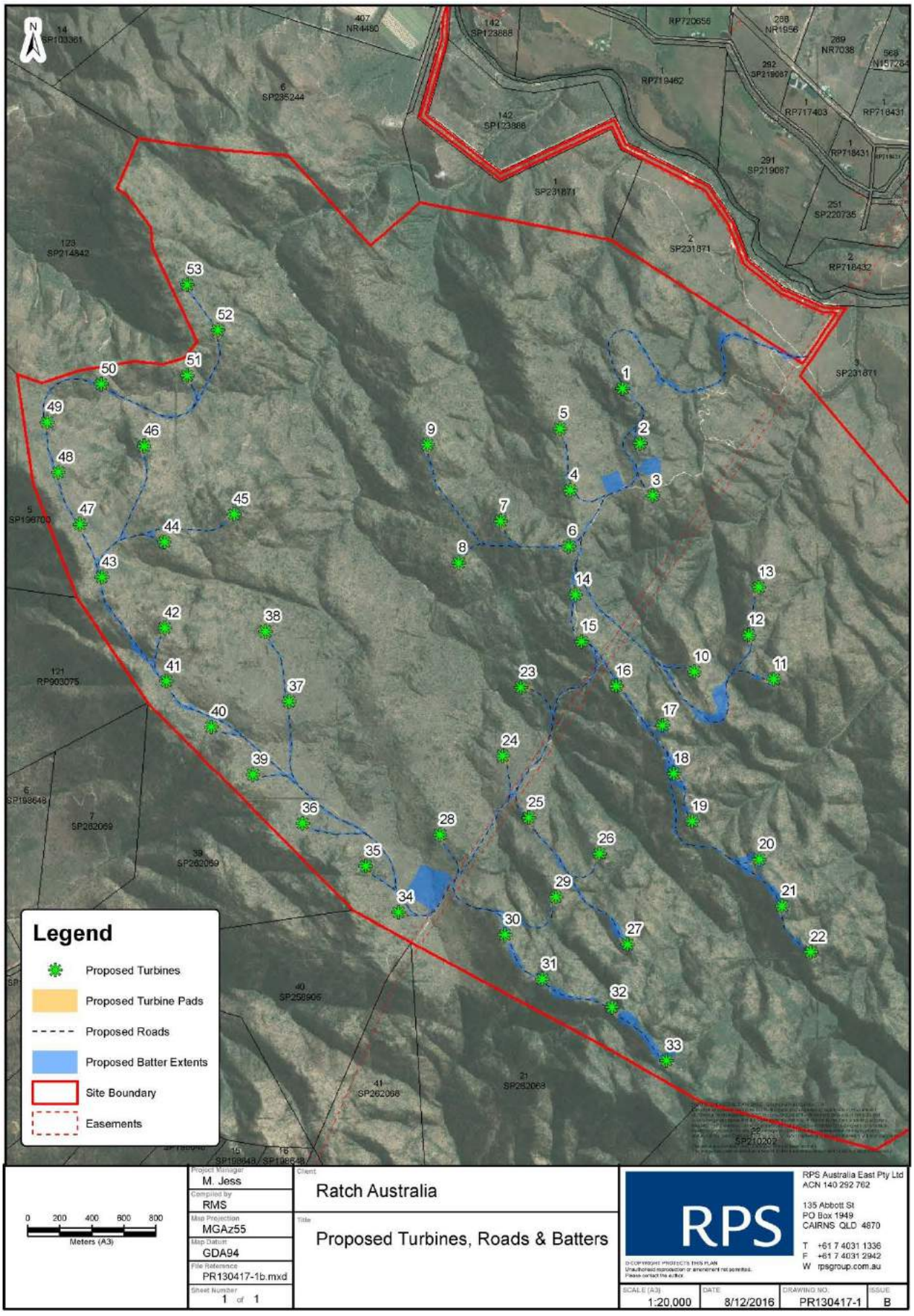


Figure 1 Project Site Location

1.3 Site Details

Lot 7 is a large rural allotment, situated (at its closest point) approximately 3.5km south-west of Walkamin, off Springmount Road at Arriga on the Atherton Tablelands. The site is characterised by rugged terrain with elevations of between 540m up to 1089m above sea level (ASL). Virtually the entire site is covered by remnant vegetation, as defined under Queensland's *Vegetation Management Act 1999* (VMA).

Bushfire hazard mapping which considers factors such as vegetation type, slope and aspect to determine the level of bushfire hazard is shown in **Appendix 1**. This map shows the majority of the eastern portion of the site (east of the powerline) is rated high and very high potential bushfire intensity risk. Northern extents of the site where the slope gradient is high also have significant areas of very high potential bushfire intensity risk. The correlation between slope gradient and bush fire potential is clear.

Fire mapping based on interpretation of satellite imagery obtained from the Northern Australia Fire Information (NAFI, 2016) indicates that the entire site was burnt most recently in a September 2015 event which covered 70.1km^2. Previous to this, a summary of recent fires recorded is provided in **Table 1**:

Table 1 Major Fires Summary (NAFI 2016).

Fire Date and Month	Area of Site Burnt
August 2011	21.8km^2
2009 (Month Unknown)	8.75km^2
December 2006	2.7km^2
November 2004	0.1km^2
October 2003	7.9km^2
November 2001	72km^2

From visual assessments of the extent of scorching on trees, the fires are presumed to have been relatively hot and ferocious – extending completely into the crowns of trees in the canopy of vegetation to 10m high. This was particularly evident on hill slopes and at the crest of hills however evidence of powerful fire was found across the entire site.

The 2009 fire does not appear to have affected the whole project area. For example, the flat-bottomed valley in the interior and the western ridgeline remained relatively unburnt and showed fewer signs of severe fire impact. In this sense, it is believed fire passes through the project area on a periodic basis – enough to limit the development of excessive fuel loads.

1.4 Climate and Rainfall

The dominant rainfall pattern of the local area is monsoonal, with alternating wet and dry seasons that typically last for four and eight months respectively. The Walkamin Research Station (Bureau of Meteorology station number 031108, elevation 594m) has been selected as a suitable reference site, due to its close proximity (situated 6km from the wind farm) and availability of long term climate records. A summary of the weather data from this station is presented in **Table 2**.

Table 2 Summary of Weather Data for Walkamin Research Station (BoM, 1965 - 2016)

Weather Conditions	Measurements
Mean Annual Rainfall	1022.3mm
Highest Annual Rainfall	1750.5mm (1974)
Lowest Annual Rainfall	470.2mm (2002)
Highest Monthly Rainfall	894.1mm (Feb 2000)
Lowest Monthly Rainfall	0.0mm (May 2001)
Mean Annual Minimum/Maximum Temperature	17.0°C/27.4°C
Highest Temperature	39.8°C (19 Nov 1990)
Lowest Temperature	2.6°C (4 July 1984)

Bureau of Meteorology (2016).

Average annual rainfall in the area is 1022.3mm with the wettest month being February (248.9mm), and the driest month being September (8.4mm). The majority of rain (80%) falls within the months of December to March. This rainfall distribution over the year is displayed in **Figure 2** (BoM, 1965 – 2016):

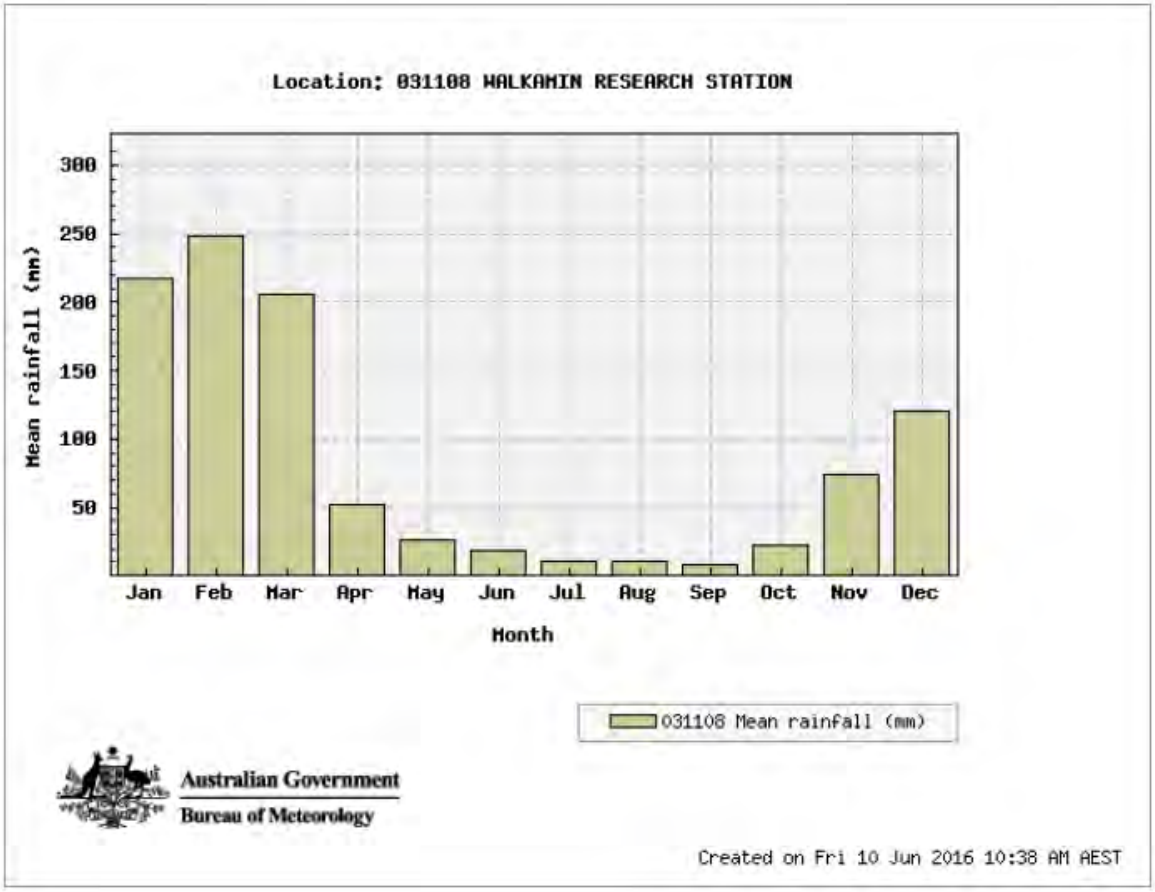


Figure 2 Mean monthly rainfall for Walkamin Research Station (BoM, 1965 – 2016)

The highest aspects of the site are 1089m ASL, which are 550m higher in altitude than the Walkamin Monitoring Station. The change in temperature as a function of elevation is typically between 0.6°C and 1°C per 100m increase in altitude (BOM, 2013), but this can vary significantly by factors such as wind speed, moisture and daily temperatures. Some of the highest elevated parts of the site also experience higher precipitation and ground moisture due to cloud stripping, as clouds intersect the landform.

1.5 Surrounding Land Uses

Land surrounding the subject site is utilised for a diverse array of land uses, as a result of the changing nature of the agricultural industry, the size of surrounding land holdings, topography and soil characteristics.

While the majority of the area surrounding the project site has been extensively cleared and historically used for livestock grazing and agricultural pursuits, a number of recent approvals issued upon adjacent properties reflect the changing land uses in the area, from passive agricultural and pastoral uses to more intensive farming practices and other industrial and agribusiness practices. A representation of these land uses is shown in **Figure 3**. There are approximately 118 receptors (representing individual residences, or in some cases groups of residences) in total, associated with both farming and other uses located within a 5 km radius of the windfarm.

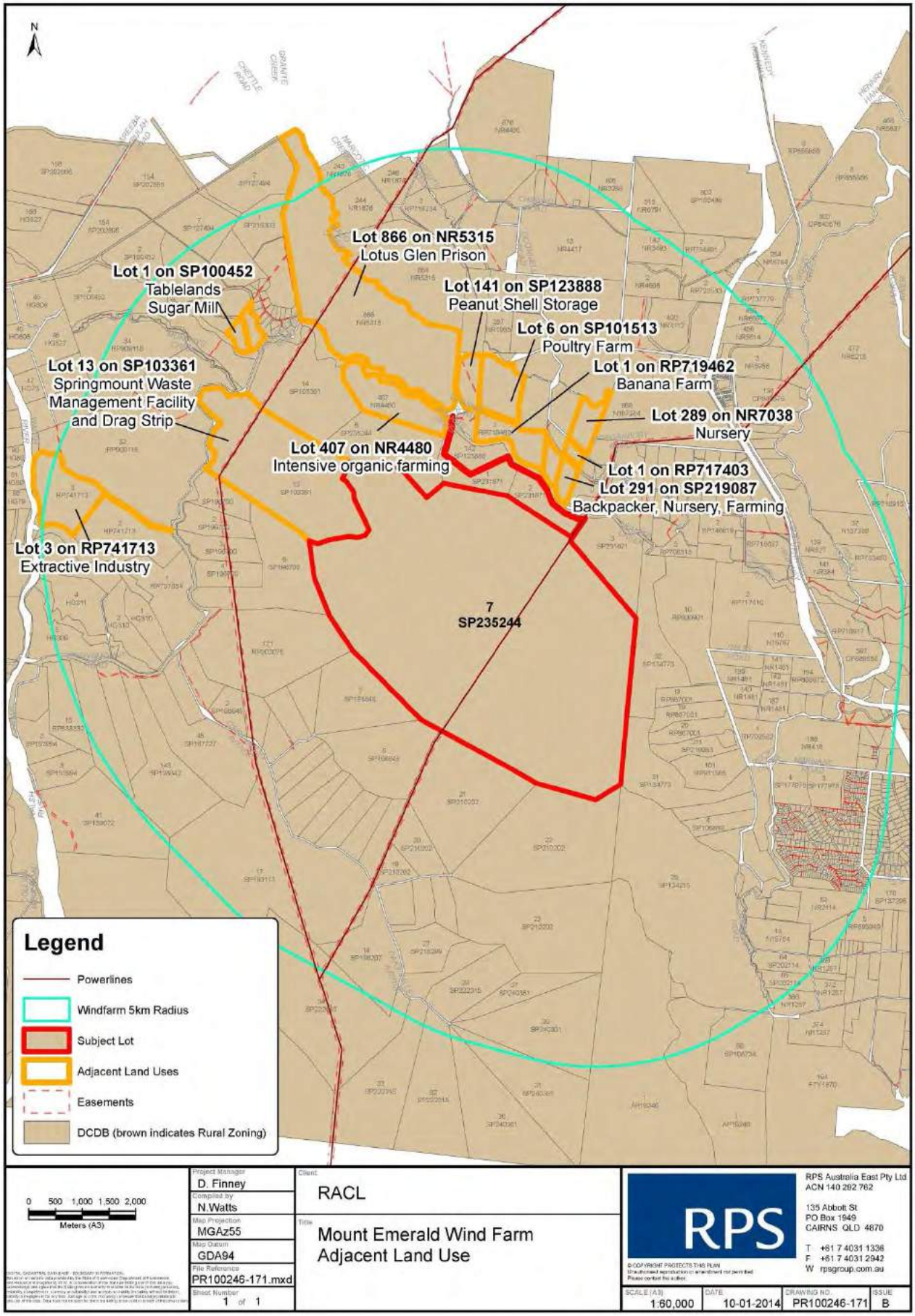


Figure 3 Surrounding Land Uses

1.6 Topography

The project site is situated over mountainous terrain coinciding with the northern extent of the Herberton Range. The site is characterised by acid igneous rhyolite geology forming windswept ridges and rock outcrops interspersed with rock pavements, which support skeletal soils. Between these prominent features are undulating valleys. The site is broadly divided in terms of the degree of surface relief. This has bearing on the landforms and vegetation types. To the south of the Chalumbin to Woree 275 kV transmission line the land is conspicuously dissected, rugged and characterised by narrow, high ridges and in some instances, precipitous slopes. The land to the north of the transmission line exhibits less surface relief, dissected ridges and steep slopes. The landform generally becomes more undulating in this northern area, until the escarpment edges of the mountainous range is reached.

1.7 Vegetation

Several REs (regional ecosystems - remnant vegetation communities) are mapped over the project site. The transmission line which bisects the site generally coincides with the boundary between two bioregions:

- The Wet Tropics to the south of the transmission line; and
- The Einasleigh Uplands to the north.

The Wet Tropics bioregion to the south of the transmission line is characterised by shrubland and low woodland with open canopies. The shrub layer can at times be quite thick, covering the ground layer. The canopy layer is dominated by Eucalyptus and Corymbia species with canopies typically 5-10m in height. These areas are typically higher in elevation and experience cloud stripping in many areas above 900m and therefore experience cooler environments with increased precipitation.

The Einasleigh Uplands to the north of the transmission line are characterised by low woodland to low open woodland. The ground layer is dominated by grass species and has a sparse shrub layer. Eucalyptus and Corymbia species again dominate the canopy layer with heights up to 8-12 meters. These areas typically have less relief, remain below 900m and hence do not receive extra precipitation due to cloud stripping and consequently are typically drier than to the south of the transmission line.

1.8 Fire History

As discussed in **Section 1.1**, fire mapping based on interpretation of satellite imagery obtained from the Northern Australia Fire Information (NAFI, 2016) indicates the entire site was burnt most recently in 2015. It should be noted that the pixel size of the MODIS satellite imagery is approximately 250 m^2 so the mapping is unable to provide an accurate indication of the degree of the spatial heterogeneity of fires. Summary reports obtained from NAFI can be found in **Appendix 2**.

From visual assessments of the extent of scorching on trees, the fires are presumed to have been relatively hot and ferocious – extending completely into the crowns of trees in the canopy of vegetation to 10 m high.

1.8.1 Wind Farms and Fire

Research and operations over the past 20 years suggest that there is little chance of operational wind farms to create a fire risk (Macintosh and Downie, 2006) in Australia. Wind turbines have the potential to create fire hazard in two ways (Flynn 2004):

- mechanically in which turbine bearings wear out, electrical shorts occur or cables are damaged for example; and
- lightning strikes due to the turbines height.

A review of available data reveals three wind turbine fires being reported in Australia with the root cause of each being attributed to mechanical issues. In each case the fires did not spread beyond the turbine due mostly to the passive nature of the turbines (few flammable materials), their lightning protection equipment, and in part due to the wind farms fire management strategy.

The impact of a bushfire on WTG's at MEWF should be limited. Fires will be hot and fast but are unlikely to burn for long enough periods in the vegetation surrounding a turbine to cause damage, especially if asset protection zones and other aspects of this plan are followed. It is unlikely that damage from flames could reach the nacelle or blade tips (lowest point is approximately 30m above ground level) given past fires height estimated at being no higher than 10m above ground level. The greatest risk will be to the substation and other associated maintenance infrastructure on site which can, if damaged, interfere significantly in the wind production capability on site.

2.0 Regulatory Requirements

2.1 Project Approvals

2.1.1 Sustainable Planning Act 2009

Conditions relevant to the preparation and implementation of the Bushfire Management and Emergency Evacuation Plan (BMP) are detailed in Condition 13 of the Ministerial Decision Notice.

2.1.1.1 Ministerial Decision Notice

The Development Notice (dated 18 December 2015) in accordance with the SPA included a number of conditions relating to the preparation of a BMP. *Condition 13 - Environmental Management* which relates to the BMP, states the following:

Submit to the chief executive administering SPA an Environmental Management Plan (EMP) prepared by a suitably qualified person(s). The EMP must:

i. be generally in accordance with the Preliminary Environmental Management Plan prepared by RPS and dated November 2013 and the draft Statement of Commitments contained within Appendix A of the RPS Development Application Material Change of Use Report dated March 2012;

ii. be based on the revised Turbine Location and Development Footprint Plan submitted in accordance with condition 2 of this approval;

iii. include the following components, as further detailed in Attachment 1:

- *a bushfire risk management plan and emergency evacuation plan (timing as required with the EMP).*
- *an ecological fire management plan (timing as required with the EMP).*

3.0 Bushfire Management Plan

Fire risk can be minimised through strategically managed vegetation and landscaping, and this Plan considers the use of Asset Protection Zones around buildings (where turbine infrastructure are also considered buildings), whereby a range of landscape features such as mature trees, can be retained to maintain elements of the natural character of the site.

3.1 Maintenance of Vegetation

Traditionally and in accordance to guidelines of SPP 1/03, vegetation is cleared around buildings to a distance of 1.5 times the average height of the adjacent trees. Vegetation is up to 12m in height; therefore in some instances a clearance distance of 18m will be required around buildings/substation/switchyard/wind turbine generators. Roadways and regularly maintained landscaped grounds with low-growing and shrubby plants can be included as part of the cleared zone (see Asset Protection Zones).

3.2 Asset Protection Zones

Where it is considered safe to do so, an Asset Protection Zone (APZ) can be incorporated as a landscaping feature into the vegetation clearing area around buildings and other wind farm infrastructure that requires protection from fire. The concept of Asset Protect Zones aims to retain natural characteristics of the ground such as trees and patches of vegetation, whilst reducing the potential for high intensity bushfire contacting with buildings and other fire sensitive wind farm infrastructure. Subsequently, the Asset Protection Zone is a low fuel load area surrounding buildings and other wind farm infrastructure.

Any Asset Protection Zones should be managed so that the fire hazard is substantially reduced and in particular to reduce the chance of a fire damaging wind farm infrastructure. For example, large and healthy trees can be retained as isolated, stand-alone specimens surrounded by areas of mowed grass or other 'fire proof' surfaces. Likewise, small pockets of natural shrubby vegetation can be preserved providing they are of a manageable area and also surrounded by mowed grass or 'fire-proof' surfaces such as pathways or short-growing vegetation with low flammable properties. This is shown diagrammatically in **Plate 1** below.

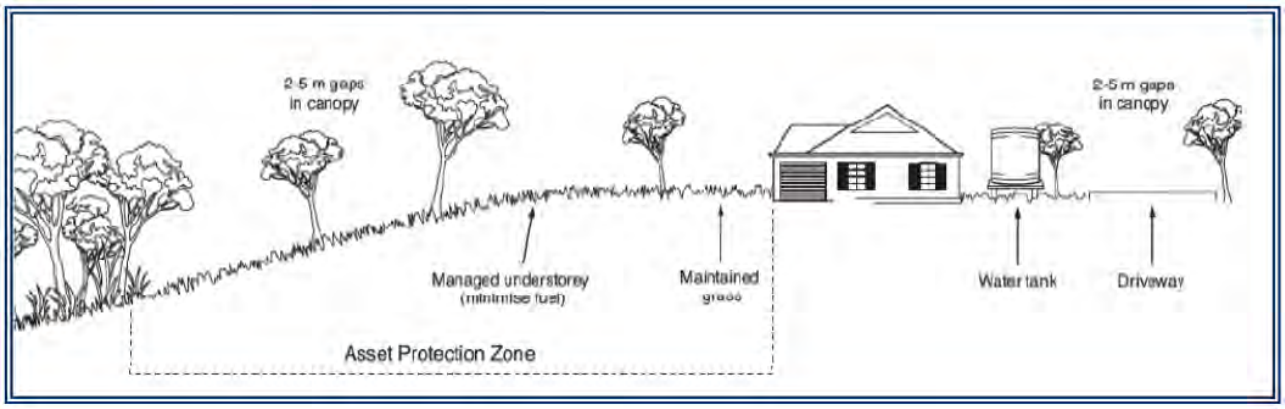


Plate 1 Asset Protection Zone

Mowed grass areas or other fire proof surfaces or short vegetation with low flammability to ensure that wind farm infrastructure is separated from contiguous and subsequently hazardous, fire-prone areas of vegetation; thereby reducing the overall fire hazard and intensity. Mowed grass areas also allow for more free-flowing pathways for emergency vehicles, and can serve as emergency evacuation points.

Where trees such as Eucalypts are to be retained, their canopies should be separated by at least 2m and ideally up to 5m to avoid crown fires developing.

4.0 Bushfire Hazard Reduction Measures

Reduction of fuel loads in an APZ does not have to be as drastic as removing all vegetation, particularly in sensitive receptor environments. Bushfire fuel loads can be reduced, removed or changed through several means as discussed below.

Bushfire Mitigation and Management Measures for the Operation Phase of the Project are contained with **Appendix 3**.

4.1 Maintenance of APZ

The following suggested recommendations for gardens and landscaping are given in relation to the maintenance of the APZ:

- Low-cut lawns or other fire resistant surfaces should be maintained adjacent to buildings.
- Areas under and along fences and gates should be maintained free of fuel (i.e. tall grasses and weeds).
- Do not allow tall, weedy grasses such as Guinea Grass (*Megathyrsus maximus*) to establish in the APZ.
- Trees and shrubs should not overhang dwellings and should be pruned as necessary.
- Tree canopies should not be continuous in the APZ (should be spaced as per section 3.2).
- Gutters and valleys should be kept clear of leaves at all times and regularly inspected.
- Minimise mulched areas, or mulch where irrigation is installed.
- Keep gardens well-watered.
- Ensure that the access is maintained entirely unobstructed around the buildings.

4.1.1 Clearing and Pruning

The management of existing vegetation involves both selective fuel reduction (removal, thinning and pruning) and the retention of vegetation. The majority of the leaves and groundcover should be removed from the surface. Valuable native trees and shrubs (such as threatened species) should be retained as clumps or islands. In selecting vegetation for removal the following features should be considered in order:

- Species that are listed by the local authority, as noxious or environmental weeds should be removed in preference to other species.
- Non-native woody plants should be removed in preference to other species.
- Species with rough, flaky or stringybark should be removed in preference to those with smooth or tightly held bark.
- Small trees without hollows should be removed in preference to larger trees and trees with hollows.
- Locally common species should be removed in preference to species listed by the authorities as threatened, regionally significant, or valuable for habitat or food source.
- Trees that have been determined to be structurally dangerous should be removed in preference to other trees.

4.1.2 Mowing and Slashing

Slashing and trittering are economical methods of reducing fuel. However, for these methods to be effective, the cut material must be removed or allowed to rot well before summer starts. Grass needs to be kept short and mowed regularly. Slashing and trittering is only practical in some situations. Alternative means of hazard reduction may be necessary where it is unsafe to implement a particular method of fuel reduction.

4.1.3 Fire Break

As clearing restraints are applicable, firebreaks around the entire site are not possible. Access tracks will help provide a break and defendable space which will assist in arresting any fires.

4.1.4 Hazard Reduction

Hazard reduction burning may be undertaken to assist in reducing fire danger, as mechanical means may be constrained by the rocky terrain. A Permit to Light Fire is required to be obtained from a Fire Warden prior to undertaking any hazard reduction burning. Local fire wardens are able to be contacted through the Mareeba Office, contact details are provided in **Table 3**.

Table 3 Mareeba Area Office Contact Details

Street Address	20 Mammino Street, Mareeba
Phone	(07) 4092 1044

Alternatively the Queensland Fire and Emergency Services can be contacted on:

Street Address	Corner of Grogan and Gatton Streets, Westcourt
Phone	(07) 4232 5468

Regional ecosystem descriptions provided by the Queensland Department of Environment and Heritage Protection (EHP) recognise the fuel loads of this vegetation community and that of surrounding country needs to be maintained so that wildfires will be limited in extent. The fire management guidelines provided by EHP are directed at maintaining the regional ecosystems biodiversity. It is recommended that annual inspections are conducted by a suitably qualified person to determine fuel load quantities and conditions (weed invasion, etc) and therefore the optimal burning interval and timing. Burning intervals and timing are likely to change depending on the annual rainfall and weed invasion. Refer to **Section 5.0**.

4.1.5 Inspections

A pre (June) and post (November) bushfire season maintenance program to reduce fuel loads (e.g. mowing and slashing) should be undertaken. An additional annual inspection to determine the requirement for hazard reduction burning should also be undertaken. This should be undertaken in conjunction with an Ecological Fire Management Strategy as outlined in **Section 5.0**.

4.2 Fire Fighting Equipment

Provision of fire fighting equipment during declared fire danger periods;

All project vehicles will contain a fire extinguisher and CB radios. A specific project vehicle will be fitted with a water tank, diesel pump, 30m fire hose and a knapsack spray. Each Wind Turbine Generator contains a fire extinguisher in the base of the tower and up in the nacelle.

4.2.1 Water Supply Tanks

Criteria for the provision of static water supply tanks solely for fire fighting processes including minimum capacities, appropriate connection and signage;

An adequate supply of water is essential for fire fighting purposes when considering all forms of development. As reticulated water supply is not available on site, two static water supplies will be available for fire fighting purposes, located centrally and which are easily accessible.

One storage container will be located at the Substation, Operation and Maintenance Building with the other at the Contractors Site Compound. Each will contain a water tank (approx. 50,000 litres capacity) collecting

water from the buildings in the compound. The tank will be fitted with outlets allowing fire trucks to connect to the tank. Should the water level drop below a minimum set point a water truck will deliver water to the tank. Guidance from Rural Fire Services Queensland (RFSQ) will be sought on what the minimum level within these tanks should be. The storage tanks shall be of non-combustible construction and fitted with a 65mm outlet completed a 65mm ball valve and Stortz coupling; or the preferred connections approved by the RFSQ. Adjacent to the water tanks will be a fire hose reel (30m) and a diesel pump to provide coverage in and around the buildings. All buildings will be fitted with smoke detectors and contain portable fire extinguishers. All fire extinguishers will be checked on a 12 monthly basis.

4.3 Emergency Services Access

Procedures for vegetation management, fuel control and the minimum standards for access roads and tracks to allow access for fire fighting vehicles including criteria for access to static water supply tanks for fire fighting vehicles;

Property and internal access roads should enable safe access, egress and defendable space for emergency services. Traffic that will require access to the site includes light vehicles, semi tippers or truck dog combinations. The access roads and manoeuvring areas throughout the site need to ensure safe access for vehicles. The following identifies road widths and design aspects to enable safe access for vehicles:

- Have a minimum cleared width of 6m and a formed width of 4m.
- Dead end roads, incorporate a minimum 12m outer radius turning circle, and be clearly sign posted as a dead end and direct traffic away from the hazard.
- A minimum vertical clearance of four metres to any overhanging obstructions, including tree branches.
- Internal roads provide a loop road around any office or incorporate a turning circle with a minimum 12m outer radius.
- Curves have a minimum inner radius of six metres and are minimal in number to allow for rapid access and egress.
- The minimum distance between inner and outer curves is 6m.
- The crossfall is not more than 10 degrees. Where a 10 degree crossfall is unachievable, either an alternate route is to be provided or the access road is sufficiently formed to prevent erosion and slope instability.
- Access road shall be designed to carry a fully laden RFSQ tanker of 15 tonnes GVM.

All onsite access roads are to provide safe, all weather access to structures and allow safe access for fire fighters while employees and contractors are evacuating the site. Directional signage should be installed to identify major tracks and the most direct route to the site office and emergency egress points.

4.3.1 Evacuation Routes

Consideration needs to be given to the safety of employees and contractors occupying the site during an incident. It may be safer to remain on site and seek shelter in a safe place. A designated assembly area should be nominated greater than 300m from the nearest significant bushfire hazard and greater than 100m from major electrical infrastructure.

4.4 Building Standards

Details of a lighting and earthing system to mitigate against the risk of bushfires caused by direct lightning strikes on the turbines

Wind Turbines and Substation

The wind farm design shall ensure all wind turbine and wind farm substation equipment is shielded and protected against direct lightning strike as detailed in International Standard *IEC61400-24 Wind Turbine Generator Systems – Part 24: Lightning Protection* and Australian Standard *AS1768 Lightning Protection*. The wind turbines, wind farm substation and associated equipment shall be suitably protected against damage caused from lightning and over-voltages due to lightning.

The lightning protection systems together with the grounding system shall:

- Minimise any danger to people in the immediate surroundings of the wind turbines and wind farm substation;
- Prevent fire / overheating; and
- Prevent any mechanical damage.

Buildings

The following recommendations for the construction of buildings and other structures have been prepared to ensure that an adequate level of protection to life and property on the site is provided.

- All exposed external cabling is adequately secured to prevent physical damage/breakage which may cause ignition of vegetation.
- All cabling within 100m of the nearest bushfire hazard is to be protected by a non-combustible conduit that is heat resistant and unlikely to melt or warp due to radiant heat.
- Any new buildings shall comply with the Bushfire Attack Exposure specifications of BAL-FZ construction in accordance with Australian Standard *AS3959-2009 Construction of buildings in bushfire prone areas*.
- External openings such as vents/louvres, skylights, cable entry ducts and air-conditioning intake grills shall be protected against the entry of flying embers. These openings shall be fitted with external mesh screens comprising stainless steel mesh with a maximum aperture of 2.0mm.

5.0 Ecological Fire Management

Fire is an integral component of many landscapes in far north Queensland and has been continually impacting on the MEWF site at interval. It plays an important role in biodiversity and ecosystem function and for some species it is a necessary dynamic in their lifecycle. Fire ecology (intensity, timing, duration etc) is critical for the successful regeneration of some plant communities and also brings a change to the fauna composition due to attraction of new species to seeding and flowering ground cover, for example.

Inappropriate fire regimes may occur due to the development and their impact can be severe. Changed fire ecology can often result in species elimination and / or the promotion of different plant functional groups, and consequently change the habitat micro-environment.

On the sensitive ridge top environments obligate seeder species are killed by fire and regenerate through germination of seed stored in the soil seed bank; whereas, resprouters recuperate after fire by reshooting from stems or rootstock. As many rock areas are considered refuges, inappropriate fire regimes that breach the natural level of protection afforded by rock pavements and outcrops are likely to have a deleterious effect at least in the short-term, with further possibility in the longer-term if the fire event is unnaturally severe. These impacts can extend to altering the habitat structure thus reducing food availability, and subsequently impacting on fauna species lifecycles.

It is therefore crucial that fire management of vegetation communities be undertaken on the MEWF project site to ensure both the project and the environmental values of the property are protected.

5.1.1 Regional Ecosystems

Several REs (regional ecosystems - remnant vegetation communities) are mapped over the project site. The transmission line which bisects the site generally coincides with the boundary between two bioregions:

- The Wet Tropics to the south of the transmission line; and
- The Einasleigh Uplands to the north.

The RE vegetation mapping for these bioregions is at a scale 1:50,000 and 1:100,000 respectively. A summary of the mapped RE's of the project area is given in **Table 4** below.

The Wet Tropics Bioregion is not considered to contribute to the Wet Tropics World Heritage Area (WTWHA). The Wet Tropics bioregion and the WTWHA are unrelated biophysical mapping areas. Mapping of the boundaries of these entities (**Figure 4** and **Figure 5**) indicates the physical separation of the Wet Tropics bioregion section of the wind farm site (see inset), and the WTWHA boundary. The WTWHA boundary has two sections – to the south, and to the east - both separated from the site by farm land, roads and built infrastructure.

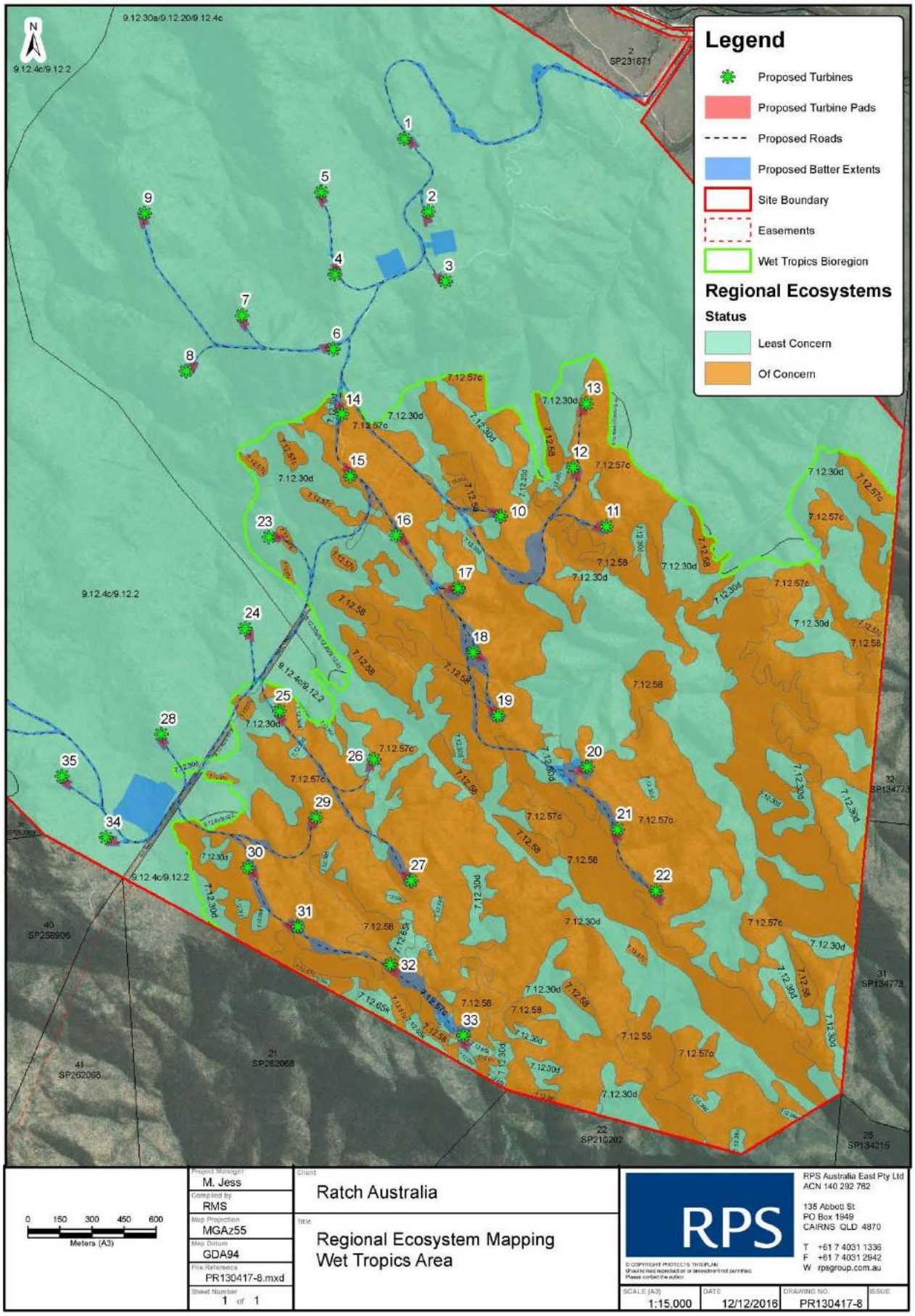


Figure 4 Regional Ecosystems on Southern Extent of MEWF.

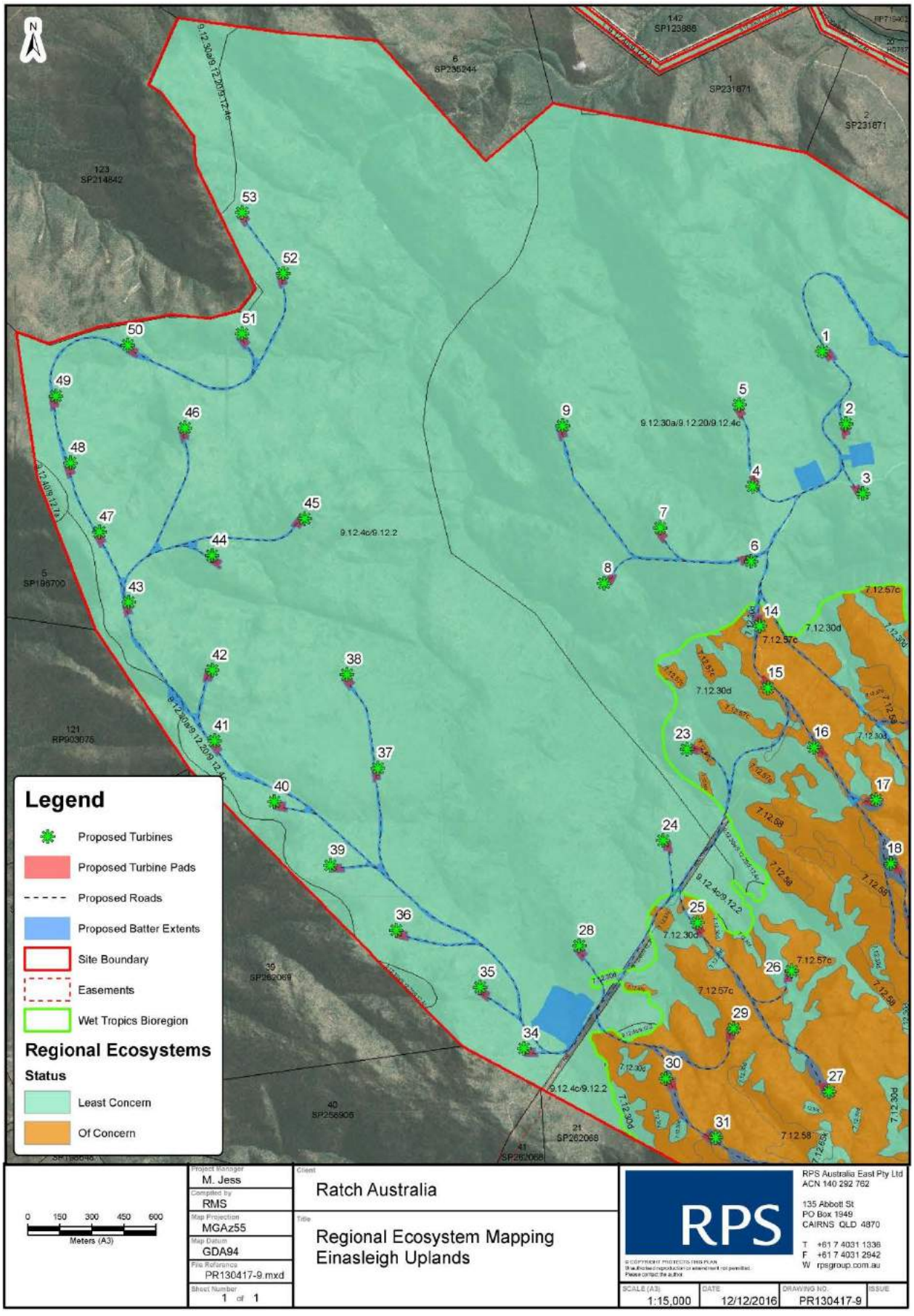


Figure 5 Regional Ecosystems on Northern extent of MEWF

5.1.2 Fire Management Guidelines

Fire management guidelines are provided below (**Table 4**) which indicates the optimal season, intensity, interval and strategy for regional ecosystems.

The objectives of these management strategies are to assist in protecting the flora and fauna habitats represented on the MEWF site and to manage the fuel load to prevent intense dangerous fires that may impact human life and property. This information is based on current knowledge and expert opinion.

Issues are also presented in the table to identify the problems associated with fire not occurring within the prescribed time frames etc.

All Rare and Threatened flora species that have been found on the MEWF site have been located within *Of Concern RE* vegetation of the Wet Tropics Bioregion. These ecosystems (7.12.57 and 7.12.58) are also the least tolerant to fire on the site.

5.1.2.1 Implementation of Guidelines

Prescribed burning will meet the ecological objectives of the management strategies presented in **Table 4** and maintain the ecological integrity of the MEWF site.

These strategies will be reviewed and evaluated with all other MEWF documentation on an annual monitoring process ensuring uptake of new information from relevant Queensland government resources.

Table 4 Fire Management Guidelines for Regional Ecosystems found on the MEWF Project Site

Regional Ecosystem	Description	Season	Intensity	Interval	Strategy	Issues
7.12.30: Wet Tropics Bioregion	Woodland to open forest mosaic with variable dominance, often including *Eucalyptus cloeziana, Corymbia abergiana, C. citriodora, E. portuensis, E. reducta, E. lockyeri, C. leichhardtii, E. atrata, E. pachycalyx* and *E. shirleyi*, on rhyolite and granite.	Cool, dry season (April-Sep).	Low to moderate	2-5 years.	Mosaic burn < 30%. Begin burning early in the fire season, with progressive patch fires burnt through the year. Stop burning when the network of fires and other breaks is sufficient to impede fire spread later in the year. Storm-burning may be used to add further diversity to the fire mosaic.	An occasional moderate severity fire may be used to manage overabundant recruitment of trees. Maintaining a fire mosaic will ensure protection of animal habitats and mitigate against wildfires.
7.12.57: Wet Tropics Bioregion	Shrubland and low woodland mosaic with *Syncarpia glomulifera*, *Corymbia abergiana*, *Eucalyptus portuensis*, *Allocasuarina littoralis*, and *Xanthorrhoea johnsonii*, on moist and dry uplands and highlands on granite and rhyolite. Shrubland/low woodland mosaic with variable dominance, often including *Eucalyptus cloeziana*, *Corymbia abergiana, E. portuensis*, *E. reducta*, *E. lockyeri*, *C. leichhardtii*, *E. atrata*, *E. pachycalyx*, *E. shirleyi* and *Homoranthus porteri*, on rhyolite and granite Of Concern	Avoid dry conditions or fires will spread too much. April to July or as early as March, conditions permitting.	Moisture and topography affect severity. With Low to high. intensity	6-10 years with some areas burnt at longer intervals. Fire intervals less than 6 years are too short to allow replenishment of obligate seeders.	Mosaic burns will be achieved through use of natural features such as topography and creek-lines. Burn in association with surrounding vegetation. Protection relies on the broad-scale management of surrounding country with numerous small fires throughout the year so that wildfires will be very limited in extent. Fire exclusion and buffering from fire are not necessary.	Any planned burning should be conducted in association with plans for surrounding vegetation. Often contains obligate seed regenerating species and as such, the application of frequent fire may reduce species richness if the intervals between fire are not sufficient for plants to produce seed. Too frequent a fire frequency may result in a net loss of nutrients over time from an already nutrient poor system. Burn when water and moisture are present on the ground.
7.12.58: Wet Tropics Bioregion	*Eucalyptus reducta, E. granitica, Corymbia dimorpha, C. citriodora* and *Syncarpia glomulifera* woodland, on granite and rhyolite. Of concern	April-May or in some years through until Sep.	Low to occasional moderate.	6-10 years.	Mosaic burn 25-70% of the target area. Across the landscape burn different areas at different intervals to add diversity.	Occasional moderate fire can assist management of overabundant tree recruitment. Too frequent fire can eliminate shrubs which require several years before they set seed.

Regional Ecosystem	Description	Season	Intensity	Interval	Strategy	Issues
7.12.65 Wet Tropics Bioregion	Rock pavements or areas of skeletal soil, on granite and rhyolite, mostly of dry western or southern areas, often with shrublands to closed forests of *Acacia* spp. and/or *Lophostemon suaveolens* and/or *Allocasuarina littoralis* and/or *Eucalyptus lockyeri* subsp. *exuta*.	Avoid dry conditions or fires will spread too much. April to July or as early as March, conditions permitting. c: April-May or in some years through until Sep. d: Cool, dry season (April-Sep).	Moisture and topography affect severity.	6-10 years with some areas burnt at longer intervals. Fire intervals less than 6 years are too short to allow replenishment of obligate seeders.	Mosaic burns will be achieved through use of natural features such as topography and creek-lines. Burn in association with surrounding vegetation. Protection relies on the broad-scale management of surrounding country with numerous small fires throughout the year so that wildfires will be very limited in extent. Fire exclusion and buffering from fire are not necessary. c: Mosaic burn 25-70% of the target area. Across the landscape burn different areas at different intervals to add diversity. d: Mosaic burn < 30%. Begin burning early in the fire season, with progressive patch fires burnt through the year. Stop burning when the network of fires and other breaks is sufficient to impede fire spread later in the year. Storm-burning may be used to add further diversity to the fire mosaic. Maintain appropriate mosaic burning in surrounding country. Do not protect from fire but do not burn deliberately.	Any planned burning should be conducted in association with plans for surrounding vegetation. Often contains obligate seed regenerating species and as such, the application of frequent fire may reduce species richness if the intervals between fire are not sufficient for plants to produce seed (e.g., loss of Banksia plagiocarpa). Too frequent a fire frequency may result in a net loss of nutrients over time from an already nutrient poor system. c: Occasional moderate fire can assist management of overabundant tree recruitment. Too frequent fire can eliminate shrubs which require several years before they set seed. d: An occasional moderate severity fire may be used to manage overabundant recruitment of trees. Maintaining a fire mosaic will ensure protection of animal habitats and mitigate against wildfires. This is mainly a self protecting community.

Regional Ecosystem	Description	Season	Intensity	Interval	Strategy	Issues
9.12.4 / 9.12.2: Einasleigh Uplands Bioregion	(9.12.4) - *Eucalyptus shirleyi or E. melanophloia* with *Corymbia peltata* and/or *C. leichhardtii* low open woodland to low woodland on acid volcanic rocks. / (9.12.2) - Open forest commonly including *Eucalyptus portuensis*, *E. crebra* (sens. lat.), *Corymbia clarksoniana*, *C. citriodora* on steep hills and ranges on acid and intermediate volcanics close to Wet Tropics boundary.	Early dry season and storm time. Timing of early dry season burns will vary depending on seasonal conditions; it may sometimes commence as early as March. Avoid burning August-October when south-easterly winds are typically strongest..	Low, with occasional moderate or high.	5-10 years.	Apply mosaic across the landscape at a range of frequencies to create varying stages of post-fire response	These ecosystems contain shrubs that germinate after fire. Seedlings typically take a number of years to mature. Avoid repeated fires at short intervals and high intensity burns of broad areas. Leave areas of long unburnt vegetation to maintain a diversity of habitat for wildlife. Shrub species diversity will decline if areas are left long unburnt. Callitris intratropica are fire sensitive. Protect from fires until plants old enough to replace seed pool.
9.12.30 / 9.12.20 / 9.12.4: Einasleigh Uplands Bioregion	(9.12.30) - *Corymbia leichhardtii +/- Callitris intratropica +/- Eucalyptus shirleyi* low woodland to low open woodland on rhyolite hills. /(9.12.20) - *Eucalyptus pachycalyx* and *E. cloeziana* woodland on acid volcanics. / (9.12.4) - *Eucalyptus shirleyi* or *E. melanophloia* with *Corymbia peltata* and/or *C. leichhardtii* low open woodland to low woodland on acid volcanic rocks.	Early dry season and storm time. Timing of early dry season burns will vary depending on seasonal conditions; it may sometimes commence as early as March. Avoid burning August-October when south-easterly winds are typically strongest	Low, with occasional moderate or high.	5-10 years.	Apply mosaic across the landscape at a range of frequencies to create varying stages of post-fire response.	These ecosystems contain shrubs that germinate after fire. Seedlings typically take a number of years to mature. Avoid repeated fires at short intervals and high intensity burns of broad areas. Leave areas of long unburnt vegetation to maintain a diversity of habitat for wildlife. Shrub species diversity will decline if areas are left long unburnt. *Callitris intratropica* are fire sensitive. Protect from fires until plants old enough to replace seed pool.

Source: environment.ehp.qld.gov.au/regionalecosystems/detail. (2016).

6.0 Emergency Evacuation Procedures

Emergency evacuation procedures, plans and strategies, including associated documentation and signage should be prepared in accordance with the guidelines outlined by the RFSQ. This could include a Fire & Evacuation Plan. The RFSQ provide examples and templates of these types of documents, with useful fire emergency guidelines. The RFSQ website is **http://www.fire.qld.gov.au**.

6.1 Contacts - Roles & Responsibilities

The following people are responsible for the evacuation of the site and emergency response.

Title	Name	Telephone Number
Fire Warden	On-site Manager	TBA
First Aid	On-site Manager	TBA

6.2 Employee and Contractor Communication

All employees whilst working within the site (and away from the main office) are required to be contactable at all times. Means of communication may be by way of mobile phone, two-way radio (closed channel) or GPS trackers installed on company vehicles. Any contractors entering the site shall be inducted to the site and made aware of the emergency evacuation procedures. Contractors may, for example, also be issued with a GPS tracker for the duration of their stay within the site.

All vehicles shall be fitted with portable fire extinguishers suitable for extinguishing small grass fires.

6.3 Storage of Fuels and Hazardous Materials

All materials that are flammable and combustible should be stored in a secure and enclosed area away from the site office or any electrical infrastructure. An area of cleared land of all vegetation including grasses of no less than 20m shall be maintained surrounding the storage enclosure.

6.4 Emergency Contacts

For all fires and emergencies call 000

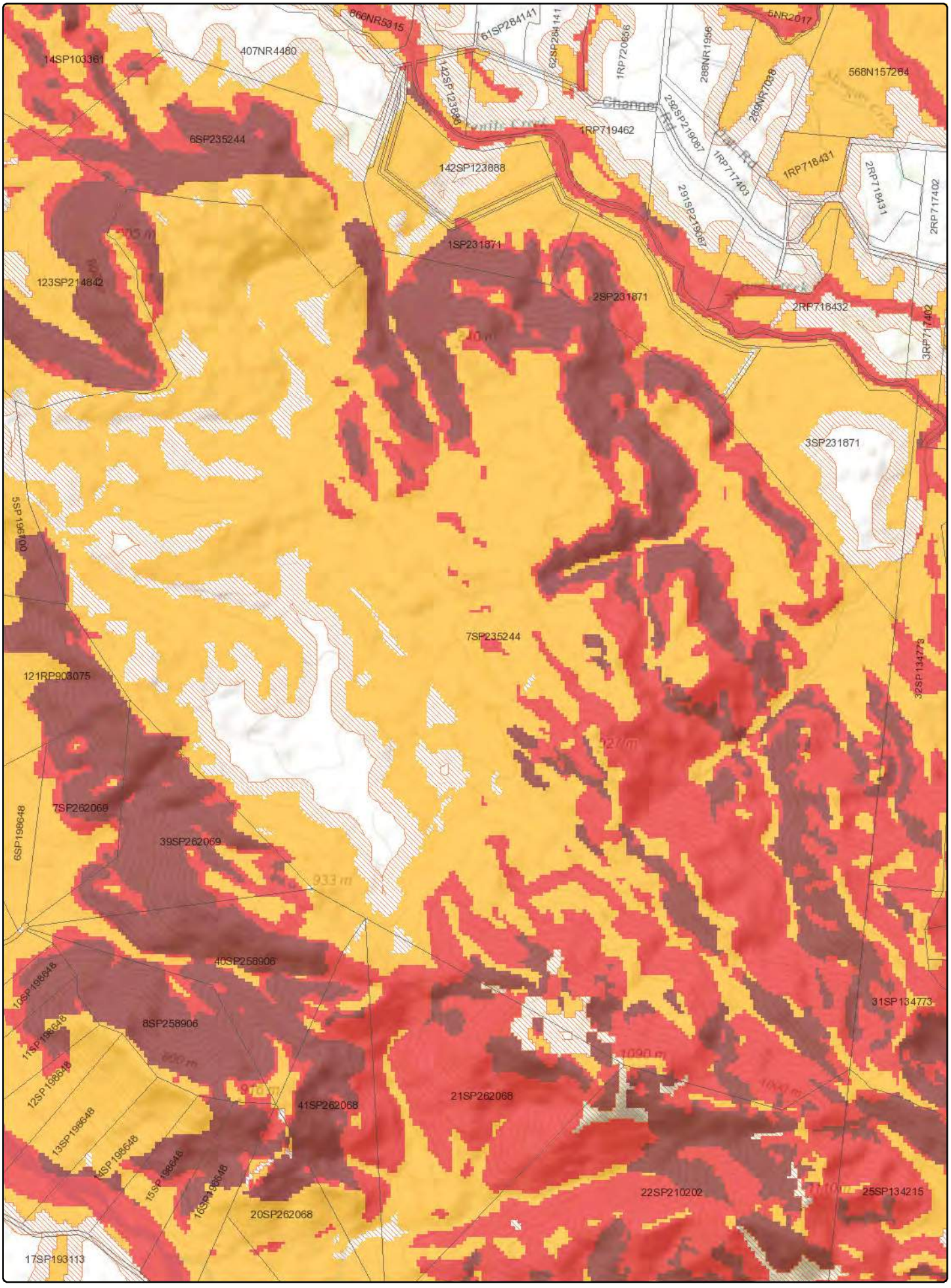
In the instance that it is not an urgent emergency the following contact details may be of assistance.

Emergency Services Contacts

Service	Location and Phone Number
Ambulance	Cairns and Hinterland Local Area Service Network: (07) 4032 8615
Fire Warden (Urban Fire Brigade)	Atherton Fire Station: (07) 4091 9290 Mareeba Fire Station: (07) 4092 1044
State Emergency Services (SES)	Cairns: (07) 4032 8682

Appendix 1

Bushfire Hazard Mapping



State Planning Policy

Local government development assessment

Date: 15/07/2016

Department of Infrastructure, Local Government and Planning

Queensland Government

0 580 1,160 1,740 2,320

Metres

Disclaimer:
This map has been prepared with due care based on the best available information at the time of publication. The State of Queensland holds no responsibility for any errors, inconsistencies or omissions within this document. Any decisions made by other parties based on this document are solely the responsibility of those parties.

Legend

Cadastre (50k)

Cadastre (50k)

Bushfire hazard area (Bushfire prone area)

Very High Potential Bushfire Intensity

High Potential Bushfire Intensity

Medium Potential Bushfire Intensity

Potential Impact Buffer

Queensland Government

Date: 15/07/2016

Department of Infrastructure, Local Government and Planning

State Planning Policy

Local government development assessment

Appendix 2

Northern Australia Fire Information (NAFI) Reports

Territory Natural Resource Management

Northern Territory Government

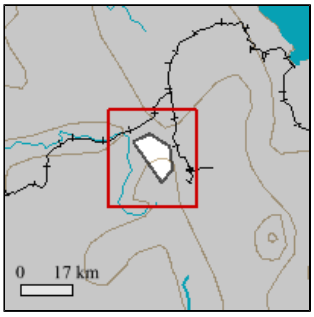
CHARLES DARWIN UNIVERSITY

Custom area

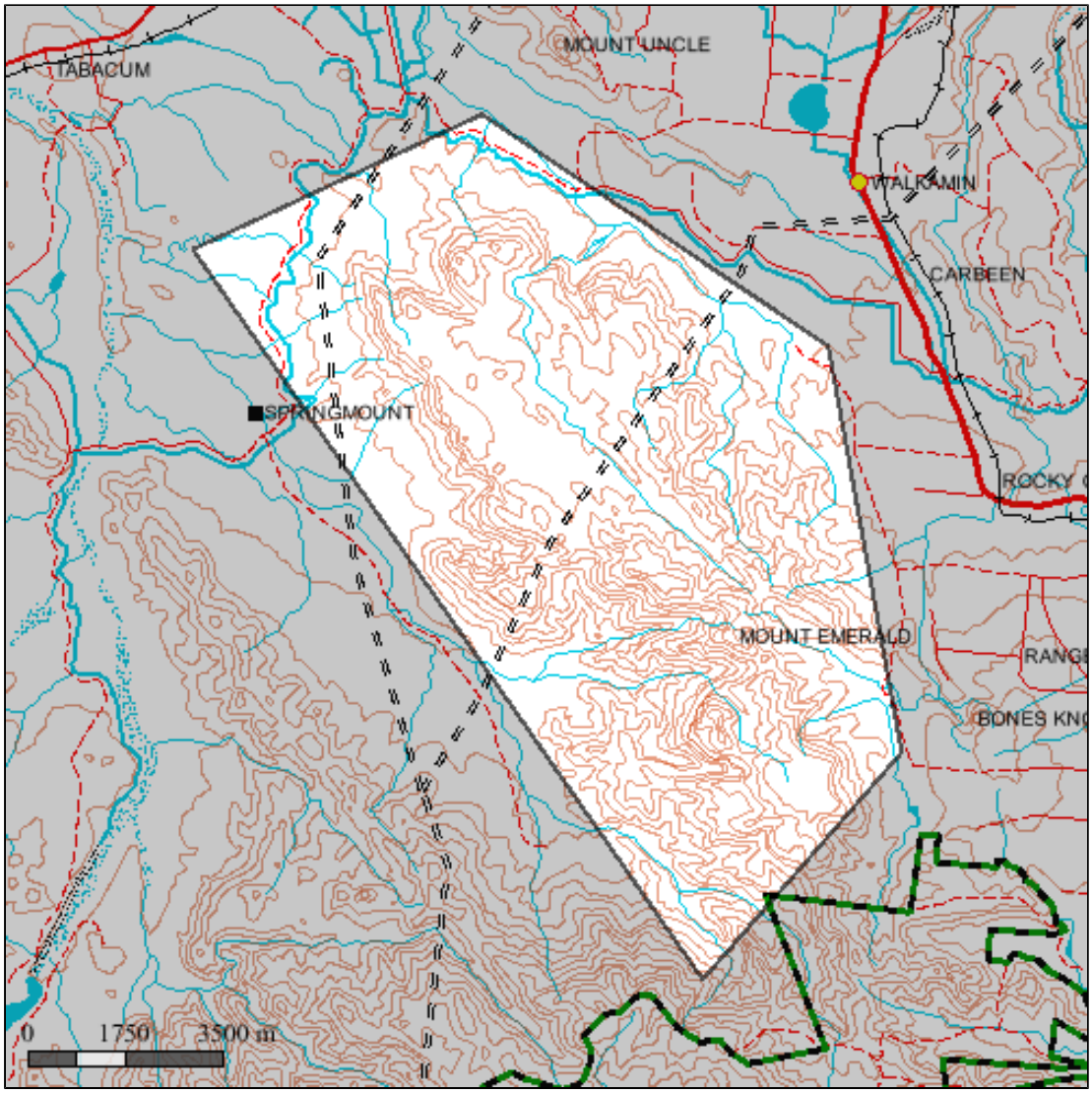
Fire History Report

Custom area

Custom area encompasses an area of 94.58 sq km extending from 17 deg 7.0 min to 17 deg 15.0 min S and 145 deg 19.0 min to 145 deg 26.0 min E.
Custom area is located in the Wet Tropics, Einasleigh Uplands, bioregion(s)



Location of Custom area

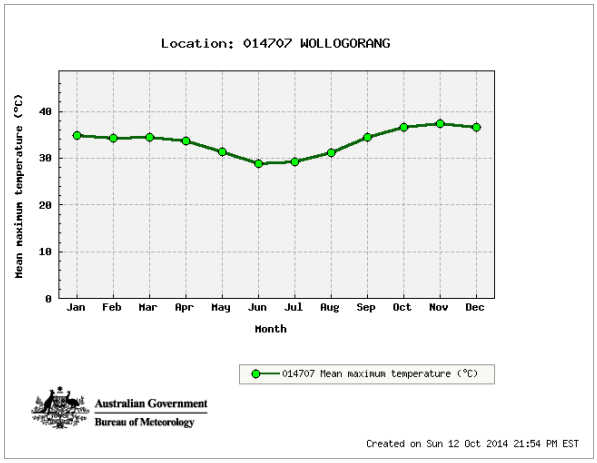


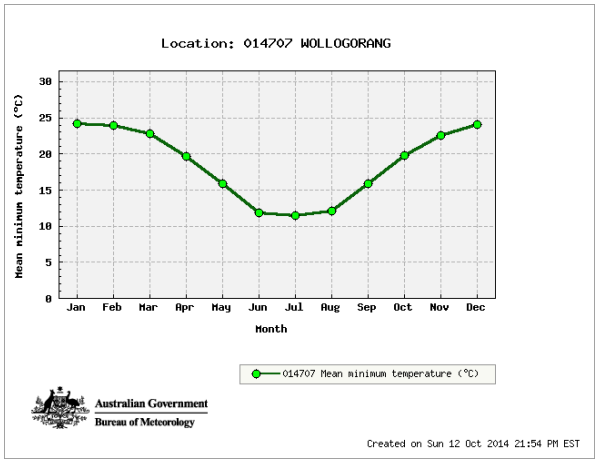
Custom area Climate

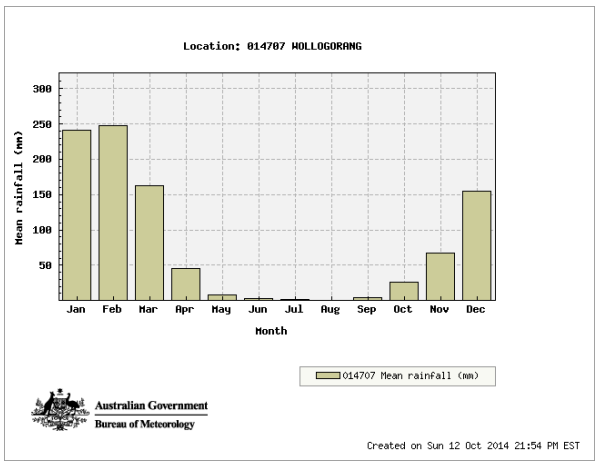
The closest long-term weather station is WOLLOGORANG (17 deg 12.0 min S, 137.9462E) 790 km W of the center of selected area

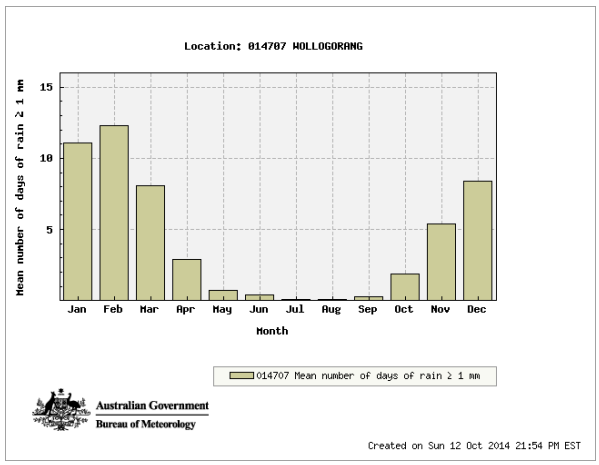
Statistics	Annual Values	Years of record
Mean max temp (deg C)	33.6	31
Mean min temp (deg C)	18.7	31
Average rainfall (mm)	973.3	38
Average days of rain	51.7	38

Climate summaries from Bureau of Meteorology (www.bom.gov.au)



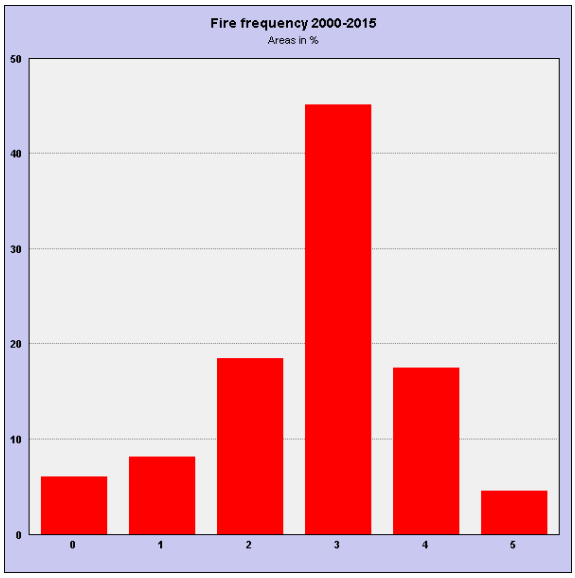






Custom area Fire History

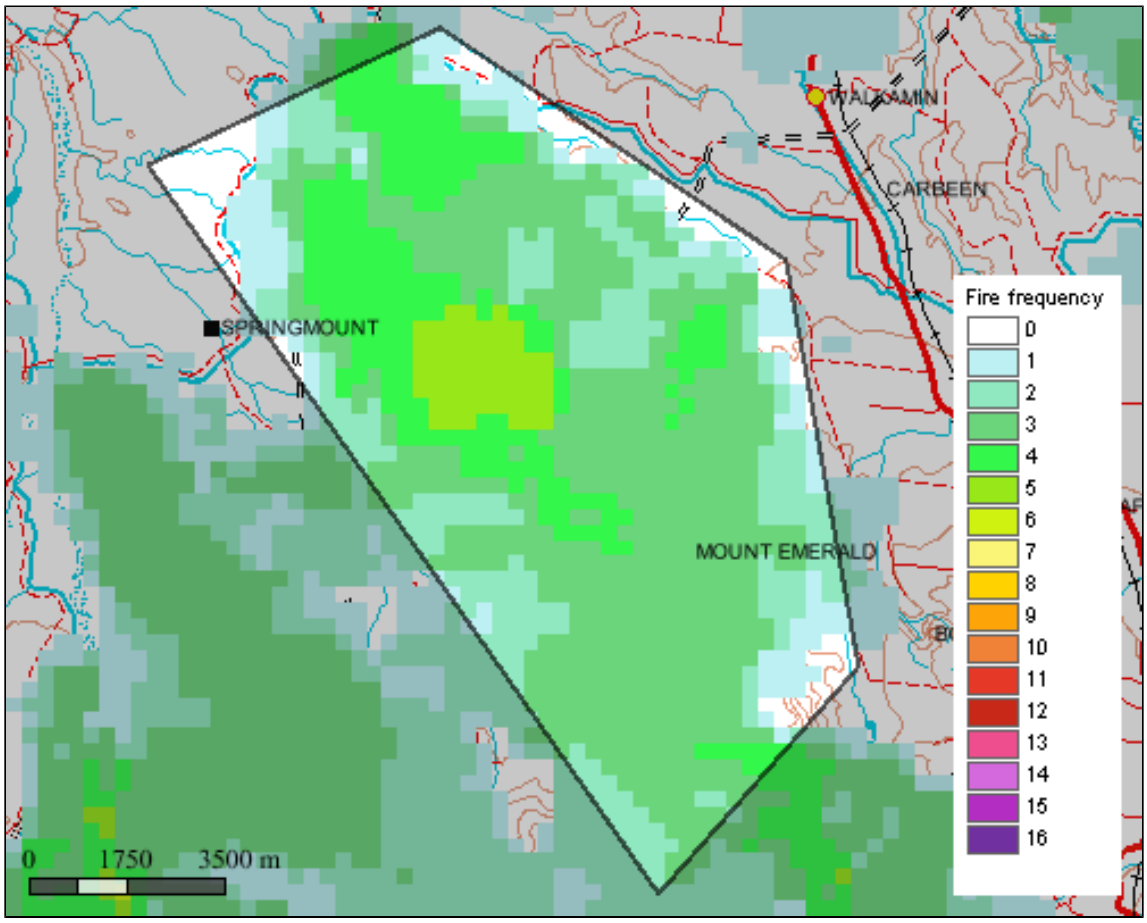
Fire frequency 2000-2015



area burnt for each fire frequency category 2000-2015

Category	Area sq km	Area%
0	5.75	6.08
1	7.71	8.15
2	17.53	18.54
3	42.71	45.16
4	16.53	17.48
5	4.35	4.60

Fire frequency 2000-2015



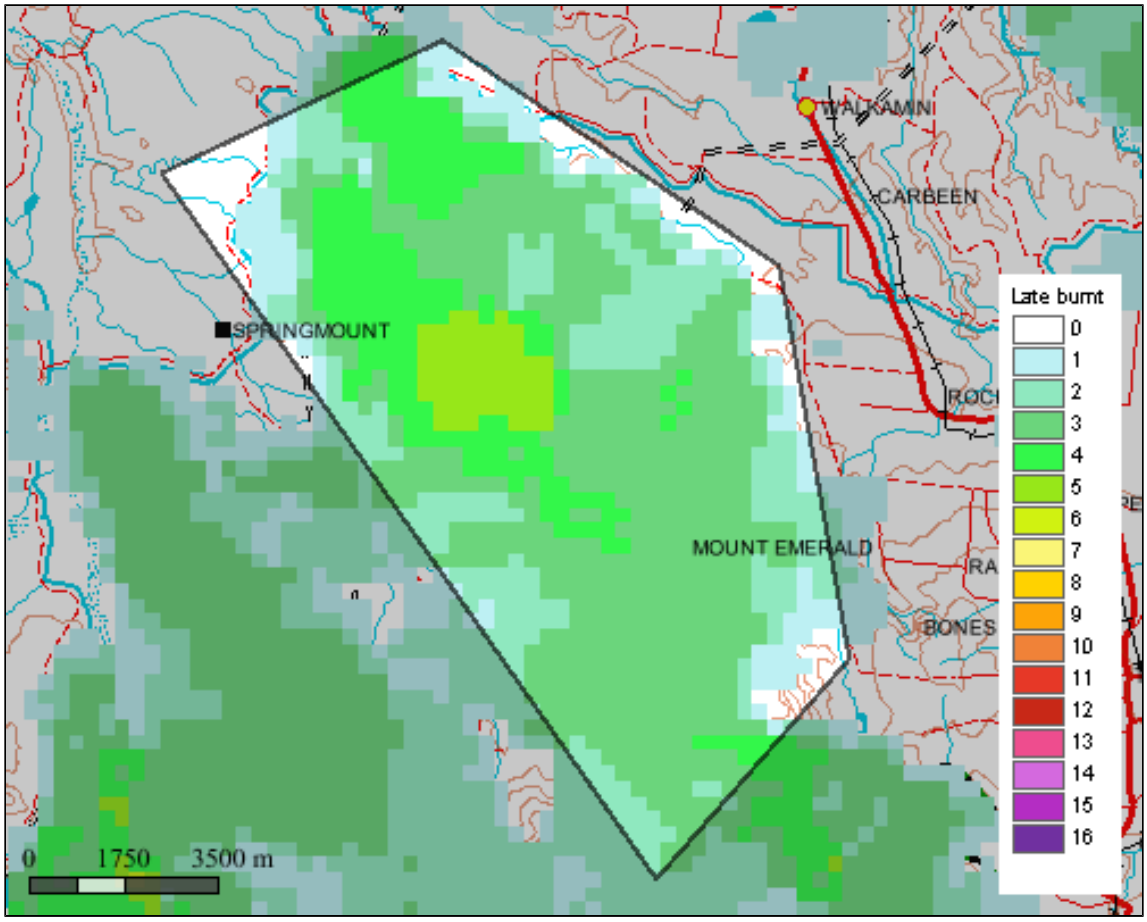
The fire frequency(250m) Layer is derived from satellite imagery sourced from the Moderate Resolution Imaging Spectroradiometer (MODIS) on the NASA Terra satellite
Spatial Resolution: 250m x 250m pixels (at Nadir).

Late fire frequency (after July 31) 2000-2015

area burnt in each late fire frequency category 2000-2015

Selected area is too small to produce reliable statistics

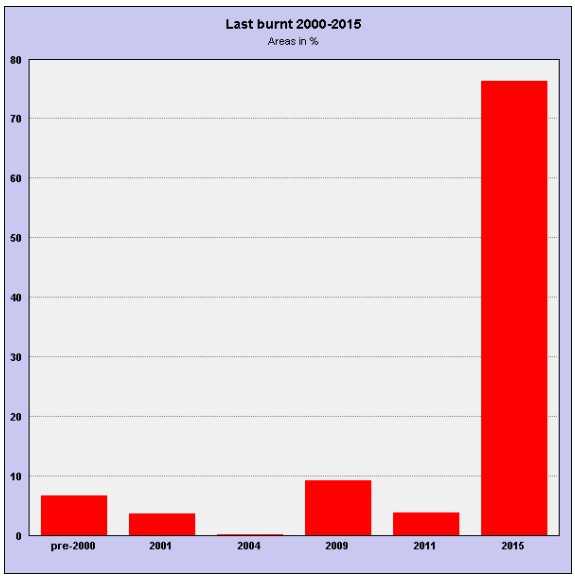
Late fire frequency 2000-2015



The fire frequency(250m) Layer is derived from satellite imagery sourced from the Moderate Resolution Imaging Spectroradiometer (MODIS) on the NASA Terra satellite Spatial Resolution: 250m x 250m pixels (at Nadir).

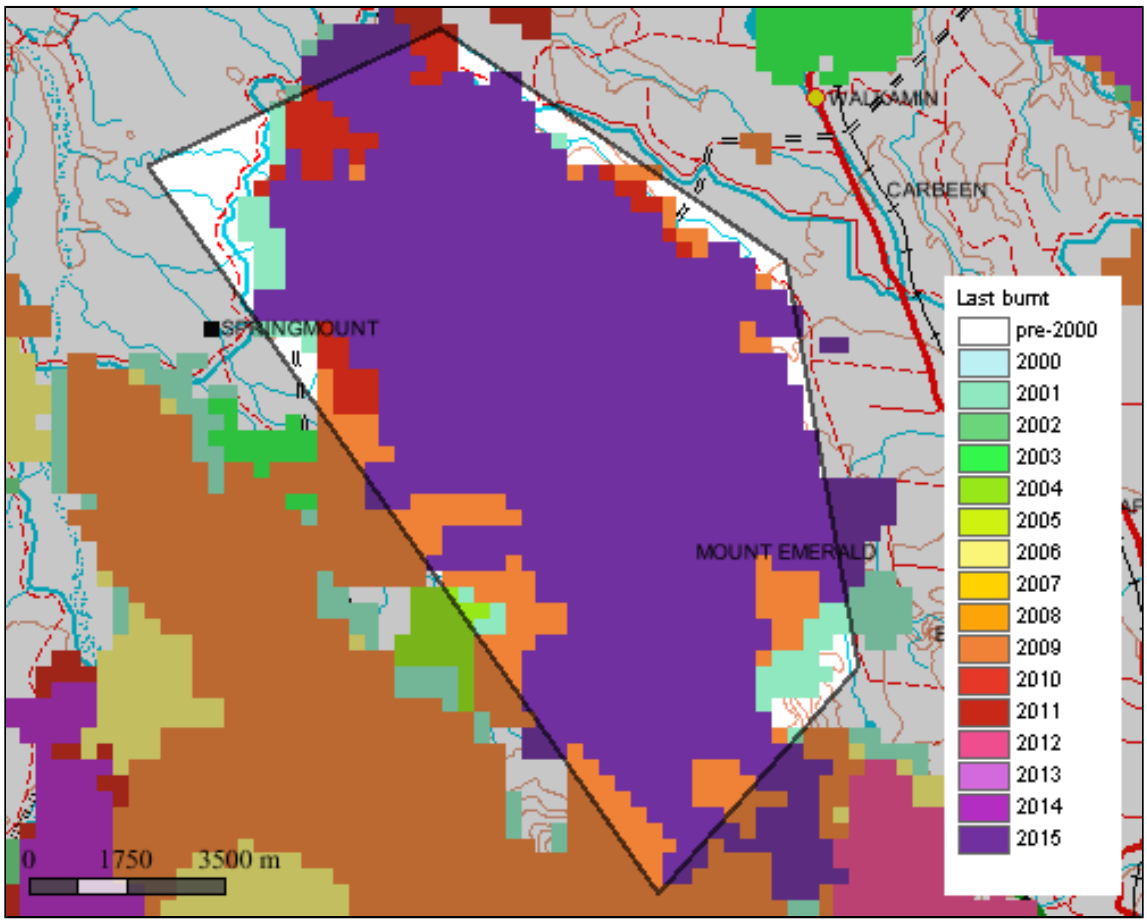
Year last burnt 2000-2015

and area of each year last burnt category



Category	Area sq km	Area%
pre-2000	6.35	6.71
2001	3.52	3.72
2004	.17	.18
2009	8.75	9.25
2011	3.64	3.84
2015	72.16	76.30

Year last burnt 2000-2015



The fire frequency(250m) Layer is derived from satellite imagery sourced from the Moderate Resolution Imaging Spectroradiometer (MODIS) on the NASA Terra satellite Spatial Resolution: 250m x 250m pixels (at Nadir).

Soils and vegetation graphs and tables refer to area of soils and vegetation only. Fire graphs and tables refer to entire selected area including sea if present. Calculations are derived from map images or vector data, and should be taken as a guide only. Accuracy cannot be guaranteed. For small areas, figures should be rounded to the nearest whole number.

Appendix 3

Bushfire Mitigation and Management Measures – Operation Phase

Table A-1 Prevention

PREVENTION				
Aspect	**ID**	**Management Action**	**Responsibility**	**Timing**
Fire Detection	1	Site personnel will report fires within the area of the Project. Site personnel will also rely on detection and reporting of bush fires in the region by neighbours, Mareeba Shire Council or RFSQ alerts.	All site personnel	During operation
	2	Identify potential sources of ignition e.g. fuel storage areas.	*[Contractor to insert]*	During operation
	3	The Contractor will advise RFSQ and Mareeba Shire Council of the contact details for the site (including after-hours contact details).	*[Contractor to insert]*	During operation
Fire Equipment	4	Vehicles will be regularly inspected and cleared of vegetation build-up.	*[Contractor to insert]*	During operation
	5	All machinery capable of causing a fire during operation will be fitted with appropriate guards to prevent accidental ignition of vegetation from sparks or heat sources.	*[Contractor to insert]*	During operation
	6	A water truck fitted with a water tank and pump system capable of initial attack of spot fires will be located on-site.	*[Contractor to insert]*	During operation
	7	The Contractor will supply sufficient fire fighting equipment (fire extinguishers, protective gear) to vehicles, machinery and amenities areas and provide a plan for employees to locate necessary equipment in the event of an emergency.	*[Contractor to insert]*	During operation
	8	Fire equipment will be checked and tested regularly to ensure it is in good working order and will be replaced or repaired where necessary.	*[Contractor to insert]*	During operation
Access	9	Access roads within the site will be regularly inspected and graded to ensure rapid deployment of fire fighting vehicles and earthmoving equipment to roll vegetation at the fire's edge (if required).	*[Contractor to insert]*	During operation
		Access roads are to be provided within the Project area in accordance with NSW RFS (2006).	*[Contractor to insert]*	During operation
	10	At least two evacuation routes will be maintained from each work area and these will be identified to all personnel working on the Project.	*[Contractor to insert]*	During operation
	12	Existing fence lines and access tracks will be maintained to assist in the control of fire.	*[Contractor to insert]*	During operation
	13	Evacuation doors, points and routes will be clearly marked and maintained around temporary construction facilities and office and amenities buildings. These will be inspected weekly as a part of the environmental inspection.	*[Contractor to insert]*	During operation
Storage	14	The Contractor will comply with all relevant regulations and the Dangerous Goods Safety Act 2004 (equivalent QLD statutory document) for fuel transport, containment and storage. All fuel will be stored in accordance with the relevant Australian Standards.	*[Contractor to insert]*	During operation
	15	Oxygen and fuel gas cylinders will not be stored together, with a minimum of 3 metres between cylinders.	*[Contractor to insert]*	During operation
	16	Flammable materials (solid, liquid or gases) shall not be stored within 5 metres of any occupied building. These materials will be suitably secured and correctly signposted "Danger, Highly Flammable."	*[Contractor to insert]*	During operation

PREVENTION				
Aspect	**ID**	**Management Action**	**Responsibility**	**Timing**
Other	17	Open fires will not be allowed in the Project area.	*[Contractor to insert]*	During operation
	18	For all work involving heat, sparks or flame, such as welding and grinding, all flammable materials will be cleared away from the area of works, whilst minimising disturbance to vegetation where possible. Fire extinguishers will be fitted to vehicles to extinguish spot fires. Where necessary a water cart and pump will be provided.	*[Contractor to insert]*	During operation
	20	The contactor shall establish and maintain Managed Fuel Zones in accordance with this BMP.	*[Contractor to insert]*	During operation

Table A-2 Preparedness

PREPAREDNESS				
Aspect	ID	**Management Action**	**Responsibility**	**Timing**
Training	1	Site induction will include information from this BMP. Employees will be shown the location and use of fire fighting equipment. Contractors will be briefed on relevant fire management practices and emergency response and evacuation procedures. Fire drills will be carried out on a quarterly basis to ensure all personnel are familiar with the procedures. These will be addressed in the site induction.	*[Contractor to insert]*	During operation
Equipment	2	Fire fighting equipment will be checked and maintained on a regular basis.	*[Contractor to insert]*	During operation
	3	Testing of alarm systems, escape routes and fire extinguishers will be conducted during weekly environmental inspections.	*[Contractor to insert]*	During operation
Housekeeping	4	Site personnel will maintain excellent housekeeping standards of storage areas and construction areas to minimize potential sources of flammable material.	*[Contractor to insert]*	During operation

Table A-3 Response

RESPONSE				
Aspect	ID	**Management Action**	**Responsibility**	**Timing**
Fire Suppression	1	Upon becoming aware of a fire, the observer will alert all bystanders and then attempt to extinguish the fire, if this can be done safely with adequately trained personnel. If the fire can be suppressed without additional resources, then personnel will suppress the fire, make the area safe and organise a patrol to monitor the suppressed fire.	All site personnel present at the fire	During operation
	2	The site personnel senior person at the fire will co-ordinate fire fighting activities and will be responsible for ensuring that all personnel are kept safe at all times.	All site personnel	During operation
	3	In the event that a fire is reported within the Project Area, *[contractor to insert position title]* will assess the situation and will decide whether to enact fire emergency procedures depending on the severity of the fire, current conditions and its potential to impact on infrastructure, or human and environmental values.	*[Contractor to insert]*	During operation

<table>
<tr><th colspan="5">RESPONSE</th></tr>
<tr><th>Aspect</th><th>ID</th><th>Management Action</th><th>Responsibility</th><th>Timing</th></tr>
<tr><td></td><td></td><td>Alternatively, if the fire is assessed as non-threatening and is not likely to impact on infrastructure, or human and environmental values, it will be closely monitored and allowed to burn out.</td><td></td><td></td></tr>
<tr><td></td><td>4</td><td>In the event that a fire occurs adjacent to the Project area, site personnel will contact the RFSQ and other relevant authorities to report the fire. The [contractor to insert position title] will assess the fire and whether it has the potential to migrate into the Project area and impact on infrastructure, or human and environmental values. If this is the case, the Contractor will implement emergency response procedures and liaise with RFSQ and other relevant authorities where necessary.</td><td>[Contractor to insert]</td><td>During operation</td></tr>
<tr><td></td><td>5</td><td>If a fire in the Project Area is considered to be of low threat to human and environmental values by [contractor to insert position title], the RFSQ will monitor the fire and liaise with other stakeholders where required.</td><td>[Contractor to insert]</td><td>During operation</td></tr>
<tr><td>Communication</td><td>6</td><td>In the event that control of the situation is taken by fire fighting authorities, the site personnel will follow the directions of the relevant authorities and assist where possible.</td><td>All site personnel</td><td>During operation</td></tr>
<tr><td></td><td>7</td><td>In the event that a significant bushfire occurs within the Project area, the Contractor will follow the communication protocol outlined below.
<table>
<tr><th>Service</th><th>Location and Phone Number</th></tr>
<tr><td>Ambulance</td><td>Cairns and Hinterland Local Area Service Network: (07) 4032 8615</td></tr>
<tr><td>Fire Warden (Urban Fire Brigade)</td><td>Atherton Fire Station: (07) 4091 9290
Mareeba Fire Station: (07) 4092 1044</td></tr>
<tr><td>State Emergency Services (SES)</td><td>Cairns: (07) 4032 8682</td></tr>
</table></td><td>[Contractor to insert]</td><td>During operation</td></tr>
<tr><td></td><td>8</td><td>If a bushfire occurs on or near the Project area, the response time to communicate with the relevant agencies will be dependent on the severity of the fire. The RFSQ and other relevant stakeholders will be notified immediately of a significant fire by [contractor to insert position title].</td><td>[Contractor to insert]</td><td>During operation</td></tr>
<tr><td></td><td>9</td><td>In the event of a significant bushfire requiring agency assistance, it is anticipated that the response time to communicate with these agencies will be less than 30 minutes.</td><td>[Contractor to insert]</td><td>During operation</td></tr>
<tr><td></td><td>10</td><td>It will be the responsibility of [contractor to insert position title] to communicate with the appropriate personnel to coordinate the necessary fire fighting equipment required for the first response of the fire. In the event that the fire is not immediately suppressed and further intervention is required [contractor to insert position title] will be responsible for contacting the appropriate fire fighting authorities.</td><td>[Contractor to insert]</td><td>During operation</td></tr>
</table>

RESPONSE				
Aspect	ID	**Management Action**	**Responsibility**	**Timing**
Responsibility	11	It will be the responsibility of *[contractor to insert position title]* to ensure the evacuation of buildings and affected areas within the Project area to a pre-arranged emergency meeting point.	*[Contractor to insert]*	During operation
	12	*[Contractor to insert position title]* will be responsible for liaisons with local authorities such as the Fire Service and Mareeba Shire Council on a as needs basis.	*[Contractor to insert]*	During operation

Table A-4 Assessment

ASSESSMENT				
Aspect	ID	**Management Action**	**Responsibility**	**Timing**
Recovery	1	Once the site has been deemed safe to re-enter *[contractor to insert position title]* will assess the extent of damage to the site and equipment and determine if works can resume. Part of the assessment will be to determine if the resumption of works will cause increased environmental damage, such as increasing the susceptibility of erosion.	*[Contractor to insert]*	During operation
Review	2	The BMP will be reviewed 12 monthly following the date of implementation, or earlier if a significant fire event has occurred to warrant a procedural review.	*[Contractor to insert]*	During operation
	3	The Contractor will review training needs and protocols on an annual basis.	*[Contractor to insert]*	During operation
Reporting	4	All fire incidents will be reported to *[contractor to insert position title]*. The person who observes the incident is responsible for reporting the incident.	*[Contractor to insert]*	During operation
	5	Fire and safety training undertaken by site personnel will be recorded and maintained.	*[Contractor to insert]*	During operation
	6	Relevant information will be provided in the monthly Project Report.	*[Contractor to insert]*	During operation

Appendix K

Pest Management Plan

Pest Management Plan

Mount Emerald Wind Farm, Herberton Range, North Queensland

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In preparing this report we have made certain assumptions. We have assumed that all information and documents provided to us by the Client or as a result of a specific request or enquiry were complete, accurate and up-to-date. Where we have obtained information from a government register or database, we have assumed that the information is accurate. Where an assumption has been made, we have not made any independent investigations with respect to the matters the subject of that assumption. We are not aware of any reason why any of the assumptions are incorrect.

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Document Status

Version	Purpose of Document	Orig	Review	Review Date
V1	Report	MJ	DF	23/02/2016
V2	Report	MJ	LL	06/06/2016
Final	Report		MJ	16/11/2016

Approval for Issue

Name	Signature	Date
Mellissa Jess		16 November 2016

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1.0 Introduction

RPS Australia East Pty Ltd (RPS) has prepared the following Pest Management Plan (PMP) to minimise the potential for the spread of pest species as a result of the Mount Emerald Wind Farm (MEWF) project developed by RATCH Australia Corporation Ltd (RATCH). In particular this plan outlines how pest management will be undertaken in accordance with the requirements of the conditions issued under the Approvals listed Development Notice pursuant to the *Sustainable Planning Act 2009* (SPA) (**Section 2**).

This PMP provides an overview of the procedures required to minimise the introduction and spread of particular pests. For those species already present on the site, the plan will appropriately manage the increased risk they present to flora and fauna with the increased access to areas of the site as a result of the development. A separate Weed Management Plan has been developed for the site which will be used in conjunction with this plan where required.

This plan provides the framework to ensure controls to manage potential pest disturbance within and directly adjacent to the MEWF project in the Mareeba Walkamin district. This PMP establishes the objectives, management requirements and management actions to mitigate and manage the potential impacts that could arise from the introduction and increase in abundance of pest species within the project area.

1.1 The Project

The Mount Emerald Wind Farm (MEWF) is approved for the construction of up to 63 wind turbines on an elevated site approximately 20 km SSW of Mareeba on the Atherton Tablelands in north Queensland (**Figure 1**). The towers will be approx 80-90m high with approximately 50m blades, utilising 3 MW machines.

The site where the wind turbines, interconnecting tracks and associated infrastructure are to be established is on land formally described as Lot 7 on SP235224, which encompasses an area of 2,422ha. This land forms the terminus of the Herberton Range and is contiguous with Mount Emerald (proper) at its southern boundary. Virtually all the wind farm project area is covered by remnant and relatively undisturbed vegetation, where the only land modification is associated with the existing 275 kV transmission line infrastructure and its series of access tracks. Kippen Drive at the base of the site is severely degraded in most zones adjacent to the unsealed road, and weeds are conspicuous.

The wind farm site has been selected on the basis that it represents an excellent wind resource because of its elevated position and series of high ridges. The elevation range of the site is between 540m up to 1089m above sea level (ASL). The highest ridges south of the existing 275 kV transmission line hold the most significant value in terms of flora and represent an important tract of land with functional connectivity to other regional nodes of high biodiversity importance. Although land to the north of the transmission line (including the landmark of Walsh Bluff) possesses lower floristic diversity, it is recognised for its habitat value for the endangered Northern Quoll (which is also expected to occur south of the transmission line).

The wind farm project estimates to deliver in the order of 650,000 megawatt hours of renewable energy, which is predicted to meet the annual needs of approximately 75,000 North Queensland homes over a 20 year period.

The wind farm will be connected to the existing Chalumbin –Woree 275 kV transmission line via a substation, which is to be located within the site. The 275 kV transmission line infrastructure that traverses the site was established in 1998 and represents a pre-existing disturbance footprint which the proposed wind farm will take advantage of in order to minimise the area of new impacts to the environment.

From a constructability perspective the northern sector of the site has more undulating landforms and fewer dissected ridges. There also appears to be a higher proportion of former landscape disturbance in the northern sector and across the east-facing slopes on the Walkamin side.

1.2 Construction Details

Access to the site will be via Kennedy Highway, onto Hansen Drive and then into the site at a realigned Springmount Road - Kippen Drive intersection. Kippen Drive is currently unsealed. A series of access and interconnecting tracks will need to be constructed within the wind farm site, and will take advantage of existing transmission line infrastructure tracks wherever possible. A number of new tracks will need to be constructed to an initial cleared width of 10m. The interconnecting tracks will form the routes for the inter-turbine underground cabling - expected to be buried in trenches at approximately 1m deep.

Each turbine construction pad is expected to occupy an area in the order of 40m (long) x 60m (wide). The substation and associated compound will be in the order of 200m x 200m or similar configuration and will be located close to the existing 275 kV transmission line which crosses the site.

Wind turbines will be "micro-sited" - a technique which involves selecting a position in the landscape where the least environmental impact is expected to occur. As part of this procedure, comprehensive ground surveys will be undertaken of each site to ensure impacts to conservation significant species and other matters of importance are minimised or avoided.

A wind farm operations building will be constructed adjacent to the substation, which will house monitoring and communications equipment. Other associated internal infrastructure will include car parking areas, construction compound and machinery area. Depending on the outcomes of relevant approvals, a batching plant may be temporarily constructed within the site.

The Mount Emerald Wind Farm (MEWF) project has been broadly categorised into four phases: pre-construction, construction, operation and maintenance and decommissioning. Rehabilitation and impact mitigation will be actively practiced throughout these stages and will be informed by respective plans and strategic documents.

In preparing the Environmental Impact Statement (EIS), several specialist investigations were undertaken and accompanying technical reports prepared. These include the disciplines of flora, fauna, general environmental reporting and offsets plan; town planning; aeronautical assessment; transport and traffic assessment; shadow flicker, electromagnetic interference, and energy yield; geotechnical; visual and landscape aesthetics; noise mapping; cultural heritage; community consultation; and social and economic assessment.

Several strategic and site-based plans were compiled to facilitate the delivery of mitigation measures. These include the Environmental Management Plan (EMP). The EMP is to be supported by a number of plans including: a Rehabilitation Plan, Weed Management Plan, Rare and Threatened Species Management Plans Bushfire Management Plan and this plan. These plans will have an effective life span to include the decommissioning phase and will be revised periodically to reflect ongoing changes and improvements.

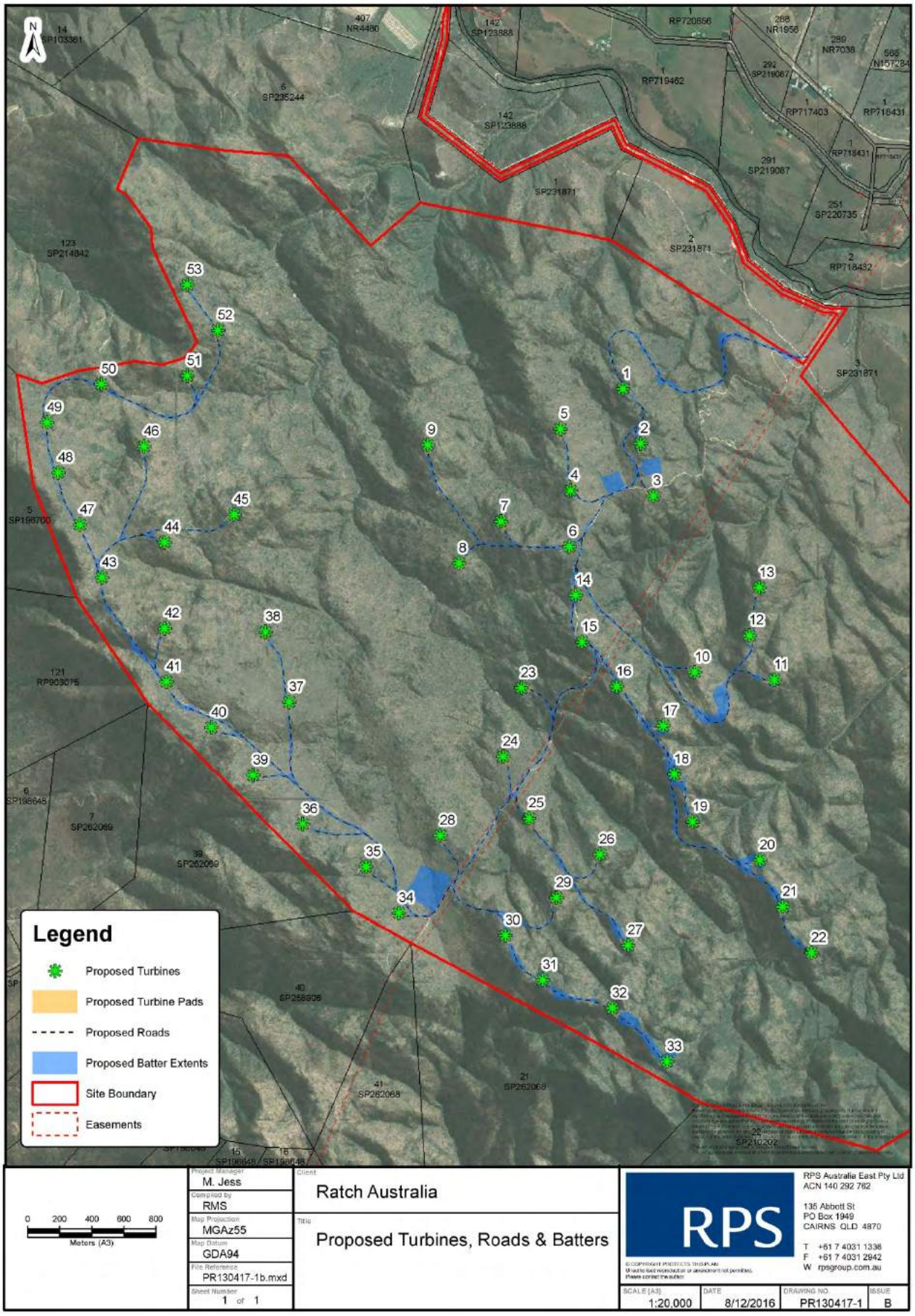

Figure 1 Project Site Location

1.3 Purpose

The objectives of the PMP are to:

- Facilitate compliance with the relevant commonwealth, state and local government legislation regulations and approvals;
- Provide a framework for MEWF to:
  - » Identify, monitor and prioritise the appropriate management of pest species present at or pose a threat to the existing environment
  - » Prevent and minimise the introduction and dispersal of pests onto the site and neighbouring properties;
  - » Engage stakeholders including landholders and local communities in assisting in the identification and management of pests at the MEWF; and
  - » Develop specific procedures as required during the project lifetime.

1.4 Scope

This report addresses all pest management planning requirements described in the MEWF Project Approval Conditions. Specifically, this report provides details-

- The incidence reporting of pest species on or near the project area;
- Impacts associated with the invasive/exotic species introduction and increase in abundance;
- Mitigation measures; and
- Evaluation of management efficacy.

2.0 Regulatory Requirements

2.1 Project Approvals

2.1.1 Sustainable Planning Act 2009

Conditions relevant to the preparation and implementation of the PMP are detailed in Condition 13 of the Ministerial Decision Notice.

2.1.1.1 Ministerial Decision Notice

The Development Notice (dated 24 April 2015) in accordance with the SPA included a number of conditions relating to the preparation of a Pest Management Plan (PMP). *Condition 13 - Environmental Management* which relates to the PMP, states the following:

> *Submit to the chief executive administering SPA an Environmental Management Plan (EMP) prepared by a suitably qualified person(s). The EMP must:*
>
> *i. be generally in accordance with the Preliminary Environmental Management Plan prepared by RPS and dated November 2013 and the draft Statement of Commitments contained within Appendix A of the RPS Development Application Material Change of Use Report dated March 2012;*
>
> *ii. be based on the revised Turbine Location and Development Footprint Plan submitted in accordance with condition 2 of this approval;*
>
> *iii. include the following components,:*
>
> - *Weed and Pest management Plans (timing as required with the EMP).*

3.0 Roles and Responsibilities

The roles and responsibilities of the various stakeholders related to the management and actions of this PMP are outlined in **Table 1** below.

Table 1 Stakeholder Roles and Responsibilities

Role	Responsibility
Environmental Representative	Manage independent consultant and pest and weed contractors and maintain records, carry out quarterly environmental inspection of site, monitor and review the effectiveness of the PMP.
MEWF Project Manager	Manage pest contractors and maintain records of pest management for site.
All Employees	Report outbreaks and sightings of declared pests.
Pest Contractors	Implement pest control activities and ensure required specifications are met.
Independent Consultants	Implement pest control activities and ensure required specifications are met.

4.0 Relevant Legislation, Policy and Strategy

This section describes the relevant Commonwealth and Queensland legislation that applies to the management and control of pests and weeds.

Legislation	Description
Nature Conservation Act 1992 and Nature Conservation (Wildlife) Regulation 2006	The *Nature Conservation Act 1992 (NC Act)* provides for the conservation and management of Queensland's native flora and fauna. The Act prohibits the taking or destruction, without authorisation, of certain listed flora and fauna species. The *Nature Conservation (Wildlife) Regulation 2006 (NC Regulation)* lists the flora and fauna species presumed extinct in the wild, endangered, vulnerable, near threatened, least concern, international and prohibited. It states the declared management intent and the principles to be observed in any taking of or destruction for each group.
Land Protection (Pest and Stock Route Management) Act 2002	The *Land Protection (Pest and Stock Route Management) Act 2002* (The Act) is the overarching legislation with the main purpose to provide for: (a) pest management for land; and (b) stock route network management. The purpose of the Act is to be achieved mainly through the following— (a) establishing principles of pest management for land and stock route network management; (b) providing for pest management planning and stock route network management planning; (c) declaring animals and plants to be declared pests; (d) restricting the introduction, keeping or sale of declared pests; (e) preventing the spread of declared pests in the State, including, for example, preventing their spread by human activity; (f) establishing responsibilities for pest and stock route network management; (g) building and maintaining fences to prevent declared pest animals moving from a part of the State to another part; (h) establishing the Land Protection (Pest and Stock Route Management) Council to give advice and make recommendations to the Minister about managing pests and the stock route network; (i) providing for the establishment of pest operational boards; (j) constructing and maintaining travelling stock facilities on the stock route network; (k) monitoring, surveying and controlling pests and the movement of travelling stock. The Act requires that local government prepare a pest management plan for its area. The plan may include provision for the following— (a) achievable objectives under the plan; (b) strategies, activities and responsibilities for achieving the objectives; (c) strategies to inform the local community about the content of the plan and achievement of its objectives; (d) monitoring implementation of the plan and evaluating its effectiveness; (e) other matters the local government considers appropriate for management of declared pests in its area. The plan must however be consistent with the principles of pest management; the State pest management strategies; and the guidelines for pest management.

Legislation	Description
Biosecurity Act 2014	The *Biosecurity Act 2014* (the Act) was passed by Parliament and will come into effect on 1 July 2016 superseding the *Land Protection (Pest and Stock Route Management) Act 2002.* The Act deals with: ▪ pests (such as wild dogs and weeds) ▪ diseases (such as foot-and-mouth disease) ▪ contaminants (such as lead on grazing land) Decisions made under the Act will depend on the likelihood and consequences of the risk. This means risks can be managed more appropriately. The main biosecurity function of each local government will continue to be the management of invasive plants and animals in its area. A more comprehensive range of response tools and associated powers will be able to be tailored to address the unique nature and tactical challenges presented by individual biosecurity threats. Under the new Act, local governments, like other persons, will be obliged to take all reasonable and practical steps to minimise biosecurity risks posed by their activities. This is known as a general biosecurity obligation (GBO). To meet their own obligations, local governments may wish to consider formal planning processes for biosecurity risk management to demonstrate due diligence. Local government will only be able to enforce the GBO if the risk is related to invasive biosecurity matter. This Act replaces the Quarantine Act of 1908.
Queensland Pest Animal Strategy	The Queensland Pest Animal Strategy establishes a state wide planning framework, providing clear direction to government, community, industry and individuals for the management of pest and problem animals across the state. It gives a common basis for addressing current and potential pest problems that impact on primary industries, ecosystems, human health and the community's enjoyment of our natural resources. It also assists in the development of regional natural resource management planning. The following species or groups of species are covered in the strategy: ▪ introduced mammals and reptiles that have pest impact, including animals declared under the Act ▪ introduced pest birds ▪ introduced amphibians ▪ some native species in certain situations, including kangaroos, bats, native rats, native birds and locusts ▪ exotic pest fishes. The strategy is based on a number of accepted principles of pest management that have been considered for both pest and problem animals and incorporated into the desired outcomes, objectives and strategic action.
National Strategies	National strategies help government, industry and the broader community manage weeds in a coordinated manner at a national level. National strategies include: ▪ Australian Pest Animal Strategy (Department of the Environment, Water, Heritage and Arts) ▪ Threat Abatement Plans
Local Area Pest Management Plans	▪ Mareeba Shire Council -Weed and Pest Management Strategy 2015-2020 Requires that all Local Governments develop and implement a Local Government Area Pest Management Plan. The Pest Management Plan has therefore been developed in line with legislation and reflects Council's views towards natural asset management and the benefits of planning with stakeholder communication and on-ground actions.

5.0 Pest Species in the Project Area

The data used to inform this PMP has come from the following databases and reports:

- **MEWF Environmental Impact Statement**: Fauna assessments have been conducted on site since May 2010. The emphasis of the initial ecological surveys was to assess the general ecology of the site and to assess the presence/absence of Matters of National Environmental Significance (MNES) species for the referral process. Further surveys (from 2012) involved targeted surveys specific threatened species considered at risk of being impacted (i.e. Northern Quoll, Bare-rumped Sheathtail Bat and Spectacled Flying-fox). The majority of these surveys focussed on fauna; where flora surveys were undertaken at lower frequency and with less spatial coverage. Surveys occurred over a three year period; however the methodologies chosen to satisfy the requirements of the EIS Guidelines were to survey from August 2012 to September 2013 (i.e. to provide a seasonal survey effort).(RPS 2011, 2013)
- **EPBC Protected Matters Database of MNES**. This database applies a range of bio-models to predict the presence of species of flora and fauna and other MNES within a given radius of the site (a search parameter was prescribed limiting the search area to a 10 km radius around an approximate central point of the study area), as cited under the Commonwealth's *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act);
- **Wildlife Online database**. This database is managed by the Queensland Department of Heritage and Environmental Protection (DEHP) and holds records animals that have either been sighted or collected within a given radius of the site (a search parameter was prescribed limiting the search area to a 10 km radius around an approximate central point of the study area).
- **Queensland Museum Biodiversity Database**. This database provides confirmed records of fauna species recorded within a specified area. Data from this source provides additional information on the known location of rare and threatened fauna species;

The above information determined the likelihood of a particular pest species occurring at or in the vicinity of the project site.

5.1 Pests

Following the review of available databases and reports, a number of declared (QLD) pest species were recorded from the project area (**Table 2**).

With the exception of the cane toad which was prevalent across the project site, only incidental observations were recorded of the dingo, wild dog, feral pig and feral cat. These observations were made during the wet season primarily around available watercourses.

There were **no** significant populations of any declared species on or within the vicinity of the project site.

The rabbit has only been recorded in desktop results and there were no confirmed sightings of the species on the project site.

Table 2 Pest Species Located on the Mount Emerald Wind Farm Project

Species Name	Survey/Desktop	Declared Species	# Potential Species Impact
Amphibian			
Rhinella marinus Cane Toad	Survey/ Desktop		The Cane Toad is poisonous at every stage of its life cycle and it's known to impact nearly all native frog larvae and many aquatic invertebrates. Cane toads are known to have caused a severe decline in small predatory mammal species across northern Australia since their introduction. The Northern Quoll is known to persist in FNQ despite the presence of the Cane Toad (research is yet to determine why) however there remain a large number of native vertebrate and invertebrate species that are impacted by this species (RPS, 2013).
Mammal			
Canus lupus dingo Dingo	Survey/ Desktop	Class 2	Dingoes prey on local native fauna and often carry parasites and pathogens.
Canus lupus familiaris Wild Dog	Survey/ Desktop	Class 2	Wild dogs prey on local native fauna and often carry parasites and pathogens.
Sus Scrofa Feral Pig	Survey/ Desktop	Class 2	Feral pigs damage crops, stock, property and the natural environment. They transmit disease and could spread exotic diseases such as foot and mouth if this was introduced to the country. (DAF, 2016)
Felis catus Feral Cat	Survey/ Desktop	Class 2	Feral cats prey on local native fauna and often carry parasites and pathogens.
Orictolagus cuniculus Rabbit	Desktop	Class 2	This species causes destruction of native vegetation and subsequent erosion. They compete heavily with native species for food and shelter therefore reducing the native species ability to survive predation.

#Refer to Species Fact Sheets for further information (**Appendix A**).

5.1.2 Risk of Pest Invasion

The confirmed presence of several threatened species within the MEWF project area increases the potential impact that pest species could have on the sites ecological values. In particular, the Northern Quoll and Bare-rumped Sheathtail Bat which have been confirmed on site may be impacted by the increase in pest numbers on the site. Therefore it is of particular importance to ensure the proposed project does not increase the opportunity for pest species to utilise the site.

Pest species can have been documented to have the following impact on native animals:

- Feral predators such as cats and wild dogs are known contributors to the decline of Northern Quoll across its range due to direct predation and competition for food which decreases the abundance of native prey (Oakwood, 2004). Fortunately, Northern Quolls are known to coexist with cane toads on the MEWF project site, however due to the species toxicity to a large number of native fauna, any reduction in opportunity for this species to breed is advised.
- Feral pigs are known to cause destruction of plants which results in invasion of weed species and changes to the vegetation composition and reduced water quality and availability.

Pests are known to congregate where resources are available, therefore they are likely to move into the temporary camp areas (construction phase) and permanent areas (operational phase) of the project for food and water. Therefore management strategies will be focused on these areas.

6.0 Management Strategies

All activities identified as being responsible from introducing pests will be subject to controls on site and managed under this plan

For successful management of pest species there are four principles:

(1) Identify the pests and the area of infestation;

(2) Avoid utilising and placing infrastructure in areas of know infestation;

(3) Prevent/minimise the translocation spread of pests by implementing sound work practices and promotion of risk awareness; and

(4) Control – identified pests to contain or eradicate populations as required.

A response to each of these four principles in relation to the MEWF project have been provided in **Table 3**.

Table 3 Response to of Pest Management Principles

Principle	Response
Identify	All pest species have been identified and regular monitoring of the site will continue on a quarterly basis to ensure any new species or infestations of known species are located.
Avoid	There are no areas of known infestations on the site, however no turbines or site compounds will be located near watering points or aggregation points.
Prevent/Minimise	To prevent/minimise the translocation spread of pests by implementing sound work practices and promotion of risk awareness, a number of procedures are incorporated into the *MEWF Environmental Management Plan* (2016) These are specifically: ▪ Water management procedures will require a focus on avoiding the clearing of artificial water points that provide a source of drinking water for vertebrate pests and additional breeding habitat for cane toads. ▪ Waste management will be required to ensure waste is managed at a central location on site and disposed of offsite to ensure any introduced species do no significantly increase numbers around these typical aggregate areas. This specifically relates to rat and mice species common to development and waste management areas.
Control/Eradicate	Controls are detailed in Section 4.2 below. An integrated approach in co-operation with State and Council representatives is required. The MEWF project site is relatively pest free which has been one of the factors in the persistence of several threatened species on the Mount Emerald massif.

6.2 Integrated Pest Management

Integrated pest management involves the use of a variety of control methods where a single control measure may be constrained by a number of environmental safety, spatial or logistical issues that prevent that control from working effectively on its own. There are four effective pest methods identified below, which if used in conjunction will ensure vertebrate pests are controlled. **Table 4** summarises those controls that will be typically required during construction and operation of the wind farm. Additionally, the Mareeba Shire Council provides further details on these controls in the Local Areas Pest Management Plan (2014) and the collaborations required with other stakeholders within the local government area.

6.2.1 Exclusion Fencing

Exclusion fencing is the installation of barriers including electric fencing or mesh fencing as a control option for vertebrate pests on smaller properties to exclude wild dogs and pigs, and sometimes macropod fauna (depending on the fence). It can only be used when the site is not too large or difficult to manage and there are not significant numbers of other large mammalian species that should be accessing the site. Typically

this works for species such as pigs and wild dogs as eradication is not a viable option of naturalised pests in these environments.

Due to the size of the site barrier fencing will be used in the case of protecting sensitive areas only).The most effective fences are fabricated sheep mesh held close to the ground with plain wire and supported on steel posts.

6.2.2 Baiting

Baiting for pest species is a cost effective and proven management control. However, the MEWF project site is a sensitive site for the Northern Quoll, a small endangered predatory mammal which may easily take any baits set for mice or declared pests. Therefore baiting on the MEWF project site is not recommended under any circumstances.

Pest baiting requires knowledge of what species are being targeted so that appropriate deployment and baits are utilised. Baiting requires trained and qualified personnel to utilise baits for pest control.

6.2.3 Trapping

Trapping is commonly used as an alternative to baiting due to the risks baiting poses to humans and wildlife, as it is a non-specific control. Some trapping methods are typically used domestically and can be used around the site compound for species such as rats and mice.

To date, large vertebrate species (pigs and wild dogs) have not been seen in significant numbers on site to warrant trapping on site. This control method requires trained and skilled personnel, and requires outsourcing to an expert contractor. Traps must be checked daily for success and pests must be removed in a humane and ethical manner.

6.2.4 Shooting

Shooting of pests may occasionally be required. If this is required it will be carried out by qualified persons. This control method is only effective for low numbers of pest animals and should be opportunistic. Pests must be disposed of in a humane and ethical manner.

Table 4 Control Methods Required at Each Stage of MEWF Project Development

Project Phase	Objective	Action
Preconstruction	Identify abundance of pest species on MEWF project site	▪ Record the incidental occurrence of pests at key locations on project site. ▪ Liaise with local government Pest Management Officer regarding pest species management on site and methods of control undertaken.
Construction	Ensure effective pest control is undertaken for the project area	▪ Erect the appropriate exclusion fence around sensitive areas. ▪ Manage solid and liquid waste generated from the site compounds. ▪ Avoid creating artificial water points. ▪ Dump all the non-hazardous waste in a designated location which (fenced if required) and then taken offsite. ▪ Ensure appropriate training and induction of staff on pest issues and strategies.

Project Phase	Objective	Action
Ongoing	Ensure pest control is undertaken	▪ Survey periodically (quarterly) of high risk areas. ▪ Continue management of waste products. ▪ Promote continued education and training of staff to ensure implementation and changes to plan are ongoing. ▪ Check the exclusion fence periodically for any breakdown on the barrier and wear and tear. ▪ Liaise with Local and state government to ensure management of declared pest around property remains current and in line with other property holders and council. ▪ Continue pest and weed control through management of solid and liquid waste. ▪ Report infestations to Environmental Manager. ▪ Review this plan within 2 years.

7.0 Records, Monitoring and Review

7.1 Records

Both hard and electronic copies of records from all pest control activities are kept in a central location at RATCH for a minimum of five years to allow for a comprehensive review of the PMP. The minimum is recorded for the control events:

- Date;
- Location of activity;
- Target species;
- Method utilised;
- Area treated; and
- Numbers successfully controlled.

7.2 Monitoring and Evaluation

An annual monitoring program will be undertaken to determine the current presence of pest species and their abundance within the study area. Any significant findings of the pest species or new species out break or actions resulting from incidents which will incorporated into the annual review.

The implementation and effectiveness of this management plan and its associated procedures will be regularly assessed to ensure:

- The management strategy remains relevant and up to date;
- The plan and procedures adequately manage the environmental issue.

The methods use to assess the effectiveness are outlines in **Table 5** below:

Table 5 Methods to Assess Management Plan Effectiveness

Assessment Tool	Description
Audit	Audit outcomes are used to develop corrective actions which may include changes to this plan and or procedures.
Review of Data	Analyse all relevant data collected for negative and or undesirable trends that may be prevented by procedural change or by implementation and/or process.

7.2.2 Performance Indicators

Performance against pest control measures will be assessed against the following:

- There is no net increase in the abundance or distribution of pest animal species in the project area.

This performance indicator will be met by implementing control actions outlined in **Table 4** Management Control Actions.

7.3 Review

The PMP is a living document and shall be reviewed annually or sooner if any of the following occur:

- The plan is not adequately managing the issue;
- Legislative requirements change;

- The area of activity changes;
- A previously unidentified declared pest is found within an area of activity ; and/or
- New procedures relating to pest management are developed.

Reviews and changes to the PMP are to be communicated to relevant RATCH project personnel.

8.0 Definitions

Term	Meaning
Management Plan	Management plans are specific to and environmental issue or topics.
Non declared Animal	While sometimes pests, they are sometimes considered a significant state-wide threat and do not require and enforceable response. If warranted, local governments can declare these animals using local laws.
Notifiable Pest	A plant or animal species whose presence must be notified to the Queensland Government within 24 hours of becoming aware of it. Notifiable pests are declared under Section 12 of the Plant Protection Act 1989 and associated regulation.
Procedure	Procedures are designed to assist in the implementation of the Management Plan by prescribing a series of processes and actions for a specific topic.
Vector	An agent (person, animal or microorganism), that carries/transmits pests or weeds.

9.0 References

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Appendix A

Species Fact Sheets

Department of Agriculture, Fisheries and Forestry
Biosecurity Queensland

Fact sheet
PEST ANIMAL
PA21 December 2013

Cane toad

Bufo marinus

The cane toad is not a declared pest in Queensland, so there is no legal requirement to control them.

Their original introduction in 1935 was to control agricultural pests, but they proved ineffective.

For the past 60 years, cane toads have been expanding their territory in Australia, and are capable of colonising at least four of the mainland Australian states.

As the toad's geographical range continues to expand, concern has increased about their detrimental environmental effects, particularly on the wetlands of the Northern Territory.

Studies into the feasibility of biological control have commenced.

History of introduction and spread

The cane toad or giant toad is an amphibian, native to Central and South America. Cane toads have been introduced throughout the world as a biological control for insect pests of agriculture, most notably sugarcane.

A consignment of cane toads from Hawaii was released into Queensland cane fields in 1935. The introduction was surrounded by controversy as to the potential costs and benefits to Australia.

It was hoped that the toad would control Frenchi and greyback beetles—pests of economic importance to the sugarcane industry.

By 1941, however, it had become evident that the cane toad was exerting only limited control over its intended prey. There were two main reasons for this:

- Greyback beetles are only rarely in contact with the ground and Frenchi beetles invade cane fields at a time when the toads are absent due to a lack of protective cover.
- The cane toad has a wide-ranging and indiscriminate diet, and it was not solely dependant upon its intended prey.

The unlimited food source, suitable environment and low rates of predation allowed dynamic reproduction and spread. Toads were recorded in Brisbane only 10 years after release. The toad continues to thrive and has now invaded the Northern Territory and New South Wales (see Map 1).

Map 1. Distribution of the cane toad in Australia

The cane toad's advance is only limited by environmental factors, such as the availability of water for breeding, tolerable temperatures, suitable shelter and availability of food.

Toads at the frontier of their range of expansion may be larger than those in established populations. This is most probably due to greater food supply, combined with a lower incidence of disease.

Description and general information

In comparison with native frog and toad species, adult cane toads have a distinctive head and face, and are large and heavily built creatures (adults may grow to 20 cm).

Following their aquatic larval stages (eggs and tadpoles), cane toads are generally encountered at night near any source of light. Cane toads are ground-dwelling—they are poor climbers and unable to jump very high.

A definite visor or awning extends over each eye and a high angular bony ridge extends from the eyes to the nose.

The parotid glands (see Figure 1) are perhaps the most characteristic feature of the adult cane toad. These glands are large, protuberant, and are situated on the head behind each ear. These glands carry a toxin.

Map 2. Distribution of the cane toad in Queensland

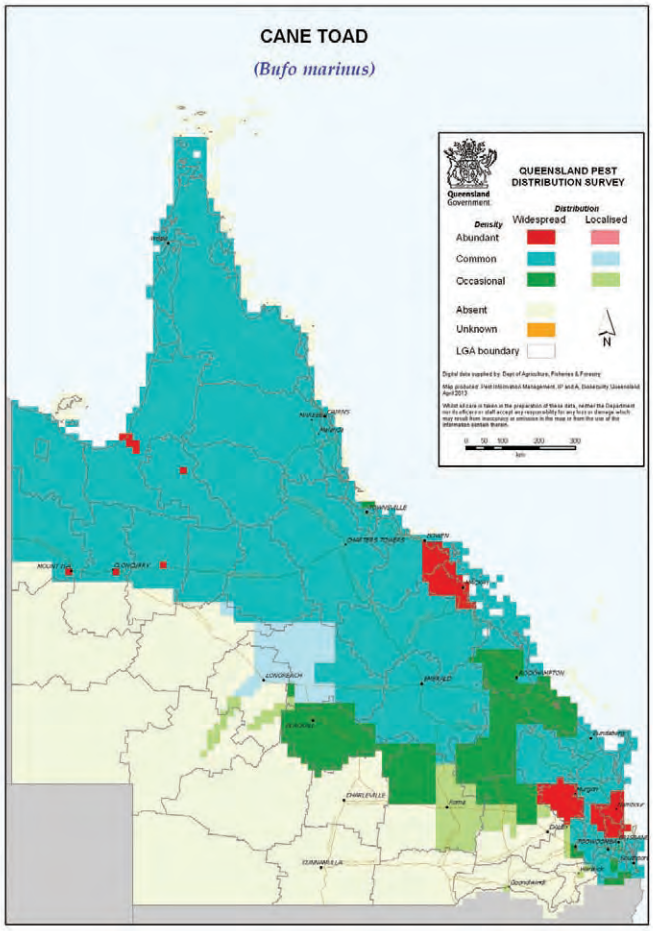
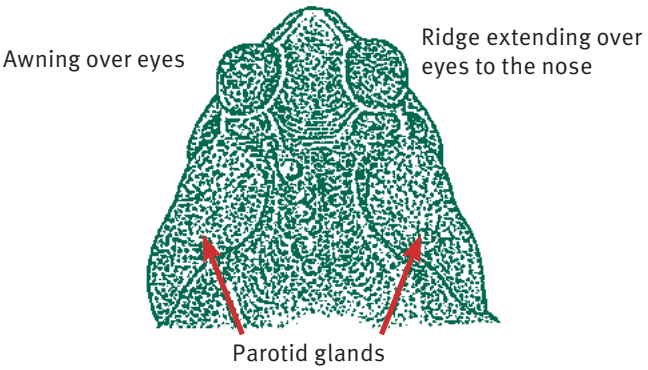


Figure 1. Distinguishing features of the cane toad



The cane toad's hands and feet are relatively small and lack discs at the tips of the digits. Webbing is absent between the fingers but is distinct and leathery between the toes.

Colouring on the dorsal (upper) surface may be brown, olive-brown or reddish-brown. The ventral (under) surface varies from white to yellow and is usually mottled with brown.

Warts are present on all cane toads; however, males possess more than females. Warts are dark brown at the caps.

Mating

Mating can occur at any time of the year and depends only on available food and permanent water. The mating call is a continuous purring trill that sounds like a running motor.

In situations where females are scarce or absent, male cane toads may have the ability to undergo a sex change to become fertile females; however, this has not been proved.

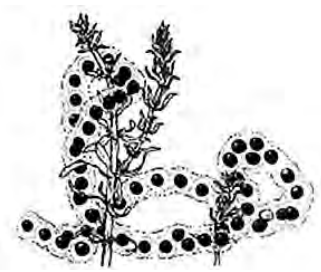
Eggs

Both cane toads and native frogs spawn in slow-moving or still water, but their eggs can be easily distinguished.

Cane toad eggs are laid in long, gelatinous 'strings' with the developing tadpoles appearing as a row of small black dots along the length. The strings are unique to cane toads, generally appearing as blobs of jelly attached to water plants or debris. Native frogs generally produce egg clusters as mounds of foam floating on the water surface.

Compared with native species, cane toad egg production is dynamic and a single clutch can contain up to 35 000 eggs. Remove any cane toad eggs found in the water and allow to dry out.

Figure 2. Drawing of toad spawn from *Wildlife of greater Brisbane*



Tadpoles

The cane toad is the only species in Australia that has a pure black tadpole. Native frogs have lighter-coloured undersides with a great range of colours and markings—cane toad tadpoles may turn paler colours to almost transparent at night.

Cane toad tadpoles are small and usually congregate in vast, slow-moving shoals. This 'shoaling' behaviour is uncharacteristic of most native species.

Unlike cane toad tadpoles, native species develop lungs at an early stage and periodically rise to the surface in order to exchange their lung gasses. Large groupings of tadpoles that do not break the water surface for air indicate cane toads.

Young toads

Following emergence from the water, the young toadlets usually congregate around the moist perimeter of the water body for about a week before they eventually disperse.

Young toads are very difficult to distinguish from the native *Uperoleiea* species, which also have parotid glands, but all *Uperolelea* species have bright red patches in the groin area.

Under ideal conditions toadlets may reach adult size within a year.

Toxicity

Bufo marinus produce venom in glands occurring in most of the skin on their upper surface. The venom is concentrated in the parotid glands as a creamy-white solution, which is released when the animal experiences extreme provocation or direct localised pressure (e.g. grasped by the mouth of a predator).

The parotid solution is highly toxic and when ingested it produces drastic acceleration of the heartbeat, shortness of breath, salivation and prostration. It is extremely painful if accidentally rubbed into the eye.

Ingestion of toads by domestic and most native animals can result in death. In some recorded cases, death has occurred within 15 minutes.

Field observations suggest that some predatory Australian species have learned how to feed safely on cane toads.

Birds have been observed flipping toads over to avoid the parotid glands. Predatory reptiles may have more trouble adapting, being unable to remove a toad from the mouth once they start feeding.

Effects on wildlife

The cane toad is poisonous at all stages of its life cycle and most native frog larvae and many aquatic invertebrates are dramatically affected by their presence.

Cane toads are voracious feeders that consume a wide variety of insects, frogs, small reptiles, mammals and even birds. Perhaps the only limiting factor to the prey taken is the width of the cane toad's mouth.

It has been suggested that cane toad competition for food and breeding grounds has been responsible for reducing the populations of some native frogs. However, many native frogs are arboreal (tree-dwelling) and occupy different niches. Cane toads don't have the native frogs' ability to 'shut down' during dry seasons when resources are limited.

Pressure from cane toads may displace native animals (frogs and other species) where they are already suffering due to manipulation of their habitat by humans and grazing animals. Animals that use waterholes as retreat sites during the dry season are especially vulnerable—toads will congregate here in large numbers.

Public health

Cane toads readily eat animal and human faecal material and, in areas of poor hygiene, they have been known to transmit disease such as salmonella.

Control

Control of cane toads is not enforced as there is currently no available effective broad scale control. Individuals and community groups have carried out removal campaigns to decrease numbers and slow the invasion front.

Fencing is recommended to keep toads out of ponds intended for native fish and frogs; a height of 50 cm is sufficient. Bird wire with 1 cm holes may keep toads out of an area.

Research indicates that spread can be delayed in semi-arid areas by blocking access to water holes.

Individual toads may be killed relatively humanely using a commercial spray available from hardware stores or may be stunned and decapitated (only by experienced operators). The removal of eggs from small water bodies such as frog ponds can be effective

Researchers have successfully mitigated impacts in recently colonised areas by 'training' predators however, large scale application of this technique is difficult.

Further information

Further information is available from your local government office, or by contacting Biosecurity Queensland (call 13 25 23 or visit our website at www.biosecurity.qld.gov.au).

This fact sheet is developed with funding support from the Land Protection Fund.

Fact sheet

DECLARED CLASS 2 PEST ANIMAL

Dingoes

Canis familiaris dingo

The dingo *(Canis familiaris dingo)* is a primitive canid related to wolves and coyote. The dingo was not a part of the ancestral fauna of Australia. Though its origins are not clear, it is thought to have arrived in Australia 3500–4000 years ago.

It is the largest mammalian carnivore remaining in mainland Australia, and as such fills an important ecological niche. Females weigh about 12 kg and males 15 kg.

The dingo has been regarded as a serious predator of domestic stock since early European settlement in Australia. Early research emphasis was on control, indeed eradication of the dingo. No attempt was made to study the animal, measure predation, or to understand why the problem existed.

Declaration details

Under the *Land Protection (Pest and Stock Route Management) Act 2002* the dingo/wild dog is a declared Class 2 pest animal. It is the responsibility of landholders to reduce the number of dingoes/wild dogs on their property.

Queensland Government

PA9 July 2010

Description and general information

Red, ginger and sandy-yellow are the dominant coat colours, though dingoes can also be pure white, black and tan or solid black.

It is not difficult to distinguish between most dingoes and hybrids. The presence of domestic genes is suggested by broken colours—brindling and patchiness in the normally pure white feet and chest patch and sable colouration (black hairs along the back and sides).

Dingoes have a more heavily boned skull and larger teeth (especially the canine) than domestic dogs of similar size.

Distribution

Dingo numbers are believed to be higher today than in pre-European times. This is thought to be due to increased food availability via the introduced rabbit and cattle carcasses, and the development of permanent waters in arid areas of the state.

Dingoes/wild dogs are now present in all parts of the state.

The distribution of the wild dog in relation to purebred dingoes varies throughout the state. In far western areas, most dingoes sighted appear to be 'pure', with characteristic white points and broad heads. Closer to settled areas a greater number of feral domestic dogs produce a generally hybrid population. It has been estimated that dingoes are 50% pure in south-eastern Queensland and 90–95% pure in south-western and central Queensland.

Reproduction

Dingoes have only one breeding season per year (usually April to June), whereas domestic bitches have two or more oestrus cycles per year. However, unless seasons are particularly favourable, or human sources of food are intentionally or inadvertently provided, feral domestic dogs are unlikely to successfully rear two litters per year.

After a nine-week gestation, dingo pups (usually four to six) are born in a hollow log or cave den. Bitches tend to use the same den each year. Pups are suckled at four to six weeks and generally weaned at four months. When large enough to travel, pups are taken from the den to kills, and other dens many be used. The range of pups is increased as they are moved from den to den. In this way the pups are gradually moved around the bitch's home range.

Independence may occur as early as six months of age when parents abandon them, but this results in high juvenile mortality. Pups that become independent around 12 months appear to disperse voluntarily. Being larger and more experienced, mortality is then usually low.

Where dingoes live alone or in small groups (most pastoral and semi-settled areas), mature females will breed successfully each year.

By contrast, dominant female infanticide results in only one litter being successfully raised each year within groups containing several adult females (e.g. undisturbed areas such as the Simpson Desert). The dominant (alpha) female will kill all pups of the other females, and then use subordinate females to suckle and rear her litter.

Home range

Radio tracking studies show dingoes occupy a discrete area known as a 'home range'. The dingo visits the edge of this area frequently.

The home range can vary in size according to the productivity of the country—from 9 km² in rainforest areas to 300 km² on the Nullarbor Plain.

The edge of the home range is commonly associated with a major topographic feature (e.g. an escarpment, a major ridge or stream).

The home range is not used uniformly. Activity is centred on areas with highest food density.

Hunting movement is slow and exploratory, in contrast to frequent rapid movement around the home range boundary.

Pads follow well defined paths and are most likely associated with sociality and home range boundary maintenance. Activity is highest at dusk and dawn.

Social organisation

Dingoes in an undisturbed area generally belong to discrete packs (3–12 members), which occupy long-term, non-overlapping territories. The group rarely moves as a pack—rather, members meet and separate again throughout the day. Dingoes are most gregarious during the breeding season.

There is overlap of home ranges within a group. In contrast, boundaries between groups are more rigid, actively defended and infrequently crossed.

Olfactory communication (smell) is important in dingo social organisation. Dingo droppings are deposited along pads in specific areas where other dingoes will encounter them (creek crossings, intersections of roads and fences).

These 'scent posts' appear to delineate the home range boundary and act as a warning to neighbouring groups and individuals.

This strong site attachment of dingoes is contrary to the notion commonly held by property owners that dingoes will travel large distances to kill stock.

Diet

Dietary research of stomach content and faecal scats has shown dingoes are opportunistic predators.

Medium-size animals such as kangaroos, wallabies, rabbits and possums consistently form the major part of the dingo diet.

Studies by the Western Australia Agriculture Protection Board show dingoes in undisturbed refuge areas killed and ate kangaroos strictly according to need.

On grazing country, however, 'dingoes harassed, bit or killed sheep in large numbers, often without eating any'. The consumption of these sheep carcasses was the exception rather than the rule. Even kangaroos in these areas were sometimes killed in 'play' type behaviour rather than for food.

Such dietary studies could suggest dingo predation of domestic stock is low. There is, however, a need for caution in using such studies to assess dingo impact on stock.

Grouping increases foraging efficiency and appears necessary to exploit larger prey. Dingoes cooperating in groups are more successful in hunting kangaroos than lone dingoes are. While lone dingoes can easily kill sheep, it is less likely a solitary dingo would successfully attack a calf in the presence of a defending cow.

Disease threat

Dingoes are vectors of canid diseases (e.g. distemper, parvovirus) and parasites. The hydatid parasite *Echinococcus granulosus* is a major problem of dogs and domestic stock. It can cause illness and occasionally death in humans.

The dingo could pose a serious risk if the exotic disease rabies was introduced to Australia.

Beneficial considerations

The establishment of watering points during post-European settlement has resulted in a huge increase in the kangaroo population, with consequent strong pasture competition with domestic livestock.

Though it is widely accepted that sheep production is near impossible in the presence of dingoes, many cattle producers will tolerate dingoes because of their believed suppression of kangaroo numbers.

Research has shown that not only does the dingo have the potential to mitigate population growth of native species during abundant seasons, it could also be an important limiting factor for many feral animal populations (e.g. feral pigs and goats).

Destruction of the dingo could cause increases in other pests to the grazing industry and result in widespread degradation of environmentally sensitive areas. However, this has not been proven.

Further information

Further information is available from your local government office, or by contacting Biosecurity Queensland (call 13 25 23 or visit our website at www.biosecurity.qld.gov.au).

PR10–5203

Department of Agriculture, Fisheries and Forestry
Biosecurity Queensland

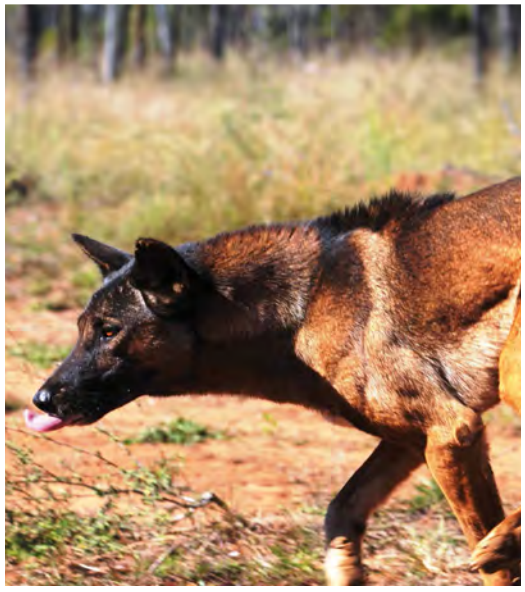
Fact sheet

DECLARED CLASS 2 PEST ANIMAL

December 2014

Wild dog control

Canis familiaris



The term wild dog refers collectively to purebred dingoes, dingo hybrids and domestic dogs that have escaped or been deliberately released.

Wild dog control methods include baiting, trapping, shooting, fencing, and the use of guardian animals to protect stock. A planned strategy using a combination of these methods that also considers wild dog behavior will enable effective management.

Declaration details

Wild dogs are a declared Class 2 pest animal under Queensland legislation. As such, all landholders in Queensland are required to reduce the number of wild dogs on their properties.

Management strategies

To increase wild dog control effectiveness, it is essential that control programs are coordinated among adjoining properties.

Queensland research has shown that in some situations wild dogs can quickly re-colonise baited areas due to a number of factors including inconsistent bait programs which do not provide comprehensive wild dog control across the landscape. Such programs may alter the dynamics of wild dog populations in the area. To prevent livestock attacks and enhance wild dog management, it is important for producers to work together using a variety of control methods.

Wild dog ecology and seasonal variations can also influence the likelihood of wild dogs coming into contact with a control tool. The timing of control should consider seasonal variations and the availability of water (where water is restricted) and then target watering points. Many land owners bait using 1080 twice a year to target wild dogs during peaks in activity associated with breeding (March/May) and then again in September/November to target pups and juveniles. However, baiting and trapping is recommended at all times when wild dogs are active.

Control

Baiting

Poison baits are the most economic, efficient and effective method of controlling wild dogs, especially in inaccessible or extensive areas. Baits can be laid quickly by hand, from vehicles and from aircraft.

Currently there are two poisons legally available for wild dog control. These are 1080 (sodium fluoroacetate) and strychnine.

Subject to restrictions, 1080 baits, either manufactured or prepared from fresh meat can only be obtained from authorised persons. A permit from the Queensland Department of Health is required for land owners to purchase strychnine. Strychnine can be used both in baits and on traps. The use of both 1080 and strychnine require adherence to the associated conditions of supply.

The use of poison baits will control some but not all wild dogs. Baits should be used in conjunction with all other control tools and not be relied on as a total control method.

Meat baits are attractive both to wild dogs and a range of non-target species. When using meat baits, they can be strategically positioned as wild dogs' keen sense of smell enables them to find baits intentionally buried in sand or otherwise hidden under bushes or in hollow logs. Meat baits may also be tied to prevent their loss to non-target species.

These meat bait placement techniques help to:

- reduce the risk of poisoning non-target species
- increase wild dog contact, hence receiving a lethal dose
- minimise bait removal by non-target scavengers
- deter ants (ant-covered baits are believed to be less attractive to wild dogs).

Heavy rain within two weeks of baiting can leach 1080 from baits, but baits may still remain toxic for a considerable time.

Trapping

A key success to trapping wild dogs (using foot-hold traps) depends on the skill of the operator. Visit www.feral.org.au to watch a PestSmart video on best practice techniques for wild dog trapping.

For humane reasons and to prevent escape, poisoning traps with strychnine is recommended to quickly kill captured wild dogs. A properly poisoned trap becomes a lethal device rather than a holding device.

A mixture of dog faeces and urine is a popular lure used by trappers. Attractiveness of lures varies with seasons and locations. No single lure has yet been found that is consistently attractive to all wild dogs and repeated use of one lure can lead to aversion amongst remaining dogs.

Traps are best placed in areas of high wild dog activity (known as leads). Here the wild dog is most likely to find and investigate the decoy/odour.

A wild dog scent post (an area where urine or faeces have been deposited) can be found by walking with a domestic dog on a lead along a known pad. Trap placement in relation to the scent post can be optimised by observing the domestic dog's behaviour as it approaches. Factors to consider are:

- where on the bush it smells
- placement of feet while urinating/defecating/sniffing
- how it approaches and where it scratches in relation to the pad and scent post.

Padded, laminated or offset foot-hold traps, in a well tuned and functioning state are recommended.

Shooting

Shooting is an opportunistic method, mostly used for control of small populations or individual problem animals.

Fencing

Property fencing suitable to exclude wild dogs is expensive to build and requires continual maintenance to repair damage caused by fallen timber, fire, floods, feral and domestic animals, as well as vegetation regrowth. However, a properly maintained fence can restrict movement into an area where wild dogs have been controlled.

Electric fences suitable for wild dogs have been developed. Electrifying a fence creates a fear of the fence itself and deters wild dogs from approaching.

For property fencing to be successful, the fence must be maintained in good order and ongoing wild dog control conducted within the protected area to limit livestock impacts.

Fencing is the most effective method of protecting livestock and pets from wild dog attack on small acreage blocks.

A fence can also be a good area to place baits and traps when wild dogs are active.

Livestock guardian animals

Livestock guardian animals have been used to protect livestock from predators in Europe, Asia and America. Some producers in Queensland have decreased predation on sheep and goats using this method. The use of trapping and poisoning in conjunction with guardian animals must be well planned and managed to ensure guardian animal safety.

Further information

Further information is available from your local government office, or by contacting Biosecurity Queensland (call 13 25 23 or visit our website at www.biosecurity.qld.gov.au).

This fact sheet is developed with funding support from the Land Protection Fund.

Department of Agriculture and Fisheries
Biosecurity Queensland

Fact sheet
DECLARED CLASS 2 PEST ANIMAL
March 2016

Feral pig

Sus scrofa

Pigs were introduced to Australia by early settlers. Subsequent accidental and deliberate releases resulted in the wild (feral) population establishing throughout Australia.

Feral pigs cause environmental and agricultural damage, spread weeds and can transmit exotic diseases such as leptospirosis and could spread foot-and-mouth disease.

Declaration details

Feral pigs are declared Class 2 pest animals under Queensland legislation. Declaration requires landholders to control declared pests on land under their control.

Description

Feral pigs are typically smaller, leaner and more muscular than domestic pigs with well developed shoulders and necks, and smaller, shorter hindquarters.

The body is usually covered in sparse, coarse hair and they have a longer, larger snout, longer tusks, a straighter tail and narrower back than domestic pigs. Feral pigs are mostly black, buff-coloured or spotted black and white.

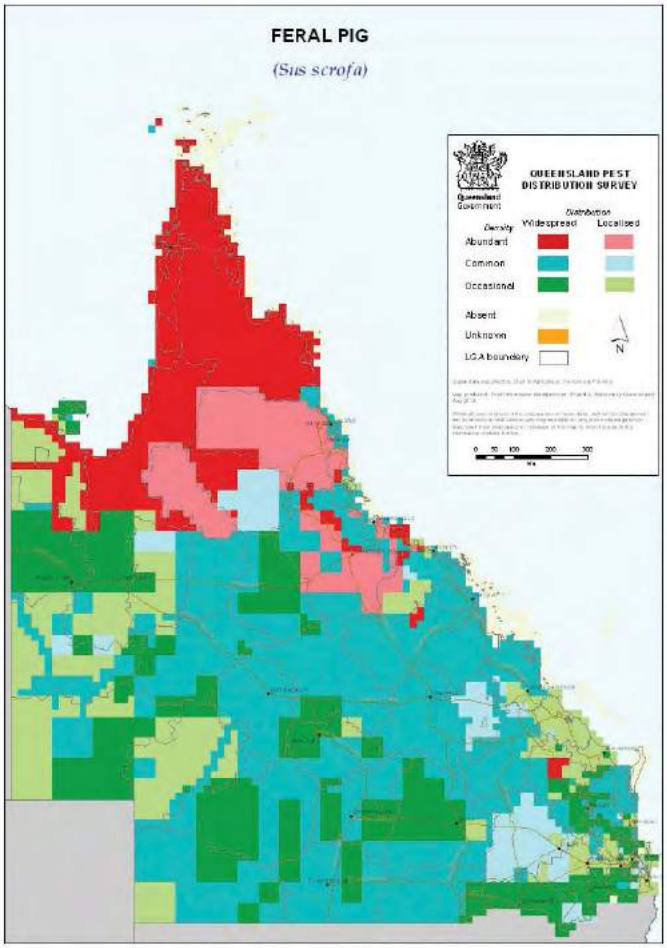
Growth potential is similar to domestic pigs, although harsh environmental conditions tend to stunt development. Adult female feral pigs usually weigh 60–75 kg, while males usually weigh 90–110 kg. Older boars (razorbacks) can have massive heads and shoulders and a raised and prominent back bone that slopes steeply down to small hams and short hind legs. Some boars develop a crest or mane of stiff bristles extending from their neck down the middle of their back.

Queensland Government

Feral pig wallow

Feral pig rooting

Map 1. Distribution of feral pigs in Queensland



Habitat and distribution

Feral pigs are found in all habitat types in Queensland. The greatest concentrations of feral pigs are on the larger drainage basins and swamp areas of the coast and inland. In hot weather, pigs need to remain near water.

Population estimates can be achieved by spotlighting, aerial survey or the use of motion cameras.

Evidence of feral pigs includes fresh digging or rooting of the ground, tracks and faeces on and off pads, mud or hair at holes in fences where pigs have pushed through, wallows, tusk marking and mud rubs on trees and fence posts and nests in vegetation made by sows before farrowing.

Biology and behaviour

Female and juvenile pigs usually live in small family groups with a home range of 2–20 km^2. Adult males are typically solitary, with a home range of 8–50 km^2. Range size varies with season, habitat, food availability and disturbance. Herds of 400 pigs have been recorded in Cape York.

Feral pigs are generally nocturnal, spending daylight hours sheltering in dense cover. Pigs are omnivorous, eating plants and animals and are extremely opportunistic feeders, exploiting any temporarily abundant food.

They prefer green feed and will eat grains, sugarcane and other crops, fruit and vegetables. They root extensively for tubers, worms and soil invertebrates.

Feral pigs have relatively high energy and protein requirements, particularly during pregnancy and lactation and often move to other parts of their home range during pregnancy.

Life cycle

Under good seasonal conditions, breeding occurs all year and sows can produce two litters per year. Adult females have a 21–day oestrus cycle, with a gestation period of about 113 days, producing a litter of 4–10 piglets. Sows can make nests of available vegetation just before farrowing. Nests sometimes have a domed roof and are usually less than 2 km from available water. Piglets normally spend the first 1–5 days of life inside the nest, with the sow nearby. Weaning occurs after 2–3 months. Sexual maturity is reached when sows weigh about 25 kg, usually around six months of age.

Mortality of juveniles is high if the mother's dietary protein intake is low (up to 100% mortality in dry seasons). Adult mortality does not vary as much with seasonal conditions, but few animals live more than five years.

Impacts

Pigs can damage almost all crops from sowing to harvest, starting with uprooting seed and seedlings to feeding on or trampling mature crop.

They feed on seed, sugar cane and grain crops (except safflower), fruit (especially banana, mango, papaw, macadamia and lychee) and vegetable crops. Research has shown feral pigs can take up to 40% of lambs.

Pastures are damaged by grazing and rooting and pigs can also transport weeds. Wallowing pigs damage and foul the water in tanks and bore drains and silt up troughs. They can also damage fences and dam walls.

Pig activity degrades water quality and the habitat for small terrestrial and aquatic animals. It also creates erosion and allows exotic weeds to establish. Predation of native fauna does occur and examination of faeces has shown remains of marsupials, reptiles, insects, and ground-nesting birds and their eggs.

Feral pig damage to river banks

Feral pig damage to sugar cane

Diseases and parasites

Feral pigs can carry many infectious diseases and internal and external parasites. Some are endemic (already present), while others are exotic to Australia.

Many of the diseases can spread to domestic pigs, other livestock and humans. Feral pigs can transmit sparganosis, melioidosis, leptospirosis, Q fever and brucellosis to humans.

To prevent contracting these diseases it is advisable to either avoid handling feral pigs or use suitable protective clothing (mask, goggles, strong rubber gloves and plastic apron and boots) to minimise contamination with blood, urine and faeces. Rare or undercooked meat should not be eaten; thoroughly cook meat to avoid contracting pathogens.

Control

Feral pigs are difficult to control because they are primarily nocturnal, breed rapidly, are generalist omnivores and have large home ranges and thus control programs need to be conducted over a wide area (often including several properties) to be effective.

Effective control requires an integrated, collaborative approach where all stakeholders participate in planning, implementation and evaluation of the actions taken.

Trapping

Trapping is an important technique that is most useful in populated areas, on smaller properties (‹5000 ha), and where there are low pig numbers. Trapping can be particularly useful in ‘mopping up’ survivors from baiting programs. It is most successful when food resources are limited.

Trigger mechanisms for pig traps can be made pig-specific and therefore pose little danger to wildlife or domestic animals.

Advantages

- This is the safest form of control and can be safely undertaken on closely populated areas.
- It’s flexible and can be incorporated into routine property activities, making economical use of labour and materials.
- Carcasses can be safely disposed.
- Traps can be moved and re-used; good trapping makes use of opportunities as they arise.
- Normal pig behaviour is not altered, which allows a greater number of the total population in an area to be targeted.
- More humane to pigs and non-target species.
- The number of animals removed can be easily monitored.

Disadvantages

- Can be time consuming and expensive to construct and maintain.
- Must be checked regularly.
- Not practical for large-scale control.
- Some pigs are trap shy.

Tips

- Stop all activities that will disturb normal feeding (i.e. do not undertake any shooting or dogging).
- Pre-feeding (i.e. ensure that pigs are visiting trap and consuming bait) prior to activating traps is an essential part of successful trapping.
- Feeding sites should be placed where feral pigs are active (i.e. water points, holes in fences, areas containing old carcasses on which pigs have been feeding).
- Bait for traps must be food that pigs usually eat in that area. Pigs feeding on one crop (e.g. sugarcane) will often not take to alternative foods. However, new, novel baits are sometimes attractive (e.g. fermented grains).
- The trap can be built around the feeding site, with feeding within the trap undertaken for several nights before it is set.
- Set the trap every night and check each day. If the trap cannot be checked daily then shade and water must be provided.
- Continue to trap until no more pigs are caught. A change of bait can be tried. Again, feed for one or two nights before re-setting the trap.
- Traps may be left permanently in locations used by pigs and can be utilised when fresh signs of pigs appear.
- If the trap is to be moved, start feeding at the new site before re-locating the trap.

Design

There are several trap designs but all are principally an enclosed area with one-way gates (see Figure 1).

The main area of the trap can be any shape and be made from materials on the property. The best material is steel mesh with a grid 100 × 100 mm, with a minimum height of at least 1.5 m. Star pickets need to be placed no more than 1.5 m apart and imbedded far enough to ensure that adult pigs cannot push them over or lift them up out of the ground.

Alternative trap entrances

Funnel entrance

Formed by the two ends of the mesh forming a funnel, the ends are tied together at the top with wire or rope. The pig moves through the funnel forcing the bottom of the mesh ends apart and once it is in the trap the ends spring back together (see Figures 1 and 2).

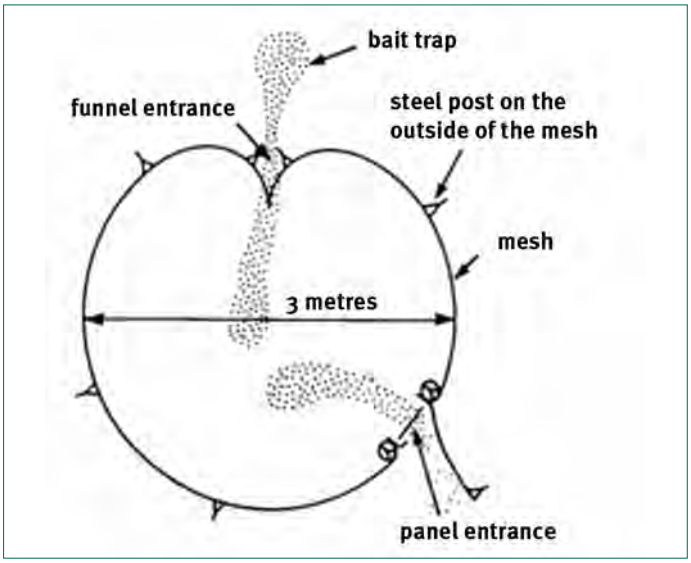


Figure 1. Alternative trap entrances – funnel entrance

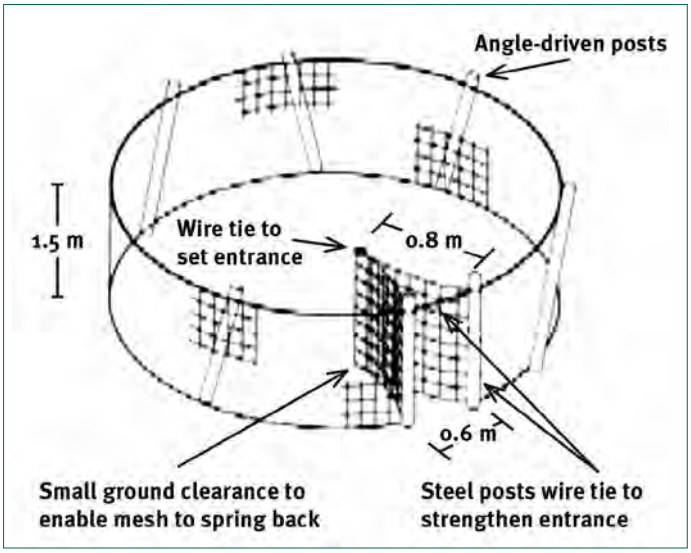


Figure 2. Silo trap with funnel entrance (14 m of silo mesh diameter about 4.5 m

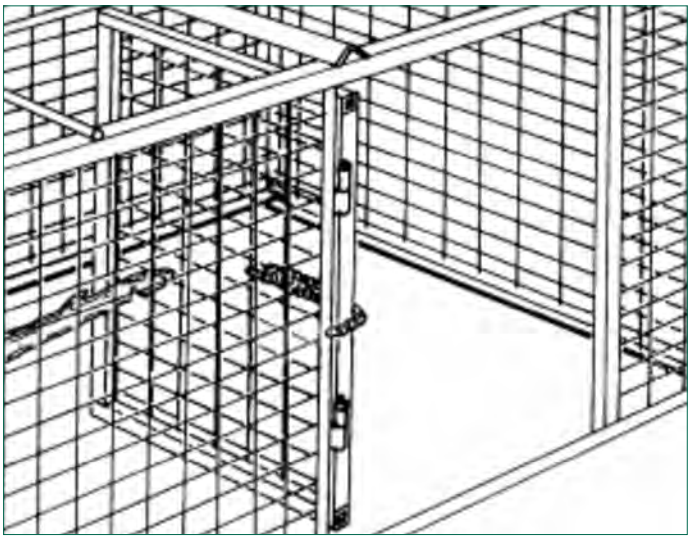


Figure 3. Pig-specific trigger

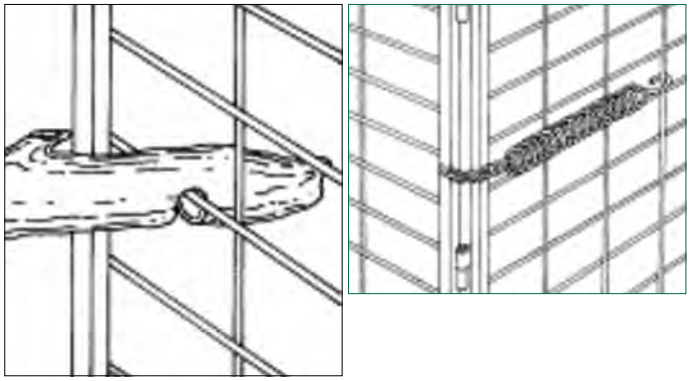


Figure 4. Close up of pig-specific trigger

Feral pig trap

Trapped feral pigs

Hog hopper – pig specific bait station

Tripped gate entrance

A side-hinged gate is pulled shut by springs and is held open by many systems that can be triggered to allow the gate to swing shut. Often trip wires or other systems are used; most of these systems are not selective for feral pigs and can be triggered by any animal attracted to the bait. Once triggered the trap is no longer effective in trapping pigs.

Pig-specific trigger

By far the simplest and most effective trigger system has the gate held open by a bar (often a branch or piece of wood) which is hooked over the wire on the gate and on the side panel (see Figure 3). For a close up of the pig specific trigger (see Figure 4).

Pigs rooting for feed in the trap lift the bar allowing the gate to swing shut. The specific feeding habit of pigs insures they are the only animals that lift the trigger bar.

The gate may be latched to prevent pigs from opening the door once triggered. However, this will prevent more pigs pushing their way in to join those inside.

Poisoning

Poisoning is the most effective control method available that can quickly reduce a pig population.

Only authorised persons can supply 1080 baits to landholders.

Pre-feeding is the most important step in ground-based poisoning operations. Free feeding with non-poisoned bait should be performed for several days prior to laying poisoned baits.

By selecting bait wisely, landholders can be species-selective in their poisoning program and avoid many of the unintentional effects of secondary poisoning.

Bait material such as fermented grains are very attractive to pigs. It is a good idea to establish a free feeding routine so that pigs are the only animals feeding, which helps to keep other non-targets away from the feeding site.

Other options (like pig-specific feeders) are now commercially available, and can assist in reducing non-target species access to bait. Other options include burying baits; feral pigs are one of the few animals that will dig up bait.

Aerial poisoning is also available and typically used for broadscale control in western and northern regional areas. Bait is distributed from an aircraft. This is particularly useful for covering large, remote, areas or restricted ground access. Aerial poisoning is a proven and cost-effective method for reducing pig populations.

A phosphorous-based poison is also available for use in Queensland.

Shooting

Shooting pigs by helicopter is effective in areas where pigs exist in reasonable numbers and are observable from the air.

Ground shooting is not effective in reducing the pig population unless intense shooting is undertaken on a small, isolated and accessible population of pigs.

Fencing

Though an expensive option, fencing can offer successful pig control especially for high value crops grown on small areas. Research has indicated that the most successful pig-proof fences are also the most expensive.

The most effective pig-proof fences use fabricated sheep mesh held close to the ground by plain or barbed wire and supported on steel posts.

Electrifying a conventional fence greatly improves its effectiveness if used before pigs have established a path through the fence.

Pigs will often charge an electric fence and unless the fence incorporates fabricated netting they often successfully breach the fence.

For crop protection or to avoid lamb predation, pig-proof fences need to be constructed before the pigs become a problem. Once pigs have adjusted to feeding on grain or lambs in a particular paddock fencing may be ineffective.

Fertility control

There are currently no available means to deliver fertility control to feral pigs. Such a technique is likely to remain unavailable for practical use given the lack of suitable contraceptives, suitable delivery mechanisms, and concerns with non-target species.

Further information

Further information is available from your local government office, or by contacting Biosecurity Queensland (call 13 25 23 or visit our website at www.biosecurity.qld.gov.au). Visit www.biosecurity.qld.gov.au to download a copy of the feral pig control manual.

Biosecurity Queensland gratefully acknowledges the contribution from Choquenot, D., McIlroy, J. and Korn T. (1996) Managing Vertebrate Pests: Feral Pigs, Bureau of Resource Sciences, AGPS, Canberra. Commonwealth of Australia copyright reproduced by permission.

Feral pig exclusion fencing

This fact sheet is developed with funding support from the Land Protection Fund.

Department of Agriculture and Fisheries
Biosecurity Queensland

Fact sheet

DECLARED CLASS 2 PEST ANIMAL

March 2015

Feral cat

Felis catus

A descendant of the African wild cat (*Felis silvestris lybica*), the common 'house' cat (*Felis catus*) has now been domesticated for about 4000 years. Although the domestic cat has a long history of association with humans, it retains a strong hunting instinct and can easily revert to a wild (feral) state when abandoned or having strayed from a domestic situation.

Semi-feral cats live around dump sites, alleys or abandoned buildings, relying on humans by scavenging rubbish scraps and sheltering in abandoned structures. The true feral cat does not rely on humans at all, obtaining its food and shelter from the natural environment.

Declaration details

The feral cat is a pest animal under Queensland legislation and landholders are required to control its numbers on their land. Declared pest animals represent a threat to agricultural industries and natural resources, and have a social impact on other human activities.

Legislation describes a feral cat as one that is not fed and kept by someone. The word 'kept' specifically means that the cat is housed in a domestic situation.

Queensland Government

Description and general information

The feral cat differs little in appearance from its domestic counterpart; however, when in good condition, the feral cat displays increased overall muscle development, especially noticeable around the head, neck and shoulders, which gives the animal a more robust appearance. The average body weight of male feral cats is 3–6 kg, while females weigh 2–4 kg. Body weights vary with condition, with some extremely large specimens documented.

Australian feral cats are predominantly short-haired, with coat colours that range between ginger, tabby, tortoiseshell, grey and black. White markings may be present on the feet, belly, chest and throat; completely white feral cats are extremely rare. In established populations, coat colours are the result of a natural, genetically selective process. Terrain, predators and the ability to capture prey limit coat colours to those that provide the most suitable camouflage and cause a predominance of these colours in subsequent offspring. Ginger cats are more likely to be found in the semi-arid and desert areas, while grey and black specimens generally predominate in scrub and more heavily timbered habitats.

The feral cat is most active at night, with peak hunting activity occurring soon after sunset and in the early hours before sunrise. At night the cat displays a distinctive green eyeshine under spotlight, making it easily distinguishable from other animals. During the day it will rest in any number of den sites, which may include hollow logs, dense clumps of grass, piles of debris, rabbit burrows, and even the hollow limbs of standing trees.

The most obvious and characteristic field signs of feral cats are their scats (droppings). Unlike the domestic cat, the feral cat does not bury its scats, but leaves them exposed at prominent sites to warn other cats of its territorial boundary.

History of introduction and dispersal

There is some evidence to suggest that the cat was present in Australia long before European settlement. This may have occurred as a result of Dutch shipwrecks and regular visits to northern Australia by early South-East Asian vessels as long as 500 years ago.

Post-settlement dispersal resulted from cats straying from areas of early colonisation. In the late 19th and early 20th centuries, large numbers of cats were purposely released in many rural areas to combat plague numbers of rabbits. Unwanted cats continue to be released into urban and rural areas by irresponsible pet owners.

The feral cat is now present Australia-wide, thriving under all climatic extremes and in vastly different types of terrain.

Population dynamics

Male cats attain sexual maturity at about 12 months, whereas females are capable of reproduction at approximately seven months. Annually, and under ideal conditions, an adult female can produce up to three litters—each of usually four kittens, but varying from two to seven.

As the breeding instinct is triggered by the increasing length of daylight, litters are less frequent in winter. Most reproduction occurs during the spring and summer months, and is generally limited to two litters per year. Birth follows a gestation period of 65 days, and kittens may be reared in a single den site or may be frequently shifted to other sites within the female's home range. Family and litter bonding begin to break down when the kittens are approximately seven months old. The female's ability to bear litters does not decrease with age, so reproduction continues for the course of her life.

Social organisation and behaviour

Feral cats maintain stable home ranges, the sizes of which depend upon the relative abundance of food and the availability of suitable den sites. Dominant male cats may have territories of up to 8 km^2, while the territories of females are smaller and may even be halved while kittens are being reared.

Scent glands are present on the chin, at the corners of the mouth, and in the anal region. Territorial boundaries are maintained by scent marking with the cheek glands, pole-clawing, urinating and leaving exposed faecal deposits.Although feral cats are often thought of as being solitary animals, studies show this behaviour is generally limited to hunting activities. At other times feral cats display a degree of social interaction that peaks during the breeding season. Group behaviour has been observed in semi-feral populations, and it has been suggested that such behaviour is exhibited also in feral populations.

Groups usually comprise several related adult females, their young of both sexes, and an adult male—whose range may include other groups of females. Young females usually remain in a group, while young males either leave or are driven from the group as they reach sexual maturity.

Effects on wildlife

The energy expended by an adult male cat requires it to consume 5–8% of its body weight in prey per day, while females raising kittens require 20%. Based on these figures, one study concluded that 375 feral cats on Macquarie Island would consume 56 000 rabbits and 58 000 sea birds per year. Where present on the mainland, rabbits may comprise up to 40% of a feral cat's diet. Cats are successful as a control mechanism only when rabbit densities are low. At other times cat predation does little to halt the build-up or spread of

rabbit populations; rabbits merely help to support a larger number of cats. When seasonal shortages of rabbits occur there is a corresponding rise in the number of native animals taken by cats.

The feral cat is an opportunistic predator, and dietary studies have shown that small mammals, birds, reptiles, amphibians, insects and even fish can be taken as prey. Cat predation is particularly harmful in island situations, and a number of species have become extinct due to the introduction of cats by early sealers and lighthouse keepers. On the mainland, native animals—which already suffer due to the destruction of their habitats by man and other introduced animals—may be endangered further by cat predation. Actual competition for prey can cause a decline in the numbers of native predatory species such as quolls, eagles, hawks and reptiles. Not only do native animals bear the brunt of predation, but they also suffer the effects of a parasite that reproduces only in the intestine of the cat. This disease (toxoplasmosis) is particularly harmful to marsupials, which may develop blindness, respiratory disorders, paralysis, and suffer the loss of offspring through abortion and stillbirths.

Exotic disease—rabies

Due to their widespread distribution, feral cats may prove to be a major vector for this fatal viral disease if it ever enters Australia. Overseas studies have revealed that wounds inflicted by rabid cats are more dangerous than those caused by rabid dogs. While the bites of rabid dog are generally inflicted on the arms and legs, the cat attacks the head of its victim, biting and clawing viciously. These head and facial bites reduce the time taken for the virus to enter the central nervous system, lessening the chance of success from subsequent remedial treatment.

Control

Exclusion

Fencing is the only feasible method of control when special areas need protection from cats. Feral cats have been successfully prevented from climbing over netted fences that use an electrified wire mounted 15 cm from the top and 10 cm outward from the fence. Non-electrified fencing should incorporate a netted ceiling, or a curved overhang, which prevents the cat from climbing straight up and over the fence.

Shooting

Night shooting is assisted by the cat's distinctive, green eyeshine. Cats have been successfully attracted by the use of a fox whistle.

Poisoning

Fresh meat baits containing 1080 may be used for controlling feral cats under an APVMA Permit (PER14015 effective until 30 June 2016).

Only authorised persons can supply 1080 baits to landholders.

Lures

Audible recorded lures for feral cats and other predators are available through a number of sources. These recordings mimic the distress call of a small animal and can be used to draw a predator to a bait or trap site.

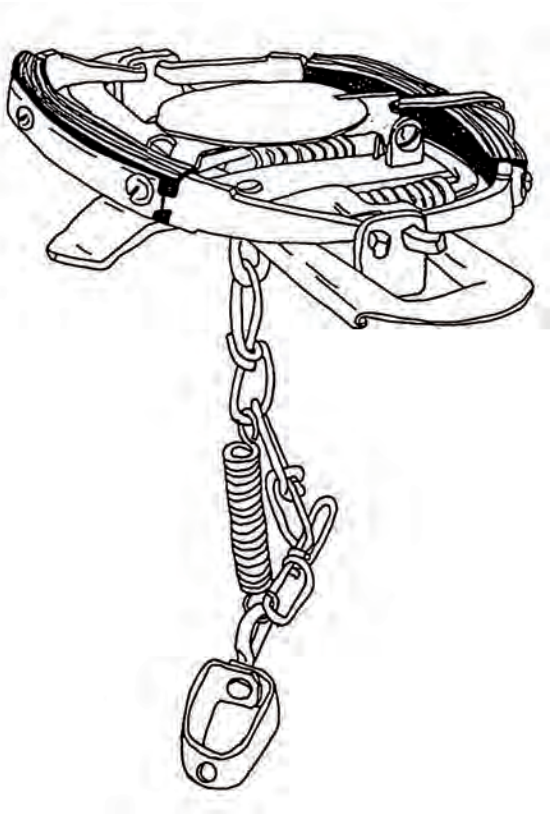
Trapping

Rubber-jawed, leg-hold traps (see below) can be laid in the same manner as they are laid for dingoes and foxes. Leg-hold traps can work well with true feral cats, which would normally avoid the live-capture box traps.

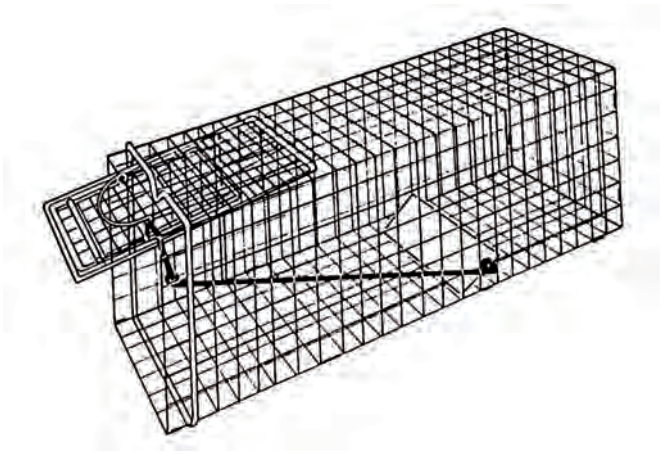
Ideal sites are those where territorial markers, such as faecal deposits and pole-clawing, are noticed. Tuna fish oil has shown some success as an attractant; however, feral cats seem more readily attracted to a site by some visual stimulus such as a bunch of bird feathers hung from a bush or stick.

Semi-feral urban cats are easily trapped in wire 'treadle-type' box traps (see diagram at right). Attractants/lures may be of meat or fish and should be placed so that they cannot be reached through the wire and be retrieved by clawing.

A number of local governments hire cat traps for the purpose of removing stray and feral cats in urban situations.



Rubber-jawed leg-hold trap



Treadle box trap

Further information

Further information is available from your local government office, or by contacting Biosecurity Queensland (call 13 25 23 or visit our website at www.biosecurity.qld.gov.au).

This fact sheet is developed with funding support from the Land Protection Fund.

Department of Agriculture, Fisheries and Forestry
Biosecurity Queensland

Fact sheet

DECLARED CLASS 2 PEST ANIMAL

December 2014

Rabbit

Oryctolagus cuniculus

Declaration details

The rabbit is a declared Class 2 pest animal under Queensland legislation. Declaration requires landholders to control declared pests on land under their control.

Description and general information

Rabbits are one of Australia's major agricultural and environmental animal pests, costing the country between $600 million and $1 billion annually. They compete with native animals, destroy the landscape and are a primary cause of soil erosion by preventing regeneration of native vegetation.

Pet rabbits

Introducing and selling rabbits in Queensland is not permitted (penalties apply). Limited numbers of permits for domestic rabbits are only available from Biosecurity Queensland for research purposes, public display, magic acts or circuses. Before a permit is granted, a number of guidelines need to be fulfilled.

Habitat

Rabbits are adaptable and sometimes live in close association with people. They live in built environments such as:

- in and under buildings
- old machinery and storage containers
- in old dumps.

In rural environments rabbits frequently live in:

- felled timber and associated windrows
- tussock grasses and rocky areas
- warrens (if soils are easy to dig).

Rabbit warrens

Rabbits prefer to live in warrens as protection against predators and extremes in temperature. However, they will survive in above-ground harbours such as logs, windrows and dense thickets of scrub (e.g. blackberry and lantana) or under built harbour, old sheds and machinery etc. In newly colonised areas without warrens, rabbits tend to live in 'scrapes' (or 'squats').

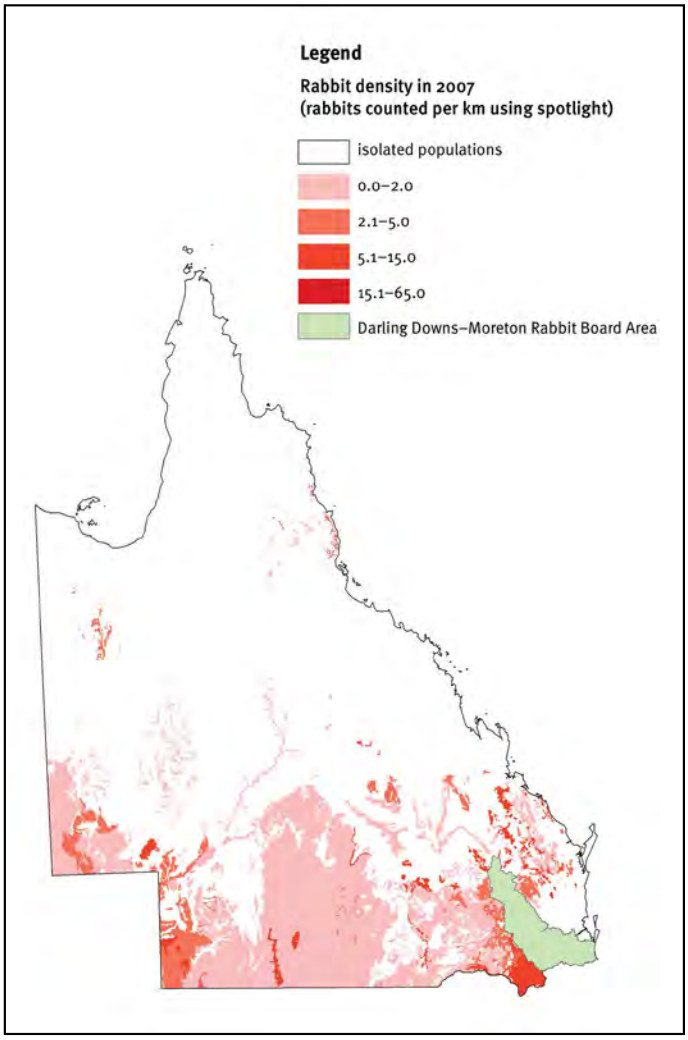
Breeding

Does (females) are pregnant for 28–30 days, but are able to mate within hours of giving birth. The average litter is 3–4 kittens but varies from two in a young doe, up to eight or more in a mature doe, and depends on the amount and quality of food available.

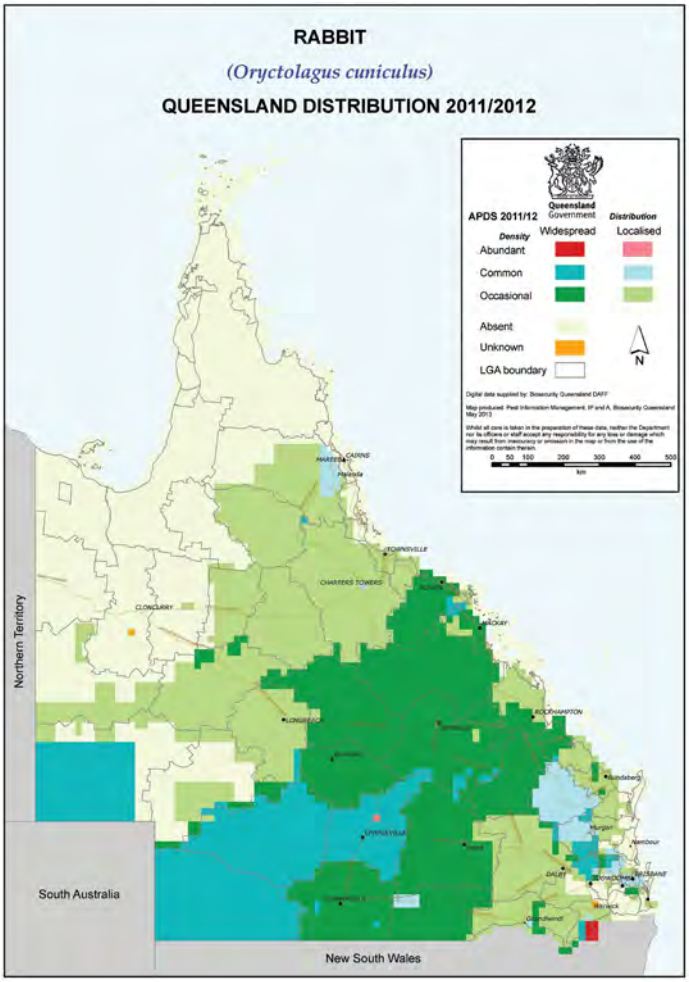
Five to six litters are possible in a good season.

Young does can breed at four months of age if conditions are suitable.

Map 1. Number of rabbits likely to be seen with a spotlight at night. Darker areas indicate more suitable rabbit habitat



Map 2. Distribution of rabbits in Queensland



Effective rabbit control cycle

Where to start control

For effective long-term rabbit control, concentrate on destroying source areas. Source areas will all have well-established warrens or ready-made structures that are cool and provide protection from predators. A source area must also have a good supply of green feed during the cooler seasons.

Coordinating control

Rabbit control is best done as a joint exercise involving all land mangers in the district. Cost-effective, long-term results can be achieved in rabbit control by following the methods outlined below.

Control

Integrated control

Landholders should adopt an integrated control approach, incorporating appropriate strategies from those listed below. Landholders must understand that

biological control agents such as myxomatosis and rabbit hemorrhagic disease virus (RHDV) are not a complete solution to rabbit problems. It is essential to incorporate them into a management strategy with other control techniques.

RHDV offers landholders a major opportunity to reduce rabbit numbers; however, failure to combine RHDV with other control strategies could cause rabbit immunity to develop (as occurred with myxomatosis).

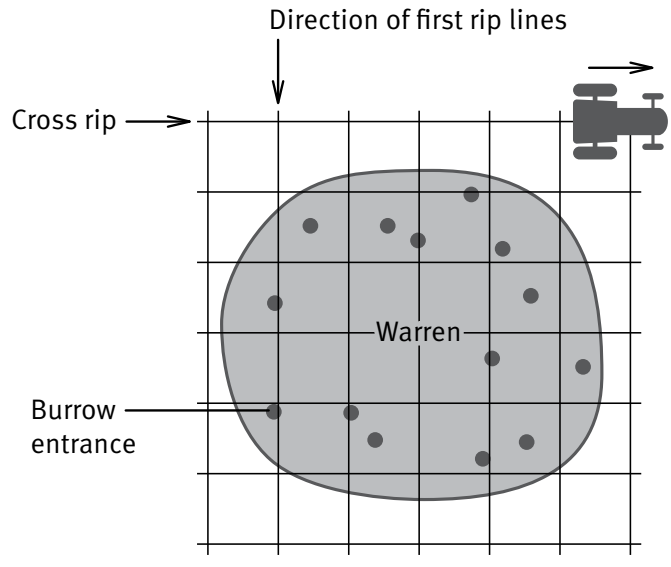
Destroying a rabbit's home (e.g. warren) is the most effective method for long-term control.

Conventional control methods, such as fumigating, ripping warrens and harbour destruction, are essential for the continued long-term reduction of rabbit numbers.

Warren ripping

In areas where rabbits live in warrens, ripping is the most effective method of long-term control. Ripping is so successful because warrens can rarely be reopened and rabbits are unable to recolonise these areas.

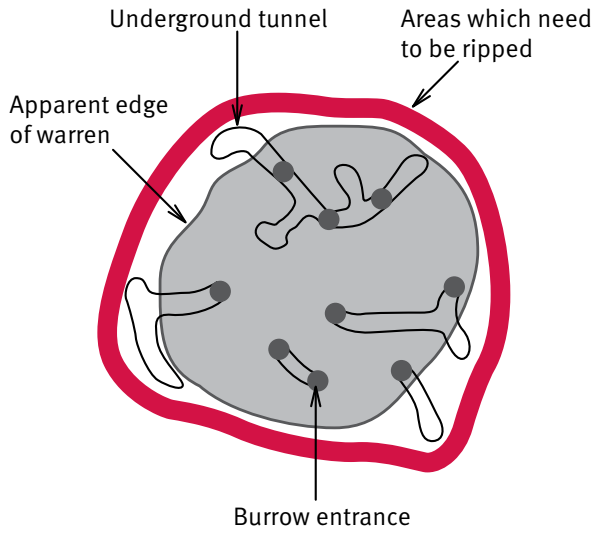
Tyne for ripping warrens (photo courtesy Mark Ridge)



Direction to rip warrens (illustration courtesy Will Dobbie)

To get the best results it is important to chase as many of the rabbits inside the warren as possible. Dogs can be used to drive rabbits into the warren before ripping starts.

The aim of ripping is to completely destroy the warren. It involves using a tractor with a tyned (sharp-pronged) implement—one tyne or many—that rips through the warren and collapses it. Larger tractors and dozers are more appropriate for properties with many warrens as they are able to move faster and rip wider.



Extent to rip warrens (illustration courtesy Will Dobbie)

Obviously, ripping is not suitable for warrens located underneath buildings or on steep rocky country. In such cases, other methods (poison baiting, releasing virus or fumigating burrows) should instead be used to reduce rabbit numbers. Warrens should then be either filled in or covered to stop rabbits from re-establishing. Burrows can be blocked with small boulders or rocks (see photo below).

Rock blocking rabbit hole

Harbour destruction

Where there is abundant surface harbour, a high proportion of rabbits may live above ground rather than in underground warrens. Rabbits can make their homes in windrows, dense thickets of shrubs (such as blackberries and lantana) and even in old machinery.

To eliminate these above-ground breeding areas, it may be necessary to:

- burn windrows and log piles
- remove noxious weeds through chemical and physical control
- remove movable objects (such as old machinery) from paddocks.

Sometimes removing harbour can expose warrens underneath. If this happens, the warrens need to be ripped.

Poison baiting

Baiting is not effective as a sole control method and will not eradicate an entire rabbit population. Numbers will quickly increase again, and you will have to continue baiting year after year with no permanent overall change in the rabbit population.

Rabbits can also become 'bait shy' and this method becomes less and less effective over time. Ideally, baiting is best used either before ripping/fumigation to reduce a population, or after ripping/fumigation as a 'mop-up'.

Baiting works best when rabbits are not breeding. During breeding season the majority of the population feeds over a larger-than-normal area, and it is the young rabbits that are most likely to take baits. While numbers will be reduced, animals of breeding age are not likely to be affected.

1080—sodium fluouroacetate

Pre-feeding is required when using 1080 because rabbits will not readily take new feed. The poison-free bait should be laid at least three times over a one-week period before the poisoned bait is laid. (1080-impregnated carrot baits are the most common form of bait used.) The practice helps to ensure that, when the poisoned bait is laid, it will be eaten by most of the rabbit population.

Only authorised persons can supply 1080 baits to landholders. Your local Biosecurity officer or your local government office should be able to assist you.

Pindone

Pindone is an anticoagulant registered for rabbit control. This poison works by preventing blood from clotting. In Queensland, it is not recommended for broadacre use and is mainly used in urban areas and near farm buildings.

Pindone works best when given as a series of small doses/feeds over a period of three days. Although pre-feeding is not essential, it does enhance the bait uptake by shy rabbits as they get used to the feed prior to any poison bait being laid. To be effective, pindone requires multiple feeds so that the poison can build up to fatal levels in the rabbit's body. Feeding over a number of nights provides plenty of opportunity for most of the rabbit population to consume the required lethal dose. Rabbits poisoned with pindone will usually die within 10–20 days.

Pindone baiting does not work well when there is a lot of green pick around for rabbits.

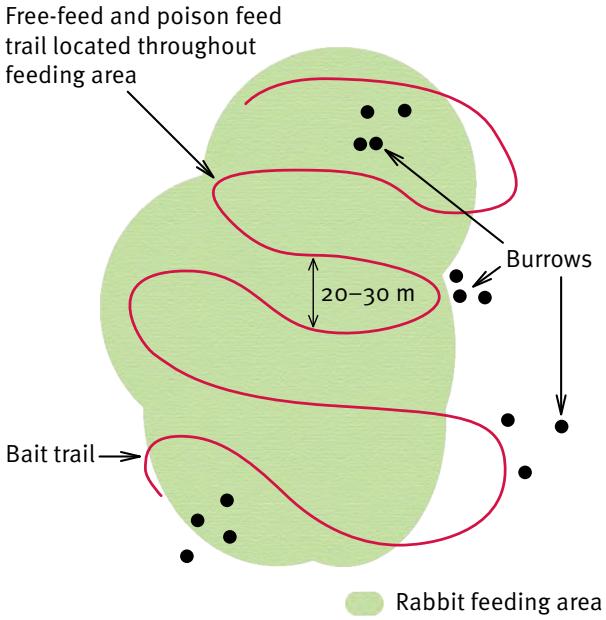
Poison bait trails

It is important that bait trails are laid properly to ensure the best results. 'Baitlayers' make it easier to put out bait trails at the correct rate, and they can be towed behind most 4WD vehicles, quad bikes and tractors.

When scratching and laying a trail, consider the following:

- Rabbits like freshly scratched/disturbed soil—this may be because rabbits are territorial and inspect newly disturbed soil, and/or the disturbed vegetation smell attracts them.
- Lay trails around warrens and in the areas where rabbits most often feed.
- Laying trails on slopes and hills requires care—it can cause erosion in some soils types (e.g. granite and traprock). Trails are best laid in a zigzag pattern in steep terrain to minimise erosion.
- A trail that has been scratched for the first feed is easy to follow for the rest of the baiting program.
- The soil should be turned only enough to scratch the surface—don't plough the ground.
- A trail that has been scratched too deep will spook the rabbits because they will not have full sight of their predators.
- Where vegetation is thick, or it is difficult to find the main feeding areas, lay bait trails in a grid pattern across the site.

As a general rule, avoid crossing the bait trail—it can cause confusion when you try to follow the same trail on subsequent occasions.



Method for laying a bait trail (illustration courtesy Animal Control Technologies)

Bait trials will be most effective if you follow these guidelines:

- Use good quality, non-contaminated bait material. (Simple rule: if you wouldn't eat it, the rabbit won't either.)
- Use enough feed to bait all the rabbits in the area. (The pre-feed will give an indication of the potential bait take.)
- Expect a greater uptake of pre-feed and bait material when vegetation is scarce, dried off or soured.
- Ensure that all the preparation equipment is clean and free of any chemical residues or smells—rabbits can be very shy of unusual odours.
- When there are kittens in a warren, lay the bait trail close to the warrens.

Fumigation

Fumigation is labour intensive and time consuming, and is not usually an effective method if used alone. However, as a 'mop-up' technique or control method for use in areas where ripping is not practical (e.g. steep and rocky terrain), it may be a good alternative.

Because this technique relies on directly affecting the rabbits, and does not affect the structure of the warren, it is crucial that as many rabbits as possible are underground when fumigation is carried out. Rabbits usually take refuge in their burrows from mid-morning to mid-afternoon and during hot weather so these are the best times to fumigate. Dogs can also be used to drive rabbits into their warrens.

For best results, fumigation should be carried out in two stages—initially, before the breeding season starts (as this reduces the breeding stock), and then again during the breeding season.

There are two types of warren fumigation—static and pressure. In Queensland, static fumigants are a more popular and safer option for controlling rabbits and will be explained below.

Static fumigation

This method is easy to use, and time- and cost-effective. Static fumigation comes in the form of aluminium phosphide (phosphine) tablets, which can be purchased from most agricultural suppliers. These tablets are small and round (about the size of a marble), and weigh 3 g. Trade names for phosphine include Pestex®, Quickphos® and Gastion®. General directions for the use of phosphine tablets appear below, but always refer to the manufacturer's specific recommendations for use.

To fumigate warrens using phosphine tablets:

1. Find all warren entrances—both active and inactive.
2. Cut back the warren entrance at right angles using a shovel.
3. Separately wrap two tablets in moistened absorbent paper (toilet paper/paper towels).
4. Insert the tablets as far down into the entrance as possible. (Polypipe and a push rod can be used to help push the tablets down.)
5. Push some scrunched-up newspaper down the hole to block the entrance and then cover it up with soil and, if possible, a rock.
6. Treat all entrances to the warren (active and inactive) the same way.
7. Check warrens about a week after fumigation and re-fumigate any reopened entrances.

Once in the warren, the moistened tablets react with air to release a toxic gas, which spreads quickly throughout the warren. The phosphine gas itself is invisible and odourless but leakages from the warren can be detected by the smell of ammonia. (This is a safety mechanism that is built into the tablet.) Any leakages need to be blocked immediately.

Biological controls

Rabbit hemorrhagic disease virus (also known as rabbit calicivirus disease)

RHDV is a virus specific to rabbits which works by infecting the lining of the throat, lungs, gut and liver.

RHDV relies primarily on direct rabbit-to-rabbit contact in order to spread. High rabbit numbers are therefore needed before this control method will be effective.

After RHDV has infected an area, it is important to use another method for follow-up control to increase the likelihood that the population is eradicated before it is able to develop resistance and increase its numbers again.

Resistance to RHDV depends primarily on the age of the rabbit. Therefore, it is better for RHDV to go through a rabbit population after rabbits have bred and the young are old enough to be affected by the virus. Rabbits that survive RHDV develop antibodies against the virus. Breeding females can also pass these antibodies on to the young (through antibodies in their milk), conferring temporary protection on rabbits up to 12 weeks old.

Myxomatosis

Myxomatosis is no longer produced as a laboratory strain but field strains are still known to recur and affect rabbit populations.

Trapping

Trapping is an extremely labour-intensive control method and requires a skilled operator to set the traps to successfully capture rabbits.

If you do plan to trap rabbits on your property, common sense and respect for animal welfare are essential. While there are currently no strict guidelines for the use of traps in Queensland, it is an area of growing concern for animal welfare advocates.

Cage trap

A cage trap has a lever that closes the cage when a rabbit steps on it. The rabbits are lured into the cage with bait—usually diced carrot. Traps need to be disabled and left open for two or three nights with bait leading into the cage. This entices rabbits to enter. A trap can be set once a rabbit has consumed a trail of bait all the way into that trap. Traps should be checked and emptied regularly—usually a couple of times a night.

This effective and humane technique is most useful for removing any remaining rabbits from places like hay sheds and after the shed has been fenced to prevent additional rabbits from entering and leaving. Free-feed then trap, and keep the shed rabbit-proof to prevent rabbits recolonising.

Barrel trap

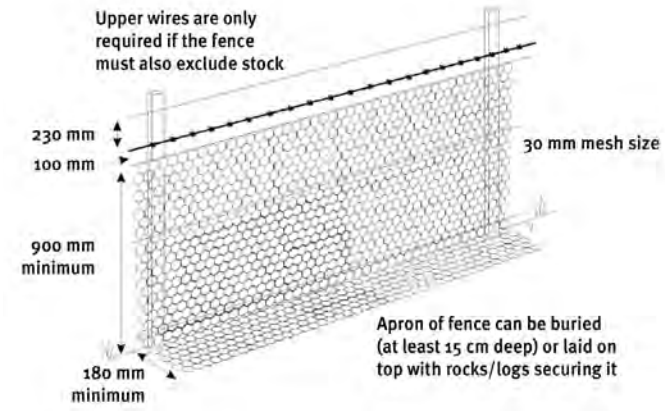
A barrel trap is designed specifically for rabbits. It is cylindrical, made of light mesh, and is about 1 m long and 15 cm in diameter. The trap has one open end with two hinged trap doors along its side. The open end is placed in the burrow, and the hinged gates close and trap the rabbit after it enters from the burrow.

The trap can be left in the burrow entrance for a number of days. However, it must be checked at least daily so that if a rabbit has been caught it does not suffer and animal welfare responsibilities are met.

Barrel rabbit trap in hole

Exclusion fencing

Rabbit exclusion fences are built with the aim of keeping rabbits out of a particular area. It is appropriate for small, high-value areas that require protection. A fully fenced area will only remain rabbit-free in the long term if all rabbits are removed from the enclosed area after fencing and the fence is regularly maintained and checked for holes.



Exclusion fence for rabbits (illustration courtesy DEWHA)

A rabbit-proof fence should be made of wire mesh netting (40 mm or smaller) and needs to be at least 900 mm high. The netting should also be buried to depth of at least 150 mm. Gates into the fenced area need to be rabbit-proof as well.

Electric fencing is a cheaper alternative, but it is not a complete physical barrier and is also prone to damage from other pest animals and stock.

Shooting

Shooting is most useful when used to 'mop up' after other control methods (such as ripping). To get the best results, shoot at the time of day when rabbits are active. This is usually in the early morning, late afternoon or at night. The best and most economical firearm to use is a .22 calibre rifle.

If your property is within an urban area, you will need to comply with local government regulations and the *Police Powers and Responsibilities Act 2000*, which restrict the use of firearms.

Further information

For further detailed reading information on specific rabbit control techniques or costing your rabbit control please refer to Rabbit control in Queensland; a guide for land managers. Download from the Biosecurity Queensland website at www.biosecurity.qld.gov.au

Further information is available from your local government office, or by contacting Biosecurity Queensland (call 13 25 23 or visit our website at www.biosecurity.qld.gov.au).

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