



# Flora and Vegetation Assessment Acker Quarry Mining Lease MCI 70/2



May 2017



Prepared for Acker Proprietary Limited

Name	Task	Version	Date
	Draft	0	31/10/2016

© EnviroBiz Pty Ltd 2017

The use of this report is solely for the Client for the purpose in which it was prepared. Range to Reef Environmental accepts no responsibility for use beyond this purpose.

All rights are reserved and no part of this report may be reproduced or copied in any form without the written permission of Range to Reef Environmental or the Client.

Range to Reef Environmental Unit 9, 18 Strang Street Beaconsfield, WA 6162

P: 08 9335 6223

F: 08 9335 6223

E: [admin@rangetoreef.com](mailto:admin@rangetoreef.com)

Prepared for Acker Proprietary Limited

## Executive Summary

Acker Pty Ltd (Acker) proposes to clear 1.48 ha of highly degraded vegetation in Mining Lease MCI 70/2, adjacent to their existing quarry, for the purposes of limestone extraction.

Acker wish to apply for a clearing permit under the *Environmental Protection Act 1986 (WA) (CI)* for this purpose and this report provides supporting information for this process.

An environmental survey was undertaken in February 2016 in support of the application. The survey did not encounter any Threatened flora species and it was considered unlikely that the clearing is at variance to the ten clearing principles under Section 5 of the *Environmental Protection Act 1986*.

# Contents

<b>Executive Summary</b> .....	<b>3</b>
<b>1 Introduction</b> .....	<b>1</b>
1.1 Background and Purpose .....	1
<b>2 Existing Environment</b> .....	<b>3</b>
2.1 Location and Land Use .....	3
2.2 Climate .....	3
2.3 Geological and Physiographic Context of the Site .....	5
2.4 Environmentally Sensitive Areas .....	7
2.5 Vegetation .....	8
2.6 Flora .....	13
<b>3 Survey Methodology</b> .....	<b>18</b>
3.1 Desktop assessment .....	18
3.2 Field Survey .....	18
<b>4 Results</b> .....	<b>23</b>
4.1 Flora .....	23
4.2 Vegetation .....	25
<b>5 Discussion and Environmental Impact</b> .....	<b>30</b>
5.1 Flora .....	30
5.2 Conservation Significant Flora .....	30
5.3 Vegetation .....	30
5.4 Application of the Ten Clearing Principles .....	31
5.5 Planning Instruments .....	35
5.6 Other Relevant Matters .....	35
5.7 Environmental Protection Policies .....	36
<b>6 Conclusions and Recommendations</b> .....	<b>37</b>
6.1 Recommendations .....	37
<b>7 References</b> .....	<b>38</b>
<b>Appendix 1 Site Data</b> .....	<b>41</b>

## Appendices

Appendix 1 Site Data

## Figures

Figure 1. Site location .....	1
Figure 2. Application Area.....	2
Figure 3. Photo of Quarry looking south towards proposed clearing area .....	2
Figure 4. Location of Christmas Island .....	3
Figure 5. Climate Averages (Airport Station 200790) .....	4
Figure 6. Existing quarry .....	5
Figure 7. Topography of Christmas Island.....	6
Figure 8. Diagrammatic cross-section of Christmas Island, showing volcanic core, limestone capping, water flow lines (arrows) and typical cave development. Vertical scale is exaggerated x10.....	7
Figure 9. Preservation of uncleared vegetation in Christmas Island National Park.....	9
Figure 10. Vegetation of Christmas Island .....	10
Figure 11. The seven major secondary (regrowth) structural types occurring on Christmas Island. ....	13
Figure 12. (from left to right) Christmas Island Spleenwort ( <i>Asplenium listeri</i> ), <i>Tectaria devexa</i> var. <i>minor</i> and <i>Pneumatopteris truncata</i> .....	15
Figure 13. Threatened Flora populations on Christmas Island .....	16
Figure 14. Vegetation map for the proposal area .....	26
Figure 15. Zoning under Local Planning Scheme 2.....	34

## Tables

Table 1. Cleared and uncleared land on Christmas Island .....	8
Table 2. Vegetation of Christmas Island.....	11
Table 3. Species richness of the vascular flora of Christmas Island as described by different authors.....	14
Table 4. Threatened Species under the EPBC Act.....	15
Table 5. Vegetation condition rating scale.....	20
Table 6. Statement of botanical survey limitations.....	22
Table 7. Flora species list and presence/absence in vegetation types 1 to 5 .....	24
Table 8. Vegetation present in Lot 3039.....	25
Table 9. Application of the Ten Clearing Principles .....	31

# 1 Introduction

## 1.1 Background and Purpose

Range to Reef Environmental was commissioned to assist Acker Pty Ltd with a vegetation assessment of Lot 3039 upon which Acker propose to expand their current mining operation. A portion of Lot 3039 has already been mined.

Acker Pty Ltd ('Acker') is the largest locally owned and operated transportation, civil works and general construction company on Christmas Island. In 2008 they acquired the Quarry Road quarry (Figure 1) with the purchase of Mining and Marine Construction Pty Ltd.



Figure 1. Site location

Acker extract and crush limestone rock at the quarry using an excavator and rock breaker. Product from the quarry is then transported offsite for processing and use in concrete manufacturing, building and road material.

The previously approved mining operation occurred in the Christmas Island National Park on Lot 111, Plan K820058 under the Christmas Island (Mining Lease Application) Exemption Extension Instrument 2012. In 1999 Mine Marine and Construction Ltd. (MMCL) applied for a mining lease for Lot 3039 to extend the mine southwards. Acker purchased MMCL in 2008. The extension area had already been partially utilised as seen in Figure 2. The Mining Lease MCI 70/2 was granted for Lot 3039 in September 2015.

In late 2014, Acker applied for a clearing permit under the *Environmental Protection Act 1986 (WA) (CI)* for Lot 3039 but the permit application was put on hold pending resolution of the site's tenure. In 2016 Range to Reef Environmental was commissioned to assist Acker with a vegetation assessment of Lot 3039 and preparation of a clearing permit application.

A flora survey was undertaken in February 2016 in support of this application and the results are outlined in this report.

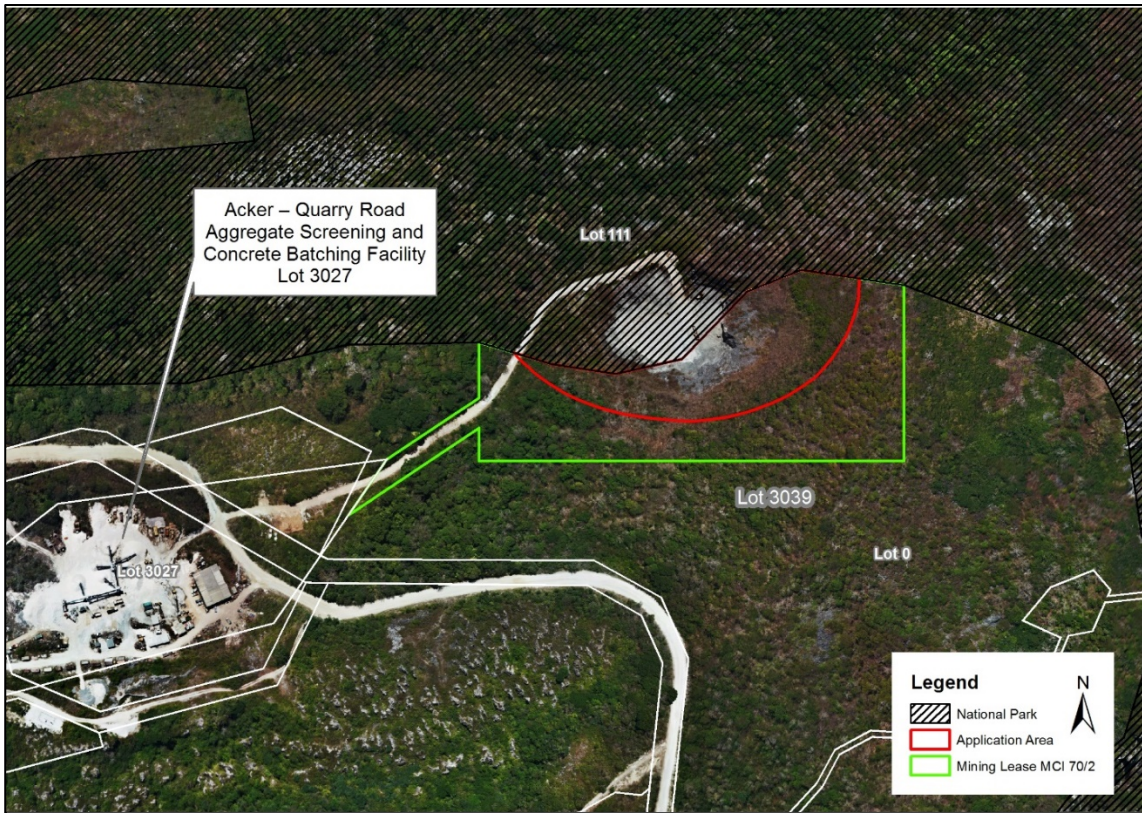


Figure 2. Application Area



Figure 3. Photo of Quarry looking south towards proposed clearing area



## 2 Existing Environment

### 2.1 Location and Land Use

Christmas Island is located approximately 2,600 km north-west of Perth, Western Australia in the Indian Ocean, 10°30' South, 105°40' East. Christmas Island is 500 km south of the Indonesian capital Jakarta (Figure 4).

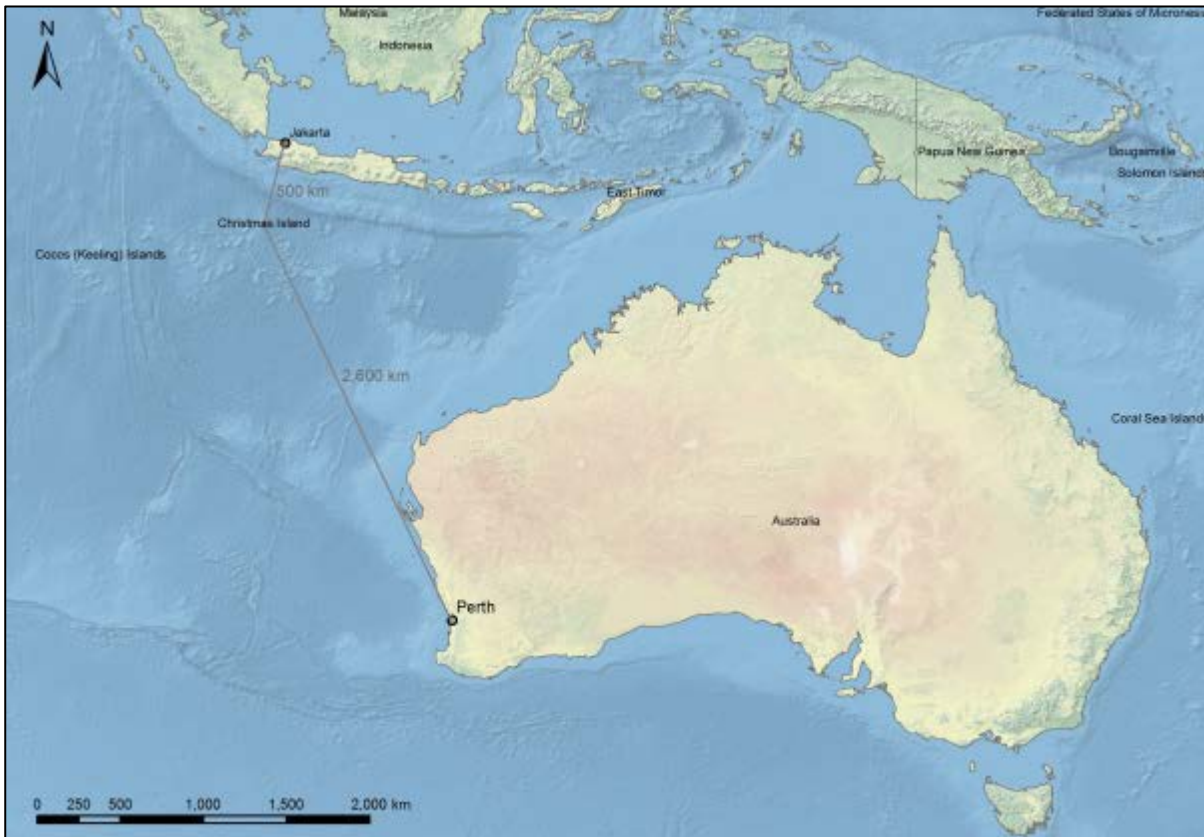


Figure 4. Location of Christmas Island

The majority (63%) of the Island is set aside as national park (Environment Australia, 2014; Geoscience Australia, 2014). The remaining third is a mix of mining lease, crown reserve, unallocated crown lands, townsite and public facilities. The island also has minor horticulture ventures.

The quarry is located approximately 2 km to the nearest townsite (Settlement). The adjacent neighbours are the Shire of Christmas Island Depot, Indian Ocean Territories Power Authority Depot, Christmas Island Cranage Depot and Gregory's Christmas Island Maintenance Depot.

### 2.2 Climate

Christmas Island lies on the southern edge of the inter-tropical convergence zone and the climate is dominated by a low-pressure trough that seasonally circles the equator. The Island has a tropical monsoonal climate with distinct wet and dry seasons and little seasonal variation in temperature.

The dry season (May to November) is dominated by low and sporadic rainfall with consistent south-east trade winds. The wet season generally occurs from December to April with the island receiving most of its rainfall during this period. Christmas Island's average annual rainfall since 1973 is 2,117 mm but may vary considerably from year to year with the island's lowest recorded annual rainfall being 1,066.9 mm in 1987 and the highest before 2016 being 3,715 mm (Bureau of Meteorology, 2017). In 2016 the island received record rainfall (>5,022 mm) with rainfall to 23 December exceeding previous annual records by 1,307 mm (Figure 5).

Temperatures remain relatively uniform throughout the year, with an average daily maximum of 28°C in March/April and average daily minimum of 22°C in August/September. The Island has high humidity (80-90%) throughout the year and frequent dews and heavy mists may occur during the wet season.

During the wet season, Christmas Island is subject to the influence of north-west monsoons, which typically cause high swells and high winds, with gusts of over 100 km/h. Many cyclones have passed nearby the island, resulting in strong winds and heavy rainfall on the island. Cyclone Gillian caused significant damage to rainforest communities in March 2014, with trees blown over and foliage stripped from many areas.

The Island does have distinct microclimates due to the island’s geography, with rainfall measurements indicating that there are significant variations in rainfall (Falkland, 1999). Average rainfall at Rocky Point (Settlement), Jedda Cave and South Point (1,931, 2,375 & 1,907 mm respectively) for example shows the significant variation across the Island (Puhlovich, Jacobsen, & Overall, 2003). Daily evaporation typically exceeds rainfall between July and October.

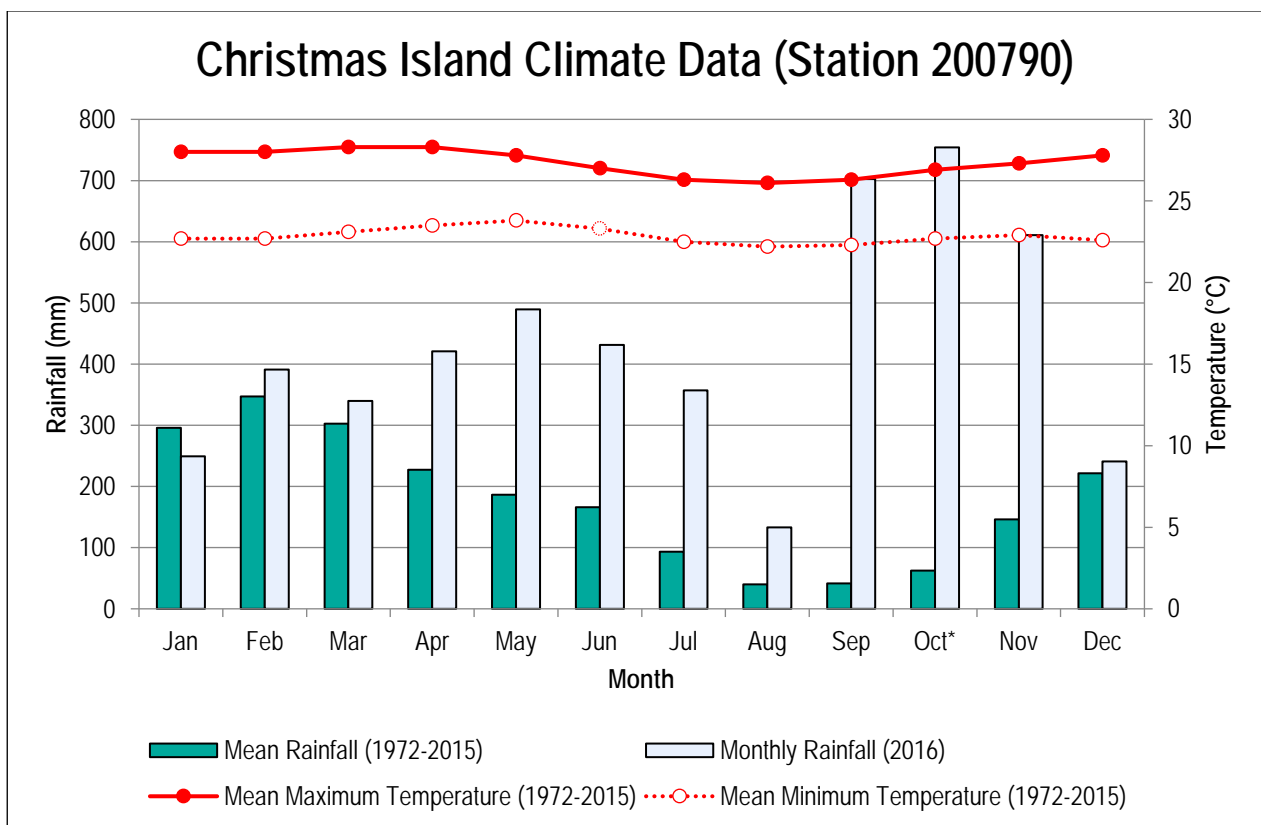


Figure 5. Climate Averages (Airport Station 200790)

Source: Bureau of Meteorology (2017)

## 2.3 Geological and Physiographic Context of the Site

### 2.3.1 Geology and Soils

Christmas Island is one of a series of submarine seamounts that rise above the 5,500 m deep abyssal areas of the West Australian Basin. At the core of the island are volcanic rocks, mainly composed of basalt with a layer of limestone generally covering these volcanic rocks, with occasionally outcrops, particularly along the present coastline.

The island is characterised by sea cliffs that rise via a series of terraces to a central plateau (Figure 7) which peaks at approximately 361 m above sea level. The shoreline is dominated by cliffs and extensive shore platforms with a few small beaches and Flying Fish Cove, which has a relatively large beach and shallow platform, being the only safe harbour for much of the year. The island's natural landscape is dominated by karstic surface landforms and cave systems.

Terrace areas on the island reflect the height above sea level in different geologic periods. Renewed vulcanism and a series of geological uplifts at different periods have resulted in a tiered effect. The oldest limestones near the peak of the island formed during the Eocene period (Grimes, 2001). Most the island's limestone deposits were formed during the Tertiary (late Oligocene to mid Miocene age), with the youngest limestones deposited on the lowest terrace in the late Quaternary (Grimes, 2001).

The limestone is mixed with dolomite sediments, basalts and tuffs. A layer of phosphate-rich soil material covers the limestone over about half of the island. Marine sediments and guano deposition have formed the island's phosphatic soils.

The red crab (*Gecarcoidea natalis*) is the principle agent of organic matter turnover and incorporation into the soil. Crab activity is a key feature of water and nutrient availability in the subsoil, with burrows also providing a preferred pathway for water drainage into the soil (Hollingsworth, 2003).

In the application area, limestone is present close to the soil surface as evidenced in the quarry walls (Figure 6).



Figure 6. Existing quarry

### 2.3.2 Landforms and Topography

The island is characterised by sea cliffs that rise via a series of terraces to a central plateau (Figure 7 and Figure 8). The shoreline is dominated by cliffs and extensive shore platforms with a few small beaches and Flying Fish Cove, which has a relatively large beach and shallow platform, being the only safe harbour for much of the year. The island's natural landscape is dominated by karstic surface landforms and cave systems (Grimes, 2001).

The application area is situated on the edge of the central plateau and falls away to the north-east with a moderate decline.

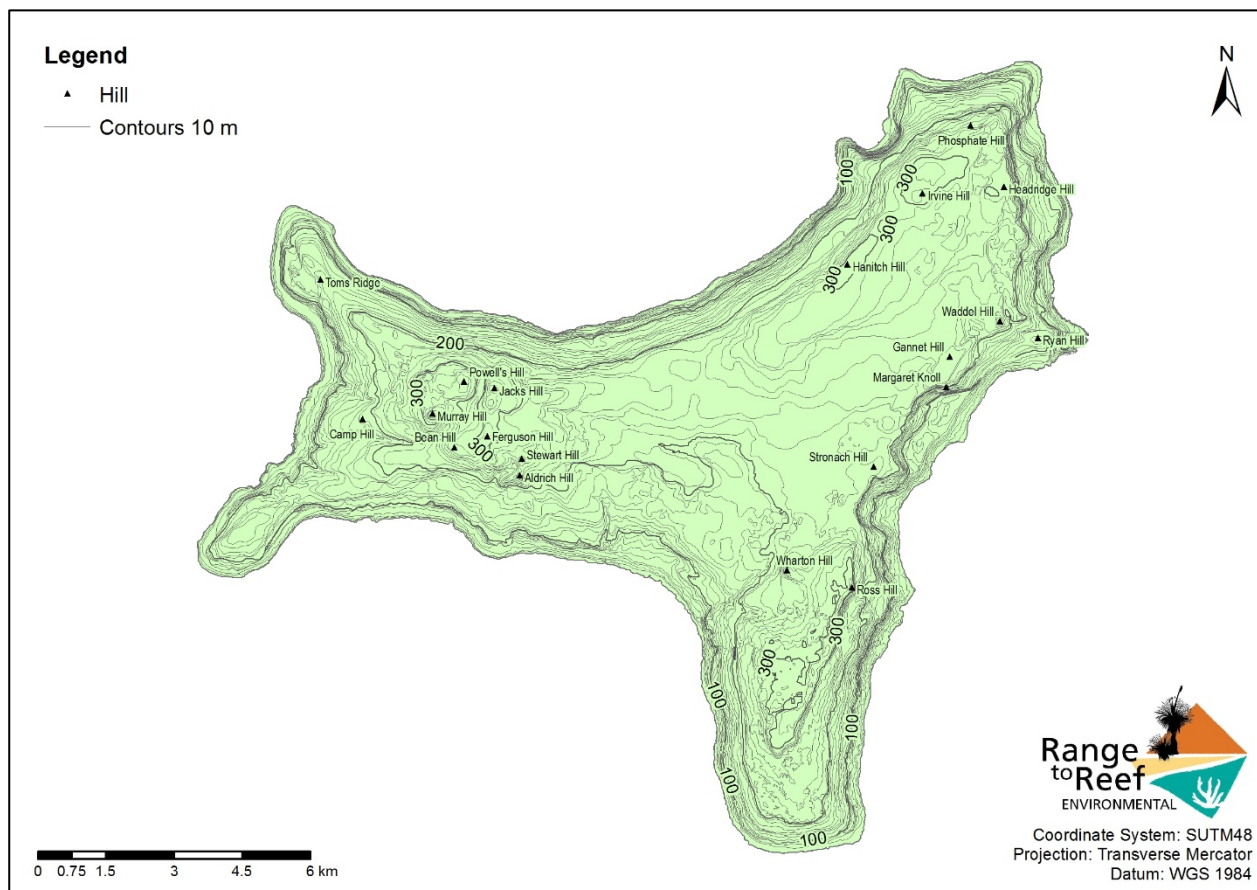


Figure 7. Topography of Christmas Island.

### 2.3.3 Hydrogeology and Hydrology

A major feature of the Christmas Island geomorphology is the lack of surface drainage. Rainfall mostly infiltrates the land surface and is utilised by plants, contributes to soil water stores or recharges to groundwater. There is therefore no significant surface drainage network except down gradient of springs that arise at the interface between limestone and basalt formations.

Christmas Island's soils are generally highly permeable and there is consequently little runoff or erosion (Hollingsworth, 2003). During the monsoon, when the soils are saturated, runoff can occur during heavy rainfall providing some risk of erosion and sedimentation. However, given the high natural infiltration rates the risk of erosion and sedimentation is generally localised to compacted areas such as roads and stockpile pads. Infiltration tests by Puhlovich, Jacobsen and Overall (2003) indicate that soil infiltration rates are typically substantially higher than hourly rainfall intensities.

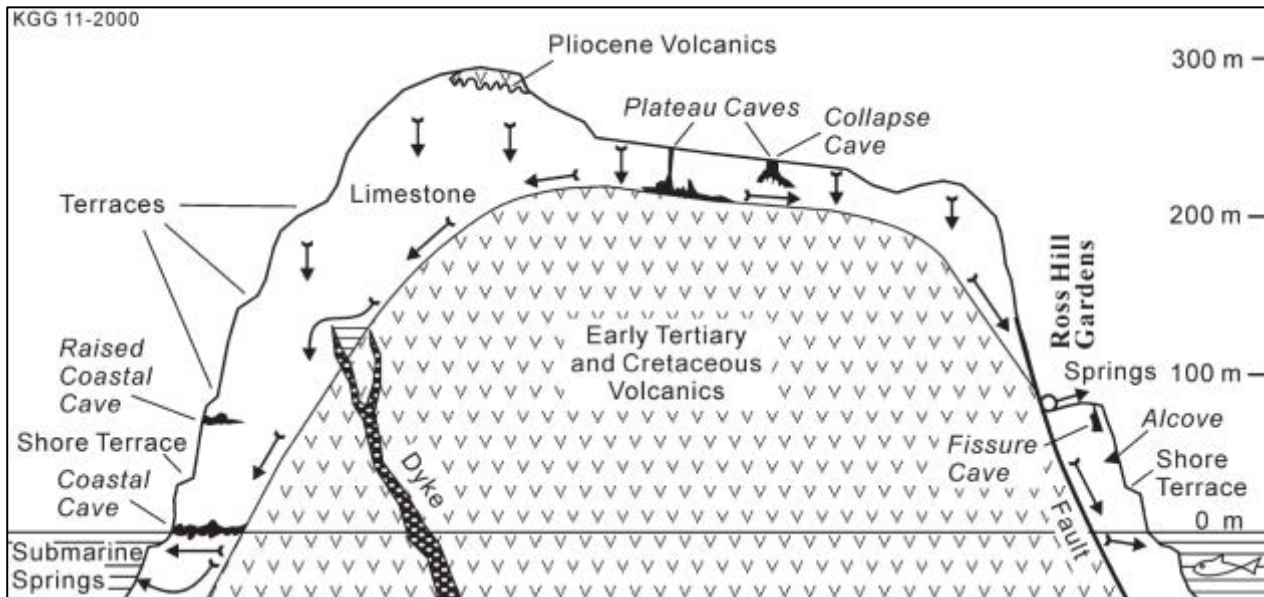


Figure 8. Diagrammatic cross-section of Christmas Island, showing volcanic core, limestone capping, water flow lines (arrows) and typical cave development. Vertical scale is exaggerated x10.

Source: Grimes (2001).

There are three key hydrogeological units on the island; shallow, residual soils, which overlie fractured, unconfined – semi-confined aquifers within the karstic limestone rocks, which in turn overlie relatively impermeable volcanic basement rocks (Puhlovich, Jacobsen, & Overall, 2003). Groundwater levels on the island are reflected by the location of the unconfined water table within the karst limestone aquifers. Limestone aquifers can be recharged when rainfall permeates through the soil zone into the underlying aquifers or by direct runoff of rainfall into karst features such as dolines and sinkholes that occur across the island (Puhlovich, Jacobsen, & Overall, 2003). Assessments suggest that approximately half of all incident rainfall passes through the soil zone and recharges the underlying limestone aquifers (Hollingsworth, 2003; Falkland, 1999). Groundwater discharge occurs at surface springs such as Hosnie’s Spring and offshore springs such as those found at Flying Fish Cove (Puhlovich, Jacobsen, & Overall, 2003). The complex behaviour and extent of weathered/fractured rock aquifers on the island are not well understood.

Perennial (permanent) surface aquatic habitats (freshwater) on Christmas Island are limited to several spring-fed streams found along coastal or sloping areas of the island. Hosnie’s Spring and The Dales are both listed as a Wetland of International Importance under the Convention on Wetlands of International Importance, Water Fowl Habitat 1971 (known as the ‘Ramsar Convention’) and are listed in the Directory of Important Wetlands in Australia.

### 2.3.4 Interim Biogeographical Regionalisation of Australia (IBRA)

Christmas Island is not included in the Interim Biogeographic Regionalisation of Australia (IBRA) (McKenzie, May, & McKenna, 2002).

## 2.4 Environmentally Sensitive Areas

Environmentally Sensitive Areas (ESAs) are defined in the Western Australian Government Gazette and no sites on Christmas Island are included as Christmas Island is a Commonwealth territory. However, Mining Lease MCI 70/2 overlaps some land included in the Register of the National Estate as “Christmas Island Natural Areas.” These areas could be considered as equivalent to an ESA as defined in the WA legislation. Acker Pty Ltd is therefore making an application for a clearing permit under the *Environmental Protection Act 1986* (WA) (CI).

## 2.5 Vegetation

The Christmas Island National Park, which covers 63% of the island, is assigned to IUCN<sup>1</sup> reserve category II, most of which is uncleared primary rainforest (Director of National Parks, 2014a). Some 25% of the island's original vegetation has been cleared for mining and infrastructure (Director of National Parks, 2014a).

Approximately 75% of Christmas Island has never been cleared and 77% of this is protected within the Christmas Island National Park (Geoscience Australia, 2014; Environment Australia, 2014). Based on the National Objectives and Targets for Biodiversity Conservation 2001-2005, the vegetation complex is adequately reserved (i.e. greater than 30% of pre-clearing extent) within the Shire of Christmas Island and at a regional, State and National level.

Table 1. Cleared and uncleared land on Christmas Island

Area	Size	Proportion of the island
Christmas Island	135 km <sup>2</sup> (13,582 ha)	100.00%
Uncleared portions of Christmas Island	101 km <sup>2</sup> (10,123 ha)	74.53%
Christmas Island National Park	85 km <sup>2</sup> (8,460 ha)	62.29%
Uncleared national park (92% of the park)	78 km <sup>2</sup> (7,769 ha)	57.20%
Proposed clearing for Acker Quarry	0 km <sup>2</sup> (1.48 ha)	0.01%

Source: Geoscience Australia (2014)

Three features of the ecology of the island's native vegetation are notable (Director of National Parks, 2014a):

- The occurrence of many of the widespread Indo-Malesian species in habitats that would be considered extremely atypical elsewhere in their natural ranges, and associated with this, the exceptionally large stature of some of these species;
- The low diversity of canopy and sub-canopy species and the lack of structural complexity (e.g. relatively poor development of robust woody vines and rattans, the absence of aroids and of gingers in the understorey) in the Island's rainforests; and
- The very low diversity and lack of speciation amongst plant genera that elsewhere in the region is characteristic of early successional, and frequently disturbed, rainforest environments (e.g. *Macaranga*, *Claoxylon* and *Pipturus*).

---

<sup>1</sup> International Union for Conservation of Nature (IUCN) protected area management categories classify protected areas according to their management objectives. The categories are recognised by international bodies such as the United Nations and by many national governments as the global standard for defining and recording protected areas and as such are increasingly being incorporated into government legislation.

Category II (National Park) protected areas are large natural or near natural areas set aside to protect large-scale ecological processes, along with the complement of species and ecosystems characteristic of the area, which also provide a foundation for environmentally and culturally compatible, spiritual, scientific, educational, recreational, and visitor opportunities.

Source: <https://www.iucn.org/theme/protected-areas/about/protected-areas-categories>

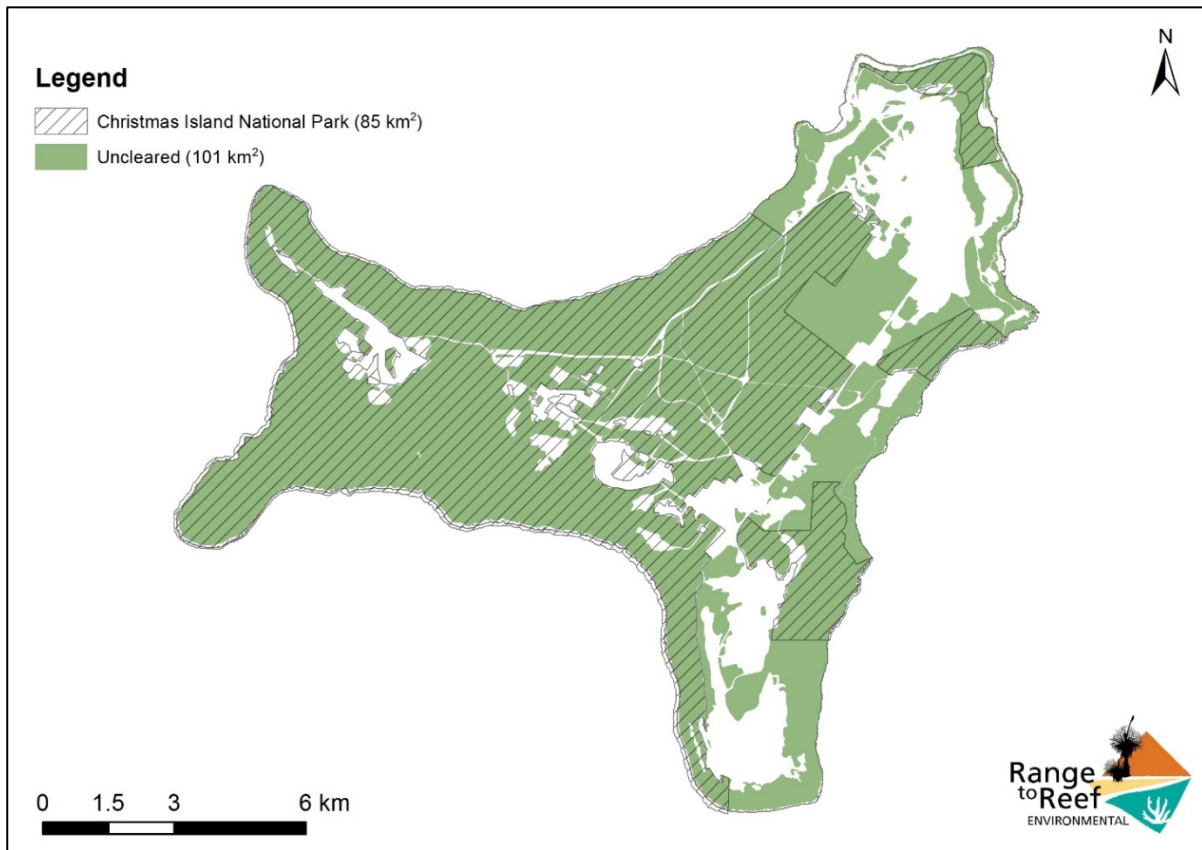


Figure 9. Preservation of uncleared vegetation in Christmas Island National Park

Source: *Geoscience Australia* (2014)

The geology, geomorphology and climate on Christmas Island create the biophysical environment and constraints for the vegetation communities. These factors determine the soil nutrient status, the seasonal availability of moisture and the degree of exposure to wind, which in turn control the distribution, structure and functioning of the natural vegetation (Reddell and Zimmerman 2003).

Vegetation mapping of the island was initially undertaken by Mitchell (1985) for the Australian Nature Conservation Agency. This mapping had limited use due to its broad scale and spatial inaccuracy. *Flora of Australia Volume 50* (Du Puy, 1993) lists eight vegetation types for the island:

- Primary Rainforest;
- Marginal Rainforest;
- Areas with Surface Water;
- Open Forest, scrubby forest and vine forest;
- Inland cliffs;
- Coastal Fringe;
- Shore cliffs and spray zone; and
- Mined areas.

A vegetation mapping project was undertaken from 2011 to 2014 to attempt to map vegetation with better spatial accuracy, to determine height categories and to apply these consistently across the Island. Additional categories were added to include wetland vegetation and regrowth in cleared areas. The Christmas Island Vegetation and Clearing Map was developed through a collaborative project by Geoscience Australia, Christmas Island Phosphates, Christmas Island National Park and the Commonwealth Department of the Environment. The map classified the full extent of Christmas Island into vegetation and land cover classes (Figure 10).

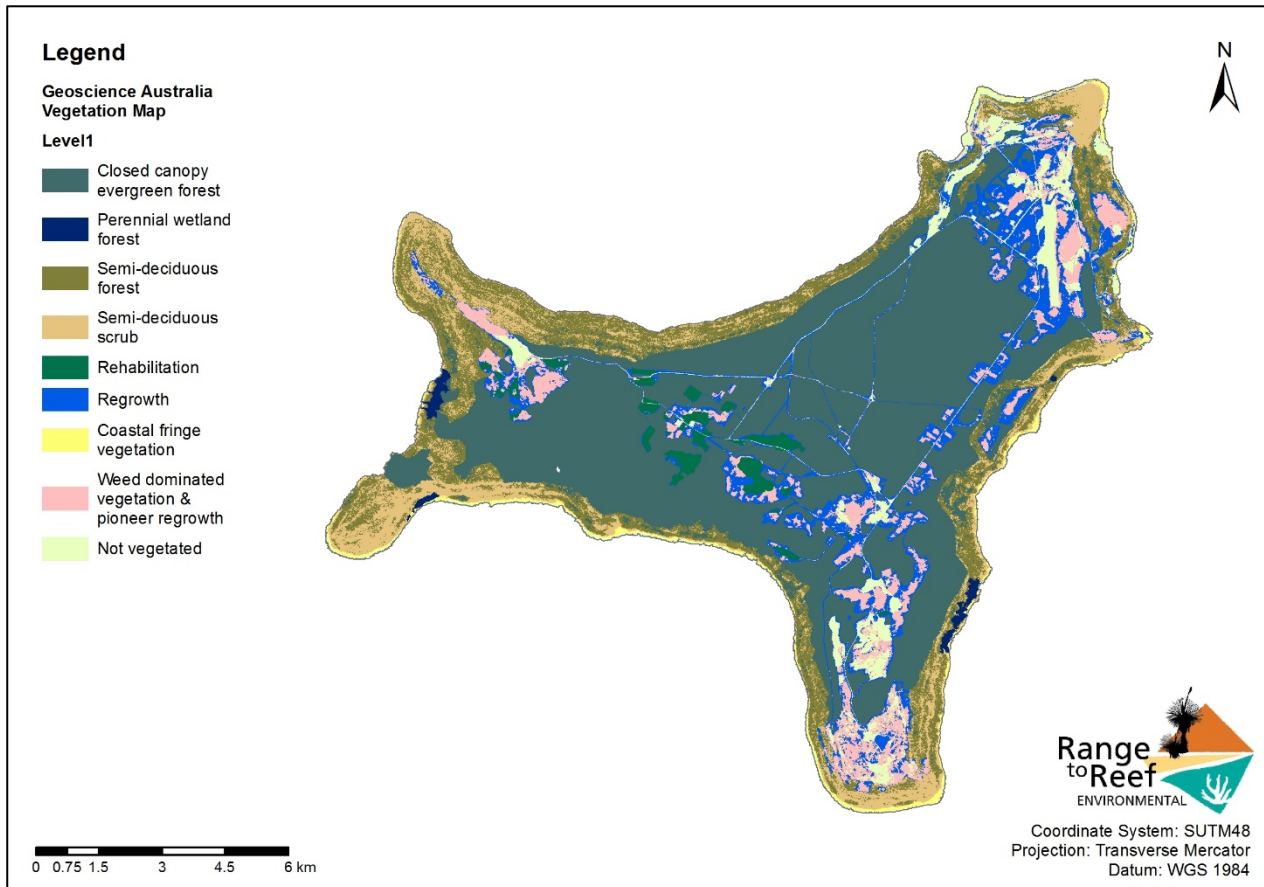


Figure 10. Vegetation of Christmas Island

Source: Geoscience Australia (2014)

The vegetation of the proposal area was mapped as a combination of regrowth, weed dominated vegetation, cleared areas and Semi-deciduous forest/scrub (Geoscience Australia, 2014).



Table 2. Vegetation of Christmas Island

Flora of Australia	Geoscience Australia			Indicator species
	Level 1	Level 2	Description	
Primary Rainforest	Closed canopy evergreen forest	Closed canopy evergreen forest (tall or moderate)	Generally found on the plateau and terraces, with a closed uneven canopy up to 40 m in height. Some trees emerge up to 10 m above the canopy. Often supports ferns and orchids, young palms and lilies in the understory.	<i>Bolbitis heteroclita</i> , <i>Syzygium nervosum</i> , <i>Hernandia ovigera</i> , <i>Planchonella nitida</i> , <i>Pisonia umbellifera</i> , <i>Corymborkis veratrifolia</i> , <i>Ehretia javanica</i>
Marginal Rainforest	Semi-deciduous forest	Semi-deciduous forest	Generally found on the slopes and terraces down to the coast - and some plateau areas. Higher occurrence of semi-deciduous trees compared to Closed Canopy Evergreen, which lose a portion of leaves during the dry season. Tree height generally 10-25m	<i>Terminalia</i> , <i>Gyrocarpus</i> , <i>Erythrina variegata</i> , <i>Premna serratifolia</i> , <i>Pisonia grandis</i> , <i>Ochrosia ackeringae</i>
Inland Cliffs AND Open Forest, scrubby forest and vine forest	Semi-deciduous scrub	Semi-deciduous scrub	Found on the terraces, steep slopes and inland cliffs. Semi-deciduous canopy with vines and shrub understory Tree height generally <10m.	§ <i>Colubrina pedunculata</i> , <i>Canavalia cathartica</i> , <i>Carmona retusa</i> , <i>Cycads</i>
Areas with Surface Water	Perennial wetland forest	<i>Inocarpus fagifer</i> dominant	Areas of fresh water runoff on the lower terraces dominated by <i>Inocarpus fagifer</i> .	<i>Inocarpus fagifer</i>
		<i>Hibiscus tiliaceus</i> dominant	Areas of fresh water runoff on the shore terrace dominated by <i>Hibiscus tiliaceus</i> .	<i>Hibiscus tiliaceus</i>
		<i>Bruguiera</i> dominant	A single patch of vegetation dominated by <i>Bruguiera</i> at Hosnie's Spring. Occurring in an area of fresh water runoff on the shore terrace.	<i>Bruguiera gymnorhiza</i>
Coastal Fringe OR Shore cliffs and spray zone, and	Coastal fringe vegetation	Coastal herbland	Found between the coastal scrub and coastal cliffs in exposed areas. Class is dominated by low-lying herbs, sedges and grasses.	<i>Portulaca tuberosa</i> , § <i>Ischaemum nativitatis</i> , <i>Oplismenus compositus</i> , <i>Sporobolus virginicus</i>
		Coastal shrubland	Dense salt-tolerant vegetation growing between the coastal herbland and the terrace cliffs.	§ <i>Pandanus christmatensis</i> , <i>Scaevola</i> , <i>Pemphis</i> , <i>Argusia argentea</i> , <i>Cordia cordata</i> , <i>Guettarda</i>

§ denotes endemic species

\* denotes introduced species

Continued over page...

Flora of Australia	Geoscience Australia			Indicator species	
	Level 1	Level 2	Description		
Mined Areas	Rehabilitation	Rehabilitation	Areas where forest rehabilitation has taken place. The standard of forest varies depending on the type of rehabilitation completed, species planted and management regime.	A mix of up to 30 native tree species when initially planted, dependent on characteristic of the site and year of rehabilitation. <i>Macaranga</i> , <i>Dysoxylum</i> , <i>Calophyllum</i> , <i>Tristiropsis</i>	
	Regrowth	Regrowth	Generally well developed regrowth vegetation over 5 m mean tree height. May include some introduced or weed species.	Various species – dependent on adjacent vegetation	
	Weed dominated veg and pioneer regrowth		<i>*Leucaena leucocephala</i>	Monoculture of <i>*Leucaena leucocephala</i> . Often occurring as regrowth in previously cleared areas.	<i>*Leucaena leucocephala</i>
			Fern field	Expanse of low-lying ferns often growing on limestone pinnacles.	<i>Nephrolepis biserrata</i> , <i>Microsorium scolopendria</i> , <i>Psilotum nudum</i>
			Mixed weed and pioneer regrowth	Regrowth vegetation with a mean tree height of <5m. Can vary between native and introduced species depending on the location and time since clearing. Tends to have a higher occurrence of weed species compared to the 'Regrowth' category.	<i>*Muntingia calabura</i> , <i>*Psidium</i> sp. (Guava), <i>*Mimosa</i> , Passionfruit, <i>Macaranga</i>

Source: Du Puy (1993) and Geoscience Australia (2014)

There are seven major structural types of secondary vegetation (i.e. vegetation that has established in areas that have been cleared of the original natural forest) on Christmas Island (Figure 11). The occurrence of these secondary vegetation types in specific disturbed areas on Christmas Island reflects the influence of four main factors:

- The areal extent and the severity/intensity of the original disturbance (especially whether the soil profile has been disrupted or removed);
- Proximity to the nearest forest boundaries and/or to weed-infested areas;
- The subsequent disturbance or management history of the area (especially the frequency and intensity of further disturbances including fire); and
- The time since the last major disturbance occurred.

Whether or not the soil profile has been removed or disturbed, the proximity to forest and/or to weed infested areas and the occurrence of further disturbance are the major environmental determinants of secondary vegetation type and successional pathways. There are four main successional pathways:

- Arrested successions dominated by ferns;
- Stagnant successions dominated by thickets of exotic shrubs and vines;
- Reconstructive successions dominated by *Macaranga tanarius*; and
- Retrogressive successions leading to fernlands.

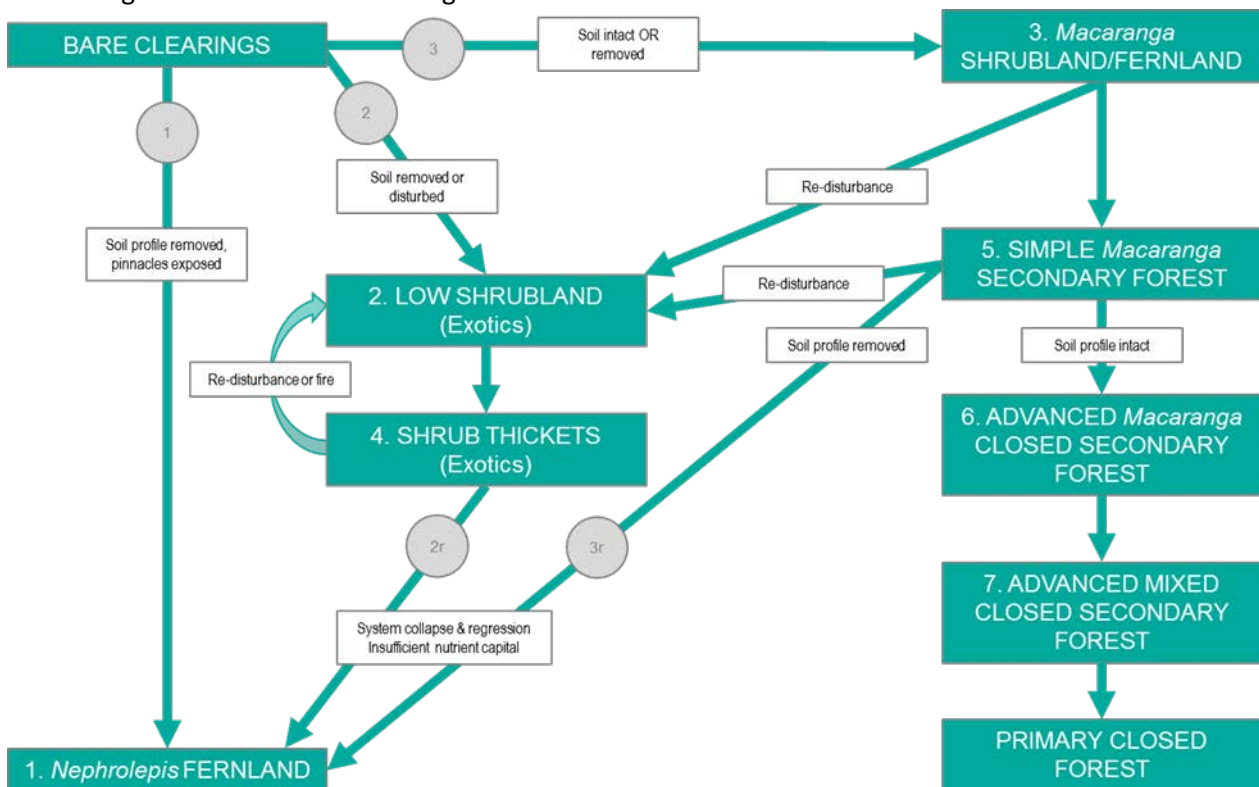


Figure 11. The seven major secondary (regrowth) structural types occurring on Christmas Island.

## 2.6 Flora

Christmas Island is occupied by a suite of species that are derivatives of colonisers from distant land masses following dispersal by air, ocean currents or by avifauna (Du Puy, 1993). The isolation of the island and the nature of the colonisation process have resulted in a unique flora, which has been further evolved by the complex relationships with land crabs. In similarity to other isolated oceanic islands populations usually have little genetic heterogeneity and form unique ecological communities. The terrestrial vegetation communities of Christmas Island comprise several types of rainforest and coastal forest, dominated by plants that are pan-tropical species (Beeton, et al., 2009). The flora has very strong

taxonomic relationships with those of the Indo-Malayan and Malesian regions with some species (e.g. *Terminalia catappa*, *Inocarpus fagifer* and *Gyrocarpus americanus*) being elements of a more widely distributed tropical Indo-Pacific littoral flora that extends as far east as the islands of Polynesia (Du Puy, 1993). Despite its isolated location, estimated 10-million year history above sea level, and diverse 'high-island' landscape, only around eighteen species are known to be endemic (denoted by §) to Christmas Island. The presence of these endemic plant species contributes to the island's significance for understanding evolutionary relationships.

The taxonomic status and affinities of the island flora are well known but detailed records of population distributions across the island (and its range of habitats) are limited for many species and, in particular, conservation significant species. More recent assessments vary slightly in terms of total species numbers, exotic species and endemics (refer to Table 3. ) although the most recent review (Director of National Parks, 2014b) lists a native flora of 240 species.

Table 3. Species richness of the vascular flora of Christmas Island as described by different authors.

Author/Study	Total Species	Native Species	Introduced Species	Endemic Species	Potentially conservation significant
Du Puy (1993), <i>Flora of Australia Vol 50</i>	411	237	174	16	-
Holmes & Homes (2002), <i>Conservation Status of the Flora of Christmas Island, Indian Ocean</i>	-	-	-	-	53
Reddell & Zimmerman (2003), <i>Terrestrial Flora of the Proposed Phosphate Mine Leases on Christmas Island and the Intended Strategy for their Rehabilitation Following Mining</i>	420	242	177	17	-
Claussen (2005), <i>Plants of Christmas Island</i>	-	213	250	17	-
Parks Australia (2008), <i>Issues Paper; Conservation status and threats to the flora and fauna of the Christmas Island Region</i>	420	240	175	19	26
Beeton et al. (2009), <i>Revised Interim Report Christmas Island Expert Working Group to Minister for the Environment, Heritage and the Arts</i>	415	240	175	19	-
Director of National Parks (2014b), <i>draft Christmas Island Biodiversity Conservation Plan</i>	420	242	177	20	5

### 2.6.1 EPBC Act Listed Flora

Three species which occur on Christmas Island were listed as Threatened Species under the EPBC Act at the time this report was prepared (Table 2). Christmas Island Spleenwort is listed as Critically Endangered and is endemic to Christmas Island. *Tectaria devexa* var. *minor* is listed as Endangered and occurs in Sri Lanka as well as Christmas Island. *Pneumatopteris truncata*, which is listed as Critically Endangered, has a fragmented distribution over Asia and Malaysia as well as being known from two sites on Christmas Island. Known populations of the three EPBC listed flora species on Christmas Island are shown in Figure 13.

Table 4. Threatened Species under the EPBC Act

Genus (& Family)	Conservation Status (EPBC Act)	Habitat	Description	Distribution
<sup>§</sup> <i>Asplenium listeri</i> (Aspleniaceae)	Cr	Limestone rock crevices in dry, exposed areas.	A lithophytic fern with short erect fronds, 3.5–9 cm long, which grow in a crown.	Christmas Island.
<i>Tectaria devexa</i> var. <i>minor</i> (Dryopteridaceae)	En	Primary rainforest (tall and largely undisturbed), above 80 metres elevation; both in deeper soils and as a lithophyte (on mossy pinnacles at the base of a slope, a wet site).	A small, tufted, terrestrial fern with pale green fronds.	Christmas Island and Sri Lanka.
<i>Pneumatopteris truncata</i> (Thelypteridaceae)	Cr	Permanently moist sites in semi-deciduous closed forest.	A large terrestrial fern with an erect rhizome and fronds growing in a crown to 120 cm long. The fronds have aerophores (respiratory structures) at the base of the pinnae.	Fragmented distribution over Asia and Malaysia and four sites on Christmas Island.

Source: (Department of the Environment and Energy, 2016)



Figure 12. (from left to right) Christmas Island Spleenwort (<sup>§</sup>*Asplenium listeri*), *Tectaria devexa* var. *minor* and *Pneumatopteris truncata*

Sources: Khaliesha Amin, Butz (2004), <http://www.phytoimages.siu.edu/>

### <sup>§</sup>*Asplenium listeri* (Christmas Island Spleenwort)

The Christmas Island Spleenwort grows colonially on limestone rocks and cliffs in marginal rainforest between 110 and 255 metres above sea level, growing mainly beneath or near *Ficus microcarpa* (Holmes & Holmes, 2002).

A review of the taxonomy and conservation status of <sup>§</sup>*Asplenium listeri* was undertaken by Ohlsen et al. (2014), with indications that the taxon is more widespread and common across its range than previously thought, and that its EPBC listing needs to be reassessed. The review also cast doubts on the taxonomic status of *A. listeri* as a separate species because of similarities to the more widespread *Asplenium polyodon*, with recommendations for further surveying of other populations on the island to accurately assess species demographics. Ohlsen et al (2014) indicate that the limestone dwelling *A. listeri* (on Christmas Island, Vanuatu and New Caledonia) are genetically more closely related to *A. polyodon* on Christmas Island than to any other accessions of *A. polyodon* sampled. Their study suggests that consistent genetic markers from limestone plants across a broad geographic range may represent a different species from *A. polyodon* from the island.

The differences between *A. listeri* and *A. polyodon* are therefore very limited, and Ohlsen et al (2014) draw attention to the size of the fertile pinnae and substrate as the discriminating morphological characteristics. Anecdotal information received from taxonomic experts recommend further testing by comparison of additional genetic markers and more sequencing of samples from Christmas Island (of both *A. polyodon* and *A. listeri*) and from *A. polyodon* from the Indo-Pacific region (D. Fell pers. comm. 2016). More samples for both molecular and morphological comparison from the island are therefore required to better understand the features that can distinguish the two species.

***Tectaria devexa* var. *minor***

*Tectaria devexa* var. *minor* grows colonially, mainly on the plateau, in primary rainforest (tall and largely undisturbed), above 80 metres elevation; both in deeper soils and as a lithophyte (Holmes & Holmes, 2002). Numerous populations of *Tectaria devexa* have been identified at Christmas Island, with most these occurring in the National Park. The species has a superficial similarity to the larger fern *Davallia solida* which is common on the island.

***Pneumatopteris truncata***

*Pneumatopteris truncata* is known from four populations in two locations on Christmas Island. Though Holmes and Holmes (2002) describe the species as growing colonially on permanently moist sites, in marginal rainforest (semi-deciduous closed forest) between 50 and 140 metres above sea level, two populations occur within primary rainforest in the centre of the island. The habitat requirements for this species are therefore poorly known. All specimens of *Pneumatopteris truncata* identified to date were found within Christmas Island National Park.

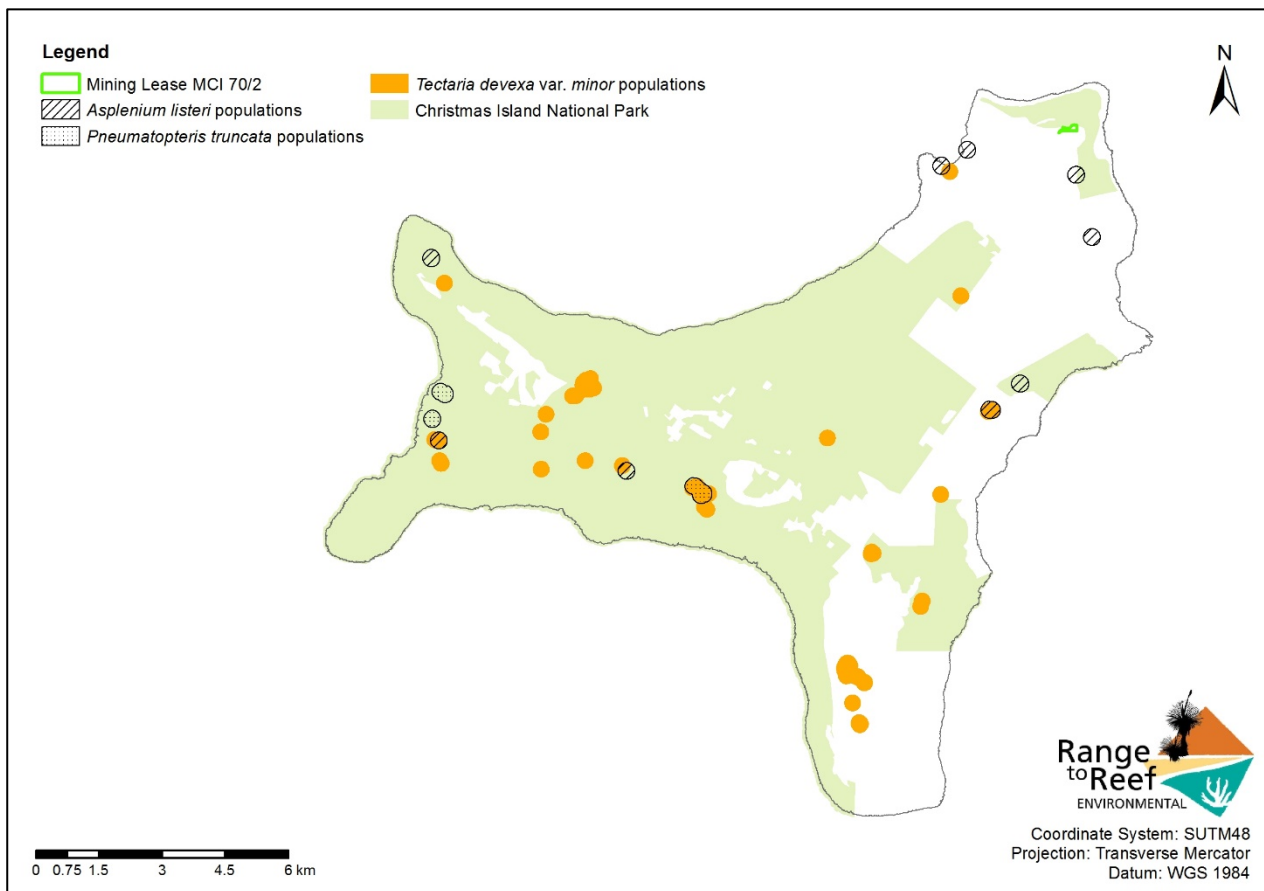


Figure 13. Threatened Flora populations on Christmas Island

Sources: Department of National Parks (2016), Range to Reef Environmental (2016)

## 2.6.2 Conservation Significant Flora

Holmes and Holmes (2002) made a number of recommendations relating to conservation significant flora including the nomination of the species <sup>§</sup>*Asplenium listeri*<sup>2</sup>, *Pneumatopteris truncata*<sup>2</sup>, <sup>§</sup>*Asystasia alba*<sup>2</sup>, <sup>§</sup>*Dicliptera maclearii*<sup>2</sup>, *Blumea lanceolaria*<sup>2,3</sup>, *Muellerargia timorensis*<sup>2</sup>, *Cycas rumphii*<sup>2</sup>, *Spondias cythera*<sup>2</sup> and <sup>§</sup>*Dendrocnide peltata* var. *murrayana*<sup>2</sup> under the EPBC Act. Most these species occur in marginal rainforest (see footnotes) or are located within National Park. These locations are not generally under threat due to legislative protection (National Park), a lack of phosphate resources or difficult terrain.

Parks Australia (2008) identified some 26 non-endemic vascular flora species as being potentially conservation significant in an issues paper prepared as part of the development of a draft regional recovery plan (which later became the Draft Christmas Island Biodiversity Conservation Plan).

The Draft Christmas Island Biodiversity Conservation Plan (Director of National Parks, 2014b) identified four flora species as significant:

- <sup>§</sup>*Asplenium listeri* (Christmas Island spleenwort, a fern);
- *Pneumatopteris truncata* (a fern);
- *Tectaria devexa* var. *minor* (a fern); and
- *Bruguiera gymnorhiza* and *B. sexangula* (mangroves).

The stand of the normally estuarine mangrove species *Bruguiera gymnorhiza* and *B. sexangula* occurs at Hosnie's Spring (listed as a Wetland of International Importance under the Ramsar Convention) about 50 metres above sea level (Director of National Parks, 2014a). This site is protected within National Park as well as a Ramsar listing.

In Western Australia, species that maybe Threatened or near Threatened but are data deficient or have not yet been adequately surveyed to be listed under the Schedules of the Wildlife Conservation (Rare Flora) Notice, are added to the Western Australian Priority Flora List under Priorities 1, 2, 3 or 4. Under the State process for assessment of clearing permits (Department of Environment Regulation, 2014), Priority listed flora are considered as contributing to biodiversity. Western Australian listings for Priority Flora species do not include Christmas Island's flora.

---

<sup>2</sup> Found in Marginal Rainforest (Holmes & Holmes, 2002)

<sup>3</sup> Found in Primary Rainforest (Holmes & Holmes, 2002) but prefers some light, usually found along disused drill lines (Du Puy, 1993).

## 3 Survey Methodology

### 3.1 Desktop assessment

A desktop assessment of the proposed clearing areas was undertaken prior to the field survey. The desktop assessment consisted of a review of existing contextual data, reports or surveys undertaken near the proposed clearing areas including:

- *Christmas Island National Park Management Plan* (Director of National Parks, 2014a)
- *Terrestrial Flora of the Proposed Phosphate Mine Leases on Christmas Island and an Assessment of Feasible Rehabilitation Options following Mining* (Reddell & Zimmermann, 2003)
- *Christmas Island Vegetation and Clearing Map* (Geoscience Australia, 2014)
- *A vegetation survey of Christmas Island* (Mitchell, A vegetation survey of Christmas Island, 1985)
- *Draft Recovery Plan for Tectaria devexa var. minor* (Butz, 2004)
- *Conservation status of the flora of Christmas Island* (Holmes & Holmes, 2002)
- *Native Plants of Christmas Island* (Claussen, 2005)
- *The forest flora of Christmas Island* (Mitchell, 1974)
- *The flora of Christmas Island* (Du Puy, 1993)
- *Control of seedling recruitment by land crabs in rain forest on a remote oceanic island* (Green, O'Dowd, & Lake, 1997)
- *The role of red land crabs (Gecarcoidea natalis (Pocock, 1888); *Brachyura*, *Gecarcinidae*) in structuring rain forest on Christmas Island, Indian Ocean* (Green, 1993)
- *Mapping of Christmas Island Native and Endemic Plants with Limited Distributions* (Du Puy, 1988)
- *Canopy Gaps in Rain Forest on Christmas Island, Indian Ocean: Size Distribution and Methods of Measurement* (Green, 1996)
- *Draft Christmas Island Phosphates Weed Management Plan* (Range to Reef Environmental 2015)
- *Christmas Island Satellite Launch Facility: Draft Environmental Impact Study* (SKM, 1999)
- *Fauna and Flora Survey Block 2, South Point, Christmas Island* (Range to Reef Environmental, 2013)
- *Interim Results of Environmental Investigations on Unallocated Crown Lands* (Range to Reef Environmental, 2016)
- *Supporting Documentation for Clearing Permit Application Proposed Exploration in Mining Lease MCI 70/10* (Range to Reef Environmental, 2015)
- *Clearing Permit Supporting Documentation CPS 6323/1* (Range to Reef Environmental, 2014)

Information gleaned from the desktop assessment was used to prepare the Introduction (Section 1) and Existing Information (Section 0) sections of this report.

### 3.2 Field Survey

The flora and vegetation field investigation was undertaken on 18 February 2016 by David Fell, a botanist with 28 years' experience in rainforest surveys throughout New South Wales, Queensland and Papua New Guinea, including four extended field surveys on Christmas Island between 2013 and 2015.

Dr Andrew Hill who has five years of experience on Christmas Island together with 30 years' experience in natural area management in Western Australia supported the survey.

The field survey aimed to provide an assessment adequate to satisfy the requirements of the clearing permit assessment process. A level one survey was undertaken due to the highly degraded nature of the proposed clearing area.

Field maps of vegetation (Geoscience Australia, 2014) and aerial imagery (Geoscience Australia, 2011a) were used to derive a preliminary understanding of the forest cover of each of the survey areas. All vegetation types present within the mining lease were examined to record any conservation significant



flora species that might be present and relevés were undertaken in less degraded, previously uncleared areas.




Data on vegetation structure and dominant floristics were recorded on field proformas at three sites including canopy height, layers, structural features and dominant floristics. The location of survey sites were also entered into a hand-held GPS. Observations of vegetation boundaries were made on a hard copy of the aerial photography to confirm the transition between regrowth vegetation and Semi-deciduous Forest/scrub. Fauna observations were recorded at each survey site. The site was also traversed to record vegetation boundaries and additional species.

A species list was compiled for the survey area. Common species that were well known to the survey botanist were identified in the field, while specimens of all other species were collected or photographed and identified on Christmas Island, using *Flora of Australia Volume 50 Oceanic Islands 2* (Du Puy, 1993) and *Native Plants of Christmas Island* (Claussen, 2005).




Vegetation condition assessment was based on the condition rating scale developed by Keighery (1994) and described in *Bush Forever* (Government of Western Australia, 2000) but adapted by Range to Reef Environmental for use in the rainforest (Range to Reef Environmental, 2014). The adapted scale examines regrowth development, retention of structural features present in undisturbed rainforest, weediness and landform disturbance. This scale was further revised by Range to Reef Environmental in 2016 to incorporate numerical rankings for vegetation condition consistent with the December 2015 *Technical Guide - Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA and DPaW, 2015). The numbering system for the Eremaean and Northern Botanical Provinces was applied following the field survey, though the condition descriptions are compared to Keighery's description of vegetation conditions used in the Perth area. The vegetation condition rating scale is provided in Table 5.

Site location coordinates including numbered waypoints and position of track logs were downloaded from the field GPS units in the ArcGIS framework and overlain onto map figures and hand drawn vegetation boundaries were digitised. Site data recorded on field proformas was transferred into an excel spread sheet. A summary of survey data is included in Appendix 1.

Table 5. Vegetation condition rating scale

Condition Rating	Keighery (1994)	Adapted scale
2 (Pristine)	Pristine or nearly so, no obvious signs of disturbance.	<p>Mature, undisturbed rainforest or very advanced secondary regrowth. Disturbance is limited to cyclone damage occurring in February 2014. Climax species dominate and full structural complexity is present with epiphytic orchids and ferns, terrestrial orchids and ferns, <i>Pandanus</i>, palms, buttressing and woody lianes.</p> 
3 (Excellent)	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.	<p>Little to no weed species and a largely intact landform with few signs of disturbance. The vegetation structure is beginning to develop the full complexity and diversity expected in rainforest, with climax species present and a range of features included such as buttressing, palms, ferns, epiphytes and orchids, but the canopy is likely to be more open than in undisturbed rainforest.</p> 
4 (Very Good)	Vegetation structure altered obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.	<p>Low diversity vegetation with few signs of disturbance or moderately diverse vegetation on a disturbed landform, a canopy dominated by pioneer species, though recruitment of climax species may be evident, an open canopy or poor structural complexity. Few weeds present or weeds are limited to less aggressive species.</p> 

Continued over page...

Condition Rating	Keighery (1994)	Adapted scale
5 (Good)	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.	Multiple signs of disturbance or with low diversity and no structural complexity. Typically displays little to no recruitment of climax tree species. Numerous weeds present or a dense understory dominated by one or two native fern species. 
6 (Degraded)	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.	Vegetation at very early successional stages with a canopy of one to two species and an understory dominated by ferns or weeds, typically adjacent to completely degraded land. May have the potential to develop into better quality vegetation as the canopy develops if weeds are managed. 
7 (Completely Degraded)	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often referred to as parkland cleared with the flora composing weed or crop species with isolated native trees or shrubs.	The structures of primary rainforest are no longer present and native species are limited to only a few species, for example, weed dominated shrubland with sparse emergent <i>Macaranga</i> or a near monoculture <i>Nephrolepis biserrata</i> fernland. The landscape may be highly disturbed, often with significantly reduced soil and pinnacles exposed. Predominantly lacking a native canopy and with little to no potential to develop one due to dense groundcover or shallow soil. 

### 3.2.1 Botanical Survey Limitations

Possible survey limitations identified in the EPA Guidance for Assessment of Environmental Factors: *Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia, No. 51* (EPA, 2004a) have been addressed in Table 6.

The most notable constraint of the survey was walking unimpeded within Lot 3039. In many instances dense understory and degraded thickets made passage difficult.

Table 6. Statement of botanical survey limitations

Potential Limitation	Constraint	Comment
Availability of contextual information for the Project at a regional and local scale	No constraint	Contextual information for the site is readily available, and was utilised where necessary during the preparation of this report. This includes review of previous flora survey reports and island wide vegetation mapping.
Competency/experience of the team carrying out the survey, including experience in the region surveyed	No constraint	The lead survey botanist has over 25 years' experience in rainforest surveys in eastern and northern Australia and Papua New Guinea, with recent experience on Christmas Island (four field surveys between 2014-15).
Proportion of flora recorded and/or collected, any identification issues	No constraint	Three relevés were undertaken within the 3.9 ha lot and traverses were undertaken in the most degraded areas. There were no identification issues with all species at the site being readily identifiable. It is likely that 80% of species present within the site were identified during this survey.
Scope	No constraint	The scope of the flora and vegetation survey was met and fully adhered to during the site visit and the reporting component of the assessment.
Sources of information (historical/recent/new or anecdotal)	No constraint	Christmas Island has been the subject of numerous flora and vegetation surveys and has a dedicated volume of Flora of Australia (Volume 50), Du Puy (1993).
Proportion of task achieved and further work that may need to be undertaken	No constraint	The three threatened fern species identified by the EPBC Act database searches would have been identifiable during the survey period, if present.
Suitable timing/weather/season/cycle	No constraint	The survey was undertaken in February during the wet season which meant that deciduous species were in leaf. The three EPBC Act listed fern species would have been readily identifiable if present.
Disturbances that may have affected the survey such as fire, flood or clearing.	No constraint	Most of the proposed clearing area has been previously cleared and overburden stockpiles have been pushed up around the perimeter. The site was extremely weedy due to the long history of usage.
Intensity of survey	No constraint	The intensity of the survey was adequate to meet the requirements of the scope of works and to assess the flora and vegetation values against the ten clearing principles within the <i>Environmental Protection Act 1986</i> .
Completeness	Yes; Moderate	Vegetation of the study areas has been mapped by Geoscience Australia using LIDAR, aerial photography and local knowledge. For the purposes of this assessment, a Level 1 survey was completed. The likelihood that threatened flora would be detected if they were present on is considered as high. Although some of areas of the site contained very dense vegetation which reduced visibility, these areas were extremely degraded by weeds and unlikely to provide suitable habitat for conservation significant flora taxa.
Resources	No constraint	Adequate resources were allocated to the survey both in terms of survey effort, allocated time, and staff resources.
Remoteness and/or access problems	No constraint	The site was highly accessible with a walkable track through vegetation.

## 4 Results

### 4.1 Flora

The investigation recorded 56 flora taxa from 32 families within the survey area. Of these 25 were native, including four endemic species, and 31 (55%) were introduced. The species recorded for each vegetation type have been included in Table 7.

#### **Conservation Significant Flora Species**

Of the three flora taxa listed as Threatened under the EPBC Act, none were identified during the field survey.

#### **Introduced Flora Species**

Thirty-one introduced flora taxa were identified during the field investigations, representing 55% of the flora.

Table 7. Flora species list and presence/absence in vegetation types 1 to 5

FAMILY	TAXA	1	2	3	4	5
Amaranthaceae	<i>Deeringia amaranthoides</i>		+	+		
Apocynaceae	§ <i>Hoya aldrichii</i>		+			
	<i>Ochrosia ackeringae</i>	+	+			
Arecaceae	§ <i>Arenga listeri</i>	+	+			
Aspleniaceae	<i>Asplenium nidus</i>	+	+	+		
Asteraceae	* <i>Synedrella nodiflora</i>					+
	* <i>Tridax procumbens</i>				+	+
Bignoniaceae	* <i>Tecoma stans</i> var. <i>stans</i>		+	+	+	+
Boraginaceae	* <i>Carmona retusa</i>	+	+	+		
	* <i>Cordia curassavica</i>		+	+	+	
Caesalpinaceae	* <i>Senna occidentalis</i>				+	+
Caricaceae	* <i>Carica papaya</i>	+	+	+		
Celastraceae	<i>Celastrus paniculatus</i>	+	+			
Combretaceae	<i>Terminalia catappa</i>	+	+	+		
Convolvulaceae	* <i>Ipomoea hederifolia</i>	+	+	+	+	+
Euphorbiaceae	* <i>Euphorbia heterophylla</i>				+	+
	* <i>Euphorbia hirta</i>				+	+
	<i>Macaranga tanarius</i>	+	+	+		
Fabaceae	<i>Canavalia cathartica</i>		+	+		
	* <i>Crotalaria pallida</i>				+	
	<i>Inocarpus fagifer</i>	+	+			
	* <i>Macroptilium atropurpureum</i>		+	+	+	+
	* <i>Stylosanthes humilis</i>					+
Malvaceae	<i>Grewia glabra</i>	+	+	+		
	§ <i>Grewia insularis</i>	+	+	+		
	<i>Kleinhovia hospita</i>		+			
	* <i>Malvastrum coromandelianum</i>					+
	<i>Melochia umbellata</i>	+				
Meliaceae	* <i>Sida acuta</i>				+	+
Meliaceae	<i>Dysoxylum gaudichaudianum</i>	+	+			
	* <i>Melia azedarach</i>	+	+	+		
Menispermaceae	<i>Pachygone ovata</i>	+				
Mimosaceae	* <i>Leucaena leucocephala</i>	+	+	+	+	
	* <i>Mimosa invisa</i>				+	+
	* <i>Mimosa pudica</i>				+	+
Moraceae	<i>Ficus microcarpa</i>	+	+			
	<i>Maclura cochinchinensis</i>	+	+	+		
Myrtaceae	* <i>Psidium guajava</i>			+	+	
Pandanaceae	§ <i>Pandanus elatus</i>	+	+			
Passifloraceae	* <i>Passiflora foetida</i>		+	+		
Pittosporaceae	<i>Pittosporum ferrugineum</i>		+	+		
Poaceae	* <i>Cenchrus echinatus</i>					+
	* <i>Chloris barbata</i>					+
	* <i>Melinis repens</i>				+	+
	* <i>Sporobolus fertilis</i>				+	+
Rubiaceae	<i>Guettarda speciosa</i>	+	+			
Rutaceae	<i>Acronychia trifoliata</i> var. <i>trifoliata</i>		+	+		
	* <i>Clausena excavata</i>	+	+	+	+	
Sapindaceae	<i>Allophylus cobbe</i>	+	+	+		
	<i>Tristiropsis acutangula</i>	+	+			
Scrophulariaceae	* <i>Scoparia dulcis</i>					+
Solanaceae	* <i>Solanum americanum</i>			+	+	
	* <i>Solanum pseudocapsicum</i>				+	
Turneraceae	* <i>Turnera ulmifolia</i>		+	+	+	
Urticaceae	<i>Dendrocnide peltata</i> var. <i>peltata</i>			+		
Verbenaceae	* <i>Stachytarpheta cayennensis</i>				+	+

## 4.2 Vegetation

Vegetation within the Mining Lease area consisted of Regrowth and Semi-deciduous Forest/Scrub (Geoscience Australia, 2014). Five vegetation types were identified within the mining lease during the field survey (Table 8).

Table 8. Vegetation present in Lot 3039

Vegetation Type	Environment	Condition
<p><b>1. Semi deciduous forest 10-15 m (Plate 1)</b>            Dominated by <i>Terminalia catappa</i> with subdominant <i>Ochrosia ackeringae</i>, <i>Kleinhovia hospita</i>, <sup>§</sup><i>Grewia insularis</i>, <i>Guettarda speciosa</i>, <i>Inocarpus fagifer</i>, <i>Dysoxylum gaudichaudianum</i>, <i>Pittosporum ferrugineum</i>, <i>Ficus microcarpa</i>, <sup>§</sup><i>Pandanus elatus</i>, <i>Macaranga tanarius</i> and <i>Tristiropsis acutangula</i>. Sparse understorey of <i>Ochrosia ackeringae</i>. Other species included <sup>§</sup><i>Arenga listeria</i>, <i>*Clausena excavata</i>, <i>Maclura cochinchinensis</i> var. <i>cochinchinensis</i>, <i>Celastrus paniculatus</i>, <i>Pachygone ovata</i>, <i>Allophylus cobbe</i>, <i>Terminalia catappa</i>, <i>Tristiropsis acutangula</i>, <i>Macaranga tanarius</i>, <i>Acronychia trifoliata</i> subsp. <i>trifoliata</i> and <i>*Leucaena leucocephala</i>. Very sparse groundcover with occasional seedlings of <i>Terminalia catappa</i>, <i>Tristiropsis acutangula</i> and <i>*Turnera ulmifolia</i>.</p>	Occurs on gentle to moderately steep terrace slopes with groundcover; 20% leaf litter, 60% bare ground and 20% surface rock. Red crab observed as common and a single robber crab.	Excellent to Very Good A track runs through this area (Plate 1)
<p><b>2. Semi deciduous thicket/ low closed forest 8-12m (Plate 2 and Plate 3)</b>            Dominated by <i>Acronychia trifoliata</i> subsp. <i>trifoliata</i>, <i>Guettarda speciosa</i>, <sup>§</sup><i>Grewia insularis</i>, <i>Ochrosia ackeringae</i> and scattered <i>*Leucaena leucocephala</i>. Very sparse emergents of <i>Terminalia catappa</i>. Deciduous species <i>G. speciosa</i>, <i>G. insularis</i> and <i>Terminalia</i>. Very dense understorey of <i>*Leucaena leucocephala</i>, <i>*Clausena excavata</i>, <i>Allophylus cobbe</i>, <i>Maclura cochinchinensis</i> var. <i>cochinchinensis</i>, <i>*Cordia curassavica</i>, <i>*Tecoma stans</i>, <i>Grewia glabra</i>, <i>G. insularis</i>, numerous thin wiry lianes of <i>Canavalia cathartica</i>, <i>Deeringia amaranthoides</i>, the exotic <i>*Ipomoea hederifolia</i>. The weeds <i>*Leucaena</i>, <i>*Clausena</i> and <i>*Cordia</i> were abundant.</p>	Gentle limestone terrace 80% rock.	Very Good to Good
<p><b>3. Exotic thicket 1-4m (Plate 4)</b>            Dominated by <i>*L. leucocephala</i> with <i>*Tecoma stans</i> var. <i>stans</i> and <i>Ipomoea hederifolia</i>.</p>	Gentle limestone terrace 80% rock.	Degraded
<p><b>4. Exotic thicket/ shrubland 2-4m (Plate 5)</b>            Dominated by <i>Tecoma stans</i> var. <i>stans</i>.</p>	Gentle limestone terrace 80% rock.	Completely Degraded
<p><b>5. Exotic grasses and herbs (Plate 6)</b>  <i>*Sporobolus fertilis</i>, <i>Ipomoea hederifolia</i>, <i>*Melinis repens</i>, <i>*Tridax procumbens</i>, <i>*Sida acuta</i>, <i>*Euphorbia heterophylla</i>, <i>*Mimosa pudica</i> and <i>*Mimosa invisa</i>.</p>	Bare rock and low weeds.	Completely Degraded

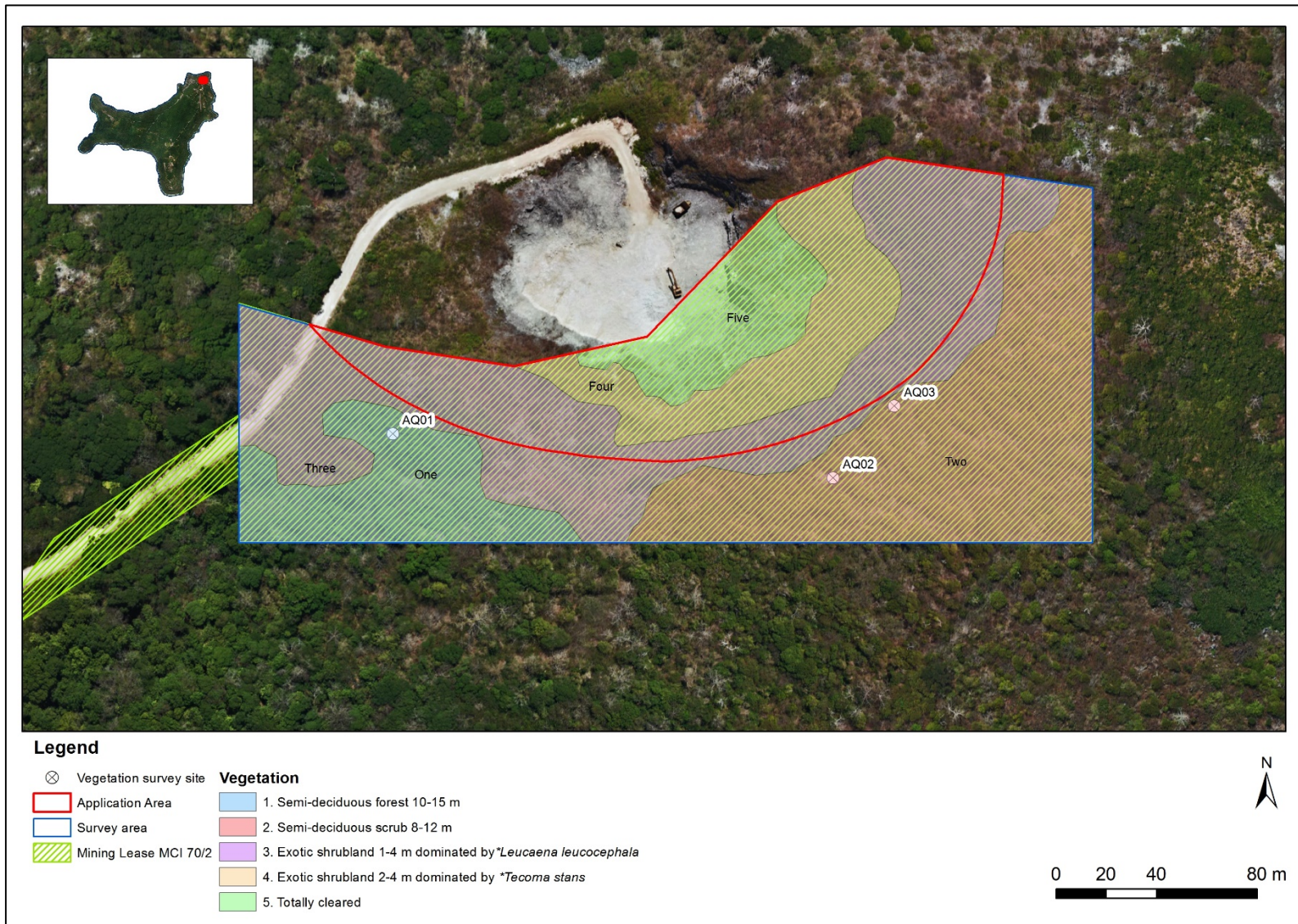


Figure 14. Vegetation map for the proposal area





Plate 1. Semi-deciduous Forest 10-15 m



Plate 2. Semi-deciduous Thicket/ low closed forest 8-12 m (example 1)



Plate 3. Semi-deciduous Thicket/ low closed forest 8-12 m (example 2)



Plate 4. Exotic Thicket 1-4m



Plate 5. Exotic Thicket/shrubland 2-4 m



Plate 6. Exotic Grasses and Herbs

## 5 Discussion and Environmental Impact

### 5.1 Flora

The investigation recorded 56 flora taxa from 32 families within the survey area. Of these 25 were native, including four endemic species, and 31 (55%) were introduced. The proposed clearing area would be restricted to vegetation types 3, 4 and 5, within which only 12 native species were identified. This represents a very low level of diversity, with the site being severely impacted by introduced flora species. The southern areas of the site which were less disturbed were the main source of native flora species and it is recommended that these areas be retained in their native state at this stage. Semi-deciduous forest is more prone to weed invasion as it lacks the protection that shading by tall canopy provides. The lower, coastal-terrace vegetation is more prone to invasive vine species such as coral vine (*\*Antigonon leptopus*). It would be worth developing a weed monitoring and management strategy for the site to target invasive species which might spread off the site.

### 5.2 Conservation Significant Flora

No EPBC Act Threatened flora species were found within areas which are proposed for clearing. Limestone outcropping which would provide suitable habitat for *Asplenium listeri* occurs in the surrounding area but these habitats were adequately surveyed within Mining Lease MCI 70/2 and no *A. listeri* was present. No impact upon threatened flora species is anticipated as a consequence of the proposed clearing which is confined to Degraded and Completely Degraded areas.

No flora species identified as conservation significant by the Draft Biodiversity Conservation Plan (Director of National Parks, 2014b) were found during the field survey.

### 5.3 Vegetation

The proposal would only impact the highly degraded vegetation within types 3, 4 and 5. These areas contained few native flora taxa. Areas covered by exotic thicket/shrubland (type 4) or exotic grasses and herbs (type 5) were Completely Degraded and should be exempted from the clearing permit application process.

There is 6,536 hectares of Closed Canopy Evergreen Forest remaining on Christmas Island, 1,977 hectares of Semi-deciduous Forest and 1,343 hectares of Semi-Deciduous Scrub. The proposal would impact less than 1.5 ha of highly degraded Semi-deciduous Forest/Scrub (<0.1% of the remaining area of these vegetation types on the island)

The National Objectives and Targets for Biodiversity Conservation 2001-2005 recognises that a retention of 30% or more of the pre-clearing extent of each ecological community is necessary if Australia's biological diversity is to be protected (ANZECC, 2000). It is recognised that biodiversity conservation presents greater challenges in an island environment, which is particularly susceptible to biodiversity losses. Approximately 75% of Christmas Island has never been cleared (refer to Table 1) and 77% of this (63% of total island area) is protected within the Christmas Island National Park (IUCN reserve category II) (Geoscience Australia, 2014; Environment Australia, 2014). Based on the National Objectives and Targets for Biodiversity Conservation 2001-2005, the vegetation complex is adequately reserved (i.e. greater than 30% of pre-clearing extent) within the Shire of Christmas Island and at a regional, State and National level.

## 5.4 Application of the Ten Clearing Principles

Ten clearing principles have been developed under Section 5 of the *Environmental Protection Act 1986* for the purposes of determining the impact of clearing. These are considered when a decision to grant or refuse a clearing permit is required. An assessment of the potential impacts of clearing, against the ten clearing principles, is outlined in Table 9 below.

Table 9. Application of the Ten Clearing Principles

Principle No.	Native Vegetation Should Not be Cleared if ...	Is the Proposed Project at Variance?	Comment
(a)	...it comprises a high level of biological diversity.	Proposal is <b>not likely to be at variance</b> to this Principle.	<p>Christmas Island is home to approximately 420 species of vascular plants, including 177 introduced species and 242 species thought to be indigenous to the island. Approximately eighteen species are known to be endemic to Christmas Island, with the other flora being more widely distributed through the Indo-Malayan and Malesian regions, or throughout the tropical Indo-Pacific. No Priority Flora species are listed for Christmas Island. Areas of the island which are previously uncleared and retain high biodiversity have been reserved as National Park, including the island's two Ramsar wetlands.</p> <p>Given the degraded nature of the proposed clearing area, its small size (&lt;1.5 ha) and the paucity of native species present (twelve), the proposal is unlikely to be at variance to this principle.</p>
(b)	...it comprises the whole or part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous to Western Australia.	Proposal is <b>not likely to be at variance</b> to this Principle.	<p>Christmas Island provides necessary habitat for fauna indigenous to the island including fourteen native bird species and nine species of seabird which use the island for breeding. Three seabird taxa and nine land bird taxa are endemic to the island. A further 104 migratory or vagrant bird species have been recorded on the island. Six of the island's endemic birds are listed as threatened under the EPBC Act.</p> <p>Five endemic native mammals have been recorded on Christmas Island with only one, the Christmas Island flying-fox, now known to remain. Christmas Island has six species of native terrestrial reptiles, five of them endemic.</p> <p>Crustaceans are the most conspicuous invertebrate fauna of Christmas Island, with the island supporting over 20 terrestrial and intertidal crab species of which 14 are regarded as true land crabs, depending on the ocean only for their larval development. Three land-crab species have been identified as conservation significant; the Red Crab, Blue Crab and Robber Crab. Red crabs are common throughout the island but are a keystone species in the island's ecology. Robber crabs have a wide distribution across many Indian and Pacific oceanic islands but in most of their range they are now scarce due to human's hunting them for food. Although abundant on Christmas Island their exact conservation status is unknown. Blue Crabs have a restricted distribution and do not occur within the areas proposed for clearing.</p> <p>Mammal and reptile species indigenous to the island have undergone a catastrophic decline since human settlement. This decline is attributed to a combination of threatening processes including the introduction of</p>

			<p>exotic fauna such as yellow crazy ant, giant centipedes, cats and black rats. These threatening processes are also believed to have impacted to some degree on the avian and crustacean fauna.</p> <p>Four conservation significant fauna species were observed near the proposed clearing area. These were the Christmas Island thrush, Christmas Island white-eye, red crab and robber crab. All of these species can be observed in many of the island's twelve known terrestrial fauna habitats, most of which are protected in the Christmas Island National Park.</p> <p>The proposed clearing area is highly degraded and does not provide habitat for conservation significant species other than on a transitory basis.</p> <p>For these reasons, it is considered that the proposal is not likely to be at variance to this principle.</p>
(c)	...it includes, or is necessary for the continued existence, or rare flora.	Proposal is <b>not likely to be at variance</b> to this Principle.	<p>Three Christmas Island flora species are listed as Threatened under the EPBC Act. These are <i>Asplenium listeri</i> (Christmas Island Spleenwort), which is listed as Critically Endangered, <i>Tectaria devexa</i> var. <i>minor</i>, which is listed as Endangered and <i>Pneumatopteris truncata</i> which is listed as Critically Endangered.</p> <p>The survey did not find any of these species and there are no known populations close to the proposed clearing site.</p> <p>For these reasons, it is considered that the proposal is not likely to be at variance to this principle.</p>
(d)	...it comprises the whole or a part of, or is necessary for the maintenance of, a threatened ecological community.	Proposal is <b>not at variance</b> to this Principle.	There are no listed Threatened Ecological Communities on Christmas Island. Therefore, the clearing as proposed is not at variance to this principle.
(e)	...it is significant as a remnant of native vegetation in an area that has been extensively cleared.	Proposal is <b>not at variance</b> to this Principle	<p>Approximately 75% (10,123 ha or 101 km<sup>2</sup>) of Christmas Island has never been cleared and 77% (7,769 ha or 78 km<sup>2</sup>) of this is protected within the Christmas Island National Park (Geoscience Australia, 2014). The proposed clearing comprises &lt;1.5 ha in highly degraded vegetation.</p> <p>The vegetation within the application area is not considered to be a significant remnant of vegetation as it is not located in an extensively cleared landscape and therefore is not at variance to this principle.</p>
(f)	...it is growing in, or in association with, an environment associated with a watercourse or wetland.	Proposal is <b>not at variance</b> to this Principle.	The application area is not associated with or adjacent to a watercourse or wetland. Therefore, the proposal is not at variance to this principle.
(g)	...the clearing of the vegetation is likely to cause appreciable land degradation.	Proposal is <b>not likely to be at variance</b> to this Principle.	<p>The proposed clearing area is situated on Crown Reserve adjacent to the existing quarry site. The area is already highly degraded and impacted by previous clearing, weed encroachment and compaction. No new degrading factors are anticipated as a result of clearing.</p> <p>For these reasons this proposal is not likely to be at variance to this principle.</p>
(h)	...the clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area.	Proposal is <b>not likely to be at variance</b> to this Principle.	There are four noteworthy conservation areas at Christmas Island. These are the Christmas Island National Park, the Ramsar wetlands Hosnie's Springs and The Dales, and the Commonwealth Heritage Site "Christmas Island Natural Areas".

			<p>The proposed clearing area is adjacent to the Christmas Island National Park but is separated from Park vegetation by a buffer created by the existing quarry and tracks which operate in the national park under an exemption.</p> <p>For these reasons this proposal is not likely to be at variance to this principle.</p>
(i)	...the clearing of the vegetation is likely to cause deterioration on the quality of surface or underground water.	Proposal is <b>not at variance</b> to this Principle.	<p>Due to the high natural rate of infiltration at Christmas Island, erosion and sedimentation is generally localised to compacted areas such as roads and stockpiles (Puhlovich et al., 2003). There is no potential for deterioration of underground water as a consequence of clearing. Due to the location of the application area, it is unlikely that the clearing of native vegetation will cause deterioration in the quality of surface water or groundwater within the local area. Therefore, this proposal is not at variance to this principle.</p>
(j)	...the clearing of the vegetation is likely to cause, or exacerbate, incidence or intensity of flooding.	Proposal is <b>not likely to be at variance</b> to this Principle.	<p>Christmas Island's soils and karstic limestone rocks are generally highly permeable so clearing on the island does not cause or exacerbate flooding (Puhlovich et al., 2003).</p> <p>For these reasons the clearing as proposed is not likely to be at variance to this principle.</p>

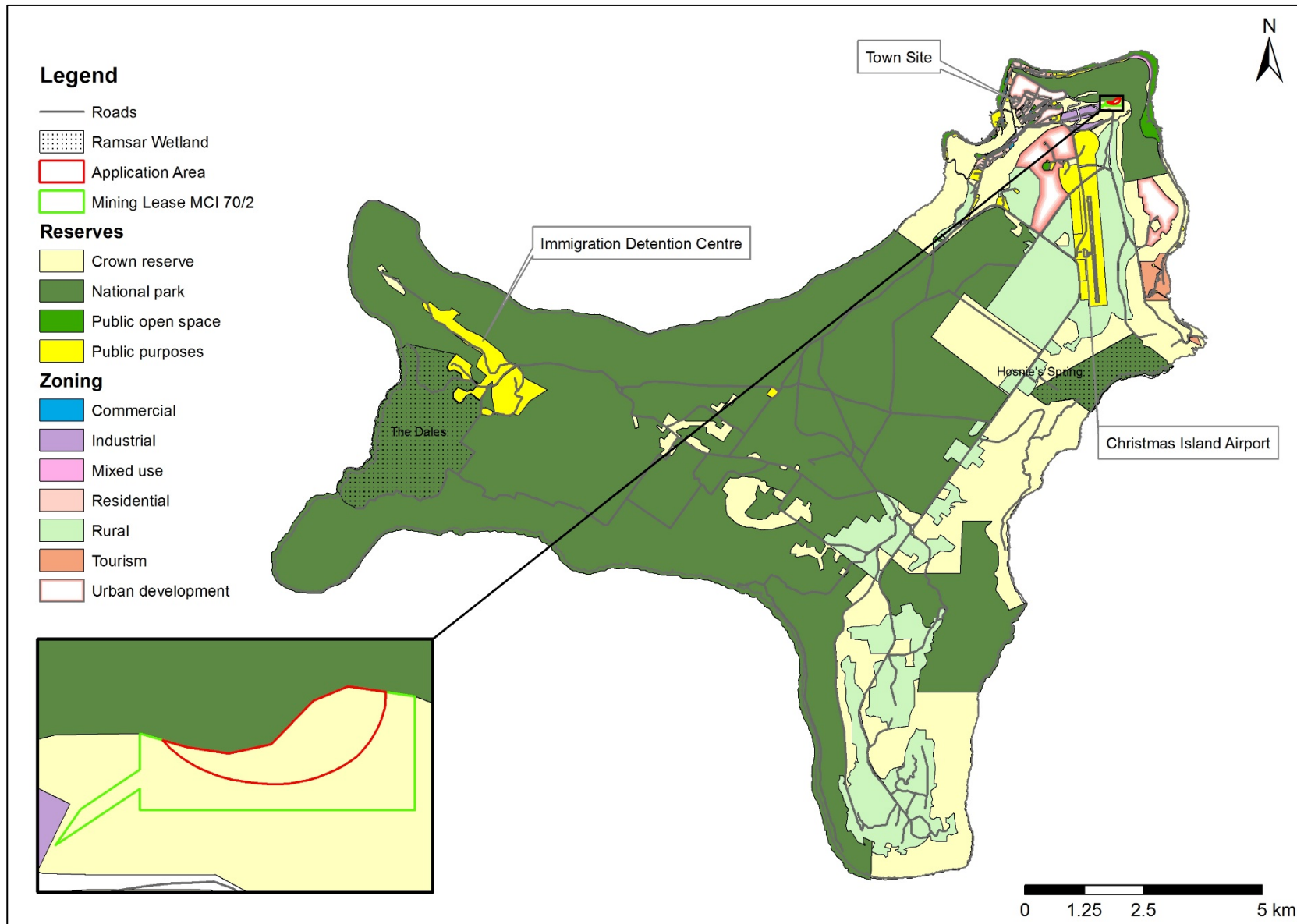


Figure 15. Zoning under Local Planning Scheme 2



## 5.5 Planning Instruments

### 5.5.1 Indian Ocean Territories Regional Plan

The Indian Ocean Territories Regional Plan (Regional Development Australia, 2012) was published in 2012. Building the capacity of the community and business to transition from a mining based economy to a diverse and broad based economy is a focus of the Regional Plan. The sectors identified for growth are tourism, food production and education and research. The care and management of the natural environment is also critical because if the natural environment is not well managed and protected, it also puts at risk the possibility of establishing a new tourism based economy.

### 5.5.2 Town Planning Scheme

Local Planning Scheme No. 2 (LPS 2) received approval February 2016. Under LPS 2, the land proposed for clearing is zoned Crown Reserve (Shire of Christmas Island, 2016).

## 5.6 Other Relevant Matters

### 5.6.1 Land Use Impacts

Acker's facilities on the island provide a source of employment for several islanders and is a necessary source of materials for construction on the island. The site is close to town and the quarry has been operating since 2000.

### 5.6.2 Previous Decisions

1. EPBC Act referral for proposed phosphate mining in South Point, Christmas Island (Ref: 2012/6653)
2. Previous clearing permit decisions:

• CPS2090/1 (Christmas Island Phosphates 'CIP')	refused
• CPS2132/2 (CIP)	exp. 11 November 2022
• CPS2373/1 (CIP Exploration Permit)	permit surrendered
• CPS2376/1 (CIP Exploration Permit)	permit surrendered
• CPS2870/1 (CIP)	permit surrendered
• CPS3290/2 (CIP)	exp. 31 August 2019
• CPS3472/4 (CIP)	exp. 11 January 2020
• CPS4506/1 (CIP)	exp. 16 March 2020
• CPS6124/1 (Parks Australia)	exp. 21 July 2019
• CPS6104/1 (Hidden Garden Sustainable Farms)	permit surrendered
• CPS6323/1 (CIP)	exp. 31 December 2024
• CPS6662/1 (CIP exploration MCI 70/10)	exp. 31 December 2018
• CPS6920/1 (CIP exploration)	exp. 3 June 2021
• CPS7040/1 (CIP exploration)	exp. 13 August 2021

### 5.6.3 Legislative Requirements

Mining Lease MCI 70/2 has been granted by the Minister for Territories.

There are no Aboriginal Sites of significance or Native Title Claims over the area.

The EPBC Act applies on Christmas Island. The Western Australian Environmental Protection Authority does not make decisions on Christmas Island.

The *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* apply to Christmas Island under the *Applied Laws (Implementation) Ordinance 1992* and are administered by the Department of Environment Regulation.

Acker have a Part V prescribed premises licence issued to them under the EP Act for the nearby concrete batching facility.

#### 5.6.4 Necessity

The Acker quarry is the only facility on the island which provides aggregate and concrete for roads and other building purposes. The existing quarry area needs to be expanded to continue to provide materials.

#### 5.7 Environmental Protection Policies

There are no Environmental Protection Policies developed under Part III of the EP Act that apply to Christmas Island.

## 6 Conclusions and Recommendations

An assessment of the proposed clearing of 1.48 ha of degraded vegetation against each of the ten clearing principles outlined in Schedule 5 of the *Environmental Protection Act 1986* has identified that the proposal is unlikely to be at variance to the clearing principles. The proposed clearing is a small area and would be predominantly of weed species. The land under consideration is on the eastern side of the island adjacent industrial areas. The existing quarry provides a buffer to the nearby Christmas Island National Park.

### 6.1 Recommendations

It is recommended that:

- Clearing is restricted to the degraded portions of the site as proposed.

## 7 References

- Beeton, B., Burbidge, A., Grigg, G., How, R., McKenzie, N., & Woinarski, J. (2009). *Revised Interim Report Christmas Island Expert Working Group to Minister for the Environment, Heritage and the Arts*.
- Bureau of Meteorology. (2017). *Climatic averages for Australian Sites, publicly available data prepared by the Bureau of Meteorology, Commonwealth of Australia*. Retrieved January 2017, from [http://www.bom.gov.au/climate/averages/tables/ca\\_wa\\_names.shtml](http://www.bom.gov.au/climate/averages/tables/ca_wa_names.shtml)
- Butz, M. (2004). *National Recovery Plan for Tectaria devexa*. Canberra: Department of the Environment and Heritage.
- Claussen, J. (2005). *Native Plants of Christmas Island, Flora of Australia Supplementary Series Number 22*. Canberra: Australian Biological Resources Study, Department of Environment and Heritage.
- Department of Environment Regulation. (2014). *A guide to the assessment of applications to clear native vegetation under Part V Division 2 of the Environmental Protection Act 1986*. Perth: Department of Environment Regulation.
- Department of National Parks. (2016). Christmas Island Island Wide Survey and Incard Data. Unpublished.
- Department of the Environment and Energy. (2016). *Species Profile and Threats Database, EPBC Act Threatened Species in Christmas Island*. Retrieved 10 31, 2016, from <http://www.environment.gov.au/cgi-bin/sprat/public/publicreports.pl>
- Director of National Parks. (2014a). *Christmas Island National Park Management Plan (2014-2024)*. Canberra: Director of National Parks.
- Director of National Parks. (2014b). *DRAFT Christmas Island Biodiversity Conservation Plan*. Canberra: Department of the Environment.
- Du Puy, D. J. (1988). *Mapping of Christmas Island native and endemic plants with limited distributions*. Kew, England: Royal Botanic Gardens.
- Du Puy, D. (1993). Christmas Island. In A. S. George, A. E. Orchard, H. J. Hewson, & H. S. Thompson (Eds.), *Flora of Australia* (Vol. 50, pp. 1-30). Canberra: Australian Government Publishing Service.
- Environment Australia. (2014). *Christmas Island National Park Management Plan 2014-2024*. Canberra: Director of National Parks.
- EPA. (2004a). *Guidance for the Assessment of Terrestrial Factors: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia, Guidance Statement No. 51*. Perth, Western Australia: Environmental Protection Authority.
- Falkland, T. (1999). *Christmas Island, Indian Ocean: Groundwater Investigations and Monitoring Report*. Canberra: ACTEW Corporation Ltd.
- Geoscience Australia. (2011a). Christmas Island 2011 Orthophotography. Canberra.
- Geoscience Australia. (2014, May). Christmas Island Vegetation and Clearing Map. (May 2014). (P. b. Environment, Compiler) Canberra, Canberra: Geoscience Australia.
- Government of Western Australia. (2000). *Bush Forever – Keeping the Bush in the City* (Vol. Volume 2 Directory of Bush Forever Sites). Perth: Western Australian Planning Commission.

- Green, P. T. (1993). *The role of red land crabs (Gecarcoidea natalis (Pocock, 1888); Brachyura, Gecarcinidae) in structuring rain forest on Christmas Island, Indian Ocean*. Monash University, Dept. of Ecology & Evolutionary Biology. Monash University.
- Green, P. T., O'Dowd, D. J., & Lake, P. (1997, December). Control of seedling recruitment by land crabs in rain forest on a remote oceanic island. *Ecology*, 78(8), 2474-2486.
- Grimes, K. (2001). Karst features of Christmas Island (Indian Ocean). *Helictite*, 37(2), 41-58.
- Hollingsworth, I. (2003). Soils and geomorphology in relation to proposed new mining leases, Christmas Island, Indian Ocean. In *Draft Environmental Impact Statement for the Proposed Christmas Island Phosphate Mines, Technical Appendices Vol 1* (2005 ed.). Perth: Phosphate Resources Ltd.
- Holmes, J., & Holmes, G. (2002). *Conservation status of the flora of Christmas Island, Indian Ocean*. Unpublished report to Parks Australia.
- Keighery, B. (1994). *Bushland Plant Survey: A Guide to Plant Community Survey for the Community*. Nedlands, Western Australia: Wildflower Society of Western Australia (Inc).
- McKenzie, N., May, J., & McKenna, S. (2002). *Bioregional Summary of the 2002 Biodiversity Audit for Western Australia*. Perth: Department of Conservation and Land Management.
- Mitchell, B. (1974, March). The forest flora of Christmas island. *The Commonwealth Forestry Review*, 53(1 (155)), 19-29.
- Mitchell, B. (1985). *A vegetation survey of Christmas Island*. Report to Australian Nature Conservation Agency, Canberra.
- Ohlsen, D., Perrie, L., Shepherd, & Bayly, M. (2014). Taxonomic status and distribution of the critically endangered Christmas Island spleenwort (*Asplenium listeri*, Aspleniaceae): it is not as rare as we thought. *Australian Systemic Botany*(27), 372-377.
- Parks Australia. (2008). *Regional Recovery Plan Issues Paper - Conservation status and threats tot he flora and fauna of the Christmas Island Region*. Canberra: Unpublished Draft Report.
- Puhalovich, A., Jacobsen, N., & Overall, R. (2003). Surface water and groundwater hydrology in relation to proposed new mining leases, Christmas Island, Indian Ocean. In *Draft Environmental Impact Statement for the Proposed Christmas Island Phosphate Mines, Technical Appendices Vol. 1* (2005 ed.). Phosphate Resources Ltd.
- Range to Reef Environmental. (2013). *Fauna and Flora Survey Block 2, South Point, Christmas Island*. Unpublished Report to Christmas Island Phosphates, Beaconsfield.
- Range to Reef Environmental. (2014). *Clearing Permit Application Supporting Documentation*. Perth: Range to Reef Environmental.
- Range to Reef Environmental. (2015). *Supporting Documentation for Clearing Permit Application Proposed Exploration in Mining Lease MCI 70/10*. Perth: Range to Reef Environmental.
- Range to Reef Environmental. (2016). *Interim Results of ENvironmental Investigations on Unallocated Crown Lands*. Perth: Unpublished Report prepared for the Department of the Environment (October 2016).
- Reddell, P., & Zimmermann, A. (2003). Terrestrial Flora of the Proposed Phosphate Mine Leases on Christmas Island and an Assessment of Feasible Rehabilitation Options following Mining. In *Draft*

*Environmental Impact Statement for the Proposed Christmas Island Phosphate Mines, Technical Appendices Vol. 1* (2005 ed.). Perth: Phosphate Resources Ltd.

Regional Development Australia. (2012). *Indian Ocean Territories Regional Plan 2012-2017*. Geraldton: Regional Development Australia Midwest Gasgoyne.

Shire of Christmas Island. (2016, February 17). Local Planning Scheme No. 2 District Zoning Scheme. *Government Gazette, WA*(No. 27 Special), pp. 480-514.

SKM. (1999). *Christmas Island Satellite Launch Facility: Draft Environmental Impact Study*. Brisbane: Sinclair Knight Merz.

## Appendix 1 Site Data

## Field Data

**Date:** 2/18/2016 **Recorders:** DF&AH **Location:** Area Acker **Site Number:** AQ01

**Coordinates:** 575949 mE, 8847793 mN (WGS84, Zone 48) **Landform:** Terrace **Aspect:** North **Slope:** 6 **Altitude:** 214 (m) **Comments:** Confirmed on DEM as regrowth.

**Geoscience Australia (2014) Vegetation Classification:** Regrowth **Height (m):** 5-10m

**Vegetation Structural and Floristic Description:** Semi-deciduous forest 10-15m dominated by *Terminalia catappa* with *Ochrosia ackeringae*, *Tristiropsis acutangula*, *Guettarda speciosa*, *Kleinhovia hospita* and *Macaranga tanarius*.

Open understory dominated by *Ochrosia ackeringae*. **Canopy Height (m):** 10-15

Strata Heights/Ranges	E (m)	T1 (m)	T2 (m)	T3 (m)	S1 (m)	G (m)
		10-15				

**Vegetation Condition:** Excellent **Last Cleared:** pre-1976 **Source of degradation:** n/a

**Threatened Flora:** 0 **Conservation Significant Fauna:** Robber crab **Comments:** 0

**Species:** 20 (natives); 3 (weeds)

Species	Cover (%)						
	E	T1	T2	T3	S1	G	Epi
<i>Terminalia catappa</i>		30			5	1	
<i>Ochrosia ackeringae</i>		10			50		
<i>Inocarpus fagifer</i>		5					
<i>Grewia speciosa</i>		5					
<i>Dysoxylum gaudichaudianum</i>		5					
<i>Pandanus elatus</i>		5					
<i>Pittosporum ferrugineum</i>		5			5		
<i>Macaranga tanarius</i>		5			5		
<i>Kleinhovia hospita</i>		5					
<i>Grewia insularis</i>			20				
<i>Ficus microcarpa</i>			5		5		
<i>Arenga listeri</i>					5		
* <i>Clausena excavata</i>					5		
<i>Maclura cochinchinensis</i> var. <i>cochinchinensis</i>					5		
<i>Celastrus paniculatus</i>					5		
<i>Pachygone ovata</i>					5		
<i>Allophylus cobbe</i>					5		
<i>Tristiropsis acutangula</i>					5	1	
<i>Melochia umbellata</i>					5		
<i>Acronychia trifoliata</i> var. <i>trifoliata</i>					5		
* <i>Leucaena leucocephala</i>					5		
<i>Asplenium nidus</i>					5		
* <i>Turnera ulmifolia</i>						11	

N/A = Not Applicable; n/a = Not Assessed.



## Field Data

**Date:** 2/19/2016 **Recorders:** DF&AH **Location:** Area Acker **Site Number:** AQ02

**Coordinates:** 576124 mE, 8847776 mN (WGS84, Zone 48) **Landform:** Terrace **Aspect:** - **Slope:** - **Altitude:** 259 (m)

**Comments:** n/a

**Geoscience Australia (2014) Vegetation Classification:** Semi-deciduous scrub **Height (m):** <5m

**Vegetation Structural and Floristic Description:** Semi-deciduous forest-low closed forest 5-10m with occasional emergents to 15m. Dominated by *Acronychia trifoliata*, *Guettarda speciosa*, *Grewia insularis*, *Ochrosia ackeringae* and *Terminalia catappa*. Dense understory of *Leucaena*. **Canopy Height (m):** 5-10

Strata Heights/Ranges	E (m)	T1 (m)	T2 (m)	T3 (m)	S1 (m)	G (m)
		5-10			1-3	

**Vegetation Condition:** Degraded **Last Cleared:** Unknown **Source of degradation:** Weeds

**Threatened Flora:** 0 **Conservation Significant Fauna:** Thrush and white-eye **Comments:** 0

**Species:** 12 (natives); 7 (weeds)

Species	Cover (%)						
	E	T1	T2	T3	S1	G	Epi
<i>Grewia speciosa</i>		20					
<i>Acronychia trifoliata</i> var. <i>trifoliata</i>		20					
<i>Terminalia catappa</i>		10					
<i>Ochrosia ackeringae</i>		5					
<i>Grewia insularis</i>		50					
* <i>Leucaena leucocephala</i>							
* <i>Clausena excavata</i>							
* <i>Ipomoea hederifolia</i>							
<i>Allophylus cobbe</i>							
<i>Maclura cochinchinensis</i> var. <i>cochinchinensis</i>							
* <i>Cordia curassavica</i>							
<i>Grewia glabra</i>							
* <i>Carica papaya</i>							
* <i>Tecoma stans</i> var. <i>stans</i>							
<i>Macaranga tanarius</i>							
<i>Hoya aldrichii</i>							
<i>Canavalia cathartica</i>							
<i>Dendrocnide peltata</i> var. <i>peltata</i>							
* <i>Turnera ulmifolia</i>							

N/A = Not Applicable; n/a = Not Assessed.

## Field Data

**Date:** 2/18/2016 **Recorders:** DF&AH **Location:** Area Acker **Site Number:** AQ03

**Coordinates:** 576148 mE, 8847805 mN (WGS84, Zone 48) **Landform:** Terrace **Aspect:** North **Slope:** 7 **Altitude:** 237 (m) **Comments:** n/a

**Geoscience Australia (2014) Vegetation Classification:** Semi-deciduous scrub **Height (m):** 5-10m

**Vegetation Structural and Floristic Description:** Low closed forest 3-8m dominated by *Leucaena leucocephala*, *Grewia insularis* and *Ochrosia ackeringae*, with *Maclura cochinchinensis*, *Allophylus cobbe* in the understory.

**Canopy Height (m):** 0-10

Strata Heights/Ranges	E (m)	T1 (m)	T2 (m)	T3 (m)	S1 (m)	G (m)
		3-8			1-3	

**Vegetation Condition:** Degraded **Last Cleared:** Unknown **Source of degradation:** n/a

**Threatened Flora:** 0 **Conservation Significant Fauna:** - **Comments:** 0

**Species:** 6 (natives); 6 (weeds)

Species	Cover (%)						
	E	T1	T2	T3	S1	G	Epi
<i>Ochrosia ackeringae</i>		20					
* <i>Leucaena leucocephala</i>		20			20		
<i>Grewia insularis</i>		40					
* <i>Clausena excavata</i>		5					
<i>Allophylus cobbe</i>					5		
<i>Celastrus paniculatus</i>					5		
<i>Canavalia cathartica</i>					1		
* <i>Cordia curassavica</i>					5		
* <i>Clausena excavata</i>					10		
<i>Carmona retusa</i>					1		
* <i>Ipomoea hederifolia</i>					5		
* <i>Turnera ulmifolia</i>						5	