



Browse LNG Precinct



Browse Liquefied Natural Gas Precinct Strategic Assessment Report

(Draft for Public Review)
December 2010

Appendix C-19

Supplementary Terrestrial Flora and
Vegetation Assessment James Price Point WA

Supplementary Terrestrial Flora and Vegetation Assessment

James Price Point, WA



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James Price Point, WA

Prepared for
Department of State Development

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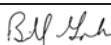
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Executive Summary

Background

The Western Australian Department of State Development (DSD) is undertaking a Strategic Environmental Assessment (SEA) for a Liquefied Natural Gas (LNG) Precinct in the vicinity of James Price Point. This Browse LNG Precinct encompasses the construction and operation of LNG facilities and associated infrastructure on the Kimberley coast for the processing of hydrocarbons from the Browse Basin gas fields.

AECOM (AECOM Australia Pty Ltd and Strategen Pty Ltd) was commissioned by DSD to undertake a supplementary dry season flora assessment in November 2009, to complement previous wet and dry season surveys. The primary aim of the survey was to refine and further map the extent of monsoon vine thickets within and beyond the precinct footprint, collect additional dry season data, undertake a targeted search for known priority species and map the extent of significant weeds. This was to ensure completeness of the data (including data collected in previous surveys), and to determine spatial locations of significant vegetation communities, priority species and weed infestations. This will allow more accurate decisions to be made in relation to impact assessment and management actions to minimise impact to the natural environment in the vicinity of the precinct footprint.

The report is supplementary in nature and does not include a consolidation of data from this and previous surveys at James Price Point.

Study Methodology and Survey Timing

The assessment was undertaken across an area approximately 15 km north and south of James Price Point and 10 km inland, with the assistance of representatives of the Kimberley Land Council. Field work commenced on 9 November and concluded on 13 November, 2009. This included aerial mapping of monsoon vine thickets, on-ground mapping of significant weeds, rescoring quadrats, and targeted and opportunistic priority flora searches.

A comprehensive aerial survey of coastal monsoon vine thickets on the Dampier Peninsula was conducted between Broome in the south and Cygnet Bay in the north.

Twenty seven species considered to be of conservation significance are known to occur, or may potentially occur, within the study area. Targeted and opportunistic searches were carried out based on potential habitat, known occurrence and localities not assessed previously. These targeted surveys identified four Priority flora species within the survey area.

Results

Patches of monsoon vine thicket, some small and isolated and others extensive and well connected, occur along much of the coastline. They exist predominantly in close association with tall beach dunes, spreading further into pindan woodland at the northern tip of the peninsula, and occasionally in association with near-coastal swamps and damplands where they may contain the Priority 3 species *Lophostemon grandiflorus* subsp. *grandiflorus*.

Opportunistic rare and priority flora surveys in localities not assessed previously located a new species of *Cleome* near Barred Creek (unlikely to be impacted by the project), two populations of the Priority 2 taxon *Pterocaulon* sp. A Kimberley Flora and the third state record of a currently unnamed truffle, *Nothocastoreum* aff. *cretaceum*. Distribution of the Priority nominated taxon *Lophostemon grandiflorus* subsp. *grandiflorus* was located in the vicinity of the study area.

On-ground weed mapping located eight significant weed species around the James Price Point Area that are likely to influence significant flora species and vegetation such as the protected (TEC) vine thickets

Conclusions

The development of the precinct footprint will impact the threatened ecological community (TEC), monsoon vine thickets, of the Dampier Peninsula and some priority flora species. It is unlikely that the direct result of clearing will seriously threaten these species or assemblages because the area of loss is relatively small in relation to the region. The main threat is likely to be the spread or introduction of weed species that typically enter the landscape with disturbance events. The introduction of threatening weed species is already evident in the local area.

Some of the precinct footprint remains un-surveyed as a result of sensitive heritage sites. As a result targeted searches for species of conservation significance have not been completed for these sites which are typically associated with drainage lines. These locations would benefit from targeted searches at the appropriate time of the year.

1.0 Introduction

1.1 Background

The Department of State Development (DSD) is undertaking a Strategic Environmental Assessment (SEA) for a Liquefied Natural Gas (LNG) Precinct in the vicinity of James Price Point. The Browse LNG Precinct (Precinct footprint) encompasses the construction and operation of LNG facilities and associated infrastructure on the Kimberley coast for the processing of hydrocarbons from the Browse Basin gas fields. The Precinct footprint, in the vicinity of James Price Point, is situated approximately 60 km north of Broome in the south west of the Kimberley region Western Australia (WA) (**Figure 1**).

AECOM (AECOM Australia Pty Ltd and Strategen Pty Ltd) was commissioned by DSD to identify the extent of further work required in relation to flora and vegetation assessment of the Precinct footprint and surrounds for the purpose of contributing to the SEA.

A review of previous wet and dry season flora and vegetation surveys of the Precinct footprint and James Price Point area was undertaken. It was identified that further studies were required in relation to flora and vegetation to fill the gaps in existing data.

Outcomes of this report will supplement previous surveys and form part of the SEA for the project.

1.2 Objectives and Scope

The objectives and scope of the late dry season flora survey were to:

- Confirm the extent of monsoon vine thickets in order to delineate the boundaries of these TEC communities within the Precinct footprint;
- undertake targeted searches for priority species known to occur in the area as identified from previous surveys or from desktop studies, to understand potential impacts of the proposed precinct on these species;
- map the extent of significant weed species within the Precinct footprint and buffer zone, to enable the preparation of suitable management protocols;
- revisit four wet season sample points established during previous surveys to obtain dry season data and to determine if any additional species occur; and
- expand the extent of the vegetation mapping to include the entire Precinct footprint.

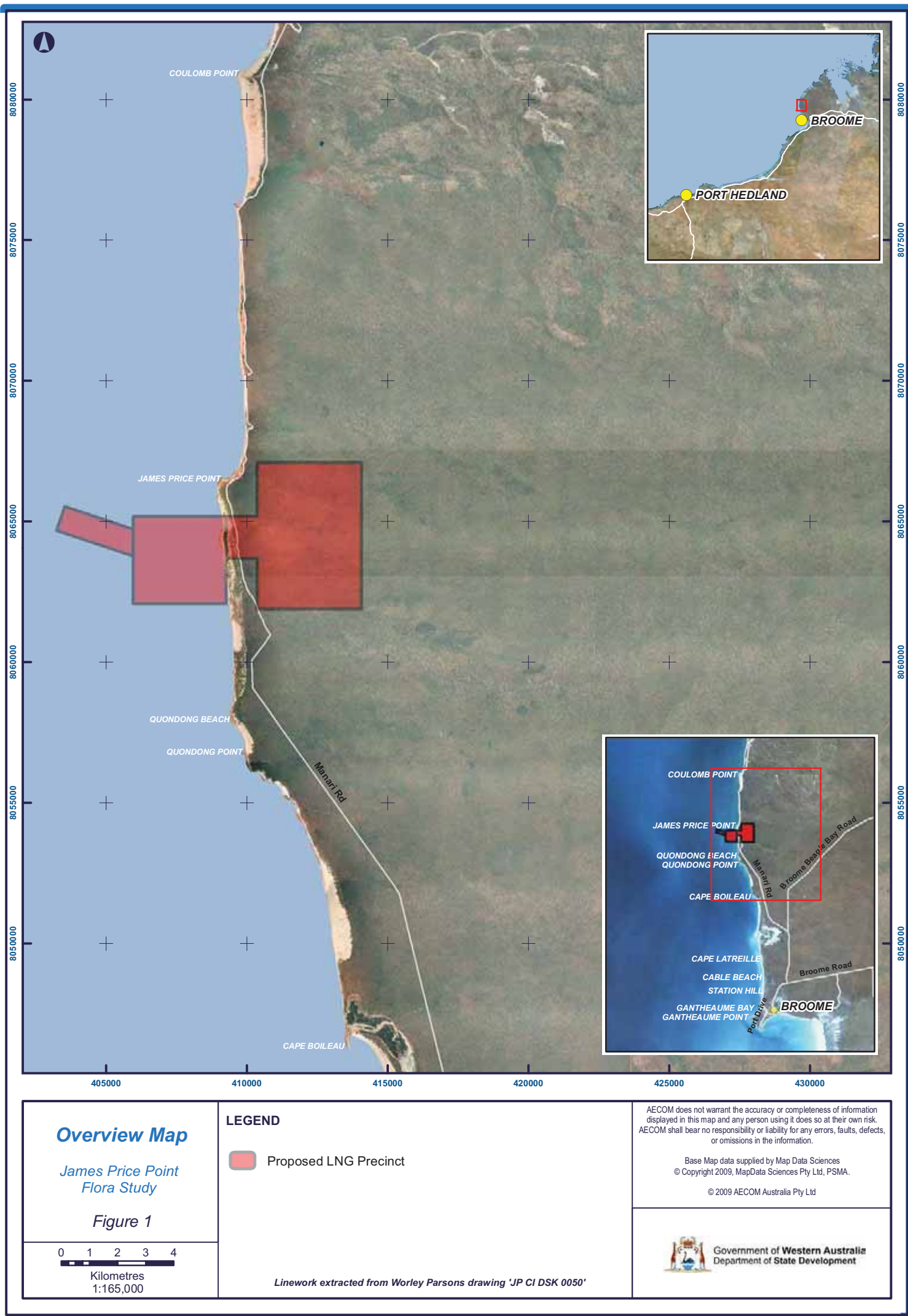
1.3 Context

Three previous flora and vegetation surveys have been undertaken within the James Price Point area. These are:

- *Perpendicular Head – North Head, Packer Island, Coulobomb-Quandong and Gourdon Bay Flora Assessment* (ENV 2008b)
- *Perpendicular Head-North Head, Packer Island, Gourdon Bay and Coulomb-Quandong Vegetation Assessment* (ENV, 2008a)
- *A Vegetation and Flora Survey of James Price Point: Wet Season 2009* (Biota, 2009).

A review of these previous surveys was undertaken, and gap analysis carried out, to evaluate the adequacy of the previous flora and vegetation assessments in terms of spatial extent, technical voracity and representation of species expected to occur in the region. Outcomes of the review were used to determine the scope of this study, as previously discussed.

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2.0 Regional Context of the Study Area

The study area is located within the Shire of Broome. It lies approximately 60km north of Broome town along the Dampier Peninsula, from Cape Boileau to Coulomb Point, taking in Quondong Point and centred at James Price Point.

The Dampier Peninsula is characterised by vast, gently undulating Pindan sandplains. The gorges, rivers and islands often associated with the Kimberley region occur north of the Dampier Peninsula, within the Kimberley Plateau.

The climate of the Dampier Peninsula is tropical, with hot and humid summers and warm dry winters. The wet season typically runs from December to March and the dry season from April to November.

2.1 Geology and Landforms

The Dampier Peninsula is located within the geological area known as the Fitzroy Trough; a major subdivision of the Canning Sedimentary Basin. The Dampier Peninsula is underlain by Jurassic marine sediments (sandstone and mudstone), with occasional outcrops of Early Cretaceous and Cainozoic rocks in some locations, including calcrete in coastal situations on Waterbank Station (McKenzie and Kenneally, 1983).

Important surfaces of the Dampier Peninsula in the vicinity of the Precinct footprint were outlined by Biota (2009) and comprise:

- coastal saline mudflats;
- Holocene coastal beach sand and sand dunes, with some lime-indurated beach-rock;
- local exposures of Broome sandstone at Quondong Point and James Price Point;
- widespread Pindan red earths of Quaternary sandplains of mixed alluvial and aeolian origin, exposed as Pindan cliffs at places along the coastline; and
- scattered seasonal fresh-water swamps, which are poorly developed (McKenzie and Kenneally 1983; DoIR 2008).

Sheet flooding is the most widespread pattern of surface water drainage as the gently sloping plains have few abrupt rises (Biota, 2009).

2.2 Bioregion and Subregions

The Interim Biogeographic Regionalisation for Australia (IBRA) recognises 85 distinct bioregions (Environment Australia 2000). The Precinct footprint is located within the Dampierland Bioregion which covers approximately 83,700 km², extending from south of Pardoo, northwards along Eighty Mile Beach to the north of Derby. This region is divided into two distinct subregions, Fitzroy Trough and Pindanland (DEC, 2009a).

The Fitzroy Trough subregion contains the middle and lower catchment of the Fitzroy River. It is dominated by alluvial plains that support woodlands with perennial bunch and annual cane grass understoreys, interrupted by riverine forests of river gum and cadjeput. Devonian limestone barrier reef structures preserved along the Trough's northern and eastern edges support scattered vine thicket trees and shrubs over hummock grass (DEC, 2009a).

The Pindanland subregion comprises gently undulating sandplain landscapes with wooded shrublands dominated by wattles and occasional low hills with hummock grasslands. The region's extensive coastal plains comprise mudflats supporting mangal, samphire and couch grasslands fringed by low paperbark forest, as well as beach strand and coastal limestone outcrops with shrub-*Spinifex* communities (DEC, 2009a).

The Precinct footprint is located within the Pindanland subregion which covers an area of approximately 51,989 km². Three basic components of the subregion were outlined by Graham (2001) and comprise:

- Quaternary sandplain overlying Jurassic and Mesozoic sandstones with Pindan. There are hummock grasslands on hills.
- Quaternary marine deposits on coastal plains, with mangal, samphire – *Sporobolus* spp. grasslands, *Melaleuca alsophila* low forests, and *Spinifex* spp. - *Crotalaria* spp. strand communities.
- Quaternary alluvial plains associated with the Permian and Mesozoic sediments of Fitzroy Trough support tree savannahs of ribbon grass (*Chrysopogon* spp.) - bluegrass (*Dichanthium* spp.) grasses with scattered coolibah (*Eucalyptus microtheca*) - *Bauhinia cunninghamii*. There are riparian forests of river red gum (*Eucalyptus camaldulensis*) and Cadjeput (*Melaleuca* spp.) fringe drainages.

2.3 Biodiversity Hotspots

Australia is one of seventeen countries described as being megadiverse. The megadiverse countries cover less than 10 percent of the global surface but support more than 70 percent of the biological diversity on earth (DEWHA, 2009).

Australia is home to between 600,000 and 700,000 species, many of which are endemic and are therefore found nowhere else in the world. Endemic species account for 84 percent of plants, 83 percent of mammals and 45 percent of bird species found in Australia. Australia's biodiversity is threatened from the impacts of many human activities, with more than 50 fauna species and 60 flora species having gone extinct since European settlement (DEWHA, 2009).

The proposed LNG Precinct footprint is located between two areas considered to be extremely biodiverse (DEWHA, 2009). This includes the North Kimberley hotspot, which is located approximately 250 km to the north of the precinct footprint, and the Hamerley-Pilbara hotspot, located 350 km to the south (**Figure 2**). In terms of recognised biodiversity hotspots the precinct area is located in a relatively low risk area and lacks many of the natural features that are unique to the North Kimberley hotspot. The North Kimberley hotspot has a variety of rare features including mound springs, swamp rainforests and the Airfield Swamp, which is a large wetland and paperbark forest (DEWHA, 2009).

2.4 Regional Broadscale Vegetation Mapping

Vegetation in the Kimberley was originally mapped at the 1:1,000,000 scale by Beard (1979). The Precinct footprint lies within the Dampier Botanical District, which broadly corresponds with the Dampierland IBRA bioregion (Environment Australia, 2000).

The vegetation is typically Pindan on sandplains, more or less densely wooded according to rainfall; tall-grass savanna with or without scattered trees on clay plains; spinifex steppe on sandstone and limestone outcrops (Beard 1979).

The area surrounding the Precinct footprint was mapped by Beard (1979) as two units:

- "Pindan woodland on monotonous sandplain comprising *Eucalyptus tectifica* and *Corymbia grandifolia* woodland over *Acacia tumida* shrubland over *Chrysopogon* and *Triodia* grasslands" (Beard's unit 750), dominating the sandy plains; and
- "bare areas of drift sand" (Beard's unit 129), mapped in narrow bands along the coast.

Given the necessarily broad scale of Beard's mapping (1:1,000,000, in order to map the entire State) these units are of only general relevance to the study area.

The vegetation of the Dampier Peninsula was also described by McKenzie and Kenneally (1983). Vegetation types described within the Land Systems and habitats occurring within the study area comprised:

- Coastal dune and beach communities of the Carpenteria Land System;
- Sub-coastal vine thickets to closed vine forests of the Carpenteria Land System; and
- Sandplain communities of the Yeeda and Wanganut Land Systems.

The most detailed vegetation mapping and vegetation descriptions specific to the James Price Point study area was completed by ENV (2008b) and refined in more detail by Biota (2009). These are discussed further in Biota's wet season flora survey report (2009).

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Figure 2



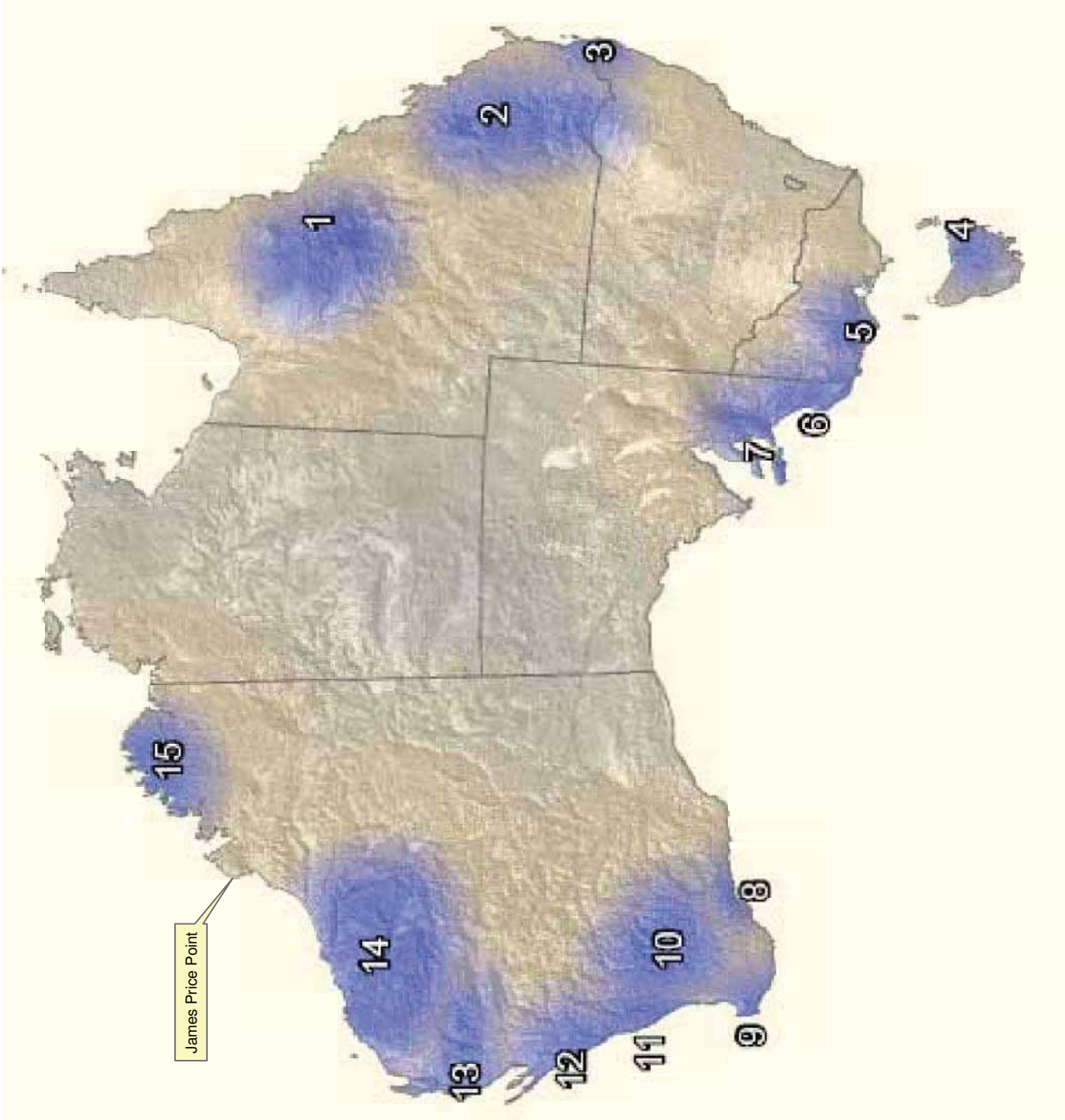
LEGEND

1. Einasleigh and Desert Uplands (Queensland)
2. Brigalow North and South (Queensland and New South Wales)
3. Border Ranges North and South (Queensland and New South Wales)
4. Midlands of Tasmania
5. Victorian Volcanic Plain
6. South Australia's South-East/ Victoria's South-West
7. Mt Lofy/Kangaroo Island (South Australia)
8. Fitzgerald River Ravensthorpe (Western Australia)
9. Busselton Augusta (Western Australia)
10. Central and Eastern Avon Wheatbelt (Western Australia)
11. Mount Lesueur-Eneabba (Western Australia)
12. Geraldton to Shark Bay sand plains (Western Australia)
13. Carnarvon Basin (Western Australia)
14. Hamersley-Pilbara (Western Australia)
15. North Kimberley (Western Australia)

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Adapted from DEWHA Australia's 15 National Biodiversity Hotspots
<http://www.environment.gov.au/biodiversity/hotspots/national-hotspots.html>

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2.5 Biological Factors of Environmental Significance

2.5.1 Declared Rare, Priority and Threatened Species

The Department of Environment and Conservation (DEC) assigns conservation status to endemic plant species that are geographically restricted to few known populations or threatened by local processes. Allocating conservation status to plant species assists in protecting populations and conserving species from potential threats (DEC, 2009b).

Declared Rare Flora (DRF) species are gazetted under subsection 2 of section 23F of the *Wildlife Conservation Act, 1950*. It is an offence to “take” or damage DRF without Ministerial approval. Section 23F of the *Wildlife Conservation Act, 1950* defines “to take” as “to gather, pick, cut, pull up, destroy, dig up, remove or injure the flora or to cause or permit the same to be done by any means.”

Species designated as Priority Flora are under consideration for declaration as ‘Rare Flora’ and are in urgent need of further survey (Priority One to Three) or require monitoring every 5-10 years (Priority Four). Table 1 presents the definitions of Declared Rare and the four Priority ratings under the *Wildlife Conservation Act, 1950* as extracted from Department of Environment and Conservation (2009b).

Table 1 Definition of Rare and Priority Flora Species

Conservation Code	Category
DRF	Declared Rare Flora – Extant Taxa “Taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection and have been gazetted as such. ”
P1	Priority One – Poorly Known Taxa “Taxa which are known from one or a few (generally <5) populations which are under threat, either due to small population size, or being on lands under immediate threat. Such taxa are under consideration for declaration as ‘rare flora’, but are in urgent need of further survey. ”
P2	Priority Two – Poorly Known Taxa “Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat (not currently endangered). Such taxa are under consideration for declaration as ‘rare flora’, but urgently need further survey. ”
P3	Priority Three – Poorly Known Taxa “Taxa which are known from several populations, and the taxa are not believed to be under immediate threat (i.e. not currently endangered), either due to the number of known populations (generally >5), or known populations being large, and either widespread or protected. Such taxa are under consideration for declaration as ‘rare flora’ but need further survey. ”
P4	Priority Four – Rare Taxa “Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5-10 years. ”

Source: Department of Environment and Conservation (2009b)

2.5.2 Local and Regional Significance of Vegetation Communities

Vegetation communities are referred to as Locally Significant where they:

- support populations of Priority Flora species;
- extend the geographic range of particular taxa from previously recorded locations;
- are restricted to only one or a few locations;
- occur as small isolated communities; or
- exhibit unusually high structural and species diversity (Dr. E. Mattiske, *pers. comm.*).

Vegetation communities are referred to as Regionally Significant where they:

- are limited to specific landform types;
- are uncommon or restricted plant community types within the regional context;
- support populations of Declared Rare Flora; (Dr. E. Mattiske, *pers. comm.*), or
- support populations of Threatened Ecological Communities (TECs) listed of state conservation significance.

Vegetation communities are referred to as Nationally Significant where they:

- support populations species of Commonwealth conservation significance, or
- support populations of TECs of Commonwealth conservation significance.

Guidance Statement 51 (EPA, 2004) states that “species, subspecies, varieties, hybrids and ecotypes may be significant for a range of reasons, other than as DRF or Priority Flora”. According to Guidance Statement 51 (EPA, 2004a), other significant flora may include taxa that:

- have a keystone role in a particular habitat for threatened species, or supporting large populations representing a significant proportion of the local regional population of a species;
- have a relic status;
- have anomalous features that indicate a potential new discovery;
- are representative of the range of a species (particularly, at the extremes of range, recently discovered range extensions, or isolated outliers of the main range);
- show the presence of restricted subspecies, varieties or naturally occurring hybrids;
- have local endemism / a restricted distribution; or
- are poorly reserved.

Guidance Statement 51 (EPA, 2004) also states that “vegetation may be significant for a range of reasons, other than a statutory listing as a Threatened Ecological Community or because the extent is below threshold level”. According to Guidance Statement 51, other significant vegetation may include communities that exhibit:

- scarcity;
- unusual species;
- novel combination of species;
- a role as a refuge;
- a role as a key habitat for threatened species or large populations representing a significant proportion of the local to regional total population of a species;
- being representative of the range of a unit (particularly, a good local and/or regional example of a unit in “prime” habitat, at the extremes of a range, recently discovered range extensions, or isolated outliers of the main range); or
- a restricted distribution.

Any species listed in State and Commonwealth legislation as being of conservation significance is said to be a significant species (EPA, 2002) and incorporates species that are endangered, vulnerable and rare or covered by international conventions. Species at risk of extinction are recognised at a Commonwealth level and are categorised according to the *Environment Protection and Biodiversity Conservation (EPBC) Act, 1999*, summarised in Table 2. Significance is not limited to species covered by State and Commonwealth Legislation and also includes species of local significance and species showing significant range extensions or at the edge of their known range.

Threats of extinction of species are also recognised at a Commonwealth level and are categorised according to the *EPBC Act, 1999*. Categories of Commonwealth listed threatened species are summarised in Table 2.

Table 2 Categories of Threatened Flora Species (*Environment Protection and Biodiversity Conservation Act, 1999*)

Conservation Code	Category
Ex	Extinct Taxa which at a particular time if, at that time, there is no reasonable doubt that the last member of the species has died.
ExW	Extinct in the Wild Taxa which is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or it has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
CE	Critically Endangered Taxa which at a particular time if, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
E	Endangered Taxa which is not critically endangered and it is facing a very high risk of extinction in the wild in the immediate or near future, as determined in accordance with the prescribed criteria.
V	Vulnerable Taxa which is not critically endangered or endangered and is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
CD	Conservation Dependent Taxa which at a particular time if, at that time, the species is the focus of a specific conservation programme, the cessation of which would result in the species becoming vulnerable, endangered or critically endangered within a period of 5 years.

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3.0 Methodology

3.1 Defining the Scope

In order to estimate the extent of further work required in relation to flora and vegetation assessments, for the purpose of contributing to the SAR, AECOM completed a review of the following previous studies undertaken within the James Price Point area:

- Perpendicular Head – North Head, Packer Island, Coulomb - Quondong and Gourdon Bay Flora Assessment (ENV, 2008a)
- Perpendicular Head – North Head, Packer Island, Gourdon Bay and Coulomb - Quondong and Vegetation Assessment (ENV, 2008b)
- A Vegetation and Flora Survey of James Price Point: Wet Season 2009 (Biota, 2009).

The field assessment was scheduled to be undertaken in the late dry season and to consist of targeted, on-ground searches and aerial transect surveys from a helicopter. Mapping of flora and vegetation from previous dry and wet season surveys would be loaded into a Panasonic Tough Book, linked to a GPS to provide real time location, thus allowing accurate ground truthing and relocation of previous survey sites. The timing of the survey is acknowledged to have not been optimal as it was very late in the dry season, but this has been driven by the short timeframe in which to complete the project.

3.2 Desktop Studies

Desktop studies have been undertaken for recent surveys and reports for this survey area. Desktop studies conducted by ENV (2008a & 2008b) and Biota (2009) were utilised for the purpose of this report. This information was used on an opportunistic basis during field investigations.

3.3 Survey Timing and Seasonal Weather Conditions

At the time of the field assessment, maximum daily temperatures averaged 35.7 ± 0.7 (mean \pm SE) and ranged from 34.1 ($^{\circ}\text{C}$) to 39.1 ($^{\circ}\text{C}$); while minimum daily temperatures averaged 26.1 ± 0.5 (mean \pm SE) and ranged from 24.2 ($^{\circ}\text{C}$) to 27.3 ($^{\circ}\text{C}$). There was 44.8 mm of rainfall recorded over the study duration (BoM: 2009a).

Late dry seasons in the Broome area are typically characterised by high temperatures and low rainfall. Compared with previous year's data, the months leading up to the 2009 late dry season survey were relatively warm and wet, with increased rainfall between June and November (52.8 mm compared to the long term average of 36.4 mm). The survey was therefore conducted under hot conditions with above average rainfall.

Most of the LNG Precinct footprint was recently burnt, with approximately 80 – 90 percent of the survey area burnt within the last six months. It is likely that all of the survey area has been burnt within the last five years.

3.4 Flora and Vegetation Assessment Team

The flora and vegetation assessment team (Table 3) consisted of lead Botanist and Kimberley region expert, Russell Barrett assisted by an AECOM (Perth) Graduate Environmental Scientist/Botanist, Alexandra Sleep. Local knowledge was provided by several Traditional Owners and members of the Kimberley Land Council (KLC), who assisted the team.

Table 3 Flora and Vegetation Assessment Team

Name	Qualifications	Involvement
Russell Barrett	Bachelor of Science Regional expert	As lead botanist, Russell Barrett was responsible for leading the flora survey and refining survey methodologies. He was involved in all aspects of the survey.
Alexandra Sleep	Bachelor of Science (Environmental Science)	Alexandra Sleep assisted Russell Barrett with all aspects of the flora survey except for bushland condition assessment.

3.5 Surveys Conducted

A number of discrete surveys and assessments were carried out, aiming to fill gaps in existing data. This range of assessments was:

- survey of vine thicket communities on the Dampier Peninsula;
- flora of conservation significance;
- condition mapping;
- weed species; and
- quadrat surveys.

3.5.1 Survey of Monsoon Vine Thicket Communities on the Dampier Peninsula

In order to accurately assess the impacts to TEC communities within the James Price Point area confirmation of the boundaries of these communities is required within the Dampier Peninsula. A survey to confirm the estimated extent of vine thickets on the Dampier peninsula and to refine regional vine thicket mapping based on spectral analysis completed by CSIRO was undertaken by helicopter on 10 November 2009. A Jetranger helicopter from Broome Helicopters was flown at a height of 500 feet along the coastline of the Dampier Peninsula (between Broome to the south and Cygnet Bay to the north). Occurrences of vine thicket were photographed, in conjunction with GPS track-recording to allow for accurate location of monsoon vine thickets for detailed mapping in conjunction with aerial photography. Assessment from the helicopter allowed different vegetation types to be accurately discriminated in order to define the boundaries between vine thicket communities, mangroves and dense pindan vegetation, all of which can appear similar on aerial photography. This information will also be used to ground truth a CSIRO study to map the vine thicket communities using spectral analysis. Data collected during the field survey allowed accurate delineation of vine thickets from otherwise undistinguishable vegetation types on aerial imagery.

Mapping of monsoon vine thicket distribution compiled by Russell Barrett for AECOM within the survey area is included in Appendix A. For mapping purposes the monsoon vine thickets occurring along the Dampier Peninsula have been separated into two categories based on density, a third category was included to show the approximate occurrence of communities dominated by *Lophostemon grandiflorus* ssp. *grandiflorus* as these communities are considered as significant as *L. grandiflorus* ssp. *grandiflorus* has been nominated as a Priority 3 species. Typically *L. grandiflorus* ssp. *grandiflorus* occurs in vine thickets occurring in damp areas such as drainage basins. The categories of the mapping are:

- Dense monsoon vine thicket;
- sparse monsoon vine thicket; and
- community dominated by *Lophostemon grandiflorus* ssp. *grandiflorus*. The occurrence of this species was able to be deduced using both aerial imagery and fly over by helicopter based on foliage.

The areas that were ground truthed are marked in Appendix B.

3.5.2 Flora of Conservation Significance

Desktop assessments have determined that 27 flora species of conservation significance are relevant to the survey area. These species are:

- *Pandanus spiralis* var. *flammeus*
- *Keraudrenia exastia*
- *Aphyllodium parvifolium*
- *Corymbia paractia*
- *Glycine pindanica*
- *Gomphrena pusilla*
- *Pterocaulon* sp. A Kimberley Flora (B.J. Carter 599)
- *Aphyllodium glossocarpum*
- *Eriachne semiciliata*
- *Polymeria distigma*
- *Schoenus punctatus*
- *Stylidium costulatum*
- *Pittosporum moluccanum*
- *Byblis guehoi*
- *Cyperus haspan* ssp. *haspan*
- *Jacquemontia* sp. *Broome* (A.A. Mitchell 3028)
- *Thespidium basiflorum*
- *Isolepis humillima*
- *Acacia* sp. *Broome* (B.R. Maslin 4918)
- *Acacia* sp. *Riddell Beach* (T. Willing 71)
- *Bonamia oblongifolia*
- *Croton aridus*
- *Dendrophthoe odontocalyx*
- *Lophostemon grandiflorus* ssp. *grandiflorus*
- *Utricularia stellaris*
- *Parsonsia kimberleyensis*
- *Spermacoce* spp.

The desktop assessment included characterisation of the key habitats that support these species. The identified key habitats were assessed for the relevant species from either a helicopter or on the ground; either driving or by traversing the area on foot. When specimens were observed either as individuals or populations, locations were recorded. Opportunistic observations were made for species identified from desk top studies while focusing on those species previously identified as occurring in the area that would be identifiable at the time of the survey. Annual species were not searched for given the survey was undertaken late in the dry season.

Distribution of the Priority nominated taxon *Lophostemon grandiflorus* ssp. *grandiflorus* was assessed by driving along Manari Road and along an inland track on the eastern extent of the precinct footprint. The extent of *Lophostemon grandiflorus* ssp. *grandiflorus* populations were delineated using aerial imagery loaded onto a Panasonic Toughbook.

Targeted surveys for *Pittosporum moluccanum* were carried out by relocating previously reported populations using GPS. Searches were then made on foot in suitable habitat for additional plants for several hundred metres to the North and South of the known plants. These targeted survey areas are labelled on the map series presented in Appendix B.

The single population of the Priority Two taxon, *Gomphrena pusilla* located during the Biota survey was revisited, and a search was carried out as per the method described above. An additional area of suitable habitat, selected

by the lead botanist, was also searched in detail. These targeted search areas are labelled on the map series presented in Appendix B.

Opportunistic DRF and Priority flora surveys were carried out on foot in selected localities not assessed by previous surveys. These targeted searches were focused on but not limited to the precinct footprint. Locations of any DRF or Priority flora were recorded using GPS and specimens were collected for voucher lodgement with the Western Australian Herbarium.

3.5.3 Vegetation Condition Mapping

Bushland condition mapping was undertaken for the precinct footprint by helicopter using mobile GIS. The results of this condition mapping are included in the Supplementary Fauna Assessment Report (AECOM 2009). This technique is a broad scale landscape approach to bushland condition assessment and as such may not always take into account isolated weed populations

3.5.4 Weed Species

A targeted survey was undertaken for significant weed species in the location of the precinct footprint. Particular attention was given to those that occur in the area of the monsoon vine thickets community, given their significance as a TEC.

Weed mapping was carried out by traversing the survey area by vehicle along Manari Road and smaller roads into the coast at James Price Point, Quandong Point and Barred Creek. The extent of major weed populations was delineated using aerial imagery loaded onto a Panasonic Toughbook.

3.5.5 Quadrat Surveys

Quadrats, established during the previous wet season flora survey (Biota, 2009), have corresponding dry season data with the exception of four locations, representing two vegetation types. For completeness, that is to ensure the project has a robust set of survey data from two seasons, it was determined that these locations should be revisited during dry season conditions.

Quadrats surveyed during the 2009 Biota survey were revisited for dry season assessment. The north west corner peg of these quadrats was located using GPS. From the north west corner 50 metres was measured in south and east directions to locate two additional pegs, the final peg was then able to be located.

A photograph was taken from each north west corner peg and the height and percentage cover of each species within the 50 x 50m quadrat was recorded.

Only two (JP37 and JP40) of the four quadrats were rescored due to a combination of factors including time constraints due to vehicle breakdown and the area containing the four quadrats was recently burnt making identification of remaining plants difficult thus providing little new information.

3.6 Study Limitations

Searches for DRF and Priority flora were either targeted or opportunistic in selected habitats. It was not possible to survey the entire survey area due to time constraints and inaccessible terrain.

Searches were not carried out for several Priority species (annuals) identified during the Biota survey, due to the late dry season timing of the survey. In addition to this, a large percentage of the survey area has been recently burnt.

Observations of weeds were limited due to the season of survey. In the late dry season conditions, many of the species recorded by Biota have now either senesced, or have been burnt. The distribution of *Cenchrus ciliaris* was only partially mapped, and it is expected that this species is much more widespread when conditions are favourable, because it occurs in most disturbed coastal areas in the region.

Due to time restrictions and vehicle failure, only two quadrats were re-scored (JP37 and JP40). The majority of areas supporting previously established quadrats has since been burnt. Of the two quadrats that were re-scored, one had been burnt completely and the other had been partially burnt.

Access to some sites was not possible due to heritage significance and remain as gaps in the data.

4.0 Results

4.1 Desktop Studies

4.1.1 Flora of Conservation Significance

Table 4 lists flora of conservation significance that are either known to occur within the survey area or could potentially occur within the area. This information was compiled from Biota (2009) and includes information from DEC and Matters of National Environmental Significance (NES), under the EPBC Act, 1999 database searches carried out by Biota (2009), and from information received from Russell Barrett. The locations of significant flora identified by Biota (2009) are included in Appendix B. Species nominated for listing as Priority were provided by local expert Russell Barrett and are likely to be listed as priority by the DEC following formal review and as such impacts to these species should be minimised. It should be noted that Priority flora species are not protected by the *Wildlife Conservation Act* (1950). However, impacts to these species need to be assessed by the DEC.

Table 4 Significant Flora Identified by Desktop Study

Species	Conservation Significance	Habitat	Flowering Period	Occurrence or Potential Occurrence within the Precinct Footprint	Conclusive Occurrence
<i>Pandanus spiralis</i> var. <i>flammeus</i>	Declared Rare Flora (WA) Endangered (EPBC)	<ul style="list-style-type: none"> White clay Rockfaces Springs 		Unlikely to occur within the precinct footprint due to the absence of preferred habitat and substrate.	Unlikely
<i>Keraudrenia exastia</i>	Declared Rare Flora (WA)	<ul style="list-style-type: none"> Red sand in pindan Coastal sites relict desert dune swale. 	Apr–Dec	The nearest known population is 33 km south of the precinct footprint. Precinct footprint provides suitable habitat.	Possible
<i>Aphyllodium parvifolium</i>	Priority 1	<ul style="list-style-type: none"> Sand Sandhills 	Apr/Jul	Considered rare within the area, but could possibly occur within drainage lines in the precinct footprint.	Possible
<i>Corymbia paractia</i>	Priority 1	<ul style="list-style-type: none"> Skeletal soils. Transition zone between coastal beach dunes Red pindan soils 	Apr–May/Oct–Dec	The nearest known population is 6 km south of the precinct footprint. Although not detected it is possible this species may occur in the precinct footprint.	Possible
<i>Glycine pindanica</i>	Priority 1	<ul style="list-style-type: none"> Pindan soils 	Feb–Mar/Jun	The nearest known population is 6.4 km east of the precinct footprint. Precinct footprint provides suitable habitat.	Possible
<i>Gomphrena pusilla</i>	Priority 2	<ul style="list-style-type: none"> Fine beach sand Behind foredune, on limestone 	Mar–Jun	Known to occur within the survey area. Recorded by Biota (2009).	Occurs

Species	Conservation Significance	Habitat	Flowering Period	Occurrence or Potential Occurrence within the Precinct Footprint	Conclusive Occurrence
<i>Pterocaulon</i> sp. A Kimberley Flora (B.J. Carter 599)	Priority 2	<ul style="list-style-type: none"> Sand Coastal areas Saline sandy flats Pindan sandplain 	Apr–Aug	Present to the north and south of the Precinct footprint. Although not detected it is possible this species may occur in the precinct footprint.	Possible
<i>Aphyllodium glossocarpum</i>	Priority 3	<ul style="list-style-type: none"> Sand Pindan 	Apr–Oct	Nearest known populations are 11 km east of the northern end and 14 km south of the Precinct footprint. Precinct footprint provides suitable habitat.	Possible
<i>Eriachne semiciliata</i>	Priority 3	<ul style="list-style-type: none"> Shallow soils over rock Red sand Sandy clay Ridges Sand dunes 	Mar–Apr	Known to occur within the survey area. Recorded by Biota (2009).	Occurs
<i>Polymeria distigma</i>	Priority 3	<ul style="list-style-type: none"> Sandy soils 	Apr–Jul	Known to occur within the precinct footprint. Recorded by Biota (2009a).	Occurs
<i>Schoenus punctatus</i>	Priority 3	<ul style="list-style-type: none"> Watercourses 	Aug	Nearest known population is 13.3 km east of the northern end of the precinct footprint. Although not detected it is possible this species may occur in the precinct footprint.	Possible
<i>Stylidium costulatum</i>	Priority 3	<ul style="list-style-type: none"> Sandy or clayey soils Creeks Seasonally wet areas 	Apr–Aug	Nearest known population is 9.3 km north of the precinct footprint. Although not detected it is possible this species may occur in the precinct footprint.	Possible
<i>Pittosporum moluccanum</i>	Priority 4	<ul style="list-style-type: none"> White sand Sand dunes 	Feb–Aug	Five records occur within the Precinct footprint. Two individual trees were recorded by Biota (2009a).	Occurs

Species	Conservation Significance	Habitat	Flowering Period	Occurrence or Potential Occurrence within the Precinct Footprint	Conclusive Occurrence
<i>Byblis guehoi</i>	Nominated as Priority 1			Only known from the vicinity of Bobbys Creek near Beagle Bay. May occur in drainage lines elsewhere on the Peninsula. Although not detected it is possible this species may occur in the precinct footprint.	Possible
<i>Cyperus haspan</i> ssp. <i>haspan</i>	Nominated as Priority 1	<ul style="list-style-type: none"> • Peat • On banks at edge of spring 		Only known from a single location near Beagle Bay.	Unlikely
<i>Jacquemontia</i> sp. Broome (A.A. Mitchell 3028)	Nominated as Priority 1			Restricted to Pindan sands between Broome and Beagle Bay. Whilst not recorded to date, this taxon is likely to occur within the study area.	Likely
<i>Thespidium basiflorum</i>	Nominated as Priority 1	<ul style="list-style-type: none"> • Sandy soils. • Creeks 	May–Aug	Only known from two populations in WA, both on the Dampier Peninsula, near Bobbys Creek and Coconut Well. May occur in drainage lines elsewhere on the Peninsula.	Possible
<i>Isolepis humillima</i>	Nominated as Priority 2	<ul style="list-style-type: none"> • Red/brown clay • Claypans • Seepages • Along watercourses 	Apr–Aug	Occurs in damplands on sand in the SW Kimberley and may occur in the survey area.	Possible
<i>Acacia</i> sp. Broome (B.R. Maslin 4918)	Nominated as Priority 3	<ul style="list-style-type: none"> • Rocky clay • Red sand • Coastal cliffs • Low-lying areas 	Apr–Jun	Known from 9 populations between Broome and Camballin. Although not detected it is possible this species may occur in the precinct footprint.	Possible
<i>Acacia</i> sp. Riddell Beach (T. Willing 71)	Nominated as Priority 3	<ul style="list-style-type: none"> • Exposed cliff top • Footscree below steep gorge • Road verges 	Jun	Restricted to the Dampier Peninsula, locally restricted in coastal areas.	Unlikely
<i>Bonamia oblongifolia</i>	Nominated as Priority 3	<ul style="list-style-type: none"> • Sandy or gravelly soils 	Feb	Known from three populations on the Dampier Peninsula.	Unlikely

Species	Conservation Significance	Habitat	Flowering Period	Occurrence or Potential Occurrence within the Precinct Footprint	Conclusive Occurrence
<i>Croton aridus</i>	Nominated as Priority 3	<ul style="list-style-type: none"> Deep red sandPindan soil Sandplains or ridges Spinifex sandplains 	Aug	Known from four populations in WA, one on the Dampier Peninsula.	Likely
<i>Dendrophthoe odontocalyx</i>	Nominated as Priority 3	<ul style="list-style-type: none"> Aerial shrub-hemiparasitic on stems of <i>Melaleuca</i> spp 	Jun–Aug	Only known from three populations in WA. One record from Lolly Spring on the Dampier Peninsula. Limited habitat.	Unlikely
<i>Lophostemon grandiflorus</i> ssp. <i>grandiflorus</i>	Nominated as Priority 3	<ul style="list-style-type: none"> Damp habitats Swamps and seepages 	Jan–Dec	Known to occur within the Precinct footprint, recorded by Biota (2009a).	Occurs
<i>Utricularia stellaris</i>	Nominated as a Priority 3	<ul style="list-style-type: none"> Swamps Lagoons 	Jun–Jul	One record from Lolly Spring on the Dampier Peninsula. A swamp-dwelling species which is unlikely to occur within the survey area.	Unlikely
<i>Parsonsia kimberleyensis</i>	To be nominated for listing as Declared Rare Flora	<ul style="list-style-type: none"> Monsoon vine thickets 	May–Jun	<i>Parsonsia kimberleyensis</i> was previously incorrectly recorded from the survey area based on sterile juvenile material which was later identified as <i>Tylophora cinerascens</i> . <i>P. kimberleyensis</i> remains known from a single locality on the northern Dampier Peninsula.	Unlikely
<i>Spermacoce</i> spp.	The taxonomic (and conservation) status of two <i>Spermacoce</i> spp. collected during the Biota wet season survey requires further clarification			Recorded by Biota (2009).	Occurs

4.1.2 Threatened and Priority Ecological Communities

The following TECs and PECs for the Dampierland bioregion identified by Biota (2009) are listed below:

TECs listed by the DEC for the Dampierland bioregion include:

- monsoon (vine) thickets on coastal sand dunes of the Dampier Peninsula;
- a species-rich faunal community of the intertidal mudflats of Roebuck Bay; and
- assemblages of various organic mound springs (DEC 2006).

These TECs are considered likely to be at risk from fragmentation, grazing pressure, changed fire regime, pollution and other human impacts, and weed invasion (May and McKenzie 2003).

A number of PECs have been identified by DEC for the Kimberley region (DEC 2008). However, only two occur in habitats supported by the landforms of the precinct footprint. These are:

- dwarf Pindan heath community of Broome coast (Priority 1); occurs between the racecourse and Gantheaume Point lighthouse; insufficient survey outside of Broome townsite area to determine full extent; and
- *Corymbia paractia* dominated community on dunes (Priority 1); *C. paractia* behind dunes in the Broome township area, Dampier Peninsula; transition zone where coastal dunes (with monsoon vine thickets) merge with Pindan (desert) vegetation; also in the port area north of Broome.

4.1.3 Other Ecosystems at Risk

There are a number of other ecosystems in the Pindanland subregion that are considered by the DEC to be “at risk”, particularly by changed fire regimes. These include:

- assemblages of permanent/ephemeral wetlands, damplands, and riparian habitat of the Dampierland bioregion;
- the Nimalaica clay pan community, inland from Willie Creek; and
- vine thickets on heavily ferruginised Emeriau sandstone at the northern end of the Dampier Peninsula (Graham, 2001).

Previous studies have indicated that the monsoon vine thickets should be the focus of this study as other communities discussed above are unlikely to occur in the precinct area.

4.1.4 Vegetation Communities Identified by Biota

Twelve vegetation types were identified by Biota (2009) for the survey area, and are described in Table 5 below (see also **Figure 3**). Some are considered to be of particular conservation significance (Biota 2009).

Table 5 Vegetation Communities and Conservation Significance

Type	Description	Conservation Significance
Eroded Coastal Pindan	bare (unvegetated) areas on eroded coastal plains	nil
Coastal Heath	low wind-pruned coastal heaths dominated by <i>Acacia tumida</i> var. <i>kulparn</i> on exposed coastal cliffs	identified as a Priority 1 Ecological Community and has moderate conservation value
Coastal Communities	coastal communities of Beach Spinifex (<i>Spinifex longifolius</i>), sedges and mixed shrubs on dunes and in blow-out areas	coastal communities: small area of representation within the survey area; is susceptible to erosion and weed invasion; and has moderate conservation value

Type	Description	Conservation Significance
Buffel Grassland	Buffel Grass (* <i>Cenchrus ciliaris</i>) tussock grassland on areas of sandy plain between coastal sand dunes and the inland pindan plain	nil
Monsoon Vine Thickets	monsoon vine thickets (evergreen and deciduous) occurring in patches in sheltered areas along the coastal dune system	Identified as a Threatened Ecological Community (TEC) by the WA Department of Environment and Conservation (DEC). This community is well developed in the survey area; supporting flora restricted to this habitat type. It is at risk from fragmentation, weed invasion and changed fire regimes; and has high conservation value
Tall Closed Scrub	mixed wattles, principally <i>Acacia monticola</i> and <i>A. colei</i> , mainly near James Price Point	nil
Pindan Shrubland	scattered Eucalypts (mainly <i>Corymbia dampieri</i> , <i>C. zygophylla</i> , <i>C. flavescens</i> , <i>Eucalyptus tectifera</i> and <i>E. miniata</i>) over a variably dense shrub cover of wattle species (particularly <i>Acacia eriopoda</i> , <i>A. monticola</i> and <i>A. tumida</i>) over Soft Spinifex (<i>Triodia schinzii</i>) and various tussock grasses on the inland plain	nil
open woodland of	<i>Eucalyptus miniata</i> , <i>Corymbia polycarpa</i> (only along Kundandu Creek) with <i>Eucalyptus jensenii</i> occurring between Quondong Point and James Price Point within 5 km of the coast	nil
Open Forest	dominated by <i>Eucalyptus miniata</i> over mixed wattles (particularly <i>Acacia tumida</i> and <i>A. platycarpa</i>) over mixed tussock grasses	nil
Drainage Basins	woodlands dominated by Lardik (<i>Lophostemon grandiflorus</i>) in drainage basins	supports flora restricted to this habitat type; is at risk from fragmentation, weed invasion and changed fire regimes; and has high conservation value
Sandstone Outcrops,	typically not large enough to support a distinct vegetation community	nil

4.1.5 Weed Species

Previous surveys by Biota (2009) and ENV (2008a and 2008b) have recorded 12 weed species with one species, *Sida acuta*, listed as a Declared Plant under the *Agriculture and Related Resource Protection Act, 1976*. Of these, nine are considered to have the potential to threaten the integrity of the vegetation assemblages of the precinct footprint, particularly the monsoon vine thickets.

4.2 Field Assessments

4.2.1 Monsoon Vine Thicket Distribution

The distribution of vine thicket communities was found to correlate very well with mapping from aerial photography at a scale of 1:10,000 prepared for a portion of the Peninsula as part of the desktop assessment. This mapping was prepared by tracing the outline of vegetation types considered recognisable as vine thicket communities by R. Barrett on the available aerial photographs. These communities were separated into two classes based on density, but no further discrimination was made. (Appendix A). This mapping was compiled independent of other vegetation mapping. Monsoon vine thicket communities were ground-truthed from south of the survey area and continued North beyond the survey area to Cygnet Bay. Results of ground truthing indicated that the distribution of the vine thicket communities as determined from Spectral analysis (a separate CSIRO study) was generally conservative and underestimated the extent by approximately 5 to 10%. This was generally related to small isolated areas of vine thicket that were not detected by the CSIRO spectral analysis.

Numerous small pockets of vine thicket not immediately apparent on prior Landsat-based mapping of monsoon vine thickets on the Peninsula provide a degree of connectivity between the survey area and monsoon vine thickets further north on the Dampier Peninsula. A few very small patches of vine thicket are evident south of the survey area towards Broome.

Monsoon vine thickets mapped variously as deciduous or evergreen were largely found to be a mixture of the two, and rarely uniform. The one exception being thickets in damplands dominated by the deciduous tree *Lophostemon grandiflorus* subsp. *grandiflorus*. Other areas mapped as deciduous vine thicket in the Biota (2009) report often had a scattered overstorey of the large deciduous tree species *Corymbia bella*, with many of the smaller trees being evergreen.

The location of monsoon vine thickets on the Peninsula often coincides with culturally sensitive areas. This prevented any entry for the purpose of assessing species composition at different sites, however low altitude observation allowed the identification of a number of the conspicuous dominant species which were common elements in almost all vine thicket communities observed. One particular exception is the swamp-based vine thicket at Bunda-Bunda Spring which is composed of a completely different suite of vine thicket species and thus is a different vegetation community to others in the survey area. The vine thicket at Bunda-Bunda Springs was observed as part of distribution mapping along the entire Dampier Peninsula coast and is not within the precinct survey area.

4.3 Flora of Conservation Significance

Significant flora located during the 2009 AECOM survey is listed in **Table 6** and their location is included in the map series presented in Appendix B.

Table 6 Significant Flora Identified by AECOM

Species	Conservation Significance	Results of Field Assessment
<i>Pterocaulon</i> sp. A Kimberley Flora	Priority 2	Two populations located to the south of the precinct footprint.
<i>Pittosporum moluccanum</i>	Priority 4	The locations of two previously surveyed individuals were confirmed.
<i>Lophostemon grandiflorus</i> ssp. <i>Grandiflorus</i>	Nominated as Priority 3	One population mapped within the precinct footprint and additional occurrences to the north of the Precinct footprint.
<i>Cleome</i> sp. Dampier Peninsula (R.L.Barrett & A.Sleep RLB 5962).*,**	New species, may be nominated as Priority 3	This new species was found to the south of the precinct footprint at Barred Creek.
<i>Merremia davenportii</i> **	Currently unlisted in WA however may be considered.	A population was recorded along a coastal strip to the north of the Precinct footprint.
<i>Nothocastoreum</i> sp. nov. aff. <i>cretaceum</i> (Lloyd) G.W. Beaton**	Poorly known taxon, third record of this genus in Western Australia	Specimen collected from Open Forest community in the north east corner of the precinct footprint.
<i>Pandanus spiralis</i> var. <i>Convexus</i> *,**	Southern most population	This population was located to the south of the precinct footprint at Barred Creek.

*Regional species of interest only and unlikely to be impacted by the project.

**Species of interest but currently not formally listed or nominated with the DEC

4.3.1 Targeted Survey for *Pittosporum moluccanum* elsewhere on the Dampier Peninsula

Pittosporum moluccanum is a significant species recorded within the survey area in the Biota (2009) survey. While only listed as Priority 4 in WA, the closest known populations are on the Maret Islands and Berthier Island, in the northern Bonaparte Archipelago, some 700 km north of the survey area. Therefore the populations within the survey area are likely to be significant as they represent significant range extensions for this species

Relocation of previously recorded individuals was made at three locations. Only two plants were found and it has been concluded that two of the GPS points available refer to the same individual. Searches were made in suitable habitat for additional plants for approximately 300 metres north and south of the known plants without locating any additional individuals. The locations of these targeted search areas are shown in Appendix B.

4.4 Weed Records

Weed species located during the AECOM (2009) dry season survey are listed in **Table 7**, their location and extent was mapped and is included in Appendix C.

Table 7 Significant Weed Species Identified and Mapped by AECOM

Species	Description	Habitat	Key Points
<i>*Aerva javanica</i>	Erect, much-branched perennial, herb, 0.4–1.6 m high. Fl. white, Jan–Oct.	<ul style="list-style-type: none"> Often on sandy soils. Along drainage lines Calcareous soils 	
<i>*¹Cenchrus ciliaris</i>	Grass, 0.2–1.5 m high. Fl. purple, Feb–Oct.	<p>Along ephemeral water courses/drainage lines</p> <p>Alluvial plains</p> <p>Calcareous rises/coastal areas</p> <p>Drainage lines and tracks provide opportunities for dispersal and also favourable sites for establishment</p>	<p>Grows rapidly under warm, moist conditions and persists under heavy grazing and drought (CRC Weed Management, 2008), also known as Buffel Grass.</p> <p>Its rapid regrowth and high biomass may alter the intensity, frequency and extent of fires, changing vegetation structure and composition (CRC weed management, 2008)</p> <p>Encouraged by fire, known to encroach into vine thicket communities, their increased fuel load and flammability impacts the vine thicket incrementally and sustains further weed spread (McGilvray, 2008).</p>
<i>*Leucaena leucocephala</i>	Small tree or shrub, 2–4 m high,. Fl. white, Jan–Nov.	<p>Sand, clay & loam soils, red gravel. Mangrove edges, woodland near creeks, roadsides</p> <p>A common weed of wetlands and riverine sites in the Kimberley (Hussey et al, 2007)</p>	<p>A serious environmental weed that forms dense thickets excluding other plants (Weeds Australia)</p> <p>Problematic weed species in vine thicket communities (McGilvray, 2008).</p> <p>Plants contains mimosine and are toxic to stock if eaten in large quantities (Weeds Australia)</p>
<i>*Macroptilium atropurpureum</i>	Trailing or twining, perennial, herb or climber, to 5 m high, to 5 m wide. Fl. red, purple, Mar–Nov.	Sand, clay, alluvium. Creek lines, dunes, edges of seasonal wetlands & mangroves, road verges, disturbed areas	Smothers native vine thicket tree and vine species (McGilvray, 2008)

¹ * denotes introduced species

Species	Description	Habitat	Key Points
* ² <i>Passiflora foetida</i> var. <i>hispida</i>	Woody climber (vine with an unpleasant smell), to 9 m high. Fl. cream, white, blue, Feb–Nov.	Coastal areas, river and creek banks Often found on roadsides, edges of rainforests, alongside watercourses and on sand dunes in tropical and subtropical Australia. (Weeds Australia)	Smothers native vine thicket tree and vine species (McGilvray, 2008)
* <i>Sida acuta</i>	Slender, erect perennial, herb or shrub, to 1 m high. Fl. yellow, Mar–Sep.	A common weed of road verges, camp grounds, and other areas where soils have been disturbed and or degraded. Found on most soil types except some of those derived from limestone and seasonally flooded clays. (Northern Territory Government, 2007)	Spread by seed in awned mericarps that catch on wool, fur and cloth, or seed spread in hay, or mud attached to animals and vehicles. (Weeds Australia) Listed by Department of Agriculture and Food Western Australia (DAFWA) as a Priority 1 Declared Weed
* <i>Stylosanthes hamata</i>	Erect or decumbent herb or shrub, to 0.7 m high. Fl. yellow, Apr–Dec.	Sand, loam & clay soils. Seepage areas, creek banks, pool edges, lawns, disturbed vegetation.	Not considered to be shade tolerant (Stur, 1991) therefore unlikely to be a specific threat to vine thicket ecosystems.
* <i>Tamarindus indica</i>	Tree, to 10m high. Fl. yellow, Dec–Jun.		Cultivated & occasionally naturalised

Observations of weeds were limited due to the season of survey, many of the species recorded by Biota 2009 either having senesced, or having been burnt. The key findings were:

- **Cenchrus ciliaris* was partially mapped but is considered likely to be present in disturbed areas;
- **Aerva javanica* was only apparent in a few locations and further surveys are required in the late wet, or early dry season;
- Populations of **Leucaena leucocephala* were mapped at James Price Point, and recorded from the Sarubin Block. The seeds of this species may be occasionally eaten by birds and may spread by this means. **Leucaena* is a highly persistent and troublesome weed and eradication is highly recommended;
- Several populations of **Macroptilium atropurpureum* were mapped however it is likely that some additional populations were senesced at the time of the survey;
- Several populations of **Passiflora foetida* var. *hispida* were mapped however it is likely that many additional populations were senesced at the time of the survey;
- **Merremia aegyptia* and **M. dissecta* were both senesced at the time of the survey and not mapped; and
- One plant of **Tamarindus indica* (Tamarind) on the North side of Barred creek at: 17°39'35.5"S, 122°12'01.6"E was recorded.

It is noted that a large number of ornamental species are present on an abandoned tenement north of Quondong Point, some of which have the potential to become weeds if allowed to spread. Some of the species persisting are not currently known as weeds in the region, but are persisting, and sometimes spreading from original plantings. These populations may invade adjacent monsoon vine thickets if not controlled.

² * Denotes introduced species

4.5 Revisited Quadrats

Due to time restrictions and vehicle failure, only two quadrats, (JP37 and JP40) were re-scored. Most quadrats had been burnt since the wet season survey and very minimal regrowth had occurred. The data from these rescored quadrats is included as Appendix D.

There were some variations between the data collected by Biota (2009) and that collected during this survey. Many species recorded by Biota (2009) were not recorded this time due to seasonal timing and very recent burn. Quadrat JP40 was completely burnt and JP37 was partially burnt. Some new species were recorded by AECOM, however, none were of conservation significance.

4.5.1 Quadrat JP37

The vegetation of this quadrat was described as a *Eucalyptus miniata*, *Corymbia bella* and *Corymbia zygophylla* low open woodland by Biota (2009). *Corymbia bella* was not recorded by AECOM, however one additional *Corymbia* species; *Corymbia polycarpa*, was recorded.

Additionally, Biota (2009) recorded *Gardenia pyriformis*, while in this survey *Gardenia resinosa* ssp. *keartlandii* was recorded. Two other additional species were recorded by AECOM; *Gyrostemon tepperi* and *Yakirra australiensis*.

4.5.2 Quadrat JP40

The vegetation of this quadrat was described as *Corymbia bella* scattered low trees over *Acacia eriopoda* (*A. monticola*, *A. colei* var *colei*) tall open scrub over *Aristida holathera* var. *holathera* scattered tussock grasses by Biota (2009). *Corymbia bella* was not recorded by AECOM, however *Corymbia polycarpa* and *Corymbia greeniana* were recorded.

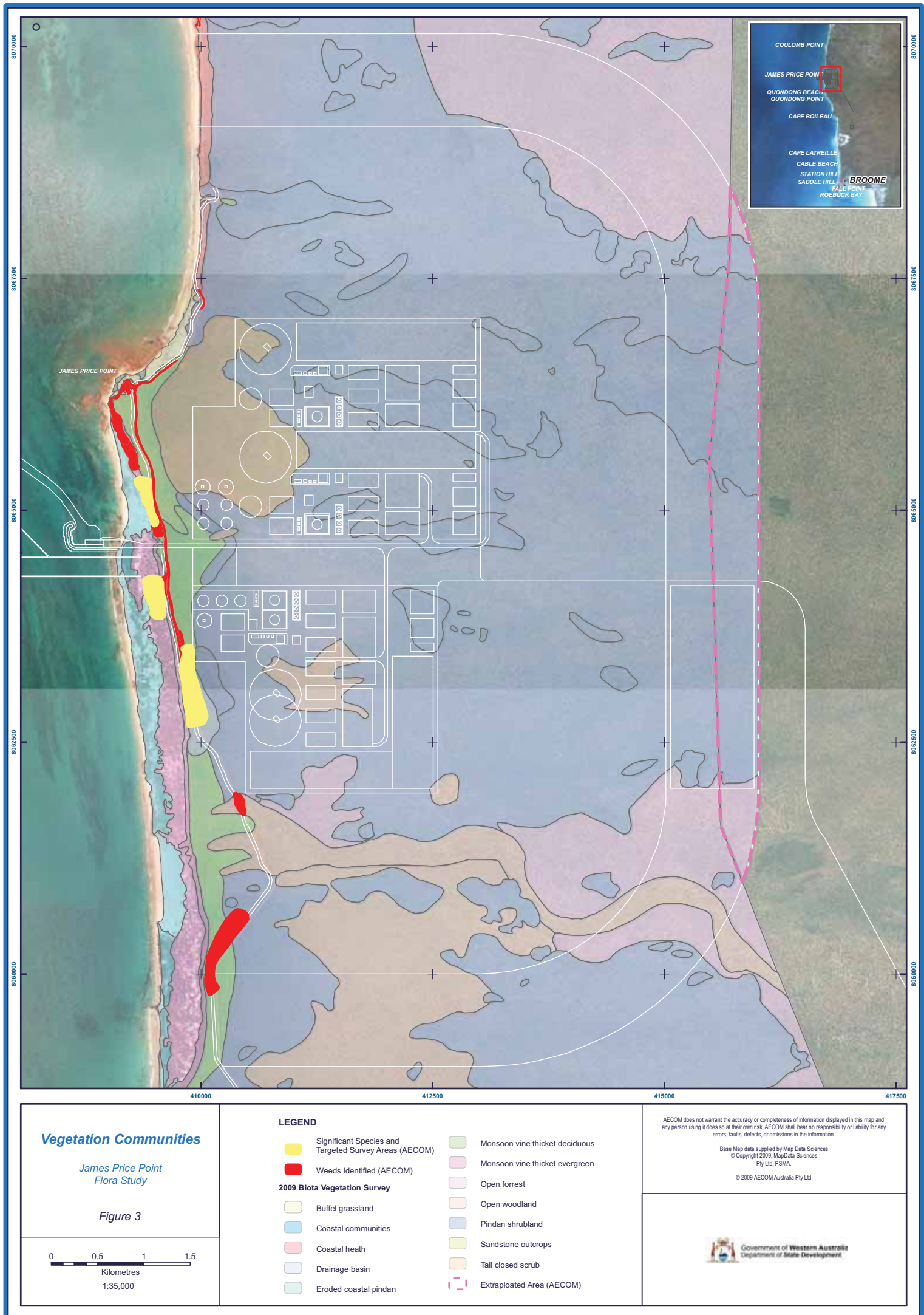
The following additional species were recorded by AECOM; *Acacia hippuroides*, *Erythrophleum chlorostachys*, *Grevillea pyramidalis*, *Ventilago viminalis*, *Waltheria indica*, *Corymbia polycarpa*, *Pavetta* sp., and *Gyrostemon tepperi*.

4.6 Vegetation Community Mapping

No new vegetation communities were located during the survey. However, based on field observations and extrapolation from aerial imagery, the extent of the following two communities has been mapped to the east of previously surveyed areas. The majority of the vegetation mapping is based on work completed by Biota.

- Pindan Shrubland comprising scattered Eucalypts (mainly *Corymbia greeniana*, *C. zygophylla*, *C. flavescens*, *Eucalyptus tectifica* and *E. miniata*) over a variably dense shrub cover of wattle species (particularly *Acacia eriopoda*, *A. monticola* and *A. tumida*) over Soft Spinifex (*Triodia schinzii*) and various tussock grasses on the inland plain; and
- Open Woodland of *Eucalyptus miniata*, *Corymbia polycarpa* (only along Kundandu Creek) with *Eucalyptus jensenii* occurring between Quondong Point and James Price Point within 5 km of the coast;

The extrapolated area of mapping is highlighted in Figure 3.



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5.0 Discussion

5.1 Significance of Vegetation Communities

The precinct footprint supports a number of vegetation communities. Only the monsoon vine thickets are considered to be of conservation significance as they are listed as TEC. These communities generally occur in a narrow strip along the coast, as do the most diverse assemblages of vegetation.

The entire area is susceptible to weed invasion adjacent to disturbed areas and a shift in vegetation structure from inappropriate fire regimes. Any future disturbance in the area should include appropriate management to limit the spread or introduction of invasive weeds species.

The majority of the survey area is dominated by Pindan vegetation of varying composition and density which is regionally widespread and apart from direct clearing in the development zone, the proposed development is likely to have minimal regional impact on this vegetation association. The opportunity for improved fire management in the vicinity of the development zone is considered to be of significant potential benefit for the local Pindan vegetation.

Pindan vegetation is currently considered to be in advanced decline due to excessive fire frequency over most of its range. Further quantitative studies are required to document the extent and nature of this decline, and determine the potential for natural regeneration under more appropriate fire regimes. Pristine Pindan vegetation should contain a significant component of vine species and mistletoes growing in the canopy of *Acacia*-based communities, or a very mixed age-class of regenerating juvenile Eucalypts in woodland-based communities.

The drainage lines in the survey area are yet to be properly surveyed for floristic values to date, largely due to the presence of significant heritage sites in their vicinity. The TEC listed vine thicket communities (mostly mixed evergreen and deciduous) are restricted to fire protected sand dunes and low lying drainage areas behind beach dunes, usually within a few hundred metres of the coastline.

5.2 Flora of Conservation Significance

A number of species occurring in and around the survey area are of conservation significance and impacts to these species and populations should be minimised where possible. Although species listed as priority are not protected under the *Wildlife Conservation Act, 1950* impacts to these species will need to be discussed with DEC. Species protected under the Acts will require formal approval if they are to be impacted by the project.

A Priority flora nomination has recently been prepared for *Lophostemon grandiflorus* ssp. *grandiflorus* in Western Australia, recommended to be listed as Priority 3. This species occurs at two locations within the survey area and two additional locations were identified to the north. Populations of *Lophostemon grandiflorus* ssp. *grandiflorus* occurring within the survey area are mapped in Appendix B. An additional population on the North side of the Great Northern Highway adjacent Taylors Lagoon has been observed previously by R. Barrett, T. Willing and K. Kenneally (Pers comm. Russell Barrett). Early records from near the Edgar Range and near Wyndham have not been relocated in recent years and both may have been burnt out, thus the Dampier Peninsula populations may be the only extant in Western Australia and they represent a significant disjunction from the nearest populations in the Northern Territory. Investigation of the genetic isolation of these populations may be warranted to determine the significance of these local populations.

A new species of *Cleome* (part of the *C. tetrandra* species complex) was collected on the north side of Barred Creek on bare sand in open Pandanus woodland. This taxon may potentially occur within the survey area. Further examination of specimens in the *Cleome tetrandra* complex found additional records of this taxon with a distribution in coastal areas from Broome to the Islands in King Sound and to near Derby. It is likely that this species is restricted to near-coastal sands of the Dampier Peninsula. It is distinctive in being a tuberous-rooted perennial (and is possibly clonal). It may be nominated as a Priority 3 taxon as it requires further survey to determine its conservation status.

Two collections of *Pterocaulon* sp. were made near the southern boundary of the survey area, both representing the Priority 2 taxon *Pterocaulon* sp. A Kimberley Flora. The presence of this taxon to the north and south of the survey area suggests that it is also likely to occur within the precinct footprint, though it has yet to be recorded

there. Further surveys should focus on sandy areas under *Melaleuca* in drainage lines. These areas were not able to be adequately surveyed due to access restrictions.

Searches for the Priority 1 taxon *Aphyllodium parvifolium* at Barred Creek (the type locality) were unsuccessful and this taxon is considered rare in the area. This species could possibly occur in drainage lines within the survey area but access to these areas would be required to determine its presence. Habitat determination is based on DEC records of previous collections. The possibility of it occurring in drainage lines is an observation by R. Barrett in similar settings in the region. A large population is known to occur around Taylors Lagoon. The original population has possibly been destroyed by frequent fire. This highlights the pressures that ecosystems in the region are facing in terms of altered fire regimes. With further dedicated surveys of wetlands on the Dampier Peninsula, this taxon may warrant listing as DRF.

The southern-most population of *Pandanus spiralis* var. *convexus* is found near Barred Creek, on the southern edge of the survey area. This taxon appears to be endemic to the Dampier Peninsula and adjacent pindan sands north to about Oobagooma.

It is noted that the only population of the Priority 2 taxon *Gomphrena pusilla* located in the survey area during the Biota wet season survey (2009) has since been burnt and thus could not be relocated during this survey

A poorly known truffle *Nothocastoreum* sp. nov. aff. *cretaceum* (Lloyd) G.W. Beaton (Mesophelliaceae) was collected from *Eucalyptus miniata* woodland on the Biota track, being only the third record of this genus in Western Australia. Previously collected from the Mitchell Plateau and Theda Station in the north Kimberley, it possibly also occurs on Cape York Peninsula, Queensland. Fungi have generally been poorly surveyed in the Kimberley region and no conservation assessment is available for this taxon.

Pittosporum moluccanum was previously located in two locations by Biota (2009). Searches were carried out in suitable habitat adjacent to these individuals, however no additional plants were located. Other than those located in Biota (2009), the closest known populations occur on islands in the northern Bonaparte Archipelago some 700km to the north.

There are some areas within the precinct footprint, such as drainage lines, that still require survey to determine the status of conservation species that are likely to occur in these areas (Pers Comm Russell Barrett). To date access to these areas have been limited given the sensitive heritage values present. Such landforms typically support important and often significant flora, and thus, such surveys are imperative.

6.0 Conclusions and Recommendations

Development of the precinct footprint will impact areas of the TEC monsoon vine thickets of the Dampier Peninsula, as well as priority and poorly known flora species. It is unlikely that the direct result of clearing will seriously threaten these species and assemblages because based on aerial mapping, the monsoon vine thicket is not restricted to the precinct footprint and occurs along much of the Dampier Peninsula to Cygnet Bay, some 120 km from the precinct footprint. The main threat to this community type is the spread or introduction of weed species that typically enter the landscape with disturbance events. The introduction of threatening weed species is already evident in the local area typically associated with disturbance events. Some of the precinct footprint and surrounds, primarily associated with drainage lines, remains un-surveyed as a result of heritage sensitivities and access restrictions. As a result further targeted surveys for species of conservation significance may be required.

6.1 Further Studies

Drainage lines typically support priority flora and vegetation assemblages, so further targeted surveys of these areas is recommended to further understand species occurrence and/or management arrangements may address this potential issue. Access to these areas will require the consent of Traditional Owners.

Although weed distribution mapping was carried out in 2009 late dry season surveys (AECOM, 2009), due to the seasonal timing, many weed species were likely to have been dormant. Supplementary weed distribution mapping may be carried out in the optimal season to determine the extent and density of weed distribution for the purpose of informing management approaches. This will assist with management objectives related to weed control and will provide a baseline for any vegetation condition monitoring.

Re-survey populations of *Gomphrena pusilla* (P2) recorded by Biota (2009), to determine if any recruitment has occurred in these areas following recent fires in order to confirm the current extent of this species.

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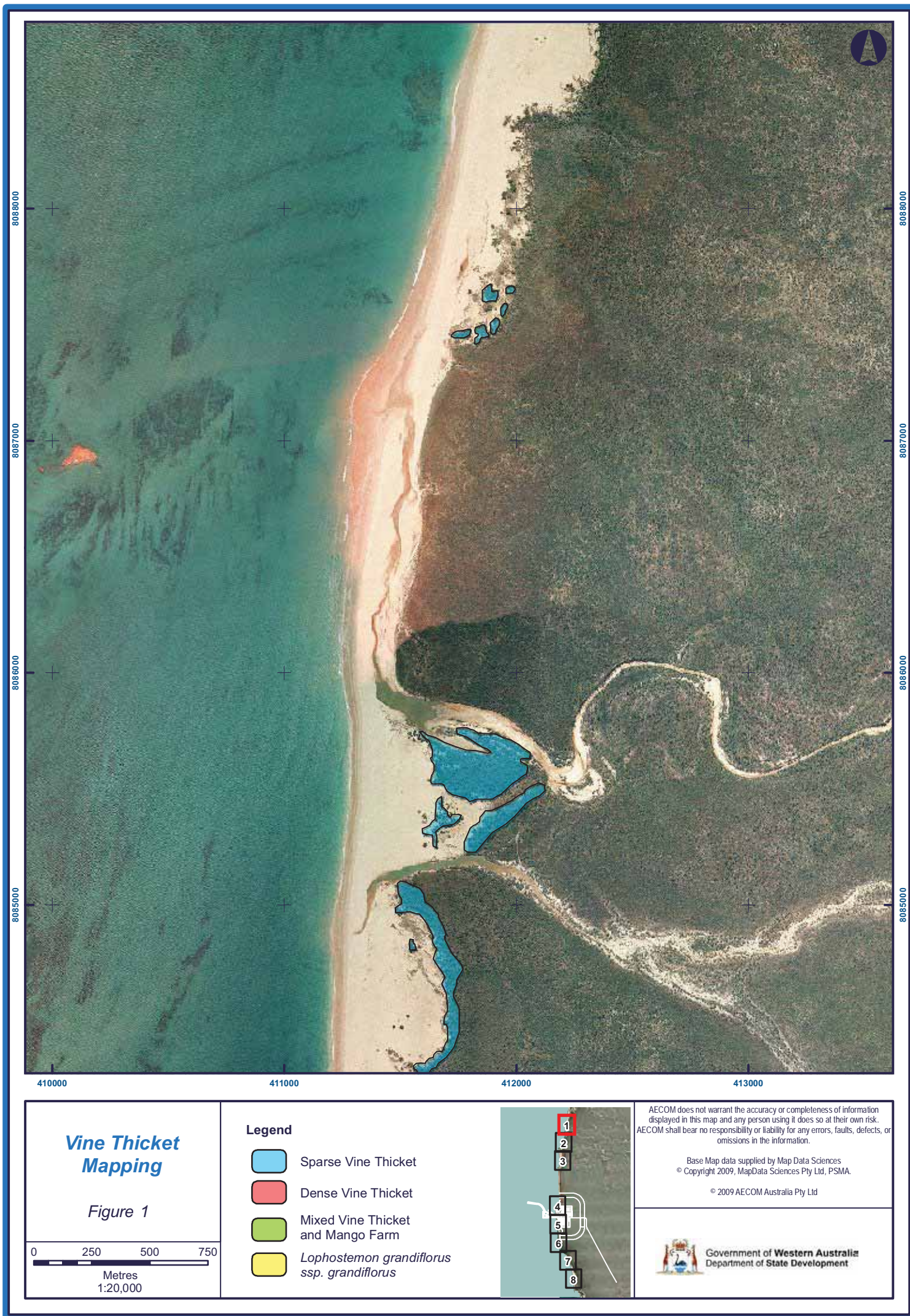
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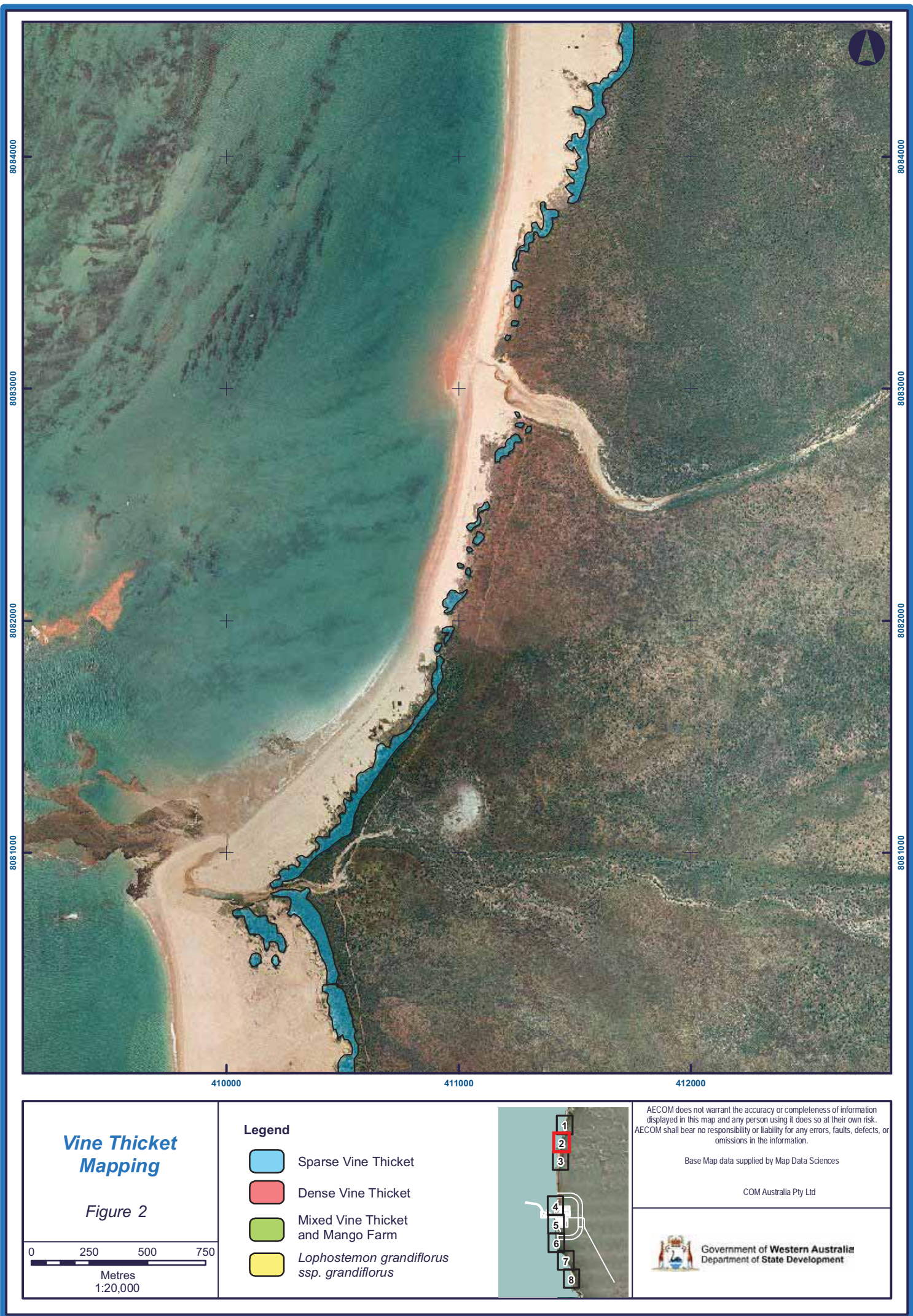
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Appendix A

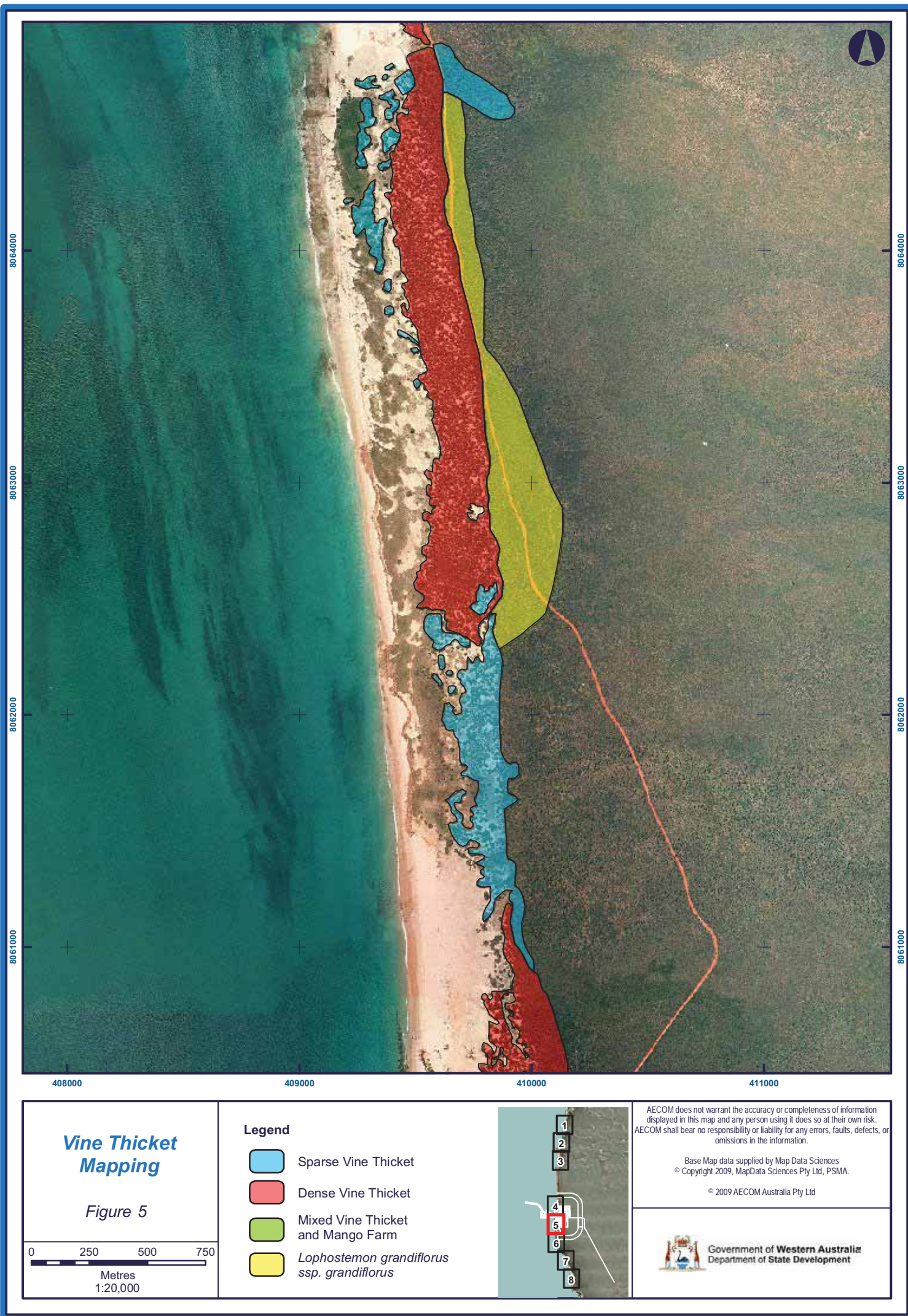
Monsoon Vine Ticket Distribution





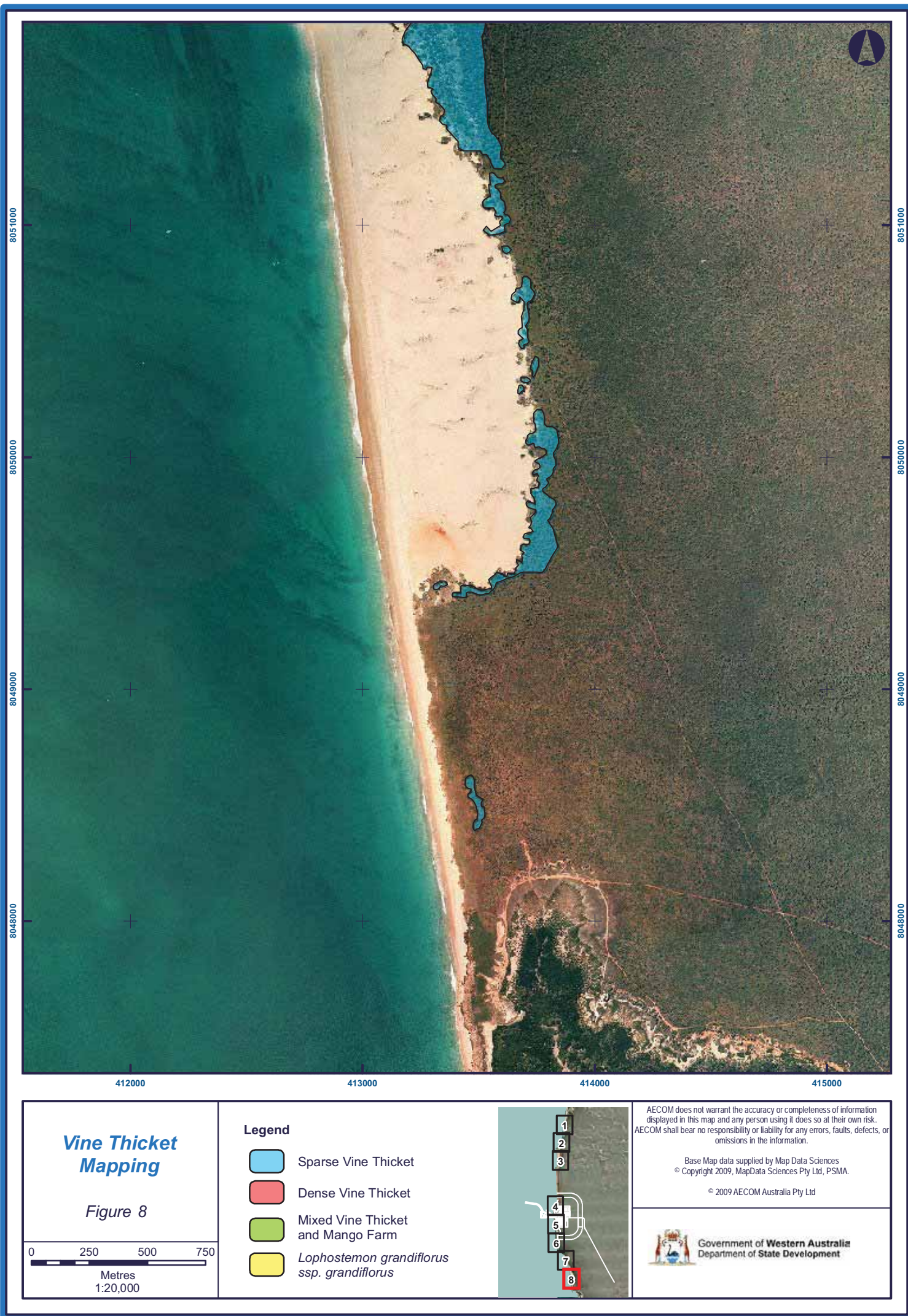






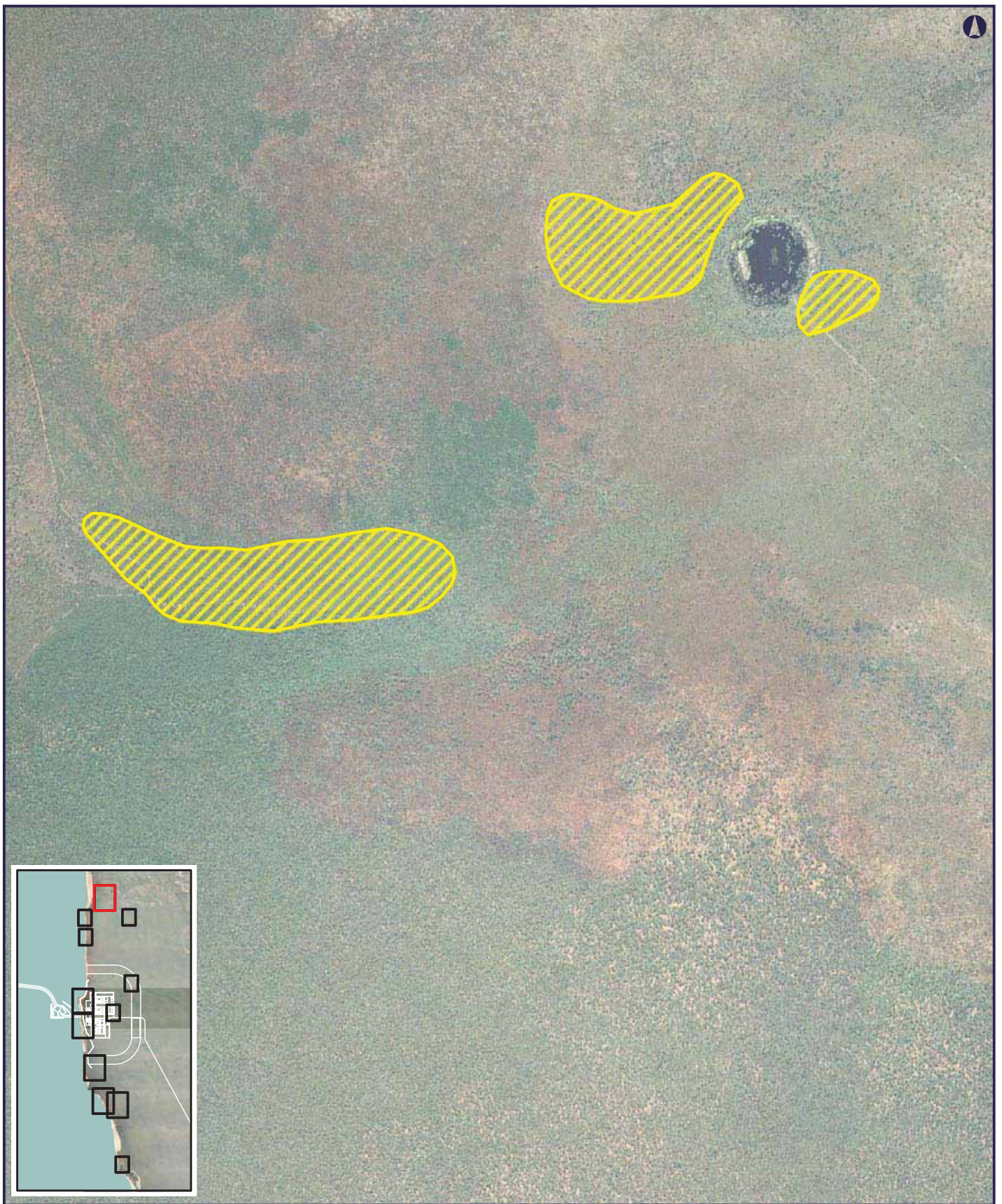






Appendix B

Priority Species and Vegetation Communities



Priority Species and Vegetation Communities

Figure 1

0 100 200 300
Metres
1:12,500

- AECOM Significant Flora
- 2009 Biota Priority Flora Survey
- 2008 ENV Priority Flora Survey
- Lophostemon grandiflorus* ssp. *grandiflorus*
- Merremia davenportii*
- Pterocaulon* sp. A Kimberley Flora (B.J.Carter 599)
- Potential habitat for *Gomphrena pusila*
- Targeted search area for *Gomphrena pusila*
- Targeted search area for *Pittosporum moluccanum*

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Priority Species and Vegetation Communities

Figure 2

0 100 200
Metres
1:8,000

- AECOM Significant Flora
- 2009 Biota Priority Flora Survey
- 2008 ENV Priority Flora Survey
- Lophostemon grandiflorus* ssp. *grandiflorus*
- Merremia davenportii*
- Pterocaulon* sp. A Kimberley Flora (B.J.Carter 599)
- Potential habitat for *Gomphrena pusila*
- Targeted search area for *Gomphrena pusila*
- Targeted search area for *Pittosporum moluccanum*

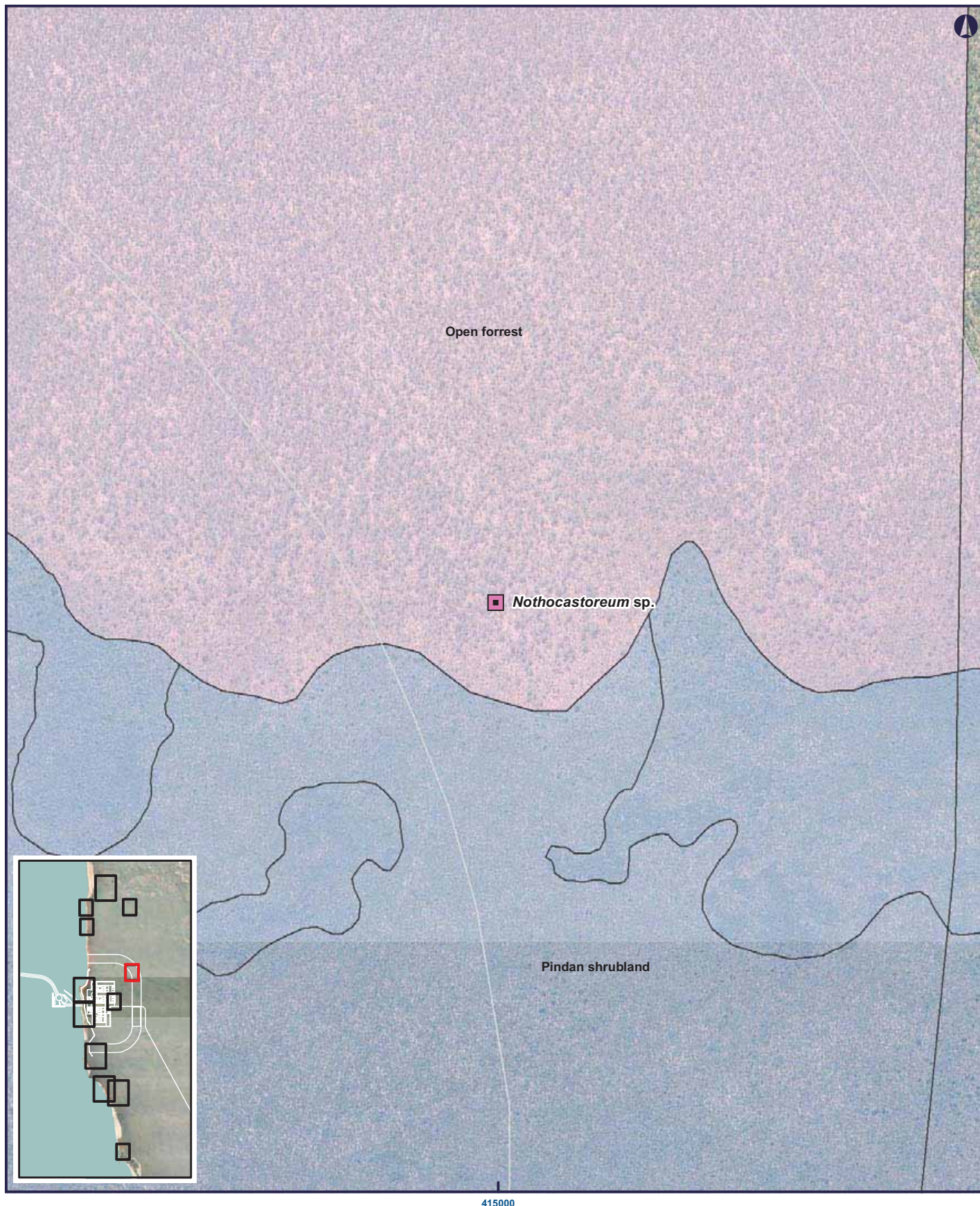
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415000

Priority Species and Vegetation Communities

Figure 3

0 100 200
Metres
1:8,000

- AECOM Significant Flora
- 2009 Biota Priority Flora Survey
- 2008 ENV Priority Flora Survey
- Lophostemon grandiflorus* ssp. *grandiflorus*
- Merremia davenportii*
- Pterocaulon* sp. A Kimberley Flora (B.J.Carter 599)
- Potential habitat for *Gomphrena pusila*
- Targeted search area for *Gomphrena pusila*
- Targeted search area for *Pittosporum moluccanum*

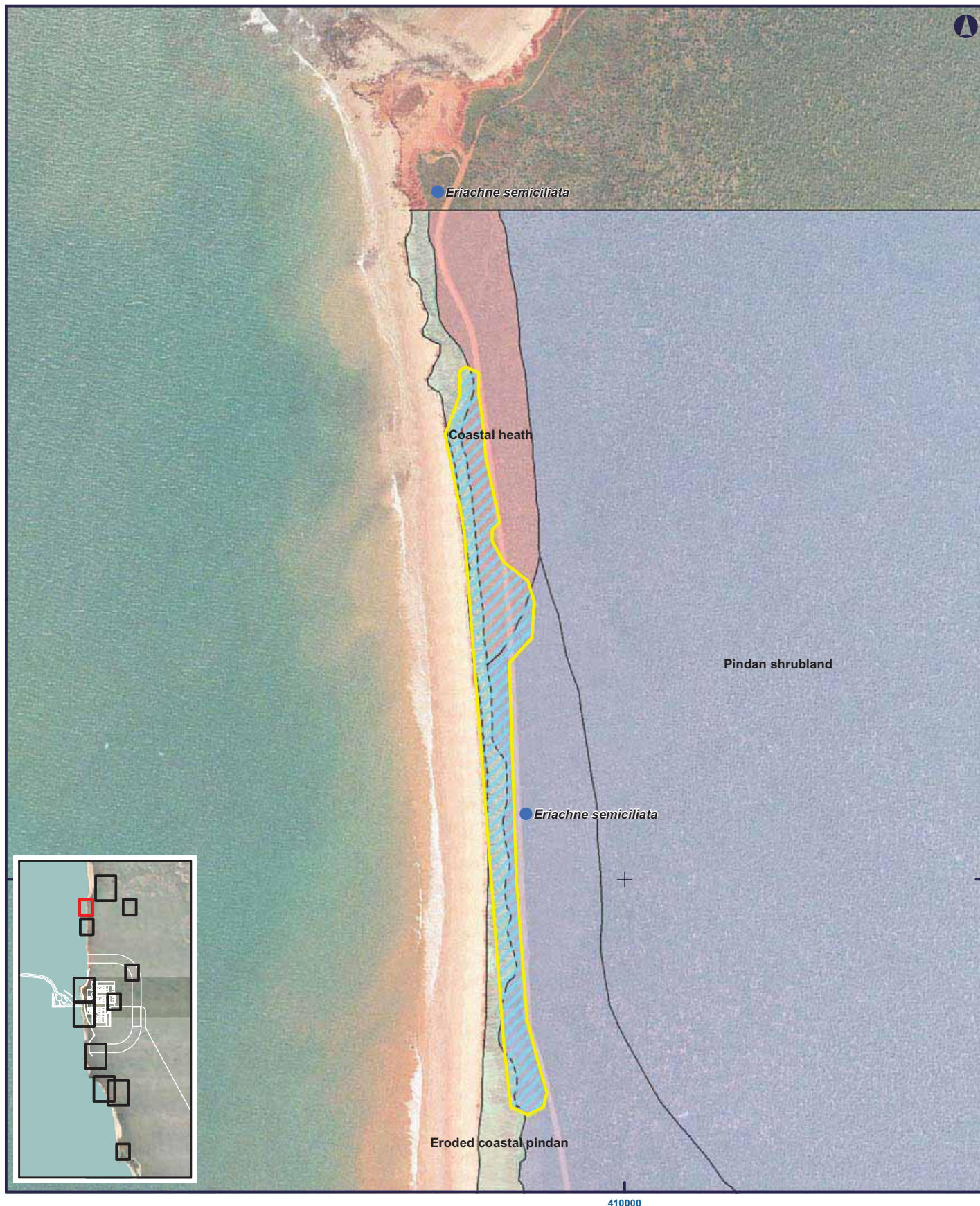
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Priority Species and Vegetation Communities

Figure 4

0 100 200
Metres
1:8,000

- AECOM Significant Flora
- 2009 Biota Priority Flora Survey
- 2008 ENV Priority Flora Survey
- Lophostemon grandiflorus* ssp. *grandiflorus*
- Merremia davenportii*
- Pterocaulon* sp. A Kimberley Flora (B.J.Carter 599)
- Potential habitat for *Gomphrena pusila*
- Targeted search area for *Gomphrena pusila*
- Targeted search area for *Pittosporum moluccanum*

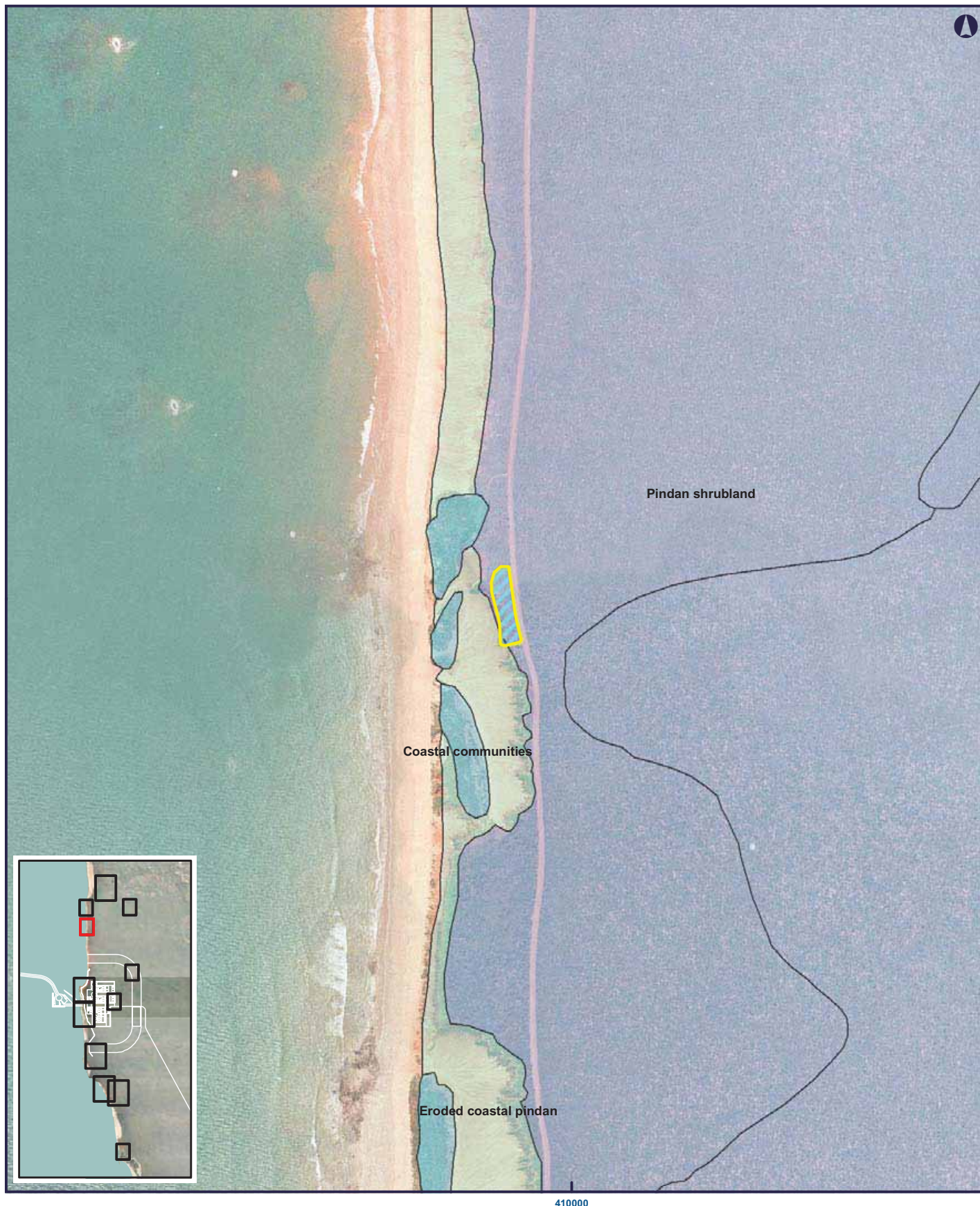
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Priority Species and Vegetation Communities

Figure 5

0 100 200
Metres
1:8,000

- AECOM Significant Flora
- 2009 Biota Priority Flora Survey
- 2008 ENV Priority Flora Survey
- Lophostemon grandiflorus* ssp. *grandiflorus*
- Merremia davenportii*
- Pterocaulon* sp. A Kimberley Flora (B.J.Carter 599)
- Potential habitat for *Gomphrena pusila*
- Targeted search area for *Gomphrena pusila*
- Targeted search area for *Pittosporum moluccanum*

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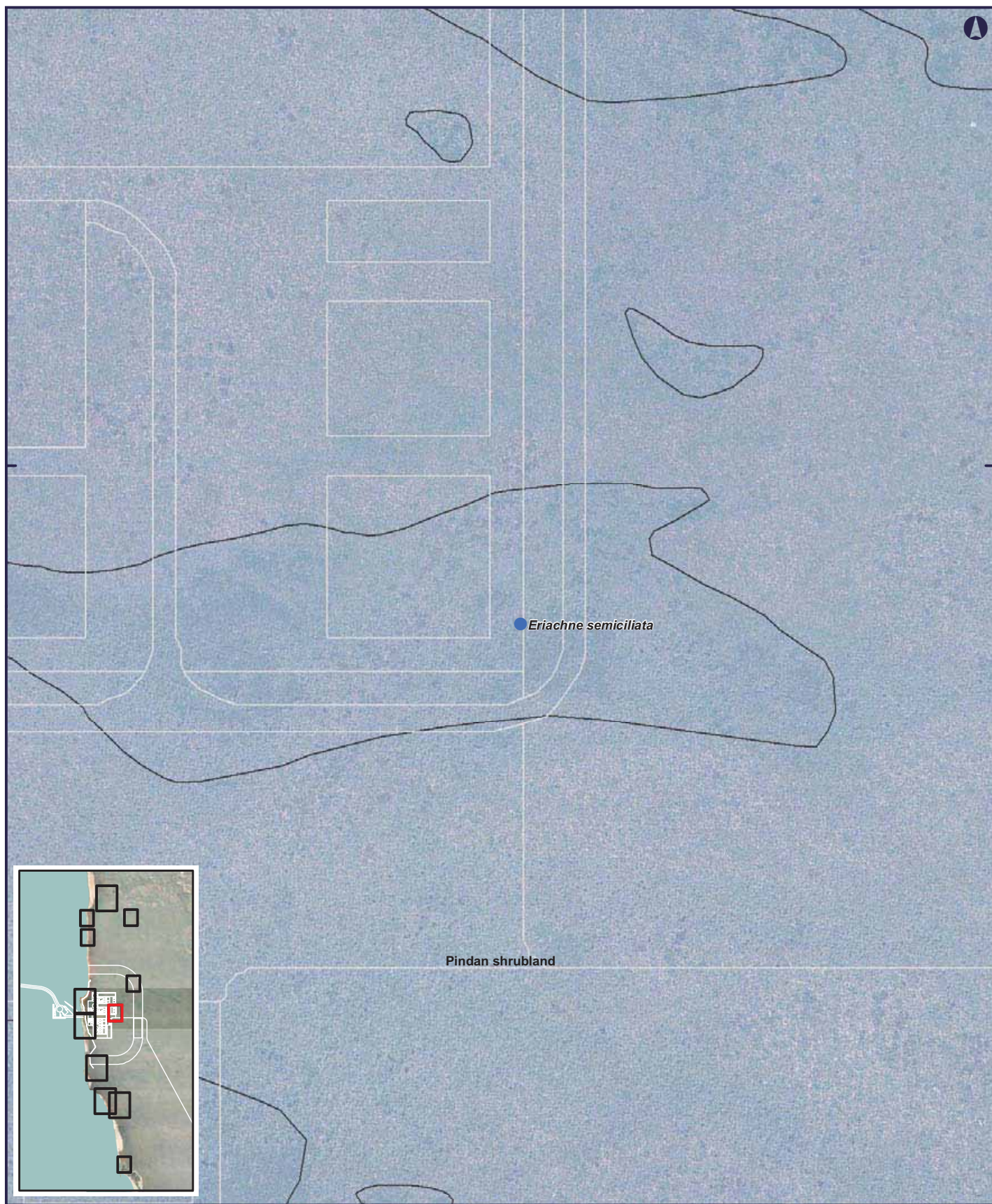
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8065000

8065000



Priority Species and Vegetation Communities

Figure 6

0 100 200
Metres
1:8,000

- AECOM Significant Flora
- 2009 Biota Priority Flora Survey
- 2008 ENV Priority Flora Survey
- Lophostemon grandiflorus* ssp. *grandiflorus*
- Merremia davenportii*
- Pterocaulon* sp. A Kimberley Flora (B.J.Carter 599)
- Potential habitat for *Gomphrena pusila*
- Targeted search area for *Gomphrena pusila*
- Targeted search area for *Pittosporum moluccanum*

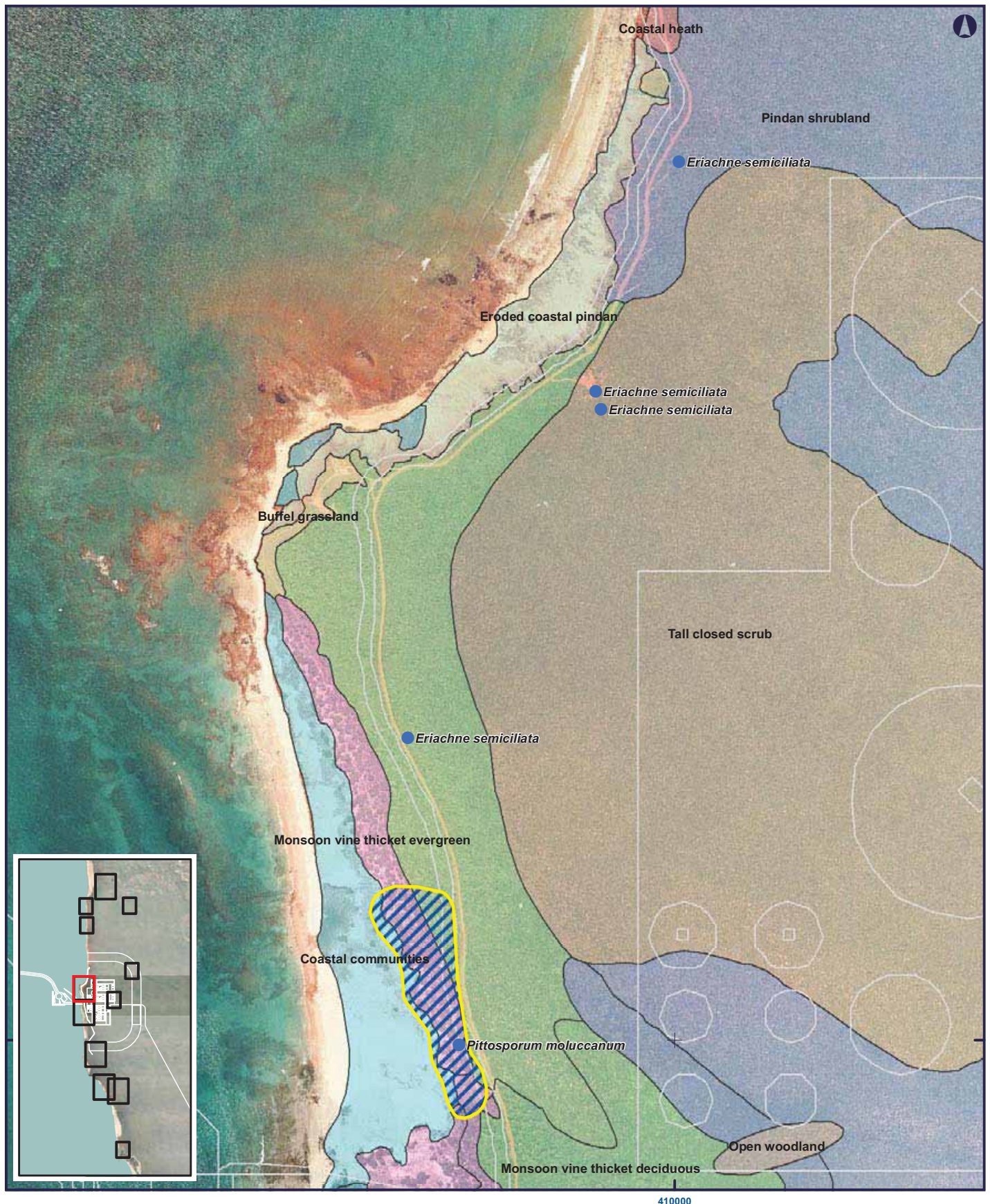
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Priority Species and Vegetation Communities

Figure 7

0 100 200 300
Metres
1:12,500

- AECOM Significant Flora
- 2009 Biota Priority Flora Survey
- 2008 ENV Priority Flora Survey
- Lophostemon grandiflorus* ssp. *grandiflorus*
- Merremia davenportii*
- Pterocaulon* sp. A Kimberley Flora (B.J.Carter 599)
- Potential habitat for *Gomphrena pusila*
- Targeted search area for *Gomphrena pusila*
- Targeted search area for *Pittosporum moluccanum*

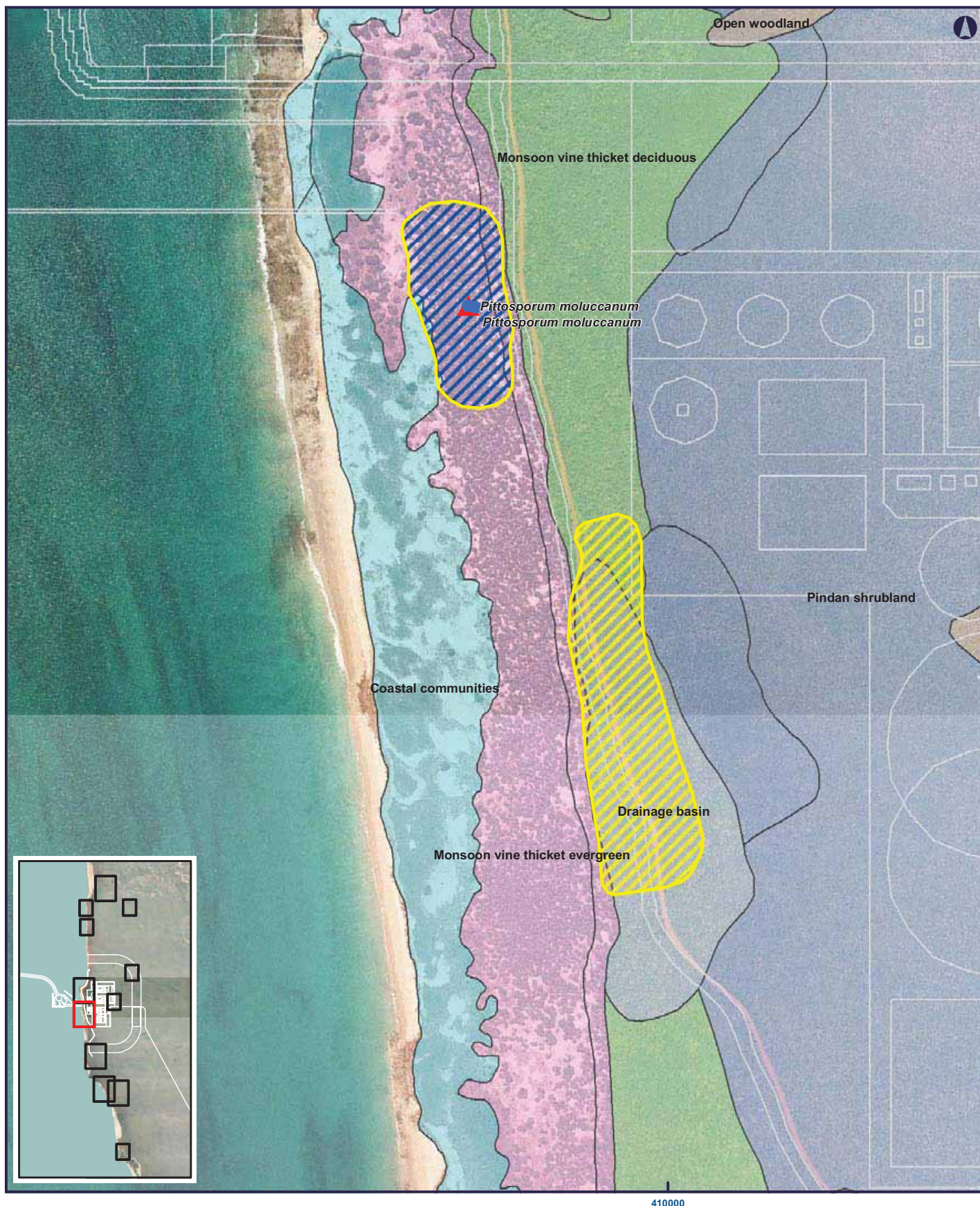
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410000

Priority Species and Vegetation Communities

Figure 8

0 100 200 300
Metres
1:12,500

- AECOM Significant Flora
- 2009 Biota Priority Flora Survey
- 2008 ENV Priority Flora Survey
- Lophostemon grandiflorus* ssp. *grandiflorus*
- Merremia davenportii*
- Pterocaulon* sp. A Kimberley Flora (B.J.Carter 599)
- Potential habitat for *Gomphrena pusila*
- Targeted search area for *Gomphrena pusila*
- Targeted search area for *Pittosporum moluccanum*

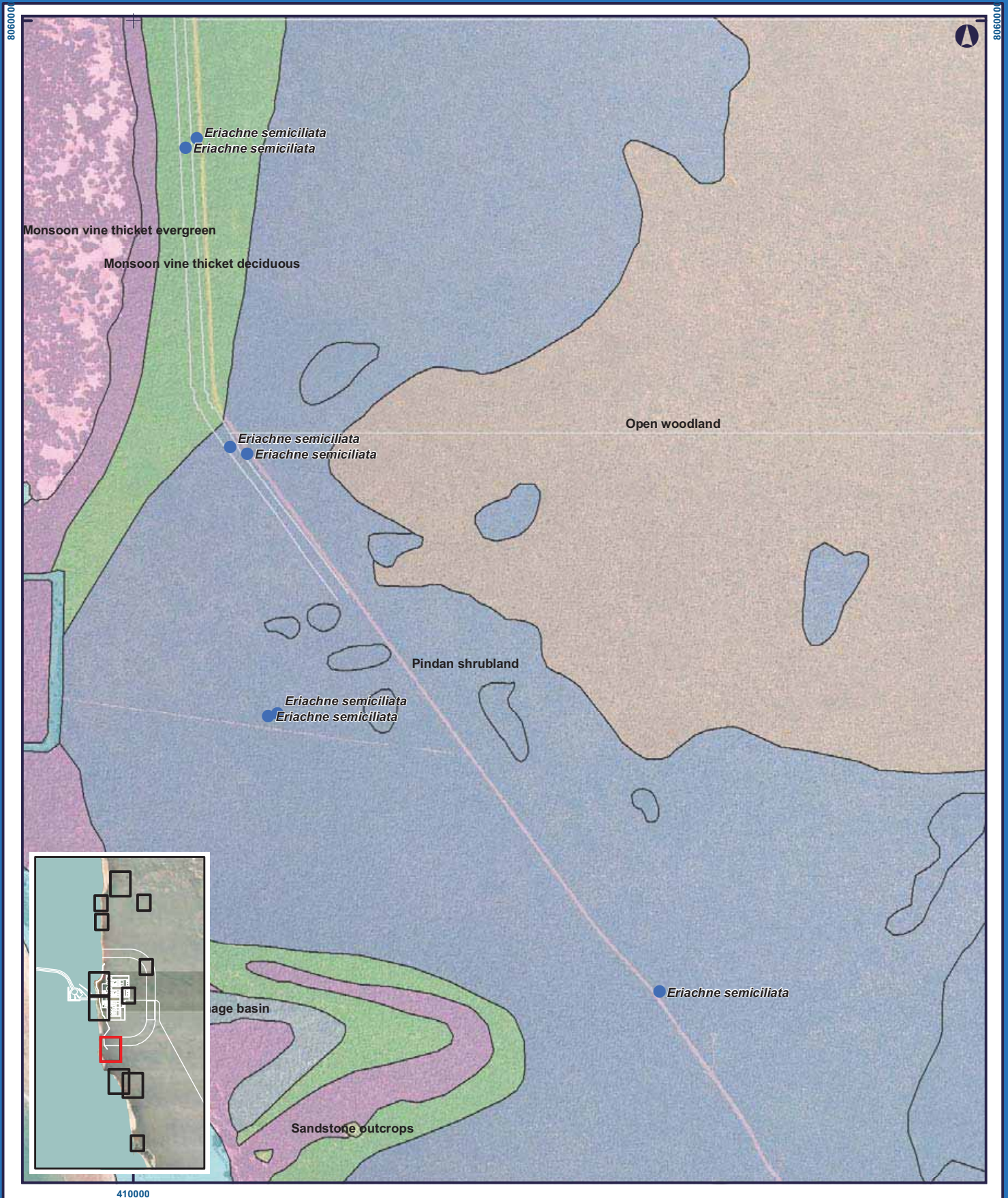
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Priority Species and Vegetation Communities

Figure 9

0 100 200 300
Metres
1:12,500

- AECOM Significant Flora
- 2009 Biota Priority Flora Survey
- 2008 ENV Priority Flora Survey
- Lophostemon grandiflorus* ssp. *grandiflorus*
- Merremia davenportii*
- Pterocaulon* sp. A Kimberley Flora (B.J.Carter 599)
- Potential habitat for *Gomphrena pusila*
- Targeted search area for *Gomphrena pusila*
- Targeted search area for *Pittosporum moluccanum*

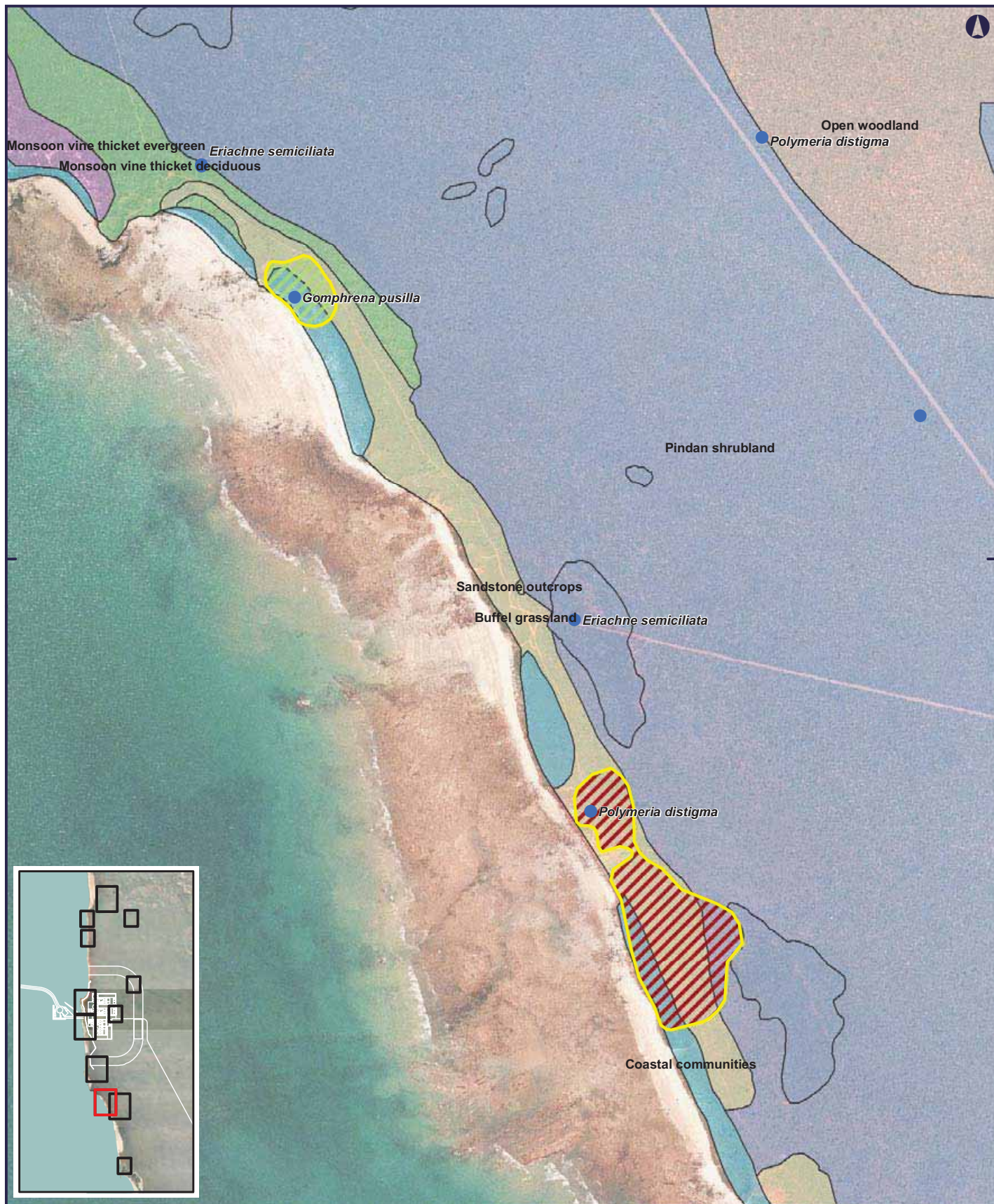
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Priority Species and Vegetation Communities

Figure 10

0 100 200 300
Metres
1:12,500

- AECOM Significant Flora
- 2009 Biota Priority Flora Survey
- 2008 ENV Priority Flora Survey
- Lophostemon grandiflorus* ssp. *grandiflorus*
- Merremia davenportii*
- Pterocaulon* sp. A Kimberley Flora (B.J.Carter 599)
- Potential habitat for *Gomphrena pusilla*
- Targeted search area for *Gomphrena pusilla*
- Targeted search area for *Pittosporum moluccanum*

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Priority Species and Vegetation Communities

Figure 11

0 100 200 300
Metres
1:12,500

- AECOM Significant Flora
- 2009 Biota Priority Flora Survey
- 2008 ENV Priority Flora Survey
- Lophostemon grandiflorus* ssp. *grandiflorus*
- Merremia davenportii*
- Pterocaulon* sp. A Kimberley Flora (B.J.Carter 599)
- Potential habitat for *Gomphrena pusila*
- Targeted search area for *Gomphrena pusila*
- Targeted search area for *Pittosporum moluccanum*

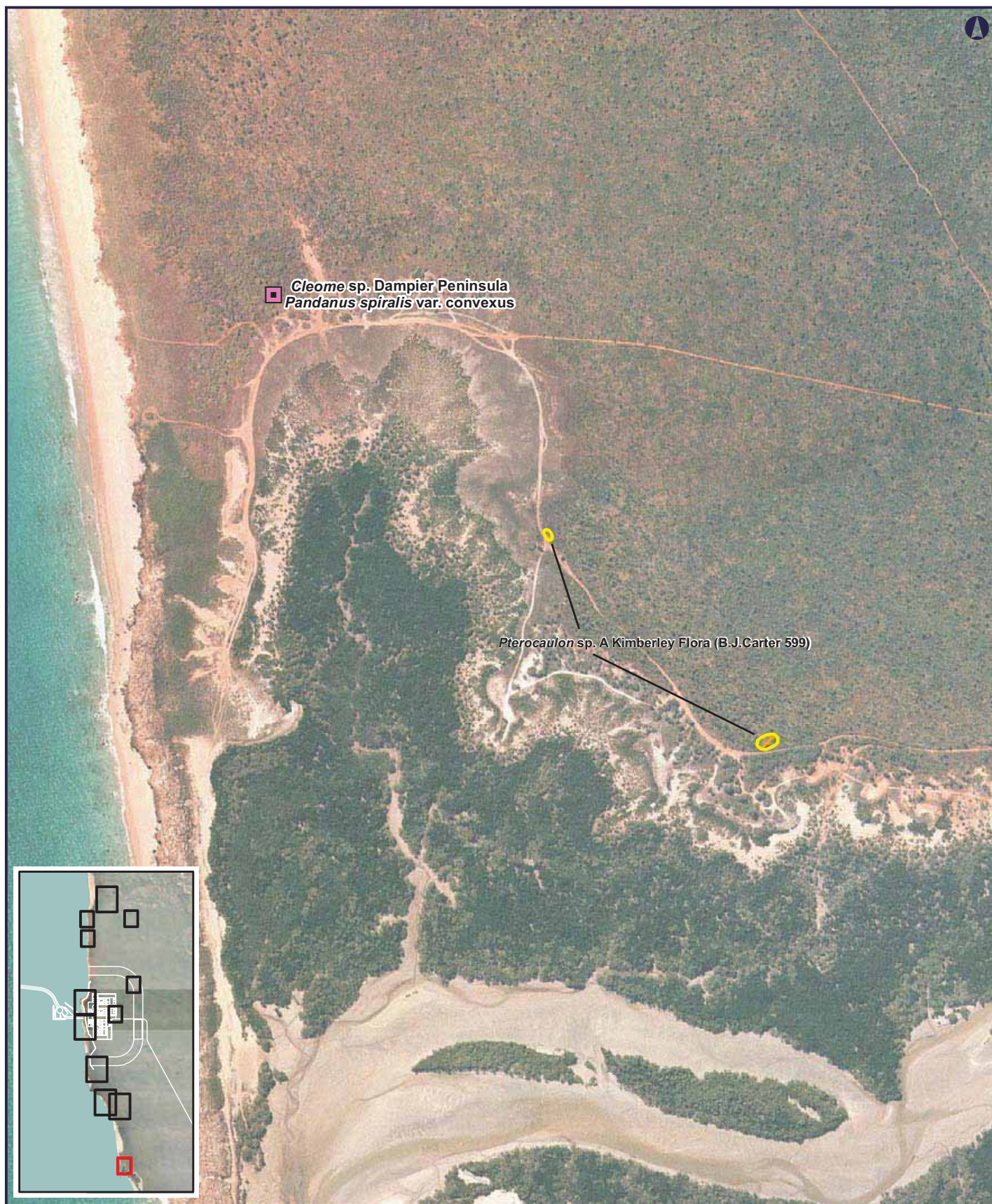
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Priority Species and Vegetation Communities

Figure 12

0 100 200
Metres
1:8,000

- AECOM Significant Flora
- 2009 Biota Priority Flora Survey
- ▲ 2008 ENV Priority Flora Survey
- ▨ *Lophostemon grandiflorus* ssp. *grandiflorus*
- ▨ *Merremia davenportii*
- ▨ *Pterocaulon* sp. A Kimberley Flora (B.J.Carter 599)
- ▨ Potential habitat for *Gomphrena pusila*
- ▨ Targeted search area for *Gomphrena pusila*
- ▨ Targeted search area for *Pittosporum moluccanum*

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Appendix C

Weed Distribution in the Precinct Footprint



Weed Mapping

Figure 1

0 100 200
Metres
1:8,000

AECOM Weed Survey

- **Leucaena leucocephala*
- **Macroptilium atropurpureum*
- **Passiflora foetida* var. *hispida*
- **Sida acuta*
- **Stylosanthes hamata*
- **Aerva javanica*
- **Cenchrus ciliaris*
- **Aerva javanica*,
**Cenchrus ciliaris*

- **Aerva javanica*,
**Macroptilium atropurpureum*
- **Leucaena leucocephala*,
**Cenchrus ciliaris*
- **Passiflora foetida* var. *hispida*,
**Cenchrus ciliaris*
- **Passiflora foetida* var. *hispida*,
**Macroptilium atropurpureum*
- **Passiflora foetida* var. *hispida*,
**Stylosanthes hamata*
- **Stylosanthes hamata*,
**Cenchrus ciliaris*
- Four species of weeds present
- 2009 Biota Survey - Weeds

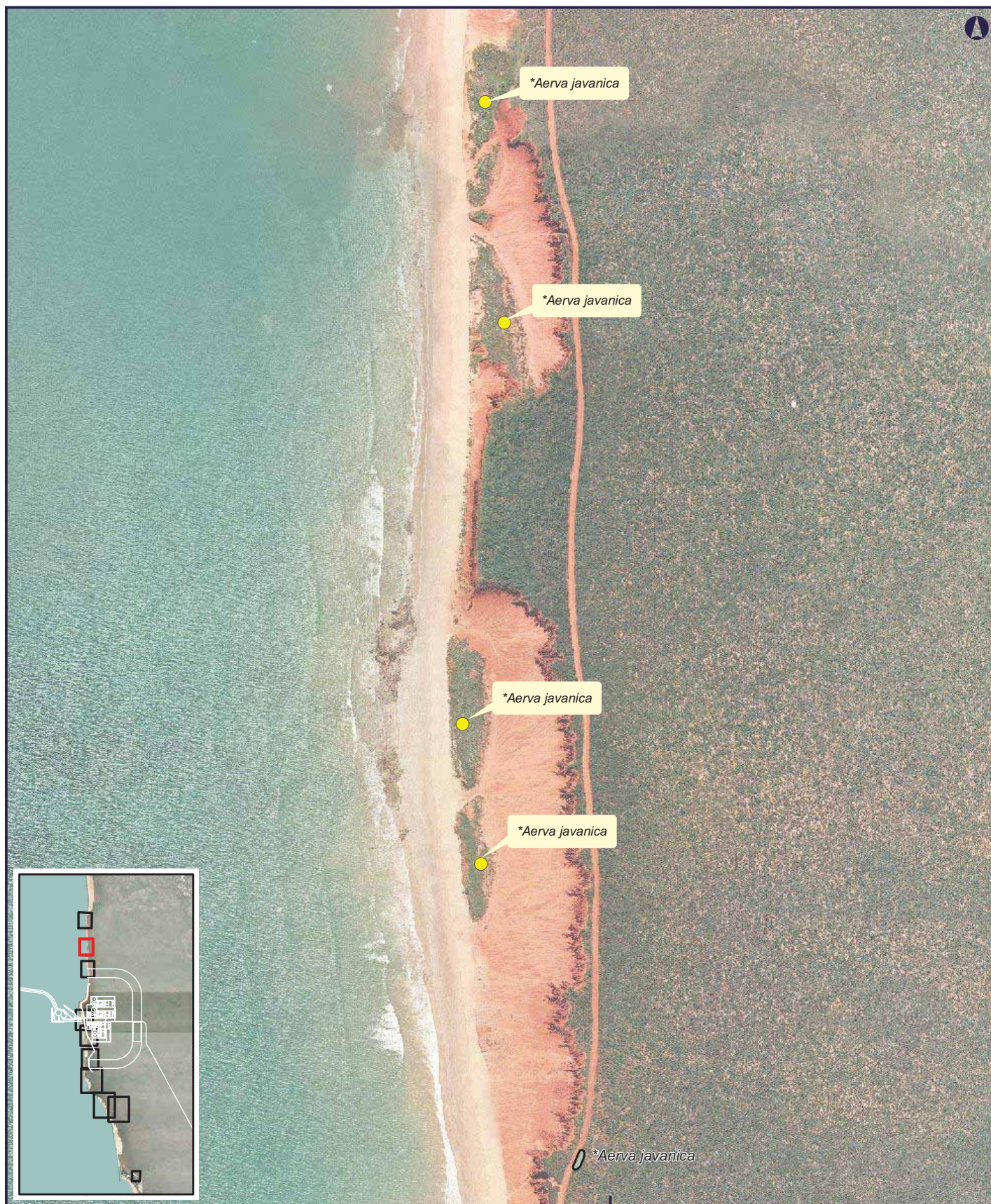
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410000

Weed Mapping

Figure 2

0 100 200
Metres
1:8,000

AECOM Weed Survey

- *Leucaena leucocephala
- *Macroptilium atropurpureum
- *Passiflora foetida var. hispida
- *Sida acuta
- *Stylosanthes hamata
- *Aerva javanica
- *Cenchrus ciliaris
- *Aerva javanica, *Cenchrus ciliaris

- *Aerva javanica, *Macroptilium atropurpureum
- *Leucaena leucocephala, *Cenchrus ciliaris
- *Passiflora foetida var. hispida, *Cenchrus ciliaris
- *Passiflora foetida var. hispida, *Macroptilium atropurpureum
- *Passiflora foetida var. hispida, *Stylosanthes hamata
- *Stylosanthes hamata, *Cenchrus ciliaris
- Four species of weeds present
- 2009 Biota Survey - Weeds

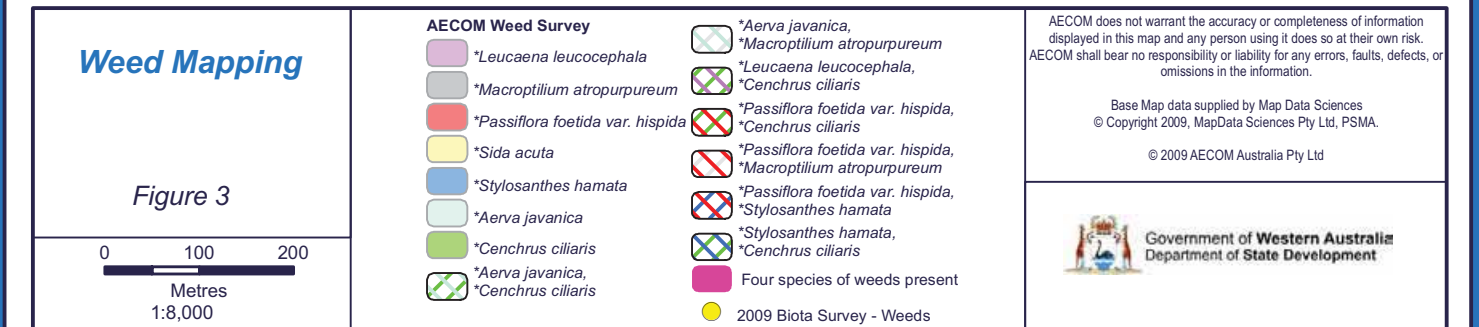
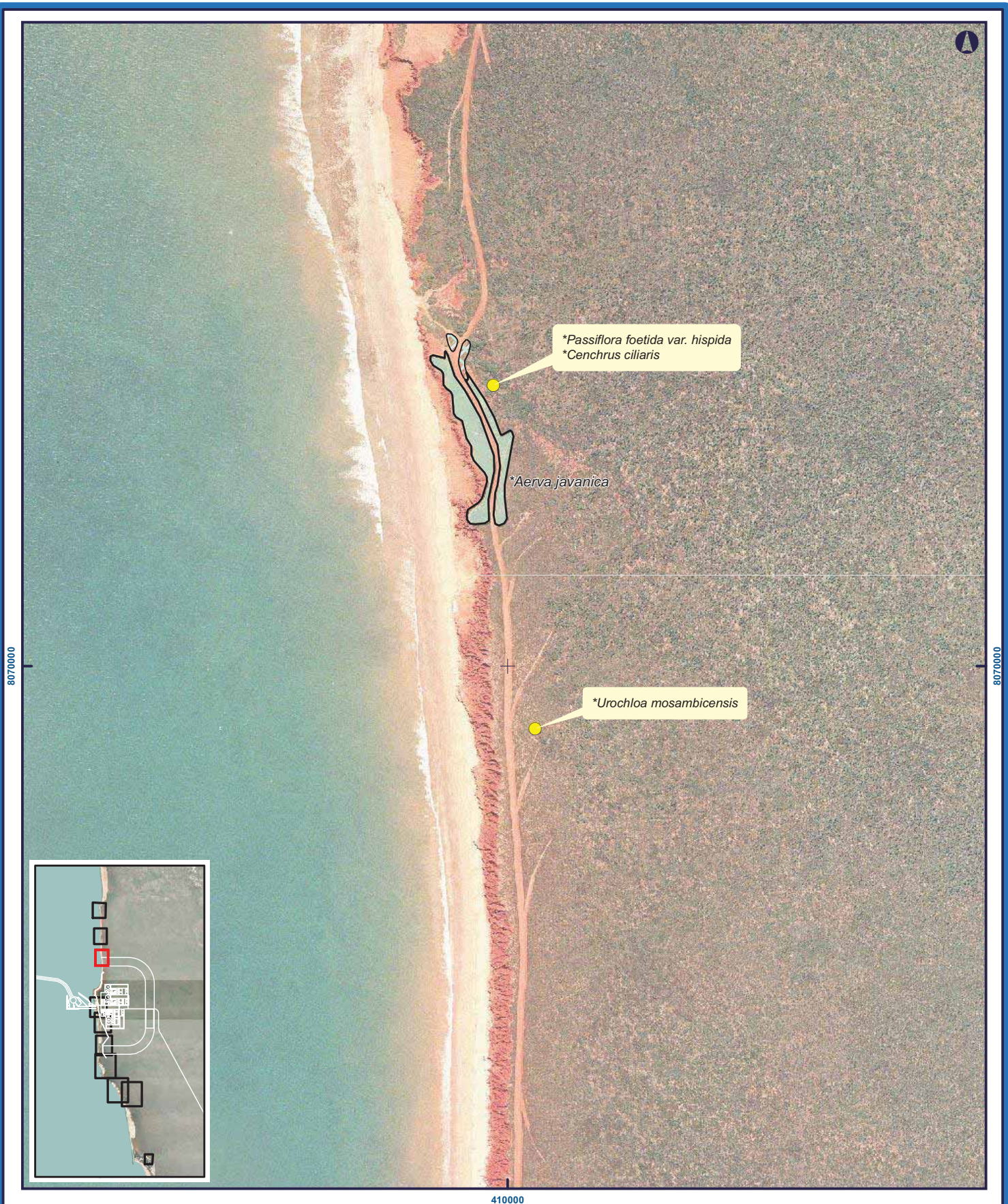
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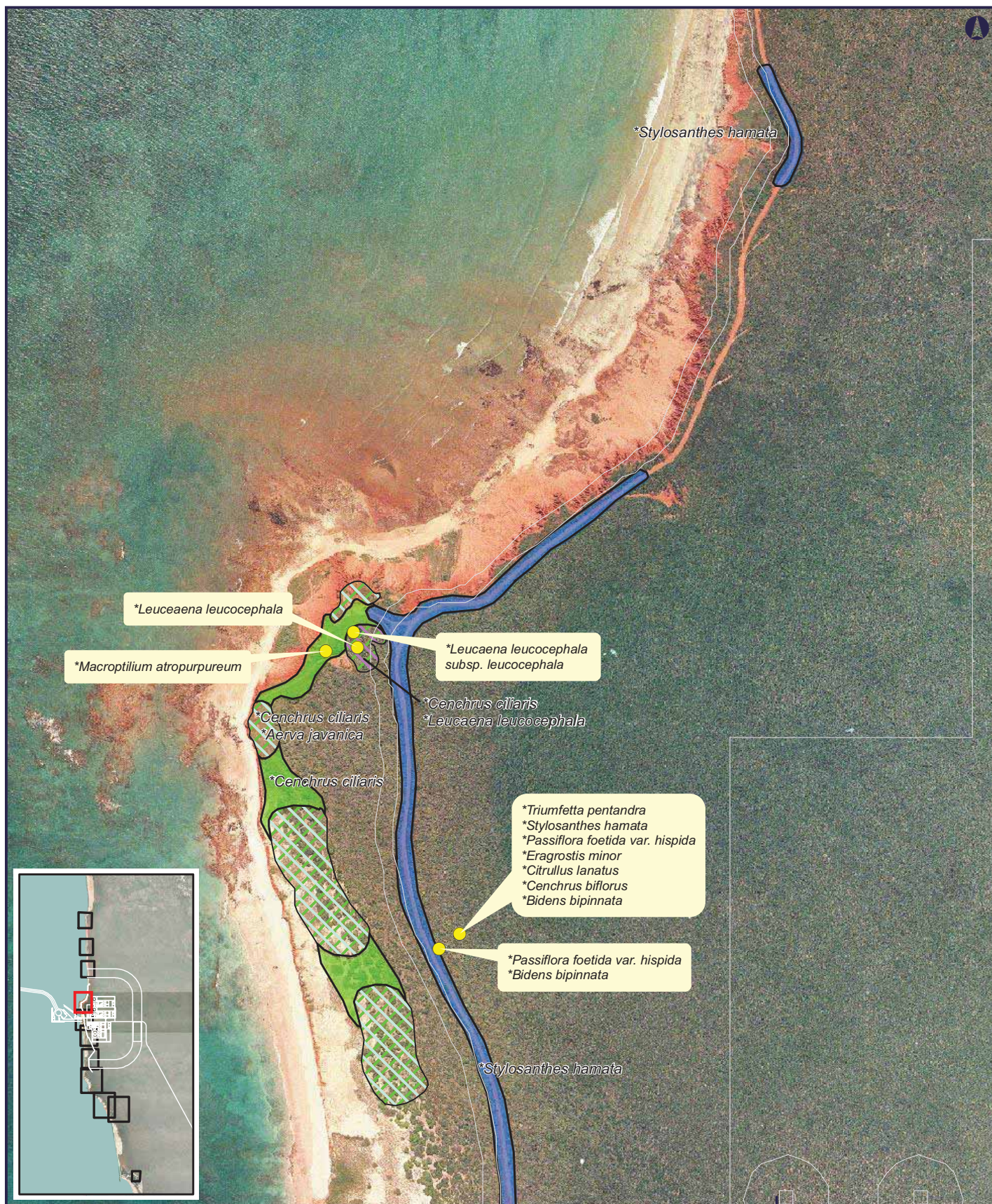
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Weed Mapping

Figure 4

0 100 200
Metres
1:10,000

AECOM Weed Survey

- *Leucaena leucocephala*
- *Macroptilium atropurpureum*
- *Passiflora foetida var. hispida*
- *Sida acuta*
- *Stylosanthes hamata*
- *Aerva javanica*
- *Cenchrus ciliaris*
- *Aerva javanica,*
**Cenchrus ciliaris*

- *Aerva javanica,*
**Macroptilium atropurpureum*
- *Leucaena leucocephala,*
**Cenchrus ciliaris*
- *Passiflora foetida var. hispida,*
**Cenchrus ciliaris*
- *Passiflora foetida var. hispida,*
**Macroptilium atropurpureum*
- *Passiflora foetida var. hispida,*
**Stylosanthes hamata*
- *Stylosanthes hamata,*
**Cenchrus ciliaris*
- Four species of weeds present
- 2009 Biota Survey - Weeds

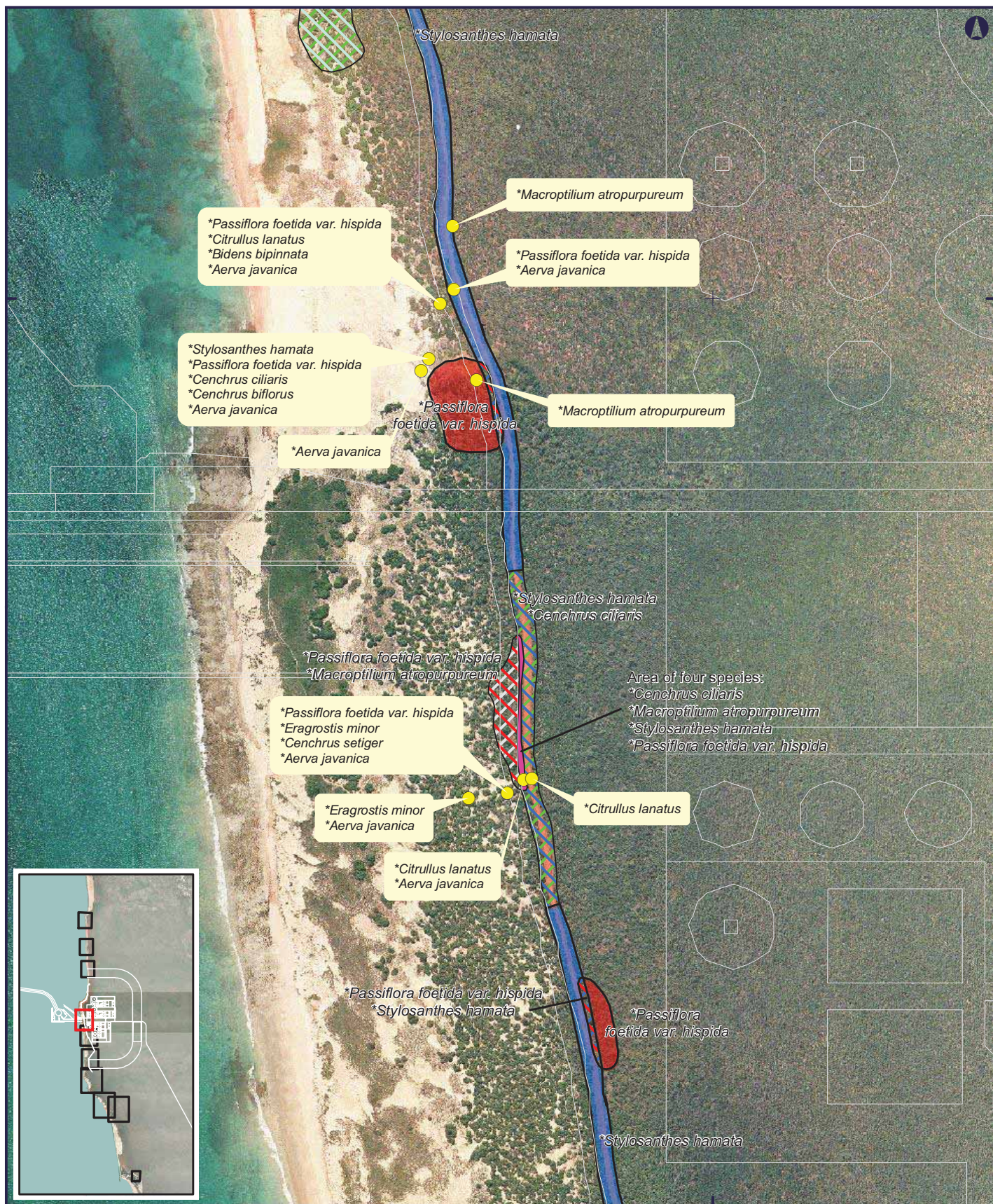
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Weed Mapping

Figure 5

0 100 200
Metres
1:10,000

AECOM Weed Survey

- *Leucaena leucocephala*
- *Macropitium atropurpureum*
- *Passiflora foetida var. hispida*
- *Sida acuta*
- *Stylosanthes hamata*
- *Aerva javanica*
- *Cenchrus ciliaris*
- *Aerva javanica*,
**Cenchrus ciliaris*

- *Aerva javanica*,
**Macropitium atropurpureum*
- *Leucaena leucocephala*,
**Cenchrus ciliaris*
- *Passiflora foetida var. hispida*,
**Cenchrus ciliaris*
- *Passiflora foetida var. hispida*,
**Macropitium atropurpureum*
- *Passiflora foetida var. hispida*,
**Stylosanthes hamata*
- *Stylosanthes hamata*,
**Cenchrus ciliaris*
- Four species of weeds present
- 2009 Biota Survey - Weeds

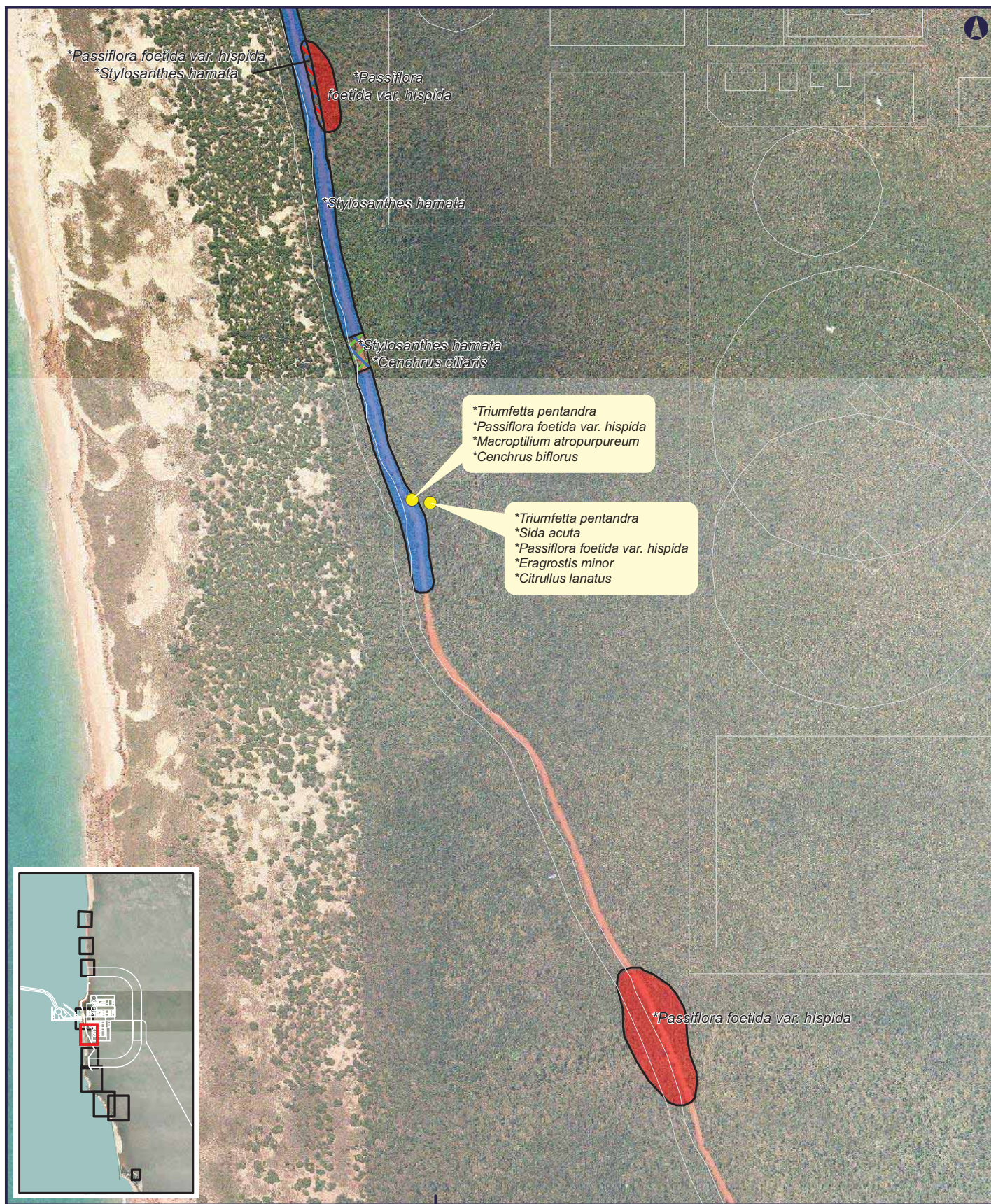
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410000

Weed Mapping

Figure 6

0 100 200
Metres
1:10,000

AECOM Weed Survey

- *Leucaena leucocephala
- *Macroptilium atropurpureum
- *Passiflora foetida var. hispida
- *Sida acuta
- *Stylosanthes hamata
- *Aerva javanica
- *Cenchrus ciliaris
- *Aerva javanica, *Cenchrus ciliaris

- *Aerva javanica, *Macroptilium atropurpureum
- *Leucaena leucocephala, *Cenchrus ciliaris
- *Passiflora foetida var. hispida, *Cenchrus ciliaris
- *Passiflora foetida var. hispida, *Macroptilium atropurpureum
- *Passiflora foetida var. hispida, *Stylosanthes hamata
- *Stylosanthes hamata, *Cenchrus ciliaris
- Four species of weeds present
- 2009 Biota Survey - Weeds

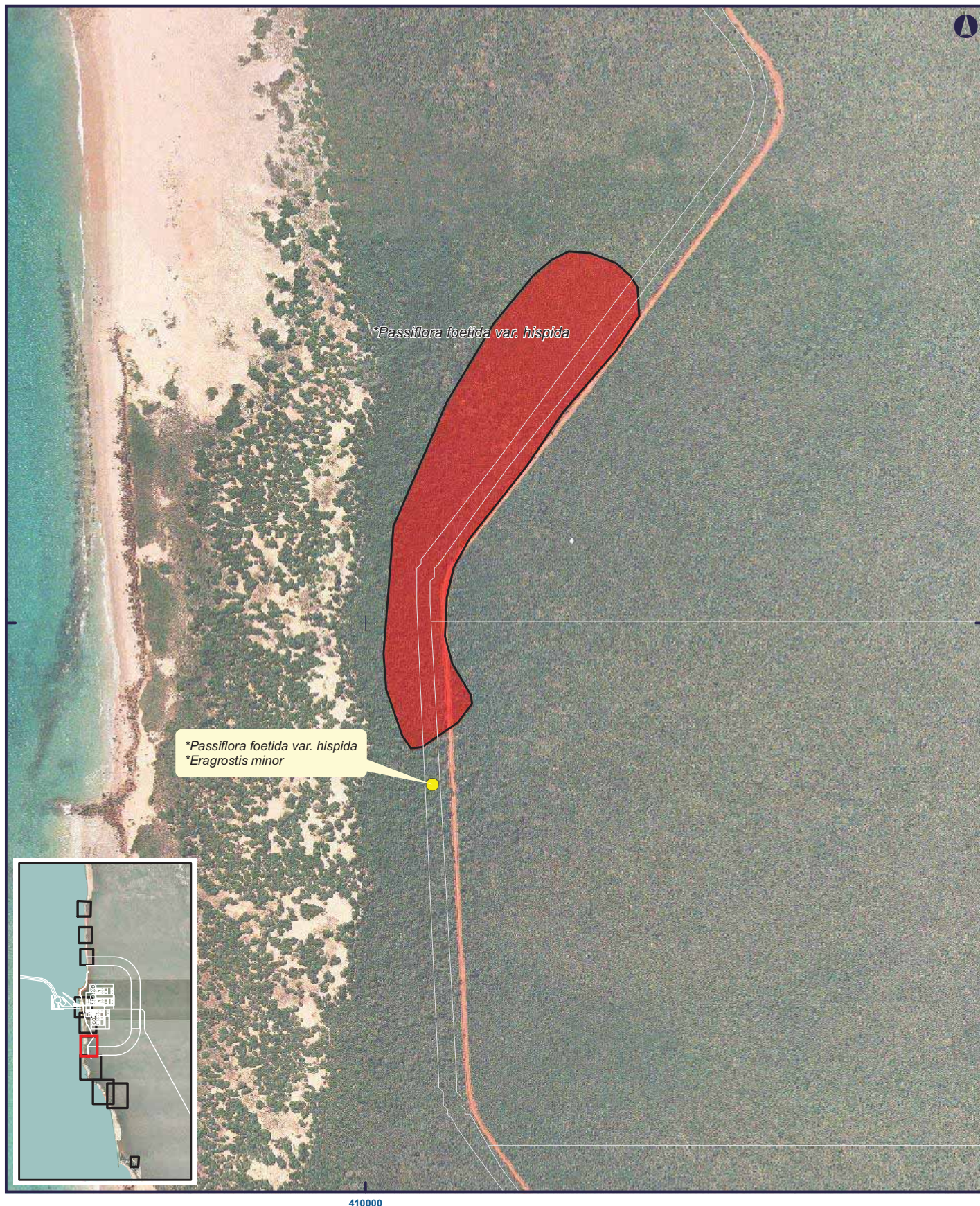
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Weed Mapping

Figure 7

0 100 200
Metres
1:10,000

AECOM Weed Survey

- *Leucaena leucocephala
- *Macroptilium atropurpureum
- *Passiflora foetida var. hispida
- *Sida acuta
- *Stylosanthes hamata
- *Aerva javanica
- *Cenchrus ciliaris
- *Aerva javanica, *Cenchrus ciliaris

- *Aerva javanica, *Macroptilium atropurpureum
- *Leucaena leucocephala, *Cenchrus ciliaris
- *Passiflora foetida var. hispida, *Cenchrus ciliaris
- *Passiflora foetida var. hispida, *Macroptilium atropurpureum
- *Passiflora foetida var. hispida, *Stylosanthes hamata
- *Stylosanthes hamata, *Cenchrus ciliaris
- Four species of weeds present
- 2009 Biota Survey - Weeds

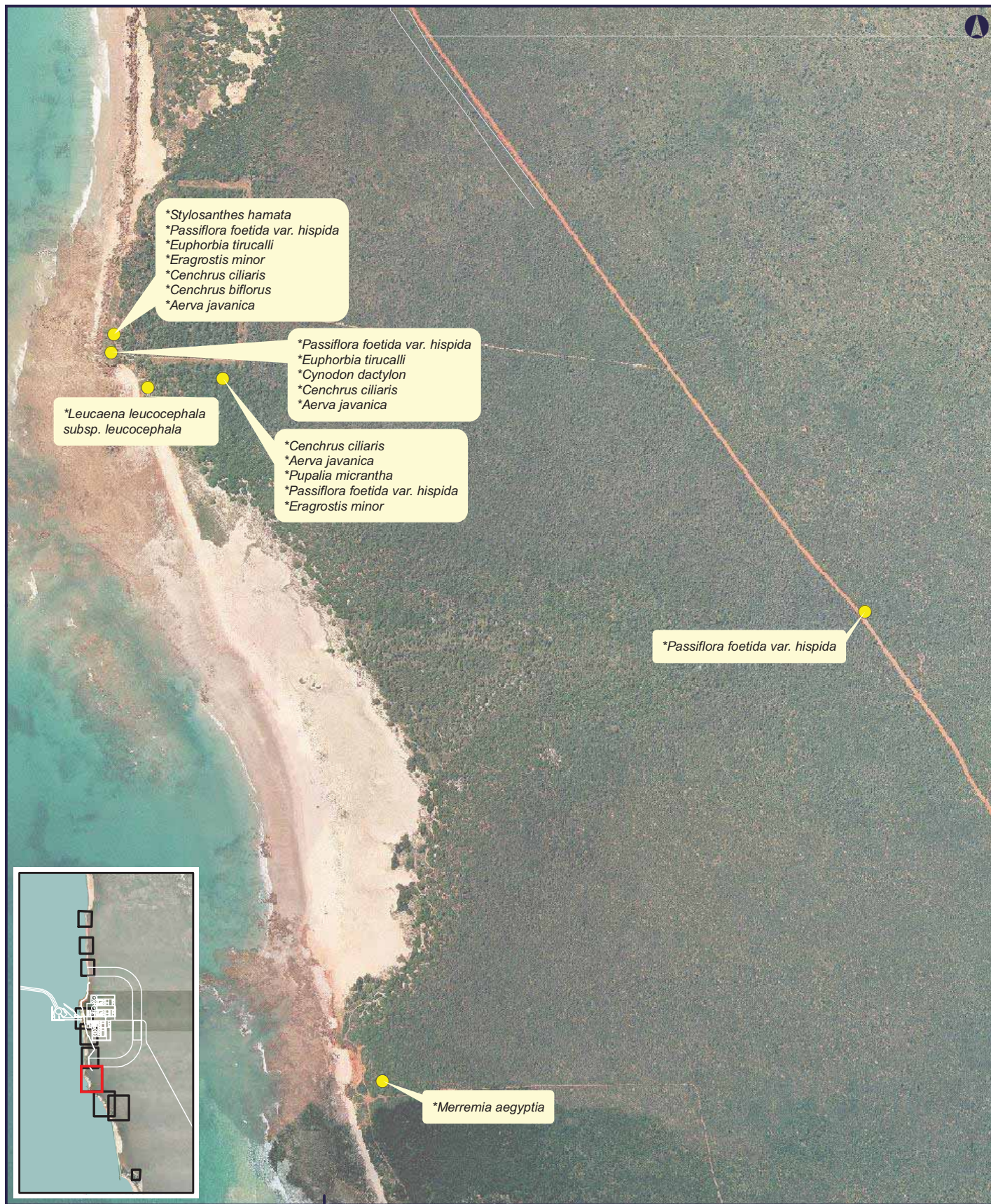
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410000

Weed Mapping

Figure 8

0 100 200 300
Metres
1:12,500

AECOM Weed Survey

- **Leucaena leucocephala*
- **Macroptilium atropurpureum*
- **Passiflora foetida* var. *hispida*
- **Sida acuta*
- **Stylosanthes hamata*
- **Aerva javanica*
- **Cenchrus ciliaris*
- **Aerva javanica*,
**Cenchrus ciliaris*

- **Aerva javanica*,
**Macroptilium atropurpureum*
- **Leucaena leucocephala*,
**Cenchrus ciliaris*
- **Passiflora foetida* var. *hispida*,
**Cenchrus ciliaris*
- **Passiflora foetida* var. *hispida*,
**Macroptilium atropurpureum*
- **Passiflora foetida* var. *hispida*,
**Stylosanthes hamata*
- **Stylosanthes hamata*,
**Cenchrus ciliaris*
- Four species of weeds present
- 2009 Biota Survey - Weeds

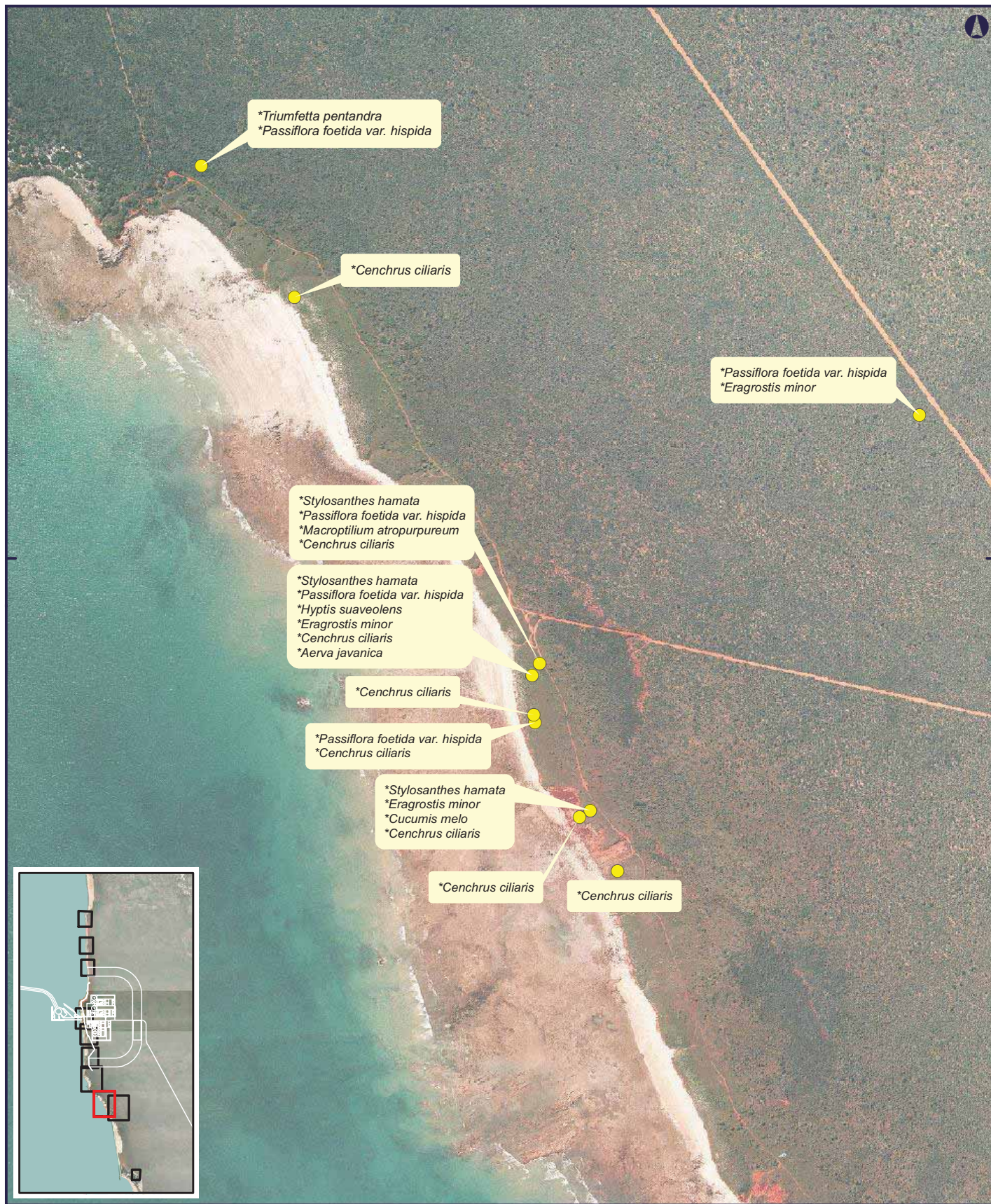
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Weed Mapping

Figure 9

0 100 200 300
Metres
1:12,500

AECOM Weed Survey

- *Leucaena leucocephala*
- *Macroptilium atropurpureum*
- *Passiflora foetida var. hispida*
- *Sida acuta*
- *Stylosanthes hamata*
- *Aerva javanica*
- *Cenchrus ciliaris*
- *Aerva javanica, *Cenchrus ciliaris*

- *Aerva javanica, *Macroptilium atropurpureum*
- *Leucaena leucocephala, *Cenchrus ciliaris*
- *Passiflora foetida var. hispida, *Cenchrus ciliaris*
- *Passiflora foetida var. hispida, *Macroptilium atropurpureum*
- *Passiflora foetida var. hispida, *Stylosanthes hamata*
- *Stylosanthes hamata, *Cenchrus ciliaris*
- Four species of weeds present
- 2009 Biota Survey - Weeds

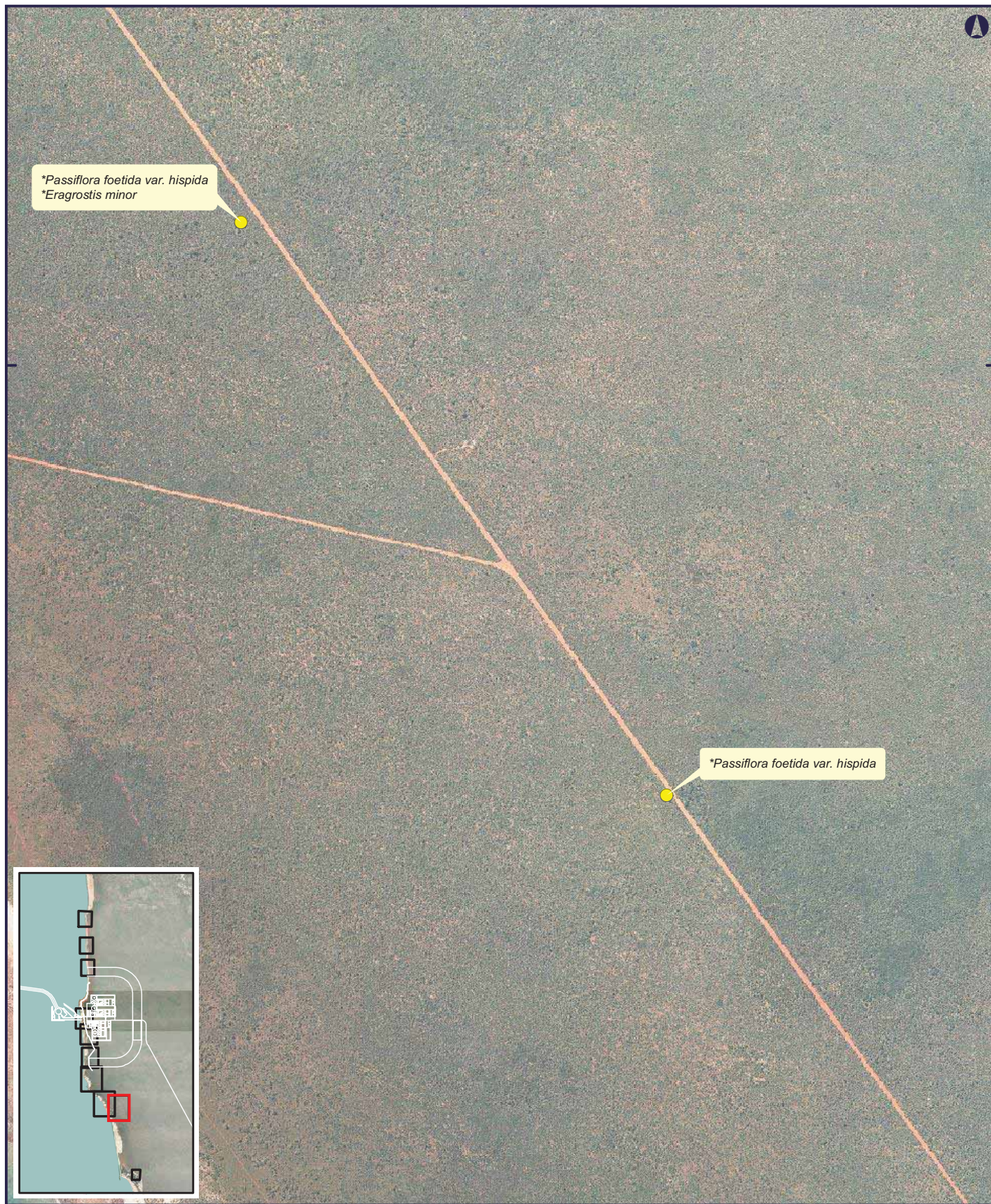
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Weed Mapping

Figure 10

0 100 200 300
Metres
1:12,500

AECOM Weed Survey

- **Leucaena leucocephala*
- **Macroptilium atropurpureum*
- **Passiflora foetida var. hispida*
- **Sida acuta*
- **Stylosanthes hamata*
- **Aerva javanica*
- **Cenchrus ciliaris*
- **Aerva javanica*,
**Cenchrus ciliaris*

- **Aerva javanica*,
**Macroptilium atropurpureum*
- **Leucaena leucocephala*,
**Cenchrus ciliaris*
- **Passiflora foetida var. hispida*,
**Cenchrus ciliaris*
- **Passiflora foetida var. hispida*,
**Macroptilium atropurpureum*
- **Passiflora foetida var. hispida*,
**Stylosanthes hamata*
- **Stylosanthes hamata*,
**Cenchrus ciliaris*
- Four species of weeds present
- 2009 Biota Survey - Weeds

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415000

Weed Mapping

Figure 11

0 100
Metres
1:5,000

AECOM Weed Survey

- **Leucaena leucocephala*
- **Macroptilium atropurpureum*
- **Passiflora foetida* var. *hispida*
- **Sida acuta*
- **Stylosanthes hamata*
- **Aerva javanica*
- **Cenchrus ciliaris*
- **Aerva javanica*,
**Cenchrus ciliaris*

- **Aerva javanica*,
**Macroptilium atropurpureum*
- **Leucaena leucocephala*,
**Cenchrus ciliaris*
- **Passiflora foetida* var. *hispida*,
**Cenchrus ciliaris*
- **Passiflora foetida* var. *hispida*,
**Macroptilium atropurpureum*
- **Passiflora foetida* var. *hispida*,
**Stylosanthes hamata*
- **Stylosanthes hamata*,
**Cenchrus ciliaris*
- Four species of weeds present
- 2009 Biota Survey - Weeds

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Appendix D

Quadrat Data

JP40

411515E 8063823N

Occasional *Corymbia polycarpa* over a Tall Open Scrub of *Acacia eriopoda* and *Acacia monticola* over a mixed Shrubland dominated by *Distichostemon hispidulus* and *Lithomyrtus retusa* over a Low Open Shrubland of *Erythrophleum chlorostachys* and *Codonocarpus cotinifolius* over scattered *Aristida* sp. and *Eragrostis* sp. on orange sandy loam (Pindan).



Species	Height (cm)	% Cover Alive	% Cover Dead
<i>Acacia colei</i>	250	<1	<1
<i>Acacia eriopoda</i>	400	5	30
<i>Acacia hippuroides</i>	120	1	5
<i>Acacia monticola</i>	300	5	15
<i>Aristida</i> sp.	50	<1	
<i>Brachychiton diversifolius</i>	80	<1	<1
<i>Cassytha filiformis</i>	Vine	<1	<1
<i>Codonocarpus cotinifolius</i>	60	<1	2
<i>Corymbia greeniana</i>	50	<1	<1
<i>Corymbia polycarpa</i>	400	1	2
<i>Distichostemon hispidulus</i>	120	2	10
<i>Eragrostis</i> sp.	30	<1	<1
<i>Erythrophleum chlorostachys</i>	60	2	5
<i>Ficus aculeata</i> var. <i>indecora</i>	260	2	2
<i>Grevillea pyramidalis</i>	180	1	2
<i>Grevillea refracta</i>	150	<1	2
<i>Gyrostemon tepperi</i>	140	<1	
<i>Lithomyrtus retusa</i>	150	2	5
<i>Marsdenia viridiflora</i>	40	<1	<1
<i>Persoonia falcata</i>	140	2	<1
<i>Pavetta</i> sp.	80	<1	
<i>Solanum cunninghamii</i>	30	<1	
<i>Terminalia ferdinandiana</i>	250	<1	<1
<i>Ventilago viminalis</i>	100	<1	<1
<i>Waltheria indica</i>	50	<1	

JP37

414549E 8066953N

Low Open Woodland of *Corymbia setosa*, *Corymbia polycarpa* and *Eucalyptus miniata* over a Tall Closed Scrub of *Acacia eriopoda*, *Acacia monticola* and *Acacia colei* var. *colei* over a Shrubland dominated by *Acacia hippuroides* and *Grevillea refracta* over scattered *Aristida* sp. and *Yakirra australis* on red-orange sand (Pindan).



Species	Height (cm)	% Cover Alive	% Cover Dead
<i>Acacia colei</i> var. <i>colei</i>	250	2	10
<i>Acacia eriopoda</i>	300	15	30
<i>Acacia hippuroides</i>	120	2	5
<i>Acacia monticola</i>	250	10	30
<i>Aristida</i> sp.	50	<1	
<i>Brachychiton diversifolius</i>	180	1	2
<i>Calytrix exstipulata</i>	50	1	
<i>Cassytha filiformis</i>	Vine	<1	
<i>Corymbia polycarpa</i>	350	<1	
<i>Corymbia zygophylla</i>	500	1	
<i>Distichostemon hispidulus</i>	110	2	
<i>Dolichandrone heterophylla</i>	250	<1	
<i>Ehretia saligna</i>	150	<1	
<i>Eucalyptus miniata</i>	350	1	
<i>Gardenia resinosa</i> ssp. <i>keartlandii</i>	150	<1	
<i>Grevillea refracta</i>	150	2	5
<i>Gyrostemon tepperi</i>	120	<1	2
<i>Lithomyrtus retusa</i>	100	2	
<i>Persoonia falcata</i>	200	<1	
<i>Santalum lanceolatum</i>	140	1	
<i>Terminalia ferdinandiana</i>	240	1	
<i>Yakirra australis</i>	10		<1