Appendix V: GHD BSIA Flora and Fauna Assessment

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LandCorp

Report for Proposed Boodarie Industrial Area

Flora and Fauna Assessment

June 2010

INFRASTRUCTURE | MINING & INDUSTRY | DEFENCE | PROPERTY & BUILDINGS | ENVIRONMENT

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Executive Summary

LandCorp commissioned GHD Pty Ltd (GHD) to conduct a Level 2 Flora and Level 1 Fauna survey of the proposed Industrial Estate in Boodarie. The proposed Boodarie site (study area) is approximately 3770 hectares and is located approximately 5 km to the west of South Hedland townsite. The site is bordered by the Great Northern Highway to the east and the BHP Billiton's hot briquetted iron (HBI) plant and Finucane Island access road to the north. The flora and fauna assessment is required to provide the necessary information to support a Native Vegetation Clearing Permit Application and other environmental approvals which may be required for the proposed activities.

The flora and fauna assessment included a field survey that was conducted between the 8th and 12th of June 2009. The results of the assessment are summarised below:

- There are no permanent natural freshwater watercourses or wetlands within the study area. A minor ephemeral watercourse/tidal creekline is situated within the proposed powerline corridor;
- The Department of Water (DoW) Geographic Data Atlas indicates that the study area is within both the RIWI Act proclaimed Pilbara groundwater area and surface water area;
- The DoW Geographic Data Atlas indicates that the southern part of the study area is located on northern boundary of a Public Drinking Water Source Area (PDWSA), the Turner River Water Reserve. This PDWSA has not been assigned a priority classification, however advice from DoW is that the Turner River PDWSA is likely to be assigned a Priority 1 classification.
- No reserves or conservation areas occur within the vicinity of the study area;
- There are no Environmentally Sensitive Areas (ESAs) within the study area or in the surrounding area;
- The study area is situated predominantly on the Uaroo Land System, which is described as 'broad sandy plains supporting shrubby hard and soft spinifex grasslands'. A small section in the proposed powerline corridor, associated with the creekline, is within the Littoral land system. The Littoral land system is described as bare coastal mudflats with mangroves on seaward fringes, samphire flats, sandy islands, coastal dunes and beaches.
- Based on the mapping by Beard (1979) and analysis of vegetation extent by Shepherd et al. (2002) and Shepherd (2005), the vegetation type present within the majority of the study area is Vegetation Association 589: short bunch grassland - savanna / grass plain (Pilbara) / Hummock grasslands, grass steppe; soft Spinifex The northern and southern parts of the study area are within vegetation association 647 described as Hummock grasslands, dwarf-shrub steppe; *Acacia translucens* over soft Spinifex. The extent of the vegetation in the study area is considered of Least Concern, with more than 50% of the pre-European extent of these vegetation types considered to be remaining;

- The vegetation within the survey area was classified into nine vegetation types, described as following:
  - Bare areas/tidal creekline with low scattered shrubs of Chenopod spp
  - *Eucalyptus victrix* Dampland
  - *Triodia epactia* tussock grassland with groves of *Acacia* spp.
  - *Acacia stellaticeps* low open heath over *T. epactia* tussock grassland
  - *A. stellaticeps* low closed heath over tussock grassland of *Triodia schinzii* and *T. epactia*
  - Open shrubland of *Acacia* spp. and *Hakea lorea* subsp. *lorea* over tussock grassland of mixed *Triodia* spp.
  - Scattered *Owenia reticulata* over shrubland of *Acacia* spp. over tussock grassland
  - Cleared/Disturbed
- The native vegetation within the study area was assessed to be predominantly in *Excellent* condition. The vegetation structure within much of the study area however, has been severly impacted by fire. Fire scarring occurs across most of the study area. Other disturbances across the study area include tracks/roads, powerlines, cattle grazing, and the existing Alinta power station;
- No Threatened Ecological Communities (TECs) or Priority Ecological Communities (PECs) were recorded within the study area;
- Plant species diversity within the study area is considered to represent a moderate degree of diversity. A total of 144 taxa from 48 families were recorded from the study area;
- No Declared Rare Flora or Priority Flora species were recorded within the study area;
- A significant range extension of approximately 500 km was recorded for *Stemodia lathraia* which has previously only been collected from the Kimberley region.
- Three weed species were recorded within the survey area; **Cenchrus ciliaris* (Buffel Grass), **Aerva javanica* (Kapok Bush), and **Chloris barbata* (Purpletop Chloris). These species were generally concentrated in previously disturbed areas such as along tracks and roads;
- A total of thirty-four bird, five mammal and seven reptile species were recorded during the reconnaissance survey within the study area;
- Mulgara (*Dasycercus cristicauda*) is a conservation significant species that is known to occur within the Port Hedland area. Mulgara have recently been recorded in the Wedgefield area in Port Hedland. Evidence of Mulgara (scats and burrows) was observed within the study area during the field survey. A detailed fauna survey would be required to verify the presence of this species within the study area;
- The project has been assessed against the Department of Environment and Conservation's "Ten Clearing Principles" as likely to be at variance with Principle

(b) and Principle (f). The project is unlikely to be at variance with all other principles;

- Short term soil erosion may occur within the project area following any potential clearing. Soil erosion can be mitigated by use of appropriate water management and rehabilitation regimes; and
- The proposed clearing has the potential to introduce and/or spread weeds within and surrounding the study area. Management measures should be implemented to minimise the introduction and spread of weeds.

1. Introduction

1.1 Background

LandCorp has commissioned GHD Pty Ltd (GHD) to conduct a Flora and Fauna Survey within the proposed Boodarie Industrial Estate. The flora and fauna assessment is required to provide the necessary information to support a Native Vegetation Clearing Permit Application and other environmental approvals which may be required for the proposed activities.

1.2 Study Area

The proposed Boodarie site (study area) lies within the Shire of Port Hedland in the Pilbara Region of Western Australia. The site is located approximately 5 km to the west of South Hedland townsite. The site is bordered by the Great Northern Highway to the east and the BHP Billiton's hot briquetted iron (HBI) plant and Finucane Island access road to the north. The study area covers an area of approximately 5000 hectares.

The location of study area is shown in Figure 1, Appendix A.

1.3 Scope of Works

This flora and fauna assessment included both desktop and field assessments. The desktop assessment included:

- A review of the Department of Environment and Conservation's (DEC) Rare and Threatened Flora database;
- A review of the DEC's Threatened Fauna database;
- A review of local and regional significance of plant communities;
- A review of the Western Australian Museum database for threatened and endangered fauna;
- A review of the DEC's Environmentally Sensitive Areas (ESAs); and
- A review of the Department of the Environment, Water, Heritage and Arts (DEWHA) database for areas listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The field survey verified the desktop study and provided a detailed assessment of the existing environment in the survey area and its relationship to adjoining areas. The field survey included the following actions and details:

- An inventory of the vascular plant species in the study area, undertaken through transect survey methods;
- A review of, and search for, significant flora species;
- An inventory of dominant exotic plants, including declared noxious plants and environmental weed species;

- Advice on whether weeds are likely to spread to and result in environmental harm to adjacent areas of native vegetation that are in good or better condition;
- A description and location, including mapping, of plant communities;
- A rating of condition of the vegetation communities or areas;
- A review of the local and regional significance of the plant communities in terms of their intrinsic value, extent, rarity and condition;
- Assessment of potential clearing against the Environmental Protection Act's 10 Clearing Principles (Schedule 5). Each principle has been assessed in accordance with the DEC's Guideline to Assessment – Clearing of Native Vegetation.
- An inventory of the vertebrate fauna species in the study area through targeted searches and opportunistic recording of species;
- Review of the fauna species considered to be rare or in need of special protection;
- Review of the presence and abundance of pest, declared or feral animals; and
- Identification of any habitats of significance.

2. Existing Environment

2.1 Climate

The Pilbara region of Western Australia has an arid to semi-arid climate with distinct seasons, a hot dry summer, autumn, winter and spring. Rainfall is low throughout the Pilbara and quite variable. Annual totals vary from 250mm to 450 mm and many years without significant rainfall occur. The lower totals are typical of the south where tropical cyclone effects are less frequent. Most of the summer rain comes from scattered thunderstorms and the occasional tropical cyclone. A secondary peak in the monthly rainfall occurs in May as a result of rainfall caused by tropical cloud bands which intermittently affect the area mostly in May and June. These events can also produce low maximum temperatures particularly away from the coast. Thunderstorms average 20-30 per annum over most of the area but 15-20 is more common near the coast. Almost all storms occur in the summer.

The Bureau of Meteorology weather station located nearest to the study areas is at Port Hedland Post Office. Recorded climatic data is summarised below:

- Mean Daily Maximum Temperature: 27.2°C (July) – 36.8°C (March)
- Mean Daily Minimum Temperature: 25.5°C (Jan/Feb) – 12.2°C (July)
- Mean Annual Rainfall: 313.9mm
- Mean Annual Rain Days: 20.6 days

(Source: BoM, 2009)

2.2 Land Systems

Land systems are described in terms of geology, landscape, soil and vegetation types. Van Vreeswyk *et al.* (2004) completed an inventory of the land systems occurring in the Pilbara Region. Within the Pilbara 102 land systems have been identified. The land systems have been derived from aerial photography, and descriptions were built up using field data collected during traversing and at inventory sites.

The study area is predominantly within the Uaroo land system which is described as broad sandy plains supporting shrubby hard and soft spinifex grasslands. A small section of the proposed powerline corridor, associated with the creekline, is within the Littoral land system. The Littoral land system is described as bare coastal mudflats with mangroves on seaward fringes, samphire flats, sandy islands, coastal dunes and beaches.

2.3 Geology

The study area is located within the Abydos Plain. The geology of this area is described as Quarternary alluvium near the coast, further inland Archean granite; other Archean rocks outcropping in small hills, ranges and dykes.

The geology of the Uaroo land system is described as Quaternary colluvium and alluvium. The geology of the Littoral land system consists of quaternary mudflat deposits, clay, salt and sand; eolian sand.

2.4 Wetlands and Watercourses

Waterways and wetland areas within the Pilbara region are ephemeral, and typically flow or fill during seasonal rainfall events. A search of the Western Australian *EPBC Act* Protected Matters Search Tool indicates no wetlands or watercourses of significance in or adjacent to the study area.

Southwest creek is a minor ephemeral watercourse/tidal creekline and is intersected by the powerlines corridor to the north-east of the study area.

2.5 Land Use

The dominant land use of the area is pastoral and the majority of the study area is currently used for cattle grazing. There is an Alinta power station on the corner of the Great Northern Highway and Boodarie Road.

2.6 Reserves and Conservation Areas

No reserves or conservation areas are within, or adjacent to, the study area.

2.7 Environmentally Sensitive Areas

The DEC's online Native Vegetation Viewer was searched to determine the location of any Environmentally Sensitive Areas (ESAs) within the vicinity of the project area, as declared by a Notice under Section 51B of the *Environmental Protection Act 1986*.

The search confirmed that there are no ESAs within or adjacent to the study area.

2.8 Public Drinking Water Source Area (PDWSA)

Public Drinking Water Source Areas (PDWSAs) is a collective term used for the description of Water Reserves, Catchment Areas and Underground Pollution Control Areas declared (gazetted) under the provisions of the *Metropolitan Water Supply, Sewage and Drainage* (MWSSD) *Act* 1909 or the *Country Area Water Supply* (CAWS) *Act 1947.* The protection of PDWSAs relies on statutory measures available in water resource management and land use planning legislation. The DoW policy for the protection of PDWSAs includes three risk management based priority classification areas and two types of protection zones.

The DoW Geographic Data Atlas indicates that the study area south of Boodarie Road is located on northern boundary of a PDWSA, the Turner River Water Reserve. This PDWSA has not been assigned a priority classification. The classification has not been assigned as the Department of Water is yet to prepare a drinking water source protection plan for this area. Advice from the DoW is that the Turner River PDWSA is likely to be assigned a Priority 1 classifcation.

Priority 1 classified areas are managed to ensure there is no degradation of the drinking water source. This is achieved by preventing the the development of potentially harmful activites. The development of an industrial estate is considered to be an incompatible landuse in a Priority 1 area.

2.9 Vegetation

2.9.1 Vegetation Descriptions

The study area falls within the Roebourne subregion of the Pilbara Biogeographic region of Western Australia. The environment of this subregion has been described as coastal and sub-coastal plains with a grass savannah of mixed bunch and hummock grasses and dwarf shrub steppe of *Acacia stellaticeps* or *A. pyrifolia* and *A. inaequilatera* (Kendrick and Stanley, 2001). The uplands of the region support *Triodia* hummock grasslands and the ephemeral drainage lines support *Eucalyptus victrix* or *Corymbia hamersleyana* (Kendrick and Stanley, 2001).

Broadscale mapping (Beard, 1979) indicates two vegetation associations are present within the Study Area. The majority of the study area is within vegetation association 589, described as Short bunch grassland - savanna / grass plain (Pilbara) / Hummock grasslands, grass steppe; soft Spinifex. The northern and southern parts of the study area are within vegetation association 647 described as Hummock grasslands, dwarf-shrub steppe; *Acacia translucens* over soft Spinifex.

2.9.2 Vegetation Extent, Type and Status

A vegetation type is considered underrepresented if there is less than 30 percent of its original distribution remaining. From a purely biodiversity perspective and not taking into account any other land degradation issues, there are several key criteria now being applied to vegetation (EPA, 2000):

- The “threshold level” below which species loss appears to accelerate exponentially at an ecosystem level is regarded as being at a level of 30% of the pre-European (pre-1750) extent of the vegetation type;
- A level of 10% of the original extent is regarded as being a level representing *Endangered*; and
- Clearing which would put the threat level into the class below should be avoided.

Such status can be delineated into five (5) classes, where:

- *Presumed Extinct*: Probably no longer present in the bioregion
- *Endangered**: <10% of pre-European extent remains
- *Vulnerable**: 10-30% of pre-European extent exists
- *Depleted**: >30% and up to 50% of pre-European extent exists
- *Least Concern*: >50% pre-European extent exists and subject to little or no degradation over a majority of this area.

* or a combination of depletion, loss of quality, current threats and rarity gives a comparable status

The extent of remnant native vegetation has been assessed by Shepherd (2002), based on vegetation association mapping undertaken by Beard (1979). The remaining extent of the vegetation associations present within the study area, for the Roebourne subregion, is detailed in Table 1.

The extent of the vegetation in the survey areas is considered of *Least Concern*, i.e. intact, with close to 100% of the pre-European extents of the vegetation types considered to be remaining.

Table 1 Major Vegetation System Associations within the Study Area (Shepherd, 2002).

Vegetation Association Number	Association Description	Pre-European Extent (ha) in Roeburne IBRA subregion	Current Extent (ha) in Roeburne IBRA subregion	% Remaining	% Pre-European Extent in Conservation Reserves
589	Mosaic: Short bunch grassland - savanna / grass plain (Pilbara) / Hummock grasslands, grass steppe; soft spinifex	730724.4	730689.6	100	1.8
647	Hummock grasslands, dwarf-shrub steppe; Acacia translucens over soft spinifex	189414.087	189414.087	100	0

2.9.3 Threatened Ecological Communities (TEC)

Ecological communities are defined as 'naturally occurring biological assemblages that occur in a particular type of habitat' (English and Blythe, 1997). Threatened Ecological Communities (TECs) are ecological communities that have been assessed and assigned to one of four categories related to the status of the threat to the community, i.e. Presumed Totally Destroyed, Critically Endangered, Endangered, and Vulnerable.

Some TECs are protected under the *EPBC Act*. Although TECs are not formally protected under the State *Wildlife Conservation Act 1950,* the loss of, or disturbance to, some TECs triggers the *EPBC Act*. The Environmental Protection Authority's (EPA's) position on TECs states that proposals that result in the direct loss of TECs are likely to require formal assessment.

Possible TECs that do not meet survey criteria are added to the Department of Environment and Conservation's (DEC) Priority Ecological Community (PEC) Lists under Priorities 1, 2 and 3. These are ecological communities that are adequately known; are rare but not threatened, or meet criteria for Near Threatened. PECs that have been recently removed from the threatened list are placed in Priority 4. These

ecological communities require regular monitoring. Conservation Dependent ecological communities are placed in Priority 5.

The Department of Environment and Conservation's (DEC's) Threatened Ecological Community (TEC) database was queried for known occurrences of TECs and PECs near the study area.

No TECs or PECs have been recorded within or in close proximity to the study area.

2.10 Significant Flora

Commonwealth

Species of significant flora are protected under both State and Commonwealth Acts. Any activities that are deemed to have a significant impact on species that are recognised by the *EPBC Act*, and the *Wildlife Conservation Act 1950* can trigger referral to the DEWHA and/or the EPA.

A description of Conservation Categories delineated under the *EPBC Act* is detailed in Table 6, Appendix B. These are applicable to threatened flora and fauna species.

A search of the *EPBC Act* Protected Matters Search Tool did not identify any Commonwealth protected flora species within 10 km of the survey area.

State

In addition to the *EPBC Act,* significant flora in Western Australia is protected by the *Wildlife Conservation Act 1950*. This *Act*, which is administered by the DEC, protects Declared Rare Flora (DRF) species. The DEC also maintains a list of Priority Listed Flora (PLF) species. Conservation codes for flora species are assigned by the DEC to define the level of conservation significance. PLF are not currently protected under the *Wildlife Conservation Act 1950*. PLF may be rare or threatened, but cannot be considered for declaration as rare flora until adequate surveys have been undertaken of known sites and the degree of threat to these populations clarified. Special consideration is often given to sites that contain PLF, despite them not having formal legislatory protection. A description of the DEC's Conservation Codes that relate to flora species is provided in Table 7, Appendix B.

A search of the DEC's Rare Flora Databases, Western Australian Herbarium (WAHERB) and Western Australian Museum (*NatureMap*) records was undertaken. Records identified no Declared Rare flora species occur within 25 km of the study area. There are however, eight Priority Flora species that have been recorded within the search area. These species are outlined in Table 2.

Table 2 Significant flora species previously recorded within 25 km of the study area (DEC, WAHERB and WA Museum)

Family	Genus	Species	Details and Habitat	DEC Conservation code
Asteraceae	*Pterocaulon*	sp. A Kimberley Flora (B.J. Carter 599)	Compact shrub, to 0.5 m high. Flowers blue, purple, Apr–Aug. Preferred habitat is sand in coastal areas, saline sandy flats, and pindan sandplain.	P2
Amaranthaceae	*Gomphrena*	*pusilla*	Slender branching annual, herb, to 0.2 m high. Flowers white, March-June. Preferred habitat is fine beach sand behind foredune on limestone.	P2
Amaranthaceae	*Ptilotus*	*appendiculatus* var. *minor*	Prostrate or ascending perennial, herb or shrub.	P1
Asclepiadaceae	*Gymnanthera*	*cunninghamii*	Erect shrub, 1–2 m high. Flowers cream, yellow, green, Jan–Dec. Preferred habitat is sandy soils.	P3
Boraginaceae	*Heliotropium*	*muticum*	Ascending to spreading perennial, herb, to 0.3 m high.	P1
Cyperaceae	*Bulbostylis*	*burbidgeae*	Tufted, erect to spreading annual, grass-like or herb (sedge), 0.03–0.25 m high, spikelets in a simple umbel or rarely solitary; stamens 3; involucral bracts long, hairy. Flowers brown, Mar/Jun–Aug. Preferred habitat is granitic soils on granite outcrops and cliff bases.	P3
Euphorbiaceae	*Euphorbia*	*clementii*	Erect herb, to 0.6 m high. Preferred habitat gravelly hillsides and stony grounds.	P2
Mimosaceae	*Acacia*	*glaucocaesia*	Dense, glabrous shrub or tree, 1.8–6 m high. Flowers yellow, Jul–Sep. Preferred habitat red loam, sandy loam, clay on floodplains.	P3
Papilionaceae	*Crotalaria*	*spectabilis* subsp. *spectabilis*	Annual herb, ca 2 m high. Flowers yellow.	P1
Papilionaceae	*Tephrosia*	*andrewii*	Ascending, multistemmed shrub, to	P1

Family	Genus	Species	Details and Habitat	DEC Conservation code
			0.8 m high. Flowers orange, Apr/Oct. Preferred habitat sand in pindan country.	
Papilionaceae	*Tephrosia*	*rosea* var. *venulosa*	Erect shrub, to 1.7 m high. Flowers re, purple, Aug-Sep. Preferred habitat in red sand near creeks.	P1

2.11 Fauna

2.11.1 Fauna within the general area

The Western Australian Museum *NatureMap* online search was conducted for a 20 km buffer of the study area. The search identifies terrestrial vertebrate species recorded in the collections of the Western Australian Museum. The search identified the potential presence of twenty-four bird, fifty-eight reptile, seven amphibians and sixteen mammal species.

A full list of species recorded from the WA Museum database is presented in Table 12, Appendix C.

It should be noted that some of the records of the Museum are historical and some of the recorded species may now be locally extinct. Additionally these records may include species (particularly bird species) that are vagrants or present in the general area but not present within the study area due to lack of suitable habitat.

2.11.2 Significant Fauna Species

The conservation of fauna species and their significance status is currently assessed under both State and Commonwealth Acts. The acts include the *Western Australian Wildlife Conservation Act* 1950; *Wildlife Conservation (Specially Protected Fauna) Notice 2003,* and the *EPBC Act*.

The significance levels for fauna used in the EPBC Act are those recommended by the International Union for the Conservation of Nature and Natural Resources (IUCN). A description of Conservation Categories delineated under the EPBC Act is detailed in, Table 6, Appendix B and the circumstances under which a project will trigger referral to the DEWHA are described in Appendix C. The *WA Wildlife Conservation Act 1950* uses a set of Schedules but also classifies species using some of the IUCN categories. These Schedules are described in Table 9, Appendix C. The EPBC Act also protects migratory species that are listed under the following International Agreements:

- Appendices to the Bonn Convention (Convention on the Conservation of Migratory Species of Wild Animals) for which Australia is a Range State under the Convention;

- The Agreement between the Government of Australia and the Government of the Peoples Republic of China for the Protection of Migratory Birds and their Environment (CAMBA);
- The Agreement between the Government of Japan and the Government of Australia for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment (JAMBA); and
- The Agreement between the Government of Australia and the Government of the Republic of Korea on the Protection of Migratory Birds (ROKAMBA).

Listed migratory species also include species identified in other international agreements approved by the Commonwealth Environment Minister.

The Act also protects marine species on Commonwealth lands and waters.

In Western Australia, the DEC also produces a supplementary list of Priority Fauna, these being species that are not considered Threatened under the Western Australian *Wildlife Conservation Act 1950* but for which the Department feels there is a cause for concern. These species have no special legislatory protection, but their presence would normally be considered. Such taxa need further survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna. Levels of Priority are described in Table 10, Appendix C.

The DEWHA maintains a database of matters of national environmental significance that are protected under the *EPBC Act.* An *EPBC Act* Protected Matters Report was generated (from the website of the DEWHA), for the matters of significance that may occur in, or may relate to, the survey area. A search of the DEC's Threatened Fauna database for any rare and priority species that may occur in the survey area was also undertaken.

From the DEC and DEWHA databases, a number of protected fauna species were identified as potentially occurring within the survey area, which are listed in Table 11, Appendix C.

Marine species have been excluded from this table as the survey area does not include marine habitat. It should be noted that some species that appear in the *EPBC Act* Protected Matters Search Tool are often not likely to occur within the specified area, as the search provides an approximate guidance to matters of national significance that require further investigation. The records from the DEC searches of threatened fauna provide more accurate information for the general area; however some records of sightings or trappings can be dated and often misrepresent the current range of threatened species.

3. Methodology

3.1 Vegetation and Flora Assessment

The vegetation and flora field survey were undertaken with regards to the EPA's Guidance Statements No. 51, where possible. GHD's qualified ecologists conducted the field flora survey between the 8th and 12th June 2009.

The flora and vegetation survey was conducted using quadrats and relévés (unbounded search areas) across the project area. The relévés included recording a list of flora species visible at the time and mapping of vegetation types and conditions (including weed status). Aerial photography was used to assist in the delineation of vegetation types present in the study area. Detailed information was collected in fourteen 50 x 50 metre quadrats in the delineated vegetation types.

A list of flora species collated from the quadrats and relévés was generated for the study area. Where identification of flora species was uncertain, confirmation was made at the Western Australian State Herbarium.

The presence of Declared Rare or Priority Flora was assessed. Suitable habitat for DRF and Priority Flora species was searched. Vegetation was also assessed to determine the presence of TECs within the study area.

3.2 Fauna

GHD's qualified ecologists conducted the fauna investigation in conjunction with the flora investigation. The fauna survey included desktop investigations and field surveys, conducted with regard to the EPA's Guidance Statement No. 56, where possible.

The fauna survey was an opportunistic survey and did not involve any fauna trapping. The survey involved visual and aural surveys for any fauna species utilising the study area. The study area was also searched for any fauna signs, such as tracks, scats, bones, diggings and feeding signs.

Surveys also included systematic searching across all habitat types, which is an effective method of surveying for many reptile species. This involved searching through microhabitats where reptiles are known to frequent, including turning over logs or rocks, turning over leaf litter and examining hollow logs. Reptiles were also sighted as they basked during the day.

Species – specific search strategies were used to identify any protected species in the area or evidence that they utilise the study area.

3.3 Nomenclature

Nomenclature used in this report follows that used by the DEC's *FloraBase* program and Western Australian Museum *NatureMap* program as they are deemed to contain the most up-to-date species information for Western Australia.

3.4 Limitations

Complete flora and vegetation assessments can require multiple surveys, at different times of year, and over a period of a number of years, to enable observation of all species present.

Some flora species, such as annuals, are only available for collection at certain times of the year, and others are only identifiable at certain times (such as when they are flowering). Additionally, climatic and stochastic events (such as fire) may affect the presence of plant species. Species that have a very low abundance in the area are more difficult to locate, due to above factors. Therefore, while this flora survey was relatively exhaustive, it is possible that some species with low abundance, or with a very restricted range in the project area may have been overlooked.

The flora surveys were also restricted to predominantly flowering plants, with consideration of some other vascular plants such as cycads. Non-vascular plants were not systematically searched for, as the information available on these plants is generally limited.

The fauna survey undertaken was a reconnaissance survey only and thus only sampled those species that can be easily seen, heard or have distinctive signs, such as tracks, scats, diggings etc. Many cryptic and nocturnal species would not have been identified during a reconnaissance survey. Extensive detailed fauna surveys, involving trapping surveys, are required to obtain a more comprehensive list of fauna species that may utilise the site.

This survey was aimed at identifying the terrestrial vertebrate fauna of the study area; no sampling for invertebrates or aquatic species occurred.

4. Field Results

4.1 Vegetation and Flora

4.1.1 Vegetation Description

The vegetation in the survey area was classified into nine vegetation types, including cleared/disturbed vegetation, where clearing or other activities have fundamentally altered the composition of the native vegetation. There is considerable overlap between vegetation communities due to the similarity of underlying geology and landform.

The vegetation within the study area is dominated by low open heath over tussock grasslands, with changes due to differing dominance of individual grass/*Triodia* species, fire and other disturbances. Tussock grasslands are present with emergent tree overstorey species (Eucalypt and Acacia) on the sandplains.

Of note there are three vegetation communities that have not been sampled from quadrats. These included areas with very few species present, such as open tidal flats/creekline and cleared/degraded areas. The tidal flats vegetation is too open to incorporate traditional plot based or relévé surveys. In the cleared/degraded areas vegetation is absent, or with flora species known to respond to disturbances. A relévé was undertaken to record species within the dampland.

These vegetation types have been mapped at Figure 3, Appendix A and are described in Table 3.

Table 3 Boodarie Study Area Vegetation Communities and Description

Vegetation Community Number	Landscape	Broad Vegetation Type	Vegetation Community Description	Representative Quadrats
1	Tidal Creekline and associated flats	Bare areas/tidal creekline with low scattered shrubs of Chenopod spp.	This area consists of tidal soils with predominantly open ground with occasional patches of very scattered low shrublands of Chenopod spp., Trianthema spp. with scattered grasses and herbs including *Eragrostis falcata*, *Triodia epactia*, **Cenchrus ciliaris*, **Aerva javanica, Streptoglossa liatroides and Goodenia forrestii.*	
2	Floodplain	*Eucalyptus victrix* Dampland	Low woodland of *Eucalyptus victrix* over open grassland of *Eragrostis speciosa*, *Elytrophorus spicatus*, **Chloris barbata*, *Eriachne glauca* var. *glauca* with scattered *Marsilea drummondii* and *Goodenia lamprosperma*.	
3	Sandplain	*Triodia epactia* tussock grassland with groves of *Acacia* spp.	Tussock grassland of *Triodia epactia*, *Aristida* spp., *Eriachne aristidea* and scattered *T. schinzii* with scattered herbs and low shrubs of *Acacia stellaticeps*, *Corchorus walcottii* and *Indigofera monophylla* with scattered groves of *Acacia colei, Acacia inaequilatera* and *A. sericophylla* shrublands.	1, 6
4	Sandplain	*Acacia stellaticeps* low open heath over *T. epactia* tussock grassland	Low open heath of *Acacia stellaticeps* over tussock grassland of *Triodia epactia* with emergent *A. colei*, *A. coriacea* and *Hakea lorea* subsp. *lorea* over low scattered shrubs and herbs of *Corchorus walcottii*, *Indigofera monophylla* and *Bonamia rosea*.	2, 11
5	Sandplain	*A. stellaticeps* low closed heath over tussock grassland of *Triodia schinzii* and *T. epactia*	Low closed heath of *Acacia stellaticeps* over tussock grassland of *Triodia schinzii*, *T. epactia* and *Eragrostis cumingii* with scattered herbs and cyperus species	8, 9, 10

Vegetation Community Number	Landscape	Broad Vegetation Type	Vegetation Community Description	Representative Quadrats
			including *Senna notablis*, *Fibristylis oxystachya*, *Hibiscus leptocladus* and *Corchorus walcottii*.	
6	Sandplain	Open shrubland of *Acacia* spp. and *Hakea lorea* subsp. *lorea* over tussock grassland of mixed *Triodia* spp.	Open shrubland of *Acacia colei*, *A. sericophylla* and *Hakea lorea* subsp. *lorea* over low shrubland of *A. stellaticeps* and *Corchorus walcottii* over tussock grassland of *Triodia epactia*, *Triodia schinzii*, *T. basedowii*, *Eragrostis falcata* and *Eriachne* spp. over scattered herbs of *Senna notablis*, *Hybanthus aurantiacus* and *Sida* sp. Pilbara.	4, 5, 7
7	Sandplain / Floodplain	Scattered *Corymbia aspera* and *Eucalyptus victrix* over low open heath of *A. stellaticeps* over tussock grassland	Scattered low trees of *Corymbia aspera* and *Eucalyptus victrix* over low open heath of *Acacia stellaticeps* and *Corchorus walcottii* and emergent *A. colei* over tussock grassland of *Triodia epactia*, *Paspalidium constrictum*, *Eriachne aristidea* and *Eragrostis cumingii* with scattered herbs of *Hybanthus aurantiacus*, *Hibiscus leptocladus* and *Mollugo molluginea*.	12, 13, 14
8	Low Rises	Scattered *Owenia reticulata* over shrubland of *Acacia* spp. over tussock grassland	Scattered low trees of *Owenia reticulata* over shrubland of *Acacia colei*, Acacia stellaticeps and *Corchorus walcottii* over Tussock grassland of *Triodia epactia*, *Eragrostis falcata* and *Eriachne obtusa* with scattered herbs of *Hybanthus aurantiacus*, *Solanum dioicum* and *Indigofera linifolia*.	3
9	Cleared/disturbed vegetation	Cleared/Disturbed	Mostly confined to roads/tracks, powerlines, sand mine, and the power station. Vegetation dominated by mixed low shrubs, herbs, and grass species (weed species).	

4.1.2 Vegetation Condition

The vegetation condition of the site was rated using the vegetation condition rating scale developed by Keighery (1994) that recognises the intactness of vegetation, which is defined by the following:

- Completeness of structural levels;
- Extent of weed invasion;
- Historical disturbance from tracks and other clearing or dumping; and
- The potential for natural or assisted regeneration.

The scale therefore consists of six rating levels as outlined below in Table 4.

Table 4 Vegetation condition rating scale (after Keighery, 1994).

Vegetation Condition Rating	Vegetation Condition	Description
1	*Pristine or Nearly So.*	No obvious signs of disturbance.
2	*Excellent*	Vegetation structure intact, disturbance affecting individual species, and weeds are non-aggressive species.
3	*Very Good*	Vegetation structure altered, obvious signs of disturbance.
4	*Good*	Vegetation structure significantly altered by very obvious signs of multiple disturbances retains basic vegetation structure or ability to regenerate it.
5	*Degraded*	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not in a state approaching good condition without intensive management.
6	*Completely Degraded*	The structure of the vegetation is no longer intact and the area is completely or almost without native species.

The native vegetation within the study area was assessed to be predominantly in *Excellent* condition. The vegetation structure within much of the study area however, has been severly impacted by fire. Fire scarring occurs across most of the study area. Other disturbances across the study area include tracks/roads, powerlines, cattle grazing, and the existing Alinta power station.

There are weed species present within the study area, with the most common, Buffel grass, occurring primarily along the edges of tracks and roads and in other previously disturbed areas. Kapok Bush was also widespread along the creekline within the proposed powerline route.

Vegetation condition has been mapped in Figure 4, Appendix A.

4.1.3 Threatened Ecological Communities

No TECs or PECs were identified as occurring within the study area during the flora survey.

4.1.4 Flora Species

Vegetation within the study area is considered to represent a moderate degree of species diversity. A total of 144 taxa from 48 families were recorded from the study area. This list includes subspecies (subsp.), variations (var.), and hybrids (x). Two collections could only be identified to genera level or could not be positively identified to species level due to lack of flowering parts or fruiting bodies.

Dominant families recorded included:

- Poaceae (grasses): 27 species;
- Papilionaceae (peas): 11 species;
- Mimosaceae (wattles): 9 species;
- Amaranthaceae (mulla-mullas): 9 species;
- Malvaceae (hibiscus): 8 species.

Dominant genera recorded from the study area included:

- Acacia: 8 species;
- Triodia: 6 species;
- Eragrostis: 5 species.

A full list of flora species present in the study area is provided in Table 8, Appendix B.

4.1.5 Significant Flora Species

No Declared Rare or Priority Flora species were recorded during the field survey.

One of the species collected from sthe site *Stemodia lathraia* (identification confirmed by Robert Davis WA Herbarium) represents a significant (500km) range extension for this species. This species has only previously been collected from the Kimberley region.

A previously undescribed species of Phyllanthus (*Phyllanthus simplex sen.lat* currently being described by Ian Telford at Australian National Herbarium) was collected. This species is not recognised as being of conservation significance.

4.1.6 Introduced Flora

Three weed species were recorded within the survey area; **Cenchrus ciliaris* (Buffel Grass), **Aerva javanica* (Kapok Bush), and **Chloris barbata* (Purpletop Chloris). These species were generally concentrated in previously disturbed areas such as along tracks and roads.

4.2 Fauna

4.2.1 Fauna Species

A total of thirty-four bird, five mammal and seven reptile species were recorded during the reconnaissance survey within the study area. These species are listed in Table 13, Appendix C.

This survey only provides a brief snapshot of those species present at the time of sampling (daytime), in one season, in one year. Not all potentially occurring species would be recorded during a single survey due to spatial and temporal variations in fauna population numbers.

4.2.2 Significant Fauna Species

The desktop surveys indicated that a number of protected fauna may occur within the study area. The habitat requirements of these species and the likelihood of their occurrence in the site (with information from the field survey) are considered below.

Southern Giant Petrel (*Macronectes giganteus*) Schedule 1, Endangered

The Southern Giant Petrel is a marine bird and occurs over open seas and inshore waters in Antarctic and subtropical waters. In summer they occur predominantly in sub-Antarctic to Antarctic waters, usually below 60ºS in the South Pacific and southeast Indian Oceans. During winter most adults disperse widely and are rare in the southern waters of the Indian Ocean. The Southern Giant Petrel breeds on the Antarctic Continent, Peninsula and islands, and on sub-Antarctic islands and South America.

Habitat Assessment: The Southern Giant Petrel is an occasional vagrant within the area. The study area is considered not to contain significant habitat for this species.

Northern Quoll (*Dasyurus hallucatus*) Schedule 1, Endangered

This species of quoll once occurred across the majority of northern Australia but its range has contracted seriously. It still occurs in the Pilbara region but in disjunct populations, predominantly in the larger conservation reserves. The Northern Quoll inhabits a range of vegetation types but is especially abundant on dissected rocky escarpment and eucalypt woodland within 200 km of the coast. They are predominantly nocturnal but occasionally active during the day, particularly during the mating season or in overcast weather (Van Dyck and Strahan, 2008).

Habitat Assessment: The study area is not considered to contain significant habitat for this species.

Bilby (*Macrotis lagotis*) Schedule 1, Vulnerable

The Bilby distribution in Western Australia is restricted to the north, including the Pilbara and the Sandy and Gibson deserts. The Bilby usually spends the daytime in burrows, often built against termite mounds spinifex hummock or shrub. After dark they leave their burrows to feed and populations are known to move long distances when current habitat ranges become unsuitable. Bilbies are largely solitary, widely dispersed and found in low numbers. Bilbies have now disappeared from many areas where they were common 10 to 15 years ago, such as between Broome and Port Hedland and the Tanami Desert. Grazing by rabbits and livestock, changes in

fire regime, and predation by foxes and feral cats are thought to be the main factors influencing the Bilby's decline.

Habitat Assessment: No evidence (burrows or diggings characteristic of this species) for the presence of Bilbies was observed during the field survey. The study area does not contain significant habitat for this species and is unlikely to occur here.

Banded Hare-wallaby (*Lagostrophus fasciatus* subsp. *fasciatus*) Schedule 1, Vulnerable

This small macropod is herbivorous, and dependent upon dense thickets of shrubs and heath for shelter. The Banded Hare-wallaby is currently restricted to Bernier and Dorre Islands in Shark Bay. It is presumed that the mainland populations of this species are now extinct. The last specimen from mainland Australia was collected in 1906 (Richards, 2003). An attempted reintroduction to Peron Peninsula showed that the species is highly vulnerable to predation from cats as well as foxes.

Habitat Assessment: The study area is outside the current range of the Banded Hare-wallaby. This species is unlikely to occur within study area.

Pilbara Leaf-nosed Bat (*Rhinonicteris aurantius*) Priority 1, Vulnerable

The Pilbara Leaf-nosed Bat roosts in deep caves or mines in the wet season and forages nearby. This species occurs in the Pilbara region of WA where its populations are scattered and localised. There are a few known populations of this species in the western Pilbara, roosting in caves formed in gorges that dissect massive siliceous sedimentary geology. It is most often observed in flight over waterholes in gorges, but appears to be rare even in the Hamersley Range where this habitat is common (Van Dyck and Strahan, 2008). Optimal roosts are thought to occur in caves that form between ascending rock layers, where humidity is maintained from seeping groundwater (Van Dyck and Strahan, 2008).

Habitat Assessment: There are no suitable roosting areas for this species within the study area making it unlikely to occur within the study area, except possibly as a forager.

Woma (*Aspidites ramsayi*) Schedule 4

The Woma Python is a nocturnal snake that feeds on lizards, snakes, birds and small mammals. This species occurs in the arid zones of Western Australia, favouring open myrtaceous heath on sandplains, and dunefields dominated by spinifex. They often inhabit animal burrows but may also use their head and neck to excavate shelters under hummock grasses or dense bushes. Land clearance and introduced predators have results in significant declines of this species. Populations are known from the Pilbara coast, north to the Eighty-mile Beach area, and south-west Western Australia, from Cape Peron south and east to the eastern Goldfields.

Habitat Assessment: Suitable habitat for the Woma Python occurs within the study area. This species potentially occurs within the study area.

Little North-western Mastiff Bat (*Mormopterus loriae* subsp. *cobourgiana*) Priority 1

The Little North-western Mastiff bat occurs along the Western Australia coast from Lake McLeod to Point Torment, occurring sparsely across its range. The Western Australian population have only been recorded from mangrove stands, particularly those that include mature Grey Mangroves (Van Dyck and Strahan, 2008).

Habitat Assessment: There are no suitable roosting areas for this species within the study area. The study area is considered not to contain significant habitat for this species however it may utilise the area for foraging. This species has previously been recorded in Boodarie in 2001 (DEC, 2009).

Australian Bustard (*Ardeotis australis*) Priority 4

The Australian Bustard occurs across much of Australia, including across most of Western Australian, excepting heavily wooded areas in the south. The Australian Bustard occurs mainly in open country, such as low heath or lightly wooded grassland.

Habitat Assessment: Evidence of the Australian Bustard (tracks) was observed throughout the study area during the field survey. This species is widespread and the study area is not considered to contain significant habitat for this species. Impacts associated with the proposed activities are unlikely to have a significant impact on this species.

Eastern Curlew (*Numenius madagascariensis*) Priority 4

The Eastern Curlew is a large, migratory wader. It is widespread in coastal regions in the northeast and south of Australia and is rarely seen inland. This species is found on intertidal mudflats and sandflats, often with seagrass, on sheltered coasts, especially estuaries, mangrove swamps, bays, harbours and lagoons (Australian Museum, 2008)

Habitat Assessment: The study area does not contain significant habitat for this species and is unlikely to occur here.

Star Finch (Western) (*Neochima ruficauda* subsp. *subclarescens*) Priority 4

This species is endemic to Australia where it is found from the Pilbara to south-eastern Australia. Its population has not been estimated but the species is typically patchy and highly variable in abundance. The Star Finch is a nomadic species which inhabits reedbeds, grasslands and eucalypt woodlands along permanent waterways. It typically nests in March and April and its nest is usually built in reeds up to several metres above ground. The main threat to this species is considered to be overgrazing by stock along waterways, which destroys the riparian vegetation on which they depend (Garnett and Crowley, 2000). Records from the DEC database have shown one confirmed sighting of this species recorded in South Hedland in 2005.

Habitat Assessment: The Star Finch was not recorded during the field survey. There are no permanent watercourses or significant habitat for this species within the study area therefore this species is unlikely to be a permanent resident in the area. This species however, may utilise the study area while moving through areas and for foraging.

Brush-tailed Mulgara (*Dasycercus blythi*) Priority 4

Dasycercus blythi has been lumped with the *D. cristicauda* (Crest-tailed Mulgara) for the last 40 years or so. Both species of Mulgara have been found, at least in the past, throughout much of the arid zone, but until specimens in museum collections are correctly identified the distribution of each species is uncertain (Van Dyck and Strahan, 2008). *Dasycercus cresticauda* is listed as Schedule 1 under the Wildlife Conservation Act 1950 and Vulnerable under the EPBC Act whereas *D. blythi* is only listed as a Priority 4 species.

The Brush-tailed Mulgara is primarily nocturnal, shelters in burrows and feeds on insects, other arthropods and small vertebrates. This species inhabits spinifex grasslands and, in central Australia, lives in burrows that it digs on the flats between low sand dunes (Van Dyck and Strahan, 2008).

Habitat Assessment: Mulgara are known to occur within the Port Hedland area. *Dasycercus cristicauda* has recently been recorded in Wedgefield in Port Hedland. Evidence of Mulgara (scats and burrows) was observed within the study area during the field survey. A detailed fauna survey would be required to verify the presence of this species within the study area.

Migratory Bird Species

Five migratory species were observed over the study area these being Wedge-tailed Eagle, Black-shouldered Kite, Black Kite, Australian Hobby and Black Falcon. Two marine species were observed over the study area these being Black-faced Cuckoo-Shrike and Nankeen Kestrel and two species recognised as Marine and Migratory were Whistling Kite and Rainbow Beet-eater. All species were observed flying over the study area except one Australian Hobby which appeared to be a permanent resident in shrubs adjacent to the power station. The study area is not deemed critical habitat to these species for survival.

In addition to those species recorded during the field survey, a number of species included in the list of significant fauna species that could potentially occur in the study area were migratory terrestrial, marine and wetland species. There is the potential for these bird species, such as the White-bellied Sea-Eagle, to occur occasionally within the study area. However, the study area cannot be considered as significant habitat for migratory species.

Other Species

In addition to the above species, the *EPBC Act* Protected Matters Search also recorded a number of marine mammals, shark species, ray-finned fishes and marine reptiles, listed under the EPBC Act, to occur within the search area. The study area is located in close proximity to the coastline and therefore the marine environment was included in the 10 km buffer search of the study area. Given that this is a terrestrial ecological survey and the proposed projects will not impact on the marine environment, these species have not been considered in this report.

4.2.3 Introduced Fauna Species

Three introduced fauna species were observed within the study area, including European Cattle (*Bos Taurus*), Goat (*Capra hircus*), and Feral Cat (*Felis catus*).

4.2.4 Fauna Habitat

Habitat Types

Four primary habitats were identified in the Boodarie study area. These were based on the predominant landforms and vegetation structure in the region, with habitats being as follows:

- Low open heath over tussock grasslands on sand plains;
- Ephemeral wetland;
- Samphire flats; and
- Scattered trees over open shrubland on low rises.

The study area is dominated by low open heath over tussock grassland on sand plains. This habitat type is considered to provide ideal fauna habitat, particularly for reptiles and small mammals.

Habitat Value

The majority of the study area was found to contain native vegetation in excellent condition, offering suitable habitat for native fauna. Some areas of the study area have been subject to inappropriate fire regimes which have reduced the habitat value in those areas. Clearing for tracks, roads, powerlines, and other infrastructure (including the power station) have also reduced the habitat value within some sections of the study area.

The vegetation type described as *Acacia stellaticeps* low closed heath over tussock grassland of *Triodia schinzii* and *T. epactia* was found to contain prime habitat for Mulgara as evidence of the Mulgara species (tracks, scats and burrows) were found throughout this vegetation type. These areas contained particularly high habitat value.

There is one wetland and associated drainage areas which would become inundated with water during high rainfall events. This areas support a number of larger trees (*Eucalyptus victrix).* Although no hollows were observed in these trees, they provide important habitat for some fauna species, particularly birds.

Habitat Linkages

Habitat linkages are important to allow animals to move between areas of resource availability. Habitat linkage is important for ground and aerial fauna, providing cover, resources, and linking areas suitable for rest and reproduction.

Fragmentation of habitat limits the resources available to species, particularly sedentary species, which means they may be more vulnerable to natural disasters or habitat changes over time. Fragmentation of habitat can also lead to edge effects, leading to degradation of the habitat. Where the distance between habitat fragments is small, species may still be able to move between these habitat areas, but may be more exposed to predation pressures in the cleared areas.

Clearing within the study area could potentially cause significant breaks to habitat linkages for fauna species, in particular Mulgara. Fragmentation of this habitat may restrict the species from accessing temporary refugia and other members of the population, which may in turn lead to a local decline of these species. The majority

of the study area is however, surrounded by native vegetation of similar type and condition to that present within the study area.

Clearing of the wetland associated vegetation will result in the loss of the larger tree species *Eucalyptus victrix* which can also cause fragmentation of habitat linkages for some fauna and bird species.

5. Assessment against the Ten Clearing Principles

Any clearing of native vegetation will require a permit under Part V Division 2 of the *Environmental Protection Act 1986* (EP Act), except where an exemption applies under Schedule 6 of the Act or is prescribed by regulation in the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*, and it is not in an Environmentally Sensitive Area (ESA).

Table 5 provides an assessment of the proposed project against the "10 Clearing Principles" as outlined in Schedule 5 of the *Environmental Protection Amendment Act 2003* to determine whether it is at variance to the Principles. These Principles aim to ensure that all potential impacts resulting from removal of native vegetation can be assessed in an integrated way.

The project has been assessed as likely to be at variance with Principle (b) and Principle (f). The project is unlikely to be at variance with all other principles.

Table 5 Assessment against the Ten Clearing Principles

Principle Number	Principle	Assessment	Outcome
(a)	Native vegetation should not be cleared if it comprises a high level of biological diversity.	The study area is not considered to be of higher biodiversity than the surrounding areas, and the proposed clearing is unlikely to have any significant impact on the biodiversity of the region.	The proposal is unlikely to be at variance with the Principle.
(b)	Native vegetation should not be cleared if it comprises the whole or part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous Western Australia.	One Priority 4 species, Australian Bustard, was recorded in the study area. This species is widespread and the study area is not considered to contain significant habitat for this species. Impacts associated with the proposed activities are unlikely to have a significant impact on this species. The study area potentially supports a population of conservation significant Mulgara. Removal of their prime habitat could potentially have a significant impact on this mammal species. A detailed fauna survey would be required to verify the presence of this species within the study area. No specific habitat was noted within the study area that was not present in the local area.	The proposal is likely to be at variance with the Principle.
(c)	Native vegetation should not be cleared if it includes, or is necessary for the continued existence of, rare flora.	No DRF or priority species were observed within the study area during the field survey.	The proposal is unlikely to be at variance with the Principle.
(d)	Native vegetation should not be cleared if it comprises the whole or	No communities listed as Threatened or Priority Ecological Communities have been identified in or adjacent to the study area.	The proposal is unlikely to be at

Principle Number	Principle	Assessment	Outcome
	a part of, or is necessary for the maintenance of, a threatened ecological community.		variance with the Principle.
(e)	Native vegetation should not be cleared if it is significant as a remnant of native vegetation in an area that has been extensively cleared.	Two vegetation associations exist within the project area (589 and 647). Both vegetation associations have approximately 100% of the pre-european extent remaining. There were no vegetation types or landscape units identified during the flora and vegetation survey that were considered as being rare, restricted or unique. The vegetation types within project area are widespread within the Pilbara region and would not be significant as remnant of native vegetation.	The proposal is unlikely to be at variance with the Principle.
(f)	Native vegetation should not be cleared if it is growing in or in association with a watercourse or wetland.	There are no permanent watercourses or wetlands within the project area. An ephemeral creekline is intersected by the powerline corridors to the north-east of the study area. Samphire shrublands occur in association with this creekline. An ephemeral wetland/dampland exists just south of Old Whim Creek Road near the BHP access Road. A patch of *Eucalyptus victrix* grows in association with this wetland. When inundated with water this area is likely to provide important fauna habitat. Clearing should be avoided in this area.	The proposal is likely to be at variance with the Principle.
(g)	Native vegetation should not be cleared if the clearing of the vegetation is likely to cause appreciable land degradation.	The majority of the study area is situated on a flat sparsely vegetated sandy plain that appears to be subject to frequent fire natural events. The site is unlikely to be subject to land degradation caused by wind or water erosion.	The proposal is unlikely to be at variance with the Principle.

Principle Number	Principle	Assessment	Outcome
(h)	Native vegetation should not be cleared if the clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area.	There are no conservation areas within or in close proximity to the study areas.	The proposal is unlikely to be at variance with the Principle
(i)	Native vegetation should not be cleared if the clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water.	The site is generally a flat sandy plain and there are no permanent water courses associated with the site. Clearing of native vegetation is unlikely to have any impact on surface water due to the permeability of the soil. The southern part of the site is situated on the northern boundary of a PDWSA. This PDWSA has not been assigned a priority classification but is likely to become Priority 1. The clearing of native vegetation in this area is unlikely to have any impact on the quality of the groundwater.	The proposal is unlikely to be at variance with the Principle
(j)	Native vegetation should not be cleared if the clearing of the vegetation is likely to cause, or exacerbate, the intensity of flooding.	The site is not situated in a flood zone. Clearing of native vegetation is unlikely to cause or exacerbate the intensity of flooding in the area.	The proposal is unlikely to be at variance with the Principle.

6. Potential Impacts and Management

A range of environmental impacts are possible during the clearing and construction within the Boodarie study area. The potential impacts and recommendations are detailed below.

6.1 Potential Impacts

The proposed land use for the site will be heavy industry sites where relatively small facility footprints will need to be cleared. The balance of the site will remain as a buffer zone to mitigate safety issues, noise and air quality. It is envisaged the on-site buffer areas will predominantly remain undisturbed apart from access and services/ infrastructure corridors.

- *Vegetation Clearing:* This project will require the clearing of native vegetation that is considered to be predominantly in excellent condition. The survey area occupies approximately 5000 ha. It is envisaged that due to the nature of the industry that will be located within the estate that only a small proportion of the site will actually be cleared The vegetation of the study area is however, well represented in the Pilbara region, with close to 100% of the pre-European extents of the vegetation types considered to be remaining.
- *Weed Introduction and Invasion*: The vegetation within the study area is generally in excellent condition with very little weed invasion evident. Disturbance from the proposed activities has the potential to introduce and/or spread weeds to the area directly impacted by, and adjacent to, the clearing.
- *Soil Degradation and Erosion*: Native vegetation serves an important role in the stabilisation of soil within the landscape. Removal of vegetation can cause land degradation, including erosion.
- *Hydrological Changes:* Changes to natural drainage from clearing or other activities may impact on both vegetation structure and fauna habitat in adjoining areas. Clearing of vegetation and the development of building and hard stands, can result in a reduction in infiltration to the ground and an increase in runoff from the site. However, given the envisaged nature of the industry proposed for the site and the large scale of the buffers required increased run off is not considered to be a significant impact.
- *Habitat Loss and Damage*: Clearing of vegetation which is used by fauna species for food, shelter and linkages between areas of habitat. Clearing within the potential Mulgara habitat could cause significant breaks to habitat linkages for the Mulgara population within and outside the study area. Removal of *Eucalyptus victrix* within the wetland/dampland would also cause fragmentation of habitat for some fauna and bird species.
- *Death or Harm to Fauna Species:* Any construction works have the potential to cause death or harm to fauna species. Vegetation clearing and vehicle movements are likely to result in an increased incidence of animal death or injury. Slower

moving land animals (including mammals, reptiles and amphibians) are most at risk, as they are often unable to vacate disturbed areas of vegetation quickly enough to avoid harm. Animals may become disorientated following destruction of their current habitat ranges. In addition clearing of vegetation may increase their susceptibility to predation.

- *Impacts to Conservation Significant Fauna:* Although none was observed during the survey, evidence of the Mulgara species (tracks, scats and burrows) was recorded within the study area. A detailed fauna survey would be required to verify the presence of this species within the study area and to assess the potential impacts.
- *Post-Development Impacts on Adjacent Bushland*: The operation of new industrial area will have potential impacts on bushland remaining in the area. The impacts will primarily be on fauna and issues could include:
  - Light overspill;
  - Litter;
  - Noise and vibration disturbance;
  - Dust production;
  - Increased predators; and
  - Increased traffic.

  These issues have the potential to disturb or harm fauna remaining in the adjacent areas.

6.2 Management of Potential Impacts

Impacts on flora and fauna can be minimised and managed by a number of measures which are outlined below:

- Clearing should be kept to a minimum necessary for proposed development;
- For any clearing occurring on site the clearing line should be clearly defined in order to prevent impact on native vegetation that is not to be cleared;
- Management measures should be implemented to ensure clearing does not cause appreciable land degradation, including preventing erosion from the cleared areas;
- Management measures should be implemented to minimise the introduction and spread of weeds, such as avoiding movement of soils containing weedy species;
- Management measures should be implemented to prevent impacts on adjacent flora and fauna from pollution, such as litter and oil spills;
- Implement measures to reduce the risk of fire starting from activities at site;
- Minimise or restrict movement and use of plant and vehicles at dusk and dawn and during night-time hours to reduce impacts to native fauna;
- Destruction of fauna habitat should be minimised during clearing. Dead, standing or fallen timber should be retained as habitat, wherever possible. Where micro-habitats, such as logs and other debris, must be disturbed for construction, these

should be retained and used in rehabilitation. Mature trees should be retained where possible;

- Avoid prime Mulgara habitat where possible (Low Open heath of *Acacia stellaticeps* over tussock grassland of *Triodia schinzii* and *T. epactia*); and
- Avoid clearing vegetation associated with the wetland/dampland area.

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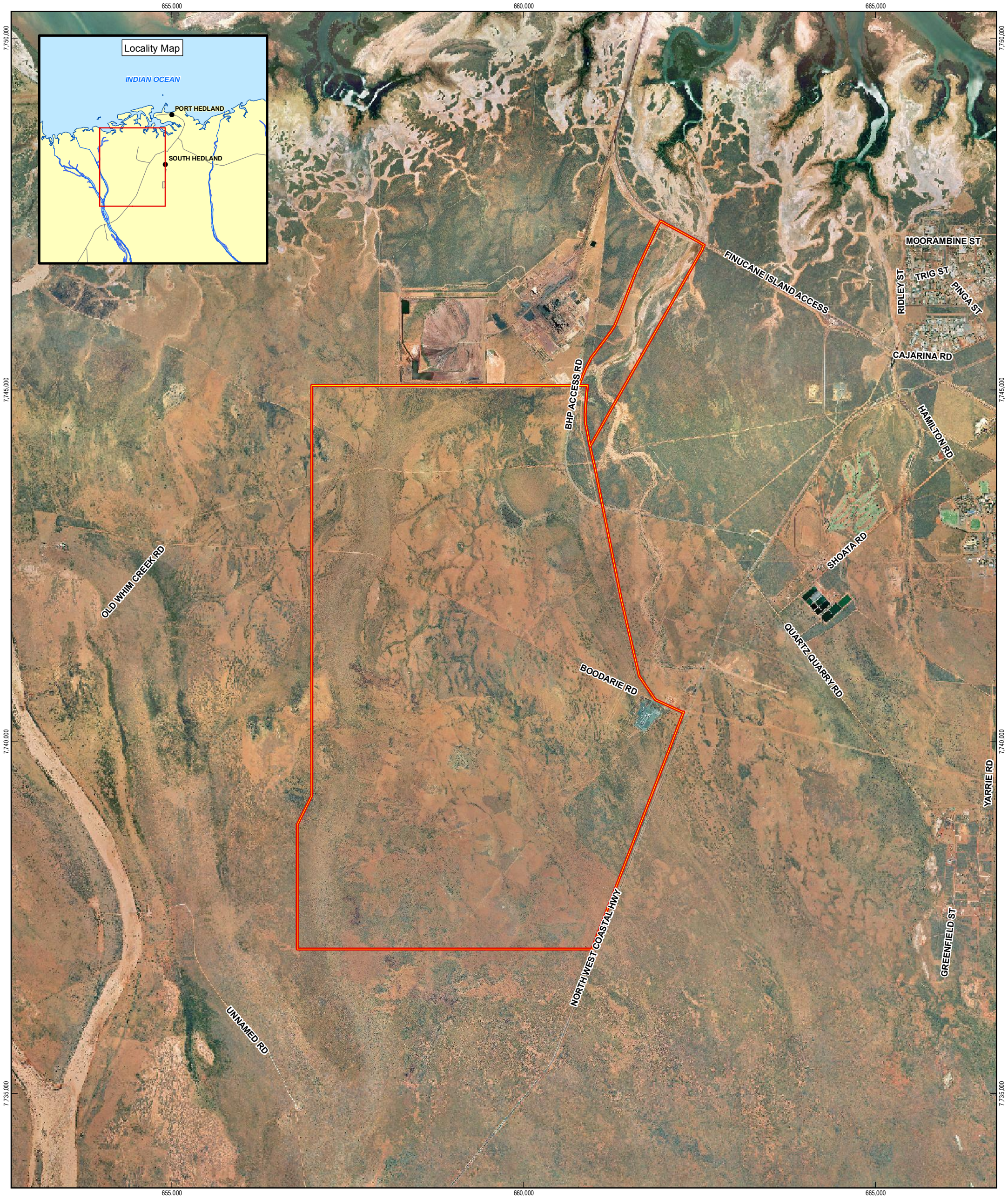
Appendix A

Figures



LEGEND

Survey Area

1:50,000 (at A3)

0 500 1,000 1,500 2,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 50

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Locality Map
Aerial Overview

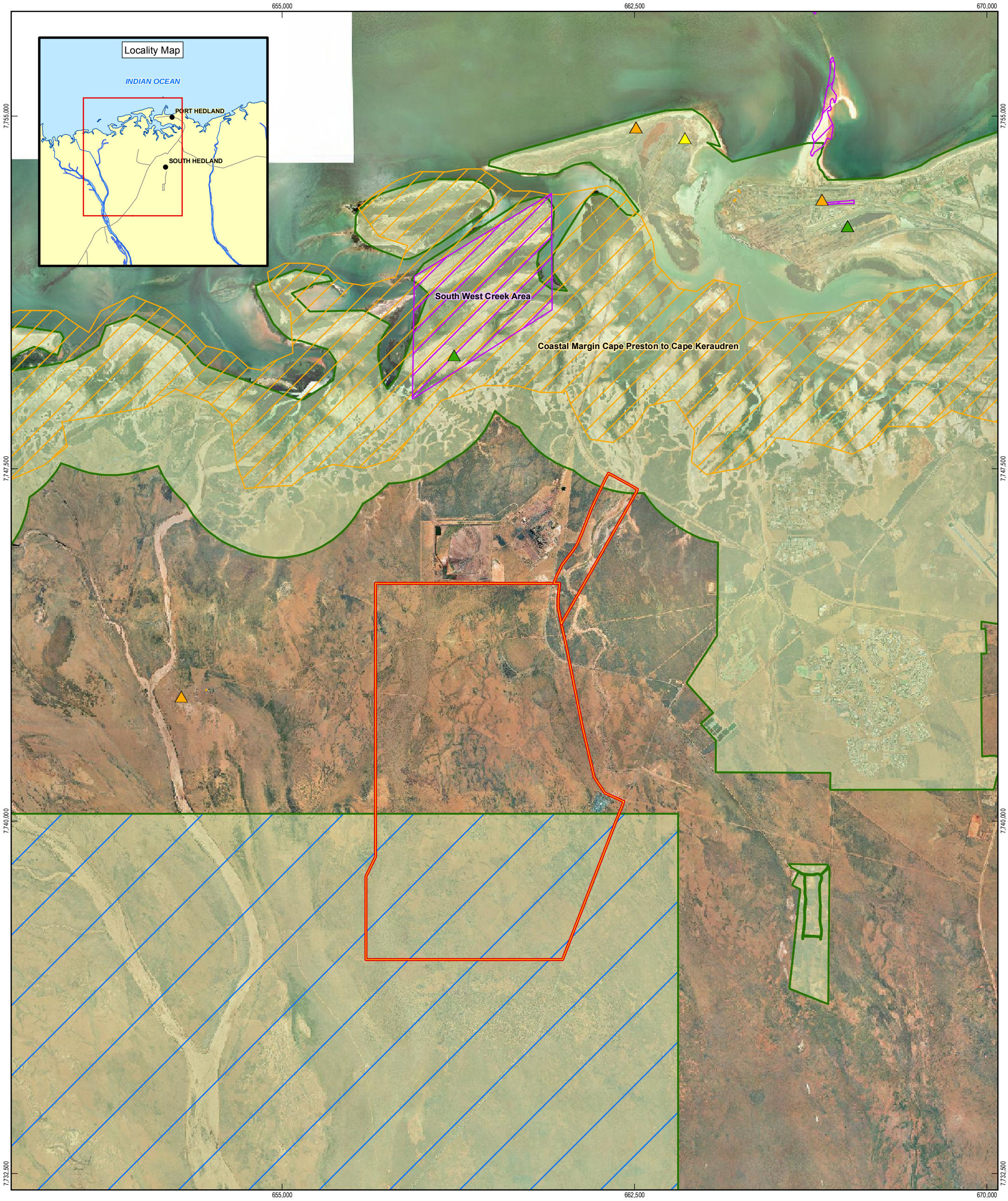
Job Number	61-24148
Revision	0
Date	01 SEP 2009

Figure 1

G:\61\24148\GIS\mxds\6124148-G007.mxd

GHD House, 239 Adelaide Terrace Perth WA 6004 **T** 61 8 6222 8222 **F** 61 8 6222 8555 **E** permail@ghd.com.au **W** www.ghd.com.au

Data Source: Landgate: Thoin Mosaic, Port Hedland Mosaic - 2004; GHD: Survey Area - 20090827. Created by: xntan



LEGEND

- Survey Area

Declared Rare & Priority Species

- (R) Declared Rare Flora - Extant Taxa
- Priority 1 - Poorly Known Taxa
- Priority 2 - Poorly Known Taxa
- Priority 3 - Poorly Known Taxa
- Priority 4 - Rare Taxa

Register of National Estate

STATUS

- Registered
- Indicative Place

- Public Drinking Water Source Areas (Priority Not Assigned)
- Clearing Regulations - Schedule One Areas

1:75,000 (at A3)

0 750 1,500 2,250 3,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 50

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Job Number	61-24148
Revision	0
Date	01 SEP 2009

Environmental Constraints

Figure 2

G:\61\24148\GIS\mxds\6124148-G008.mxd

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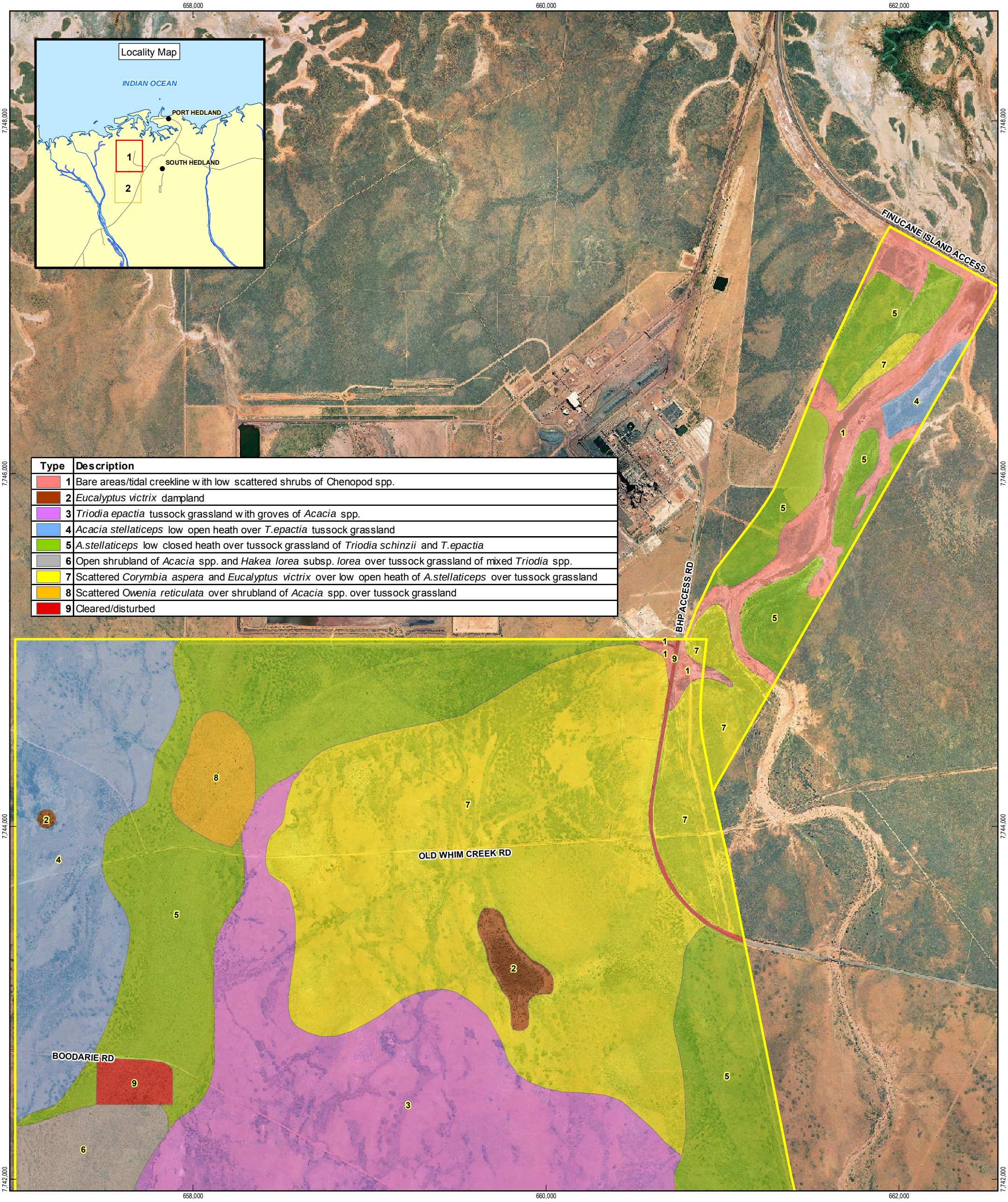
Data Source: Landgate: Thoin Mosaic, Port Hedland Mosaic - 2004; GHD: Survey Area - 20090827; DEC: Declared Rare & Priority Species - 20090708 REF No. 14-0709, Schedule One Areas - 20090310; DEH: Register of National Estate - 2006; DOW: Public Drinking Water Source Areas - 20090525. Created by: xntan



Type		Description
	1	Bare areas/tidal creekline with low scattered shrubs of Chenopod spp.
	2	*Eucalyptus victrix* dampland
	3	*Triodia epactia* tussock grassland with groves of *Acacia* spp.
	4	*Acacia stellaticeps* low open heath over *T.epactia* tussock grassland
	5	*A.stellaticeps* low closed heath over tussock grassland of *Triodia schinzii* and *T.epactia*
	6	Open shrubland of *Acacia* spp. and *Hakea lorea* subsp. *lorea* over tussock grassland of mixed *Triodia* spp.
	7	Scattered *Corymbia aspera* and *Eucalyptus victrix* over low open heath of *A.stellaticeps* over tussock grassland
	8	Scattered *Owenia reticulata* over shrubland of *Acacia* spp. over tussock grassland
	9	Cleared/disturbed

LEGEND

Survey Area

1:20,000 (at A3)

0 100 200 400 600 800 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 50

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Vegetation Types Map Sheet 1

Job Number	61-24148
Revision	0
Date	01 SEP 2009

Figure 3

G:\61\24148\GIS\mxds\6124148-G005.mxd

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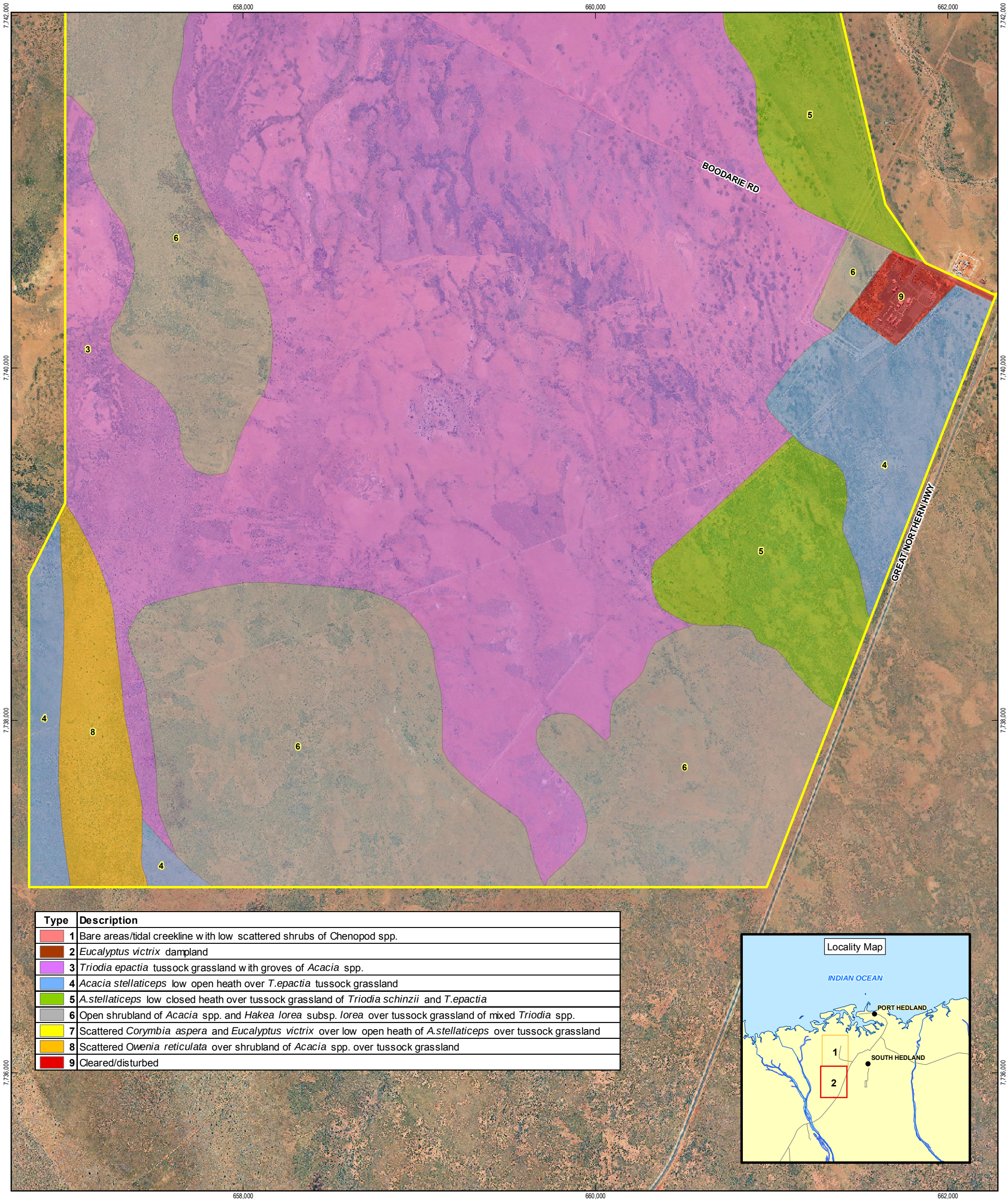
Data Source: Landgate: Port Hedland Mosaic - 2004; GHD: Survey Area - 20090827, Vegetation Types - 20090824. Created by: xntan



Type	Description
1	Bare areas/tidal creekline with low scattered shrubs of Chenopod spp.
2	*Eucalyptus victrix* dampland
3	*Triodia epactia* tussock grassland with groves of *Acacia* spp.
4	*Acacia stellaticeps* low open heath over *T.epactia* tussock grassland
5	*A.stellaticeps* low closed heath over tussock grassland of *Triodia schinzii* and *T.epactia*
6	Open shrubland of *Acacia* spp. and *Hakea lorea* subsp. *lorea* over tussock grassland of mixed *Triodia* spp.
7	Scattered *Corymbia aspera* and *Eucalyptus victrix* over low open heath of *A.stellaticeps* over tussock grassland
8	Scattered *Owenia reticulata* over shrubland of *Acacia* spp. over tussock grassland
9	Cleared/disturbed

LEGEND

Survey Area

1:20,000 (at A3)

0 100 200 400 600 800 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 50

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Vegetation Types
Map Sheet 2

Job Number	61-24148
Revision	0
Date	01 SEP 2009

Figure 3

G:\61\24148\GIS\mxds\6124148-G005.mxd

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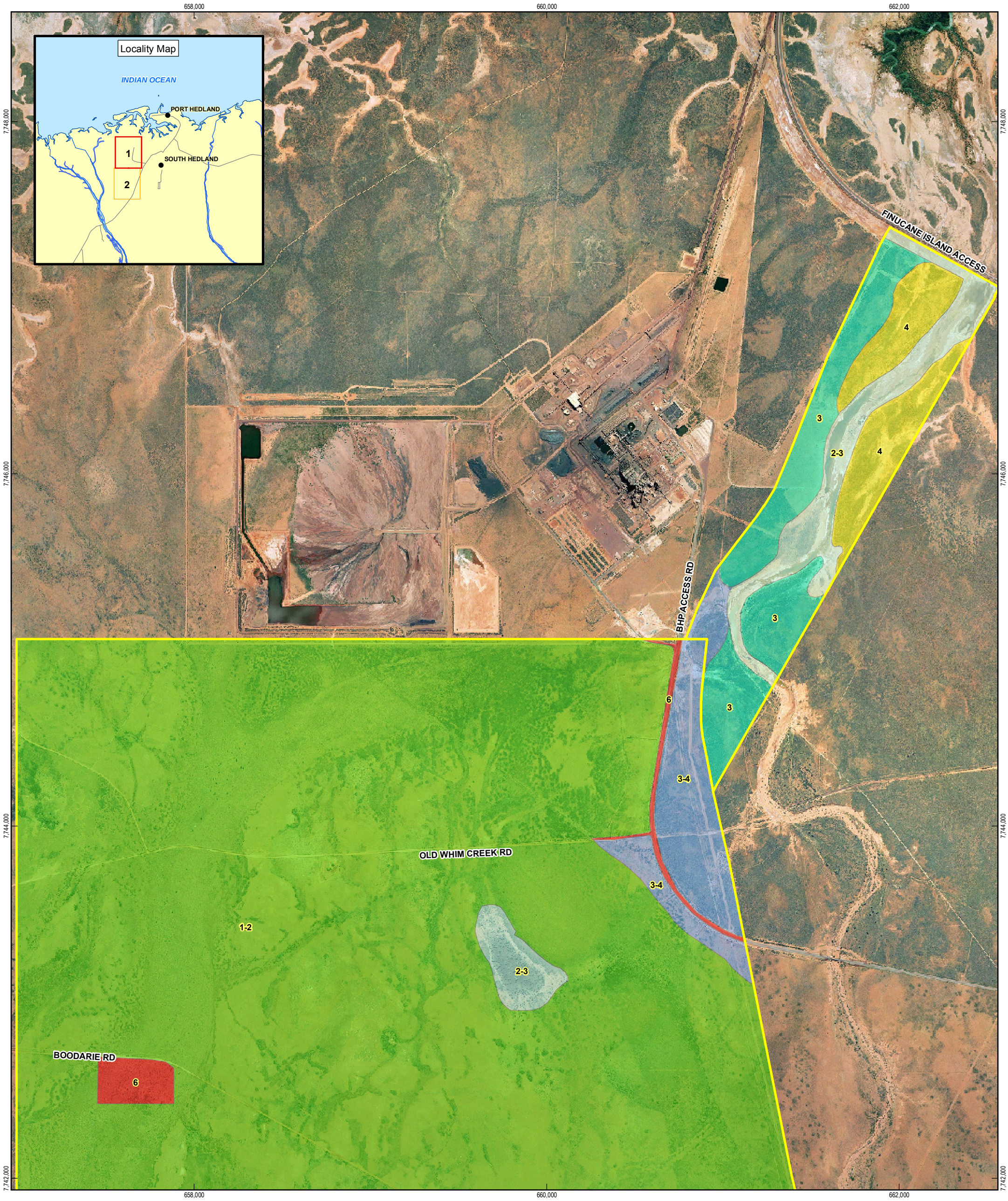
Data Source: Landgate: Port Hedland Mosaic - 2004; GHD: Survey Area - 20090827, Vegetation Types - 20090824. Created by: xntan



LEGEND

Survey Area

Vegetation Condition

1. Pristine or nearly so
2. Excellent
3. Very Good
4. Good
5. Degraded
6. Completely degraded

1:20,000 (at A3)

0 100 200 400 600 800 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 50

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Vegetation Condition
Map Sheet 1

Job Number	61-24148
Revision	0
Date	01 SEP 2009

Figure 4

G:\61\24148\GIS\mxds\6124148-G006.mxd

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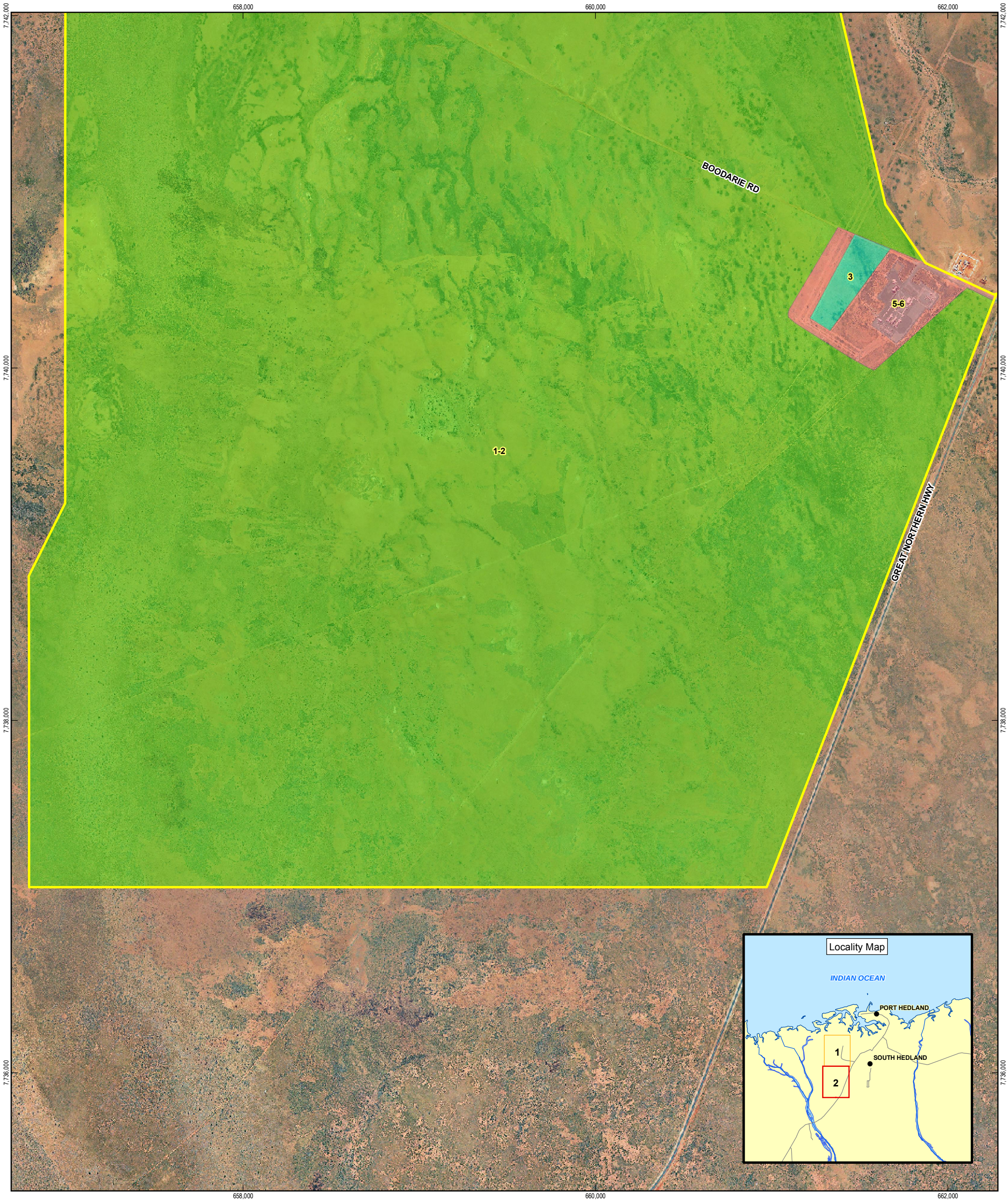
Data Source: Landgate: Port Hedland Mosaic - 2004; GHD: Survey Area - 20090827, Vegetation Condition - 20090824. Created by: xntan



LEGEND

Survey Area

Vegetation Condition

1. Pristine or nearly so
2. Excellent
3. Very Good
4. Good
5. Degraded
6. Completely degraded

1:20,000 (at A3)

0 100 200 400 600 800 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 50

N

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LandCorp
Port Hedland Boodarie Ecological Study

Vegetation Condition
Map Sheet 2

Job Number	61-24148
Revision	0
Date	01 SEP 2009

Figure 4

G:\61\24148\GIS\mxds\6124148-G006.mxd

GHD House, 239 Adelaide Terrace Perth WA 6004 **T** 61 8 6222 8222 **F** 61 8 6222 8555 **E** permail@ghd.com.au **W** www.ghd.com.au

Data Source: Landgate: Port Hedland Mosaic - 2004; GHD: Survey Area - 20090827, Vegetation Condition - 20090824. Created by: xntan

Appendix B

Flora

Conservation Categories and Definitions for EPBC Act Listed Flora and Fauna Species

Conservation Codes and Descriptions for DEC Declared Rare and Priority Flora Species

Flora Species Recorded within the Study Area

Quadrat Data

Table 6 Conservation Categories and Definitions for EPBC Act Listed Flora and Fauna Species

Conservation Category	Definition
Extinct	Taxa not definitely located in the wild during the past 50 years
Extinct in the Wild	Taxa known to survive only in captivity
Critically Endangered	Taxa facing an extremely high risk of extinction in the wild in the immediate future
Endangered	Taxa facing a very high risk of extinction in the wild in the near future
Vulnerable	Taxa facing a high risk of extinction in the wild in the medium-term
Near Threatened	Taxa that risk becoming Vulnerable in the wild
Conservation Dependent	Taxa whose survival depends upon ongoing conservation measures. Without these measures, a conservation dependent taxon would be classified as Vulnerable or more severely threatened.
Data Deficient (Insufficiently Known)	Taxa suspected of being Rare, Vulnerable or Endangered, but whose true status cannot be determined without more information.
Least Concern	Taxa that are not considered Threatened

Table 7 Conservation Codes and Descriptions for DEC Declared Rare and Priority Flora Species

Conservation Code	Description
R: 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, e.g. road verges, urban areas, farmland, active mineral leases, etc., or the plants are under threat, e.g. from disease, grazing by feral animals etc. May include taxa with threatened populations on protected lands. 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 (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of 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 are in need of further survey.
P4: Priority Four – Taxa in need of monitoring	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.

Table 8 Flora Species Recorded within the Study Area

Family	Genus	Species	Common Name	Status
Aizoaceae	*Trianthema*	*pilosa*		
Aizoaceae	*Trianthema*	*turgidifolia*		
Amaranthaceae	*Achyranthes*	*aspera*	Chaff Flower	
Amaranthaceae	*Aerva*	*javanica*	Kapok Bush	*
Amaranthaceae	*Amaranthus*	*mitchellii*	Boggabri Weed	
Amaranthaceae	*Gomprena*	*sordida*		
Amaranthaceae	*Hemichroa*	*diandra*		
Amaranthaceae	*Ptilotus*	*arthrolasius*		
Amaranthaceae	*Ptilotus*	*fusiformis*		
Amaranthaceae	*Ptilotus*	*obovatus*	Cotton Bush	
Amaranthaceae	*Ptilotus*	*polystachyus*	Prince of Wales Feather	
Apocynaceae	*Carissa*	*lanceolata*	Conkerberry	
Asteraceae	*Pluchea*	*ferdinandi-muelleri*		
Asteraceae	*Pluchea*	*rubelliflora*		
Asteraceae	*Pterocaulon*	*sphaeranthoides*		
Asteraceae	*Streptoglossa*	*liatroides*		
Bignoniaceae	*Dolichandrone*	*heterophylla*	Lemonwood	
Boraginaceae	*Ehretia*	*saligna*	False Cedar	
Boraginaceae	*Heliotropium*	*diversifolium*		
Boraginaceae	*Heliotropium*	*foliatum*		
Boraginaceae	*Heliotropium*	*pachyphyllum*		
Boraginaceae	*Heliotropium*	*vestitum*		
Caesalpiniaceae	*Senna*	*notabilis*		
Capparaceae	*Cleome*	*uncifera* subsp. *uncifera*		
Caryophyllaceae	*Polycarpea*	*corymbosa*		
Chenopodaceae	*Neobassia*	*astrocarpa*		
Chenopodaceae	*Salsola*	*tragus*		
Chenopodaceae	*Tecticornia*	*pergranulata*		
Chenopodaceae	*Tecticornia*	*pterogosperma*		
Commelinaceae	*Commelina*	*ensifolia*	Wandering Jew	

Family	Genus	Species	Common Name	Status
Convolvulaceae	*Bonamia*	*linearis*		
Convolvulaceae	*Bonamia*	*pannosa*		
Convolvulaceae	*Merremia*	*davenportii*		
Convolvulaceae	*Polymeria*	*ambigua*	Morning Glory	
Convulvulaceae	*Bonamia*	*rosea*	Felty Bellflower	
Convulvulaceae	*Evolvulus*	*alsinoides* var. *villosicalyx*		
Convulvulaceae	*Ipomoea*	*muelleri*	Poison Morning Glory	
Cucurbitaceae	*Cucumis*	*maderaspatanus*		
Cyperaceae	*Bulbostylis*	*barbata*		
Cyperaceae	*Cyperus*	*hesperius*		
Cyperaceae	*Fimbristylis*	*dichotoma*		
Cyperaceae	*Fimbristylis*	*oxystachya*		
Droseraceae	*Drosera*	*indica*	Indian Sundew	
Elatinaceae	*Bergia*	*perennis* subsp. *perennis*		
Euporbiaceae	*Euphorbia*	*australis*	Namana	
Euporbiaceae	*Euphorbia*	*coghlanii*	Namana	
Goodeniaceae	*Goodenia*	*forrestii*		
Goodeniaceae	*Goodenia*	*lamprosperma*		
Goodeniaceae	*Goodenia*	*microptera*		
Gyrostemonaceae	*Codonocarpus*	*cotinifolius*	Native Poplar	
Hemerocallidaceae	*Corynotheca*	*pungens*		
Lauraceae	*Cassytha*	*filiformis*	Love Vine	
Loganiaceae	*Mitrasacme*	*connata*		
Malvaceae	*Abutilon*	*otocarpum*		
Malvaceae	*Hibiscus*	*sturtii*	Sturt's Hibiscus	
Malvaceae	*Hibiscus*	*brachychlaenus*		
Malvaceae	*Hibiscus*	*leptocladus*		
Malvaceae	*Sida*	sp. (insufficient material)		
Malvaceae	*Sida*	*arenicola*		
Malvaceae	*Sida*	*rohlenae* subsp. *rohlenae*		
Malvaceae	*Sida*	sp. Pilbara		
Marsileaceae	*Marsilea*	*drummondii*	Common Nardoo	

Family	Genus	Species	Common Name	Status
Meliaceae	*Owenia*	*reticulata*		
Menispermaceae	*Tinospora*	*smilacina*	Snakevine	
Mimosaceae	*Acacia*	*colei*		
Mimosaceae	*Acacia*	*coriacea*	Wirewood	
Mimosaceae	*Acacia*	*inaequilatera*	Baderi	
Mimosaceae	*Acacia*	*sericophylla*		
Mimosaceae	*Acacia*	*stellaticeps*		
Mimosaceae	*Acacia*	*synchronicia*		
Mimosaceae	*Acacia*	*trachycarpa*	Minni Ritchi	
Mimosaceae	*Acacia*	*bivenosa*		
Mimosaceae	*Neptunia*	*dimorphantha*		
Molluginaceae	*Mollugo*	*molluginea*		
Myrtaceae	*Corymbia*	*aspera*		
Myrtaceae	*Corymbia*	*hamerslyana*		
Myrtaceae	*Eucalyptus*	*victrix*		
Myrtaceae	*Melaleuca*	*lasiandra*		
Nyctaginaceae	*Boerhavia*	*coccinea*	Tar Vine	
Papilionaceae	*Crotularia*	*ramosissima*		
Papilionaceae	*Cullen*	*martinii*		
Papilionaceae	*Desmodium*	*filiforme*		
Papilionaceae	*Indigofera*	*linifolia*		
Papilionaceae	*Indigofera*	*linnaei*		
Papilionaceae	*Indigofera*	*monophylla*		
Papilionaceae	*Leptosema*	*anomalum*		
Papilionaceae	*Rhynchosia*	*minima*	Rhynchosia	
Papilionaceae	*Tephrosia*	*leptoclada*		
Papilionaceae	*Vigna*	*lanceolata* var. *lanceolata*		
Papilionaceae	*Zornia*	*muelleriana*		
Plumbaginaceae	*Muellerolimon*	*salcorniaceum*		
Poaceae	*Aristida*	*holathera* var. *holathera*		
Poaceae	*Aristida*	*latifolia*	Feathertop Wiregrass	
Poaceae	*Cenchrus*	*ciliaris*	Buffel Grass	*
Poaceae	*Chloris*	*barbata*	Purpletop Chloris	*

Family	Genus	Species	Common Name	Status
Poaceae	*Dactyloctenium*	*radulans*	Button Grass	
Poaceae	*Digitaria*	*brownii*	Cotton Panic Grass	
Poaceae	*Elytrophorus*	*spicatus*	Spikegrass	
Poaceae	*Eragrostis*	*cumingii*	Cuming's Love Grass	
Poaceae	*Eragrostis*	*dielsii*	Mallee Lovegrass	
Poaceae	*Eragrostis*	*falcata*	Sickle Lovegrass	
Poaceae	*Eragrostis*	*speciosa*	Handsome Lovegrass	
Poaceae	*Eragrostis*	*tenelluta*	Delicate Lovegrass	
Poaceae	*Eriachne*	*aristidea*		
Poaceae	*Eriachne*	*glauca* var. *glauca*		
Poaceae	*Eriachne*	*helmsii*	Buck Wanderrie Grass	
Poaceae	*Eriachne*	*obtusa*	Northern Wandarrie Grass	
Poaceae	*Paraneurachne*	*muelleri*	Northern Mulga Grass	
Poaceae	*Paspalidium*	*constrictum*	Knottybutt Grass	
Poaceae	*Paspalidium*	*rarum*	Rare Paspalidium	
Poaceae	*Sorghum*	*timorense*		
Poaceae	*Triodia*	*basedowii*	Lobed Spinifex	
Poaceae	*Triodia*	*epactia*		
Poaceae	*Triodia*	*longiceps*	Giant Grey Spinifex	
Poaceae	*Triodia*	*pungens*	Soft Spinifex	
Poaceae	*Triodia*	*schinzii*		
Poaceae	*Triodia*	*secunda*		
Poaceae	*Yakirra*	*australiensis*		
Polygalaceae	*Polygale*	*tepperi*		
Portulacaceae	*Calandrinia*	*quadrivalvis*		
Portulacaceae	*Calandrinia*	sp. Pinga		
Portulacaceae	*Calandrinia*	*stagnensis*		
Proteaceae	*Grevillea*	*pyramidalis*	Caustic Bush	
Proteaceae	*Grevillea*	*wickhamii*	Wickham's Grevillea	
Proteaceae	*Hakea*	*lorea* subsp. *lorea*		
Rubiaceae	*Dentella*	*asperata*		
Rubiaceae	*Synaptantha*	*tillaeacea* var. *tillaeacea*		
Santalaceae	*Santalum*	*lanceolatum*	Northern Sandalwood	

Family	Genus	Species	Common Name	Status
Sapindaceae	*Dodonaea*	*coriacea*		
Scrophulariaceae	*Mimulus*	*uvedaliae* subsp. *uvedaliae*		
Scrophulariaceae	*Stemodia*	*lathraia*		
Solanaceae	*Nicotiana*	sp. (insufficient material)		
Solanaceae	*Solanum*	*dioicum*	Gilu	
Solanaceae	*Solanum*	*phlomoides*		
Stackhousiaceae	*Stackhousia*	*intermedia*		
Sterculiaceae	*Waltheria*	*indica*		
Stylidiaceae	*Stylidium*	*desertorum*		
Thymelaeaceae	*Pimelea*	*ammocharis*		
Tiliacea	*Triumfetta*	*ramosa*		
Tiliaceae	*Corchorus*	*walcottii*	Woolly Corchorus	
Tiliaceae	*Triumfetta*	*ramosa*		
Violaceae	*Hybanthus*	*aurantiacus*		
Zygophyllaceae	*Tribulopis*	*angustifolia*		
Zygophyllaceae	*Tribulus*	*occidentalis*		

QUADRAT DATA – Field Survey June 2009

Quadrat 1

Field Vegetation Description: *Triodia epactia* grassland

Landform/soil: Flat, red sand

Open ground: 30%

Condition: 2

Fire: <5 years

Disturbance: Powerlines, cattle grazing

Quadrat 1 Species List

Family	Genus	Species	Status	% Cover
Poaceae	*Triodia*	*epactia*		70
Cyperaceae	*Bulbostylis*	*barbata*		1

Quadrat 2

Field Vegetation Description: *Acacia stellaticeps* over *T. epactia* grassland

Landform/soil: Flat, red sand

Open ground: 20%

Condition: 1/2

Fire: >5 years

Disturbance: Cattle grazing

Quadrat 2 Species List

Family	Genus	Species	Status	% Cover
Mimosaceae	*Acacia*	*stellaticeps*		50
Poaceae	*Triodia*	*epactia*		20
Mimosaceae	*Acacia*	*colei*		5
Proteaceae	*Hakea*	*lorea* subsp. *lorea*		1
Poaceae	*Eriachne*	*obtusa*		1
Poaceae	*Eragrostis*	*speciosa*		1
Poaceae	*Eragrostis*	*falcata*		1
Poaceae	*Aristida*	*latifolia*		1
Papilionaceae	*Leptosema*	*anomalum*		1
Tiliaceae	*Corchorus*	*walcottii*		1
Malvaceae	*Sida*	sp. Pilbara		1

Quadrat 3

Field Vegetation Description: Scattered *Owenia reticulata* over *A. stellaticeps* over tussock grassland of *T. epactia* and *Eragrostis falcata.*

Landform/soil: Hill sloping west, red sand

Open ground: 10-20%

Condition: 2

Fire: >5 years

Disturbance: Weeds present under *Owenia reticulata*

Quadrat 3 Species List

Family	Genus	Species	Status	% Cover
Poaceae	*Triodia*	*epactia*		30
Poaceae	*Eragrostis*	*falcata*		30
Mimosaceae	*Acacia*	*stellaticeps*		10
Mimosaceae	*Acacia*	*colei*		2
Meliaceae	*Owenia*	*reticulata*		1
Papilionaceae	*Indigofera*	*linifolia*		1
Caryophyllaceae	*Polycarpea*	*corymbosa*		1
Convolvulaceae	*Polymeria*	*ambigua*		1
Aizoaceae	*Trianthema*	*pilosa*		1
Tiliaceae	*Corchorus*	*walcottii*		1
Violaceae	*Hybanthus*	*aurantiacus*		1
Euporbiaceae	*Euphorbia*	*australis*		1

Family	Genus	Species	Status	% Cover
Solanaceae	*Solanum*	*dioicum*		1
Malvaceae	*Sida*	*rohlenae* subsp. *rohlenae*		1
Sterculiaceae	*Waltheria*	*indica*		1
Poaceae	*Eriachne*	*obtusa*		1
Convulvulaceae	*Evolvulus*	*alsinoides* var. *villosicalyx*		1
Papilionaceae	*Indigofera*	*monophylla*		1
Tiliaceae	*Triumfetta*	*ramosa*		1
Papilionaceae	*Crotularia*	*ramosissima*		1
Amaranthaceae	*Aerva*	*javanica*	*	1
Cucurbitaceae	*Cucumis*	*maderaspatanus*		1
Caesalpiniaceae	*Senna*	*notabilis*		1
Molluginaceae	*Mollugo*	*molluginea*		1
Amaranthaceae	*Amaranthus*	*mitchellii*		1
Convolvulaceae	*Merremia*	*davenportii*		1
Amaranthaceae	*Achyranthes*	*aspera*		1

Quadrat 4

Field Vegetation Description: *A. stellaticeps* over *T. epactia* grassland with emergent *E. colei*

Landform/soil: Flat, slightly sloping west. Red sand

Open ground: 20%

Condition: 2

Fire: >5 years

Disturbance: No signs of obvious disturbance

Quadrat 4 Species List

Family	Genus	Species	Status	% Cover
Mimosaceae	*Acacia*	*stellaticeps*		60
Poaceae	*Triodia*	*epactia*		20
Mimosaceae	*Acacia*	*colei*		1
Mimosaceae	*Acacia*	*sericophylla*		1
Poaceae	*Eriachne*	*obtusa*		1
Malvaceae	*Sida*	sp. Pilbara		1
Amaranthaceae	*Ptilotus*	*obovatus*		1

Quadrat 5

Field Vegetation Description: *A. stellaticeps* shrubland over *T. epactia* grassland

Landform/soil: Flat, red sand

Open ground: 60%

Condition: 1/2

Fire: 1-2 years, patchy burn

Disturbance: Potentially inappropriate fire regime

Quadrat 5 Species List

Family	Genus	Species	Status	% Cover
Mimosaceae	*Acacia*	*stellaticeps*		5
Poaceae	*Paraneurachne*	*muelleri*		5
Poaceae	*Triodia*	*epactia*		5
Poaceae	*Eriachne*	*helmsii*		1
Caesalpiniaceae	*Senna*	*notabilis*		1
Myrtaceae	*Corymbia*	*aspera*		1
Malvaceae	*Sida*	sp. Pilbara		1
Cyperaceae	*Bulbostylis*	*barbata*		1
Poaceae	*Eriachne*	*aristidea*		1
Poaceae	*Eragrostis*	*falcata*		1
Tiliaceae	*Corchorus*	*walcottii*		1

Family	Genus	Species	Status	% Cover
Malvaceae	*Sida*	*rohlenae* subsp. *rohlenae*		1
Poaceae	*Aristida*	*holathera* var. *holathera*		1
Aizoaceae	*Trianthema*	*pilosa*		1
Proteaceae	*Hakea*	*lorea* subsp. *lorea*		1
Amaranthaceae	*Waltheria*	*indica*		1
Papilionaceae	*Indigofera*	*monophylla*		1
Mimosaceae	*Acacia*	*colei*		1
Malvaceae	*Hibiscus*	*leptocladus*		1
Euporbiaceae	*Euphorbia*	*australis*		1

Quadrat 6

Field Vegetation Description: *A. stellticeps* shrubland over *T. epactia* grassland

Landform/soil: Flat, red sand

Open ground: 30%

Condition: 1/2

Fire: Patchy, <5 years

Disturbance: Fire

Quadrat 6 Species List

Family	Genus	Species	Status	% Cover
Mimosaceae	*Acacia*	*stellaticeps*		50
Poaceae	*Triodia*	*epactia*		5
Tiliaceae	*Corchorus*	*walcottii*		1
Poaceae	*Aristida*	*holathera* var. *holathera*		1
Caesalpiniaceae	*Senna*	*notabilis*		1
Cyperaceae	*Bulbostylis*	*barbata*		1
Poaceae	*Aristida*	*latifolia*		1
Papilionaceae	*Indigofera*	*monophylla*		1
Mimosaceae	*Acacia*	*inaequilatera*		1
Mimosaceae	*Acacia*	*colei*		1
Amaranthaceae	*Ptilotus*	*obovatus*		1
Poaceae	*Dactyloctenium*	*radulans*		1
Papilionaceae	*Indigofera*	*linifolia*		1
Malvaceae	*Hibiscus*	*leptocladus*		1
Aizoaceae	*Trianthema*	*pilosa*		1
Euporbiaceae	*Euphorbia*	*coghlanii*		1
Poaceae	*Eriachne*	*aristidea*		1
Poaceae	*Triodia*	*schinzii*		1
Caryophyllaceae	*Polycarpea*	*corymbosa*		1
Nyctaginaceae	*Boerhavia*	*coccinea*		1
Convolvulaceae	*Bonamia*	*linearis*		1

Quadrat 7

Field Vegetation Description: *Acacia* shrubland over tussock grassland

Landform/soil: Flat, red sand

Open ground: 20%

Condition: 1/2

Fire: >5 years, adjacent to burnt vegetation

Disturbance: No obvious disturbances

Quadrat 7 Species List

Family	Genus	Species	Status	% Cover
Mimosaceae	*Acacia*	*colei*		20
Mimosaceae	*Acacia*	*stellaticeps*		10
Poaceae	*Triodia*	*epactia*		10
Poaceae	*Eragrostis*	*falcata*		10
Papilionaceae	*Indigofera*	*monophylla*		1
Proteaceae	*Hakea*	*lorea* subsp. *lorea*		1
Convolvulaceae	*Bonamia*	*linearis*		1
Mimosaceae	*Acacia*	*sericophylla*		1
Violaceae	*Hybanthus*	*aurantiacus*		1
Poaceae	*Dactyloctenium*	*radulans*		1
Tiliaceae	*Corchorus*	*walcottii*		1
Papilionaceae	*Indigofera*	*linearis*		1

Quadrat 8

Field Vegetation Description: Mixed tussock grassland and herbland (recovery from fire)

Landform/soil: Flat, red sand

Open ground: 80%

Condition: 2

Fire: Burnt 1-2 years

Disturbance: Fire

Quadrat 8 Species List

Family	Genus	Species	Status	% Cover
Caesalpiniaceae	*Senna*	*notabilis*		5
Cyperaceae	*Fimbristylis*	*oxystachya*		5
Poaceae	*Triodia*	*epactia*		5
Malvaceae	*Hibiscus*	*leptocladus*		1
Portulacaceae	*Calandrinia*	sp. Pinga		1
Poaceae	*Yakirra*	*australiensis*		1
Cyperaceae	*Bulbostylis*	*barbata*		1
Molluginaceae	*Mollugo*	*molluginea*		1
Mimosaceae	*Acacia*	*stellaticeps*		1
Poaceae	*Eragrostis*	*cumingii*		1
Tiliaceae	*Corchorus*	*walcottii*		1

Family	Genus	Species	Status	% Cover
Amaranthaceae	*Ptilotus*	*fusiformis*		1
Scrophulariaceae	*Stemodia*	*lathraia*		1
Gyrostemonaceae	*Codonocarpus*	*cotinifolius*		1
Violaceae	*Hybanthus*	*aurantiacus*		1
Caryophyllaceae	*Polycarpea*	*corymbosa*		1
Poaceae	*Aristida*	*holathera var. holathera*		1
Papilionaceae	*Desmodium*	*filiforme*		1
Convulvulaceae	*Evolvulus*	*alsinoides var. villosicalyx*		1
Malvaceae	*Hibiscus*	*leptocladus*		1

Quadrat 9

Field Vegetation Description: *A. stellaticeps* shrubland over *T. schinzii* grassland

Landform/soil: Flat, red sand

Open ground: 10%

Condition: 1/2

Fire: >5 years

Disturbance: No obvious disturbances

Quadrat 9 Species List

Family	Genus	Species	Status	% Cover
Mimosaceae	*Acacia*	*stellaticeps*		80
Poaceae	*Triodia*	*schinzii*		20
Proteaceae	*Hakea*	*lorea* subsp. *lorea*		1
Mimosaceae	*Acacia*	*colei*		1
Asteraceae	*Pluchea*	*ferdinandi-muelleri*		1

Quadrat 10

Field Vegetation Description: *A. stellaticeps* over mixed *T. epactia* and *T. schinzii* grassland

Landform/soil: Flat, red sand

Open ground: 10%

Condition: 1/2

Fire: >5 years

Disturbance: No obvious disturbances

Quadrat 10 Species List

Family	Genus	Species	Status	% Cover
Poaceae	*Triodia*	*schinzii*		30
Mimosaceae	*Acacia*	*stellaticeps*		40
Poaceae	*Triodia*	*epactia*		20

Tiliaceae	*Corchorus*	*walcottii*		1
Myrtaceae	*Corymbia*	*aspera*		1
Poaceae	*Cenchrus*	*ciliaris*	*	1
Amaranthaceae	*Amaranthus*	*mitchellii*		1
Amaranthaceae	*Aerva*	*javanica*	*	1
Amaranthaceae	*Achyranthes*	*aspera*		1
Nyctaginaceae	*Boerhavia*	*coccinea*		1
Mimosaceae	*Acacia*	*colei*		1
Papilionaceae	*Indigofera*	*monophylla*		1
Tiliaceae	*Triumfetta*	*ramosa*		1

Quadrat 11

Field Vegetation Description: *A. stellaticeps* shrubland over *T. epactia* grassland

Landform/soil: Flat, red sand

Open ground: 10%

Condition: 1/2

Fire: >5 years

Disturbance: No obvious disturbances

Quadrat 11 Species List

Family	Genus	Species	Status	% Cover
Mimosaceae	*Acacia*	*stellaticeps*		60
Poaceae	*Triodia*	*epactia*		50
Amaranthaceae	*Ptilotus*	*obovatus*		1
Papilionaceae	*Indigofera*	*monophylla*		1
Mimosaceae	*Acacia*	*coriacea*		1
Convulvulaceae	*Bonamia*	*rosea*		1
Solanaceae	*Solanum*	*dioicum*		1

Quadrat 12

Field Vegetation Description: Very open tussock grassland with open herbs (recovery from fire)

Landform/soil: Flat, red sand

Open ground: 60%

Condition: 2

Fire: <2 years

Disturbance: Fire

Quadrat 12 Species List

Family	Genus	Species	Status	% Cover
Poaceae	*Triodia*	*epactia*		25
Poaceae	*Eragrostis*	*cumingii*		15
Caesalpiniaceae	*Senna*	*notabilis*		5
Myrtaceae	*Eucalyptus*	*victrix*		1
Apocynaceae	*Carissa*	*lanceolata*		1
Mimosaceae	*Acacia*	*stellaticeps*		1
Poaceae	*Paspalidium*	*constrictum*		1
Poaceae	*Yakirra*	*australiensis*		1
Convulvulaceae	*Evolvulus*	*alsinoides* var. *villosicalyx*		1

Family	Genus	Species	Status	% Cover
Goodeniaceae	*Goodenia*	*microptera*		1
Tiliaceae	*Corchorus*	*walcottii*		1
Cyperaceae	*Fimbristylis*	*dichotoma*		1
Cyperaceae	*Bulbostylis*	*barbata*		1
Papilionaceae	*Rhynchosia*	*minima*		1
Violaceae	*Hybanthus*	*aurantiacus*		1
Malvaceae	*Hibiscus*	*leptocladus*		1
Portulacaceae	*Calandrinia*	sp. Pinga		1
Convulvulaceae	*Ipomoea*	*muelleri*		1
Poaceae	*Eriachne*	*aristidea*		1
Scrophulariaceae	*Stemodia*	*lathraia*	RE	1
Stackhousiaceae	*Stackhousia*	*intermedia*		1
Euporbiaceae	*Euphorbia*	*australis*		1
Asteraceae	*Pterocaulon*	*sphaeranthoides*		1
Rubiaceae	*Synaptantha*	*tillaeacea* var. *tillaeacea*		1
Papilionaceae	*Desmodium*	*filiforme*		1
Asteraceae	*Streptoglossa*	*liatroides*		1
Poaceae	*Eriachne*	*obtusa*		1
Amaranthaceae	*Ptilotus*	*fusiformis*		1
Droseraceae	*Drosera*	*indica*		1
Polygalaceae	*Polygale*	*tepperi*		1
Aizoaceae	*Trianthema*	*turgidifolia*		1
Loganiaceae	*Mitrasacme*	*connata*		1
Mimosaceae	*Acacia*	*colei*		1

Quadrat 13

Field Vegetation Description: Scattered *Corymbia aspera* over low shrubland and tussock grassland

Landform/soil: Flat, red sand

Open ground: 60%

Condition: 1/2

Fire: <1 year

Disturbance: Fire

Quadrat 13 Species List

Family	Genus	Species	Status	% Cover
Myrtaceae	*Corymbia*	*aspera*		25
Poaceae	*Triodia*	*epactia*		10
Poaceae	*Paspalidium*	*constrictum*		10
Convulvulaceae	*Ipomoea*	*muelleri*		1
Poaceae	*Eriachne*	*aristidea*		1
Portulacaceae	*Calandrinia*	*stagnensis*		1
Cyperaceae	*Bulbostylis*	*barbata*		1
Violaceae	*Hybanthus*	*aurantiacus*		1
Portulacaceae	*Calandrinia*	sp. Pinga		1
Poaceae	*Eragrostis*	*cumingii*		1
Papilionaceae	*Indigofera*	*monophylla*		1
Mimosaceae	*Acacia*	*stellaticeps*		1

Family	Genus	Species	Status	% Cover
Malvaceae	*Sida*	*arenicola*		1
Mimosaceae	*Acacia*	*colei*		1
Caesalpiniaceae	*Senna*	*notabilis*		1
Amaranthaceae	*Ptilotus*	*fusiformis*		1
Cucurbitaceae	*Cucumis*	*maderaspatanus*		1
Poaceae	*Chloris*	*barbata*	*	1
Malvaceae	*Hibiscus*	*leptocladus*		1
Molluginaceae	*Mollugo*	*molluginea*		1
Polygalaceae	*Polygale*	*tepperi*		1
Tiliaceae	*Corchorus*	*walcottii*		1
Malvaceae	*Sida*	sp. Pilbara		1

Quadrat 14

Field Vegetation Description: Scattered *Corymbia aspera* over *A. stellaticeps* over *T. epactia* grassland

Landform/soil: Flat, red sand

Open ground: 60%

Condition: 2

Fire: <1 year

Disturbance: Fire

Quadrat 14 Species List

Family	Genus	Species	Status	% Cover
Mimosaceae	*Acacia*	*stellaticeps*		50
Poaceae	*Triodia*	*epactia*		5
Myrtaceae	*Corymbia*	*aspera*		2
Poaceae	*Paspalidium*	*constrictum*		2
Violaceae	*Hybanthus*	*aurantiacus*		1
Poaceae	*Yakirra*	*australiensis*		1
Convulvulaceae	*Evolvulus*	*alsinoides* var. *villosicalyx*		1
Poaceae	*Eriachne*	*aristidea*		1
Poaceae	*Eragrostis*	*cumingii*		1
Poaceae	*Aristida*	*holathera* var. *holathera*		1
Amaranthaceae	*Ptilotus*	*fusiformis*		1
Cyperaceae	*Bulbostylis*	*barbata*		1
Malvaceae	*Sida*	*rohlenae* subsp. *rohlenae*		1
Tiliaceae	*Corchorus*	*walcottii*		1
Papilionaceae	*Indigofera*	*monophylla*		1
Menispermaceae	*Tinospora*	*smilacina*		1
Cyperaceae	*Fimbristylis*	*oxystachya*		1
Convulvulaceae	*Ipomoea*	*muelleri*		1
Euporbiaceae	*Euphorbia*	*australis*		1
Convolvulaceae	*Merremia*	*davenportii*		1
Mimosaceae	*Acacia*	*sericophylla*		1
Apocynaceae	*Carissa*	*lanceolata*		1
Portulacaceae	*Calandrinia*	*sp. Pinga*		1
Zygophyllaceae	*Tribulopis*	*angustifolia*		1
Cyperaceae	*Fimbristylis*	*dichotoma*		1
Malvaceae	*Hibiscus*	*leptocladus*		1
Molluginaceae	*Mollugo*	*molluginea*		1
Mimosaceae	*Acacia*	*colei*		1

Appendix C

Fauna

EPBC Act Fauna Conservation Categories

Western Australian Wildlife Conservation Act 1950 Conservation Codes

DEC Priority Fauna Codes

Listing of Potentially Occurring Significant, Rare and Priority Fauna Species within 20 km of the Study Area, with Information Source

WA Museum “NatureMap” Fauna Records within approx. 20 km of the Study Area

Fauna Species Observed During the Field Survey

EPBC Act Fauna Conservation Categories

Listed threatened species and ecological communities

An action will require approval from the Environment Minister if the action has, will have, or is likely to have a significant impact on a species listed in any of the following categories:

- extinct in the wild,
- critically endangered,
- endangered, or
- vulnerable.

(see Table 6)

Critically endangered and endangered species

An action has, will have, or is likely to have a significant impact on a critically endangered or endangered species if it does, will, or is likely to:

- lead to a long-term decrease in the size of a population, or
- reduce the area of occupancy of the species, or
- fragment an existing population into two or more populations, or
- adversely affect habitat critical to the survival of a species, or
- disrupt the breeding cycle of a population, or
- modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline, or
- result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat*, or
- interfere with the recovery of the species.

**Introducing an invasive species into the habitat may result in that species becoming established. An invasive species may harm a critically endangered or endangered species by direct competition, modification of habitat, or predation.*

Vulnerable species

An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to:

- lead to a long-term decrease in the size of an important population of a species, or
- reduce the area of occupancy of an important population, or
- fragment an existing important population into two or more populations, or
- adversely affect habitat critical to the survival of a species, or
- disrupt the breeding cycle of an important population, or

- modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline, or
- result in invasive species that are harmful a vulnerable species becoming established in the vulnerable species' habitat*, or
- interferes substantially with the recovery of the species.

An important population is one that is necessary for a species' long-term survival and recovery. This may include populations that are:

- key source populations either for breeding or dispersal,
- populations that are necessary for maintaining genetic diversity, and/or
- populations that are near the limit of the species range.

*Introducing an invasive species into the habitat may result in that species becoming established. An invasive species may harm a vulnerable species by direct competition, modification of habitat, or predation.

Listed migratory species

An action will require approval from the Environment Minister if the action has, will have, or is likely to have a significant impact on a listed migratory species. Note that some migratory species are also listed as threatened species. The criteria below are relevant to migratory species that are not threatened.

An action has, will have, or is likely to have a significant impact on a migratory species if it does, will, or is likely to:

- substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat of the migratory species, or
- result in invasive species that is harmful to the migratory species becoming established* in an area of important habitat of the migratory species, or
- seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of the species.

An area of important habitat is:

1. habitat utilized by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species, or
2. habitat utilized by a migratory species which is at the limit of the species range, or
3. habitat within an area where the species is declining.

Listed migratory species cover a broad range of species with different life cycles and population sizes. Therefore, what is an ecologically significant proportion of the population varies with the species (each circumstance will need to be evaluated).

*Introducing an invasive species into the habitat may result in that species becoming established. An invasive species may harm a migratory species by direct competition, modification of habitat, or predation.

The Commonwealth marine environment

An action will require approval from the Environment Minister if:

- the action is taken in a Commonwealth marine area and the action has, will have, or is likely to have a significant effect on the environment, or
- the action is taken outside a Commonwealth marine area and the action has, will have, or is likely to have a significant effect on the environment in a Commonwealth marine area.

An action has, will have or is likely to have a significant impact on the environment in a Commonwealth marine area if it does, will, or is likely to:

- result in a known or potential pest species becoming established in the Commonwealth marine area*, or
- modify, destroy, fragment, isolate or disturb an important or substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity in a Commonwealth marine area results, or
- have a substantial adverse effect on a population of a marine species or cetacean including its life cycle (eg breeding, feeding, migration behaviour, and life expectancy) and spatial distribution, or
- result in a substantial change in air quality** or water quality (including temperature) which may adversely impact on biodiversity, ecological integrity, social amenity or human health, or
- result in persistent organic chemicals, heavy metals, or other potentially harmful chemicals accumulating in the marine environment such that biodiversity, ecological integrity, social amenity or human health may be adversely affected.

*Translocating or introducing a pest species may result in that species becoming established.

**The Commonwealth marine area includes any airspace over Commonwealth waters.

Table 9 *Western Australian Wildlife Conservation Act 1950* Conservation Codes

Conservation Code	Description
Schedule 1	"…fauna that is rare or likely to become extinct, are declared to be fauna that is in need of special protection."
Schedule 2	"…fauna that is presumed to be extinct, are declared to be fauna that is in need of special protection."
Schedule 3	"…birds that are subject to an agreement between the governments of Australia and Japan relating to the protection of migratory birds and birds in danger of extinction, are declared to be fauna that is in need of special protection."
Schedule 4	"…fauna that is in need of special protection, otherwise than for the reasons mentioned [in Schedule 1 – 3]"

Table 10 DEC Priority Fauna Codes

(Species not listed under the *Wildlife Conservation Act 1950*, but for which there is some concern).

Conservation Code	Description
Priority 1	Taxa with few, poorly known populations on threatened lands.
Priority 2	Taxa with few, poorly known populations on conservation lands. Taxa which are known from few specimens or sight records from one or a few localities on lands not under immediate threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, vacant Crown Land, water reserves, etc.
Priority 3	Taxa which are known from few specimens or sight records, some of which are on lands not under immediate threat of habitat destruction or degradation.
Priority 4	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.
Priority 5	Taxa in need of monitoring. Taxa which are not considered threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years.

Table 11 Listing of Potentially Occurring Significant, Rare and Priority Fauna Species within 20 km of the Study Area, with Information Source

Genus	Species	Common Name	Listing under Wildlife Conservation Act 1950 or DEC Priority List	Listing under EPBC Act	Source of Information		
					DEC Database	EPBC Protected Matters Search Tool	NatureMap
Birds							
Macronectes	*giganteus*	Southern Giant-Petrel	S1	Endangered,		X	
Haliaeetus	*leucogaster*	White-bellied Sea-Eagle		Migratory, Listed, overfly marine areas		X	
Hirundo	*rustica*	Barn Swallow		Migratory, Listed, overfly marine areas		X	
Merops	*ornatus*	Rainbow Bee-eater		Migratory, Listed, overfly marine areas			
Ardea	*alba*	Great Egret, White Egret		Migratory, Listed, overfly marine areas		X	
Ardea	*ibis*	Cattle Egret		Migratory, Listed, overfly marine areas		X	
Charadrius	*veredus*	Oriental Plover, Oriental Dotterel		Migratory, Listed overfly marine areas		X	
Glareola	*maldivarum*	Oriental Pratincole		Migratory, Listed, overfly marine areas		X	

Genus	Species	Common Name	Listing under Wildlife Conservation Act 1950 or DEC Priority List	Listing under EPBC Act	Source of Information		
					DEC Database	EPBC Protected Matters Search Tool	NatureMap
Numenius	*minutus*	Little Curlew, Little Whimbrel		Migratory, Listed, overfly marine areas		X	
Ardeotis	*australis*	Australian Bustard	Priority 4		X		X
Numenius	*madagascariensis*	Eastern Curlew	Priority 4				X
Neochima	*ruficauda* subsp. *subclarescens*	Star Finch (western)	Priority 4		X		X
Apus	*pacificus*	Fork-tailed Swift		Migratory, Listed, overfly marine areas		X	
Mammals							
Mormopterus	*loriae* subsp. *cobourgiana*	Little North-western Mastiff Bat	Priority 1		X		X
Macrotis	*lagotis*	Bilby, Dalgyte	Schedule 1	Vulnerable			X
Dasycercus	*blythi*	Brush-tailed Mulgara, Ampurta	Priority 4				X
Dasyurus	*hallucatus*	Northern Quoll	Schedule 1	Endangered	X	X	X
Lagostrophus	*fasciatus* subsp. *fasciatus*	Banded Hare-wallaby	Schedule 1	Vulnerable	X		X
Rhinonicteris	*aurantius* (Pilbara form)	Pilbara Leaf-nosed Bat		Vulnerable		X	*
Reptiles							
Aspidites	*ramsayi*	Woma	Schedule 4				X

Table 12 WA Museum "NatureMap" Fauna Records within approx. 20 km of the Study Area

Species	Common Name	Status
Amphibian		
Cyclorana australis	Giant Frog	
Cyclorana maini	Sheep Frog	
Litoria rubella	Little Red Tree Frog	
Neobatrachus aquilonius	Northern Burrowing Frog	
Notaden nichollsi	Desert Spadefoot	
Opisthodon spenceri	Centralian Burrowing Frog	
Uperoleia russelli	Northwest Toadlet	
Bird		
Ardeotis australis	Australian Bustard	P4
Arenaria interpres subsp. *interpres*		
Artamus cinereus subsp. *melanops*		
Artamus leucorynchus	White-breasted Woodswallow	
Calidris ruficollis	Red-necked Stint	
Corvus orru subsp. cecilae	Western Crow	
Eopsaltria pulverulenta	Mangrove Robin	
Gallinago stenura	Pin-tailed Snipe	
Gallirallus philippensis subsp. *mellori*		
Gerygone tenebrosa	Dusky Gerygone	
Limnodromus semipalmatus	Asian Dowitcher	
Motacilla flava subsp. *simillima*		
Neochima ruficauda subsp. *subclarescens*	Star Finch (western)	P4
Numenius madagascariensis	Eastern Curlew	P4
Nycticorax caledonicus subsp. *hilli*		
Oceanites oceanicus	Wilson's Storm Petrel	
Pachycephala lanioides	White-breasted Whistler	
Passer montanus	Eurasian Tree Sparrow	
Ptilonorhynchus maculatus subsp. *guttatus*	Western Bowerbird	
Sterna caspia	Caspian Tern	
Sterna leucoptera	White-winged Black Tern	
Tringa brevipes	Grey-tailed Tattler	

Species	Common Name	Status
Tringa cinerea	Terek Sandpiper	
Turnix velox	Little Button-quail	
Mammal		
Antechinomys laniger	Kultarr	
Chaerephon jobensis	Northern Freetail-bat	
Dasycercus blythi	Brush-tailed Mulgara, Ampurta	P4
Dasykaluta rosamondae	Little Red Kaluta	
Dasyurus hallucatus	Northern Quoll	Endangered
Dugong dugon	Dugong	Schedule 1
Lagostrophus fasciatus subsp. *fasciatus* Bernier Is.	Banded Hare-wallaby (name not current)	Vulnerable
Macropus robustus subsp. *erubescens*	Euro, Biggada	
Macrotis lagotis	Bilby, Dalgyte	Vulnerable
Mormopterus loriae subsp. *cobourgiana*	Little North-western Mastiff Bat	P1
Nyctophilus arnhemensis	Arnhem Land Long-eared Bat	
Nyctophilus geoffroyi	Lesser Long-eared Bat	
Pseudomys hermannsburgensis	Sandy Inland Mouse	
Sminthopsis youngsoni	Lesser Hairy-footed Dunnart	
Sousa chinensis	Indo-Pacific Humpback Dolphin	P4
Vespadelus finlaysoni	Finlayson's Cave Bat	
Reptile		
Acanthophis pyrrhus	Desert Death Adder	
Amphibolurus longirostris		
Antaresia perthensis	Pygmy Python	
Antaresia stimsoni subsp. *stimsoni*		
Aspidites melanocephalus	Black-headed Python	
Aspidites ramsayi	Woma	Schedule 1
Chelonia mydas	Green Turtle	Vulnerable
Cryptoblepharus buchananii		
Ctenophorus caudicinctus subsp. caudicinctus		
Ctenophorus isolepis subsp. isolepis		
Ctenotus duricola		
Ctenotus hanloni		
Ctenotus helenae		

Species	Common Name	Status
Ctenotus pantherinus subsp. ocellifer		
Ctenotus rufescens		
Ctenotus saxatilis	Rock Ctenotus	
Ctenotus serventyi		
Delma haroldi		
Delma pax		
Demansia rufescens	Rufous Whipsnake	
Diplodactylus conspicillatus	Fat-tailed Gecko	
Diporiphora winneckei	Blue-lined Dragon	
Disteira stokesii		
Eremiascincus fasciolatus	Narrow-banded Sand Swimmer	
Eretmochelys imbricata subsp. *bissa*	Hawksbill Turtle (name not current)	
Fordonia leucobalia	White-bellied Mangrove Snake	
Furina ornata	Moon Snake	
Gehyra pilbara		
Gehyra punctata		
Gehyra purpurascens		
Gehyra variegata		
Hemidactylus frenatus	Asian House Gecko	
Hydrelaps darwiniensis		
Hydrophis elegans		
Lerista bipes		
Lerista clara		
Lialis burtonis		
Lucasium stenodactylum		
Menetia greyii		
Nephrurus levis subsp. *pilbarensis*		
Pogona minor subsp. *mitchelli*		
Pseudechis australis	Mulga Snake	
Pseudonaja modesta	Ringed Brown Snake	
Pseudonaja nuchalis	Gwardar	
Pygopus nigriceps		
Ramphotyphlops ammodytes		
Ramphotyphlops braminus		

Species	Common Name	Status
Ramphotyphlops grypus		
Ramphotyphlops pilbarensis		
Rhynchoedura ornata	Beaked Gecko	
Simoselaps anomalus	Desert Banded Snake	
Strophurus ciliaris subsp. *aberrans*		
Strophurus jeanae		
Suta punctata	Spotted Snake	
Tiliqua multifasciata	Central Blue-tongue	
Varanus acanthurus	Spiny-tailed Monitor	
Varanus eremius	Pygmy Desert Monitor	
Varanus gouldii	Bungarra or Sand Monitor	

Table 13 Fauna Species Observed During the Field Survey

Family	Genus	Species	Common Name	Status
Birds				
Accipitridae	*Accipiter*	*fasciatus*	Brown Goshawk	
Accipitridae	*Aquila*	*audax*	Wedge-tailed Eagle	Mi
Accipitridae	*Elanus*	*caeruleus*	Black-shouldered Kite	Mi
Accipitridae	*Haliastur*	*sphenurus*	Whistling Kite	Mi, Ma
Accipitridae	*Milvus*	*migrans*	Black Kite	Mi
Alaudidae	*Mirafra*	*javanica*	Singing Bushlark	
Alcedinidae	*Geopelia*	*cuneata*	Diamond Dove	
Alcedinidae	*Geopelia*	*humeralis*	Bar-shouldered Dove	
Alcedinidae	*Phaps*	*chalcoptera*	Common Bronzewing	
Artamidae	*Artamus*	*cinereus*	Black-faced Woodswallow	
Artamidae	*Cracticus*	*nigrogularis*	Pied Butcherbird	
Campephagidae	*Coracina*	*novaehollandiae melanops*	Black-faced Cuckoo-Shrike	Ma
Columbidae	*Ocyphaps*	*lophotes*	Crested Pigeon	
Corvidae	*Corvus*	*orru*	Torresian Crow	
Dicruridae	*Rhipidura*	*leucophrys*	Willie Wagtail	
Dricruridae	*Grallina*	*cyanoleuca*	Magpie-Lark	
Falconidae	*Falco*	*cenchroides*	Nankeen Kestrel	Ma
Falconidae	*Falco*	*longipennis*	Australian Hobby	Mi
Falconidae	*Falco*	*subniger*	Black Falcon	Mi
Halcyonidae	*Todiramphus*	*pyrrhopygia*	Red-backed Kingfisher	
Maluridae	*Malurus*	*leucopterus*	White-winged Fairy Wren	
Meliphagidae	*Lichenostomus*	*keartlandi*	Grey-headed Honeyeater	
Meliphagidae	*Lichenostomus*	*virescens*	Singing Honeyeater	
Meliphagidae	*Manorina*	*flavigula*	Yellow-throated Miner	
Meropidae	*Merops*	*ornatus*	Rainbow Bee-eater	Mi, Ma
Motacillidae	*Anthus*	*australis*	Australian Pipit	
Otididae	*Ardeotis*	*australis*	Australian Bustard	P4
Passeridae	*Taeniopygia*	*guttata*	Zebra Finch	
Phalacrocoracidae	*Phalacrocorax*	*sulcirostris*	Little Black Cormorant	
Phasianidae	*Coturnix*	*ypsilophora*	Brown Quail	
Psittacidae	*Cacatua*	*sanguinea*	Little Corella	

Family	Genus	Species	Common Name	Status
Psittacidae	*Eolophus*	*roseicapilla*	Galah	
Psittacidae	*Melopsittacus*	*undulatus*	Budgerigar	
Psittacidae	*Nymphicus*	*hollandicus*	Cockatiel	
Mammals				
Bovidae	*Bos*	*taurus*	European Cattle	*
Bovidae	*Capra*	*hircus*	Goat	*
Dasyuridae	*Dasycercus*	*cristicauda*	Mulgara	V, S1
Felidae	*Felis*	*catus*	Feral Cat	*
Macropodidae	*Macropus*	*rufus*	Red Kangaroo	
Reptiles				
Agamidae	*Ctenophorus*	*isolepis isolepis*	Central Military Dragon	
Scincidae	*Ctenotus*	*pantherinus ocellifer*	Leopard Ctenotus	
Scincidae	*Ctenotus*	*piankai*	Piankai Ctenotus	
Scincidae	*Ctenotus*	*saxatilis*	Rock Ctenotus	
Scincidae	*Ctenotus*	*serventyi*	Serventy's Skink	
Varanidae	*Varanus*	*acanthurus acanthurus*	Spiny-tailed Monitor	
Varanidae	*Varanus*	*brevicauda*	Short-tailed Pygmy Monitor	

* Introduced

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