

Roebourne townsite

Environmental strategy

Prepared for Shire of Roebourne

By Essential Environmental

February 2013



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Acknowledgements

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1 INTRODUCTION

The Shire of Roebourne is currently preparing a structure plan for the Roebourne townsite that will guide future use and development of the townsite in the short and longer term.

There are a number of conservation reserves that currently exist in the local planning scheme. The townsite is also situated on the banks of the Harding River and is nestled around Mount Welcome. These features are broadly considered to have environmental values, as they are generally associated with riparian vegetation and habitat, as well as rocky hills with steep slopes and gullies.

The Shire of Roebourne is currently pursuing resolution of planning matters within the structure plan area to provide guidance for assessment of future development proposals.

1.1 Purpose

The Shire of Roebourne engaged Essential Environmental to undertake an environmental scoping review of the Roebourne area to support the future planning for the townsite.

The purpose of this environmental strategy is to provide guidance for strategic and statutory planning of the Roebourne townsite. The scope of the environmental review is flora, fauna, contamination and climate. It does not include a review of water resources or aboriginal heritage as this work is being done separately.

This environmental strategy will:

- identify areas with environmental values
- make recommendations for additional areas to be protected (if warranted)
- recommend strategies to be incorporated into the future local structure plan and scheme

It is noted that although the townsite area is around three square kilometres, a large proportion of this area is already developed. This study is therefore focused on areas of vacant land within the study area (not already zoned urban), in order to identify those with environmental significance and other areas that are unlikely to be constrained by biodiversity or contamination issues.

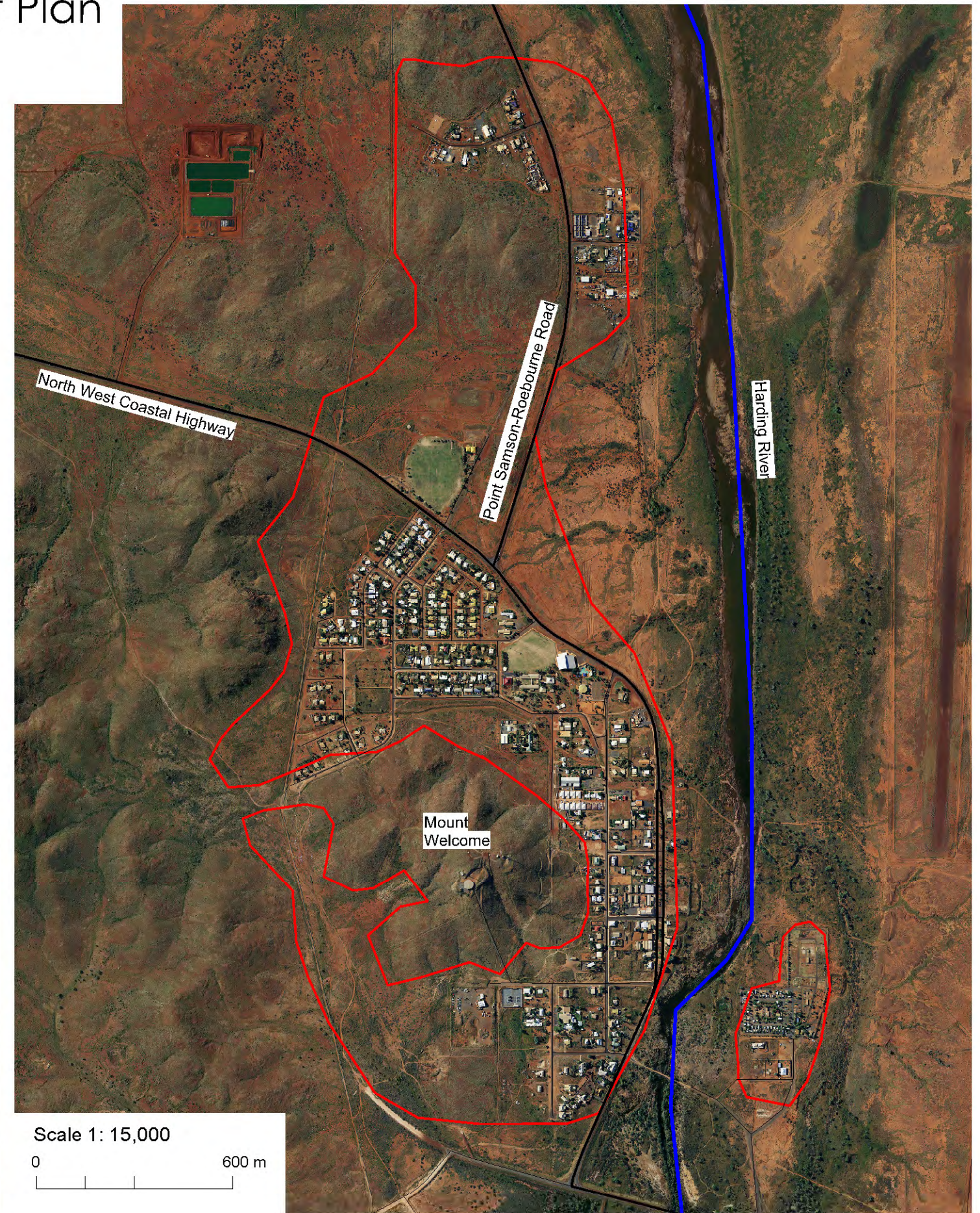
1.2 Location and land use

The town of Roebourne is located in the Pilbara region in the northwest of Western Australia. It is located inland on the North West Coastal Highway, on the banks of the Harding River, approximately 10 km south of the nearest coastline. It is approximately 30 km east of Karratha, 160 km west of Port Hedland and 1,300 km north of Perth (Figure 1). The area within the boundaries of the proposed local structure plan is approximately 400ha.

Roebourne was established in 1864 to support pastoralism, mining (gold, copper and lead) and pearling, and is the oldest active town North of Geraldton. Until the 1960s, Roebourne operated as a regional administrative centre to support mining and agricultural industry, however, the construction of Dampier, Wickham and Karratha and the decline in pastoralism, has resulted in a decrease in population and activity.

Roebourne, Stormwater and Flood Management Plan

Figure 1 - Site Location and Study Area



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The townsite currently serves passing highway traffic and tourism, particularly as a gateway to a number of national parks, including the Millstream-Chichester National Park. Roebourne is a hub for Aboriginal enterprise and culture and is home to the Ngarluma people, as well as many Yindjibarndi and Banyjima people from outlying stations. The town is mostly residential with some mixed business in the north along the Point Samson-Roebourne Road. There are significant areas set aside for conservation and recreation, particularly around the Harding River.

The townsite local structure plan area is bound to the south by the North West Coastal Highway and rural areas extend beyond its northern boundary. A wastewater treatment facility is located to the northwest.

The majority of the Roebourne townsite structure plan area is located on the western side of the Harding River. However, a smaller separate area is located south-east of the town centre and east of the Harding River. This area includes the Harding River caravan park and a residential zone which provides for worker's accommodation.

Key areas of focus for potential land use change and development include (figure 2):

- Industrial development to the east of the existing industrial area in the north of the site. (Note: Part of this land is outside the survey area as it was added to the project area after commencement of the study)
- Consolidation of residential development within the townsite in existing vacant lots
- New residential development to the south east of Mt Welcome
- Redevelopment and enhancement of community facilities in the central region
- Celebration of heritage buildings and creation of commercial opportunities in the southern node.

1.3 Zoning

The Shire of Roebourne Town Planning Scheme No 8 identifies the following zones within the Roebourne townsite structure plan area (shown in Figure 3):

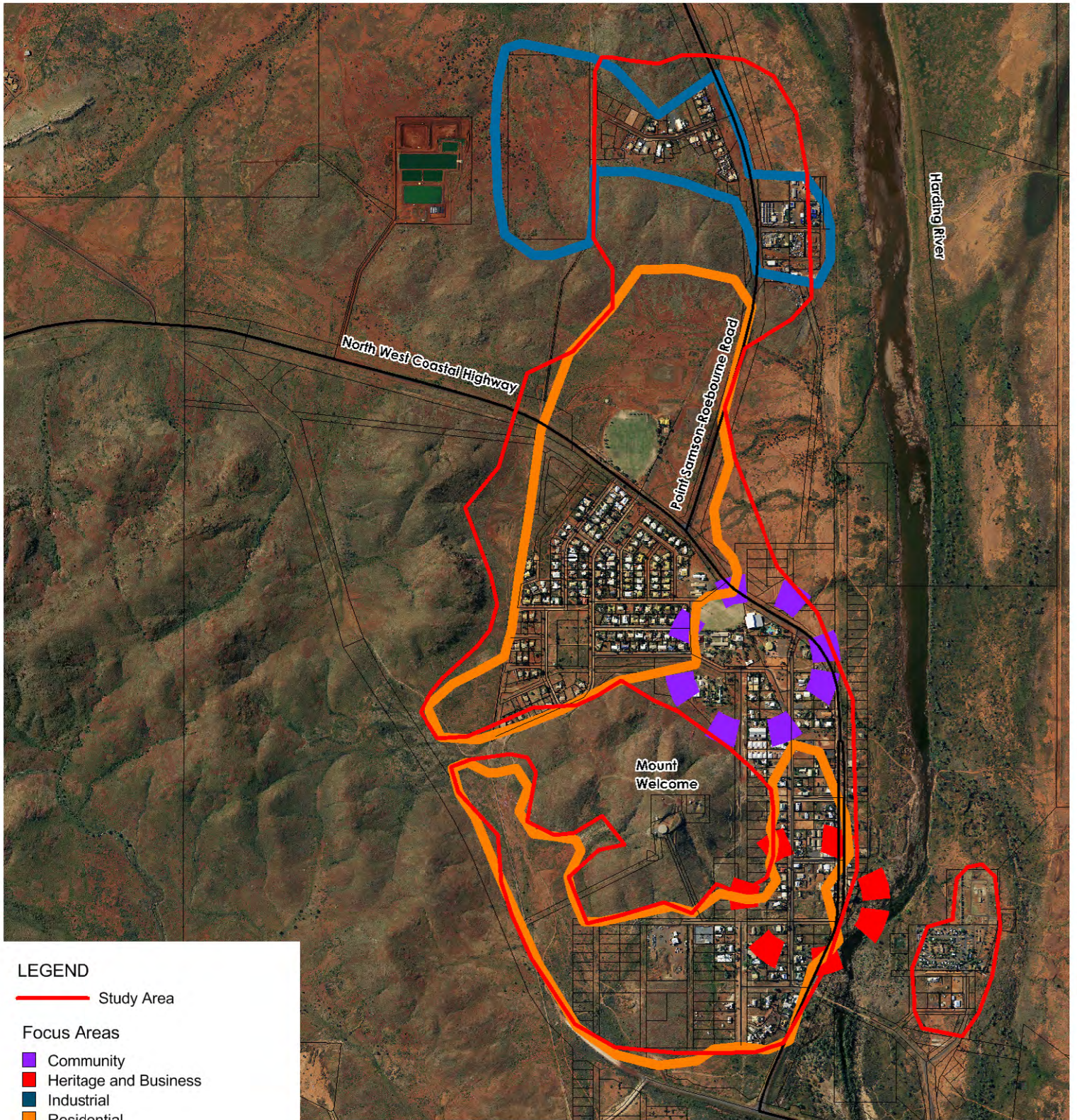
- (i) "Conservation Recreation and Natural Landscape"
- (ii) "Parks, Recreation and Drainage"
- (iii) "Rural"
- (iv) "Public Purposes"
- (v) "Mixed Business"
- (vi) "Urban Development"
- (vii) "Town Centre"
- (viii) "Residential"
- (ix) "Tourism"

These zones are likely to be revised as a result of the Roebourne townsite structure plan.


1.4 Ownership

The majority of the Roebourne townsite is owned by the Federal Government as both allocated and unallocated crown land. A small number of residential, mixed business and town centre lots are privately owned. Urban development land under Development Application 25 in the north of the Roebourne townsite is also privately owned.


Shire of Roebourne - Roebourne Environmental Strategy
 Figure 2: Structure plan area of focus





LEGEND

 Study Area

Focus Areas

 Community

 Heritage and Business

 Industrial

 Residential



Scale 1: 17500



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2 EXISTING ENVIRONMENT

A desktop review of relevant documents and available information was undertaken to determine the key characteristics of the townsite's existing environment.

This is supported by a level 1 flora and fauna study of the site, undertaken by Eco Logical Australia on 25 October 2012 (attachment 1). A description of the existing environment is presented below.

2.1 Climate

The Roebourne townsite's arid and semi-arid climate is typical of the Pilbara region of Western Australia, with hot summers accompanied by irregular rainfall and milder, dry winters. Average annual rainfall is 312 mm.

The north coast of the Pilbara region experiences occasional tropical cyclones which results in highly variable rainfall patterns in the region. The Bureau of Meteorology maintains a weather station in Roebourne that has been operating continuously since 1887.

2.1.1 Temperature and Rainfall

Both temperature and rainfall reach their maximum in summer, with temperature peaking in December at 39°C, and rainfall peaking at 67.5 mm in February. During the winter, the situation is reversed with maximum temperatures reaching their lowest point in July (approximately 27°C) whilst rainfall reaches its lowest amount, of approximately 0.7 mm, later in the year, in October (shown in Plate 1 below).

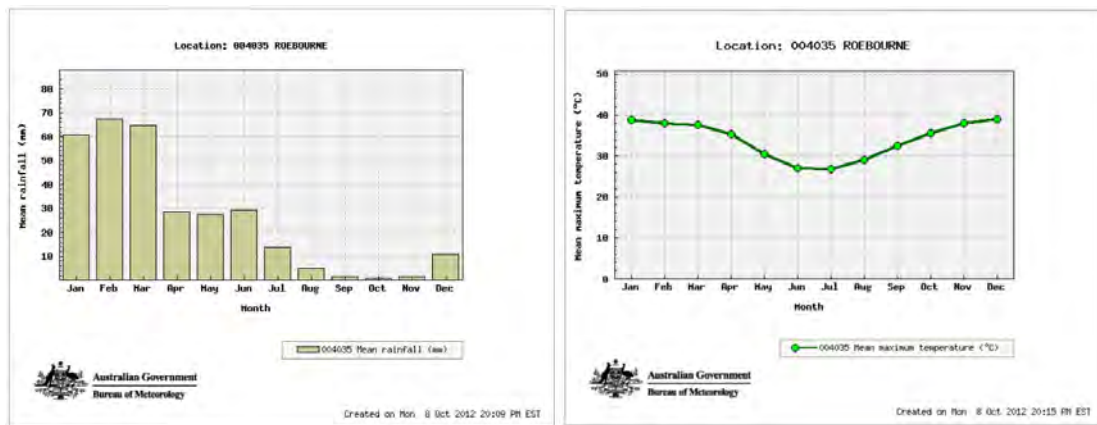


Plate 1: Monthly mean temperature and rainfall at Roebourne (Source: Bureau of Meteorology)

2.1.2 Wind Direction and Speed

Prevailing winds in Roebourne are seasonally variable and exhibit diurnal variation caused by the regional weather patterns.

Wind data from the Bureau of Meteorology weather station in Roebourne shows that mean wind speeds are higher in winter in the morning (9am) and higher in summer in the afternoon (3pm), with mean monthly speeds ranging from 7 – 14 km/h at these times (Plate 2). Wind

direction in Roebourne is typically easterly in the morning (9am) and varies between a north-westerly and north-easterly direction in the afternoon (3pm).

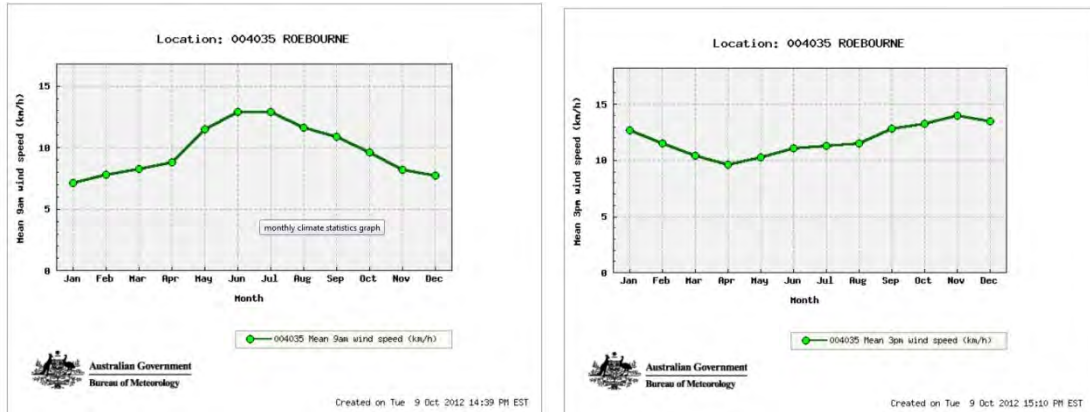


Plate 2: Monthly mean wind speeds at 9am and 3pm at Roebourne (Source: Bureau of Meteorology)

2.2 Topography

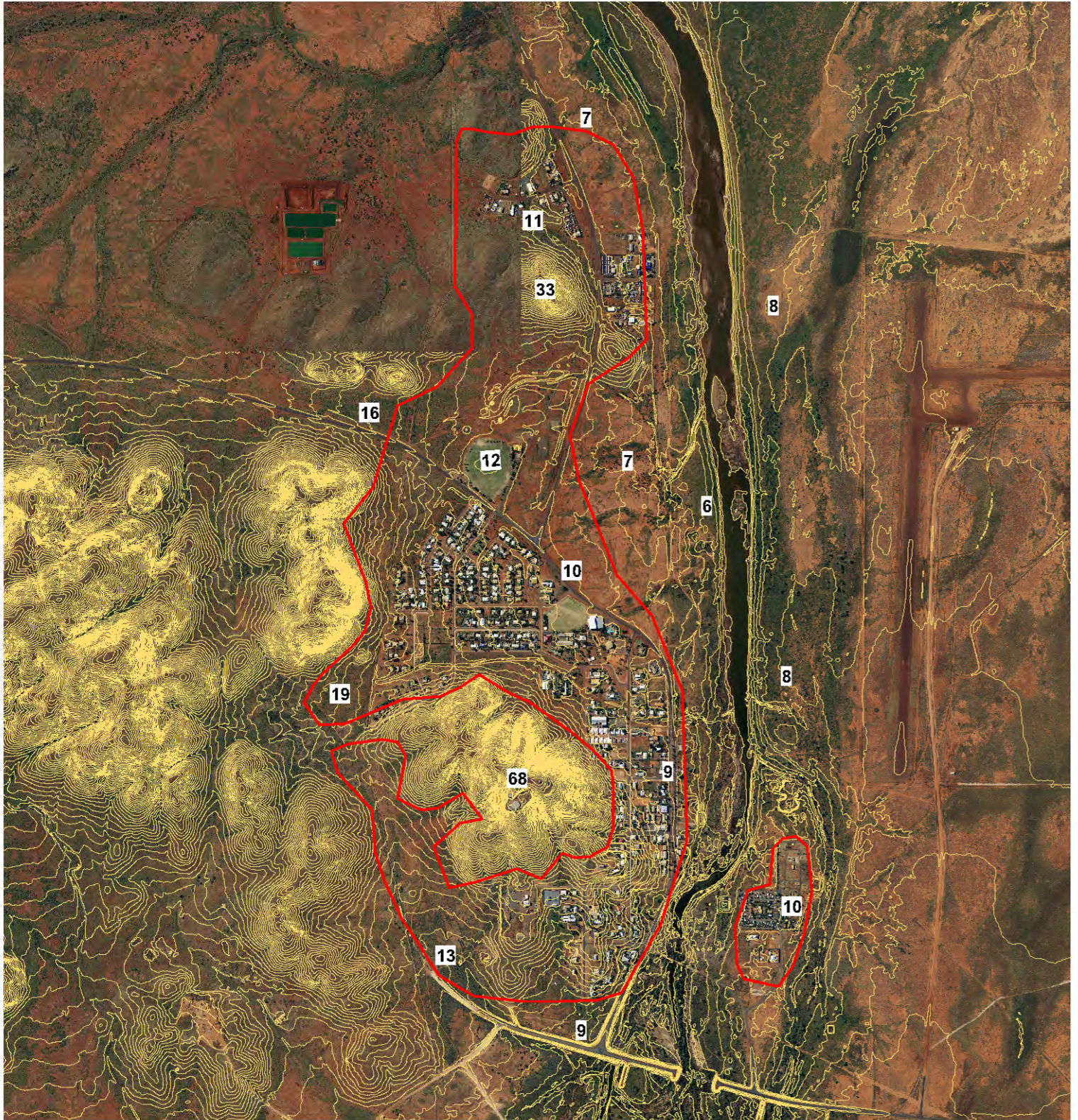
The Roebourne townsite local structure plan area extends north-south, situated between a series of hills along the western boundary, peaking at Mount Welcome, with the Harding River along its eastern boundary. A smaller area of the Roebourne townsite lies separate from the main site, disconnected by the Harding River to the southeast.

The townsite local structure plan area is generally flat, most of which lies at an elevation between approximately 10 – 20 m AHD. However, a significant feature is Mount Welcome which peaks at approximately 70 m AHD and cuts through the central southern area of the townsite. A second, smaller hill peaking at approximately 38 m AHD cuts through the north of the townsite (Figure 4).



Plate 3: Roebourne townsite around the foot of Mt Welcome

Shire of Roebourne - Roebourne Environmental Strategy
 Figure 4: Topography



LEGEND

- Study Area
- Contours (1 m)



Scale 1: 20000
 0 400m

A horizontal scale bar with a vertical tick at the 0 mark and another at the 400m mark.

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2.3 Soils, geology and landforms

Soils in Roebourne are generally a combination of floodplain alluvial sediments (Qa) consisting of sands and clay (GHD, 2012 and Stewart *et al.*, 2008) and igneous rock (Adav) (Figure 5).

The geology of the Roebourne townsite local structure plan area may be broadly described as granite and greenstone (Van Vreeswyk *et al.*, 2004). The Hydrogeological Atlas of WA describes the geology of Roebourne as: Volcanic and sedimentary rocks in greenstone belts, undifferentiated (DoW, 2012). The geology of Roebourne has been similarly mapped by the Department of Mines and Petroleum as part of the Ruth Well Formation which is composed of Metamorphosed basic and ultrabasic volcanic and intrusive rocks (DMP, 2012).

There is also potential for Gilgai soils to be found in the Roebourne townsite structure plan area and surroundings. Gilgai soils have been found in Karratha (Coffey Geotechnics Pty Ltd, 2008) and between Karratha and Tom Price (Main Roads, 2006). These are soils consisting of clay that rapidly expand as they absorb moisture and then contract as they dry. These soils create instable surfaces which can result in cracking of any infrastructure built over them.

Ridge lines west of the Roebourne townsite, including the highest point at Mount Welcome, are the defining landform of the townsite local structure plan area.

Just outside the structure plan area to the east, the riparian landscape of the Harding River is a contrasting but similarly distinctive landform.



Plate 4: Mt Welcome from the west



Plate 5: Riparian habitat of the Harding River

2.3.1 Acid sulfate soils

A search of Landgate's WA Atlas shows the Roebourne townsite structure plan area to have no known risk of acid sulfate soils (ASS) occurring within 3 m of the natural surface (Figure 5). However, a 'moderate to low risk of ASS occurring within 3m of natural soil surface but high to moderate risk of ASS beyond 3m of natural soil surface' has been indicated along the banks of the Harding River and its tributaries including a surface water flow path from the back of Mt Welcome to the river. If development is proposed in land located within this risk category, acid sulphate soils may be present and require specific management actions if disturbed during construction. Any development in this area will require further investigation to determine whether ASS is present. Should ASS be found, management should be undertaken consistent with advice from the Department of Environment and Conservation, as outlined in their ASS management guideline series.

A high to moderate risk of ASS has been identified in the Harding River itself.

2.3.2 Contamination

No contaminated sites are recorded in Roebourne on the Department of Environment and Conservation (DEC)'s Contaminated Sites Database. However, asbestos contamination has been previously recorded in a number of areas by the Shire of Roebourne.

2.3.3 Asbestos

Roebourne was historically part of a transportation route for crocidolite (blue asbestos) mined in Wittenoom and transferred to Point Samson. Asbestos was once considered a safe material and used for many different applications including construction, roofing, fencing, insulation and water pipes (Shire of Roebourne, 2012). Wide spread use of asbestos is thought to have resulted in the continued presence of low levels of asbestos throughout many areas of the town.

The following areas have been identified by the Shire of Roebourne as contaminated with asbestos (GHD, 2012):

- Lots 32 and 34, Sholl Street – used as a truck stop;
- Old caravan park site on Lot 393 Sholl Street - used as a truck stop and asbestos may also have been buried at this location (Reserve);
- Vacant Crown land at the base of Mount Welcome – identified burial point;
- Lot 396 and 397 Sholl Street – asbestos identified on verge after trenching of verge;
- Lot 35, 36 Sholl Street;
- Reserve 41666 Roebourne
- Lot 772, drainage and public utilities services
- Roebourne Courthouse, Hampton Road – asbestos contamination identified as low and over relatively small areas;
- Old Roebourne Union Bank – asbestos contamination identified;
- Roebourne Depot - asbestos contamination identified; and
- Roebourne Airstrip – asbestos contamination identified.

In 2003, work was undertaken to remove asbestos discovered on selected sites in Roebourne and on vacant crown land on the southern flanks of Mount Welcome (ABC, 2012). Areas identified as requiring clean up included; Lots 32, 34 Sholl Street, the road verge in front of lots 396 and 397 Sholl Street, vacant crown land behind Roebourne Village, the Old Roebourne Union Bank, Roebourne Depot, and Roebourne Airstrip (GHD, 2012). This resulted in areas around the Bank and Depot having restricted access and the Airstrip being temporarily closed.

The remaining properties are not considered by the Shire of Roebourne to have recorded levels of asbestos high enough to be considered an environmental hazard or require clean-up (GHD, 2012).

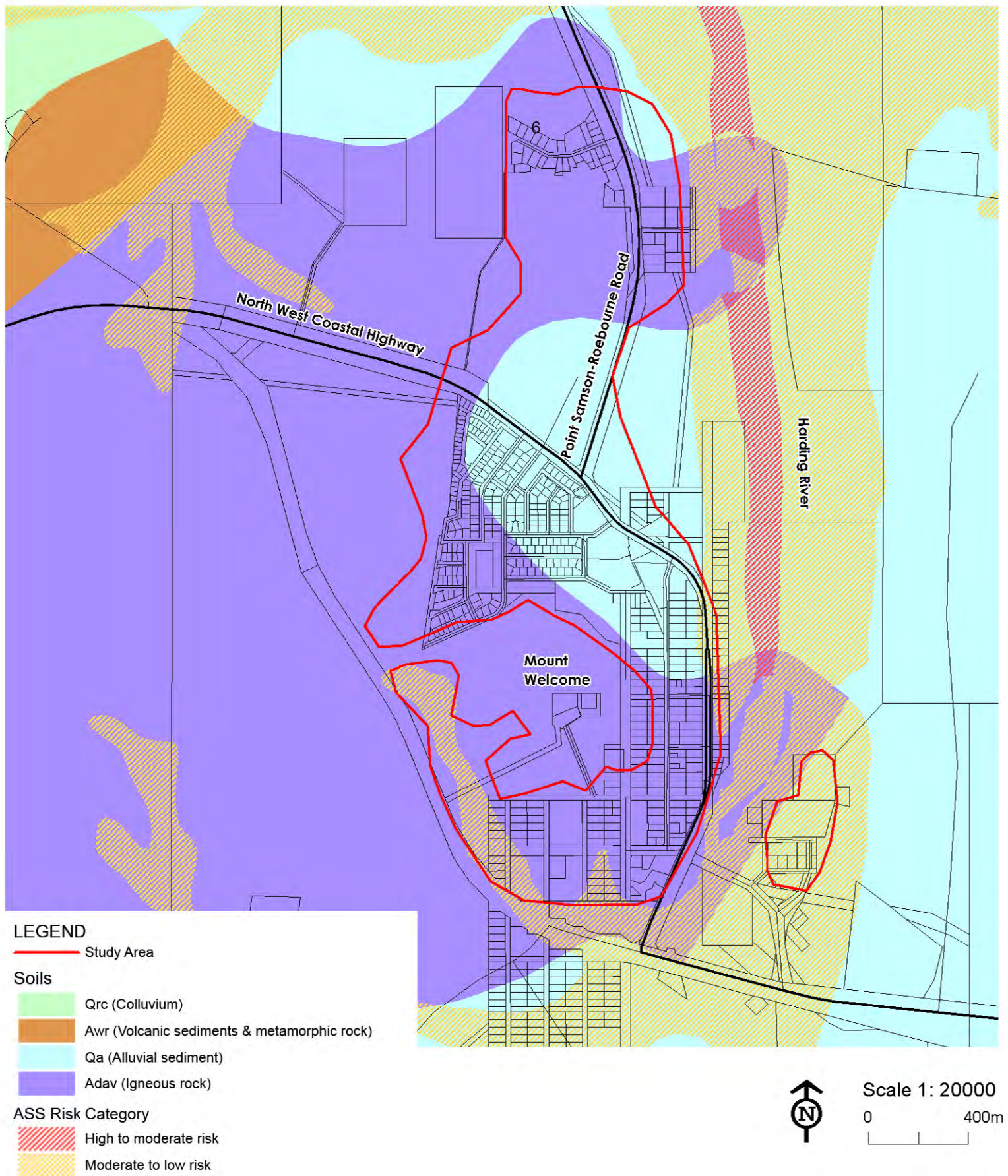
All hazardous waste from the Roebourne townsite, including asbestos, is disposed of at the 7 Mile Waste Facility in Karratha (Shire of Roebourne, 2012).

2.3.4 Arsenic

Arsenic is thought to occur naturally in certain areas of the region and contamination of groundwater is suspected in and around Roebourne (ABC, 2010, GHD, 2012 and Plexus Town Planning P/L, 2007).

Shire of Roebourne - Roebourne Environmental Strategy

Figure 5: Soils and acid sulphate soils



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2.4 Vegetation and flora

The Roebourne townsite lies within the Pilbara (IBRA¹) bioregion and contains parts of two IBRA subregions: the majority lies within the Chichester subregion with only a small portion on the eastern side of the study area within the Roebourne Plains subregion.

Eco Logical Australia (2012, unpublished, attachment 1) notes that the majority of the study area has been mapped as Abydos Plain Chichester (Vegetation Code 157) hummock grasslands, grass steppe, hard spinifex, *Triodia wiseana*. This vegetation has a medium rating for reservation priority, with 99.06% of its pre-European extent remaining and is considered of least concern by the Department of Natural Resources and Environment (2002) for protection. A small isolated area to the east of the main study area has been mapped as Abydos Plain (Vegetation Code 619) medium woodland, river gum *Eucalyptus camaldulensis*. This vegetation has a high rating for reservation priority but with 99.02% of its pre-European extent remaining, it is also considered of least concern by the Department of Natural Resources and Environment (2002) for conservation. Vegetation communities are presented in Figure 6.

A preliminary search of the Department of Environment and Conservation (DEC)'s Naturemap database returned no record of Declared Rare Flora within 5 km of Roebourne. One Priority 3 species, *Acacia glaucocaesia*, was recorded within 5 km of the townsite. There are no Environmentally Sensitive Areas within the structure plan boundary.

A search of the *Environment Protection and Biodiversity Conservation (EPBC) Act 1999* protected matter search tool returned no record of threatened ecological communities or threatened species within 2 km of the site.

2.5 Fauna

A preliminary search of the Department of Environment and Conservation (DEC)'s Naturemap database returned one record of Declared Rare Fauna, *Dasyurus hallucatus* (Northern Quoll) within 15 km of the site. Five species of birds protected under international agreement have also been recorded within 5 km of the townsite (Table 1).

Table 1: Naturemap database fauna species records within 5 km of Roebourne

Category	Name ID	Taxa	Common Name
Rare or likely to become extinct	24093	<i>Dasyurus hallucatus</i>	Northern Quoll
Protected under international agreement	24436	<i>Cuculus saturatus subsp. Optatus</i>	Oriental Cuckoo
	24598	<i>Merops ornatus</i>	Rainbow Bee-eater
	24806	<i>Tringa glareola</i>	Wood Sandpiper
	24808	<i>Tringa nebularia</i>	Common Greenshank
	24809	<i>Tringa stagnatilis</i>	Marsh Sandpiper

¹ Interim Biogeographical Regionalisation for Australia – which provides a framework for the description of biodiversity across the country.

A search of the EPBC Act 1999 protected matter search tool identified four threatened species of mammals of both vulnerable and endangered status and ten migratory species (including terrestrial, wetlands and marine birds) within 5 km of the site (Table 2).

Table 2: EPBC Protected matters database search results within 5 km of Roebourne

Category	Status	Taxa	Common Name
Threatened Species	Endangered	<i>Dasyurus hallucatus</i>	Northern Quoll
	Vulnerable	<i>Dasyercus cristicauda</i>	Mulgara
	Vulnerable	<i>Macrotis lagotis</i>	Greater Bilby
	Vulnerable	<i>Rhinonictis aurantia (Pilbara form)</i>	Pilbara Leaf-nosed Bat
Migratory Species (Threatened)	Migratory Wetlands Species	<i>Charadrius veredus</i>	Oriental Plover, Oriental Dotterel
		<i>Glareola maldivarum</i>	Oriental Pratincole
	Migratory Wetlands Species / Marine Birds	<i>Ardea alba</i>	Great Egret, White Egret
		<i>Ardea ibis</i>	Cattle Egret
	Marine Birds	<i>Apus pacificus</i>	Fork-tailed Swift
	Terrestrial Species	<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle
		<i>Hirundo rustica</i>	Barn Swallow
		<i>Merops ornatus</i>	Rainbow Bee-eater

2.6 Level 1 survey findings

A Level 1 flora, vegetation and fauna survey was undertaken by Eco Logical Australia on the 25th October 2012. The completed report is contained in attachment 1. The survey focussed on areas of vacant land including areas already reserved for conservation. Areas that were not surveyed include the existing residential footprint (as this is already cleared) as well as the NASH land in the northern part of the study area as this is already zoned residential and has an approved structure plan over the area.

The following text is an extract from the Eco Logical report.

A total of 34 dominant flora taxa were identified within the study area. The taxa comprised ten families and 23 genera. The two most commonly occurring families were the Fabaceae (16 taxa) and Poaceae (6 taxa) families. *Acacia* (Fabaceae) was the most common genus with 11 taxa.

No Threatened flora species listed under the Federal *Environment Protection and Biodiversity Conservation Act 1999* or the State *Wildlife Conservation Act 1950* were recorded within the study area. No Priority flora species or species at the extent of their range, represent a range extension, or are considered regionally significant were recorded.

All vegetation communities in the study area have been subject to historic disturbances such as vegetation clearing, proliferation of tracks, historical grazing and rubbish dumping. These disturbances have modified the vegetation structure, increased weed invasion and reduced native species diversity across the majority of the study area. Vegetation condition ranged from Completely Degraded to Good with the majority of the study area described as being in Degraded condition (Figure 7).

One vegetation community identified within the study area during the site inspection shares similarities with a Priority Ecological Community (PEC) known as the 'Horseflat land system of the Roebourne Plains'. However this portion of the study area is degraded with significantly reduced species diversity that would be typically found in this PEC (Figure 7). Note that PECs do not have statutory protection under either Federal or State legislation.

A total of 46 native fauna species were recorded during the Level 1 fauna survey. One mammal, four reptiles and 41 birds were identified during the survey of the study area. Fifteen of the 41 bird species recorded were observed within the Harding River on the eastern edge of the study area boundary.

Two conservation significant fauna species were recorded within the study area during the survey, and a further two conservation significant species were recorded just beyond the eastern edge of the study area within the Harding River (Figure 8). All four species are federally listed migratory birds:

- Rainbow Bee-eater (*Merops australis*) - observed in several locations within project area
- Great Egret (*Ardea alba*) - observed flying over the project area
- Cattle Egret (*Ardea ibis*) - observed in Harding River just beyond the project area
- Common Greenshank (*Tringa nebularia*) - observed in Harding River just beyond project area.

No other conservation significant fauna or signs of their presence were detected. A number of other conservation significant species were assessed as possibly occurring due to their local and regional distribution. Of these, the most likely to occur are the Bush Stone Curlew (*Burhinus grallius*) and the Australian Bustard (*Ardeotis australis*) both Priority 4 species.

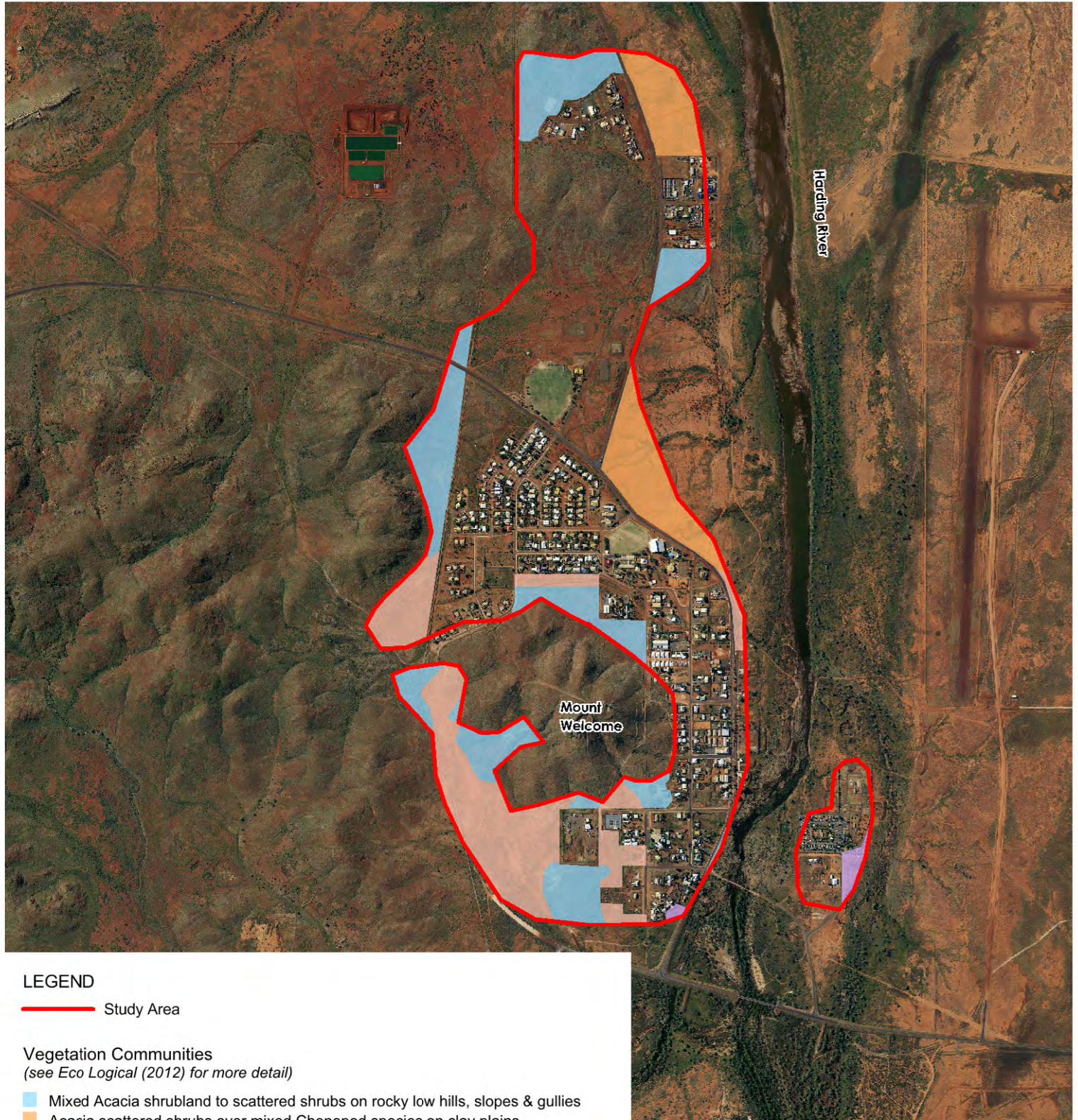
2.7 Surface water and drainage

The north west of Western Australia experiences unreliable and highly variable rainfall. Rainfall occurs predominantly in summer as a result of the northern Australian wet season and often as a result of tropical cyclones. Consequently, much of the north-west region is subject to inundation during cyclonic events due to riverine flooding and local runoff from smaller catchments.

The Harding River is the major water body in and around the Roebourne townsite. It is the low point to which all stormwater from the townsite ultimately drains. Areas of the townsite are also affected by flooding from the Harding River in major rainfall events.

Areas within the townsite, predominantly comprising drains, have been set aside for the management of local stormwater generated on the site or from adjacent areas, as well as for the management of flood risk from the Harding River. The adequacy of these areas to manage stormwater and flood risk is the subject of a separate investigation.





Shire of Roebourne - Roebourne Environmental Strategy
 Figure 6: Vegetation communities



LEGEND

 Study Area

Vegetation Communities
 (see *Eco Logical (2012)* for more detail)

-  Mixed Acacia shrubland to scattered shrubs on rocky low hills, slopes & gullies
-  Acacia scattered shrubs over mixed Chenopod species on clay plains
-  Scattered trees over mixed Acacia shrublands on drainage plains & washes
-  Scattered trees over mixed Acacia shrubs on alluvial flats & major drainage line



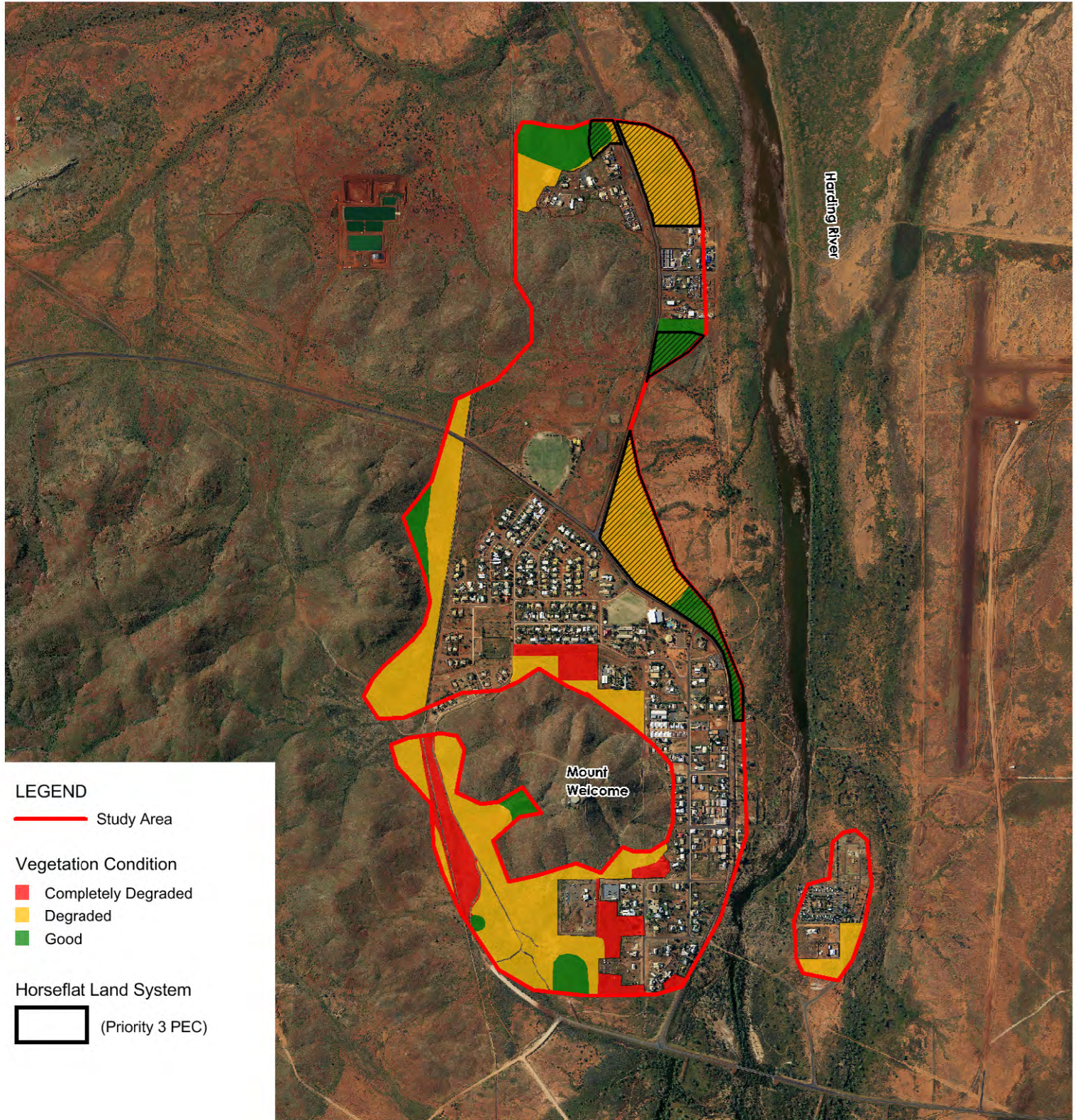
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Shire of Roebourne - Roebourne Environmental Strategy
 Figure 7: Vegetation condition



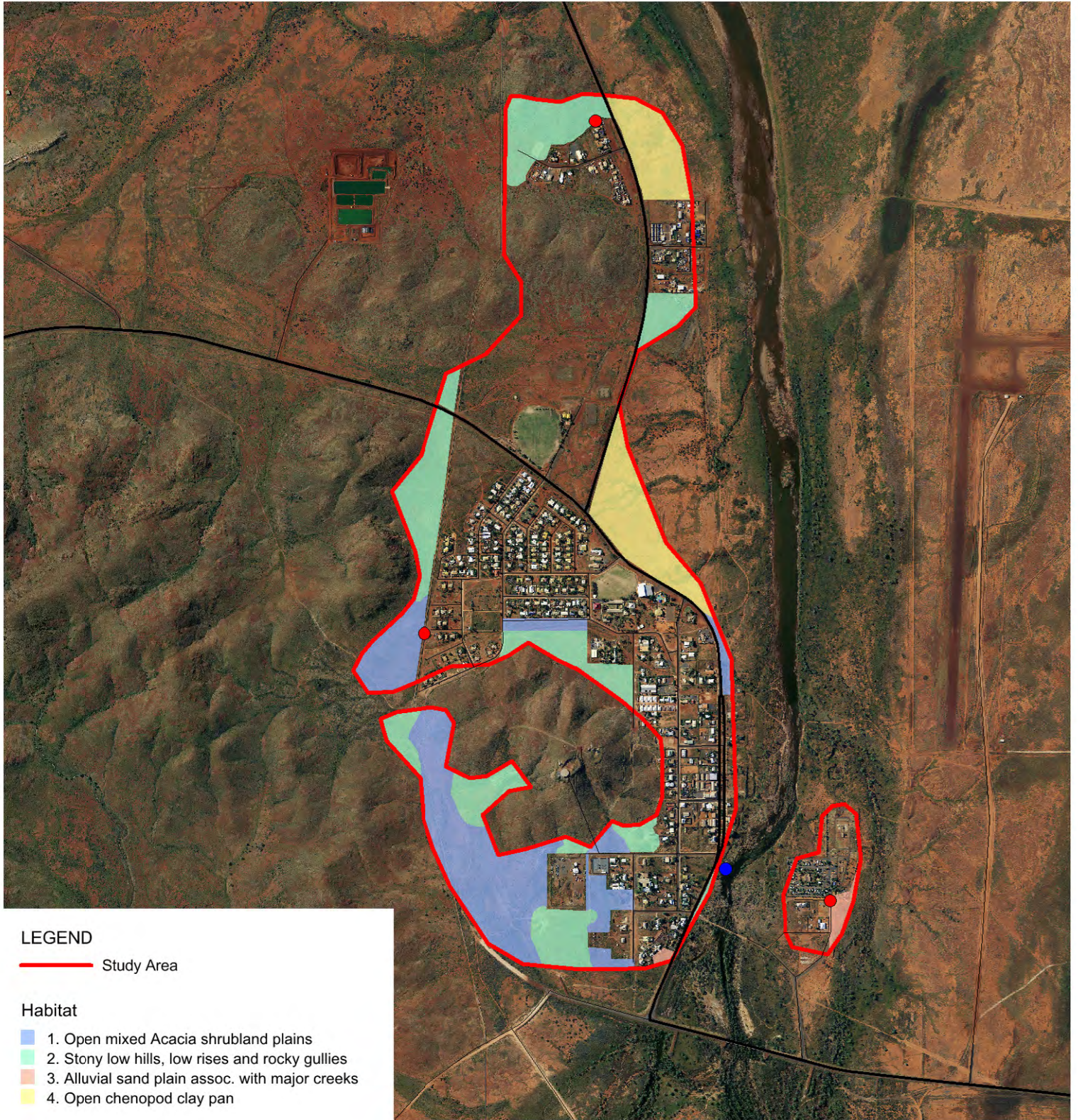
- LEGEND**
- Study Area
 - Vegetation Condition**
 - Completely Degraded
 - Degraded
 - Good - Horseflat Land System**
 - (Priority 3 PEC)

Scale 1: 20000
 0 400m


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Shire of Roebourne - Roebourne Environmental Strategy
 Figure 8: Fauna Habitat and Species





LEGEND

 Study Area

Habitat

-  1. Open mixed Acacia shrubland plains
-  2. Stony low hills, low rises and rocky gullies
-  3. Alluvial sand plain assoc. with major creeks
-  4. Open chenopod clay pan

Significant Conservation Species

-  Rainbow Bee-eater
-  Great Egret



Scale 1: 20000
 0 400m

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essential
 environmental

2.8 Groundwater

The Roebourne townsite is situated over the Pilbara fractured rock aquifer, which consists of Precambrian granite-greenstone terrain overlain by surficial sediments in the river valleys. The water table is generally within 5 to 10 m of the surface in the granitic areas, but may be quite deep below the greenstone hills. Groundwater is mainly fresh, ranging up to brackish towards the coast. Bore yields vary depending on intersection of fractures (DoW, 2012).

2.9 Summary of environmental values

The site has a degree of intrinsic ecological value on the basis that it supports a range of native flora and fauna and provides habitat for a wide range of common and widespread fauna species. The potential occurrence of a number of wetland bird species is possible within the site due to the proximity of the Harding River, a significant riparian habitat, although this river system occurs outside the study area.

The PEC 'Horseflat land system of the Roebourne Plains' is present but in a degraded condition. The PEC across its complete range has been severely impacted by development and historically grazing. Due to the degraded condition of this land system within the structure plan area, it may no longer be considered to be a good representation of the community. This would require confirmation from the DEC in regard to its value for retention (Eco Logical, 2012).

The Study area lacks several key fauna habitat characteristics including caves, significant rock outcrops, gorges, and riparian habitats. Therefore the site lacks core habitat for conservation significant fauna such as cave roosting bats, Northern Quolls, and Pilbara Olive Pythons. Based on the available habitat types and lack of core habitat, it is concluded that the site has few constraints to development. In addition, the relatively poor condition and high level of disturbance evident contribute to the low ecological value of the site in the context of the surrounding land and wider northern Pilbara in which there is extensive similar habitat types (Eco Logical, 2012).

A number of locations within the structure plan area have been identified as being contaminated by asbestos. The Shire of Roebourne is working to clean up these sites and ensure that the remaining areas are safe to develop.

In summary, no ecological values were identified that are considered to pose a constraint to development; however liaison with the DEC is recommended to confirm the status of the PEC in the Study area given its degraded condition.

Furthermore, no ecological values were identified that warrant retention within additional conservation reserves. The relatively poor condition and high level of disturbance evident contribute to the low ecological value of the site in the context of the surrounding land and wider northern Pilbara in which there are very extensive areas of similar habitat types (Eco Logical, 2012).

3 ENVIRONMENTAL MANAGEMENT STRATEGY

The Environmental Strategy aims to:

- Highlight environmental considerations across the study area, identifying those that have no, limited or significant environmental issues that may impact on any future development.
- Consider risks to environmental values and provide strategies to address and/or minimise potential environmental impacts where required.
- Provide recommendations in regard to preservation of environmental reserves and habitat identified in during the study.
- Provide recommendations in regard to further remediation or development constraints on areas where contamination has been identified

3.1 Objectives

The broad context for setting objectives for this environmental strategy is protection of the environment as part of the future planning and development of the Roebourne townsite. Within this context, the following more specific objectives are proposed:

- To protect and enhance the environmental values of the Roebourne townsite.
- To maintain the abundance, diversity, distribution and productivity of flora and fauna at species and ecosystem levels through the avoidance or management of adverse impacts.
- To ensure that future residents and ecosystems are not adversely affected by contamination of soils

3.2 Key considerations

A review of the existing environment in the context of the future planning and development likely to be proposed as part of the Roebourne townsite structure plan raises a number of issues that require consideration. These are:

- Existence of the 'Horseflat land system of the Roebourne Plains' PEC, although it is acknowledged that this portion of the study area is degraded with significantly reduced species diversity that would be typically found in this PEC
- Areas of good quality vegetation remaining to the north of the existing industrial area at Jager Street (currently zoned Rural) and to the south of the Hall St industrial area (currently reserved for Conservation, Recreation and Natural Landscape), as well as to the east of Cleaverville Rd and Roe St (currently reserved for Conservation, Recreation and Natural Landscape and Parks, Recreation and Drainage), as well as scattered areas in the south and west of the structure plan area (zoned Urban Development, and reserved for Conservation, Recreation and Natural Landscape) (Figure 7)
- The need to maintain a vegetated corridor linking the habitat of Welcome Mountain to the west.
- The presence of asbestos across various locations in the townsite that have required clean-up.
- Environmental values are likely to be associated with the nearby Harding River, which provides riparian habitat and associated vegetation communities, evidenced by the recording of conservation significant species.

3.3 Environmental strategies

In order to address the key considerations outlined above, the following strategies and actions are proposed.

- i. Site development in areas of low conservation value (Figure 7) and avoid disturbance of good quality vegetation.
- ii. Aim to retain the vegetated corridors between Mt Welcome and the rural area to the west and consider linkages between Mt Welcome and the Harding River to retain and protect the heritage and ecological values of the various habitats. Ecological corridors should retain or be rehabilitated with local native vegetation, ensuring that no barriers with the potential to obstruct native fauna movement are present.
- iii. Any development that is proposed adjacent to Harding River should consider weed control and revegetation using locally native flora species, and aim to maintain or improve the condition, width and density of the existing vegetated buffer.
- iv. Utilise native and/or local provenance species in revegetation or landscaping of streetscapes and public places.
- v. Retain as many healthy trees as possible and plant locally native tree species in streetscape and public open space to provide valuable fauna habitats, retain a "sense of place" and deliver aesthetic values and thermal comfort.
- vi. Increase the active management of areas reserved for Conservation, Recreation and Natural Landscape to reduce issues associated with rubbish dumping, weeds and uncontrolled access. Consider the establishment of a hard-edge boundary between vegetation and development, interpretive signage and provision of dedicated access paths.
- vii. If activities requiring excavation are necessary, then an assessment should be carried out in areas not already assessed to determine the potential for contamination (most notably from asbestos), risks to the environment and public health, including acid sulphate soils. Remediate any contaminated land in accordance with regulatory requirements and approved standards. A check for caveats reflecting this should be undertaken before land is developed.
- viii. Groundwater investigations targeting arsenic should also be undertaken if groundwater is to be used in the future development of Roebourne.
- ix. Develop an appropriate emergency management plan that recognises and addresses the risk of bushfires.
- x. The management of stormwater and erosion to be consistent with the Roebourne Townsite Stormwater and Flood management plan (Essential Environmental, in prep)

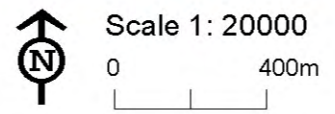
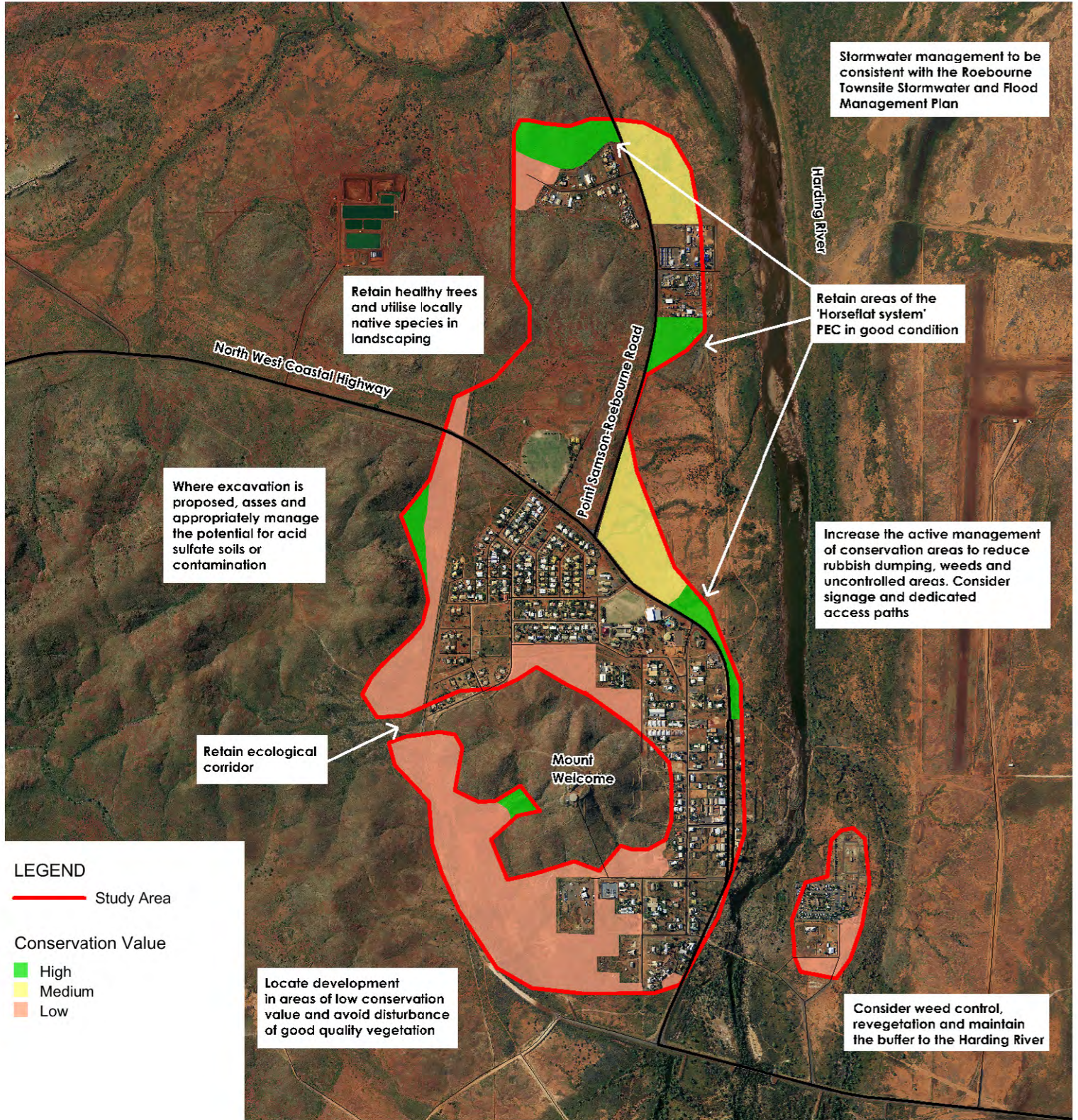
3.4 Implementation

The implementation of this strategy should occur through the translation of the strategies identified above into the Roebourne townsite structure plan, in the form of design responses or actions for future development.

Future rezonings may need to occur to progress development. These rezonings will require referral to the EPA. With the exception of the area to the west of the Jager Rd industrial area, further ecological survey is not likely to identify additional ecological values that would constitute a constraint, or provide additional information for decision-making and therefore this strategy should be sufficient (if accompanied by the EPA's environmental checklist) to support any scheme amendment.

A level 1 study will be required to support any proposal to rezone the area between the wastewater treatment plant and the Jager St industrial area, however.

Shire of Roebourne - Roebourne Environmental Strategy
 Figure 9: Environmental Strategy



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ATTACHMENT 1

ECO LOGICAL LEVEL 1 FLORA AND FAUNA SURVEY REPORT



ROEBOURNE ENVIRONMENTAL SCOPING

Level 1 flora and fauna survey

Prepared for
Essential Environmental

November 2012



DOCUMENT TRACKING

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Abbreviations

ABBREVIATION	DESCRIPTION
BoM	Bureau of Meteorology
CALM	Department of Conservation and Land Management (now known as DEC)
CAMBA	China - Australia Migratory Bird Agreement
DAFWA	Department of Agriculture and Food WA
DEC	Department of Environment and Conservation
DEFL	Declared (Threatened) Flora Database
DRF	Declared Rare Flora
ELA	Eco Logical Australia
EP Act	<i>Environmental Protection Act 1986 (State)</i>
EPA	Environmental Protection Authority
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999 (Federal)</i>
ESA	Environmentally Sensitive Area
GDA	Geocentric Datum of Australia
GPS	Global Positioning System
IUCN	International Union for Conservation of Nature
JAMBA	Japan – Australia Migratory Bird Agreement
MGA	Map Grid of Australia
NVIS	National Vegetation Information System
PECs	Priority Ecological Communities
ROKAMBA	Republic of Korea – Australia Migratory Bird Agreement
SEWPaC	Department of Sustainability, Environment, Water, Population and Communities
TECs	Threatened Ecological Communities
WA	Western Australia
WAH	Western Australian Herbarium
WAHERB	Western Australian Herbarium Database
WC Act	<i>Wildlife Conservation Act 1950 (State)</i>

Executive Summary

Essential Environmental is undertaking a review of the environmental characteristics of the Roebourne town site (the study area) on behalf of the Town of Roebourne to identify potential areas for future development and to identify potential environmentally sensitive areas, such as conservation significant species and communities. Eco Logical Australia Pty Ltd (ELA) was engaged by Essential Environmental to undertake a Level 1 flora, vegetation and fauna survey of the study area surrounding the Roebourne town site.

The aim of this survey was to:

- Describe background research and undertake desktop review of relevant databases and documents
- Undertake a field survey to assess flora, vegetation and fauna habitat values
- Summarise field survey findings in terms of flora, fauna, ecological communities and habitats
- Identify key implications for potential development of the site in terms of areas most suitable for future development and areas most suitable to retain for conservation.

The Level 1 flora, vegetation and fauna survey was undertaken on the 25th October 2012.

A total of 34 dominant flora taxa were identified within the study area. The taxa comprised ten families and 23 genera. The two most commonly occurring families were the Fabaceae (16 taxa) and Poaceae (6 taxa) families. *Acacia* (Fabaceae) was the most common genus with 11 taxa.

No Threatened flora species listed under the Federal *Environment Protection and Biodiversity Conservation Act 1999* or the State *Wildlife Conservation Act 1950* were recorded within the study area. No Priority flora species or species at the extent of their range, represent a range extension, or are considered regionally significant were recorded.

All vegetation communities in the study area have been subject to historic disturbances such as vegetation clearing, proliferation of tracks, historical grazing and rubbish dumping. These disturbances have modified the vegetation structure, increased weed invasion and reduced native species diversity across the majority of the study area. Vegetation condition ranged from Completely Degraded to Good with the majority of the study area described as being in Degraded condition.

One vegetation community identified within the study area during the site inspection shares similarities with a Priority Ecological Community (PEC) known as the „Horseflat land system of the Roebourne Plains“. However this portion of the study area is degraded with significantly reduced species diversity that would be typically found in this PEC. Note that PECs do not have statutory protection under either Federal or State legislation.

A total of 46 native fauna species were recorded during the Level 1 fauna survey. One mammal, four reptiles and 41 birds were identified during the survey of the study area. Fifteen of the 41 bird species recorded were observed within the Harding River on the eastern edge of the study area boundary.

Two conservation significant fauna species were recorded within the study area during the survey, and a further two conservation significant species were recorded just beyond the eastern edge of the study area within the Harding River. All four species are Federally listed migratory birds:

- Rainbow Bee-eater (*Merops australis*) - observed in several locations within project area
- Great Egret (*Ardea alba*) - observed flying over the project area
- Cattle Egret (*Ardea ibis*) - observed in Harding River just beyond the project area
- Common Greenshank (*Tringa nebularia*) - observed in Harding River just beyond project area.

No other conservation significant fauna or signs of their presence were detected. A number of other conservation significant species were assessed as possibly occurring due to their local and regional distribution. Of these, the most likely to occur are the Bush Stone Curlew (*Burhinus grallius*) and the Australian Bustard (*Ardeotis australis*) both Priority 4 species.

A conservation opportunities analysis was conducted to determine and rank areas in the study area that have High, Medium and Low conservation value. An assessment of these conservation values is provided to inform the Town of Roebourne of areas that contain higher value conservation assets to minimise potential environmental impacts on remaining areas of good vegetation. It should be noted however that the term “high” conservation value used in the context of this report does not indicate the presence of values that constitute a statutory constraint.

The assessment of conservation values provides a guide to identify areas most appropriate for future development consistent with Federal and State government requirements. Therefore areas of lowest conservation value are deemed most suitable for development.

The site has a degree of intrinsic ecological value on the basis that it supports a range of native flora and fauna and provides habitat for a wide range of common and widespread fauna species. The potential occurrence of a number of wetland bird species is possible within the site due to the proximity of the Harding River, a significant riparian habitat, although this river system occurs outside the study area.

Development adjacent to Harding River should consider issues such as allowance for appropriate riparian buffers. The PEC „Horseflat land system of the Roebourne Plains” is present but in a degraded condition. The PEC across its complete range has been severely impacted by development and historically grazing. Due to its degraded condition, it may no longer be considered to be a good representation of the community. This would require liaison with DEC in regard to its value for retention.

The relatively poor condition and high level of disturbance evident contribute to the low ecological value of the site in the context of the surrounding land and wider northern Pilbara in which there are very extensive areas of similar habitat types.

1 Introduction

1.1 PROJECT BACKGROUND

Essential Environmental is undertaking a review of the environmental characteristics of the Roebourne town site (the study area) on behalf of the Town of Roebourne to identify potential areas for future development and to identify potential environmentally sensitive areas, such as conservation significant species and communities.

Eco Logical Australia Pty Ltd (ELA) was engaged by Essential Environmental to undertake a Level 1 flora, vegetation and fauna survey of the study area surrounding the Roebourne town site.

1.2 OBJECTIVES

The scope of work undertaken for the assessment of the flora, vegetation and fauna around the Roebourne town site was to satisfy Level 1 flora, vegetation and fauna survey requirements as described in the following:

- Environmental Protection Authority (EPA) Position Statement No. 3, Terrestrial Biological Surveys as an Element of Biodiversity Protection (EPA, 2002)
- EPA Guidance Statement No. 51, Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia (EPA, 2004)
- EPA Guidance Statement No. 56, Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia (EPA, 2004).

The aim of this report was to:

- Describe background research and undertake desktop review of:
 - Study site location, features and topography
 - All known ecologically significant fauna, including Threatened, Priority and Migratory species relevant to the study site
 - All known ecologically significant vegetation, Threatened Flora/Declared Rare Flora (DRF) and Priority flora relevant to the study site.
- Undertake and summarise field survey findings including:
 - Description and mapping of the broad vegetation communities and condition within the study area
 - Description and mapping of fauna habitats within the study area
 - Identification of the dominant flora species present
 - Identification of dominant fauna assemblages present
- Identify key implications for potential development of the site.

1.3 STUDY AREA

The study area is located surrounding the town site of Roebourne, in the Pilbara region of Western Australia (WA) (**Figure 1**).

1.4 CLIMATE

The climate of the Pilbara is semi-arid to arid, with high daily temperatures and low irregular rainfall that generally follows the summer cyclones. A hot and usually wet summer is experienced from October to April and a mild winter is common from May to September. The average rainfall over the broader Pilbara area ranges from about 200 – 350 millimetres (mm), although rainfall can vary widely from year to year (BoM 2012). The Roebourne weather station recorded 1 mm of rain within the three months prior to field survey, which is below the long term average of 7.1 mm for the August – October period (BOM 2012).

Maximum air temperatures exceed 32°C almost every day during the summer months, with January usually recording the highest temperatures every year (with mean maximum temperatures of 39.5°C); temperatures in excess of 45°C are not uncommon (BoM 2012). During winter, mean maximum air temperatures are in the mid-twenties and the mean minimum temperatures drop to around 6–8°C.

1.5 LAND SYSTEMS

Land system mapping is based on regional patterns in topography, soils and vegetation. The most recent land system mapping of the Pilbara bioregion, in which the project area lies, was completed by Van Vreeswyk *et al.* (2004).

The mapping classifies the Pilbara region into 102 land systems. The project area lies within two land systems: Horseflat and Ruth, and their descriptions are provided below:

- HOF: Horseflat forms gilgaied clay plains supporting tussock grasslands and minor grassy snakewood shrublands
- RUT: Ruth forms hills and ridges of volcanic and other rocks supporting hard spinifex (occasionally soft spinifex) grasslands

1.6 ENVIRONMENTALLY SENSITIVE AREAS

Environmentally Sensitive Areas (ESAs) are areas of high conservation value defined within the State *Environmental Protection Act 1986* (EP Act) and include presence of, or habitat for, threatened species and communities. Exemptions for requiring a native vegetation clearing permit do not apply to ESAs in accordance with Section 51B of the EP Act. There are no terrestrial ESAs located within the study area.

1.7 IBRA AND REGIONAL VEGETATION DESCRIPTIONS

The Interim Biogeographical Regionalisation for Australia (IBRA) Version 7 recognises 89 large geographically distinct bioregions based on common climate, geology, landform, native vegetation and species information. The 89 bioregions are further refined into 419 subregions which are more localised and homogenous geomorphological units in each bioregion (Department of Sustainability, Environment, Water, Population and Communities 2012b).

The project area lies within the Pilbara bioregion (PIL) which has an area of 179,287 km². The study area is within two IBRA subregions:

- Chichester (PIL1): Archaean granite and basalt plains supporting shrub steppes of *Acacia pyrifolia* over *Triodia pungens* hummock grasses, with Snappy Gum (*Eucalyptus leucophloia*) steppes occurring on the ranges (Kendrick & McKenzie 2001).

- Roebourne Plains (PIL4): Quaternary alluvial plains with a grass savannah and shrub steppe of *Acacia translucens* over *Triodia pungens* and marine alluvial flats with Samphire, Sporobolus and Mangal (Kendrick & Stanley 2001).

The majority of the study area is within the Chichester subregion with only a small portion on the eastern side of the study area within the Roebourne Plains subregion.

Figure 1: Regional location of the study area



2 Desktop review

2.1 PREVIOUS ECOLOGICAL SURVEYS

Early systematic flora survey work in the Pilbara bioregion was undertaken by Burbidge (1959) and Beard (1975). These surveys involved the mapping of broad floristic vegetation formations and vegetation associations across the bioregion. More recently, the Department of Agriculture and Food WA (DAFWA) conducted a regional inventory of flora, vegetation, vegetation condition and land resources of the bioregion (Van Vreeswyk *et al.* 2004). In addition, the Department of Environment and Conservation (DEC) has undertaken a comprehensive regional survey of the Pilbara (DEC 2011). In this survey, DEC counted, sampled, documented, and mapped the way plant communities are distributed in relation to soil, climate, landforms and geology.

Over recent decades there has been an expansion of resource development projects occurring within the Pilbara. As a result, there has been an increase in site-specific ecological surveys to fulfil the statutory requirements of the EP Act, the State *Wildlife Conservation Act 1950* (WC Act), and the Federal *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). However, Roebourne's immediate surrounds have not been subjected to systematic flora and fauna surveys, most likely due to the absence of mining resources in the area.

2.2 DATABASE SEARCHES

The following Federal and State databases were searched for information relating to conservation significant flora, fauna and ecological communities to target during the field survey:

- Federal EPBC Act Protected Matters search tool
- DEC and Western Australian Museum's NatureMap online database
- DEC Threatened flora database search – includes Threatened and Priority flora
- DEC Threatened and Priority fauna database search for Scheduled fauna
- DEC Threatened and Priority Ecological Communities (TECs, PECs) database search
- DEC ESAs database
- Fauna listed on the International Union for the Conservation of Nature and Natural Resources (IUCN) Red List

2.3 CONSERVATION SIGNIFICANT FLORA

Specific criteria were used to assess the likelihood of occurrence of conservation significant flora species listed in Error! Reference source not found.. The likelihood of occurrence assessment was used on the species matching one or more of the criteria below.

- Likelihood: No
 - Species not known to occur within the IBRA bioregion
 - Project area lacks important habitat for a species that has highly selective habitat requirements
 - Species has been historically recorded within project area or locally, however it is considered locally extinct due to significant habitat changes such as land clearing

- Likelihood: Unlikely
 - Species has been recorded locally through DEC database search, however, is unlikely to occur due lack of critical habitat and/or the site being severely degraded
 - Species has been recorded locally through DEC database search, however, is unlikely to occur due to few historic record/s and no other current collections in the local area
- Likelihood: Possible

Species has not been previously recorded in the project area; however, targeted surveys may locate the species based on records occurring in close proximity to the project area (5-10 km) and suitable habitat potentially occurring in the project area

Species has been recorded in the project area by a previous consultant survey, however, doubt remains over the species taxonomic identification

 - Historical evidence of species occurrence within or outside of project area with coordinates doubtful
- Likelihood: Likely
 - Critical habitat in excellent condition and landform for the species occurs within the project area
 - Species has been recorded in proximity (<5 km) and in similar habitat to that which occurs within the area
- Likelihood: Yes
 - Species previously recorded within project area from DEC database search results and the species has been confirmed through a current vouchered specimen at WA Herbarium

Table 1: Threatened and priority flora identified from searches of State and Federal databases as potentially occurring, and their likelihood of occurrence in the study area

SPECIES/TAXON	CONSERVATION STATUS ¹	PREFERRED HABITAT ²	LIKELIHOOD OF OCCURRENCE (based on the habitat types and condition identified within the site together with local occurrence, and habitat requirements of each species)
<i>Acacia glaucocaesia</i>	P3	Red loam, sandy loam, clay. Floodplains.	Possible
<i>Atriplex lindleyi</i> subsp. <i>conduplicata</i>	P3	Crabhole plains.	Unlikely
<i>Cladium procerum</i>	P2	Perennial pools.	Unlikely
<i>Eragrostis crateriformis</i>	P3	Clayey loam or clay. Creek banks, depressions.	Unlikely
<i>Eragrostis lanicaulis</i>	P3	Red sandy clay soils on flats.	Unlikely

SPECIES/TAXON	CONSERVATION STATUS ¹	PREFERRED HABITAT ²	LIKELIHOOD OF OCCURRENCE (based on the habitat types and condition identified within the site together with local occurrence, and habitat requirements of each species)
<i>Eragrostis surreyana</i>	P3	Seasonally wet, shallow, grey alluvial soils over rock, with some from deeper soils in a seasonally wet creek line ^{2a}	Unlikely
<i>Eremophila spongiorarpa</i>	P1	Weakly saline alluvial plain on margins of marsh	Unlikely
<i>Euphorbia inappendiculata</i>	P3	Clay soils among broken rocky screes	Unlikely
<i>Fimbristylis sieberiana</i>	P3	Pool edges and sandstone cliffs	Unlikely
<i>Glycine falcata</i>	P3	Along drainage depressions in crabhole plains on river floodplains	Unlikely
<i>Gomphrena pusilla</i>	P2	Fine beach sand behind foredune on limestone.	No
<i>Gymnanthera cunninghamii</i>	P3	Sandy soils in drainage and sand plains.	Unlikely
<i>Livistona alfredii</i>	P4	Edges of permanent pools.	No
<i>Nicotiana heterantha</i>	P1	Seasonally wet flats or saline plains.	No
<i>Oldenlandia</i> sp. Hamersley Station (A.A. Mitchell PRP 1479)	P3	Undulating plains, cracking clay, basalt, flat crabhole plain	Unlikely
<i>Olearia mucronata</i>	P3	Schistose hills, along drainage channels	Unlikely
<i>Owenia acidula</i>	P3	Clayey loams and loamy plains.	Unlikely
<i>Paspalidium retiglume</i>	P2	Cracking clay	Unlikely
<i>Phragmites karka</i>	P3	Permanent pools, rivers and floodplains	No
<i>Phyllanthus aridus</i>	P3	Sandstone, gravel or red sand.	Unlikely
<i>Polymeria distigma</i>	P3	Plains or floodplain with sandy soils.	Unlikely
<i>Pterocaulon intermedium</i>	P3	Sandplains	Unlikely

SPECIES/TAXON	CONSERVATION STATUS ¹	PREFERRED HABITAT ²	LIKELIHOOD OF OCCURRENCE (based on the habitat types and condition identified within the site together with local occurrence, and habitat requirements of each species)
<i>Rhynchosia bungarensis</i>	P4	Rockpiles (boulder scree) and drainage lines	No
<i>Senna</i> sp. Millstream (E. Leyland s.n. 30/8/1990)	P1	Drainage lines	Unlikely
<i>Solanum</i> sp. Hamersley clay (D. Halford Q 9280) PN	P3	Cracking clays	Unlikely
<i>Sporobolus pulchellus</i>	P1	Deep sands, sandstone and sandy ironstone.	Unlikely
<i>Stackhousia clementii</i>	P3	Skeletal soils on sandstone hills and in tidal inlets.	Unlikely
<i>Swainsona</i> sp. Hamersley Station (A.A. Mitchell 196)	P3	Creeks, semi-permanent pool and wetlands	No
<i>Terminalia supranitifolia</i>	P3	Rockpiles and outcrops	No
<i>Teucrium pilbaranum</i>	P1	Cracking clays, crab-hole plains with calcrete	Unlikely
<i>Themeda</i> sp. Hamersley Station (M.E. Trudgen 11431)	P3	Red clay soils on clay pan grasslands.	Unlikely
<i>Trianthema</i> sp. Python Pool (G.R. Guerin & M.E. Trudgen GG 1023)	P2	Brown dry rocky soils on floodplain and on rangeland.	Unlikely
<i>Vigna</i> sp. rockpiles (R. Butcher et al. RB 1400)	P3	Rockpiles and boulder scree	No

Source: DEC 2012a & DEC 2012b

¹ V = Listed as „Vulnerable“, E= „Endangered“ and CR=“Critically Endangered“ under the EPBC Act, T = Threatened Flora under the WC Act and P = Priority Flora listed by DEC

² Source of preferred habitat is Florabase (DEC 2012b), except as follows:

- a) Shepherd and Trudgen (2011)

2.4 CONSERVATION SIGNIFICANT ECOLOGICAL COMMUNITIES

An ecological community is a group of species that interact with one another and occur in a particular area. Ecological communities are deemed Threatened if their geographical distribution is dramatically reduced, they are geographically isolated, they are at serious risk from a threatening process, or if it's

ecological functioning is greatly reduced (DEC 2010b). In WA, TECs are separated into three categories; Critically Endangered, Endangered and Vulnerable. All TECs are protected under the EP Act, and some have statutory protection under the EPBC Act.

PECs are potential TECs that do not meet survey criteria to be recognised as a TEC or are not adequately described. There are five PEC categories, three of which describe ecological communities that are poorly known (Priority 1 – 3), Priority 4 describes ecological communities that are adequately known and are rare but not Threatened, while Priority 5 represents ecological communities that are conservation dependent (DEC 2010b). PECs are not recognised under Federal or State legislation.

A search of Federal and State TEC databases identified a PEC occurring within the study area of Roebourne town site (DEC 2012c). The Priority 3 PEC „Horseflat land system of the Roebourne Plains“ is associated with the land system mapping of Van Vreeswyk et al. (2004), namely Unit 3 (Gilgai plains), Unit 5 (Alluvial Plains) and some Unit 7 (Drainage Depressions). The study area is mapped as part of the Horseflat land system of the Roebourne Plains - alluvial plains with tussock grasslands (Van Vreeswyk et al. 2004), which defines the current extent of the PEC.

The PEC Horseflat land system of the Roebourne Plains is described as extensive, weakly gilgaied clay plains dominated by tussock grasslands on mostly alluvial non-gilgaied, red clay loams or heavy clay loams. Perennial tussock grasses include *Eragrostis xerophila* and other *Eragrostis* spp., *Eriachne* spp. and *Dichanthium* spp. The community also supports a suite of annual grasses including *Sorghum* spp. and *Astrebela* spp. (DEC 2010a).

The conservation definition of this community type is:

Priority Three: Poorly known ecological communities

(i) Communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation.

The database search also found the PEC „Stony Chenopod association of the Roebourne area“, which has a PEC occurrence buffer within the study area. The „Stony Chenopod association of the Roebourne area“, is a Priority 1 Ecological Community (DEC 2012c). This PEC is more typical of the Cheerawarra land system mapping of Van Vreeswyk et al. (2004). There is a known occurrence of this PEC outside of the study area within the fenced off area of the Roebourne airport, the buffer of which extends into the study area. DEC establish buffers of varying distances around TECs and PECs to consider impacts to a community, in this case, impacts that may be caused by changes in hydrology within the buffer.

No other TECs or PECs have been recorded within the study area (DEC 2012c).

2.5 CONSERVATION SIGNIFICANT FAUNA

Threatened fauna is protected under the Federal EPBC Act and the State WC Act and can be listed as Critically Endangered, Endangered, or Vulnerable as per the IUCN definitions and as reviewed by Mace and Stuart (1994). The WC Act also applies a set of Schedules. These Schedules, together with conservation categories are described in **Appendix A**.

In addition to the above, the DEC maintains a list of Priority species for protection. These are species that do not meet the requirements to be listed as Threatened species under the WC Act, but are considered by the DEC to be rare and/or under threat.

Species that are at the limit of their distribution, have a very restricted range and those that occur in breeding colonies can also be considered of conservation significance. This level of significance is recognised by the EPA (EPA 2004b).

Migratory birds are listed under the EPBC Act in recognition of species listed under international treaties; such as the China Australia Migratory Bird Agreement (CAMBA), the Japan Australia Migratory Bird Agreement (JAMBA), the Republic of Korea Australia Migratory Bird Agreement (ROKAMBA), and the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention).

A search of the State's Threatened Fauna database was performed on 15 October 2012 for ELA by DEC using a 50 km buffer around the point location -20.771421 latitude and 117.141590 longitude (using GDA94). Searches of NatureMap and the EPBC Act Protected Matters databases were also undertaken by ELA. Specific criteria were used to assess the likelihood of occurrence of fauna species listed in Table 2.

The searches identified a total of 60 conservation significant fauna species as potentially occurring within the vicinity of the project area (Table 3). Five of these species either occur or are likely to occur within the project area due to historic data on their occurrence and the assessment of habitat characteristics within and in proximity to the site. It is noted that the majority of fauna species in the likelihood table are bird species adapted to coastal tidal habitats therefore they are unlikely of occurring within the project area.

Table 2: Likelihood of occurrence criteria for fauna

CRITERIA OF ASSESSING LIKELIHOOD OF OCCURRENCE	LIKELIHOOD OF OCCURRENCE				
	NO	UNLIKELY	POSSIBLE	LIKELY	YES
Species not known to occur within the bioregion, based on current literature and distribution.					
Project area and adjacent areas lacks important habitat for a species that has highly selective habitat requirements.					
Species has been historically recorded within project area or locally, however it is considered locally extinct due to significant habitat changes and introduced predators.					
Species has been recorded within the bioregion based on literature review but not recorded locally based on DEC database search.					
Adequate survey efforts, such as a standardised methodology or targeted searching within potentially suitable habitat have not detected the species.					
Project area assessed as having at best marginally suitable or low quality habitat, or is unlikely to be suitable due to other factors including disturbance or habit connectivity.					
Species has been recorded locally through database search or regionally through literature review, and due to other factors such as species ecology and distribution, its occurrence within the site cannot be ruled out.					
Extensive survey efforts have not detected the species, however the species is known to be cryptic and no effective standardised procedure is available.					
Project area assessed as having potentially suitable habitat. This may include habitat modelling.					
Historical evidence of species occurrence within project area.					

CRITERIA OF ASSESSING LIKELIHOOD OF OCCURRENCE	LIKELIHOOD OF OCCURRENCE				
	NO	UNLIKELY	POSSIBLE	LIKELY	YES
Species is highly mobile and has extensive foraging range.					
Core habitat for the species occurs within project area either year-round or seasonally (e.g. this could be a host plant, seasonal wetland, roosting cave or other geomorphic characteristic).					
Species has been recorded in proximity to the study area, and in similar habitat to that which occurs within the area.					
Recent (fresh) evidence of species positively identified within project area such as scats, foot prints or burrows.					
Species recorded within project area during recent site inspection.					

Table 3: Threatened and Priority fauna identified from searches of State and Federal databases as potentially occurring in the project area

COMMON NAME	SCIENTIFIC NAME	CONSERVATION STATUS*		LIKELIHOOD OF OCCURRENCE (based on the habitat types and condition identified within the site together with local occurrence, distribution and habitat requirements of each species)
		Federal EPBC Act	State WC Act / DEC	
Reptiles				
<i>Liasis olivaceus barroni</i>	Pilbara Olive Python	VU	S1 (VU)	Possible. The site is within the species' known range, and is known to occur locally. No evidence of this species was recorded during the site inspection, and preferred shelter of hunting habitat such as deep rocky canyons, gorges or riparian habitat does not occur within the site, however the eastern edge of the site is adjacent to the Harding River therefore this species potentially occurs within the site on at least an occasional basis.
<i>Lerista neviniae</i>	Burrowing Skink	-	S1 (VU)	Unlikely. The species has been recorded at Wickham approximately 11 km north of Roebourne. However this burrowing skink is quite habitat specific and its preferred habitat is coastal or near-coastal sand dunes. The preferred habitat for this species is very limited and marginal at best within Roebourne.
<i>Lerista quadrivincula</i>	Burrowing Skink	-	P1	Unlikely. Only known from the Maitland River area approximately 50 kilometres west of Roebourne.
<i>Ctenotus angusticeps</i>	Arlie Island Skink	VU	VU	Unlikely. The species has been recorded at Mount Anketell approximately 15 kilometres northwest of Roebourne. The preferred habitat of this lizard is coastal sand dunes supporting tussock grasslands, and near-coastal mud flats supporting samphire shrublands. The site lacks these habitat characteristics.
<i>Notoscincus butleri</i>	Lined Soil-crevice Skink	-	P4	Possible. The site contains potential, albeit disturbed, habitat. Therefore its local occurrence should not be ruled out.

COMMON NAME	SCIENTIFIC NAME	CONSERVATION STATUS*		LIKELIHOOD OF OCCURRENCE (based on the habitat types and condition identified within the site together with local occurrence, distribution and habitat requirements of each species)
		Federal EPBC Act	State WC Act / DEC	
Birds				
<i>Ardeotis australis</i>	Australian Bustard	-	P4	Likely. Known to occur locally and in a variety of arid shrubland plains habitats. Expected to occur on at least a seasonal basis following substantial rain.
<i>Anous stolidus pilea</i>	Common Noddy	M	S3	Unlikely. The site lacks suitable habitat. A coastal and pelagic species. Closest record is Burrup Peninsula.
<i>Haliaeetus leucogaster</i>	White-bellied Sea Eagle	M	S3	Unlikely. The site is approximately 10 km from the coast.
<i>Apus pacificus</i>	Fork-tailed Swift	M	S3	Possible. Known to occur in the Dampier area. It is a relatively common seasonal trans-equatorial migrant throughout mainland Australia in October to April (Slater et al., 2003).
<i>Ardea alba</i>	Great Egret	M	-	Yes. Recorded flying over the site during the site inspection. Due to the proximity to adjacent estuarine habitat of Harding River, this species is expected to occur on at least an occasional basis.
<i>Ardea ibis</i>	Cattle Egret	M	S3	Likely. Recorded within the Harding River during the site inspection. Due to the proximity to adjacent estuarine habitat of Harding River, this species is expected to occur on at least an occasional basis.
<i>Burhinus grallius</i>	Bush-stone Curlew	-	P4	Likely. Has been previously recorded locally. The site has suitable foraging habitat including open shrubland plains and clay pans as well as disturbed habitats.
<i>Heteromunia pectoralis</i>	Pictorella Mannikin	-	P4	Unlikely. Not recorded locally.
<i>Neochmia ruficauda subclaescens</i>	Star Finch	-	P4	Possible. Potentially occurs along the Harding River system, and with the site being adjacent to this river, this bird potentially forages within the site on an occasional basis.
<i>Falco hypoleucos</i>	Grey Falcon	-	P4	Possible. Potentially occurs along the Harding River system, and with the site being adjacent to this river, this bird potentially forages within the site on an occasional basis.
<i>Falco peregrinus</i>	Peregrine Falcon	-	S4	Possible. Known to occur locally. Not recorded during site inspection. The site lacks potential nesting habitat (high cliffs and breakaways) however potentially hunts or flies over the site on an occasional basis.
<i>Arenaria interpres</i>	Ruddy Turnstone	M	S3	Unlikely. Several local coastal records. Possibly occurs occasionally along Harding River adjacent to Roebourne, but the site lacks suitable habitat.
<i>Calidris acuminata</i>	Sharp-tailed Sandpiper	M	S3	Unlikely. Wide-ranging including inland wetlands. However the site lacks potentially suitable wetland habitat.
<i>Calidris alba</i>	Sanderling	M	S3	Unlikely. The site lacks preferred habitat of this species - tidal mud flats and estuarine shorelines.
<i>Calidris canutus</i>	Red Knot	M	S3	Unlikely. The site lacks preferred habitat of this species - tidal mud flats and estuarine shorelines.
<i>Calidris ferruginea</i>	Curlew Sandpiper	M	S3	Unlikely. The site lacks preferred habitat of this species - tidal mud flats and estuarine shorelines.

COMMON NAME	SCIENTIFIC NAME	CONSERVATION STATUS*		LIKELIHOOD OF OCCURRENCE (based on the habitat types and condition identified within the site together with local occurrence, distribution and habitat requirements of each species)
		Federal EPBC Act	State WC Act / DEC	
<i>Calidris ruficollis</i>	Red-necked Stint	M	S3	Unlikely. The site lacks preferred habitat of this species - tidal mud flats and estuarine shorelines.
<i>Calidris subminuta</i>	Long-toed Stint	M	S3	Unlikely. The site lacks preferred habitat of this species - tidal mud flats and estuarine shorelines.
<i>Calidris tenuirostris</i>	Great Knot	M	S3	Unlikely. The site lacks preferred habitat of this species - tidal mud flats, beaches and sandbars.
<i>Charadrius leschenaultii</i>	Greater Sand Plover	M	S3	Unlikely. The site lacks preferred habitat of this species - tidal mud flats, beaches and sandbars.
<i>Charadrius mongolus</i>	Lesser Sand Plover	M	S3	Unlikely. The site lacks preferred habitat of this species - tidal mud flats, beaches and sandbars.
<i>Chlidonias leucopterus</i>	White-winged Black Tern	M	S3	Unlikely. A wide-ranging sea bird also known to occur inland. Possible occurs occasionally along Harding River adjacent to Roebourne, but the site lacks suitable habitat.
<i>Cuculus saturatus opatus</i>	Oriental Cuckoo	M	S3	Possible. One historical record from Roebourne in 1977. This was prior to the construction of Harding River Dam. Suitable habitat is considered marginal. However may occur locally on an occasional basis..
<i>Egretta sacra</i>	Eastern Reef Egret	M	S3	Unlikely. A coastal species. The site lacks suitable habitat. Closest record is Dampier Archipelago.
<i>Fregata ariel</i>	Lesser Frigatebird	M	S3	No. A pelagic species known from Dampier Archipelago.
<i>Limosa lapponica</i>	Bar-tailed Godwit	M	S3	Unlikely. A wide-ranging species. Possibly occurs occasionally along Harding River adjacent to Roebourne, but the site lacks suitable habitat.
<i>Glareola maldivarium</i>	Oriental Pratincole	M	S3	Possible. Not recorded locally, or during the survey, however the adjacent Harding River represents potential habitat and may hawk for insects over this wetland area and adjacent Roebourne town site.
<i>Hirundo rustica</i>	<i>Barn Swallow</i>	M	S3	Unlikely. Not recorded locally, or during the survey, however given the mobility of this vagrant species and broad habitat preferences, its occurrence within the Project area on an infrequent or occasional basis cannot be ruled
<i>Merops ornatus</i>	Rainbow Bee-eater	M	S3	Yes. Recorded during the site inspection.
<i>Numenius minutus</i>	Little Curlew	M	S3	Unlikely. A wide-ranging species. But prefers coastal habitat.
<i>Numenius phaeopus</i>	Whimbrel	M	S3	Unlikely. A wide-ranging species. But prefers coastal habitat.
<i>Numenius madagascariensis</i>	Eastern Curlew	M	S3	Unlikely - the project area lacks suitable coastal tidal mud flats or estuarine habitat.
<i>Oceanites oceanicus</i>	Wilson's Storm Petrel	M	S3	No. A pelagic species.
<i>Phaps histrionica</i>	Flock Bronzewing	-	P4	Possible. The site has potentially suitable habitat.
<i>Plegadis falcinellus</i>	Glossy Ibis	M	S3	Unlikely. The site lacks suitable tidal habitat.
<i>Pulvialis fulva</i>	Pacific Golden Plover	M	S3	Unlikely. The site lacks suitable tidal habitat.
<i>Pulvialis squatarola</i>	Grey Plover	M	S3	Unlikely. The site lacks suitable tidal habitat.
<i>Puffinus pacificus</i>	Wedge-tailed Shearwater	M	S3	No. A pelagic species.

COMMON NAME	SCIENTIFIC NAME	CONSERVATION STATUS*		LIKELIHOOD OF OCCURRENCE (based on the habitat types and condition identified within the site together with local occurrence, distribution and habitat requirements of each species)
		Federal EPBC Act	State WC Act / DEC	
<i>Sterna caspia</i>	Lesser Crested Tern	M	S3	Unlikely. A wide-ranging species. But prefers coastal habitat.
<i>Sterna dougallii</i>	Roseate Tern	M	S3	Unlikely. A wide-ranging species. But prefers coastal habitat.
<i>Sterna hirundo</i>	Common Tern	M	S3	Unlikely. A wide-ranging species. But prefers coastal habitat.
<i>Sula leucogaster</i>	Brown Booby	M	S3	No. A pelagic species.
<i>Tringa brevipes</i>	Grey-tailed Tattler	M	-	Unlikely. A wide-ranging species. But prefers coastal habitat.
<i>Tringa glareola</i>	Wood Sandpiper	M	S3	Possible. Not recorded during the survey, however has been recorded locally. Open plains and alluvial low-lying areas subject to occasional flooding within the Study area represent potentially suitable foraging habitat, and given the high mobility, its occurrence at least on an infrequent or occasional basis cannot be ruled out.
<i>Tringa hypoleucos</i>	Common Sandpiper	M	-	Possible. Not recorded during the survey, however has been recorded locally. Estuarine habitat of the adjacent Harding River represent potentially suitable foraging habitat, and given the high mobility, its occurrence at least on an infrequent or occasional basis cannot be ruled out.
<i>Tringa nebularia</i>	Common Greenshank	M	S3	Possible. Recorded during the survey in the nearby Harding River. Estuarine habitat of the adjacent Harding River represents potentially suitable foraging habitat, and given the high mobility, its occurrence at least on an infrequent or occasional basis cannot be ruled out.
<i>Tringa stagnatilis</i>	Marsh Sandpiper	M	S3	Possible. Potential. Not recorded during the survey, however has been recorded locally. Open plains and alluvial low-lying areas subject to occasional flooding within the Study area represent potentially suitable foraging habitat, and given the high mobility, and broad habitat preference its occurrence at least on an infrequent or occasional basis cannot be ruled out.
<i>Xenus cinereus</i>	Terek Sandpiper	M	S3	Unlikely. A wide-ranging species. But prefers coastal habitat.
Mammals				
<i>Dasyercus blythi</i>	Brush-tailed Mulgara		P4	Unlikely. Not recorded locally, and the site lacks suitable habitat due to the high level of disturbance.
<i>Dasyercus cristicauda</i>	Crest-tailed Mulgara	VU	S1 (VU)	Unlikely. Not recorded locally, and the site lacks suitable habitat due to the high level of disturbance
<i>Dasyurus hallucatus</i>	Northern Quoll	EN	S1 (EN)	Possible. No signs of this species (scats or prints) were recorded. It has been previously recorded locally, however the site lacks suitable denning habitat, and potential foraging habitat is marginal at best due to the high level of disturbance. Due to local records and proximity to Harding River, this species may occur within the site on an occasional basis.

COMMON NAME	SCIENTIFIC NAME	CONSERVATION STATUS*		LIKELIHOOD OF OCCURRENCE (based on the habitat types and condition identified within the site together with local occurrence, distribution and habitat requirements of each species)
		Federal EPBC Act	State WC Act / DEC	
<i>Mormopterus loriae coburgiana</i>	Little Northwest Mastiff Bat	-	P1	Unlikely. Prefers coastal mangrove habitat.
<i>Macroderma gigas</i>	Ghost Bat	-	P4	Unlikely. Not recorded locally. No roosting caves occur within the project area.
<i>Leggadina lakedownensis</i>	Lakeland Downs Mouse	-	P4	Unlikely. The rocky habitat within the project area is highly disturbed including extensive ground disturbance and weeds. The site represents marginal habitat at best.
<i>Pseudomys chapmani</i>	Western Pebble-mound Mouse	-	P4	Possible. Not recorded during the site inspection, however stony plains and low hills within the site represent potentially suitable, albeit marginal, due to the high level of disturbance.

Source: DEC 2011

*M = species listed as „migratory“ under the EPBC Act.

S1 – 4 = Schedule of species listed under the WC Act.

VU = species listed as „vulnerable“ under EPBC Act

EN = species listed as „endangered“ under EPBC Act

P1 = species considered not currently Threatened but few poorly known populations on Threatened lands.

P2 = species considered not currently Threatened but few poorly known populations on conservation lands.

P4 = species considered not currently Threatened or in need of special protection but populations require monitoring.

3 Field survey methodology

3.1 FLORA AND FAUNA SURVEY METHODS

The Level 1 flora survey design was aligned with methodology outlined in EPA *Guidance Statement No. 51: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia* (EPA 2004a).

The Level 1 fauna survey design was aligned with methodology outlined in the EPA's *Guidance Statement No. 56: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia* (EPA 2004b) and the principles outlined in *EPA Position Statement No. 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection* (EPA 2002).

3.2 STUDY TEAM AND TIMING OF SURVEY

Field survey team members are listed in **Table 4**. The flora survey was conducted under scientific collection licence SL010104 and permit to take DRF collection licence 34-1213 issued to Mr Joel Collins.

Table 4: ELA staff involved in the flora and fauna survey

NAME	QUALIFICATION	RELEVANT EXPERIENCE
Joel Collins	BAgribus Hort (Hons)	Extensive flora surveys throughout the Pilbara bioregions and a broad knowledge of WA flora
Robert Browne-Cooper	BSc Biological Science	Extensive fauna surveys within the Pilbara bioregion and most WA bioregions

The survey was undertaken during one single phase survey on the 25th October 2012. The maximum and minimum temperatures on this date were 33.5 °C and 22.9 °C, respectively (BoM 2012). No rain fell during the survey.

3.3 FLORA AND VEGETATION

3.3.1 Conservation significant flora

Targeted survey was completed within the study area for conservation significant flora and vegetation communities including:

- Threatened Flora listed under the EPBC Act
- DRF listed under the latest WA *Wildlife Conservation (Rare Flora) Notice*
- Priority Flora recognised by DEC
- TECs listed under the EPBC Act
- TECs endorsed by the Western Australian Minister of the Environment
- PECs recognised by DEC

To assess the presence of conservation significant flora and vegetation communities, the target approach was conducted in two ways. Firstly, where the desktop reviews of previous surveys and/or database results suggested the species/communities were present within the Study area, these locations were revisited to determine current status (i.e. presence, condition and extent). Secondly, by reviewing the habitat preferences of conservation significant species and vegetation communities in the region (including those previously identified as being within the study area), those habitats were specifically targeted for surveys to identify whether new populations exist. All other vegetation communities in the study area were searched for conservation significant flora.

For any population of conservation significant species/community identified in the study area the following data is collected:

- GPS coordinates of the location (points for individual plants or polygons for populations)
- Description of vegetation community in which the species is located
- Estimation of population size
- Photograph of the plant/community in situ
- Reference specimen, to be verified at the WA Herbarium
- Extent of vegetation community

3.3.2 Vegetation condition and communities

The vegetation communities were mapped based on dominant species present, landform, and soil type and described using the vegetation structural table of Specht as modified by Aplin (1979) vegetation structural classes. Relevés were used as the sampling techniques for the rapid assessment of the dominant vegetation communities in the study area. A relevé does not use a defined boundary, such as a quadrat, however, are used by experienced botanists to rapidly assess a vegetation community. The location of the relevés was chosen randomly so as not to create a subjective bias, however the locations were chosen to represent a vegetation of one type and were placed in a representative area with care taken to avoid sampling ecotones.

The vegetation communities recorded in the study area were compared to conservation significant communities listed as TECs and PECs by the DEC (2012c).

Vegetation condition assessment was in accordance with the Bush Forever Vegetation Condition Scale (Government of Australia 2000) as shown in **Table 5**. Mapping of vegetation communities and condition utilised aerial imagery to assist in defining boundaries as well as utilising GPS to spatially record waypoints and tracks.

Table 5: Vegetation condition rating scale (Government of Australia 2000)

RATING	DESCRIPTION
Pristine	Pristine or nearly so, no obvious signs of disturbance.
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.
Very Good	Vegetation structure altered obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.

RATING	DESCRIPTION
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.
Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
Completely Degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as “parkland cleared” with the flora comprising weed or crop species with isolated native trees or shrubs.

3.4 FAUNA

Information on fauna and fauna habitats was collected throughout the Study area and searching for evidence of species opportunistically. All fauna observations and signs such as scats, tracks and calls were recorded. A complete list of all fauna recorded is presented in **Appendix B**.

3.4.1 Fauna habitats

Broad habitat types within the project area were identified and described, and included information on:

- Degree and types disturbance evident
- Location of the broad habitat type within the project area (GPS co-ordinates)
- Landscape position
- Associated vegetation and dominant structure
- Hollow-bearing trees, and logs
- Description of rock and rocky outcrops
- Leaf and twig litter percentage
- Topography
- Geomorphology
- Wetlands, and other water bodies
- Description of observed nests and roosts
- Subterranean roosts (e.g. caves, and other geological features)
- Associated fauna species observed using the habitat
- Ecological processes important to the habitat
- Photo showing a typical example of the broad habitat type.

3.4.2 Conservation significant fauna

Conservation significant fauna was searched for opportunistically throughout the project area based on preferred or likely habitats and locations of previous records that were identified in the desktop assessment.

3.5 LIMITATIONS OF FLORA AND FAUNA SURVEY

EPA Guidance Statement 51, Terrestrial Flora and Vegetation Surveys (EPA 2004a) and EPA Guidance Statement No. 56, Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia (EPA, 2004b) recommend including discussion of the constraints and limitations of the survey methods used. Constraints and limitations for the flora assessment for the study area are summarised in **Table 6**.

Table 6: Constraints and limitations of the Roebourne Level 1 flora and fauna survey

CONSTRAINT	LIMITATIONS
Sources of Information	The Pilbara bioregion has been relatively well surveyed, with increasing survey work occurring due to the mining boom in the region. The Roebourne town site has not been subjected to recent flora and fauna surveys that the authors are aware of; however, numerous flora and fauna surveys have been undertaken in the wider area.
Scope of works	The survey requirements of a Level 1 terrestrial flora, vegetation and fauna survey were adequately met. No quadrat sampling or fauna trapping was undertaken.
Completeness of survey	The project area was fully surveyed to the satisfaction of a Level 1 survey; however additional time may have uncovered additional opportunistic species.
Intensity of survey	A Level 1 survey effort was satisfactory given the level of disturbance, number of species, and types of habitats identified within the project area as per Guidance Statements No. 51/ 56. A Level 2 flora, vegetation and fauna survey would contribute to a much larger species list, particularly for flora and reptiles.
Timing, weather, season, cycle	The timing of the survey was appropriate for a Level 1 flora and fauna survey.
Disturbances	There were numerous tracks and roads throughout the study area, as well as a section of the project area being completely cleared as a construction site.
Resources	The lead botanist and zoologist undertaking the surveys were suitably qualified to identify specimens in their respective fields.
Accessibility / remoteness	All relevant areas in the study area were easily accessed and surveyed

4 Results

4.1 FLORA

A total of 34 dominant flora taxa were identified within the whole study area. The taxa comprised ten families and 23 genera. The two most commonly occurring families were the Fabaceae (16 taxa) and Poaceae (6 taxa) families. *Acacia* (Fabaceae) was the most common genus with 11 taxa.

Refer to **Appendix C** for flora and vegetation survey data sheets. A dominant flora species matrix is available in **Appendix D**.

4.1.1 Conservation significant flora

No Threatened flora species listed under the EPBC Act or the WC Act were recorded within the study area. No Priority flora species were recorded.

No species identified are considered to be at the extent of their range, represent a range extension, or are considered regionally significant.

4.2 VEGETATION

4.2.1 Vegetation condition

All vegetation communities in the study area have been subject to historic disturbances, such as vegetation clearing, proliferation of tracks, historical grazing and rubbish dumping. These disturbances have modified the vegetation structure, increased weed invasion and reduced native species diversity across the majority of the study area. Vegetation condition ranged from Completely Degraded to Good (**Figure 2**). The majority of the study area was described as Degraded with areas adjacent to the town site and along some tracks as Completely Degraded. There were only small portions described as Good with these areas generally being further away from the town-site boundary. The vegetation found in these areas has retained some vegetation structure and species diversity, such as flora releve sites ECO37_R01, ECO37_R04 and ECO37_R08.

4.2.2 Vegetation communities

Four broad vegetation communities were identified in the study area, which were:

- (1) *Corymbia hamersleyana* scattered trees over mixed *Acacia* shrublands on drainage plains and washes
- (2) Mixed *Acacia* shrubland to scattered shrubs on rocky low hills, slopes and gullies
- (3) *Eucalyptus camaldulensis* scattered trees over mixed *Acacia* shrubs on alluvial flats adjoining major drainage line
- (4) *Acacia xiphophylla* scattered shrubs over mixed Chenopod species on clay plains

The broad vegetation communities recorded are summarized in

Table 7. Flora quadrat data sheets are presented in Appendix C. The spatial extent of each vegetation community and the location of each survey plot are shown in **Figure 3**.

Table 7: Vegetation communities identified within the study area

VEGETATION CODE	VEGETATION COMMUNITY DESCRIPTION	FLORA PLOTS
ChApAbAa	<i>Corymbia hamersleyana</i> scattered trees over <i>Acacia pyrifolia</i> , <i>Acacia bivenosa</i> and <i>Acacia arida</i> open shrubland to shrubland over <i>Salsola australis</i> scattered low shrubs over * <i>Cenchrus ciliaris</i> and <i>Sporobolus australasicus</i> very open grassland to grassland and <i>Triodia wiseana</i> very open hummock grassland to hummock grassland	ECO37_R01 & ECO37_R03
ApAbAiAa	<i>Acacia pyrifolia</i> , <i>Acacia bivenosa</i> , <i>Acacia inaequilatera</i> and <i>Acacia ancistrocarpa</i> open shrubland to scattered shrubs over <i>Salsola australis</i> scattered low shrubs over * <i>Cenchrus ciliaris</i> and <i>Aristida contorta</i> very open grassland to grassland and <i>Triodia wiseana</i> very open hummock grassland to hummock grassland	ECO37_R02, ECO37_R04, ECO37_R06 & ECO37_R08
EcAsAp	<i>Eucalyptus camaldulensis</i> scattered trees over <i>Acacia sclerosperma</i> subsp. <i>sclerosperma</i> and/or <i>Acacia pyrifolia</i> scattered shrubs over <i>Salsola australis</i> scattered low shrubs over * <i>Cenchrus ciliaris</i> open grassland to grassland	ECO37_R05
AxScAbSa	<i>Acacia xiphophylla</i> scattered shrubs over <i>Sclerolaena cuneata</i> , <i>Atriplex bunburyana</i> and <i>Salsola australis</i> scattered low shrubland over * <i>Cenchrus ciliaris</i> and <i>Eragrostis eriopoda</i> open grassland	ECO37_R07

4.2.3 Threatened and priority ecological communities

The PEC – Horseflat land system of the Roebourne Plains was identified from the desktop review has not been ground truthed by the DEC and is based on the land system mapping described by Van Vreeswyk et al. (2004). The PEC incorporates Unit 3 (Gilgai plains), Unit 5 (Alluvial Plains) and some Unit 7 (Drainage Depressions) described in Van Vreeswyk et al. (2004) and occurs over a wide area extending from Cape Preston to Balla Balla. The study area contains mapped Horseflat land system of the Roebourne Plains - alluvial plains with tussock grasslands (Van Vreeswyk et al. 2004). The extent of the PEC is shown in **Figure 4**. The vegetation community AxScAbSa is analogous to the PEC, however is degraded with significantly reduced species diversity than would be typically found in this community.

4.3 FAUNA

A total of 46 native fauna species were recorded during the Level 1 fauna survey. Four reptile, 41 bird and one mammal species were identified during the fauna survey the project area. Fifteen of the 41 bird species recorded were observed within the Harding River on the immediate adjacent eastern edge of the study area boundary.

Refer to **Appendix B** for a complete fauna species list.

4.3.1 Fauna habitats

Four broad habitat types were identified within the project area. These were noted as having varying degrees of disturbance, such as **Cenchrus ciliaris* (Buffel grass) infestation, ground disturbance from vehicles and earthmoving equipment, and dumped rubbish. Descriptions on which the condition ratings were based are included in

Table 7. In general, areas assessed as Good condition are considered of highest value to fauna species. The following habitat types were identified:

1. Open mixed *Acacia* shrubland plains over mixed low shrubs and *Triodia* hummock grasses and varying degrees of introduced grasses on red clay-loam soil.
2. Stony low hills, low rises and rocky gullies with shallow clay soils supporting sparse mixed *Acacia* and hummock grasses, and with varying degrees of introduced grasses.
3. Alluvial sand plain associated with major creeks supporting occasional River Red Gum trees mixed open *Acacia* with varying degrees of introduced grasses.
4. Open Chenopod clay pan with spares *Acacia* and *Atriplex* and varying degrees of introduced grasses.

See **Appendix E** for fauna habitat photos.

4.3.2 Conservation significant fauna

Two conservation significant fauna species were recorded within the study area and a further two conservation significant species were recorded just beyond the eastern edge of the Study area within the Harding River. All four species are federally listed migratory birds:

- Rainbow Bee-eater (*Merops australis*) - observed in several locations within project area;
- Great Egret (*Ardea alba*) - observed flying over the project area;
- Cattle Egret (*Ardea ibis*) - observed in Harding River just beyond the project area;
- Common Greenshank (*Tringa nebularia*) - observed in Harding River just beyond project area;

The Rainbow Bee-eater was recorded flying over the area at three locations: **Figure 5**. This species is seasonally common and widespread throughout most of Australia. Breeding is unlikely to occur within the Study area due to the paucity of sandy areas such as river or creek embankments. This species is likely to feed within the site seasonally. Given the small size of the Study area it is not considered significant habitat for this species in relation to feeding habitat available throughout the Pilbara.

The local occurrence of the Great Egret, Cattle Egret and Common Greenshank is due to the presence of the Harding River system located just beyond the eastern edge of the Study area.

No other conservation significant fauna or signs of their presence were detected. The likelihood of occurrence provides further information based on species ecology, local distribution, and the habitat characteristics and condition within the project area. A number of other conservation significant species were assessed as possibly occurring due to their local and regional distribution (Table 3). Of these, the most likely to occur are the Bush Stone Curlew (*Burhinus grallius*), a Priority 4 species that has previously been recorded within the Roebourne area and potentially forages within open stony plains and clay pans habitat. In addition, the Priority 4 Australian Bustard (*Ardeotis australis*) is likely to forage within the site on an occasional or season basis following adequate rain.

4.4 CONSERVATION OPPORTUNITIES ANALYSIS

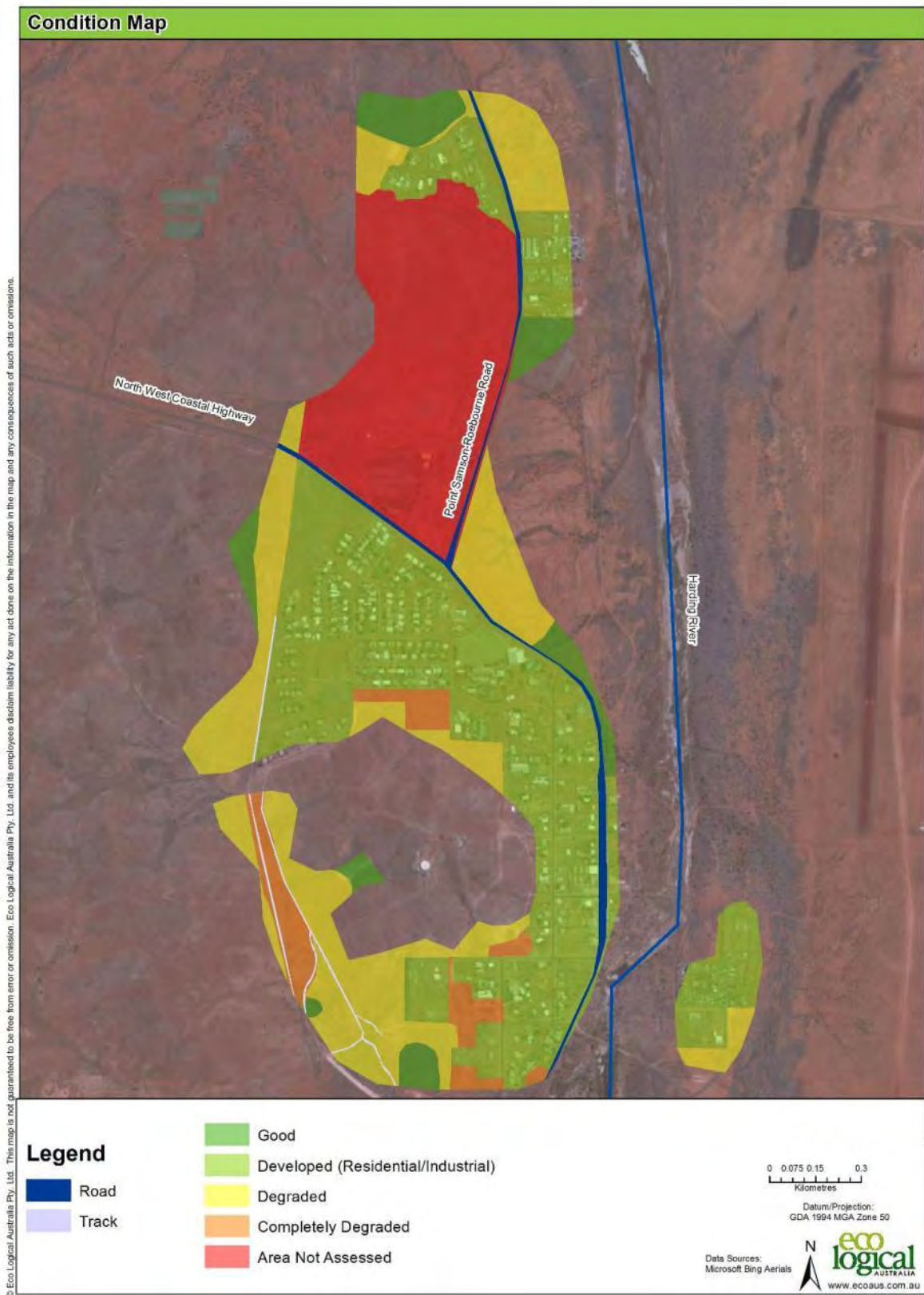
A comparative conservation opportunities analysis was conducted to determine and rank areas in the study area that have High, Medium and Low conservation value (**Figure 6**). The conservation values are based on the following factors:

- High value – areas of vegetation that are in good condition and/or connectivity to surrounding vegetation and/or contains the PEC 3 „Horseflat land system of the Roebourne plain“ in good condition
- Medium value – contains the PEC 3 „Horseflat land system of the Roebourne plain“ in degraded condition, which also serves as a riparian buffer for the Harding River
- Low value – contains vegetation that is degraded or completely degraded and has low ecological functioning in terms of habitat value for conservation significant species

An assessment of these conservation values was made to inform the Town of Roebourne of areas that contain higher value conservation assets to minimise potential environmental impacts on remaining areas of good vegetation. It should be noted that the term “high” conservation value used in the context of the Roebourne site does not correspond to a legislative or policy constraint. That is the conservation value assessment is comparative and does not represent a constraint on future potential development within the Study area.

The assessment of conservation values provides a guide to identify areas most appropriate for future development consistent with Federal and State government requirements. Therefore areas of lowest conservation value shown in **Figure 6** are deemed most suitable for development and areas of highest conservation value most suitable for retention.

Figure 2: Vegetation condition of the Roebourne study area



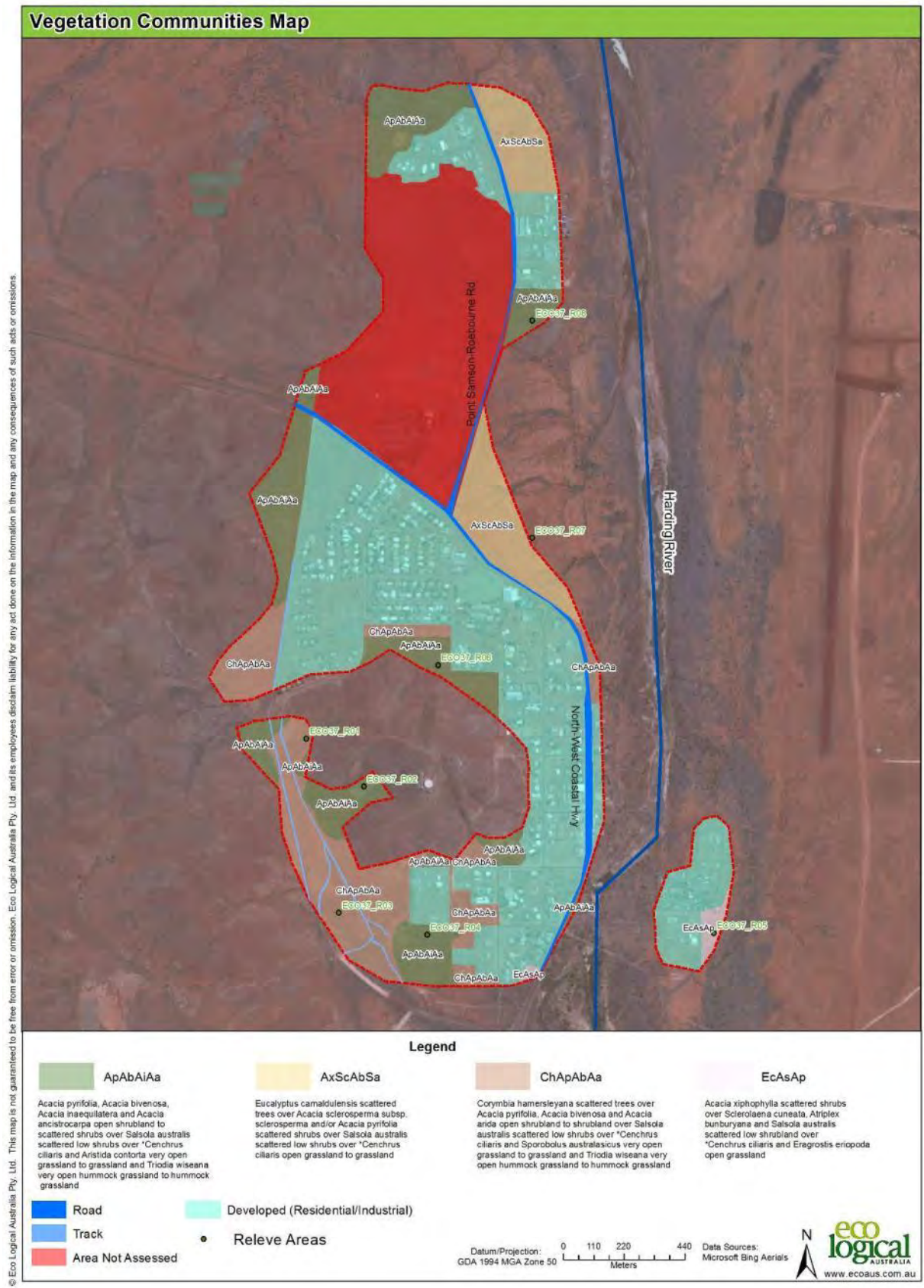


Figure 3: Broad vegetation communities within the Roebourne study area

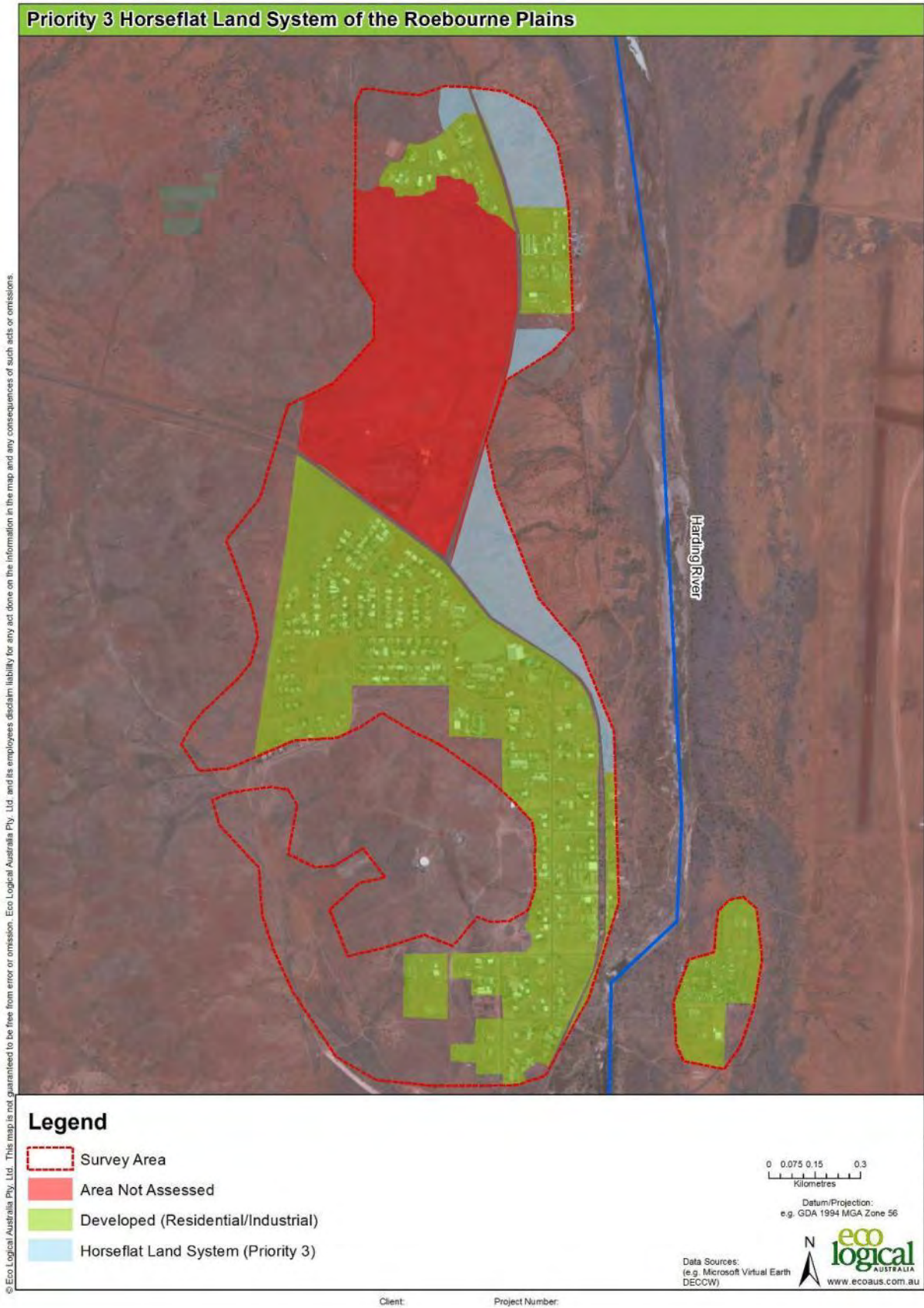


Figure 4: Extent of PEC 3 Horseflat land system of the Roebourne Plains within the study area

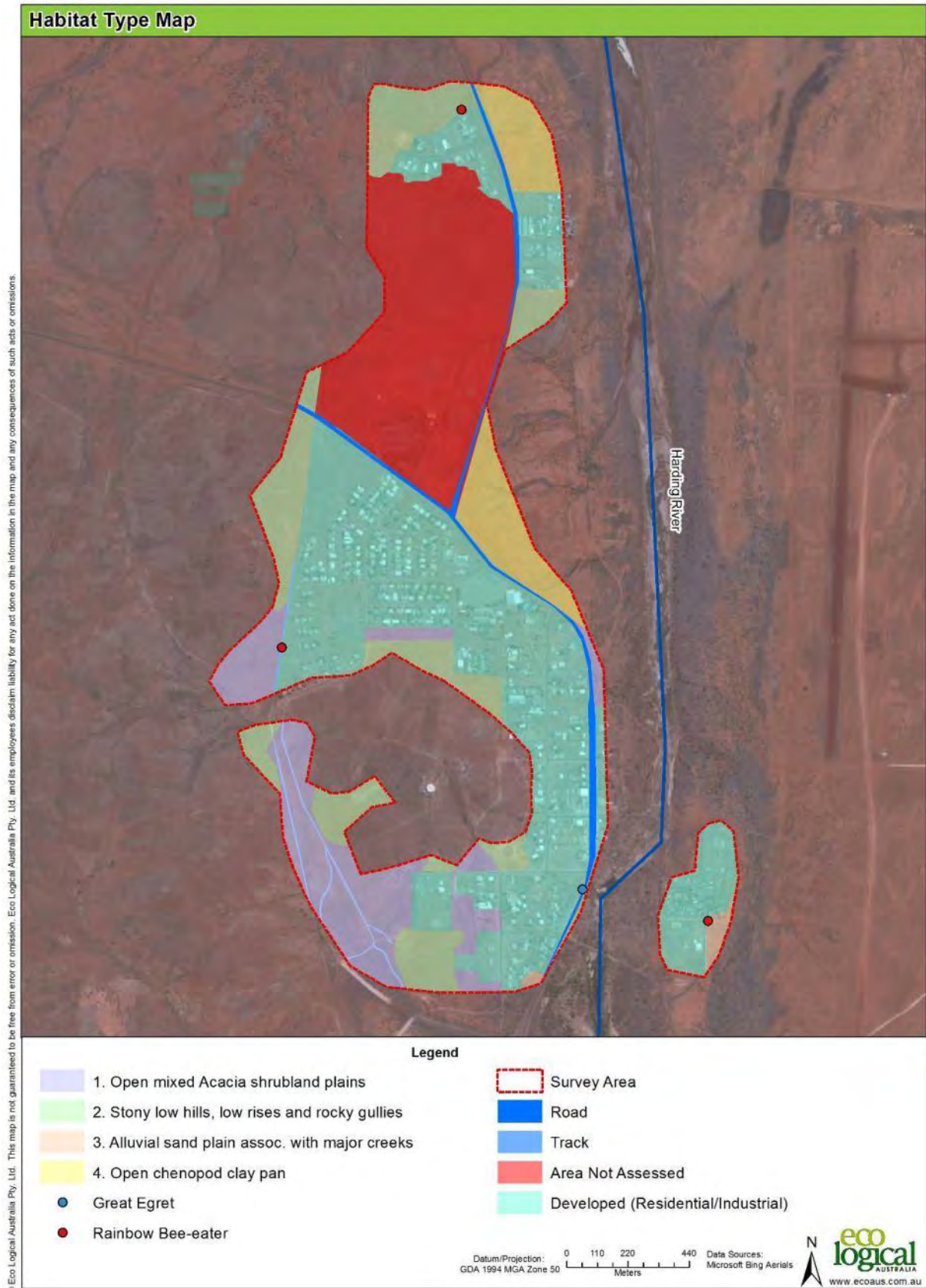


Figure 5: Fauna habitat types and conservation significant fauna species locations within the study area

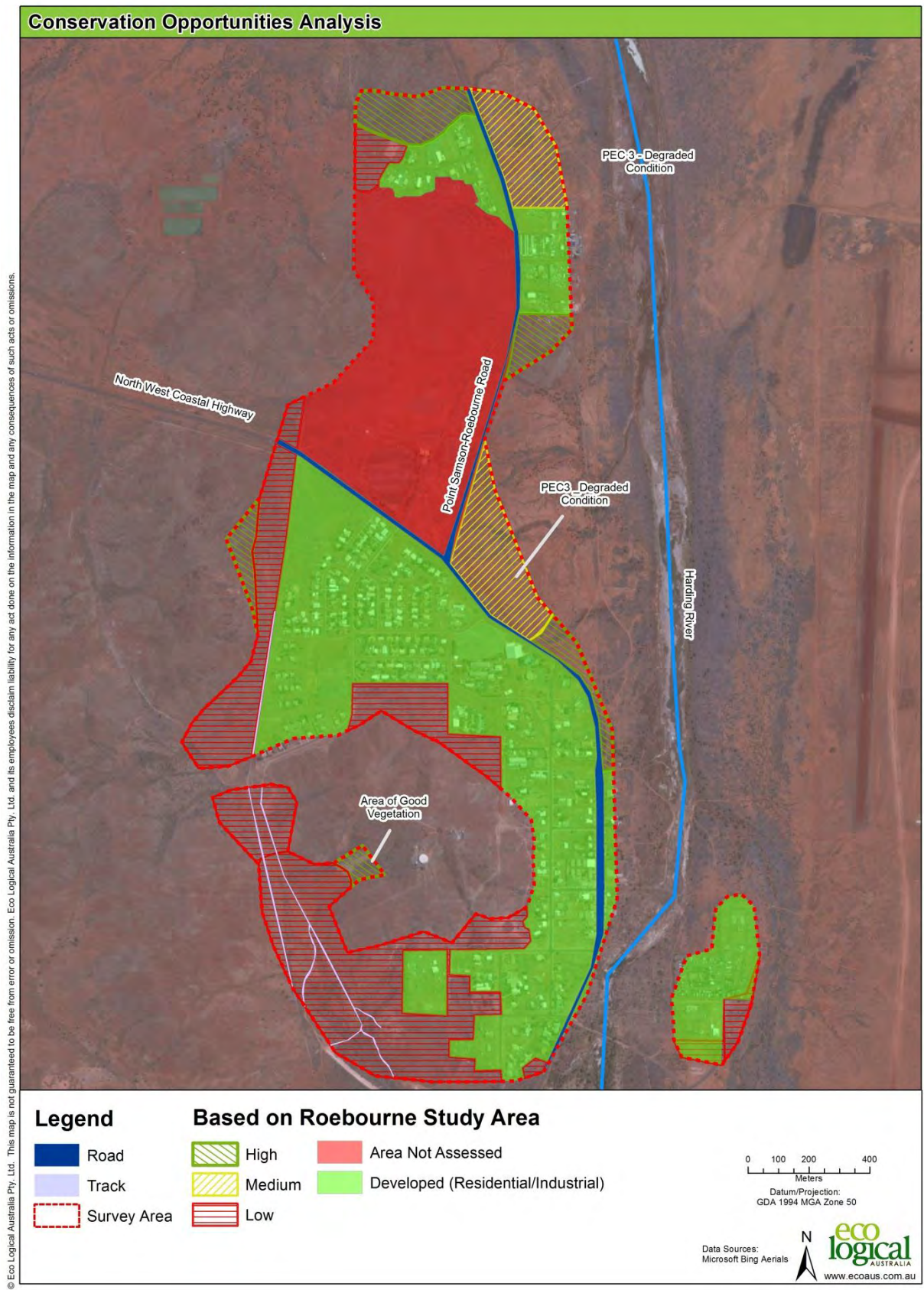


Figure 6: Conservation opportunities analysis of the study area

5 Discussion and Recommendations

The majority of the vegetation communities described in the study area are typical of the bioregion and are not considered under threat. The majority of the study area has been mapped by Shepherd et al. (2002) as Abydos Plain Chichester (Vegetation Code 157) hummock grasslands, grass steppe, hard spinfex, *Triodia wiseana*. This vegetation has 99.06% of its pre-European extent remaining and has a medium rating for reservation priority (Kendrick and Stenley 2001). This vegetation type is considered least concern by the Department of Natural Resources and Environment (2002) for protection. The small isolated area to the east of the main study area has been mapped by Shepherd et al. (2002) as Abydos Plain (Vegetation Code 619) medium woodland, river gum *Eucalyptus camaldulensis*. This vegetation has 99.02% of its pre-European extent remaining and has a high rating for reservation priority (Kendrick and Stenley 2001). This vegetation type is considered least concern by the Department of Natural Resources and Environment (2002) for conservation.

The PEC Horseflat land system of the Roebourne plain is present but in a degraded condition. The PEC across its complete range has been severely impacted by development and historically grazed. As its overall extent has not been mapped by DEC, and because of its degraded condition, it may no longer be considered to be a good representation of the community. Determining this would require liaison with DEC in regard to its remnant value.

The Study area has a degree of intrinsic ecological value on the basis that it supports a range of native flora and fauna and provides habitat for a wide range of common and widespread fauna species. The potential occurrence of a number of wetland / coastal bird species is possible within the site due to the proximity of the Harding River, a significant riparian habitat, however this river system occurs outside the Study area.

The Study area lacks several key fauna habitat characteristics including caves, significant rock outcrops, gorges, and riparian habitats. Therefore the site lacks core habitat for conservation significant fauna such as cave roosting bats, Northern Quolls, and Pilbara Olive Pythons. Based on the habitat types and available and the lack of core habitat, it is concluded that the site has few constraints to development. In addition, the relatively poor condition and high level of disturbance evident contribute to the low ecological value of the site in the context of the surrounding land and wider northern Pilbara in which there is extensive similar habitat types.

- A summary of the findings and resulting recommendations resulting from the Level 1 Flora, Vegetation and Fauna assessment are:
- No ecological values were identify that pose a constraint to development; however liaison with DEC is recommended to confirm the status of the PEC in the Study area given its degraded condition
- Development should be preferentially sited in areas of comparatively low conservation value as illustrated in Figure 6.
- No ecological values were identified that warrant retention within conservation reserves

- If additional extent of, or modification to, existing conservation areas is desired, then sites in better condition or rated as high conservation value (Figure 6) should be preferentially selected
- Management of conservation areas, or retained vegetation, would benefit from access management, including establishment of a hard-edge boundary between vegetation and development, fencing and provision of dedicated access paths
- Further ecological survey is not likely to identify additional ecological values that would constitute a constraint, or provide additional information for decision-making.

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Appendix A: Flora and fauna conservation codes for Western Australia

IUCN flora and fauna categories (based on review by Mace and Stuart 1994) as used for the Federal *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the State *Wildlife Conservation Act 1950* (WC Act).

CODE	CONSERVATION STATUS	DESCRIPTION
EX	Extinct	Taxa not definitely located within the last 50 years
EW	Extinct in the Wild	Taxa only known to survive in captivity
CR	Critically Endangered	Taxa facing an extremely high risk of extinction in the wild in the immediate future
EN	Endangered	Taxa facing a very high risk of extinction in the wild in the near future
VU	Vulnerable	Taxa facing a high risk of extinction in the wild in the medium-term future
CD	Conservation Dependent	Taxa whose survival depends upon ongoing conservation measures. Without these measures, a conservation dependent taxon would be classed as Vulnerable or more severely Threatened.

Flora and fauna Schedules under the State *Wildlife Conservation Act 1950* (WC Act).

SCHEDULE	CODE	CONSERVATION STATUS	DESCRIPTION
<p>Schedule 1</p> <p>Taxa that 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. Schedule 1 flora and fauna are further ranked according to their level of threat using IUCN Red List criteria (CR, EN, VU).</p>	S1	Threatened Flora	Declared Rare Flora - Extant
		Threatened Fauna	Fauna that is rare or likely to become extinct
<p>Schedule 2</p> <p>Taxa which have been adequately searched for and there is no reasonable doubt that the last individual has died, and have been gazetted as such.</p>	S2	Presumed Extinct Flora	Declared Rare Flora - Extinct
		Presumed Extinct Fauna	
<p>Schedule 3</p> <p>Birds that are subject to an agreement between governments of Australia and Japan relating to the protection of migratory birds and birds in danger of</p>	S3	Migratory	Birds protected under an international agreement

SCHEDULE	CODE	CONSERVATION STATUS	DESCRIPTION
extinction.			
Schedule 4 Fauna that is in need of special protection, otherwise than for the reasons mentioned in the above schedules.	S4	Specially Protected Fauna	Other specially protected fauna

Priority flora and fauna categories used by the Department of Environment and Conservation (DEC).

CODE	CONSERVATION STATUS	DESCRIPTION
P1	Priority 1: Poorly known taxa	Taxa that are known from one or a few collections or sight records (generally less than five), all on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, Shire, Westrail and Main Roads WA road, gravel and soil reserves, and active mineral leases and under threat of habitat destruction or degradation. Taxa may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes.
P2	Priority 2: Poorly known taxa	Taxa that are known from one or a few collections or sight records, some of which are on lands not under imminent threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, vacant Crown land, water reserves, etc. Taxa may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes.
P3	Priority 3: Poorly known taxa	Taxa that are known from collections or sight records from several localities not under imminent threat, or from few but widespread localities with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Taxa may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and known threatening processes exist that could affect them.
P4	Priority 4: Rare, Near Threatened and other taxa in need of monitoring	<p>(a) Rare. Taxa that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These taxa are usually represented on conservation lands.</p> <p>(b) Near Threatened. Taxa that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable.</p> <p>(c) Taxa that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.</p>

P5	Priority 5: Conservation Dependent taxa	Taxa that are not threatened but are subject to a specific conservation program, the cessation of which would result in the taxa becoming threatened within five years.
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Appendix B: Fauna species list

Species Name	Common Name	Conservation Status		Nature Map	DEC database	PMST (EPBC search)	This survey (ELA 2012)
		EPBC Act	WC Act/DEC				
Reptiles							
<i>Ctenophorus caudicinctus</i>	Ring-tailed Dragon			x			x
<i>Ctenophorus isolepis</i> subsp. <i>isolepis</i>	Military Dragon			x			x
<i>Ctenophorus nuchalis</i>	Central Netted Dragon			x			x
<i>Ctenotus angusticeps</i>	Airlie island Skink	VU	S1	x	x		
<i>Ctenotus saxatilis</i>	Rock Ctenotus			x			x
<i>Lerista neviniae</i>	Skink		S1	x	x		
<i>Lerista quadrivincula</i>	Four-chained Slider		P1		x		
<i>Liasis olivaceus barroni</i>	Pilbara Olive Python	VU	S1	x	x	x	
<i>Notoscincus butleri</i>	Lined Soil-crevice Skink		P4	x	x		
Birds							
<i>Actitis hypoleucos</i>	Common Sandpiper	M	S3	x	x		
<i>Anas gracilis</i>	Grey Teal			x			x
<i>Anas superciliosa</i>	Pacific Black Duck			x			x
<i>Anous stolidus</i>	Common Noddy	M	S3		x		
<i>Anthus novaeseelandiae</i>	Richard's Pipit						x
<i>Apus pacificus</i>	Fork-tailed Swift	M	S3		x	x	
<i>Ardea alba</i>	Great Egret	M	S3	x	x	x	x
<i>Ardea ibis</i>	Cattle Egret	M	S3			x	x
<i>Ardea sacra</i>	Eastern Reef Egret	M	S3	x	x		
<i>Ardeotis australis</i>	Australian Bustard		P4	x	x		
<i>Arenaria interpres</i>	Ruddy Turnstone	M	S3	x	x		
<i>Artamus cinereus</i>	Black-faced Woodswallow			x			x
<i>Aythya australis</i>	Hardhead			x			x
<i>Burhinus grallius</i>	Bush-stone Curlew		P4	x	x		
<i>Cacatua roseicapilla</i> subsp. <i>assimilis</i>	Galah			x			x
<i>Cacatua sanguinea</i>	Little Corella			x			x
<i>Calidris acuminata</i>	Sharp-tailed Sandpiper	M	S3	x	x		
<i>Calidris alba</i>	Sanderling	M	S3	x	x		
<i>Calidris cantus</i>	Red Knot	M	S3	x	x		
<i>Calidris ferruginea</i>	Curlew Sandpiper	M	S3	x	x		
<i>Calidris ruficollis</i>	Red-necked Stint	M	S3	x	x		
<i>Calidris subminuta</i>	Long-toed Stint	M	S3	x	x		
<i>Calidris tenuirostris</i>	Great Knot	M	S3	x	x		
<i>Certhionyx variegatus</i>	Pied Honeyeater			x			x
<i>Charadrius leschenaultii</i>	Greater Sand Plover	M	S3	x	x		
<i>Charadrius melanops</i>	Black-fronted Dotterel	M	S3				x


<i>Charadrius mongolus</i>	Lesser Sand Plover	M	S3	x	x		
<i>Charadrius veredus</i>	Oriental Plover	M	S3	x		x	
<i>Chlidonias leucopterus</i>	White-winged Black Tern	M	S3		x		
<i>Cincloramphus mathewsi</i>	Rufous Songlark			x			x
<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike			x			x
<i>Cracticus nigrogularis</i>	Pied Butcherbird			x			x
<i>Cuculus saturatus</i>	Oriental Cuckoo	M	S3	x	x		
<i>Cygnus atratus</i>	Black Swan			x			x
<i>Epthianura tricolor</i>	Crimson Chat						x
<i>Falco cenchroides</i>	Australian Kestrel			x			x
<i>Falco hypoleucos</i>	Grey Falcon		P4	x	x		
<i>Falco peregrinus</i>	Peregrine Falcon		S4	x	x		
<i>Fregata ariel</i>	Lesser Frigatebird	M	S3		x		
<i>Geophaps plumifera</i>	Spinifex Pigeon			x			x
<i>Glareola maldivarium</i>	Oriental Pratincole	M	S3	x	x	x	
<i>Grallina cyanoleuca</i>	Magpie-lark			x			x
<i>Haliaeetus leucogaster</i>	White-bellied Sea Eagle	M	S3	x	x	x	
<i>Haliastur sphenurus</i>	Whistling Kite			x			x
<i>Hirundo ariel</i>	Fairy Martin						x
<i>Hirundo rustica</i>	Barn Swallow	M	S3	x		x	
<i>Larus novaehollandiae</i>	Silver Gull						x
<i>Lichenostomus ornatus</i>	Yellow-plumed Honeyeater						x
<i>Lichenostomus virescens</i>	Singing Honeyeater			x			x
<i>Lichmera indistincta</i>	Brown Honeyeater			x			x
<i>Limosa lapponica</i>	Bar-tailed Godwit	M	S3	x	x		
<i>Limosa limosa</i>	Black-tailed Godwit	M	S3	x	x		
<i>Manorina flavigula</i>	Yellow-throated Miner			x			x
<i>Merops ornatus</i>	Rainbow Bee-eater	M	S3	x	x	x	x
<i>Numenius phaeopus</i>	Whimbrel	M	S3	x	x		
<i>Numenius minutus</i>	Little Curlew	M	S3		x		
<i>Numenius madagascariensis</i>	Eastern Curlew	M	S3	x	x		
<i>Nymphicus hollandicus</i>	Cockatiel			x			x
<i>Ocyphaps lophotes</i>	Crested Pigeon			x			x
<i>Pachycephala rufiventris</i>	Rufous Whistler			x			x
<i>Pelecanus conspicillatus</i>	Australian Pelican			x			x
<i>Phalacrocorax melanoleucos</i>	Little Pied Cormorant						x
<i>Phalacrocorax sulcirostris</i>	Little Black Cormorant			x			x
<i>Phaps histrionica</i>	Flock Bronzewing		P4	x	x		
<i>Plegadis falcinellus</i>	Glossy ibis	M	S3	x	x		
<i>Pluvialis squatarola</i>	Grey Plover	M	S3	x	x		
<i>Pluvialis fulva</i>	Pacific Golden Plover	M	S3	x	x		
<i>Prophyrio prophyrio</i>	Swamp Hen						x
<i>Rhipidura leucophrys</i>	Willie Wagtail			x			x
<i>Smicromis brevirostris</i>	Weebill			x			x

<i>Sterna bengalensis</i>	Lesser Crested Tern	M	S3	x	x		
<i>Sterna caspia</i>	Caspian Tern	M	S3	x	x		
<i>Sterna dougallii</i>	Roseate Tern	M	S3		x		
<i>Sterna hirundo</i>	Common Tern	M	S3	x	x		
<i>Sterna nilotica</i>	Gull-billed Tern						x
<i>Taeniopygia guttata</i>	Zebra Finch			x			x
<i>Todiramphus pyrrhopygia</i>	Red-backed Kingfisher			x			x
<i>Todiramphus sanctus</i>	Sacred Kingfisher			x			x
<i>Tringa brevipes</i>	Grey-tailed Tattler	M	S3	x	x		
<i>Tringa glareola</i>	Wood Sandpiper	M	S3	x	x		
<i>Tringa nebularia</i>	Common Greenshank	M	S3	x	x		x
<i>Tringa stagnatilis</i>	Marsh Sandpiper	M	S3	x	x		
<i>Xenus cinereus</i>	Terek Sandpiper	M	S3	x	x		
Mammals							
<i>Dasyercus cristicauda</i>	Crest-tailed Mulgara	VU	S1			x	
<i>Dasyurus hallucatus</i>	Northern Quoll	EN	S1	x	x	x	
<i>Leggadina lakedownensis</i>	Lakeland Downs Mouse		P4	x	x		
<i>Macroderma gigas</i>	Ghost Bat		P4	x	x		
<i>Macropus robustus</i> subsp. <i>erubescens</i>	Euro			x			x
<i>Macrotis lagotis</i>	Greater Bilby	VU	S1			x	
<i>Mormopterus loriae</i>	Western Little Free-tailed Bat		P1		x		
<i>Pseudomys chapmani</i>	Western Pebble-mound Mouse		P4	x	x		
<i>Rhinonicteris aurantius</i>	Pilbara Leaf-nosed Bat	Vu	S1			x	

Appendix C: Flora field survey data sheets

Project #: 12PERECO_0037




Date: 25/10/12

Project area: Roebourne townsite		Releve # : ECO_37_01		Observer/s: JC		
Location				Datum: GDA94		Zone: 50J
	Coordinates: (UTM)	E 0514242	N 7703166	WPT:	01JC	
Habitat	Landform unit:	Drainage plains and washes				
	Rock type:	Ironstone				
	Soil:					
	Colour:	Brown				
	Type:	Sandy loam				
	Condition:	Dry				
	Outcropping:	Nil				
	Veg Condition:	Degraded				
Disturbance type:	Weeds, Tracks, Clearing Rubbish					
Age since fire (yrs):	Approx 8+ yrs					
Bare Soil (%): 5		Leaf litter (%): +		Logs (%): +		
Cover (%):		Overstorey: +	Midstorey: 6	Understorey: 68		
Vegetation description:						
<i>Corymbia hamersleyana</i> scattered trees over <i>Acacia pyrifolia</i> , <i>Acacia bivenosa</i> and <i>Acacia arida</i> open shrubland over <i>Scaevola</i>						
<i>spinescens</i> , <i>Corchorus walcottii</i> and <i>Salsola australis</i> scattered low shrubs over * <i>Cenchrus ciliaris</i> tussock grassland and <i>Triodia</i>						
<i>wiseana</i> very open hummock grassland						

SPECIMEN #	SPECIES NAME	HEIGHT (m)	COVER (%)	INTRODUCED
NC	<i>Acacia ancistrocarpa</i>	0.8	+	
ECO37.01.01	<i>Acacia arida</i>	1.2	1	
NC	<i>Acacia bivenosa</i>	1.3	1	
NC	<i>Acacia pyrifolia</i>	1.5-2	2	
NC	<i>Aerva javanica</i>	0.3	+	Y
NC	<i>Cenchrus ciliaris</i>	0.4	60	Y
ECO37.01.02	<i>Corchorus walcottii</i>	0.5	1	
NC	<i>Corymbia hamersleyana</i>	2.2	1	
NC	<i>Salsola australis</i>	0.3	+	
NC	<i>Scaevola spinescens</i>	0.5	1	
NC	<i>Sporobolus australasicus</i>	0.1	1	
ECO37.01.04	<i>Tephrosia rosea</i> var. <i>clementii</i>	0.5	+	
NC	<i>Trichodesma zeylanicum</i>	0.6	4	
ECO37.01.03	<i>Triodia wiseana</i>	0.5	8	
NC	<i>Vachellia farnesiana</i>	1.5	+	Y

Project #: 12PERECO_0037


Date: 25/10/12

Project area: Roebourne townsite		Releve # : ECO_37_02		Observer/s: JC																					
Location				Datum: GDA94																					
				Zone: 50J																					
Habitat	Coordinates: (UTM)	E 0514451	N 7702994	WPT:	02JC																				
	<table border="0"> <tr> <td>Landform unit:</td> <td>Low rocky hill</td> <td rowspan="10" style="vertical-align: middle; text-align: center;">  </td> </tr> <tr> <td>Rock type:</td> <td>Calcrete/Ironstone</td> </tr> <tr> <td>Soil:</td> <td></td> </tr> <tr> <td>Colour:</td> <td>Light Brown</td> </tr> <tr> <td>Type:</td> <td>Sandy loam</td> </tr> <tr> <td>Condition:</td> <td>Dry</td> </tr> <tr> <td>Outcropping:</td> <td>Nil</td> </tr> <tr> <td>Veg Condition:</td> <td>Good</td> </tr> <tr> <td>Disturbance type:</td> <td>Weeds, Tracks, Rubbish</td> </tr> <tr> <td>Age since fire (yrs):</td> <td>Approx 8+ yrs</td> </tr> </table>					Landform unit:	Low rocky hill		Rock type:	Calcrete/Ironstone	Soil:		Colour:	Light Brown	Type:	Sandy loam	Condition:	Dry	Outcropping:	Nil	Veg Condition:	Good	Disturbance type:	Weeds, Tracks, Rubbish	Age since fire (yrs):
Landform unit:	Low rocky hill																								
Rock type:	Calcrete/Ironstone																								
Soil:																									
Colour:	Light Brown																								
Type:	Sandy loam																								
Condition:	Dry																								
Outcropping:	Nil																								
Veg Condition:	Good																								
Disturbance type:	Weeds, Tracks, Rubbish																								
Age since fire (yrs):	Approx 8+ yrs																								
Bare Soil (%): 25		Leaf litter (%): 5		Logs (%): +																					
Cover (%):		Overstorey:	Midstorey: 8	Understorey: 45																					
Vegetation description:																									
<i>Acacia bivenosa</i> and <i>Acacia ancistrocarpa</i> open shrubland over <i>Senna artemisioides</i> subsp. <i>oligophylla</i> scattered low shrubs																									
* <i>Cenchrus ciliaris</i> tussock grassland and <i>Triodia wiseana</i> open hummock grassland																									

SPECIMEN #	SPECIES NAME	HEIGHT (m)	COVER (%)	INTRODUCED
NC	<i>Acacia ancistrocarpa</i>	1.5	3	
NC	<i>Acacia bivenosa</i>	1.2	4	
NC	<i>Acacia pyrifolia</i>	1.5-2	2	
NC	<i>Acacia tetragonophylla</i>	0.6	+	
NC	<i>Cenchrus ciliaris</i>	0.3	40	Y
ECO37.02.02	<i>Pteracaulon sphacelatum</i>	0.2	+	
NC	<i>Salsola australis</i>	0.3	+	
ECO37.02.01	<i>Senna artemisioides</i> subsp. <i>oligophylla</i>	0.5	1	
ECO37.01.03	<i>Triodia wiseana</i>	0.4	12	

Project #: 12PERECO_0037


Date: 25/10/12

	Project area: Roebourne townsite		Releve # : ECO_37_03		Observer/s: JC
Location				Datum: GDA94	Zone: 50J
	Coordinates: (UTM)	E 0514360	N 7702537	WPT:	03JC
Habitat	Landform unit:	Drainage plains and washes			
	Rock type:	Ironstone			
	Soil:				
	Colour:	Brown			
	Type:	Sandy loam			
	Condition:	Dry			
	Outcropping:	Nil			
	Veg Condition:	Good			
Disturbance type:	Weeds, Tracks, Rubbish				
Age since fire (yrs):	Approx 8+ yrs				
	Bare Soil (%): 15		Leaf litter (%): +	Logs (%): +	
	Cover (%):	Overstorey: 3	Midstorey: 35	Understorey: 48	
	Vegetation description:				
	<i>Corymbia hamersleyana</i> scattered trees over <i>Acacia bivenosa</i> and <i>Acacia pyrifolia</i> shrubland over				
	<i>Salsola australis</i> scattered low shrubs over * <i>Cenchrus ciliaris</i> very open tussock grassland and <i>Triodia wiseana</i>				
	hummock grassland				

SPECIMEN #	SPECIES NAME	HEIGHT (m)	COVER (%)	INTRODUCED
NC	<i>Acacia stellaticeps</i>	0.5	+	
ECO37.01.01	<i>Acacia arida</i>	1.2	1	
NC	<i>Acacia bivenosa</i>	1.5	15	
NC	<i>Acacia coriacea</i> subsp. <i>pendens</i>	3.0	+	
NC	<i>Acacia pyrifolia</i>	1.6	10	
ECO37.03.01	<i>Acacia trachycarpa</i>	1.0	+	
NC	<i>Cenchrus ciliaris</i>	0.3	8	Y
NC	<i>Corymbia hamersleyana</i>	3.5	2	
NC	<i>Salsola australis</i>	0.3	+	
NC	<i>Sporobolus australasicus</i>	0.1	1	
NC	<i>Stemodia grossa</i>	0.2	+	
ECO37.01.04	<i>Tephrosia rosea</i> var. <i>clementii</i>	0.5	+	
NC	<i>Trichodesma zeylanicum</i>	0.6	4	
ECO37.01.03	<i>Triodia wiseana</i>	0.5	40	
NC	<i>Vachellia farnesiana</i>	1.5	+	Y

Project #: 12PERECO_0037


Date: 25/10/12

	Project area: Roebourne townsite		Releve # : ECO_37_04		Observer/s: JC
Location			Datum: GDA94		Zone: 50J
	Coordinates: (UTM)	E 0514679	N 7702457	WPT:	04JC
Habitat	Landform unit:	Low rocky hill slope			
	Rock type:	Ironstone			
	Soil:				
	Colour:	Red-Brown			
	Type:	Sandy loam			
	Condition:	Dry			
	Outcropping:	Nil			
Veg Condition:	Good				
Disturbance type:	Weeds, Tracks, Rubbish				
Age since fire (yrs):	Approx 5+ yrs				
	Bare Soil (%): 25		Leaf litter (%): +	Logs (%): +	
	Cover (%):	Overstorey:	Midstorey: 2	Understorey: 55	
	Vegetation description:				
	<i>Acacia bivenosa</i> scattered shrubs over <i>Triodia wiseana</i> open hummock grassland and <i>Aristida contorta</i> scattered tussock				
	grasses				

SPECIMEN #	SPECIES NAME	HEIGHT (m)	COVER (%)	INTRODUCED
NC	<i>Acacia bivenosa</i>	1.5	2	
NC	<i>Aristida contorta</i>	0.2	2	
NC	<i>Trichodesma zeylanicum</i>	0.5	+	
ECO37.01.03	<i>Triodia wiseana</i>	0.3	55	

Project #: 12PERECO_0037

Date: 25/10/12

Project area: Roebourne townsite		Releve # : ECO_37_05		Observer/s: JC	
Location	Datum: GDA94			Zone: 50J	
	Coordinates: (UTM)	E 0515714	N 7702464	WPT:	06JC
Habitat	Landform unit:	Drainage plain			
	Rock type:	Ironstone			
	Soil:				
	Colour:	Brown			
	Type:	Sandy loam			
	Condition:	Dry			
	Outcropping:	Nil			
	Veg Condition:	Degraded			
Disturbance type:	Weeds, Tracks, Rubbish				
Age since fire (yrs):	Approx 5-8 yrs				
Bare Soil (%): 20		Leaf litter (%): +		Logs (%): +	
Cover (%):		Overstorey: 1	Midstorey: 1	Understorey: 60	
Vegetation description:					
<i>Eucalyptus camaldulensis</i> scattered trees over <i>Acacia sclerosperma</i> subsp. <i>sclerosperma</i> scattered shrubs over					
<i>Salsola australis</i> scattered low shrubs over * <i>Cenchrus ciliaris</i> and <i>Eragrostis xerophila</i> tussock grassland					

SPECIMEN #	SPECIES NAME	HEIGHT (m)	COVER (%)	INTRODUCED
NC	<i>Acacia bivenosa</i>	1.5	2	
ECO37.05.01	<i>Acacia sclerosperma</i> subsp. <i>sclerosperma</i>	1.5	1	
NC	<i>Acacia pyrifolia</i>	1.5	+	
NC	<i>Cenchrus ciliaris</i>	0.2	40	Y
ECO37.05.02	<i>Eragrostis xerophila</i>	0.2	20	
ECO37.05.04	<i>Eucalyptus camaldulensis</i>	5-7	+	
NC	<i>Salsola australis</i>	0.3	1	

Project #: 12PERECO_0037

Date: 25/10/12


Project area: Roebourne townsite		Releve # : ECO_37_06		Observer/s: JC	
Location				Datum: GDA94	
				Zone: 50J	
Coordinates: (UTM)	E 0514719		N 7703432		WPT: 08JC
Habitat	Landform unit:	Low rocky hill and gentle slopes			
	Rock type:	Ironstone			
	Soil:				
	Colour:	Brown			
	Type:	Sandy loam			
	Condition:	Dry			
	Outcropping:	Nil			
	Veg Condition:	Degraded			
	Disturbance type:	Weeds, Tracks, Rubbish, Clearing			
	Age since fire (yrs):	Approx 5-8 yrs			
Bare Soil (%): 5		Leaf litter (%): +		Logs (%): +	
Cover (%):		Overstorey:	Midstorey: 4	Understorey: 65	
Vegetation description:					
<i>Acacia pyrifolia</i> and <i>Acacia inaequiletera</i> open shrubland over <i>Triodia wiseana</i> very open hummock grassland and					
* <i>Cenchrus ciliaris</i> and <i>Aristida contorta</i> tussock grassland					



SPECIMEN #	SPECIES NAME	HEIGHT (m)	COVER (%)	INTRODUCED
NC	<i>Acacia inaequilatera</i>	1.5-2	2	
NC	<i>Acacia pyrifolia</i>	1.5-1.8	4	
ECO37.03.01	<i>Acacia trachycarpa</i>	1.2	+	
NC	<i>Aristida contorta</i>	0.3	1	
NC	<i>Cenchrus ciliaris</i>	0.4	55	Y
NC	<i>Salsola australis</i>	0.5	1	
ECO37.02.01	<i>Senna artemisioides</i> subsp. <i>oligophylla</i>	1	+	
ECO37.01.03	<i>Triodia wiseana</i>	0.5	10	
NC	<i>Vachellia farnesiana</i>	1	+	Y

Project #: 12PERECO_0037

Date: 25/10/12

		Project area: Roebourne townsite		Releve # : ECO_37_07		Observer/s: JC	
Location			Datum: GDA94			Zone: 50J	
	Coordinates: (UTM)	E 0515059		N 7703891		WPT:	09JC
Habitat	Landform unit:	Low plain					
	Rock type:	Ironstone and calcrete small pebbles					
	Soil:						
	Colour:	Light-Brown					
	Type:	Clay loam					
	Condition:	Dry					
	Outcropping:	Nil					
Veg Condition:	Degraded						
Disturbance type:	Weeds, Tracks, Rubbish, Clearing, earthworks						
Age since fire (yrs):	10 + yrs						
Bare Soil (%): 50		Leaf litter (%): +		Logs (%): +			
Cover (%):		Overstorey:	Midstorey: 6	Understorey: 25			
Vegetation description:							
<i>Acacia xiphophylla</i> scattered shrubs over <i>Sclerolaena cuneata</i> , <i>Atriplex bunburyana</i> and <i>Salsola australis</i> scattered low							
shrubland over * <i>Cenchrus ciliaris</i> and <i>Eragrostis eriopoda</i> open tussock grassland							

SPECIMEN #	SPECIES NAME	HEIGHT (m)	COVER (%)	INTRODUCED
NC	<i>Acacia inaequilatera</i>	2	+	
NC	<i>Acacia bivenosa</i>	1.6	+	
NC	<i>Acacia pyrifolia</i>	1.5	+	
NC	<i>Acacia xiphophylla</i>	1.5	+	
ECO37.07.01	<i>Atriplex bunburyana</i>	0.5	2	
NC	<i>Cenchrus ciliaris</i>	0.4	10	Y
ECO37.05.02	<i>Eragrostis xerophila</i>	0.3	10	
NC	<i>Gomphrena canescens</i>	0.2	+	
NC	<i>Panicum decompositum</i>	0.5	+	
NC	<i>Salsola australis</i>	0.4	2	
ECO37.07.02	<i>Sclerolaena cuneata</i>	0.4	15	
NC	<i>Sesbania cannabina</i>	0.4	+	

Project #: 12PERECO_0037

Date: 25/10/12

Project area: Roebourne townsite		Releve # : ECO_37_08	Observer/s: JC
Location	Datum: GDA94		Zone: 50J
	Coordinates: (UTM)	E 0515060 N 7704676	WPT: 09JC
Habitat	Landform unit:	Low rocky hill and slopes	
	Rock type:	Ironstone and basalt	
	Soil:		
	Colour:	Light-Brown	
	Type:	Sandy loam	
	Condition:	Dry	
	Outcropping:	<2%	
Veg Condition:	Degraded		
Disturbance type:	Weeds, Tracks, Rubbish		
Age since fire (yrs):	5 + yrs		
	Bare Soil (%): 60	Leaf litter (%): +	Logs (%): +
Cover (%):	Overstorey:	Midstorey: 5	Understorey: 40
Vegetation description:			
<i>Acacia pyrifolia</i> , <i>Senna glutinosa</i> subsp. <i>pruinosa</i> and <i>Acacia bivenosa</i> scattered shrubs over <i>Triodia wiseana</i> open hummock			
grassland over <i>Aristida contorta</i> tussock grassland			



SPECIMEN #	SPECIES NAME	HEIGHT (m)	COVER (%)	INTRODUCED
NC	<i>Acacia bivenosa</i>	0.5	+	
NC	<i>Acacia pyrifolia</i>	1.5	2	
NC	<i>Acacia synchronicia</i>	0.8	+	
NC	<i>Aristida contorta</i>	0.2	2	
ECO37.01.02	<i>Corchorus walcottii</i>	0.3	1	
ECO37.08.01	<i>Senna glutinosa</i> subsp. <i>pruinosa</i>	1.5	1	
NC	<i>Sporobolus australasicus</i>	0.2	1	
ECO37.01.03	<i>Triodia wiseana</i>	0.4	15	

Appendix D: Flora species matrix

Family	Species Name	Releve							
		1	2	3	4	5	6	7	8
Amaranthaceae	<i>Aerva javanica</i>	x							
Amaranthaceae	<i>Gomphrena canescens</i>							x	
Asteraceae	<i>Pterocaulon sphacelatum</i>		x						
Boraginaceae	<i>Trichodesma zeylanicum</i>	x		x	x				
Chenopodiaceae	<i>Atriplex bunburyana</i>							x	
Chenopodiaceae	<i>Salsola australis</i>	x	x	x		x	x	x	
Chenopodiaceae	<i>Sclerolaena cuneata</i>							x	
Fabaceae	<i>Acacia inaequilatera</i>						x	x	
Fabaceae	<i>Acacia sclerosperma</i> subsp. <i>sclerosperma</i>					x			
Fabaceae	<i>Acacia ancistrocarpa</i>	x	x						
Fabaceae	<i>Acacia arida</i>	x		x					
Fabaceae	<i>Acacia bivenosa</i>	x	x	x	x	x		x	x
Fabaceae	<i>Acacia coriacea</i> subsp. <i>pendens</i>			x					
Fabaceae	<i>Acacia pyrifolia</i>	x	x	x		x	x	x	x
Fabaceae	<i>Acacia stellaticeps</i>			x					
Fabaceae	<i>Acacia synchronicia</i>								x
Fabaceae	<i>Acacia tetragonophylla</i>		x						
Fabaceae	<i>Acacia trachycarpa</i>			x			x		
Fabaceae	<i>Acacia xiphophylla</i>							x	
Fabaceae	<i>Senna artemisioides</i> subsp. <i>oligophylla</i>		x				x		
Fabaceae	<i>Senna gluntinosa</i> subsp. <i>pruinosa</i>								x
Fabaceae	<i>Sesbania cannabina</i>							x	
Fabaceae	<i>Tephrosia rosea</i> var. <i>clementii</i>	x		x					
Fabaceae	<i>Vachellia farnesiana</i>	x		x			x		
Goodeniaceae	<i>Scaevola spinescens</i>	x							
Malvaceae	<i>Corchorus walcottii</i>	x							x
Myrtaceae	<i>Corymbia hamersleyana</i>	x		x					
Myrtaceae	<i>Eucalyptus camaldulensis</i>					x			
Plantaginaceae	<i>Stemodia grossa</i>			x					
Poaceae	<i>Aristida contorta</i>				x		x		x
Poaceae	<i>Cenchrus ciliaris</i>	x	x	x		x	x	x	
Poaceae	<i>Eragrostis xerophila</i>					x		x	
Poaceae	<i>Panicum decompositum</i>							x	
Poaceae	<i>Sporobolus australasicus</i>	x		x					x
Poaceae	<i>Triodia wiseana</i>	x	x	x	x		x		x

Appendix E: Fauna habitats and species photos



1. Open mixed Acacia shrubland plains



2. Stony low hills, rises and associated rocky gullies.



3. Alluvial sand plains associated with creeks



4. Open chenopod clay pans



Military Dragon (*Ctenophorus isolepis*)



Striped Rock Skink (*Ctenotus saxatilis*)



Ring-tailed Rock Gragon (*Ctenophorus caudicinctus*)



Rainbor Bee-eater (*Merops ornatus*)

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Client: Shire of Roebourne

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