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LandCorp

Report for Port Hedland Industrial Land LIA 3,4,5, General Industry/Transport Part A and Part B

Preliminary Environmental Impact Assessment and Biological Survey

October 2009

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

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Background and Scope

LandCorp has commissioned GHD Pty Ltd (GHD) to complete a combined Preliminary Environmental Impact Assessment (PEIA) and Biological Survey for the proposed subdivision and development of Light Industry Area (LIA) 3,4,5, and the General Industry/Transport Area Part A. An additional flora and fauna survey was conducted in June 2009 of the Transport Use Area Part B at Wedgefield and the Port Hedland Port Authority land for the new loop road. These areas are located approximately 10km south of Port Hedland.

LandCorp is investigating opportunities to deliver further industrial land in Port Hedland to meet an increasing and demonstrated demand from the expanding mining, export, transport, construction and service industries.

The Draft Port Hedland Land Use Master Plan (LUMP) has identified the following Crown Land Areas to provide for industrial growth.

Proposed Light Industrial Area (LIA) Subdivisions are:

- LIA 2 (Infill) 8.1 ha at Iron Ore and Pinnacles Streets, Wedgefield
- LIA 3 (Infill) 10.4 ha at Pinga Street and Cajarina Roads, Wedgefield
- LIA 4 (Infill) 13.3 ha at Cajarina and Dalton Roads, Wedgefield
- LIA 5 (Broad acre) 58 ha bounded by Great Northern Highway, Wallwork Road and Goldsworthy Railway, Wedgefield

The above parcels are proposed to be subdivided into lots between 2000m^2 and 8000m^2 for light industrial development.

Proposed Transport Land Subdivisions (Part A and B) are:

- 271 ha between the existing Wedgefield Industrial area and Great Northern Highway.

GHD has undertaken a desktop investigation and site survey of the proposed LIAs in order to ensure that all potential environmental and social issues relating to the proposed land development have been considered.

The field survey for the proposed LIA 3, 4, 5 and the General Industry/Transport Area Part A was undertaken by a qualified ecologist in June 2008. An additional survey of Transport Use Area Part B and the Port Hedland Port Authority land for the new loop road was undertaken in June 2009.

The field assessment included a Level 2 Flora survey (as per EPA Guideline 51) which included:

- Surveying of 50m x 50m quadrats, within representative vegetation types;
- Surveying along targeted and random transects throughout the sites;
- Development of a full flora list;

- Assessment of the vegetation condition and any threatening processes.

Fauna was recorded opportunistically, through examination of scats, tracks, burrows and with a visual and aural survey. An additional visit was made to the area on dusk to attempt to observe any nocturnal species.

Survey and Assessment Outcomes

- The study areas were found to contain similar vegetation across them. The vegetation community is as expected for the area as per existing regional vegetation mapping (Beard, 1974) and remains well conserved.
- Vegetation was in excellent to pristine condition over much of the survey area, with small patches having been degraded by previous activities, tracks and weed invasion.
- No Declared Rare or Priority flora species were identified.
- Evidence of the Mulgara, a fauna species of conservation significance, was identified during the recent field assessment.
- Tidal mudflats occur in the northern boundary of Transport Area B.
- No site contamination or acid sulphate soils are evident or likely to be present.
- Four aboriginal heritage sites have been previously recorded within the study areas.
- Adjacent land uses are compatible with the proposed development.

Actual and Potential Impacts

- Clearing of approximately 353 ha native vegetation in good to excellent condition
- The vegetation of the area is well represented in the Pilbara region, with approximately 196,372.2 ha remaining undisturbed.
- Clearing of fauna habitat as above. The areas are likely to support a range of reptiles which will be killed or displaced as a result of vegetation clearing and land disturbance.
- Clearing of fauna habitat which could support the conservation significant Mulgara. The significance of the impact on the Mulgara would need to be further investigated and the impacts relate specifically to Transport Area B. Further to any development within the Transport Area B, LandCorp will undertake Level 2 fauna assessments and will liaise with DEC regarding potential management of any Mulgara found.
- Post-development impacts on adjacent bushland. The operation of new industrial lots will have potential impacts on bushland remaining in the area. The impacts will primarily be on fauna and issues could include:
  - Light overspill;
  - Litter;
  - Noise and vibration disturbance;
  - Dust production;
  - Increased predators; and
  - Increased traffic.

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

Physical and Social Impacts

- Alteration to surface drainage. As a result of vegetation clearing and the development of building and hard stands, there will be a reduction in infiltration to the ground and an increase in runoff from the sites. This runoff will be collected in drainage systems and most likely transferred to South Creek.
- Nuisance impacts such as dust or pollutant production and noise and vibration will occur during the construction phases of the subdivision and during development of individual lots. Given the industrial location, it is likely that noise and vibration will not be a significant issue, however some caretaker residences and transient workforce accommodation are present within the existing Wedgefield area. LandCorp has considered a range of planning and development measures in order to mitigate noise risks to these receptors.
- Additional traffic will be generated as a result of new businesses. This will create impacts of noise, safety and possible delays, especially as a result of large turning movements.
- The addition of industrial lots closer to Great Northern Highway will have the potential to create a less desirable visual impact for tourists and travellers. Due to the nature of industrial lots and the likelihood of storage of equipment outside, such areas can be messy and unsightly. Some screening may be required to GNH.

Recommendations

Sensitive design of the proposed developments has the potential to mitigate a number of the potential impacts above. Suitable design and planning controls can reduce the impacts related to:

- Degradation of adjacent bushland;
- Visual impact;
- Changes to hydrology;
- Noise and pollution risks to adjacent land occupiers;
- Traffic risks.

Initial fauna surveys have indicated evidence for the presence of Mulgara, listed as Vulnerable under the EPBC Act, within parts of Transport Area B. Given the likely presence of this species within the northern part of the study area, the project may require referral to the DEWHA for assessment under the EPBC Act and/or referral to the EPA under the Environmental Protection Act.

Further detailed fauna investigations (Level 2 fauna survey) would be required to verify the population size of this species within the study area. This investigation will be undertaken prior to any development of the high risk area of Transport Area B.

Careful management of vegetation clearing and development of a fauna relocation program could reduce the risk of impacts to any Mulgara resident on the site.

1. Introduction

LandCorp has commissioned GHD Pty Ltd (GHD) to complete a combined Preliminary Environmental Impact Assessment (PEIA) and Biological Survey for the proposed subdivision and development of Light Industry Area (LIA) 3,4, and 5, the General Industry/Transport Area Part A and Part B and the Port Hedland Port Authority land for a new access road. These areas are located approximately 10km south of Port Hedland. The study areas are shown in Figure 1, Appendix A.

LandCorp requires a biological survey of the study areas. The purpose of the survey is to provide an appropriate examination and description of the receiving environment to ensure that all aspects of biological/ecological significance are identified and recorded.

This combined PEIA and Biological Survey seeks to determine and assess the potential environmental impacts of the proposed works within the project area. Recommendations to LandCorp on the actions and requirements necessary for completion of this project with legislative guidelines are also provided.

1.1 Background

LandCorp is investigating opportunities to deliver further industrial land in Port Hedland to meet an increasing and demonstrated demand from the expanding mining, export, transport, construction and service industries.

The Draft Port Hedland Land Use Master Plan (LUMP) has identified the following Crown Land Areas to provide for industrial growth.

Proposed Light Industrial Area (LIA) Subdivisions are:

- LIA 2 (Infill) 8.1 ha at Iron Ore and Pinnacles Streets, Wedgefield
- LIA 3 (Infill) 10.4 ha at Pinga Street and Cajarina Roads, Wedgefield
- LIA 4 (Infill) 13.3 ha at Cajarina and Dalton Roads, Wedgefield
- LIA 5 (Broad acre) 58 ha bounded by Great Northern Highway, Wallwork Road And Goldsworthy Railway, Wedgefield

The above parcels are proposed to be subdivided into lots between 2000m^2 and 8000m^2 for light industrial development.

Proposed Transport Land Subdivisions are:

- Transport Area Part A - 101 ha between Wedgefield Industrial area and Great Northern Highway;
- Transport Area Part B - 170 ha adjacent to Transport Area Part A, between Wedgefield Industrial area and Great Northern Highway; and

The above transport areas are proposed to be subdivided into lots between 1.0 ha to 2.5 ha for general industry/transport use development. A new loop road is proposed on Port Hedland Port Authority land, part of Transport Area Part B.

This report focuses on the environmental aspects of LIA 3,4,5, the General Industry/Transport areas Part A and Part B and the Port Hedland Port Authority land for the new loop road. A separate report has been prepared for LIA 2.

1.2 Scope of the Report

This PEIA and Biological Survey has been prepared according to the scope of works requested by LandCorp and includes a desktop assessment, contaminated sites assessment and a field biological survey.

1.2.1 Desktop Assessment

The desktop assessment considered all biological constraints, which may be in, or adjoining the project area. This included, but was not limited to, an examination of the following matters:

- Adjoining land use
- Broad vegetation types
- Threatened Ecological Communities (TECs)
- Declared Rare and Priority flora
- Threatened or otherwise protected fauna
- Remnant Vegetation in relation to statutory requirements;
- Listed wetlands
- Public Drinking Water Source Areas (PDWSA)
- Other lists of significant areas

1.2.2 Contaminated Sites Assessment

The contaminated site assessment involved the following:

- Review of existing investigations and other data available made available by LandCorp;
- A search of historical title deeds to determine past owners of the site, and the likely associated site uses;
- A review, on a 10-year basis, of historical aerial photographs showing the site, to assist in establishing the patterns of site development over time;
- A review of any available historical site plans that may be provided to GHD that will help identify the nature and location of any potential contaminant sources at the site;
- A review of information made available to GHD, which documents historical spills, waste disposal, or other potentially contaminating activities at the site;
- A review of regional geology and hydrogeology, which will assist in determining the likely soil type and groundwater regime at the site, including a review of Department of Water Registered Bore Search to ascertain local hydrogeological conditions;

- A Department of Consumer and Employment Protection Dangerous Goods Licence Freedom of Information Search will be requested to ascertain whether underground storage tanks (USTs) are present at the property;
- A search of the Department of Environment and Conservation *Contaminated Sites Register* to ascertain whether the site or surrounding properties have been registered as potentially contaminated sites;
- Contact local planning authorities to determine whether potential environmental issues are likely to exist at the site.

1.2.3 Field Biological Survey

The field survey will seek to verify the desktop study and provide a detailed assessment of the existing environment in the project areas and its relationship to adjoining areas. The survey included the following:

Vegetation and Flora

- An inventory of the vascular plant species in the survey area;
- A review of, and search for, native plant species considered to be rare or potentially endangered. Locations of Declared Rare or Priority Flora will be accurately mapped at a suitable scale. Other species of interest, including those of limited distribution or outliers from their known range, will be discussed.
- An inventory of dominant exotic plants and also including declared noxious plants and environmental weed species;
- Advice on whether weeds are likely to spread to and result in environmental harm to adjacent areas of native vegetation that is in good or better condition;
- A description and location, including mapping, of plant communities.
- A rating of condition of the vegetation communities or areas using a published rating scale (Western Australian Government, 2000);
- A review of the local and regional significance of the plant communities in terms of their intrinsic value, extent, rarity and condition;
- An flora assessment with regards to EPA Guidance Statement No. 51;
- An assessment of the proposed clearing against the 10 clearing principles. Each principle shall be properly assessed in accordance with the Department of Environment and Conservation's (DEC's) Guideline to Assessment – Clearing of Native Vegetation.

Fauna

- An inventory of the vertebrate fauna species in the survey area. This does not require a trapping program but will require a targeted search and opportunistic recording of species;
- A review of the fauna species considered to be rare or in need of special protection;
- A review of the presence and abundance of pest, declared or feral animals;
- Habitats of significance and the risks to fauna from loss of the habitat.

Wetlands and Drainage

- A description of existing surface drainage patterns with respect to topography, and to flora and fauna communities;
- An inventory and brief description of any wetlands and their conservation value.

Contaminated Sites

- A brief examination of the area with regard to previous dumping, any surface aspects such as drum storage, obvious contamination.
- Photographs of any potential issues/areas of concern.

2. Desktop Investigation

2.1 Legal Identification

Table 1 Legal Identification

Site	Identification	
LIA 3	Street Address	No Street Address Information Available
	Description	Unallocated Crown Land
	Local Government Authority	Town of Port Hedland
	Ownership	State of Western Australia
LIA 4	Street Address	No Street Address Information Available
	Description	Unallocated Crown Land
	Local Government Authority	Town of Port Hedland
	Ownership	State of Western Australia
LIA 5	Street Address	No Street Address Information Available
	Description	Unallocated Crown Land
	Local Government Authority	Town of Port Hedland
	Ownership	State of Western Australia

2.2 Site Description

The layout and location of the sites is displayed in Figure 1, with site description provided in Table 2.

Table 2 Site Descriptions

Site	Identification
LIA3	The approximate 104,00m^2 and comprises of vegetation common to the Pilbara region. During the site visit no areas of particular interest (such as rubbish or earth disturbance) where noted at this site.
LIA4	The site is approximately 133,300m^2 and comprises of vegetation common to the Pilbara region. During the site visit no areas of particular interest (such as rubbish or extensive earth disturbance) where noted at this site. However the site does contain some cleared areas including vehicle tracks and 4 trenches (unknown use).
LIA5	The site is approximately 580,000m^2 and comprises of vegetation common to the Pilbara region. During the site visit no areas of particular interest (such as rubbish or extensive earth disturbance) where noted at this site. However the site does contain cleared areas including vehicle tracks, overhead power cable clearings and underground water pipes.
Transport	The site is approximately 1,010,000 m^2 and comprises native vegetation.

Site	Identification
Part A	No significant areas of previous disturbance were noted, apart from a small, fenced area which may have been a horse yard.
Transport Part B	The site is approximately 1,700,000 m^2 and comprises predominately of native vegetation. Disturbances to the site include a petrol station, roads and tracks and the existing Wedgefield Industrial area.

In general all the sites display similar levels of disturbance with previous indicators of human activity including cleared areas, roads and tracks, industrial development, petrol station and small amounts of dumped rubbish including old fuel/oil drums, concrete bonded fencing and small areas of pushed up earthen material.

2.3 Climate

The climate of the Pilbara region is arid (semi-desert) tropical with highly variable rainfall, which falls mainly in summer. Cyclonic activity is a significant aspect of the weather in the region.

The closest Bureau of Meteorology weather station to the study area is located at Port Hedland Airport. Recorded climatic data for this weather station is summarised below:

- Mean Daily Maximum Temperature: 27.1°C (July) – 36.8°C (March)
- Mean Daily Minimum Temperature: 12.2°C (July) – 25.5°C (Jan/Feb)
- Annual Rainfall: 313.5 mm
- Mean Annual Rain Days: 20.6 days

(Source: BOM, 2009)

2.4 Topography and Soils

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

The project areas are situated entirely on the coastal alluvium, with the surface soil being red silty sand. At the north eastern corner of the site, the soils become saline, probably as a result of periodic inflows from the coastal flood zone during high tide and storm surge events.

2.5 Hydrology and Hydrogeology

There are no surface freshwater flows within or adjacent to the study area.

The Department of Environment and Conservation (DEC) bore database search indicates that there are seven registered bores within a five kilometre radius. One bore was identified in the proposed Wedgefield Industrial Site in the north and another within one kilometre of LIA 5 in a southerly direction. This bore was stipulated in the DEC database as being used for livestock watering purposes.

No groundwater information is available for the sites.

2.6 Wetlands and Watercourses

No freshwater wetlands or watercourses occur on or adjacent to the project area.

A creekline, South Creek, flows from the south to the north approximately 200 m west of the western corner of the LIA 3. It is likely that runoff from the broader area enter this creek. The creek channel is also possibly inundated during high tide and storm surge events.

The northern boundary of the proposed Transport Part B area is within and adjacent to an area of semi- saline low lands (mudflats) which again, may be inundated during storm surge events. However, there is no wetland specific vegetation within proximity to the project sites. *(Note: further information on the risks of storm surge events and the water levels in the channel will be provided in the engineering report.)*

2.7 Public Drinking Water Source Areas

There are no Public Drinking Water Source Areas within the vicinity of the proposed study areas.

2.8 Acid Sulphate Soils

Acid sulphate soils (ASS) are mapped at Figure 2. The majority of the study areas are situated on an area believed to have no known risk of ASS to a depth of 3 m, however the northern most boundary of the proposed Industrial Site is considered to have a high to moderate ASS disturbance risk to a depth of 3 m.

2.9 Contaminated Sites

As identified from the Department of Environment and Conservation (DEC) Contaminated Sites Search there are no registered contaminated sites located within or adjacent to the study areas. One registered contaminated site was identified approximately 7 km to the north east of the study areas.

Site investigations undertaken by GHD employees did not identify any areas within the project area that would indicate contamination of areas LIA 3, 4 and 5 and Transport Area A. A range of drums, old building materials and general building waste was located as fill under the powerline running north through Port Authority land north of Transport Area B. The powerline fill may warrant more detailed investigation prior to development in the future.

The service station between Transport Areas A and B indicates a potential for hydrocarbon contamination in the water table below the area. This is only of concern if water is to be drawn from bores in the area or if the water table is breached during subdivision earthworks. As the land is relatively low-lying, it is unlikely that earthworks will occur much below natural ground level.

2.10 Surrounding Land Use

The land use surrounding the 3 proposed LIAs, Transport Area A and Transport Area B is described in Table 3.

Table 3 Surrounding Land Uses

Site	Identification
LIA3	The subject site is part of the larger Wedgefield Industrial Estate. Existing industrial / residential properties occur to the north, with both occupied and unoccupied lots existing in this area. South of the site is vacant land and contains vegetation and cleared areas similar to the site under investigation. To the west of the site the land is vacant, and the Wedgefield Industrial area industrial leading down to the tidal/ephemeral South Creek. East of the site is undeveloped land containing tracks and vehicle access paths, this area is predominately undisturbed.
LIA4	The subject site is part of the larger Wedgefield Industrial Estate. Existing industrial / residential properties occur to the north, with both occupied and unoccupied lots in this area. South of the site is the access road and railway to Finucane Island with vacant land beyond. The vacant land contains vegetation similar to the survey site. To the west the land is vacant land and leads down to the tidal/ephemeral South Creek. East of the site is the proposed LIA 3 area and undeveloped land containing tracks and vehicle access paths, this area is predominantly undisturbed.
LIA5	The subject site is part of the larger Wedgefield Industrial Estate. The vacant land of proposed LIA sites 3 and 4 exists immediately to the north with Wedgefield industrial area existing past this. Immediately south of the site is the access road and railway to Finucane Island, and vacant land with South Hedland existing past this. The South Hedland water storage tanks are in this location. To the west the land is vacant land and leads down to the tidal/ephemeral South Creek. The land east of the site vacant land containing tracks and vehicle access paths, this area is predominantly undisturbed bushland common to the area.
Transport Area A	Land to the north west and west is part of the existing Wedgefield Industrial Estate, and includes vacant land at LIA 3 and 5 across Pinga Road. Land to the south east is bordered by the Great Northern Highway, and beyond that unallocated crown land and the Port Hedland Cemetery. Immediately to the north-east is a service station and attached dwelling and an area proposed for General Industry (Transport Part B) which is currently unallocated crown land.
Transport Area B	Transport Area B is bordered by Transport Area A to the south. Land to the west is part of the existing Wedgefield Industrial Estate, with parts

Site	Identification
	of the proposed site already been cleared. Land to the east is bordered by the Great Northern Highway, and beyond that unallocated crown land and the Port Hedland Cemetery. A service station and attached dwelling exists within the south east corner of the site. Tidal flats and a motorcross tracks exists to the north.

2.11 Review of Aerial Photography

GHD has reviewed aerial photographs of the site from 1949 to 2004 to ascertain the development history of the site and land uses and practices that may lead to potential contaminating activities.

The photographs are reproduced in Appendix D and summaries of observations are provided in Table 4.

Table 4 Aerial Photograph Review

Photo Date	Description
19 June 1949	This photograph displays that no development has occurred within or nearby to the site.
13 September 1971	The LIA 5 area is clearly visible. LIA areas 3 and 4 still remain within a larger block of land with some clearing occurring adjacent to LIA 3.
04 August 1993	The proposed LIA areas are clearly visible. The aerial pictures display that activities are occurring within the sites, specifically the creation of tracks or boundary lines. Urban/residential development exists to the north of areas 3 and 4.
31 July 2004	The proposed LIA areas 3, 4, and 5 are clearly visible with no indication from the aerial pictures of development activities occurring within the designated areas. Urban/residential development surrounds the site. A petrol station exists between the Transport Use Areas, along the Great Northern Highway.

2.12 Certificate of Title Review

The ownership of the three LIA sites as identified from the Certificate of Titles for the sites is outlined in Table 5. The Certificate of Titles are provided in Appendix D.

Table 5 Certificate of Title Review

Site	Certificate of Title
LIA3	The Certificate of Title indicates that this land is Unallocated Crown land with the primary interest holder being the State of Western Australia.

Site	Certificate of Title
LIA4	Unallocated Crown Land – No Certificate of Title was available.
LIA5	The Certificate of Title indicates that this land is Unallocated Crown land with the primary interest holder being the State of Western Australia.

2.13 Aboriginal Heritage

The Aboriginal Site Register is held under Section 38 of the State *Aboriginal Heritage Act 1972.* It protects places and objects customarily used by, or traditional to, the original inhabitants of Australia.

Where an activity disturbs an Aboriginal site or object an application for permission to disturb those sites will need to be submitted under Section 18 of the *Aboriginal Heritage Act 1972.* Where an area of previously unknown Aboriginal heritage is to be disturbed, it is advised that a detailed anthropological and archeological heritage survey is undertaken to find if there any sites or objects of significance in that area, as it is an offence to disturb all Aboriginal Heritage sites even those not contained on the Aboriginal Heritage Site Register.

A search of the Department of Indigenous Affairs (DIA) Aboriginal Heritage Inquiry system in July 2009, indicated that, at that time, ten heritage sites were within 500m of the study area, these are shown in Table 6.

Table 6 Aboriginal heritage sites within the study area

Site ID	Site Name	Site Type
23612	Fmg Par 06-09	Midden / Scatter
23609	Fmg Par 06-06	Midden / Scatter
23605	Fmg Par 06-02	Midden / Scatter
23606	Fmg Par 06-03	Midden / Scatter
23611	Fmg Par 06-08	Midden / Scatter
23548	Fmg Par 06-01 (Shell Midden Scatter)	Engraving
25005	WN 07 - 13	Midden / Scatter
24995	WN 07 - 03	Midden / Scatter
26699	Lan 08 - 02	Midden / Scatter
26700	Lan 08 - 03	Midden / Scatter
26701	Lan 08 - 04	Midden / Scatter

Four of these heritage sites are recorded within the study areas. These are shown in Figure 2, Appendix A.

To confirm the occurrence and significance of sites within the study, a detailed Aboriginal heritage survey was undertaken in November 2008 by Anthropos Australis (March, 2009). This

survey and consultation considered the shell midden sites within Transport Area B and made recommendations as to the extent of Site IS 22874, which also impacts Transport Area B.

2.14 Native Title

The Port Hedland area is subject to one Native Title application, that being WC 99/3 for the Kariyarra people. Consultation over the use of Crown Land must be held with representatives of this group prior to development.

2.15 Environmentally Sensitive Areas

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

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

2.16 Reserves and Conservation Areas

There are no conservation reserves managed by the Department of Environment and Conservation within or immediately adjacent to the study areas.

2.17 Vegetation

2.17.1 Vegetation Description

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

Remnant native vegetation mapped for the project area can be assessed using recently acquired data from the Western Australian Department of Agriculture (Shepherd, 2002; 2005), based on vegetation association mapping undertaken by Beard (1971). The major vegetation association occurring within the study areas is "Hummock grasslands, dwarf-shrub steppe; *Acacia translucens* (now *A. stellaticeps*) over soft spinifex". The vegetation association within the northern boundary of proposed Industrial site is described as "Bare areas; mud flats".

2.17.2 Vegetation Extent and Status

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

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

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

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

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

Native vegetation types represented in the survey areas; their regional extent and reservation status are drawn from Shepherd, *et al.* (2002), and Shepherd pers. comm. (2005). These are shown in Table 7.

Table 7 Major Vegetation System Associations within the Study Area (after Shepherd, 2002).

Vegetation Association Number	Association Description	Pre-European Extent (ha) in Roebourne IBRA subregion	Current Extent (ha) in Roebourne IBRA subregion	% Remaining	% Pre-European Extent in Conservation Reserves
647	Hummock grasslands, dwarf-shrub steppe; Acacia translucens over soft spinifex	189414	189414	100	0
127	Bare areas; mud flats	179917	177262	98.5	0

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

2.17.3 Threatened Ecological Communities

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

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

Possible TECs that do not meet survey criteria are added to the Department of Environment and Conservation's (DEC) Priority Ecological Community (PEC) Lists under Priorities 1, 2 and 3. These are ecological communities that are adequately known; are rare but not threatened, or meet criteria for Near Threatened. PECs that have been recently removed from the threatened list are placed in Priority 4. These ecological communities require regular monitoring. Conservation Dependent ecological communities are placed in Priority 5.

The Department of Environment and Conservation's (DEC's) Threatened Ecological Community (TEC) database was queried for known occurrences of TECs and PECs near the study area. No TECs or PECs have been recorded within or in the vicinity of the study areas.

2.18 Flora

2.18.1 Significant Flora

Commonwealth

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

A description of Conservation Categories delineated under the *EPBC Act* is detailed in Table 11, Appendix B. These are applicable to threatened flora and fauna species.

A search of the *EPBC Act* Protected Matters Search Tool did not identify any Commonwealth protected flora species within 20 km of the survey area.

State

In addition to the *EPBC Act,* significant flora in Western Australia is protected by the *Wildlife Conservation Act 1950*. This *Act*, which is administered by the DEC, protects Declared Rare Flora (DRF) species. The DEC also maintains a list of Priority Listed Flora (PLF) species. Conservation codes for flora species are assigned by the DEC to define the level of conservation significance. PLF are not currently protected under the *Wildlife Conservation Act 1950*. PLF may be rare or threatened, but cannot be considered for declaration as rare flora until adequate surveys have been undertaken of known sites and the degree of threat to these populations clarified. Special consideration is often given to sites that contain PLF, despite them not having formal legislatory protection. A description of the DEC's Conservation Codes that relate to flora species is provided in Table 12, Appendix B.

A search of the DEC's Rare Flora Databases and the Western Australian Herbarium (WAHERB) records was undertaken. Significant flora species recorded in these databases for the general Port Hedland area are outlined databases are outlined in Table 8.

Table 8 Significant flora previously recorded in the Port Hedland area from records of the DEC and WAHERB

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

Family	Genus	Species	Details and Habitat	DEC Conservation Code
Papilionaceae	*Crotalaria*	*spectabilis* subsp. *spectabilis*	Annual herb, ca 2 m high. Flowers yellow.	P1
Papilionaceae	*Tephrosia*	*andrewii*	Ascending, multistemmed shrub, to 0.8 m high. Flowers orange, Apr/Oct. Preferred habitat sand in pindan country.	P1
Papilionaceae	*Tephrosia*	*rosea* var. *venulosa*	Erect shrub, to 1.7 m high. Flowers re, purple, Aug-Sep. Preferred habitat in red sand near creeks.	P1

None of these species has been previously recorded either within or closely adjacent to the study areas. The two large shrub species, *Acacia glaucocaesia* and *Gymnanthera cunninghamii*, are unlikely to have been overlooked during the survey, as there were very few tall shrubs in the study areas. Other species, such as *Gomphrena pusilla, Bulbostylis burbidgeae* and *Euphorbia clementii,* are known to grow on soil types that were not present in the area, so are unlikely to be present.

2.19 Fauna

2.19.1 Fauna Previously Recorded

The Western Australian Museum *NatureMap* online search was conducted for a 20 km buffer of the study areas. The search identifies terrestrial vertebrate species recorded in the collections of the Western Australian Museum and the Department of Environment and Conservation (DEC) records. The search identified the potential presence of twenty-four bird, fifty-nine reptile, seven amphibians and seventeen mammal species.

A full list of species recorded from the WA Museum database is presented in Table 16, Appendix C.

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

2.19.2 Significant Fauna Species

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

The significance levels for fauna used in the *EPBC Act* are those recommended by the International Union for the Conservation of Nature and Natural Resources (IUCN). A description of Conservation Categories delineated under the *EPBC Act* is detailed in Table 11, Appendix B and the circumstances under which a project will trigger referral to the DEWHA are described in Appendix C. The *WA Wildlife Conservation Act 1950* uses a set of Schedules but also classifies species using some of the IUCN categories. These Schedules are described in Table 14, Appendix C. The *EPBC Act* also protects migratory species that are listed under the following International Agreements:

- Appendices to the Bonn Convention (Convention on the Conservation of Migratory Species of Wild Animals) for which Australia is a Range State under the Convention;
- The Agreement between the Government of Australia and the Government of the Peoples Republic of China for the Protection of Migratory Birds and their Environment (CAMBA);
- The Agreement between the Government of Japan and the Government of Australia for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment (JAMBA); and
- The Agreement between the Government of Australia and the Government of the Republic of Korea on the Protection of Migratory Birds (ROKAMBA).

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

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

In Western Australia, the DEC also produces a supplementary list of Priority Fauna, these being species that are not considered Threatened under the Western Australian *Wildlife Conservation Act 1950* but for which the Department feels there is a cause for concern. These species have no special legislatory protection, but their presence would normally be considered. Such taxa need further survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna. Levels of Priority are described in Table 15, Appendix C.

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

From the DEC and DEWHA databases and the records of the Western Australian Museum (WAM), a number of protected fauna species were identified as potentially occurring within the survey area, which are listed in Table 17, Appendix C.

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

More detail on the likely presence of threatened species in the study areas is provided in Section 3.4 below.

3. Field Assessment

3.1 Field Survey Methodology

The field survey of LIA 3, 4, and 5 and the General Industry/Transport Part A sites was undertaken by GHD on June 23rd 2008 by Anna Napier, an experienced ecologist and Lisa Marwick, an environmental scientist.

An additional flora and fauna survey was conducted on the 11th June 2009 of the General Industry/Transport Area Part B and the Port Hedland Port Authority land for the new loop road. This was undertaken by Georgina Nielssen, an experienced ecologist and Erin D'Raine, an environmental scientist.

3.1.1 Flora and Vegetation Assessment

The field assessments included a Level 2 Flora survey (as per EPA Guideline 51) which included:

- Surveying of 50m x 50m quadrats, within representative vegetation types;
- Surveying along targeted and random transects throughout the sites;
- Development of a full flora list;
- Assessment of the vegetation condition and any threatening processes;

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

Where identification of flora species was uncertain, confirmation was made at the Western Australian State Herbarium.

3.1.2 Fauna Assessment

GHD's qualified ecologists conducted the fauna investigation in conjunction with the flora investigation. The Level 1 fauna survey included desktop investigations and field surveys, conducted with regard to the EPA's Guidance Statement No. 56, where possible.

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

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

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

3.1.3 Nomenclature

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

3.1.4 Limitations

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

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

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

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

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

3.2 Flora

A total of 123 species of plants was recorded within the combined study areas. Of these, three were introduced weed species and three were planted.

The study areas contain moderate species diversity, due partly to the limited range of habitats (i.e. the area was all flat, near coastal, mostly red sand plain) and also to the size of the survey area. Spinifex (*Triodia*) species dominate the vegetation, with a range of small shrubs and herbs also being present. The most diversity was observed in disturbed areas such as road edges, where grading has disturbed the soil and extra water runoff had produced conditions more suitable for herbaceous species to occur.

It is likely that these species are present over much of the area but are currently dormant (in seed form) and will only appear following a disturbance such as fire and after good rains.

The dominant families are:

- Poaceae (grasses) 20 species
- Papilionaceae (peas) 17 species
- Amaranthaceae (mulla-mullas) 10 species
- Mimosaceae (wattles) 10 species
- Convolvulaceae (morning glorys) 8 species

Well represented genera were: *Acacia* (wattles), *Ptilotus* (mulla mullas) and *Eragrostis* (grasses).

A complete list of the flora is provided at Table 13, Appendix B.

No Declared Rare or Priority flora species were identified during the survey.

3.3 Vegetation

3.3.1 Vegetation Type

The vegetation is almost completely uniform across the survey areas, with minor changes due to differing dominance of individual grass/Spinifex species, and also to historical disturbance. The northern-most part of the Transport Use Area (Lot B) consists predominately of bare areas with some vegetation associated with tidal/mud flats and contains a mixture of chenopod and saline-adapted species.

Four vegetation types were recorded within the study areas. The vegetation types match the descriptions by Beard (1971) and Kendrick and Stanley (2001) and are described as follows:

1. Low shrubland of *Acacia stellaticeps* over mixed tussock grassland of *Triodia epactia* and *T. schinzii* over very open herbs

This vegetation supports a small range of herbaceous and trailing plants, primarily: *Hybanthus aurantiacus, Eragrostis cumingii, Eragrostis eriopoda, Corchorus walcottii, Bonamia erecta, Cassytha* and the introduced Buffel grass (*Cenchrus ciliaris*).

Occasional patches of taller Acacia species occur, primarily in disturbed areas. The Acacia species include: *Acacia trachycarpa, A. colei, A. ampliceps, A. bivenosa and A. sericophylla*.

2. Bare Areas/Tidal Flats with low scattered shrubs of Chenopod spp.

This area consists of tidal soils with predominately bare, open ground with occasional patches of very scattered low shrublands of Chenopod spp., Mangrove spp., Trianthema spp. with scattered grasses including *Sorghum timorense, Eragrostis falcata, Panicum decompositum* and introduced Buffel Grass (*Cenchrus ciliaris*).

3. Tussock grassland of *Triodia secunda, Triodia schinzii*, and *Sorghum timorense* over scattered herbs and Chenopod spp.

This vegetation occurs along the fringes of the tidal flats/drainage areas in the northern half of Transport Area Part B. This vegetation type supports a small range of herbaceous and Chenopod species including *Commelina ensifolia, Desmodium filiforme, Frankenia ambita, Trianthema* spp., *Tecticornia* spp., and *Salsola tragus.*

4. Cleared/Disturbed Areas

Heavily disturbed / predominantly cleared areas, with occasional planted species and some disturbance opportunists such as **Cenchrus ciliaris* present

Details of the quadrats representing these vegetation types are provided in Appendix B. The vegetation types have been mapped in Figure 3, Appendix A.

3.3.2 Vegetation Condition

Developed for Bush Forever, the vegetation Condition Rating is a scale that recognises the intactness of vegetation, which is defined by the following (Government of WA, 2000):

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

The scale therefore consists of six (6) rating levels as outlined below in Table 9.

Table 9 Bush Forever (Government of WA, 2000) vegetation condition rating scale.

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

The vegetation within the study areas is generally in *Excellent* condition, with small parts having a rating of *Good* to *Completely Degraded* due to clearing and other disturbances. Signs of disturbances across the study areas included old tracks, powerlines, petrol station and an existing industrial area.

There are few weeds species present across the area, with the most common, Buffel Grass, occurring primarily along the edges of tracks and roads and in other disturbed areas.

Vegetation condition is mapped in Figure 4, Appendix A.

3.3.3 Threatened Ecological Communities

No TECs or PECs were identified as occurring on the site during the field survey.

3.4 Fauna

3.4.1 Observed Fauna

A total of twenty bird, four mammal and three reptile species were recorded during the reconnaissance survey of the study areas. These species are listed in Table 18, Appendix C.

This survey only provides a brief snapshot of those species present at the time of sampling (daytime), in one season, over two years (2008 and 2009 surveys). Not all potentially occurring species would be recorded during a single survey due to spatial and temporal variations in fauna population numbers.

A number of tracks (mostly from reptiles) were observed on sand tracks within the LIA sites however, none of these were positively identified.

In addition, a number of fauna burrows were observed. These were present across all sites during both field surveys (Plates 2 and 3 below).

Plate 2 Burrow, LIA 3 (2008)

Plate 3 Burrow, LIA 5 (2008)

Significant Fauna Species

Brush-tailed Mulgara (*Dasycercus blythi*) Priority 4 (Wildlife Conservation Act)

Brush-tailed Mulgara (*Dasycercus cristicauda)* Schedule 1 (Wildlife Conservation Act, Vulnerable, EPBC Act*)*

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

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

The Schedule 1 species, Mulgara (*Dasycercus cristicauda*) has previously been recorded in surveys of the Fortescue Metals Group land, west of Wedgefield (FMG, pers. comm.). In addition, Mulgara were recently trapped during a Level 2 fauna survey conducted by GHD in the surrounding Wedgefield area.

Burrows recorded during the 2008 survey may have been indicative of this species. A range of photos of the burrows was sent in 2008 to Dr Peter Kendrick at the DEC in Karratha for any advice on their potential occupants. On the verbal evidence of GHD, and the photos, Dr Kendrick was of the opinion that the burrows looked unused and that although some looked like potential Mulgara burrows they were now more likely to be used by lizards (P. Kendrick pers. comm. Aug 2008).

During the 2009 survey of the Transport Area Part B study area, evidence of the Mulgara species, including scats, tracks and diggings, was recorded (locations shown in Figure 2). Most of the survey area is suitable Mulgara habitat but recent use of the area by Mulgara has only been indicated in Transport Area B.

3.4.2 Potential for Other Significant Fauna Species

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

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

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

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

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

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

Habitat Assessment: The study areas are within the range of this species but do not contain suitable habitat as there are no trees for shelter. Additionally, the proximity to dogs and cats would likely preclude the use of the site by this animal.

Bilby (Macrotis lagotis) Schedule 1, Vulnerable

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

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

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

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

Habitat Assessment: The study area is outside the current range of the Banded Hare-wallaby. Given that the mainland populations of this species are thought to be extinct, it is unlikely to occur within the study areas.

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

The Pilbara Leaf-nosed Bat roosts in deep caves or mines in the wet season and forages nearby. This species occurs in the Pilbara region of WA where its populations are scattered and localised. There are a few known populations of this species in the western Pilbara, roosting in caves formed in gorges that dissect massive siliceous

sedimentary geology. It is most often observed in flight over waterholes in gorges, but appears to be rare even in the Hamersley Range where this habitat is common (Van Dyck and Strahan, 2008). Optimal roosts are thought to occur in caves that form between ascending rock layers, where humidity is maintained from seeping groundwater (Van Dyck and Strahan, 2008).

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

Woma (*Aspidites ramsayi*) Schedule 4

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

Habitat Assessment: Suitable habitat for the Woma Python occurs within the study area. This species may occur within or in the vicinity of the study areas.

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

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

Habitat Assessment: There are no suitable roosting areas for this species within the study area. The study area is considered not to contain significant habitat for this species however it may utilise the area for foraging.

Australian Bustard (*Ardeotis australis*) Priority 4

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

Habitat Assessment: This species may occur within the study areas as it contains potential habitat and has been recorded utilising the nearby Boodarie area. However, due to the likely prevalence of cats and dogs in the vicinity it is highly unlikely that the Australian Bustard would utilise the area. In addition, this species is widespread and the study area is not considered to contain significant habitat for this species. Impacts associated with the proposed activities are unlikely to have a significant impact on this species.

Eastern Curlew (*Numenius madagascariensis*) Priority 4

The Eastern Curlew is a large, migratory wader. It is widespread in coastal regions in the northeast and south of Australia and is rarely seen inland. This species is found on

intertidal mudflats and sandflats, often with seagrass, on sheltered coasts, especially estuaries, mangrove swamps, bays, harbours and lagoons (Australian Museum, 2008)

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

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

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

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

Migratory species

Two migratory species were observed over the study areas, the Black-shouldered Kite and Black Kite. Two marine species were observed over the study areas', including the Black-faced Cuckoo-Shrike and Nankeen Kestrel and one species recognised as Marine and Migratory, the Rainbow Beet-eater, was also recorded. Most of these species were observed flying over the study area; however the Rainbow Bee-eater was observed utilising the area for feeding. No existing breeding areas for the Rainbow Bee-eater were observed during the field surveys. The study areas are not deemed critical habitat to the above species for survival.

In addition to those species recorded during the field survey, a number of species included in the list of significant fauna species that could potentially occur in the study area were migratory terrestrial, marine and wetland species. There is the potential for these bird species, such as the White-bellied Sea-Eagle, to occur occasionally within the study area. However most of these species require wetlands where they feed (Oriental Plover, Oriental Dotterel, Egrets, Little Curlew) or trees, cliffs or embankments where they roost or breed (White Bellied Sea eagle and Southern Giant Petrel). It is not considered that the study areas provide any suitable feeding or breeding habitat for migratory species.

Other Species

In addition to the above species, the DEC and *EPBC Act* Protected Matters Search also recorded a number of marine mammals, shark species, ray-finned fishes and marine reptiles, listed under the *Wildlife Conservation Act 1950* and/or the *EPBC Act 1999*, to occur within the search area. The study area is located in close proximity to

the coastline and therefore the marine environment was included in the 20 km buffer area. Given that this is a terrestrial ecological survey and the proposed projects will not impact on the marine environment, these species have not been considered in this report.

3.4.3 Introduced Fauna

Evidence of two introduced species were recorded during the field surveys, including the Feral Cat and Dog (domestic/wild).

3.4.4 Fauna Habitat

The field fauna assessment covered two main fauna habitat types, including:

- Low open shrubland over tussock grasslands; and
- Tidal mud flats/Chenopod shrubland.

The study area was dominated by low open shrubland over tussock grasslands which were found to provide ideal fauna habitat, particularly for reptiles and small mammals.

Evidence of the Mulgara species (scats, burrows and prints) was found within the vegetation type described as 'Low shrubland of *Acacia stellaticeps* over mixed tussock grassland of *Triodia epactia* and *T. schinzii* over very open herbs.' The location of Mulgara evidence is in the north of the development site, in Transport Area B. Most of this area will be not developed for some 8 to 10 years.

Within the northern half of the proposed transport use area, tidal mudflats are present that support numerous bird and potentially fiddler crab species.

Habitat Value

The majority of the study areas were considered to contain native vegetation in excellent condition, offering suitable habitat for native fauna. The low open shrubland over tussock grasslands of the study area is considered to be potentially good Mulgara habitat. However, this vegetation type covers some 189,000 ha in the near-coastal Pilbara, as indicated by the Shepherd *et al.* data provided in Section 2.17.2.

Native vegetation, including the vegetation types found within the study areas (including the Mulgara habitat) is found outside the survey areas in the surrounding area and is of similar condition to that of the survey area.

Clearing for tracks, roads, petrol station, motocross track and other infrastructure that have occurred within and adjacent to the study areas have reduced the habitat value within some sections of the study areas.

Habitat Linkages

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

Fragmentation of habitat limits the resources available to species, particularly sedentary species, which means they may be more vulnerable to natural disasters or

habitat changes over time. Fragmentation of habitat can also lead to edge effects, leading to degradation of the habitat. Where the distance between habitat fragments is small, species may still be able to move between these habitat areas, but may be more exposed to predation pressures in the cleared areas.

Clearing of the native vegetation remaining within the study area could cause breaks to habitat linkages for the Mulgara population within and outside the survey areas. Fragmentation of this habitat may restrict the species from accessing temporary refugia and other members of the population, which may in turn lead to a local decline of these species. It could also result in direct mortality to the species during clearing.

4. Clearing of Native Vegetation

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

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

This project has been assessed to "*may be at variance*" to Principle (b) and not at variance or not likely to be at variance with any of the other 9 Clearing Principles.

The project may be at variance to Principle (b) due to the potential presence of the Mulgara species, which is classified as Vulnerable and Schedule 1, in the study areas.

Table 10 Assessment against the Ten Clearing Principles

Principle Number	Principle	Assessment	Outcome
(a)	Native vegetation should not be cleared if it comprises a high level of biological diversity.	The study area is not considered to be of higher biodiversity than the surrounding areas, and the proposed clearing is unlikely to have any significant impact on the biodiversity of the region.	The proposal is unlikely to be at variance with the Principle.
(b)	Native vegetation should not be cleared if it comprises the whole or part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous Western Australia.	The project areas are likely to support a number of reptile, bird and mammal species. The 2008 survey of the LIAs and Transport Area A sites appeared to have supported small mammals but burrows seemed to be unused. However during the 2009 survey of the Transport Area B, evidence of the Mulgara species, including scats, tracks and diggings, was recorded. Mulgara are a conservation significant fauna that are known to occur within the Port Hedland and Wedgefield area. *Dasycercus cristicauda* (Mulgara) has recently been recorded by GHD in the nearby Wedgefield area. Due to the proximity of the sites to human populations and the presence of feral cats and dogs, the Mulgara may no longer occur in much of the study area. A detailed fauna survey would be required to verify the population of this species within the study area.	The proposal may be at variance with the Principle.
(c)	Native vegetation should not be cleared if it includes, or is necessary for the continued existence of, rare flora.	No Declared Rare flora species are known from the general area. Some Priority species could potentially be present but none were recorded during the field survey.	The proposal is unlikely to be at variance with the Principle.

Principle Number	Principle	Assessment	Outcome
(d)	Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of, a threatened ecological community.	No TECs are known to occur within or adjacent to the study area.	The proposal is unlikely to be at variance with the Principle.
(e)	Native vegetation should not be cleared if it is significant as a remnant of native vegetation in an area that has been extensively cleared.	The extent and status of vegetation identified for the study area (Beard, 1973; Shepherd pers. comm., 2005) has indicated that the vegetation association, Hummock grasslands, dwarf-shrub steppe; *Acacia translucens* (now *A. stellaticeps*) over soft spinifex has 100% remaining and is classed Least Concern.	The proposal is unlikely to be at variance with the Principle.
(f)	Native vegetation should not be cleared if it is growing in or in association with a watercourse or wetland.	There are no wetlands or permanent watercourses within the study area.	The proposal is not at variance with the Principle.
(g)	Native vegetation should not be cleared if the clearing of the vegetation is likely to cause appreciable land degradation.	Clearing of the land is unlikely to cause appreciable degradation to adjoining land. Clearing will create runoff to constructed drainage systems which will eventually flow into the saline coastal tidal zones during heavy rainfall events. The major weed of the area, Buffel grass, is widespread on adjacent tracks and disturbed areas. Clearing may create further weed spread. These potential impacts can be mitigated by use of appropriate management plans.	The proposal is not likely to be at variance with the Principle.

Principle Number	Principle	Assessment	Outcome
(h)	Native vegetation should not be cleared if the clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area.	There are no conservation areas within or in the vicinity of the study areas.	The proposal is not at variance with the Principle
(i)	Native vegetation should not be cleared if the clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water.	Clearing will create runoff to constructed drainage systems which will eventually flow into the saline coastal tidal zones during heavy rainfall events. This may create additional sedimentation for short periods but is unlikely to cause deterioration of surface water overall.	The proposal is unlikely to be at variance with the Principle
(i)	Native vegetation should not be cleared if the clearing of the vegetation is likely to cause, or exacerbate, the intensity of flooding.	Runoff from the study areas will be directed into constructed drainage and then to South Creek and the coastal tidal zone. A potential flood analysis is being undertaken.	The proposal is unlikely to be at variance with the Principle.

5. Impacts and Management

5.1 Actual and Potential Environmental Impacts

The proposed development of LIAs 3, 4 and 5, Transport Area Part A and Part B and the Port Hedland Port Authority land will have a range of impacts on the environment.

Biological Impacts

- Clearing of native vegetation in good to excellent condition as follows:
  - LIA 3: 10.4 ha
  - LIA 4: 13.3 ha
  - LIA 5: 58 ha
  - Transport Part A: 101 ha.
  - Transport Part B: 170 ha
- The vegetation of the area is well represented in the Pilbara region, with approximately 196,372.2 ha remaining undisturbed.
- Clearing of fauna habitat as above. The areas are likely to support a range of reptile and small mammal species which will be killed or displaced as a result of vegetation clearing and land disturbance. Although none was observed during the survey, evidence of the Mulgara species (Vulnerable, Schedule 1) was recorded within Transport Area Part B. A detailed (Level 2) fauna survey would be required to verify the population size of this species within the study area of Transport Area Part B. Clearing of Mulgara habitat may have a significant impact on the population of this mammal species in the Port Hedland area, dependent on the outcomes of a detailed survey. Transport Area Part B will not be developed for at least 10-15 years. It is the last of the areas proposed for development as part of this project.
- Clearing within potential Mulgara habitat may cause breaks to habitat linkages within the Mulgara population.
- Post-development impacts on adjacent bushland. The operation of new industrial lots will have potential impacts on bushland remaining in the area. The impacts will primarily be on fauna and issues could include:
  - Light overspill;
  - Litter;
  - Noise and vibration disturbance;
  - Dust production;
  - Increased predators; and
  - Increased traffic.

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

- Changes to natural drainage from clearing may impact on the vegetation types and fauna in the area.

Physical and Social Impacts

- Alteration to surface drainage. As a result of vegetation clearing and the development of building and hard stands, there will be a reduction in infiltration to the ground and an increase in runoff from the sites. This runoff will be collected in drainage systems and most likely transferred to South Creek.
- Nuisance impacts such as dust or pollutant production and noise and vibration will occur during the construction phases of the subdivision and during development of individual lots. Given the industrial location, it is likely that noise and vibration will not be a significant issue, however some caretaker residences and transient workforce accommodation are present within the existing Wedgefield area. LandCorp has considered the potential noise risks to the existing transient workforce accommodation and has developed the following mitigation:
  - Changes to the estate layout;
  - a sale strategy;
  - design guidelines; and
  - planning controls.

  This mitigation is detailed in a letter to the DEC of September 2009 which is attached at Appendix E.
- Additional traffic will be generated as a result of new businesses. This will create impacts of noise, safety and possible delays, especially as a result of large turning movements.
- The addition of industrial lots closer to Great Northern Highway will have the potential to create a less desirable visual impact for tourists and travellers. Due to the nature of industrial lots and the likelihood of storage of equipment outside, such areas can be messy and unsightly. Some screening may be required to GNH.

5.2 Possible Impact Management Actions

Some of the actual and potential impacts of the development of the LIA and Transport landuses will be manageable through design, construction controls and by-laws. Other impacts cannot be easily mitigated.

Biological Impact Management

Clearing of native vegetation cannot be mitigated in the immediate area. The loss of vegetation is not considered significant regionally, but will have an impact visually and on native fauna.

Suggested management actions are as follows:

- Ensure lot design provides for retention of 'nature strips', particularly bordering Great Northern Highway;

- Minimise clearing adjacent to the development during construction phases;
- Ensure cleared bushland and topsoil is removed from site or used in rehabilitation of any adjacent disturbed areas (i.e. not retained in mounds or windrows);
- During major clearing, allow any existing fauna to move off-site, if possible, and discourage or prohibit the presence of dogs. This can be achieved with the following actions:
  - clear vegetation from disturbed areas towards undisturbed (or outward from already developed areas);
  - use experienced fauna clearance personnel to spot and catch Mulgara which may be disturbed and which are moving away from clearing machinery; and
  - develop a relocation program.
- Mulgara are not readily trapped and avoidance of active burrows is recommended over relocation. Where avoidance of active burrows is not possible, trapping and relocation to nearby similar vegetation immediately prior to clearing is recommended. Trapping and relocation works are to be done by suitable qualified and experienced fauna consultants only, and in consultation with the DEC.

Physical and Social Impact Management

- Ensure drainage design reduces the risk of scour and sedimentation into South creek;
- Provide planning guidelines with regard to developing new caretaker residences in the development areas and with regard to noise impact on existing caretaker residences and transient workforce accommodation;
- Follow Council by-laws with regard to construction noise and dust, and DEC Guidelines where appropriate;
- Consider traffic flows during design and develop a traffic management plan for the initial construction phase; and
- Provide lot development guidelines for setbacks, verges and fencing. Provide screening design along Great Northern Highway.

6. Environmental Approvals

6.1 Referral to the Department of Environment, Water, Heritage and the Arts (DEWHA)

Referral to the Commonwealth Department of the Environment, Water, Heritage and the Arts under the *Environment Protection and Biodiversity Conservation Act 1999* (the *EPBC Act*) is triggered by seven major issues. These are:

- World Heritage properties;
- National Heritage places (from 1 January 2004);
- Ramsar wetlands of international significance;
- Nationally listed threatened species and ecological communities;
- Listed migratory species;
- Commonwealth marine areas; and
- Nuclear actions (including uranium mining).

The *EPBC Act* is also triggered if a proposal is likely to have a significant environmental impact on Commonwealth Land.

Initial fauna surveys have indicated evidence for the presence of Mulgara, listed as Vulnerable under the EPBC Act, within parts of Transport Area B. Given the likely presence of this species within the northern part of the study area, the project may require referral to the DEWHA for assessment under the EPBC Act.

Further detailed fauna investigations (Level 2 fauna survey) would be required to verify the population size of this species within the study area. This investigation will be undertaken prior to any development of the high risk area of Transport Area B.

6.2 Referral to the Environmental Protection Authority (EPA)

Projects may require referral to the EPA under Part IV of the *Environmental Protection Act, 1986*, if the project will have significant impacts on any of the following matters:

- Native remnant vegetation;
- Rare flora and fauna species and threatened communities;
- Wetlands;
- Watercourses and rivers;
- Estuaries and inlets;
- Coastlines and near shore marine areas;
- Catchments with special requirements;
- Contaminated soils;
- Noise and vibration;

- Public Drinking Water Source Areas - groundwater and surface water;
- Aboriginal heritage;
- European cultural heritage; or
- Adjacent land uses.

Matters relating to this proposal which could require referral under this Act include:

- Impacts on threatened fauna.

Mulgara are listed as a Schedule 1 species under the *Wildlife Conservation Act 1950*. The clearing and proposed development of the study areas could cause breaks to habitat linkages for the Mulgara population within and outside the survey area.

Further detailed fauna investigations (Level 2 fauna survey) are recommended to verify the population size of this species prior to any development in Transport Area B.

Formal assessment of the project would preclude the requirement to obtain a separate Clearing Permit. Clearing Permits are required under the *Environmental Protection Act (Clearing of Native Vegetation Regulations) 2004* for any loss of native vegetation. However, if the project is formally assessed, the provisions for a clearing permit would be considered as part of that assessment.

The DEWHA has signed a Bilateral Agreement with the DEC. This agreement gives the DEC the power to assess some projects which would otherwise be assessed by the DEWHA. Projects which trigger the *EPBC Act* must still be referred under that *Act* but there will not be a duplication of assessment at both a State and Federal level.

7. References

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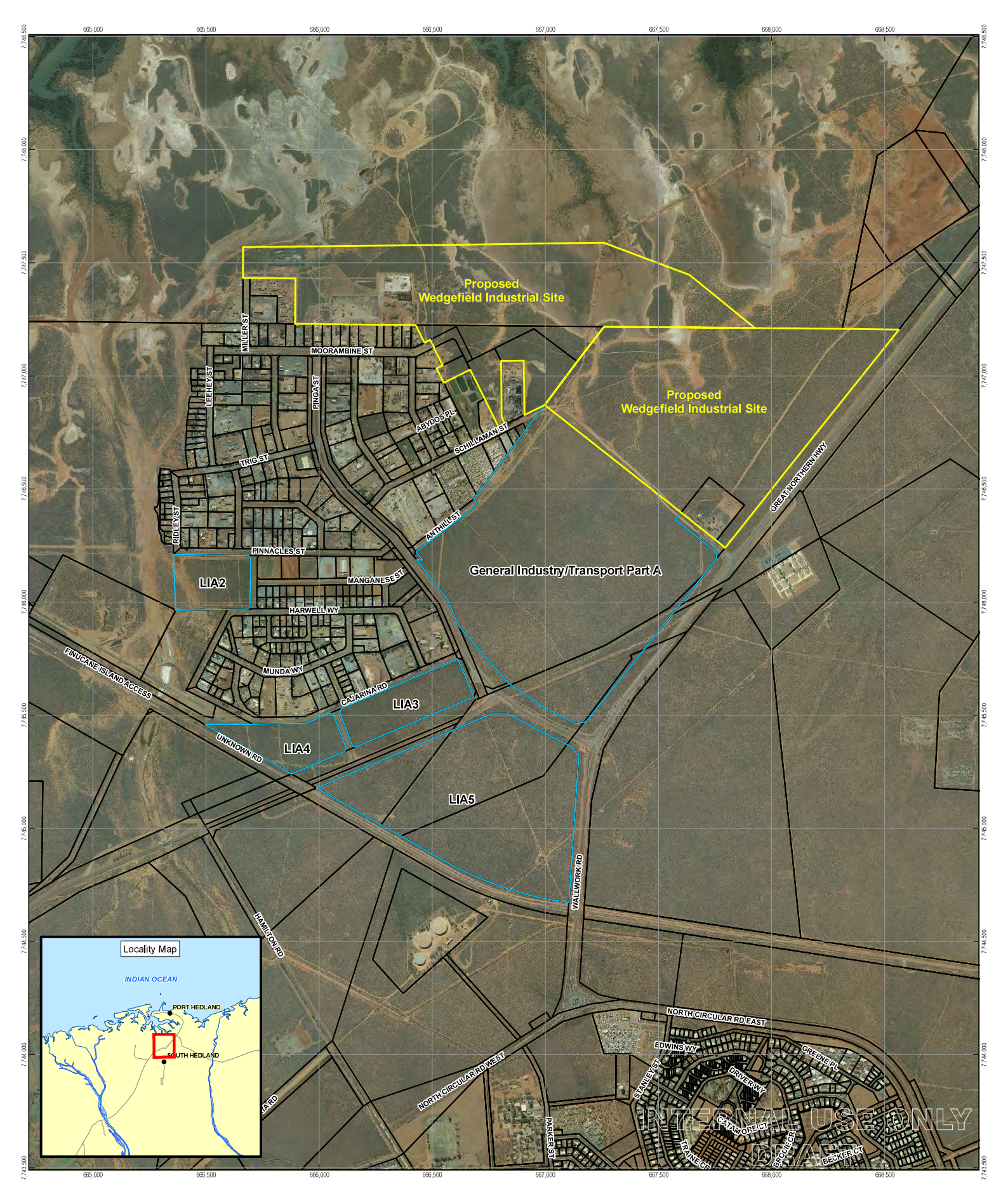
Appendix A

Figures



LEGEND

- Proposed Wedgefield Industrial Site
- Areas of Interest
- Cadastre

1:15,000 (at A3)

0 75 150 300 450 600 750

Metres

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

N

CLIENTS | PEOPLE | PERFORMANCE

Landcorp
LECP - Port Hedland Industrial Land PEIA

Job Number 61-22635
Revision A
Date 20 JUL 2009

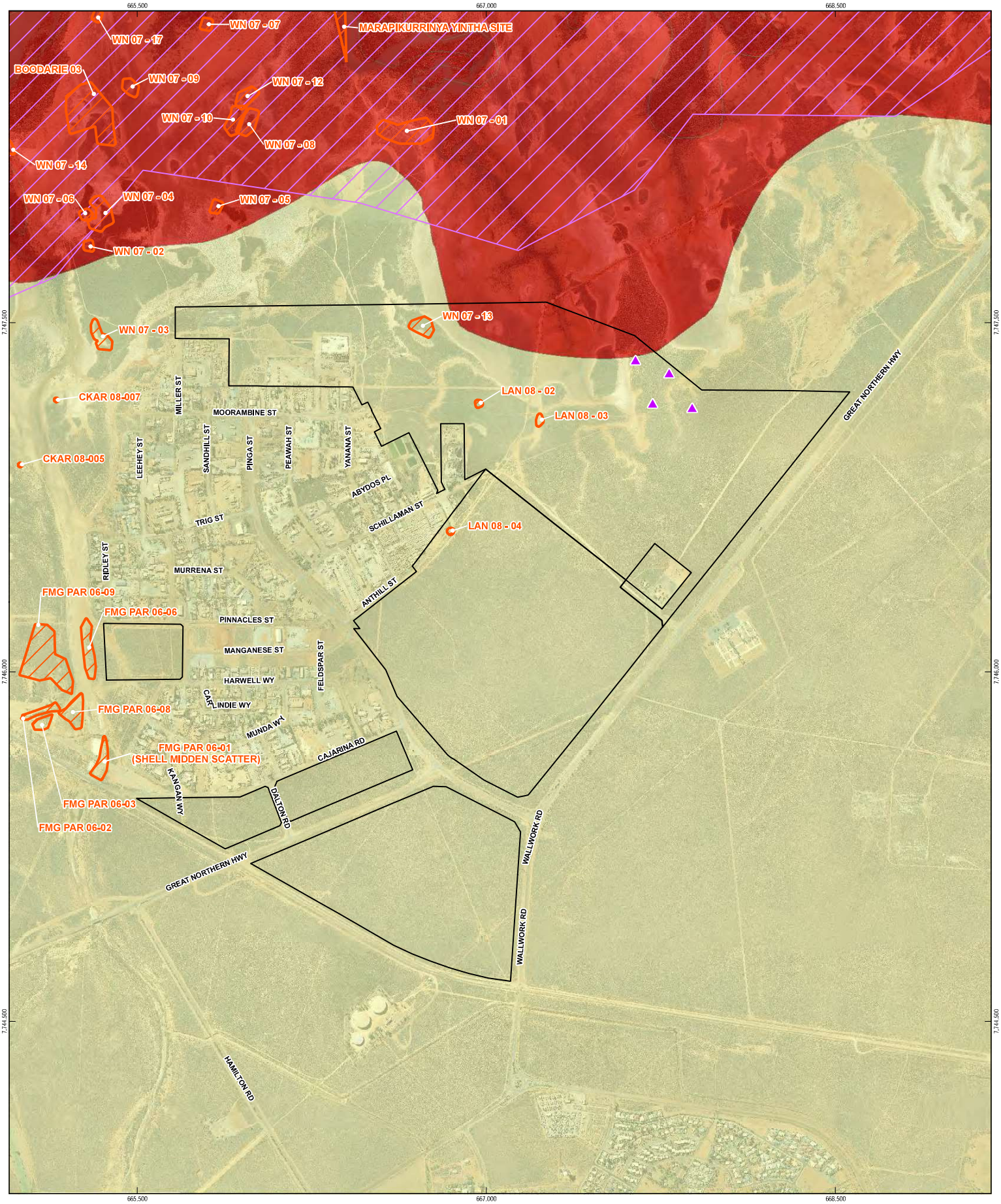
Locality Map

Figure 1

G:\61\22635\GIS\mxds\6122635-G009_RevB.mxd

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

Data Source: Landgate: Pt Hedland Mosaic - 2008; MRWA: Cadastre - 200811, Roads - 2009; GHD: Boodarie Industrial Estate (ind. Alternative Site) - 20090716. Created by: slee2



LEGEND

- Evidence of Mulgara (Vulnerable Fauna)
- Aboriginal Heritage Sites
- Register of National Estate
- Study Area

Acid Sulfate Soils

- High to moderate ASS disturbance risk (<3m from surface)
- Moderate to low ASS disturbance risk (<3m from surface)
- No known ASS disturbance risk (<3m from surface)

1:15,000 at A3

0 75 150 300 450 600

Metres

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

N

LandCorp

LECP - Port Hedland Industrial Land PEIA

Environmental Constraints

LIA 3, LIA 4, LIA 5, General Industry/Transport Part A, B

Job Number 61-22635
Revision 1
Date 20 OCT 2009

Figure 2

G:\61\22635\GIS\mxds\6122635-G01_Rev01.mxd

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

Data Source: Landgate: Port Hedland Townsite Mosaic - 200208 (SLIP: 20090811); GHD: Study Area - 20090811, Mulgara (Vulnerable Fauna) - 20091020; DIA: Aboriginal Heritage Sites - 20090715; DEH: Register of National Estate - 2006; DEC: Acid Sulfate Soils - 20060906. Created by: C Hoermann, K Iralu

1:5,000 (at A3)

0 25 50 100 150 200

Metres

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

N

LEGEND

Study Area

Cadastre

Vegetation Type

Cleared/Disturbed areas

Low shrubland over mixed tussock grassland over very open herbs

GHD

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LANDCORP

LandCorp
LECP - Port Hedland Industrial Land
PEIA

Job Number 61-22635
Revision 0
Date 20 AUG 2009

LIA 3, LIA 4, LIA 5 Vegetation Type

Figure 3

G:\61\22635\GIS\mxds\6122635-G013.mxd

Data Source: GHD: Study Areas (LandCorp) - 20090811, Vegetation Type - 20080904; Landgate: Cadastre - 20090727; Landgate: WA Wedgefield Project Port Hedland Jun 2008 Mosaic - June 2008 (SLIP: 20090820). Created by: kdiraju

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

1:7,500 (at A3)

0 37.5 75 150 225 300

Metres

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

N

LEGEND

Study Area

Cadastre

Vegetation Type

Cleared/Disturbed areas

Low shrubland over mixed tussock grassland over very open herbs

GHD

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LandCorp
LECP - Port Hedland Industrial Land PEIA

General Industry/ Transport Part A Vegetation Type

Job Number	61-22635
Revision	0
Date	20 AUG 2009

Figure 3

G:\61\22635\GIS\mxds\612263S-G014.mxd

Data Source: GHD: Study Areas (LandCorp) - 20090811; Vegetation Type - 20080904; Landgate: Cadastre - 20090727; Landgate: WA Wedgefield Project Port Hedland Jun 2008 Mosaic - June 2008 (SLIP: 20090820). Created by: kdiralu

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

1:10,000 (at A3)

0 50 100 200 300 400

Metres

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

N

LEGEND

- Proposed Wedgefield Industrial Estate
- Cadastre

Vegetation Type

- Bare areas/tidal flats
- Cleared/Disturbed areas
- Low shrubland over mixed tussock grassland over very open herbs
- Tussock grassland over scattered herbs

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LandCorp
LECP - Port Hedland Industrial Land PEIA

General Industry/ Transport Part B Vegetation Type

Job Number	61-22635
Revision	0
Date	20 AUG 2009

Figure 3

G:\61\22635\GIS\mxds\6122635-G016.mxd

Data Source: GHD: Proposed Wedgefield Industrial Estate - 20090716; GHD: Vegetation Type - 20080904; Landgate: Cadastre - 20090727; Landgate: WA Wedgefield Project Port Hedland Jun 2008 Mosaic - June 2008 (SLIP: 20090820). Created by: kdiralu

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

1:10,000 (at A3)

0 50 100 200 300 400

Metres

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

N

LEGEND

- Proposed Wedgefield Industrial Estate
- Cadastre

Vegetation Condition

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

GHD
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LANDCORP

LandCorp
LECP - Port Hedland
Industrial Land PEIA

Job Number	61-22635
Revision	0
Date	20 AUG 2009

General Industry/Transport Part B
Vegetation Condition

Figure 4

G:\61\22635\GIS\mxds\6122635-G015.mxd

Data Source: GHD: Proposed Wedgefield Industrial Estate - 20090716; GHD: Vegetation Condition - 20080904; Landgate: Cadastre - 20090727, WA Wedgefield Project Port Hedland Jun 2008 Mosaic - June 2008 (SLIP: 20090820). Created by: kdiralu

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

Appendix B

Flora

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

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

Flora Species Recorded within the Study Areas

Quadrat Data

Table 11 Conservation Categories and Definitions for *EPBC Act* Listed Flora and Fauna Species

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

Table 12 Conservation Codes and Descriptions for DEC Declared Rare and Priority Flora Species

Conservation Code	Description
R: Declared Rare Flora – Extant Taxa	Taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such.
P1: Priority One – Poorly Known Taxa	Taxa which are known from one or a few (generally <5) populations which are under threat, either due to small population size, or being on lands under immediate threat, e.g. road verges, urban areas, farmland, active mineral leases, etc., or the plants are under threat, e.g. from disease, grazing by feral animals etc. May include taxa with threatened populations on protected lands. Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.
P2: Priority Two – Poorly Known Taxa	Taxa which are known from one or a few (generally<5) populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.
P3: Priority Three – Poorly Known Taxa	Taxa which are known from several populations, and the taxa are not believed to be under immediate threat (i.e. not currently endangered), either due to the number of known populations (generally >5), or known populations being large, and either widespread or protected. Such taxa are under consideration for declaration as 'rare flora' but are in need of further survey.
P4: Priority Four – Taxa in need of monitoring	Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5 – 10 years.

Table 13 Flora Species Recorded within the Study Areas

Family	Genus	Species	Common Name	Status
Aizoaceae	*Trianthema*	*pilosa*		
Aizoaceae	*Trianthema*	*turgidifolia*		
Amaranthaceae	*Aerva*	*javanica*	Kapok Bush	*
Amaranthaceae	*Gomphrena*	*canescens* ssp. *canencens*		
Amaranthaceae	*Gomprena*	*sordida*		
Amaranthaceae	*Hemichroa*	*diandra*		
Amaranthaceae	*Ptilotus*	*?macrocephalus*	Featherheads	
Amaranthaceae	*Ptilotus*	*arthrolasius*		
Amaranthaceae	*Ptilotus*	*austrolasius*		
Amaranthaceae	*Ptilotus*	*axillaris*	Mat Mulla Mulla	
Amaranthaceae	*Ptilotus*	*fusiformis*		
Amaranthaceae	*Ptilotus*	*obovatus*	Cotton Bush	
Amaranthaceae	*Ptilotus*	*polystachyus*	Prince of Wales Feather	
Apocynaceae	*Carissa*	*lanceolata*		
Asteraceae	*Pterocaulon*	*sphacelatum*	Apple Bush	
Asteraceae	*Pterocaulon*	*sphaeranthoides*		
Asteraceae	*Streptoglossa*	*liatroides*		
Avicenniaceae	*Avicennia*	*marina*	White Mangrove	
Bignoniaceae	*Dolichandrone*	*heterophylla*		
Boraginaceae	*Heliotropium*	*vestitum*		
Caesalpiniaceae	*Senna*	*artemisioides*		
Caesalpiniaceae	*Senna*	*artemisioides* subsp. *oligophylla*		
Caesalpiniaceae	*Senna*	*glutinosa* subsp. *glutinosa*		
Caesalpiniaceae	*Senna*	*notabilis*		
Caryophyllaceae	*Polycarpaea*	*?corymbosa*		
Chenopodaceae	*Neobassia*	*astrocarpa*		
Chenopodaceae	*Tecticornia*	*pergranulata*		
Chenopodaceae	*Tecticornia*	*pterogosperma*		
Chenopodiaceae	*Dysphania*	*kalpari*	Rat's Tail	
Chenopodiaceae	*Salsola*	*tragus*		
Chenopodiaceae	*Threlkeldia*	*diffusa*	Coast Bonefruit	

Family	Genus	Species	Common Name	Status
Commelinaceae	*Commelina*	*ensifolia*		
Convolvulaceae	*Bonamia*	*linearis*		
Convolvulaceae	*Bonamia*	*alatisemina*		
Convolvulaceae	*Bonamia*	*erecta*		
Convolvulaceae	*Evolvulus*	*alsinoides* var. *villosicalyx*		
Convolvulaceae	*Ipomoea*	*muelleri*	Poison Morning Glory	
Convolvulaceae	*Ipomoea*	*pes-caprae*		
Convolvulaceae	*Merremia*	*davenportii*		
Convolvulaceae	*Operculina*	*aequisepala*		
Cucurbitaceae	*Cucumis*	*maderaspatanus*		
Cyperaceae	*Bulbostylis*	*barbata*		
Cyperaceae	*Cyperus*	*hesperius*		
Euphorbiaceae	*Euphorbia*	*australis*	Namana	
Euphorbiaceae	*Euphorbia*	*coghlanii*	Namana	
Frankeniaceae	*Frankenia*	*ambita*		
Goodeniaceae	*Goodenia*	*forrestii*		
Goodeniaceae	*Goodenia*	*muelleriana*		
Gyrostemonaceae	*Codonocarpus*	*cotinifolius*	Native Poplar	
Lamiaceae	*Clerodendrum*	*floribundum*	Lollybush	
Lauraceae	*Cassytha*	*filiformis*	Love Vine	
Malvaceae	*Abutilon*	sp.(insufficient material)		
Malvaceae	*Hibiscus*	*brachychlaenus*		
Malvaceae	*Sida*	*clementii*		
Malvaceae	*Sida*	*rohlenae* subsp. *rohlenae*		
Mimosaceae	*Acacia*	*ampliceps*		
Mimosaceae	*Acacia*	*colei*	Cole's Wattle	
Mimosaceae	*Acacia*	*sericophylla*		
Mimosaceae	*Acacia*	*stellaticeps*		
Mimosaceae	*Acacia*	*trachycarpa*	Minni Ritchi	
Mimosaceae	*Acacia*	*ancistrophylla*		P
Mimosaceae	*Acacia*	*bivenosa*		
Mimosaceae	*Acacia*	*pyrifolia*	Kajni bush	
Mimosaceae	*Acacia*	*tumida*		
Mimosaceae	*Neptunia*	*dimorphantha*	Sensitive Plant	

Family	Genus	Species	Common Name	Status
Molluginaceae	*Mollugo*	*molluginea*		
Myrtaceae	*Eucalyptus*	*victrix*		P
Myrtaceae	*Melaleuca*	sp. (insufficient material)		P
Myrtaceae	*Melaleuca*	*lasiandra*		
Papilionaceae	*Cajanus*	*cinereus*		
Papilionaceae	*Cajanus*	*marmoratus*		
Papilionaceae	*Cleome*	*viscosa*	Tickweed	
Papilionaceae	*Crotalaria*	*cunninghamii*	Bird flower	
Papilionaceae	*Crotularia*	*ramosissima*		
Papilionaceae	*Cullen*	*pognocarpum*		
Papilionaceae	*Cullen*	*stipulaceum*		
Papilionaceae	*Desmodium*	*filiforme*		
Papilionaceae	*Indigofera*	*linifolia*		
Papilionaceae	*Indigofera*	*linnaei*		
Papilionaceae	*Indigofera*	*monophylla*		
Papilionaceae	*Rhynchosia*	*minima*	Rhynchosia	
Papilionaceae	*Sesbania*	*cannabina*	Sesbania Pea	
Papilionaceae	*Swainsona*	*pterostylis*		
Papilionaceae	*Tephrosia*	*leptoclada*		
Papilionaceae	*Tephrosia*	*rosea*		
Papilionaceae	*Vigna*	*lanceolata* var. *lanceolata*		
Plumbaginaceae	*Muellerolimon*	*salcorniaceum*		
Poaceae	*Aristida*	*holathera* var. *holathera*		
Poaceae	*Cenchrus*	*ciliaris*	Buffel Grass	*
Poaceae	*Chloris*	*barbata*	Purpletop Chloris	*
Poaceae	*Digitaria*	*brownii*		
Poaceae	*Eragrostis*	*cumingii*		
Poaceae	*Eragrostis*	*dielsii*		
Poaceae	*Eragrostis*	*eriopoda*	Woollybutt Grass	
Poaceae	*Eragrostis*	*falcata*		
Poaceae	*Eragrostis*	*speciosa*		
Poaceae	*Eriachne*	*aristidea*		
Poaceae	*Eriachne*	*obtusa*	Northern Wanderrie Grass	

Family	Genus	Species	Common Name	Status
Poaceae	*Panicum*	*decompositum*	Native Millet	
Poaceae	*Paraneurachne*	*muelleri*	Northern Mulga Grass	
Poaceae	*Paspalidium*	*constrictum*		
Poaceae	*Sorghum*	*plumosum*		
Poaceae	*Sorghum*	*timorense*		
Poaceae	*Triodia*	*epactia*		
Poaceae	*Triodia*	*schinzii*		
Poaceae	*Triodia*	*secunda*		
Poaceae	*Yakirra*	*australiensis*		
Portulacaceae	*Calandrinia*	sp. Pinga		
Portulacaceae	*Calandrinia*	*stagnensis*		
Proteaceae	*Hakea*	*lorea*	Witinti	
Santalaceae	*Santalum*	*lanceolatum*	Northern Sandalwood	
Sapindaceae	*Dodonaea*	*coriacea*		
Scrophulariaceae	*Stemodia*	*grossa*	Vicks bush	
Solanaceae	*Solanum*	*diversiflorum*		
Sterculiaceae	*Waltheria*	*indica*		
Thymelaceae	*Pimelea*	*ammocharis*		
Tiliaceae	*Corchorus*	sp.(insufficient material)	'Round leaf'	
Tiliaceae	*Corchorus*	sp. (insufficient material)	'Linear leaf"	
Tiliaceae	*Corchorus*	*walcottii*	Woolly Corchorus	
Tiliaceae	*Triumfetta*	*appendiculata*		
Tiliaceae	*Triumfetta*	*ramosa*		
Violaceae	*Hybanthus*	*aurantiacus*		
Zygophyllaceae	*Tribulus*	*occidentalis*	Perennial Caltrop	

* Introduced
P Planted

QUADRAT DATA – Field Survey June 2008

LIA 3 Quadrat 1

Field Vegetation Description: *Acacia stellaticeps* and *Triodia* very low shrubland over scattered herbs.

Landform/soil: Flat; red sandy loam

Open ground: 20%

Leaf Litter: <5%

Rocks 0%

Condition: 1/2

Disturbance: Scattered Buffel Grass. Occasional rubbish.

Quadrat 1 species data

Family	Genus	Species	Status	Height (m)	Coverage (%)
Mimosaceae	*Acacia*	*stellaticeps*		<0.5m	30-40%
Poaceae	*Triodia*	*epactia*		0.6	10
Poaceae	*Triodia*	*schinzii*		0.6	10
Poaceae	*Eriachne*	*obtusa*		0.5	10
Mimosaceae	*Acacia*	*colei*		2	<2
Papilionaceae	*Indigofera*	*monophylla*		0.3	<2
Convolvulaceae	*Bonamia*	*erecta*		0.3	2-10
Violaceae	*Hybanthus*	*aurantiacus*		0.3	2-10
Lauraceae	*Cassytha*	*filiformis*		N/A	2-10

Family	Genus	Species	Status	Height (m)	Coverage (%)
Tiliaceae	*Corchorus*	*sp.*		0.4	<2
Poaceae	*Cenchrus*	*ciliaris*	*	0.5	<2

LIA 4 Quadrat 1

Field Vegetation Description: *Acacia stellaticeps* and *Triodia* very low shrubland over very scattered herbs.

Landform/soil: Flat; red sandy loam

Open ground: 25%

Leaf Litter: <5%

Rocks 0%

Condition: 1/2 Very mature (long unburnt), plants ageing.

Disturbance: Very scattered Buffel grass.

Quadrat 1 species data

Family	Genus	Species	Status	Height (m)	Coverage (%)
Mimosaceae	*Acacia*	*stellaticeps*		<0.5m	30%
Poaceae	*Triodia*	*epactia*		0.6	20
Poaceae	*Triodia*	*schinzii*		0.6	10
Poaceae	*Eriachne*	*obtusa*		0.5	2-10
Poaceae	*Cenchrus*	*ciliaris*	*	0.5	<2

LIA 5 Quadrat 1

Field Vegetation Description: *Acacia stellaticeps* and *Triodia* low shrubland over scattered herbs.

Landform/soil: Flat; red sandy loam

Open ground: 20%

Leaf Litter: <5%

Rocks 0%

Condition: 1/2

Disturbance: Buffel grass.

Quadrat 1 species data

Family	Genus	Species	Status	Height (m)	Coverage (%)
Mimosaceae	*Acacia*	*stellaticeps*		<0.6m	30-40%
Poaceae	*Triodia*	*epactia*		0.6	10
Poaceae	*Triodia*	*schinzii*		0.6	10
Poaceae	*Eriachne*	*obtusa*		0.5	2-10
Convulvulaceae	*Bonamia*	*alatisemina*		0.2	2-10
Amaranthaceae	*Ptilotus*	*macrocephalus*		0.5	<2
Amaranthaceae	*Ptilotus*	*austrolasius*		0.4	<2
Lauraceae	*Cassytha*	*filiformis*		N/A	2-10
Caesalpinaceae	*Senna*	*nemophila*		0.4	<2
Poaceae	*Cenchrus*	*ciliaris*	*	0.5	<2

LIA 5 Quadrat 2

Field Vegetation Description: *Acacia stellaticeps* and *Triodia* low shrubland over scattered herbs.

Landform/soil: Flat; red sandy loam

Open ground: 25%

Leaf Litter: <5%

Rocks 0%

Condition: 1/2

Disturbance: Buffel Grass.

Quadrat 2 species data

Family	Genus	Species	Status	Height (m)	Coverage (%)
Mimosaceae	*Acacia*	*stellaticeps*		<0.7m	30%
Poaceae	*Triodia*	*epactia*		0.6	10
Poaceae	*Triodia*	*schinzii*		0.6	10
Poaceae	*Eriachne*	*obtusa*		0.5	10
Convulvulaceae	*Bonamia*	*alatisemina*		0.2	2-10
Poaceae	*Cenchrus*	*ciliaris*	*	0.5	15%

Transport Area A <u>Quadrat 1</u>

Field Vegetation Description: *Acacia stellaticeps* and *Triodia* very low shrubland over scattered herbs.

Landform/soil: Flat; red sandy loam

Open ground: 20%

Leaf Litter: <5%

Rocks 0%

Condition: 1

Disturbance: None.

Quadrat 1 species data

Family	Genus	Species	Status	Height (m)	Coverage (%)
Mimosaceae	*Acacia*	*stellaticeps*		<0.3m	10-15
Poaceae	*Triodia*	*epactia*		0.4	40
Poaceae	*Eriachne*	*obtusa*		0.4	30
Poaceae	*Sorghum*	*plumosa*		0.6	2-10
Violaceae	*Hybanthus*	*aurantiacus*		0.2	<2
Cyperaceae	*Cyperus*	*bulbosus*		0.5	<2
Lauraceae	*Cassytha*	*filiformis*		0.2	2-10
Papilionaceae	*Indigofera*	*linifolia*		0.3	2-10
Convolvulaceae	*Bonamia*	*alatisemina*		0.2	<2
Sapindaceae	*Dodonaea*	*coriaceae*		1.0	<2
Tiliaceae	*Corchorus*	*walcottii*		0.5	<2

Transport Area A Quadrat 2

Field Vegetation Description: *Triodia* and tussock grassland

Landform/soil: Flat; red sandy clay loam

Open ground: 20%

Leaf Litter: <5%

Rocks 0%

Condition: 1

Disturbance: None.

Quadrat 2 species data

Family	Genus	Species	Status	Height (m)	Coverage (%)
Poaceae	*Triodia*	*epactia*		0.4	<60
Poaceae	*Triodia*	*schinzii*		0.4	15
Poaceae	*Sorghum*	*plumosa*		0.6	2-10

QUADRAT DATA – Field Survey June 2009 (Transport Area B)

Quadrat 1

Field Vegetation Description: *Acacia stellaticeps* over *Triodia epactia* and *T. schinzii* hummock grassland

Landform/soil: Flat; red sand

Open ground: 20%

Leaf Litter: <5%

Rocks 0%

Condition: 1/2

Disturbance: None.

Quadrat 1 species list

Family	Genus	Species	Common Name	% Cover
Mimosaceae	*Acacia*	*stellaticeps*		50
Poaceae	*Triodia*	*epactia*		5-10
Poaceae	*Triodia*	*schinzii*		20
Poaceae	*Eragrostis*	*cumingii*		1-2
Cyperaceae	*Bulbostylis*	*barbata*		2
Euphorbiaceae	*Euphorbia*	*coghlanii*	Namana	2
Poaceae	*Eragrostis*	*speciosa*		2
Asteraceae	*Streptoglossa*	*liatroides*		1

Amaranthaceae	*Ptilotus*	*fusiformis*		1
Sapindaceae	*Dodonaea*	*coriacea*		1
Caesalpiniaceae	*Senna*	*glutinosa* subsp. *glutinosa*		1
Amaranthaceae	*Ptilotus*	*obovatus*	Cotton Bush	1
Amaranthaceae	*Ptilotus*	*polystachyus*	Prince of Wales Feather	1
Mimosaceae	*Acacia*	*sericophylla*		1

Quadrat 2

Field Vegetation Description: *Triodia epactia* and *T. schinzii* hummock grassland over low open shrubland of *Acacia stellaticeps*.

Landform/soil: Flat; red sand

Open ground: 5%

Leaf Litter: <5%

Rocks 0%

Condition: 2

Disturbance: Some old vehicle tracks

Quadrat 2 species list

Family	Genus	Species	Common Name	% Cover
Poaceae	*Triodia*	*schinzii*		40

Poaceae	*Triodia*	*epactia*		40
Mimosaceae	*Acacia*	*stellaticeps*		5
Poaceae	*Eragrostis*	*cumingii*		5
Violaceae	*Hybanthus*	*aurantiacus*		1
Cyperaceae	*Cyperus*	*hesperius*		1
Asteraceae	*Pterocaulon*	*sphacelatum*	Apple Bush	1

Quadrat 3

Field Vegetation Description: *Acacia stellaticeps* over *Triodia epactia* and *T. schinzii* hummock grassland

Landform/soil: Flat; red sand

Open ground: 20%

Leaf Litter: <5%

Rocks 0%

Condition: 2

Disturbance: Old vehicle tracks

Quadrat 3 species list

Family	Genus	Species	Common Name	% Cover
Poaceae	*Triodia*	*schinzii*		25
Mimosaceae	*Acacia*	*stellaticeps*		30

Poaceae	*Triodia*	*epactia*		5
Poaceae	*Aristida*	*holathera* var. *holathera*		5
Amaranthaceae	*Ptilotus*	*arthrolasius*		1
Tiliaceae	*Corchorus*	*walcottii*	Woolly Corchorus	1
Sterculiaceae	*Waltheria*	*indica*		1
Violaceae	*Hybanthus*	*aurantiacus*		1
Poaceae	*Eragrostis*	*cumingii*		1
Malvaceae	*Hibiscus*	*brachychlaenus*		1
Amaranthaceae	*Ptilotus*	*polystachyus*	Prince of Wales Feather	1
Bignoniaceae	*Dolichandrone*	*heterophylla*		1
Lamiaceae	*Clerodendrum*	*floribundum*	Lollybush	1

Quadrat 4

Field Vegetation Description: *Acacia stellaticeps* over *Triodia epactia* and *T. schinzii* hummock grassland

Landform/soil: Flat; red sand

Open ground: 20%

Leaf Litter: <2%

Rocks 0%

Condition: 2

Disturbance: Minor disturbance – old tracks

Quadrat 4 species list

Family	Genus	Species	Common Name	% Cover
Poaceae	Triodia	schinzii		50
Mimosaceae	Acacia	stellaticeps		15
Poaceae	Digitaria	brownii		5
Poaceae	Triodia	epactia		5
Poaceae	Eragrostis	eriopoda	Woollybutt Grass	1
Boraginaceae	Heliotropium	vestitum		1
Molluginaceae	Mollugo	molluginea		1
Poaceae	Yakirra	australiensis		1
Tiliaceae	Corchorus	walcottii	Woolly Corchorus	1
Cyperaceae	Cyperus	hesperius		1
Poaceae	Eragrostis	cumingii		1

Quadrat 5

Field Vegetation Description: *Triodia epactia, T. schinzii* and *Sorghum timorense* grassland.

Landform/soil: Flat; red sand

Open ground: 10%

Leaf Litter: <2%

Rocks 0%

Condition: 2

Disturbance: No evidence of disturbance

Quadrat 4 species list

Family	Genus	Species	Common Name	% Cover
Poaceae	*Sorghum*	*timorense*		20
Poaceae	*Triodia*	*epactia*		40
Poaceae	*Triodia*	*schinzii*		30
Poaceae	*Eragrostis*	*cumingii*		1
Mimosaceae	*Acacia*	*stellaticeps*		1
Asteraceae	*Pterocaulon*	*sphaeranthoides*		1
Cyperaceae	*Cyperus*	*hesperius*		1

Appendix C

Fauna

EPBC Act Fauna Conservation Categories

Western Australian Wildlife Conservation Act 1950 Conservation Codes

DEC Priority Fauna Codes

WA Museum / DEC “NatureMap” Fauna Records within 20 km of the Study Area

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

Fauna Species Observed within the Study Area During the Field Survey

EPBC Act Fauna Conservation Categories

Listed threatened species and ecological communities

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

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

(See Table 11)

Critically endangered and endangered species

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

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

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

Vulnerable species

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

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

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

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

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

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

Listed migratory species

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

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

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

An area of important habitat is:

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

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

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

The Commonwealth marine environment

An action will require approval from the Environment Minister if:

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

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

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

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

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

Table 14 *Western Australian Wildlife Conservation Act 1950* Conservation Codes

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

Table 15 DEC Priority Fauna Codes

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

Conservation Code	Description
Priority 1	Taxa with few, poorly known populations on threatened lands.
Priority 2	Taxa with few, poorly known populations on conservation lands. Taxa which are known from few specimens or sight records from one or a few localities on lands not under immediate threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, vacant Crown Land, water reserves, etc.
Priority 3	Taxa which are known from few specimens or sight records, some of which are on lands not under immediate threat of habitat destruction or degradation.
Priority 4	Rare taxa. Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5 – 10 years.
Priority 5	Taxa in need of monitoring. Taxa which are not considered threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years.

Table 16 WA Museum / DEC "NatureMap" Fauna Records within 20 km of the Study Area

Species	Common Name	Status
Amphibians		
Cyclorana australis	Giant Frog	
Cyclorana maini	Sheep Frog	
Litoria rubella	Little Red Tree Frog	
Neobatrachus aquilonius	Northern Burrowing Frog	
Notaden nichollsi	Desert Spadefoot	
Opisthodon spenceri	Centralian Burrowing Frog	
Uperoleia russelli	Northwest Toadlet	
Birds		
Ardeotis australis	Australian Bustard	Priority 4
Arenaria interpres subsp. *interpres*		
Artamus cinereus subsp. *melanops*		
Artamus leucorynchus	White-breasted Woodswallow	
Calidris ruficollis	Red-necked Stint	
Corvus orru subsp. *cecilae*	Western Crow	
Eopsaltria pulverulenta	Mangrove Robin	
Gallinago stenura	Pin-tailed Snipe	
Gallirallus philippensis subsp. *mellori*		
Limnodromus semipalmatus	Asian Dowitcher	
Motacilla flava subsp. *simillima*		
Neochima ruficauda subsp. *subclarescens*	Star Finch (western)	Priority 4
Numenius madagascariensis	Eastern Curlew	Priority 4
Nycticorax caledonicus subsp. *hilli*		
Oceanites oceanicus	Wilson's Storm Petrel	
Pachycephala lanioides	White-breasted Whistler	
Passer montanus	Eurasian Tree Sparrow	
Ptilonorhynchus maculatus subsp. *guttatus*	Western Bowerbird	
Sterna caspia	Caspian Tern	
Sterna leucoptera	White-winged Black Tern	
Tringa brevipes	Grey-tailed Tattler	

Species	Common Name	Status
Tringa cinerea	Terek Sandpiper	
Turnix velox	Little Button-quail	
Tyto alba subsp. delicatula		
Mammals		
Antechinomys laniger	Kultarr	
Chaerephon jobensis	Northern Freetail-bat	
Dasycercus blythi	Brush-tailed Mulgara, Ampurta	Priority 4
Dasykaluta rosamondae	Little Red Kaluta	
Dasyurus hallucatus	Northern Quoll	Endangered
Dugong dugon	Dugong	Schedule 1
Lagostrophus fasciatus subsp. *fasciatus* Bernier Is.	Banded Hare-wallaby (name not current)	Vulnerable
Macropus robustus subsp. *erubescens*	Euro, Biggada	
Macrotis lagotis	Bilby, Dalgyte	Vulnerable
Mormopterus loriae subsp. *cobourgiana*	Little North-western Mastiff Bat	Priority 1
Nyctophilus arnhemensis	Arnhem Land Long-eared Bat	
Nyctophilus geoffroyi	Lesser Long-eared Bat	
Pseudomys hermannsburgensis	Sandy Inland Mouse	
Sminthopsis youngsoni	Lesser Hairy-footed Dunnart	
Sousa chinensis	Indo-Pacific Humpback Dolphin	Priority 4
Vespadelus finlaysoni	Finlayson's Cave Bat	
Reptiles		
Acanthophis pyrrhus	Desert Death Adder	
Amphibolurus longirostris		
Antaresia perthensis	Pygmy Python	
Aspidites melanocephalus	Black-headed Python	
Aspidites ramsayi	Woma	Schedule 1
Chelonia mydas	Green Turtle	Vulnerable
Cryptoblepharus buchananii		
Ctenophorus caudicinctus subsp. *caudicinctus*		
Ctenophorus isolepis subsp. *isolepis*		
Ctenotus duricola		

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

Species	Common Name	Status
Pseudonaja nuchalis	Gwardar	
Pygopus nigriceps		
Ramphotyphlops ammodytes		
Ramphotyphlops braminus		
Ramphotyphlops grypus		
Ramphotyphlops pilbarensis		
Simoselaps anomalus	Desert Banded Snake	
Strophurus ciliaris subsp. *aberrans*		
Strophurus elderi		
Strophurus jeanae		
Suta punctata	Spotted Snake	
Tiliqua multifasciata	Central Blue-tongue	
Varanus acanthurus	Spiny-tailed Monitor	
Varanus brevicauda	Short-tailed Pygmy Monitor	
Varanus eremius	Pygmy Desert Monitor	
Varanus gouldii	Bungarra or Sand Monitor	

Table 17 Listing of Potentially Occurring Significant, Rare and Priority Fauna Species within 20 km of the Study Area, with Information Source

Genus	Species	Common Name	Listing under Wildlife Conservation Act 1950 or DEC Priority List	Listing under EPBC Act	Source of Information		
					DEC Database	EPBC Protected Matters Search Tool	NatureMap
Birds							
Macronectes	*giganteus*	Southern Giant-Petrel	Schedule 1	Endangered,		X	
Haliaeetus	*leucogaster*	White-bellied Sea-Eagle		Migratory, Listed, overfly marine areas		X	
Hirundo	*rustica*	Barn Swallow		Migratory, Listed, overfly marine areas		X	
Merops	*ornatus*	Rainbow Bee-eater		Migratory, Listed, overfly marine areas			
Ardea	*alba*	Great Egret, White Egret		Migratory, Listed, overfly marine areas		X	
Ardea	*ibis*	Cattle Egret		Migratory, Listed, overfly marine areas		X	
Charadrius	*veredus*	Oriental Plover, Oriental Dotterel		Migratory, Listed overfly marine areas		X	

Genus	Species	Common Name	Listing under Wildlife Conservation Act 1950 or DEC Priority List	Listing under EPBC Act	Source of Information		
					DEC Database	EPBC Protected Matters Search Tool	NatureMap
Glareola	*maldivarum*	Oriental Pratincole		Migratory, Listed, overfly marine areas		X	
Limicola	*falcinellus*	Broad-billed Sandpiper		Migratory, Marine		X	
Numenius	*minutus*	Little Curlew, Little Whimbrel		Migratory, Listed, overfly marine areas		X	
Tringa	*nebularia*	Common Greenshank, Greenshank		Migratory, Marine		X	
Calidris	*melanotos*	Pectoral Sandpiper		Marine		X	
Calidris	*subminuta*	Long-toed Stint		Marine		X	
Charadrius	*ruficapillus*	Red-capped Plover		Marine		X	
Himantopus	*himantopus*	Black-winged Stilt		Marine		X	
Ardeotis	*australis*	Australian Bustard	Priority 4		X		X
Numenius	*madagascariensis*	Eastern Curlew	Priority 4				X
Neochima	*ruficauda* subsp. *subclarescens*	Star Finch (western)	Priority 4		X		X
Apus	*pacificus*	Fork-tailed Swift		Migratory, Listed, overfly marine areas		X	

Genus	Species	Common Name	Listing under Wildlife Conservation Act 1950 or DEC Priority List	Listing under EPBC Act	Source of Information		
					DEC Database	EPBC Protected Matters Search Tool	NatureMap
Mammals							
Mormopterus	*loriae* subsp. *cobourgiana*	Little North-western Mastiff Bat	Priority 1		X		X
Macrotis	*lagotis*	Bilby, Dalgyte	Schedule 1	Vulnerable			X
Dasycercus	*blythi*	Brush-tailed Mulgara, Ampurta	Priority 4				X
Dasyurus	*hallucatus*	Northern Quoll	Schedule 1	Endangered	X	X	X
Lagostrophus	*fasciatus* subsp. *fasciatus* Bernier Is.	Banded Hare-wallaby	Schedule 1	Vulnerable	X		X
Rhinonicteris	*aurantius* (Pilbara form)	Pilbara Leaf-nosed Bat		Vulnerable		X	*
Reptiles							
Aspidites	*ramsayi*	Woma	Schedule 4				X

Table 18 Fauna Species Observed within the Study Area During the Field Survey

Family	Genus	Species	Common Name	Status
Birds				
Accipitridae	*Elanus*	*caeruleus*	Black-shouldered Kite	Mi
Accipitridae	*Milvus*	*migrans*	Black Kite	Mi
Alcedinidae	*Geopelia*	*humeralis*	Bar-shouldered Dove	
Artamidae	*Artamus*	*cinereus*	Black-faced Woodswallow	
Artamidae	*Artamus*	*leucorynchus*	White-breasted Woodswallow	
Campephagidae	*Coracina*	*novaehollandiae melanops*	Black-faced Cuckoo-Shrike	Ma
Columbidae	*Ocyphaps*	*lophotes*	Crested Pigeon	
Corvidae	*Corvus*	*orru*	Torresian Crow	
Dicruridae	*Rhipidura*	*leucophrys*	Willie Wagtail	
Dricruridae	*Grallina*	*cyanoleuca*	Magpie-Lark	
Falconidae	*Falco*	*cenchroides*	Nankeen Kestrel	Ma
Halcyonidae	*Todiramphus*	*pyrrhopygia*	Red-backed Kingfisher	
Maluridae	*Malurus*	*leucopterus*	White-winged Fairy Wren	
Meliphagidae	*Lichenostomus*	*virescens*	Singing Honeyeater	
Meliphagidae	*Manorina*	*flavigula*	Yellow-throated Miner	
Meropidae	*Merops*	*ornatus*	Rainbow Bee-eater	Mi, Ma
Motacillidae	*Anthus*	*australis*	Australian Pipit	
Passeridae	*Taeniopygia*	*guttata*	Zebra Finch	
Psittacidae	*Cacatua*	*sanguinea*	Little Corella	
Psittacidae	*Eolophus*	*roseicapilla*	Galah	
Mammals				
Canidae	*Canus*	*domesticus*	Dog	*
Dasyuridae	*Dasycercus*	*cristicauda*	Mulgara	V, S1
Felidae	*Felis*	*catus*	Feral Cat	*
Macropodidae	*Macropus*	*rufus*	Red Kangaroo	
Reptiles				
Agamidae	*Ctenophorus*	*isolepis isolepis*	Central Military Dragon	
Scincidae	*Ctenotus*	*pantherinus ocellifer*	Leopard Ctenotus	
Varanidae	*Varanus*	*brevicauda*	Short-tailed Pygmy Monitor	