Rio Tinto

Wickham Town Expansion Flora and Vegetation Survey

Native Vegetation Clearing Permit Supporting Report

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Department: Environmental Approvals

Report Created by: Anna Rowe & Sam Luccitti

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Rio Tinto Iron Ore (RTIO) comprises wholly owned subsidiaries and joint venture initiatives including iron ore operations in the Pilbara region of Western Australia, owned by Hamersley Iron and Robe River, and managed by Pilbara Iron

Executive Summary

Rio Tinto Iron Ore proposes to expand the Wickham Township to support additional housing and associated infrastructure to accommodate both permanent and Fly-in Fly-out (FIFO) workers who will be required for the expansion of the Cape Lambert port facilities.

The Wickham town expansion study area consists of four polygons totalling 98.7 ha that are situated within and directly north and south of the Wickham Township (Figure 2.1).

A botanical survey was conducted over the study area by Rio Tinto botanist Sam Luccitti from the 28th to 30th of September 2010. The aim of the survey along with desktop studies was to describe the local environment including flora, vegetation, geology, landforms, soils and hydrology in order to support an application for a Native Vegetation Clearing Permit under Part V and/or an Environmental Impact Assessment under Part IV of the *Environmental Protection Act 1986*. The proposal was assessed against the 10 Clearing Principles as defined in Schedule 5 (Principles for Clearing Native Vegetation) of the *Environmental Protection Act 1986.*

Intact native vegetation occupied 79.2 ha of the study area and was typically in Good or better condition. Disturbance was most prevalent where the vegetation bordered cleared urban areas and disturbance was typically related to clearing for tracks and infrastructure. Weeds were common throughout Wickham Survey Polygon (WSP) 1, 2 and 3 and were observed frequently along the northern boundary of WSP 4.

Eleven vegetation units were identified across the study area. None of the 11 vegetation units are listed under the *EPBC Act 1999* nor are any defined as TECs or PECs by the DEC (DEC 2010a; 2010b). Vegetation units associated with sandy plains and aeolian sand dunes were, however, identified as having moderate conservation significance on the basis that such habitats are locally uncommon in the Wickham and Cape Lambert localities.

A total of 97 native vascular plant taxa from 56 genera belonging to 27 families were recorded in the study area. The genera and families represented within the survey area are considered characteristic of coastal Pilbara flora. The total number of vascular flora species (i.e. species richness) present within the study area was considered to be low to moderate; a result which can be attributed to the small size of the area, the dry seasonal conditions, lack of diversity in landforms and coastal location of the study area.

No Declared Rare Flora species or flora species listed under the *EPBC Act 1999* were recorded from the study area, and none would be expected to occur. No Priority flora or flora of conservation significance were recorded in the study area.

Seven introduced flora species were recorded within the study area; *Cenchrus ciliaris* (Buffel Grass), *Cenchrus setiger* (Birdwood Grass), *Aerva javanica* (Kapok Bush), *Chloris barbata* (Purpletop Chloris), *Taraxacum officinale* (Dandelion), *Stylosanthes hamata* (Verano Stylo) and *Cynodon dactylon* (Couch Grass). None of the species are listed as Declared Plants under the *Agriculture and Related Resources Protection Act 1976*; however Kapok Bush (*Aerva javanica*) and the two *Cenchrus* species are considered to be serious environmental weeds.

Consideration of the proposal with regard to the “10 Clearing Principles” as defined in Schedule 5 of the *Environmental Protection Act 1986* found that the proposal is unlikely to be at variance with any of the clearing principles.

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Introduction

1. Project Background

Rio Tinto Iron Ore proposes to expand the Wickham Township to accommodate additional permanent and Fly-in, Fly-out (FIFO) workers required to support the expansion of the Cape Lambert port facilities. The town expansion will require the construction of permanent houses, a FIFO village and associated infrastructure facilities.

1.1 Study Area Location and Description of Proposed Clearing

The Wickham town expansion study area consists of four polygons that are situated in the centre and directly north and south of the Wickham Township, which is located in the Shire of Roebourne, within the Pilbara region (Figure 2.1).

The northern polygon is 11.4 ha (*WSP 1) and along with the southern area which is 78.2 ha (WSP 4) is proposed for the construction of residential housing, while the two smaller areas within the Town centre WSP 2 (6.2 ha) and WSP 3 (2.5 ha) have been designated for the development of a FIFO village and associated infrastructure (Figure 2.1). Together the 4 WSPs total 98.3 ha and are collectively referred to as the study area in this report.

**WSP Wickham Survey Polygons*

1.2 Scope and Objectives of the Study

In September 2010 Rio Tinto undertook flora and vegetation surveys of the Wickham Town Expansion study area.

The survey was planned and implemented as far as practicable (no seasonal sampling component was possible in the timeframe) according to the Environmental Protection Authority (EPA) Position Statement No. 3 “Terrestrial Biological Surveys as an Element of Biodiversity Protection” (EPA 2002) and Guidance Statement No. 51 “Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia” (EPA 2004).

The scope of the botanical survey was to:

- Describe the local environment of the proposed clearing area including flora, vegetation, geology, landforms, soils and hydrology.
- Describe and map the vegetation types occurring within the study area;
- Identify any vegetation types or flora species of particular conservation significance, including Declared Rare Flora (DRF), Priority flora and other flora of interest;
- Describe the potential impacts of the proposal on the local environment through application of the 10 Clearing Principles, as outlined in Schedule 5 of the *Environmental Protection Act 1986*.

- Recommend ways to avoid and/or mitigate impacts of the proposal on areas of conservation significance and on the local environment in general.

This report describes the methodology employed for the flora and vegetation survey of the study area, as well as documenting the results of the survey, in particular identifying vegetation and flora of conservation significance. The intended use of this report is as a supporting document to Rio Tinto Iron Ore's application for a Native Vegetation Clearing Permit (NVCP) as well as a supporting document for the Environmental Impact Assessment process for the proposed project.

2. Review of the Physical and Non-Physical Aspects of the Study Area

2.1 Climate

The closest Meteorological station providing climate data is located in the township of Roebourne; approximately 9 km south of the study area.

The regional climate is semi-arid to semi-tropical with a summer rainfall season and a winter dry season, which varies in frequency and volume from year to year. The summer wet months extend from November to April when temperatures can exceed 47°C. The remainder of the year is moderate to warm with a continental effect resulting in low minimum temperatures below 15°C in June and July.

Annual rainfall is variable with tropical lows producing large regional rainfall events (between 100 mm and 200 mm in a few days) to isolated thunderstorm events in the dry (winter) season. For Roebourne; the mean annual rainfall for the period 1981 to 2010 is 289.2 mm with most precipitation occurring between December and June (coinciding with cyclone season). Rainfall for the 2009/2010 season in the December to May summer/autumn period fell well below average. A total of 53.3 mm of rainfall was recorded in the 8 month period from February to September 2010. The mean total rainfall for the same period from 1981 – 2010 is 225.8 mm. The last significant rainfall event was in the middle of September, with 15 mm of rainfall (BoM, 2010).

Maximum temperatures reflected a moderately warm summer to winter period (BoM, 2010). Temperatures recorded at Roebourne in the 6 months to September 2010 were generally within expected ranges and close to mean maximum temperatures. A lack of significant summer or follow-up winter rainfall has produced a higher number of sunshine days, thereby increasing evaporation rates, reducing soil moisture. This has shown in the vegetation condition across the study area, where very dry conditions were observed. This has also resulted in a reduction of short-lived annual species being recorded within the study area.

2.2 Land Systems

Land Systems (Rangelands) mapping covering the study area has been prepared by the Western Australian Department of Agriculture (van Vreeswyk *et al.* 2004). These are broad units that each consist of a series of "land units" that occur on characteristic physiographic types within the Land System.

The study area is located within 2 of the 107 Land Systems described for the Pilbara Bioregion by van Vreeswyk *et al.* (2004) and Payne *et al*. (1998) (Figure 2.1). The Land Systems and their extent within the study area are presented in Table 2.1 below.

Table 2.1: Land Systems occurring within the study area and their representation in the Pilbara bioregion (van Vreeswyk *et al.* 2004)

Land System (Map Code)	Description (Van Vreeswyk *et al.* 2004)	Extent in the Pilbara (ha)	Extent within study area in hectares (Extent within study area as % of total Land System area)
Ruth (RGERUT)	Hills and ridges of volcanic and other rocks supporting hard spinifex (and occasionally soft spinifex) grasslands.	169,299	3.8 (0.002)
Uaroo (RGEUAR)	Broad sandy plains supporting shrubby hard and soft spinifex grasslands.	987,066	94.5 (0.009)

2.2.1 Uaroo Land System

The Uaroo Land System covers approximately 96% of the study area and is characterised by broad sandy plains with little organised through drainage supporting shrubby hard and soft spinifex grasslands. This Land system occurs extensively around Port Hedland and Onslow but is uncommon in coastal areas surrounding Karratha, Wickham and Cape Lambert. Van Vreeswyk *et al.* (2004) divided the Uaroo land system into 6 land units and of these; the 'Sandy/loamy plains' land unit is the only one to occur within the study area.

2.2.2 Ruth Land System

The Ruth Land System covers the remainder (~4%) of the study area and is characterised by hills and ridges of volcanic and other rocks supporting hard spinifex (and occasionally soft spinifex) grasslands. Van Vreeswyk *et al.* (2004) divided the Ruth land system into 4 land units and of these; the 'hills, ridges and upper slopes', and 'narrow drainage floors, creeklines and channels' land units occur within the study area.

2.3 Geology and Soils

Geologically the study area is dominated by poorly consolidated Quaternary colluvium and alluvium associated with the Uaroo land system. Low rocky hills of volcanic and metamorphosed sedimentary rock rise up from the surrounding plain in the central and western parts of WSP 4 and are associated with the Ruth land system.

Deep red sands and red loamy earths cover the majority of the study area including all of WSPs 1, 2 & 3 and the most of WSP 4. Much shallower red silt loam soils occur in pockets on rocky hills in the central and western parts of WSP 4

2.4 Hydrology

2.4.1 Surface Hydrology

The most prominent drainage features across the study area are located within WSP 4 and consist of narrow, minor flowlines associated with the low rocky hills which rise from the surrounding sandy plain. These flowlines drain in a predominately easterly direction before emptying onto a broad sandy plain. A single minor flowline traverses the sandy plain in the south but overall, drainage across the sand plains within the study area occurs via sheet flow.

2.4.2 Groundwater Hydrology

Groundwater along the Pilbara coast is associated with alluvial aquifers along major rivers (Dept. of Fisheries 2001). In the Cape Lambert area, approximately 8 km to the north east of the study area, groundwater is typically associated with Quaternary alluvial sediments and fractured Precambrian bedrock and is located between 2 m and 8 m below the land surface (Sinclair Knight Mertz 2008).

2.5 Vegetation

2.5.1 IBRA Bioregions and Subregions

The study area is located within the Pilbara (PIL) bioregion as defined in the most recent interim Bioregionalisation of Australia (IBRA) Report (Environment Australia 2000). The Pilbara bioregion has been divided into 4 subregions; described by Environment Australia (2000) as;

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

- Fortescue Plains (PIL2): alluvial plains and river frontages with salt marsh, Mulga-bunch grass and short grass communities on alluvial plains and River Gum woodlands fringing drainage lines;

- Hamersley (PIL3): mountainous area of Proterozoic ranges and plateaux with low Mulga (*Acacia aneura*) woodland over bunch grasses on fine textured soils, and Snappy Gum over *Triodia brizoides* on the skeletal sandy soils of the ranges; and

- Roebourne Plains (PIL4): quaternary alluvial plains with a grass savanna and shrub steppe of *Acacia translucens* over *Triodia pungens* and marine alluvial flats with Samphire, *Sporobolus* and Mangal.

The majority of the study area lies within the Chichester subregion, with a small area in the south-eastern section of the study area mapped as part of the Roebourne Plains subregion.

2.5.2 Beard's Regional Vegetation Mapping

The study area lies within the Fortescue Botanical District of the Eremaean Botanical Province as defined by Beard (1975). The vegetation of this province is typical of arid landscapes; including bunch grasslands, spinifex, wattles and eucalypts. The study area falls within two vegetation mapping units, which are described by Beard (1975) in broad scale (1:1,000,000) mapping of the Pilbara region.

The study area is mapped by Beard (1975) as;

- **Abydos Plain/Chichester – 157** –Hummock grasslands, grass steppe; hard spinifex, *Triodia wiseana.*
- **Abydos Plain/Roebourne – 589** - Mosaic of short bunch grassland - savanna / grass plain (Pilbara) / hummock grasslands, grass steppe; soft spinifex.

The extent of these Beard (1975) vegetation mapping units within the study area is presented in Table 2.2 below.

2.5.3 Pre-European Vegetation Extent

The pre-European and current extent of native vegetation associations in Western Australia has been interpreted by Shepherd *et al.* (2002) using data from Beard (1975) regional vegetation mapping and other vegetation mapping activities as well as satellite imagery and orthophoto interpretation.

Shepherd *et al.* (2002) identified the Pilbara Bioregion as having native vegetation largely intact owing to the absence of intensive agricultural land use practices. Although the extent of the vegetation associations remain largely intact, their floristic composition and structural characteristics are likely to have been substantially altered since European settlement by grazing and inappropriate fire regimes (Shepherd *et al.* 2002). Table 2.2 presents the pre-European and current extent of the mapping units (largely 100% of their original extent) across their range and their extent within the study area.

Table 2.2: Beard (1975) mapping units occurring within the study area, their current and pre-European extent (following Shepherd *et al*. 2002) and their extent across the study area

Beard (1975) Mapping Units	Pre-European extent (Shepherd *et al*. 2002)	Current extent within Hamersley subregions (Shepherd *et al*. 2002)	Extent within the Study Area (% of current extent)

Abydos Plain/Roebourne 589	848,201 ha	848,201 ha	23.9 ha (0.003%)
Abydos Plain/Roebourne 157	542,861 ha	542,861 ha	74.7 ha (0.01%)

2.6 Conservation Areas and Environmentally Sensitive Areas (ESA)

The DEC online Native Vegetation Map Viewer was used to identify the location of environmentally sensitive areas as declared by a Notice under section 51B of the *Environmental Protection Act 1986.*

The study area does not occur within any environmentally sensitive areas including reserves or conservation areas. The northern boundary of the Millstream-Chichester National Park is located approximately 52 km south east of the study area and is the closest existing conservation area to the study area. The proposal is unlikely to directly or indirectly impact the Millstream-Chichester National Park.

There are also several C-class nature reserves on islands off the coast to the north-west of Cape Lambert; however they are not relevant given the nature of this project.

The study area does lie within Schedule 1 Area 2325; a 2 km band which follows the coastline. No other Schedule 1 areas occur within or adjacent to the study area

2.7 Threatened Ecological Communities (TECs) and Priority Ecological Communities (PECs)

Threatened Ecological Communities (TECs) are communities which have been found to fit into one of the following categories; “presumed totally destroyed”, “critically endangered”, “endangered” or “vulnerable”. TECs are informally listed by the DEC as they are not formally listed under WA legislation. While some TECs for WA are also listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999,* this does not apply to any currently describe from the Pilbara bioregion.

There are no TECs listed by the DEC for the Chichester subregion.

Possible threatened ecological communities that do not meet survey criteria for listing as TECs are added to DEC’s Priority Ecological Community (PEC) Lists under Priorities 1, 2 and 3. Ecological Communities that are adequately known, are rare but not threatened, or meet criteria for Near Threatened, or 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

No PECs occur within the study area nor are any likely to be directly or indirectly impacted on by the current proposal. There closest PECs to the study area are;

(Priority 1) Roebourne Plains coastal grasslands with gilgai microrelief on deep cracking clays

"The Roebourne Plains coastal grasslands with gilgai micro-relief occur on deep cracking clays that are self mulching and emerge on depositional surfaces. The Roebourne Plains gilgai grasslands occur on microrelief of deep cracking clays, surrounded by clay plains/flats and sandy coastal and alluvial plains. The gilgai depressions supports ephemeral and perennial tussock grasslands dominated by *Sorghum* sp. and *Eragrostis xerophila* (Roebourne Plains grass) along with other native species including *Astrebla pectinata* (Barley Mitchell Grass), *Eriachne benthamii* (Swamp Wanderrie Grass), *Chrysopogon fallax* (Golden Beard Grass) and *Panicum decompositum* (Native Millet).

Restricted to the Karratha area, this community differs from the surrounding clay flats of the Horseflat land system which are dominated by *Eragrostis xerophila* and other perennial tussock grass species (*Eragrostis* spp. mostly)."

(Priority 3) Horseflat land system of the Roebourne Plains
This PEC is described in (DEC 2010) as *"The remainder of the Horseflat land system – not including the Roebourne Plains gilgai grasslands and the Chenopod association of the Roebourne Plains area. Extent- from Cape Preston to Balla Balla (Whim Creek)."*

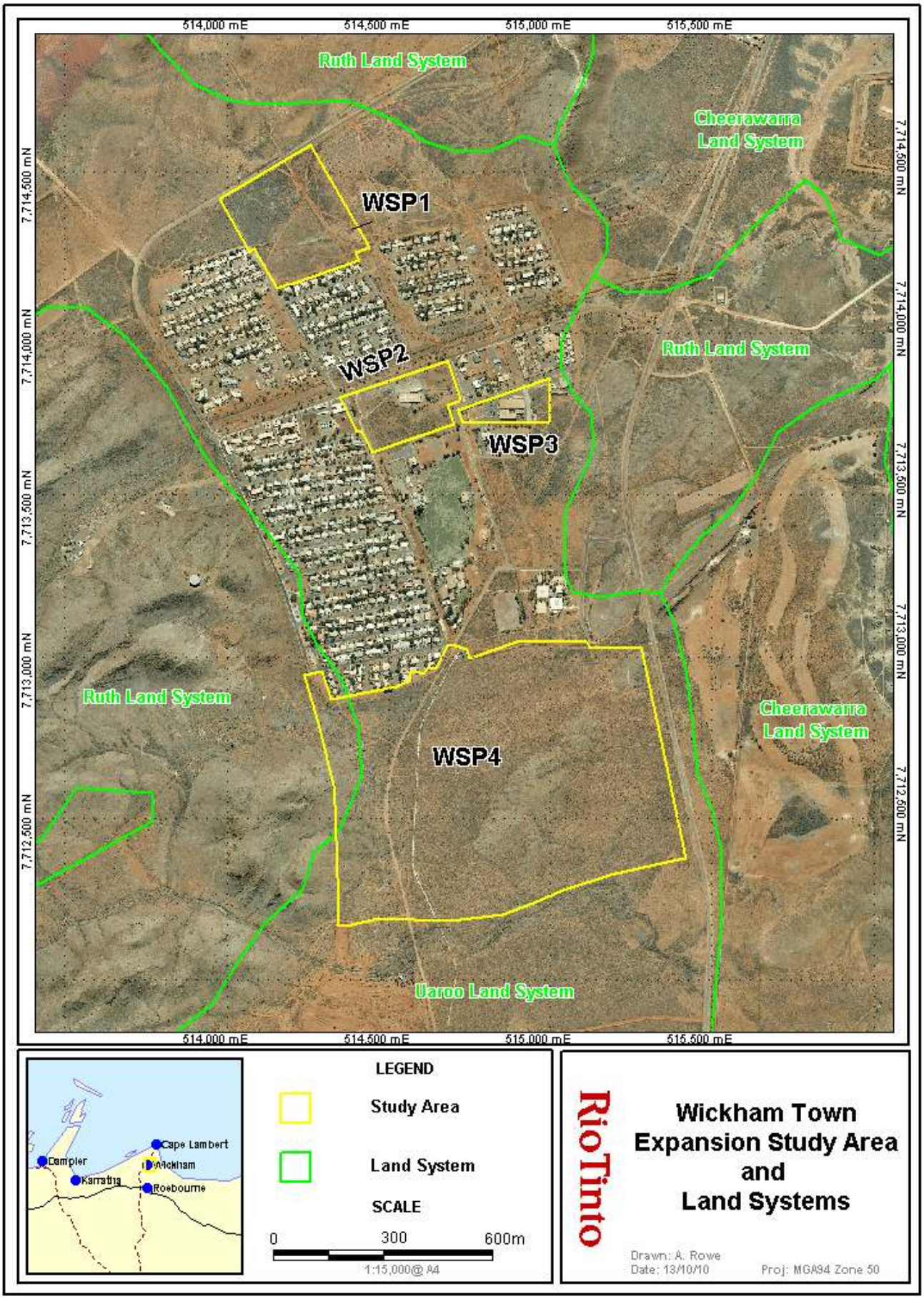

Figure 2.1: Wickham Town Expansion Study Area and Land Systems.

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3. Desktop Study and Field Survey

3.1 Literature review

The study area had not been previously surveyed for flora, or vegetation. However several previous botanical studies in the vicinity of the study area were reviewed to provide site-specific data (Table 3.1).

A fauna assessment and short range endemic (SRE) fauna survey for the study area was undertaken by Biota Environmental Sciences (Biota 2010) in order to provide site specific fauna information required to address Clearing Principle 6.1.2 (see Appendix 1).

Table 3.1: Summary of biological surveys conducted within the vicinity of the Wickham Town Expansion study area.

Survey Reference	Survey Date
Biota (2008a) *Karratha to Cape Lambert Transmission Line Corridor: Native Vegetation Clearing Permit Report*. Unpublished report prepared for Rio Tinto Iron Ore Pty Ltd.	July, 2008
Biota (2008b) *A Vegetation and Flora Survey of the Rio Tinto Rail Duplication Project – Cape Lambert to Emu Siding*. Unpublished report prepared for Rio Tinto Iron Ore Pty Ltd.	April, 2008
Biota (2008c) *Cape Lambert Port B Development: Flora and Vegetation Survey*. Unpublished report prepared for Pilbara Iron Pty Ltd.	July, 2008
Biota (2008d). *7 Mile Power Station and Ancillary Works NVCP*. Unpublished report prepared for Rio Tinto Iron Ore.	March & April, 2008
Rio Tinto (2009) *Dampier 7-Mile to Cape Lambert 220 kV Transmission Line Corridor Additional Areas Native Vegetation Clearing Permit Supporting Report* Unpublished internal report for Rio Tinto Iron Ore.	April, 2009
GHD (2008) *Report for 320 Mt Marshalling Yards, Maintenance Workshop and Quarry – Flora and Fauna Assessment*. Unpublished report prepared for Rio Tinto Iron Ore Pty Ltd.	November, 2008
Biota (2010) *Wickham Town Expansion Level 1 Fauna Assessment and SRE Fauna Survey*. Unpublished report prepared for Rio Tinto Iron Ore Pty Ltd.	September, 2010

3.2 Database Searches

Databases maintained by the WA DEC and WA Herbarium were searched in October 2010 for Declared Rare and Priority Flora, and Threatened Ecological Communities (Appendix 2). The searches encompassed a central point between the coordinates (GDA94) 503,102mE 7,698,381mN (SW corner) and 526,548mE 7,723,236mN (NE corner), with a 50 km radial buffer.

The Commonwealth Department of Sustainability, Environment, Water, Population and Communities (DSEWPC) (formerly the Department of Environment, Water, Heritage and the Arts) administered *Environmental Protection and Biodiversity Conservation Act, 1999* (EPBC Act) Protected Matters Search Tool was searched in October 2010 for Matters of National Environmental Significance encompassing an area of a 50 km radius around the study area (-20 40.40 °S 117.08.20 °E (WGS 84)).

Spatial data for rare flora held and maintained by Rio Tinto Iron Ore was also searched as part of the desk top study. Any Ecologically Sensitive Areas (ESA), Reserves and/or conservation areas within or surrounding the study area were also identified using relevant GIS layers held by Rio Tinto Iron Ore.

3.3 Field Survey Timing and Effort

The flora and vegetation of the study area was surveyed by Rio Tinto botanist Sam Luccitti from the 28th to the 30th of September 2010. A number of survey methods including relevés and quadrat sampling were employed in order to map the vegetation across the study area and to obtain an inventory of flora species inhabiting the survey area.

3.4 Vegetation Description and Mapping

Vegetation units within the study area were described based on the height and estimated percentage foliage cover of the dominant plant species within the vegetation unit. The description of each vegetation unit was based on the structural classification system of Muir (1977) and Aplin (1979) adapted from Specht (1970) (see Appendix 3).

During the field survey the boundaries of each vegetation unit were mapped using a combination of aerial photograph interpretation and hand-held GPS units. Where a vegetation unit boundary could not be confidently discerned on aerial photographs, representative points were marked along the vegetation boundary using a hand-held GPS. These points were then uploaded into a GIS software package.

The vegetation boundaries were digitised on-screen using the MapInfo Professional 10.0 GIS software package. Digitising followed either vegetation boundaries discernible from geo-referenced aerial photographs or points collected by hand-held GPS unit as described above.

3.5 Assessment of Floristic Quadrats & Relevés

A total of 14 detailed flora-recording quadrats were surveyed across the study area (Figure 4.1 & 4.2). The locations of the quadrats were chosen to capture the main vegetation units occurring within the study area. In the majority of cases, the approximate locations of the quadrats were chosen prior to the field survey with the aid of aerial photographs.

The dimensions of most quadrats were 50 m x 50 m. The 50 m x 50 m quadrat has become somewhat of a standard quadrat size for vegetation surveys conducted in the Pilbara bioregion as it is thought to provide a good indication of the shrub and grass layer

vegetation structure for most vegetation types. In some instances the quadrat dimensions were altered in order to accommodate vegetation associated with linear habitats (e.g. creeklines). Where quadrat dimensions were altered, every effort was made to maintain the overall area (i.e. 2,500 m2) of the quadrat.

The following parameters were recorded for each quadrat:

1. **Location** – recorded using a hand-held GPS unit (WGS84 datum) at the north-west corner of each quadrat.

2. **Aspect** – N, NNE, NE, E etc.

3. **Slope** – estimated to nearest 5°.

4. **Soil physical properties** - texture, colour and estimated depth (Deep, shallow or skeletal).

5. **Habitat** – description of landform and habitat.

6. **Vegetation Description** - based on the height and estimated percentage foliage cover of the dominant plant species within the vegetation unit (see Section 2.3 above).

7. **Disturbance details** – observed disturbance such as Clearing, grazing, feral animals, weeds and too frequent fire. The condition of vegetation was assessed using the vegetation condition scale of Trudgen (1988) (see Appendix 3).

8. **Percentage foliage cover and height** – estimated for each plant species recorded within the quadrat.

In some instances the vegetation was not extensive enough to warrant quadrat-based survey. In such cases, relevés were conducted. Each relevé survey consisted of a random meander through vegetation during which all plant species encountered were recorded. A subset of variables recorded during quadrat based sampling (see points above) was also recorded during relevé surveys. Overall, 16 relevés were conducted across the study area (Figure 4.1 & 4.2).

Opportunistic sampling of the flora within the study area was also used in order to supplement relevé and quadrat surveys.

3.6 Specimen Identification, Nomenclature and Data Entry

All vascular plants encountered during traverses were recorded. Plants not readily identifiable in the field were collected, pressed and assigned a unique specimen code for later identification.

Plant specimens collected in the field were identified using relevant published taxonomic keys and by comparison with collections held within the Rio Tinto reference herbarium.

Botanical data was entered into the Max3 database and nomenclature therefore follows the current listing of scientific names recognised by the Western Australian Herbarium.

3.7 Study Limitations

There are a number of limitations to the current study which must be taken into consideration when reviewing and applying the results of this study. Limitations of the current study include:

- Fungi and non-vascular flora (e.g. algae, mosses and liverworts) were not systematically sampled during field survey.
- The study area was surveyed once only over a single season. The single phase survey was conducted in early spring following a dry summer and autumn with generally below average rainfall in the months leading up to the survey. It is therefore likely that some ephemeral and cryptic plant taxa which occur at the site were not recorded. Multiple surveys over several seasons would be required in order to compile an exhaustive list of species that occur within the study area.
- All vegetation types were traversed during the survey with targeted searches for DRF and Priority flora undertaken in representative areas of suitable habitat. However, the entire study area was not systematically searched and as such, the inventory of plant species recorded within the study area should be considered as indicative rather than exhaustive.
- No quantitative statistical analysis was undertaken of data collected within survey quadrats and relevés. All vegetation units have been derived by qualitative assessment of vegetation data.

4. Vegetation of the Study Area

A total of 11 vegetation units were recorded across the study area covering 79.2 ha. The remaining 19.5 ha of the study area was categorised as 'Heavily Disturbed' and lacked any discernible native vegetation.

The 11 vegetation units were recorded from 4 habitat types which dominated the locality (Table 4.1). These broad habitats were:

- Plains of red sand including areas with saline influence
- Low aeolian red sand dunes
- Low rocky volcanic and metamorphosed sedimentary hills
- Minor narrow drainage channels of rocky hills and surrounding red sand plains

The distribution of these broad habitats closely followed the spatial distribution of land systems across the study area. The sand dune and sand plain habitats described above occurred exclusively on the colluvial and alluvial deposits associated with the Uaroo land system while the low rocky volcanic and sedimentary hills were consistent with the Ruth land system.

The overall vegetation condition within the study area was Very Good however the condition of vegetation varied in response to proximity to infrastructure related to the Wickham Township. Weeds such as Buffel Grass (*Cenchrus ciliaris*) were predominately recorded around the perimeter of each of the 4 Wickham survey polygons (WSPs) and along the edges of the numerous unsealed tracks which traversed the study area. Weeds were also common in drainage channels. Patches of WSPs 1, 2 and 3 had been recently burnt and it is possible that the vegetation in these areas had been impacted by the passage of too frequent fires.

Table 4.1: Summary of vegetation units recorded within the Wickham Town Expansion study area

Vegetation Code	Vegetation Description	Hectares
Vegetation of red sand plains including areas with saline influence		
SP-1	*Acacia stellaticeps* low open heath over *Triodia schinzii, Triodia epactia* hummock grassland	*36.4*
SP-2	*Grevillea wickhamii* tall open shrubland over *Santalum lanceolatum*, *Acacia bivenosa* open shrubland over *Acacia stellaticeps*, *Diplopeltis eriocarpa* low open shrubland over *Triodia schinzii*, *Triodia epactia* open hummock grassland.	*2.8*
SP-3	*Dolichandrone heterophylla*, *Acacia bivenosa* shrubland over *Acacia stellaticeps*, *Scaevola spinescens* shrubland to low open heath over *Triodia schinzii*, *Triodia epactia* hummock grassland.	2.1
SP-4	*Grevillea wickhamii*, *Acacia tumida* var. *pilbarensis* tall open shrubland to tall open scrub over *Acacia tumida* var. *pilbarensis*, *Acacia bivenosa*, *Acacia ancistrocarpa* shrubland over *Acacia stellaticeps* open scattered shrubs over *Triodia schinzii*, *Triodia epactia* hummock grassland.	7.4
SP-5	*Corymbia hamersleyana* scattered low trees over *Acacia trachycarpa* tall open shrubland over *Acacia stellaticeps* scattered low shrubs over *Triodia epactia* hummock grassland over *Cenchrus ciliaris* very open tussock grassland.	3.2
SP-6	*Acacia synchronicia* open shrubland to tall open shrubland over *Pluchea ferdinandi-muelleri* low open heath over *Triodia epactia* hummock grassland and *Cenchrus ciliaris* very open tussock grassland over *Trianthema turgidifolia*, *Streptaglossa liatroides* herbland.	2.4
SP-7	*Atriplex bunburyana*, *Tecticornia halocnemoides* subsp. *tenuis*, *Tecticornia auriculata* low open heath over *Triodia epactia* scattered hummock grasses.	1.1
Vegetation of low aeolian red sand dunes		
SD-1	*Acacia sabulosa* tall open shrubland over *Acacia sabulosa*, *Santalum lanceolatum* shrubland over *Acacia stellaticeps*, *Diplopeltis eriocarpa*, *Scaevola sericophylla* low shrubland over *Triodia schinzii* open hummock grassland.	8.2
Vegetation of low rocky hills		
LH-1	*Grevillea wickhamii* tall scattered shrubs over *Acacia bivenosa*, *Acacia ancistrocarpa*, *Hakea lorea* open shrubland over *Triodia wiseana*, *Triodia epactia* hummock grassland.	11.7

Vegetation Code	Vegetation Description	Hectares
Vegetation of minor narrow drainage channels of rocky hills and surrounding red sand plains		
MF-1	*Acacia tumida* var. *pilbarensis*, *Grevillea wickhamii* open scrub over *Acacia stellaticeps*, *Scaevola spinescens* low scattered shrubs over *Triodia schinzii* scattered hummock grasses.	0.4
MF-2	*Corymbia hamersleyana* scattered low trees over *Acacia tumida* var. *pilbarensis*, *Grevillea wickhamii* tall open shrubland over *Acacia tumida* var. pilbarensis, *Eremophila longifolia* open shrubland over *Acacia stellaticeps*, *Scaevoila spinescens* low open shrubland over *Triodia epactia* open hummock grassland.	3.5

4.1 Vegetation Units of the Study Area

4.1.1 Vegetation of deep red sand plains

SP-1 *Acacia stellaticeps* low open heath over *Triodia schinzii*, *Triodia epactia* hummock grassland

This vegetation unit was the dominant unit on the deep red sand plains of the Uaroo land system and occupied the greatest total area within the study area (36.4 ha, 37%). Large tracts occurred across WSP 4 with smaller areas mapped in WSP 2 and 3. The vegetation was in Excellent condition in WSP 4 but was disturbed in WSP 2 and 3 due mainly to weed encroachment and possibly too frequent fires. SP-1 vegetation within WSP 2 and 3 was assessed as being in Good condition.

Plant species associated with this vegetation unit included *Pimelea ammocharis*, *Scaevola spinescens*, *S. sericophylla*, *Diplopeltis eriocarpa*, *Bonamia rosea*, *B. linearis*, *Senna glutinosa* subsp. *glutinosa*, *S. artemisioides* subsp. *helmsii*, *A. bivenosa*, *A. sphaerostachya*, *Santalum lanceolatum, Cassytha capillaris* and *Grevillea wickhamii*.

SP-2 *Grevillea wickhamii* tall open shrubland over *Santalum lanceolatum, Acacia bivenosa* open shrubland over *Acacia stellaticeps, Diplopeltis eriocarpa* low open shrubland over *Triodia schinzii, Triodia epactia* open hummock grassland.

This vegetation unit occupied two relatively small areas totalling 2.8 ha (2.8%) in the north and south-east of WSP 4. The vegetation appeared to be associated with slight run-on areas of the sandy plain. Overall the vegetation was in Excellent condition with no obvious signs of disturbance.

Plant species associated with this vegetation unit included Bonamia rosea, *Senna glutinosa* subsp. *luerssenii*, *Acacia pyrifolia*, *A. coriacea*, *A. tumida* var. *pilbarensis*, *A. sphaerostachya*, *Indigofera monophylla*, *Scaevola spinescens* and *Diplopeltis eriocarpa*.

SP-3 *Dolichandrone heterophylla, Acacia bivenosa* shrubland over *Acacia stellaticeps, Scaevola spinescens* shrubland to low open heath over *Triodia schinzii, Triodia epactia* hummock grassland.

This vegetation unit was recorded from two small areas totalling 2.1 ha in the west of WSP 2 and north-east of WSP 4. The vegetation within WSP 4 was in Excellent condition while in WSP 2 the vegetation was assessed as being in Poor condition due to the apparent history of soil disturbance and consequent invasion by Buffel Grass (*Cenchrus ciliaris*).

Plant species associated with this vegetation unit included *Bonamia rosea*, *Indigofera monophylla*, *Santalum lanceolatum*, *Corymbia hamersleyana*, *Hakea lorea*, *Senna glutinosa* subsp. *pruinosa*, *Acacia pyrifolia* and *Hibiscus sturtii*.

SP-4 *Grevillea wickhamii, Acacia tumida* var. *pilbarensis* tall open shrubland to tall open scrub over *Acacia tumida* var. *pilbarensis, Acacia bivenosa, Acacia ancistrocarpa* shrubland over *Acacia stellaticeps* open scattered shrubs over *Triodia schinzii, Triodia epactia* hummock grassland.

This vegetation unit occupied 7.4 ha of land in the central and western parts of WSP 4 and was associated with areas of increased soil moisture at the base of low rocky hills. The vegetation was typically in Excellent condition though some areas in the south west had been cleared for track construction and the extraction of borrow material.

Plant species associated with this vegetation unit included *Scaevola spinescens*, *Hakea lorea*, *Acacia pyrifolia*, *Indigofera monophylla*, *Senna glutinosa* subsp. *glutinosa*, *Diplopeltis eriocarpa*, *Dodonaea coriacea*, *Acacia sphaerostachya*, *Bonamia rosea*, *Ptilotus astrolasius*, *P. calostachyus*, *Goodenia stobbsiana*, *Hybanthus aurantiacus*, and *Santalum lanceolatum*.

SP-5 *Corymbia hamersleyana* scattered low trees over *Acacia trachycarpa* tall open shrubland over *Acacia stellaticeps* scattered low shrubs over *Triodia epactia* hummock grassland over *Cenchrus ciliaris* very open tussock grassland.

This vegetation unit was recorded from the north western corner of WSP 1 and a small area in the north west of WSP 4. Overall SP-5 vegetation covered 3.2 ha of the study area. Weeds were a feature in both the WSP 1 and WSP 4 examples of this vegetation unit and are a consequence of historic and on-going soil disturbance and vegetation clearing within the study area. Overall the vegetation unit was assessed as being in Good to Very Good condition.

Plant species associated with the SP-5 vegetation unit included *Senna artemisioides* subsp. *helmsii*, *Diplopeltis eriocarpa*, *Acacia coriacea* subsp. *pendens*, *A. ancistrocarpa*, *A. sphaerostachya*, *A. bivenosa*, *A. pyrifolia*, *Grevillea wickhamii*, *Pimelea ammocharis*, *Trichodesma zeylanicum*, *Abutilon lepidum*, *A. fraseri*, *Enchylaena tomentosa*, *Solanum horridum*, *Bonamia linearis*, *Cassytha capillaris*, *Panicum decompositum* and *Waltheria indica*.

SP-6 *Acacia synchronicia* open shrubland to tall open shrubland over *Pluchea ferdinandi-muelleri* low open heath over *Triodia epactia* hummock grassland and *Cenchrus ciliaris* very open tussock grassland over *Trianthema turgidifolia, Streptoglossa liatroides* herbland.

This vegetation unit was restricted to sand plain habitat within WSP 1 and covered 2.4 ha of the study area. Parts of this vegetation unit had been recently burnt and *Pluchea ferdinandi-muelleri* formed dense stands approaching monocultures in the burnt patches. Numerous tracks had been cut through this vegetation unit and Buffel Grass was common and widespread within the groundcover stratum. Overall the vegetation was in Good condition according to the condition rating scale of Trudgen (1988).

Other plant species associated with the SP-6 vegetation unit included *Panicum decompositum*, *Sclerolaena hostilis*, *Neptunia dimorphantha*, *Maireana villosa*, *Cassytha capillaris*, *Scaevola acacioides*, *Acacia coriacea* subsp. *pendens*, *Enchylaena tomentosa*, *Eragrostis falcata* and *Atriplex bunburyana*.

SP-7 *Atriplex bunburyana, Tecticornia halocnemoides* subsp*. tenuis, Tecticornia auriculata* low open heath over *Triodia epactia* scattered hummock grasses*.*

This vegetation unit was recorded from the eastern boundary of WSP 1 on parts of the sandy plain with obvious saline influence given the dominance of the halophytic low shrubs; *Atriplex bunburyana, Tecticornia halocnemoides* subsp*. tenuis* and *Tecticornia auriculata*. This vegetation occurred within the mapped extent of the Uaroo land system but is probably more closely associated with vegetation of the nearby Cheerawarra land system. The vegetation was in Good condition.

Plant species associated with the SP-7 vegetation unit included *Scaevola acacioides*, *Neptunia dimorphantha* and *Maireana villosa*.

4.1.2 Vegetation of low aeolian red sand dunes

SD-1 *Acacia sabulosa tall* open shrubland over *Acacia sabulosa, Santalum lanceolatum* shrubland over *Acacia stellaticeps, Diplopeltis eriocarpa, Scaevola sericophylla* low shrubland over *Triodia schinzii* open hummock grassland*.*

This vegetation unit was recorded from an aeolian sand dune feature that ran in a roughly east-west direction and dominated the northern part of WSP 4 (8.3% of study area). A small patch of this unit was also recorded in the south of WSP 4 on a localised sandy rise. Soil disturbance and subsequent minor erosion related to an old telecommunications easement was the most notable disturbance observed within the vegetation unit, however overall, this vegetation was in Excellent condition. This vegetation unit is likely to be susceptible to erosion if the vegetation cover is removed.

Plant species associated with this vegetation unit included *Bonamia rosea*, *Eragrostis eriopoda*, *Acacia tumida* var. *pilbarensis*, *Grevillea wickhamii*, *Scaevola spinescens* and *Triodia epactia*.

Plate 1: Vegetation Unit SP-1

Plate 4: Vegetation Unit SP-4

Plate 2: Vegetation Unit SP-2

Plate 5: Vegetation Unit SP-5

Plate 3: Vegetation Unit SP-3

Plate 6: Vegetation Unit SP-6

Plate 7: Vegetation Unit SP-7

Plate 10: Vegetation Unit MF-1

Plate 8: Vegetation Unit SD-1

Plate 11: Vegetation Unit MF-2

Plate 9: Vegetation Unit LH-1

4.1.3 Vegetation of low rocky hills

LH-1 *Grevillea wickhamii* tall scattered shrubs over *Acacia bivenosa, Acacia ancistrocarpa, Hakea lorea* open shrubland over *Triodia wiseana, Triodia epactia* hummock grassland.

This vegetation unit occupied the lower slopes of rocky hills along the western boundary of WSP 4 as well as a low hill which rose several metres above the sandy plain in the central part of WSP 4. The rocky hills are associated with the Ruth land system and consist of volcanic rocks as well as sedimentary strata of chert, jaspilite, shale and siltstone. The LH-1 vegetation unit occupied a total area of 11.7 ha and was in Excellent condition.

Plant species associated with this vegetation unit included *Senna glutinosa* subsp. *pruinosa*, *S. glutinosa* subsp. *glutinosa*, *Acacia synchronicia*, *Ptilotus exaltatus*, *Ptilotus calostachyus*, *Ficus brachypoda*, *Goodenia stobbsiana*, *Dodonaea coriacea*, *Acacia tumida* var. *pilbarensis*, *Hybanthus aurantiacus*, *Eriachne mucronata*, *Corymbia hamersleyana*, *Corchorus parviflorus* and *Tribulus suberosus*.

4.1.4 Vegetation of minor narrow drainage channels of rocky hills and surrounding red sand plains

MF-1 *Acacia tumida* var. *pilbarensis, Grevillea wickhamii* open scrub over *Acacia stellaticeps, Scaevola spinescens* low scattered shrubs over *Triodia schinzii* scattered hummock grasses.

This vegetation was recorded from two minor flowlines which drained the low rocky hill in the centre of WSP 4 and covered 0.4 ha of the study area. The MF-1 unit was in Excellent condition with no evidence of past disturbance observed.

Plant species associated with the MF-1 vegetation unit included *Corymbia hamersleyana*, *Acacia bivenosa*, *Triodia wiseana*, *Acacia ancistrocarpa* and *Keraudrenia velutina*.

MF-2 *Corymbia hamersleyana* scattered low trees over *Acacia tumida* var. *pilbarensis, Grevillea wickhamii* tall open shrubland over *Acacia tumida* var. *pilbarensis, Eremophila longifolia* open shrubland over *Acacia stellaticeps, Scaevola spinescens* low open shrubland over *Triodia epactia* open hummock grassland.

This vegetation unit was recorded from minor flowlines draining the rocky hills in the west of WSP 4 and also within a minor flowline traversing the sandy plain along the southern boundary of WSP 4. Overall the MF-2 vegetation unit occupied 3.5 ha within the study area. The condition of the vegetation was generally Very Good however some areas

located close to urban development in the north-west corner of WSP 4 were in Poor condition. Buffel Grass was recorded from all areas of this vegetation unit.

Plant species associated with this vegetation unit included *Hakea lorea*, *Solanum horridum*, *Indigofera monophylla*, *Bonamia rosea*, *Santalum lanceolatum*, *Trichodesma zeylanicum*, *Acacia pyrifolia*, *Abutilon lepidum* and *Diplopeltis eriocarpa*.

HD Heavily Disturbed Ground

A relatively large proportion of the study area (~20%) did not contain any intact native vegetation and was therefore mapped as 'Heavily Disturbed' ground. These areas included unsealed tracks, infrastructure related to the township of Wickham (e.g. buildings, carparks, roads, powerline easements), an old borrow pit (WSP 4) and previously disturbed vegetation subsequently dominated by weeds such as Buffel Grass.

4.2 Probable distribution of the Vegetation Units Based on their Correspondence with Land Systems

Vegetation within the study area was closely associated with the distribution of land systems. Vegetation of the sandy plains and aeolian red sand dunes were restricted to the Uaroo land system while vegetation of the low rocky hills and minor drainage lines typically occurred within areas mapped as the Ruth land system (van Vreeswyk *et al.* 2004).

The Uaroo land system is common and distributed widely across the western Pilbara with extensive areas around Onslow and Port Hedland. However, this land system is relatively uncommon in the Karratha, Wickham and Cape Lambert areas. On the basis of the distribution of the Uaroo land system, vegetation of the sandy plains and aeolian dunes recorded within the study area are likely to be locally uncommon but widespread in coastal areas of the Roebourne Plains and Chichester sub-regions of the Pilbara bioregion. This interpretation appears to be supported by previous studies with only small areas of similar vegetation having been recorded sporadically throughout the Karratha, Wickham and Cape Lambert locality (see Biota 2008a).

On the basis of the distribution of the Ruth land system and the widespread nature of the dominant plant species within the study area; vegetation units associated with the Ruth land system within the study area are likely to be common and widespread in the western Pilbara.

4.3 Conservation Significance of Vegetation Units

None of the vegetation units identified within the study area are consistent with any TECs or PECs as defined by the DEC (DEC 2010a; 2010b). Moreover, none of the vegetation units qualify for legislative protection under the EPBC Act. Several vegetation units were considered to have moderate conservation significance at a local scale (see Section 4.3.1) while the remaining vegetation within the study area is though to have low conservation significance.

4.3.1 Vegetation Units of Moderate Conservation Significance

Vegetation units associated with the Uaroo land system within the study area may be locally uncommon and are therefore considered to have moderate conservation significance. These vegetation units include SP-1 to SP-7 and SD-1. Unnecessary disturbance to these vegetation types should be kept to a minimum and areas of Poor condition should be cleared in preference to areas of Very Good or Excellent condition.

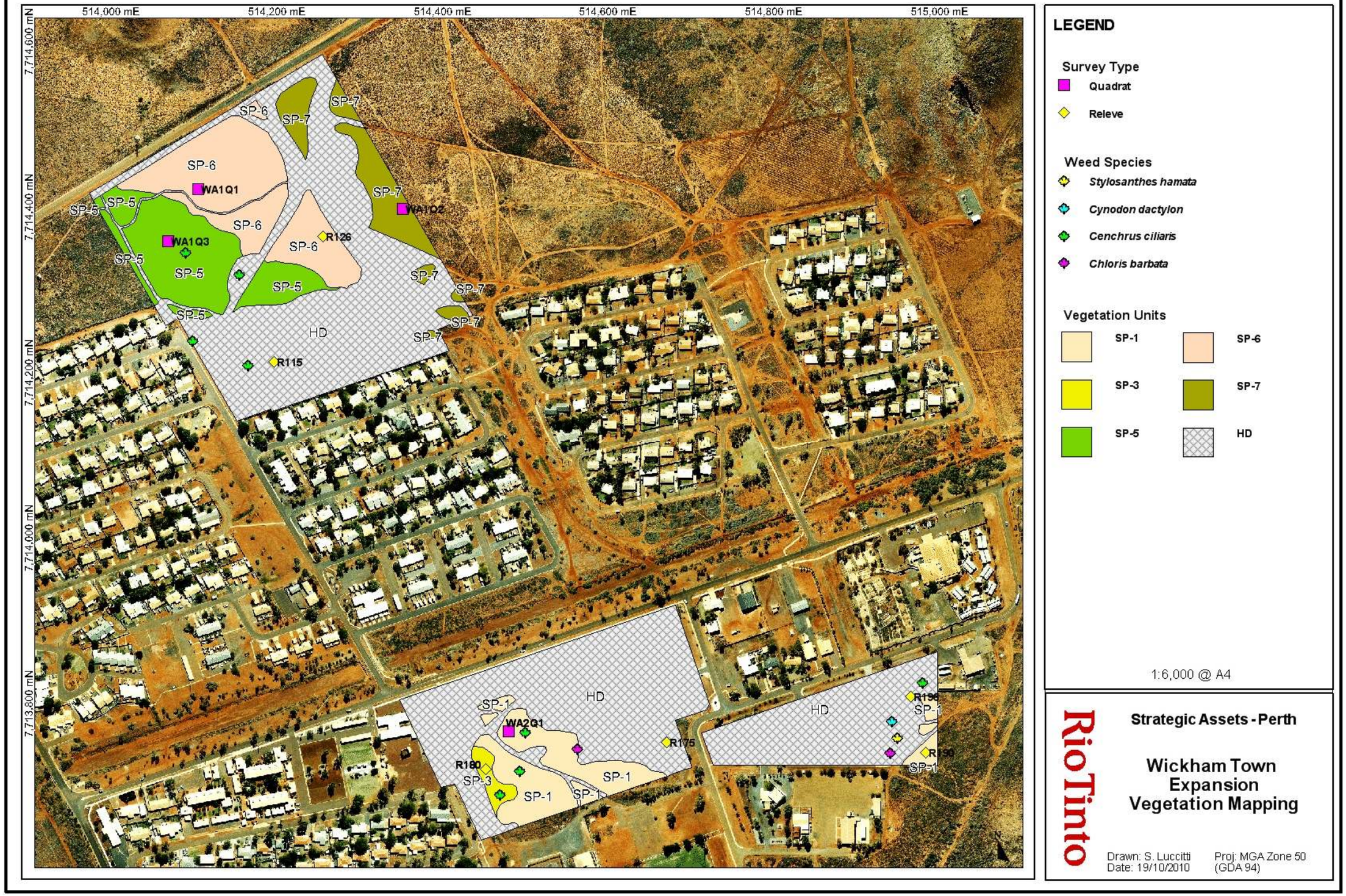

Figure 4.1: Vegetation mapping within the northern WSPs (WSP 1, 2 & 3) of the proposed Wickham Town Expansion study area.

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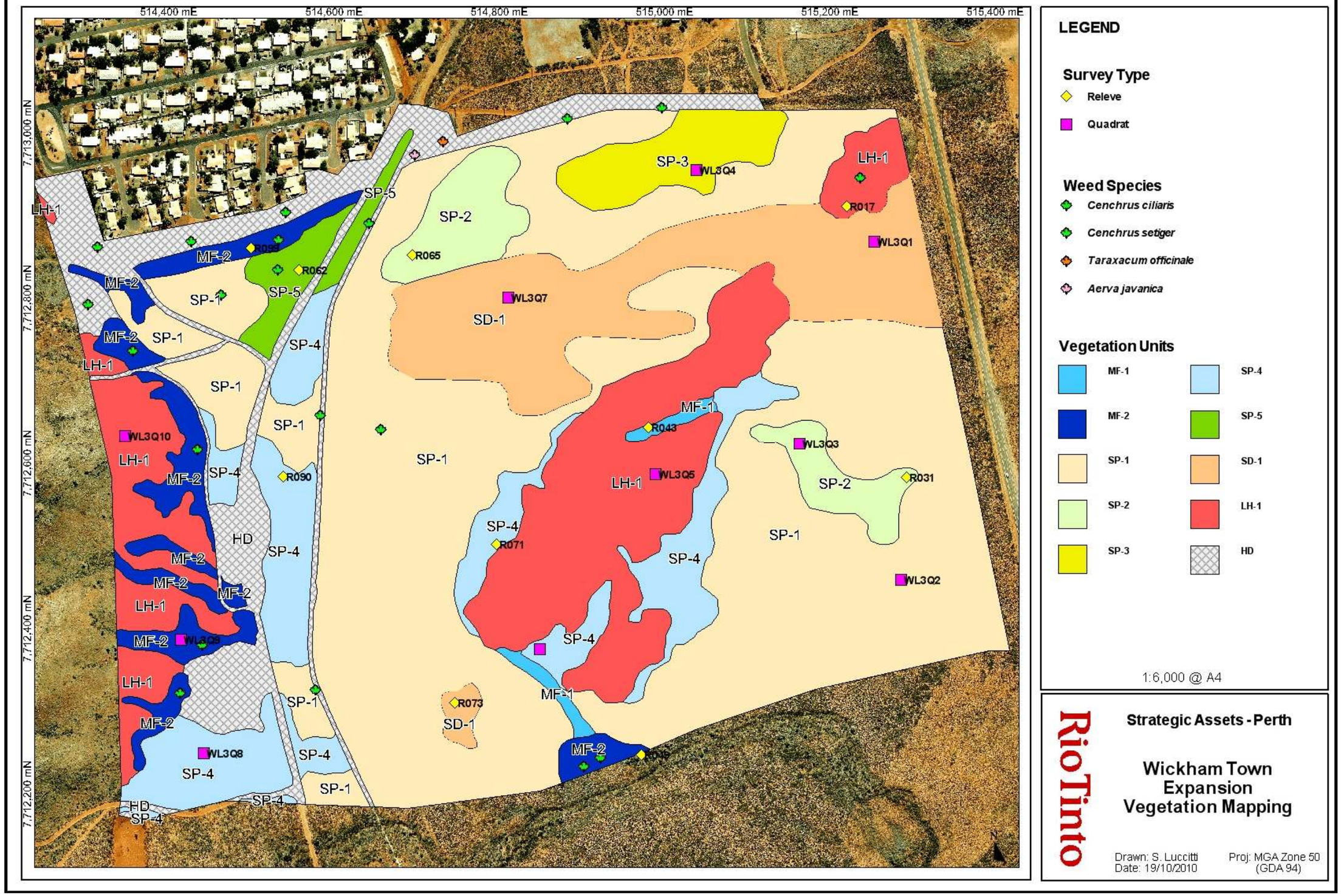

Figure 4.2: Vegetation mapping within the southern WSP (WSP 4) of the proposed Wickham Town Expansion study area.

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5. Flora of the Study Area

5.1 Native flora within the Study Area

A total of 97 native vascular plant taxa from 56 genera belonging to 27 families were recorded in the study area (Appendix 4). No Declared Rare Flora (DRF) or Priority flora species were recorded during the survey (Section 5.2.1). In addition, 7 weed species were recorded (Section 5.2.3).

The study area is considered to have a species richness value within the range expected for its size when compared to results obtained by other studies in the Wickham/Cape Lambert locality (Table 5.1). Biota (2008c) have noted that coastal areas in the Pilbara bioregion typically do not have high levels of specie richness due to; (a) the general paucity of the flora of the coastal environments within the Roebourne and Chichester subregions, and (b) the harshness of many habitats to plant growth (e.g. saline clay flats).

The number of species recorded during the current study is partly a function of the number of habitat types within the study area as well as the amount of rainfall received by the locality. Conditions were very dry at the time of survey and it is likely that a number of ephemeral species were overlooked during the current study.

Table 5.1: The number of native plant species, genera and families recorded during the current survey and by previous surveys in the vicinity of the Wickham Town Expansion survey area.

	Current Survey	Biota (2008a)	Biota (2008c)	Biota (2008e)	Pilbara Iron (2005)	GHD (2008)
Study area (ha)	98	1078	602	465	24	1793
# Native species	97	221	183	153	94	156
# Native genera	56	116	98	89	63	Not reported
# Native families	27	41	42	40	29	34

The families and genera within the study area with the greatest number of taxa are indicative of the plant groups which typically dominate survey areas in the coastal Pilbara locality. Mimosaceae (17 taxa), Malvaceae (9 taxa), Chenopodiaceae (8 taxa) and Poaceae (8 taxa) were the most species rich families recorded across the study area, while *Acacia* and *Senna* were the best represented genera within the study area.

5.2 Conservation Significant Flora Recorded During the Field Survey

5.2.1 Declared Rare Flora Occurring in the Locality

No Declared Rare Flora listed under the Commonwealth *EPBC Act 1999* or listed by the WA DEC were recorded within the study area, and none would be expected to occur on the basis of available habitats.

Lepidium catapycnon and *Thryptomene wittweri* are the only DRF species that occur within the Pilbara region. Ideal habitat for *Thryptomene wittweri* is restricted to mountain crests in high altitude areas (i.e. >1,000 m above sea level) and such habitat was not represented within the study area. Therefore this species is not expected to occur within or adjacent to the study area.

Lepidium catapycnon is known to occur on stony hills habitat in the Hamersley Ranges; with a distribution extending broadly from Tom Price across to east of Newman. Given the distribution of this species and lack of suitable habitat, it would not be expected to occur in the study area.

5.2.2 Priority Flora Occurring in the Locality

No Priority flora species or other flora of conservation significance were recorded within the study area.

Database searches undertaken during the desktop study identified 11 Priority flora as potentially occurring in the study area. A brief description of each Priority flora species and the likelihood of occurrence within the study area are presented in Table 5.2 below.

Table 5.2: Priority flora returned by database searches for a 50 km radius around the study area.

Scientific Name	Conservation Listing		Likelihood of Occurrence within the Study Area	Habitat and Discussion
	WCA	EPBCA		
Acacia glaucocaesia	P3	N/A	Low	Large shrub to small tree found on red loam, sandy loam and clay soils on floodplains. While suitable habitat exists, no individuals were observed
Rhynchosia bungarensis	P4	N/A	Low	Twining herb or creeper with resinous, sticky glands. Occurs in large creeks/rivers and gorges. No suitable habitat exists within the study area.
Gymnanthera cunninghamii	P3	N/A	Low	Shrub to 2m, recorded amongst rockpiles of the Dampier Archipelago. No records from the Cape Lambert/Wickham vicinity. Species unlikely occur.
Schoenus punctatus	P3	N/A	Low	Small sedge growing in muddy creek on the Burrup Peninsula. No suitable habitat occurs within the study area.
Stackhousia clementii	P3	N/A	Low	Cryptic taxa, little is known of the habitat requirements for this species. Has been recorded on saline soils in King Bay on the Burrup Peninsula. No records from the Cape Lambert/Wickham vicinity however this species could occur within the study area.

Scientific Name	Conservation Listing		Likelihood of Occurrence within the Study Area	Habitat and Discussion
	WCA	EPBCA		
Tephrosia bidwillii	P3	N/A	Low	Shrub. Recorded in the Karratha locality. No specimens have been recorded despite extensive surveying efforts across the Cape Lambert/Wickham area. Despite this, this species may potentially occur in the study area.
Terminalia supranitifolia	P3	N/A	Low	Spreading tangled tree or shrub growing among basalt rocks. No records from the Cape Lambert/Wickham area despite extensive surveying efforts.
Themeda sp. Hamersley Station (M.E. Trudgen 11431)	P3	N/A	Low	Recorded on cracking clay associated with mixed tussock grasslands of the Roebourne grasslands plains community. No habitat for this species exists within the study area.
Vigna sp. Rockpiles (R. Butcher et al. RB 1400)	P3	N/A	Low	Twining herb or climber, recorded on the Burrup peninsula. No records from Cape Lambert/Wickham vicinity, unlikely to be recorded in the study area.
Helichrysum oligochaetum	P1	N/A	Low	Herb growing to 25 cm known from scattered records in the Pilbara and Gascoyne. Growing in the Cape Lambert locality on red clay. Extensive surveys undertaken within and adjacent to the study area, no new records have been recorded. No areas of red clay occur within the study area.
Nicotiana heterantha	P1	N/A	Low	Decumbent, short-lived annual or perennial, herb, to 0.5 m high, forming low, spreading colonies. Was recorded by Biota (2008d) on a broad loamy plain in a floodout of the Harding Dam. Broad floodout habitats are absent from the study area.

The majority of the 11 Priority flora species returned by the database searches are considered unlikely to inhabit the study area due to the fact that:

1. Available habitats within the study area are not suitable, and/or
2. The species is perennial and readily identifiable in the field and therefore unlikely to have been overlooked during the survey.

The majority of Priority flora species returned by database searches are associated with habitats such as rock piles, cracking clay plains or large creeklines; none of which occurred within the study area.

The study area provides potential habitat for two Priority 3 plant species, *Stackhousia clementii* and *Tephrosia bidwillii* however neither of these two species have been recorded in the Cape Lambert locality. Both *S. clementii* and *T. bidwillii* are only known from locations approximately 25-30 km west of the study area. Given the dearth of local records for these species, it is unlikely that they would be significantly impacted under the current proposal.

5.2.3 Introduced Flora Occurring within the Study Area

Seven introduced flora species were recorded within the study area (Figure 4.1 & 4.2; Table 5.3). None of the species are listed as Declared Plants under the *Agriculture and*

Related Resources Protection Act 1976; however Kapok Bush (*Aerva javanica*) and the two *Cenchrus* species are considered to be serious environmental weeds.

Cenchrus ciliaris (Buffel Grass) is a tufted perennial which was widely planted throughout pastoral regions of WA as a pasture grass and has since become a major weed of roadsides, creeklines and river edges (Hussey *et al.* 2007). Buffel Grass was the most common weed species encountered within the study area and was most prevalent along disturbed vegetation edges.

Cenchrus setiger (Birdwood Grass) has a similar form and habit to its congener, Buffel Grass and was similarly established in north west Australia as a fodder species in pastoral areas. As is the case for Buffel Grass, this species has established itself as a major weed of watercourses and disturbed areas. Birdwood Grass was recorded from a minor flowline which skirted the southern boundary of WSP 4.

Aerva javanica (Kapok Bush) is a common and widespread weed of disturbed areas in the Pilbara. This species was recorded in low numbers from heavily disturbed areas within the study area, particularly road and track verges.

Chloris barbata (Purpletop Chloris) is an annual grass, or herb that prefers growing on sand dunes and river levees (Florabase). This species was recorded sporadically from a heavily disturbed, artificial drainage swale in the north of WSP 4.

****Taraxacum officinale*** (Dandelion) is a rosetted perennial herb that is a weed of lawns, roadsides and waste places (Florabase). Individuals of this species were recorded sporadically from heavily disturbed areas in the north of WSP 4.

Stylosanthes hamata (Verano Stylo) is a perennial herbaceous pea which grows to approximately 30 cm. It was imported in to Australia as a fodder crop for tropical regions and has become naturalised in the Kimberley and coastal areas of the Pilbara bioregion. Verano Stylo was recorded from a heavily disturbed area in the east of WSP 3.

Cynodon dactylon (Couch Grass) is a prostrate, perennial grass, which spreads by rhizomes and stolons which root at the nodes (Florabase). It grows in sandy, loamy or clay soils and is widely planted as a lawn grass. The species was recorded from a heavily disturbed area in the east of WSP 3.

Table 5.3: Representative locations of introduced flora recorded within the proposed Wickham Town Expansion study area. Projection: MGA Zone 50 (GDA 94).

Species Name	Common Name	Easting	Northing
Aerva javanica	Kapok Bush	514700	7712972
Cenchrus ciliaris	Buffel Grass	514093	7714343
Cenchrus ciliaris	Buffel Grass	514101	7714237
Cenchrus ciliaris	Buffel Grass	514158	7714317
Cenchrus ciliaris	Buffel Grass	514472	7713688
Cenchrus ciliaris	Buffel Grass	514495	7713716
Cenchrus ciliaris	Buffel Grass	514981	7713823
Cenchrus ciliaris	Buffel Grass	514502	7713763
Cenchrus ciliaris	Buffel Grass	514168	7714207
Cenchrus ciliaris	Buffel Grass	514316	7712862
Cenchrus ciliaris	Buffel Grass	514885	7713016
Cenchrus ciliaris	Buffel Grass	514999	7713030
Cenchrus ciliaris	Buffel Grass	514442	7712379
Cenchrus ciliaris	Buffel Grass	514416	7712321
Cenchrus ciliaris	Buffel Grass	514437	7712616
Cenchrus ciliaris	Buffel Grass	514465	7712803
Cenchrus ciliaris	Buffel Grass	514534	7712833
Cenchrus ciliaris	Buffel Grass	514535	7712870
Cenchrus ciliaris	Buffel Grass	514359	7712735
Cenchrus ciliaris	Buffel Grass	514304	7712792
Cenchrus ciliaris	Buffel Grass	514924	7712243
Cenchrus ciliaris	Buffel Grass	515239	7712945
Cenchrus ciliaris	Buffel Grass	514658	7712640
Cenchrus ciliaris	Buffel Grass	514645	7712890
Cenchrus ciliaris	Buffel Grass	514585	7712657
Cenchrus ciliaris	Buffel Grass	514579	7712325
Cenchrus ciliaris	Buffel Grass	514429	7712868
Cenchrus ciliaris	Buffel Grass	514544	7712903
Cenchrus setiger	Birdwood Grass	514905	7712233
Chloris barbata	Purpletop Chloris	514565	7713743
Chloris barbata	Purpletop Chloris	514943	7713738
Cynodon dactylon	Couch	514944	7713776
Stylosanthes hamata	Verano Stylo	514951	7713756
Taraxacum officinale	Dandelion	514734	7712989

6. Statement Addressing the 10 Clearing Principles

Under Part V Division 2 of the Environmental Protection Act 1986, clearing of 1 ha or more of native vegetation requires a permit 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 ESA.

The Department of Mines and Petroleum (DMP) has responsibility for the administration, assessment and approval of clearing permit applications relating to mineral and petroleum activities in Western Australia. The DMP is required to assess applications for clearing permits against the 10 "Clearing Principles", as defined in Schedule 5 of the Environmental Protection Act 1986.

Section 6.1 provides an assessment of the proposed project against the "10 Clearing Principles" to determine whether it is at variance to the Principles. Assessment against the Principles identified clearing within the survey area is unlikely to be at variance with any of the clearing principles.

6.1 Clearing Principles

6.1.1 Comprises a high level of biological diversity

Native vegetation should not be cleared if it comprises a high level of biological diversity.

6.1.1.1 Ecosystem level

The study area lies within the Uaroo and Ruth land systems. The Ruth land system is the least extensive of the two within the Pilbara bioregion however neither is particularly restricted in their distribution.

The study area contains a moderate diversity of landforms including low rocky hills, sandy plains, low sand dunes and minor watercourses. While the sand plains and sand dunes within the study area are possibly locally uncommon, these landforms are widespread in the coastal areas of the Pilbara to the north and south.

Eleven intact vegetation units were identified from the various habitats within the study area. None of the vegetation units are consistent with any listed TECs or PECs and none are listed as threatened under the Commonwealth EPBC Act. Moreover, none of the vegetation units recorded within the study area is thought to be restricted to the study area or broader Wickham/Cape Lambert locality. Vegetation associated with the sandy plains and sand dunes may be locally uncommon but such vegetation would occur extensively in other areas of the Uaroo land system.

The condition of vegetation units ranged from Poor to Excellent with most units assessed as Good to Excellent condition. None of the 11 vegetation units were considered to be particularly rich in native flora.

6.1.1.2 Species level

The study area did not contain a particularly high diversity of native flora at the time of survey. A total of 97 native plant taxa were identified within the study area from 56 genera belonging to 27 plant families. Species richness within families and genera were considered typical for the Pilbara bioregions as was the types of families and genera represented.

The study area was surveyed in September, 2010 following poor summer and winter rainfall and, as such, some annual and short-lived perennial plant species are likely to have been overlooked. As a result the tally of native species recorded during the survey probably underestimates the plant species richness within the study area. Additional ephemeral species would be expected to occur following good winter and/or summer rainfall. It is unlikely however, given the habitats present, that additional survey effort would dramatically increase the number of species recorded such that the study area was considered to contain a high diversity of plant species.

Fauna habitats identified within the study area are considered to be well represented both locally and regionally and the study area is unlikely to contain a high diversity of fauna species (Biota 2010).

6.1.2 Potential impact to any significant habitat for fauna indigenous to Western Australia

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 to Western Australia.

A Level 1 fauna assessment of the Wickham town expansion study area was conducted by Biota Environmental Sciences in 2010 (Biota 2010). The level 1 assessment was conducted using searches of the DSEWPC Protected Matters Database, the DEC NatureMap Database, Biota Environmental Sciences Internal Database, and a review of previous fauna surveys in the area and other relevant literature (Biota 2010). A targeted survey for Short-range Endemic (SRE) invertebrates and a habitat assessment was conducted by Biota in September 2010 at various locations both within and adjacent to the study area (Biota 2010).

Biota identified seven broad fauna habitat types occurring within the Wickham study area. The majority of the fauna habitats in the study area were considered by Biota to be degraded and were not considered to be significant from a conservation perspective. The remaining fauna habitats in the study area were considered to be widespread and well represented elsewhere in the region (Biota, 2010)

Federal and State government database searches, and searches of the Biota internal database in combination with literature reviews yielded a potential total of 199 avifauna species, 40 native mammal species, seven introduced mammals species, six frog species and 92 reptile species occurring within the Wickham study area (Biota 2010).

In addition, the database searches indicated that 18 species of threatened fauna could potentially occur within the study area (Biota 2010). However an assessment of each species found that habitat within the study area was unlikely to support fauna of elevated

conservation significance and, the small scale and the nature of the development indicated that the conservation status of fauna species listed under Federal or State legislation is unlikely to be adversely affected (Biota 2010).

Similarly Biota stated that the potential impact on invertebrate taxa is considered negligible and the potential SRE species that were recorded within the proposed development area during the survey were also recorded outside the impact area (Biota 2010.

6.1.3 Potential impact to any rare flora

Native vegetation should not be cleared if it includes, or is necessary for the continued existence of rare flora.

The study area was traversed by a Rio Tinto botanist from the 28th to the 30th of September 2010. No Declared Rare Flora or any EPBC Act listed threatened flora were observed within the study area and none would be expected to occur.

No Priority Flora listed species were recorded in the study area, however two Priority 3 species could occur (see Section 5.2.2). It is unlikely the proposal will impact on the conservation status of either of the two species.

6.1.4 Presence of any Threatened Ecological Communities

Native vegetation should not be cleared if it comprises the whole or part of, or is necessary for the maintenance of a threatened ecological community (TEC).

No Threatened Ecological Communities (TEC) or Priority Ecological Communities (PECs) occur within the study area nor are any likely to be directly or indirectly impacted on by the proposal (see Section 2.7).

6.1.5 Significance as a remnant of native vegetation in the area that has been extensively cleared

Native vegetation should not be cleared if it is significant as remnant vegetation in an area that has been extensively cleared.

The majority of the Pilbara region, including the Chichester subregion, has never been extensively cleared, however grazing, inappropriate fire regimes and weed invasion have greatly altered the vegetation in some areas.

Native vegetation within the study area is consistent with Beard (1975) mapping units;

- **Abydos Plain/Chichester - 157** Hummock grasslands, grass steppe; hard spinifex*, Triodia wiseana* and;
- **Abydos Plain/Roebourne – 589** -Mosaic of short bunch grassland - savanna / grass plain (Pilbara) / hummock grasslands, grass steppe; soft spinifex.

According to Shepherd *et al.* (2002) there are approximately 100% of these vegetation types remaining. These vegetation associations are widely represented within the Chichester bioregion and would not be considered remnant vegetation.

6.1.6 Impact on any watercourses and/or wetlands

Native vegetation should not be cleared if it is growing in, or in association with, an environment associated with a watercourse or wetland.

No permanent watercourses or wetlands are found within the study area however the study area does contain numerous minor, ephemeral watercourses. The current proposal may, therefore, result in the loss of vegetation associated with a watercourse.

The proposed clearing is likely to have a negligible impact on minor watercourses and creeklines within and outside the study area. The loss of vegetation is not likely to significantly increase runoff or sediment transport to the watercourses nor is removal of riparian vegetation likely to destabilise creek banks or lead to significant erosion of riparian zones.

6.1.7 Potential to cause appreciable land degradation

Native vegetation should not be cleared if the clearing of vegetation is likely to cause appreciable land degradation.

Vegetation within the study area occurs on the Uaroo and Ruth land systems; neither of which are considered to be susceptible to erosion or vegetation degradation (van Vreeswyk *et al.* 2004). Some small areas of soil erosion were noted within WSP 4 however these were associated with extensive soil disturbance (i.e. borrow pit excavation) as well as vegetation clearing. The removal of vegetation from the sand dune feature in the north of WSP 4 has the potential to exacerbate erosion within the study area.

Clearing of vegetation within the study area is unlikely to result in acidification, salinisation, water-logging or nutrient export within or outside the study area.

Weeds are already common across the study area and it is unlikely that the proposal will greatly exacerbate the spread of weeds in the local area.

Strict weed hygiene measures together with adequate sediment and erosion control procedures will minimise potentially adverse impacts of the proposal such that the proposal is unlikely to lead to appreciable land degradation.

6.1.8 Potential to impact on the environmental values of any adjacent or nearby conservation areas

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.

The nearest land-based, non-marine DEC conservation estate, Millstream-Chichester National Park is located approximately 52 km south east of the study area. The proposal would therefore not impact on the environmental values of the National Park, or any other conservation area.

6.1.9 Potential deterioration in the quality of surface or underground water

Native vegetation should not be cleared if the clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water.

The study area is not located within a Public Drinking Water Source Area (PDWSA) (GIS Database).

The proposal is unlikely to significantly impact on the quality of surface or groundwater resources in the area.

Drainage lines within the study area are ephemeral and would only hold surface water for short durations following significant rainfall events. Sediment loads are typically high in flowlines at such times and therefore any increase to the sediment load caused by the proposal is likely to be negligible. The proposal is unlikely to alter other chemical or physical water quality parameters.

Given the small scale of proposed clearing there is no reason to expect the proposal will have any impact on the quantity or quality of groundwater in the local area.

6.1.10 Potential of clearing to cause, or exacerbate, the incidence or intensity of flooding

Native vegetation should not be cleared if the clearing of vegetation is likely to cause, or exacerbate, the incidence of flooding.

Local flooding occurs seasonally in the Pilbara region as a result of cyclonic activity and sporadic thunderstorm activity. It is likely the ephemeral drainage lines within the study area would experience natural seasonal flooding during times of intense rainfall. However, the small area to be cleared (98.3 ha) is not likely to lead to an increase in flood height or duration.

Conservation Significance Summary

Intact native vegetation occupied 79.2 ha of the study area and was typically in Good or better condition. Disturbance was most prevalent where the vegetation bordered cleared urban areas and disturbance was typically related to clearing for tracks and infrastructure. Weeds were common throughout WSP 1, 2 and 3 and were observed frequently along the northern boundary of WSP 4.

Eleven vegetation units were identified across the study area. None of the 11 vegetation units are listed under the *EPBC Act 1999* nor are any defined as TECs or PECs by the DEC (DEC 2010a; 2010b). Vegetation units associated within sandy plains and aeolian sand dunes were, however, identified as having moderate conservation significance on the basis that such habitats are locally uncommon in the Wickham and Cape Lambert localities.

No DRF or Priority flora were recorded during the field survey nor have any been recorded previously within the study area. The study area may provide suitable habitat for the Priority 3 species *Stackhousia clementii* and *Tephrosia bidwillii* however the proposed development of the Wickham Town Expansion project is unlikely to impact the conservation significance of this species.

An assessment of fauna habitats and SRE fauna survey undertaken by Biota (2010) found that habitat within the study area was unlikely to support fauna of elevated conservation significance and, the small scale and the nature of the development indicated that the conservation status of fauna species listed under Federal or State legislation is unlikely to be adversely affected (Biota 2010). Similarly Biota (2010) found that the potential impact on invertebrate taxa is considered negligible and the potential SRE species that were recorded within the proposed development area during the survey were also recorded outside the impact area (Biota 2010).

Recommendations

The following recommendations are made to minimise impacts to the vegetation, flora and fauna within and surrounding the study area.

- Disturbance to SP-1, SP-2, SP-3, SP-4, SP-5, SP-6, SP-7 & SD-1 vegetation in Excellent condition should be minimised wherever possible.
- Clearing of vegetation unit SD-1, where necessary, should be undertaken in a manor commensurate with the erosion risk posed by this vegetation unit.
- Strict weed hygiene protocols are to be implemented during clearing of vegetation and subsequent earth works to minimise the spread of weeds.
- All topsoil from cleared areas is to be collected and stockpiled for use in any rehabilitation programs within the study area or surrounding areas.
- As a general rule, disturbance to the soil and vegetation should be kept to a minimum.

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Appendix 1: Biota Environmental Sciences (2010) *Wickham Town Expansion Level 1 Fauna Assessment and SRE Fauna Survey*. Unpublished report prepared for Rio Tinto Iron Ore, October 2010.

Appendix 2: Results of DEC Flora Searches and EPBC Act Protected Matters Database Search

SHEET	SPNAME	CONSVCODE	POPID1	GDA94LAT	GDA94LONG	OWNERDATE
Threatened Flora Database Search Results						
29320	Acacia glaucocaesia	3	4	-20.7845	117.14383	18/07/2004
29318	Acacia glaucocaesia	3	6	-20.72489	117.01611	5/10/2004
28289	Stackhousia clementii	3	4	-20.62942	116.78422	30/04/2002
28290	Stackhousia clementii	3	5	-20.61761	116.78939	14/06/2003
19026	Terminalia supranitifolia	3	1	-20.609	116.78259	6/12/1978
19027	Terminalia supranitifolia	3	2	-20.65856	116.74411	12/12/1971
19028	Terminalia supranitifolia	3	3	-20.627	116.79939	1/05/1983
19029	Terminalia supranitifolia	3	4	-20.68334	116.74411	1/12/1986
19030	Terminalia supranitifolia	3	5	-21.05723	116.8042	6/07/1986
19032	Terminalia supranitifolia	3	7	-20.61678	116.78697	30/10/2001
19033	Terminalia supranitifolia	3	7	-20.61284	116.79272	31/10/2001
WA Herbarium Search Results						
PERTH 06492347	Acacia glaucocaesia	P3		-20.72339	117.01623	05 07 2003
PERTH 00152897	Acacia glaucocaesia	P3		-20.78333	116.96667	07 1979
PERTH 00669423	Acacia glaucocaesia	P3		-20.78333	116.96667	11 1979
PERTH 06492339	Acacia glaucocaesia	P3		-20.72358	117.01753	05 07 2003
PERTH 00872148	Acacia glaucocaesia	P3		-20.66666	116.70306	26 07 1987
PERTH 00153397	Acacia glaucocaesia	P3		-20.73972	116.84806	09 1961

SHEET	SPNAME	CONSVCODE	POPID1	GDA94LAT	GDA94LONG	OWNERDATE
PERTH 00808458	Acacia glaucocaesia	P3		-20.66666	116.70306	07 1986
PERTH 07871929	Acacia glaucocaesia	P3		-20.78333	117.16667	18 08 1983
PERTH 07161263	Acacia glaucocaesia	P3		-20.7845	117.14384	18 07 2004
PERTH 06926940	Acacia glaucocaesia	P3		-20.72488	117.01611	05 10 2004
PERTH 08253293	Rhynchosia bungarensis	P4		-20.53011	116.83526	27 06 2000
PERTH 02907690	Rhynchosia bungarensis	P4		-20.50805	116.84	05 06 1962
PERTH 08158886	Rhynchosia bungarensis	P4		-20.53011	116.83526	27 06 2000
PERTH 08158908	Rhynchosia bungarensis	P4		-20.48741	116.83286	29 05 2000
PERTH 08158851	Rhynchosia bungarensis	P4		-20.53011	116.83526	27 06 2000
PERTH 08158878	Rhynchosia bungarensis	P4		-20.53011	116.83526	27 06 2000
PERTH 08158894	Rhynchosia bungarensis	P4		-20.50267	116.8268	29 05 2000
PERTH 08158983	Rhynchosia bungarensis	P4		-20.50267	116.8268	29 05 2000
PERTH 08158991	Rhynchosia bungarensis	P4		-20.57404	116.8051	26 06 2000
PERTH 08159009	Rhynchosia bungarensis	P4		-20.61269	116.78227	22 05 2000
PERTH 08159017	Rhynchosia bungarensis	P4		-20.53496	116.81955	27 05 2000
PERTH 08131090	Rhynchosia bungarensis	P4		-20.60637	116.75697	26 05 2000
PERTH 08159025	Rhynchosia bungarensis	P4		-20.53371	116.81913	27 05 2000
PERTH 08131104	Rhynchosia bungarensis	P4		-20.61543	116.75805	26 05 2000

SHEET	SPNAME	CONSVCODE	POPID1	GDA94LAT	GDA94LONG	OWNERDATE
PERTH 08131120	Rhynchosia bungarensis	P4		-20.53369	116.83808	27 05 2000
PERTH 08131139	Rhynchosia bungarensis	P4		-20.56604	116.82089	05 06 2000
PERTH 08131147	Rhynchosia bungarensis	P4		-20.54908	116.84486	25 05 2000
PERTH 08131155	Rhynchosia bungarensis	P4		-20.64027	116.77736	20 05 2000
PERTH 08131163	Rhynchosia bungarensis	P4		-20.54632	116.82824	25 05 2000
PERTH 08131171	Rhynchosia bungarensis	P4		-20.63894	116.78666	20 05 2000
PERTH 08159041	Rhynchosia bungarensis	P4		-20.64576	116.76178	21 05 2000
PERTH 08159068	Rhynchosia bungarensis	P4		-20.69183	116.72146	28 05 2000
PERTH 08159076	Rhynchosia bungarensis	P4		-20.64895	116.75974	21 05 2000
PERTH 08159084	Rhynchosia bungarensis	P4		-20.56679	116.81918	05 06 2000
PERTH 07271484	Rhynchosia bungarensis	P4		-20.78333	116.76667	21 09 1983
PERTH 06298400	Schoenus punctatus	P3		-20.56589	116.82356	10 07 1999
PERTH 06404146	Stackhousia clementii	P3		-20.63026	116.78416	30 04 2002
PERTH 02923017	Tephrosia bidwillii	P3		-20.73972	116.84806	08 1982
PERTH 01026828	Tephrosia bidwillii	P3		-20.71666	116.76667	
PERTH 1061763	Terminalia supranitifolia	P3		-20.63333	116.75	06 12 1978
PERTH 07195958	Terminalia supranitifolia	P3		-20.6704	116.757	02 11 1998
PERTH 07195923	Terminalia supranitifolia	P3		-20.66687	116.76439	28 11 1998

SHEET	SPNAME	CONSVCODE	POPID1	GDA94LAT	GDA94LONG	OWNERDATE
PERTH 07196075	Terminalia supranitifolia	P3		-20.65143	116.79218	08 11 1998
PERTH 07195966	Terminalia supranitifolia	P3		-20.66859	116.76342	02 11 1998
PERTH 07195907	Terminalia supranitifolia	P3		-20.64303	116.76777	28 11 1998
PERTH 07195842	Terminalia supranitifolia	P3		-20.6543	116.7784	24 11 1998
PERTH 07196040	Terminalia supranitifolia	P3		-20.66073	116.77171	03 11 1998
PERTH 07196008	Terminalia supranitifolia	P3		-20.6587	116.77505	03 11 1998
PERTH 07196229	Terminalia supranitifolia	P3		-20.64153	116.79626	12 11 1998
PERTH 07196091	Terminalia supranitifolia	P3		-20.63861	116.79376	10 11 1998
PERTH 07195796	Terminalia supranitifolia	P3		-20.6452	116.77981	22 11 1998
PERTH 07196016	Terminalia supranitifolia	P3		-20.65839	116.77965	05 11 1998
PERTH 07196067	Terminalia supranitifolia	P3		-20.65249	116.78715	08 11 1998
PERTH 07196113	Terminalia supranitifolia	P3		-20.63536	116.79939	10 11 1998
PERTH 07196164	Terminalia supranitifolia	P3		-20.64244	116.78226	20 11 1998
PERTH 07196148	Terminalia supranitifolia	P3		-20.63373	116.78594	20 11 1998
PERTH 07195761	Terminalia supranitifolia	P3		-20.64068	116.77855	22 11 1998
PERTH 07196180	Terminalia supranitifolia	P3		-20.64676	116.78322	18 11 1998
PERTH 07195826	Terminalia supranitifolia	P3		-20.65611	116.77323	24 11 1998
PERTH 07195885	Terminalia supranitifolia	P3		-20.64257	116.77326	26 11 1998

SHEET	SPNAME	CONSVCODE	POPID1	GDA94LAT	GDA94LONG	OWNERDATE
PERTH 07195869	Terminalia supranitifolia	P3		-20.65113	116.77254	26 11 1998
PERTH 1061771	Terminalia supranitifolia	P3		-21.05	116.8	06 07 1986
PERTH 1061755	Terminalia supranitifolia	P3		-20.66666	116.7	12 1986
PERTH 1155059	Terminalia supranitifolia	P3		-20.63333	116.8	05 1983
PERTH 1061798	Terminalia supranitifolia	P3		-20.66666	116.7	12 1971
PERTH 07288999	Terminalia supranitifolia	P3		-20.66666	116.75	21 07 2004
PERTH 07469713	Terminalia supranitifolia	P3		-20.63333	116.8	11 03 1983
PERTH 07469721	Terminalia supranitifolia	P3		-20.63333	116.8	11 03 1983
PERTH 07469748	Terminalia supranitifolia	P3		-20.63333	116.8	11 03 1983
PERTH 07469756	Terminalia supranitifolia	P3		-20.78333	116.76667	10 02 1982
PERTH 07469764	Terminalia supranitifolia	P3		-20.63597	116.7917	15 11 1998
PERTH 07469772	Terminalia supranitifolia	P3		-20.64153	116.79625	12 11 1998
PERTH 07469780	Terminalia supranitifolia	P3		-20.67039	116.757	02 11 1998
PERTH 07196202	Terminalia supranitifolia	P3		-20.63597	116.7917	15 11 1998
PERTH 3144909	Themeda sp. Hamersley Station (M.E. Trudgen 11431)	P3		-20.72916	116.76222	20 08 1992
PERTH 08141339	Vigna sp. rockpiles (R. Butcher et al. RB 1400)	P3		-20.60913	116.782	21 05 2000
PERTH 08141355	Vigna sp. rockpiles (R. Butcher et al. RB 1400)	P3		-20.6487	116.75917	21 05 2000
PERTH 08141363	Vigna sp. rockpiles (R. Butcher et al. RB 1400)	P3		-20.58063	116.79481	22 05 2000

SHEET	SPNAME	CONSVCODE	POPID1	GDA94LAT	GDA94LONG	OWNERDATE
PERTH 08145105	Vigna sp. rockpiles (R. Butcher et al. RB 1400)	P3		-20.649	116.75947	21 05 2000
PERTH 08091382	Vigna sp. rockpiles (R. Butcher et al. RB 1400)	P3		-20.9824	117.1054	04 06 2000
PERTH 08091404	Vigna sp. rockpiles (R. Butcher et al. RB 1400)	P3		-21.03497	117.10456	04 06 2000
PERTH 07905513	Vigna sp. rockpiles (R. Butcher et al. RB 1400)	P3		-20.64661	116.76061	29 05 2009
PERTH 07905718	Vigna sp. rockpiles (R. Butcher et al. RB 1400)	P3		-20.98286	117.10189	28 05 2009
PERTH 07905726	Vigna sp. rockpiles (R. Butcher et al. RB 1400)	P3		-20.68711	117.00811	26 05 2009
PERTH 08217661	Vigna sp. rockpiles (R. Butcher et al. RB 1400)	P3		-20.68864	117.00667	14 05 2004
PERTH 08217653	Vigna sp. rockpiles (R. Butcher et al. RB 1400)	P3		-20.68864	117.00667	10 09 2004
PERTH 08217645	Vigna sp. rockpiles (R. Butcher et al. RB 1400)	P3		-20.68864	117.00667	23 08 2005

EPBC Act Protected Matters Search Results

Search Type:	Point
Buffer:	50 km
Coordinates:	-20.71111,116.7527

Commonwealth Lands:	**2**
Commonwealth Heritage Places:	**None**
Places on the RNE:	**29**
Listed Marine Species:	**99**
Whales and Other Cetaceans:	**12**
Critical Habitats:	**None**
Commonwealth Reserves:	**None**

Threatened Species	Status	Type of Presence
Birds		
Macronectes giganteus Southern Giant-Petrel	Endangered	Species or species habitat may occur within area
Mammals		
Balaenoptera musculus Blue Whale	Endangered	Species or species habitat may occur within area
Dasycercus cristicauda Mulgara	Vulnerable	Species or species habitat likely to occur within area
Dasyurus hallucatus Northern Quoll	Endangered	Species or species habitat known to occur within area
Macrotis lagotis Greater Bilby	Vulnerable	Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale	Vulnerable	Species or species habitat known to occur within area
Rhinonicteris aurantia (Pilbara form) Pilbara Leaf-nosed Bat	Vulnerable	Species or species habitat likely to occur within area
Reptiles		
Caretta caretta Loggerhead Turtle	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle	Vulnerable	Breeding known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth	Endangered	Species or species habitat likely to occur within area
Eretmochelys imbricata Hawksbill Turtle	Vulnerable	Breeding known to occur within area
Liasis olivaceus barroni Olive Python (Pilbara subspecies)	Vulnerable	Species or species habitat may occur within area
Natator depressus Flatback Turtle	Vulnerable	Breeding known to occur within area
Sharks		
Pristis clavata Dwarf Sawfish, Queensland Sawfish	Vulnerable	Species or species habitat may occur within area

Rhincodon typus Whale Shark	Vulnerable	Species or species habitat may occur within area
Migratory Species	Status	Type of Presence
Migratory Terrestrial Species		
Birds		
Haliaeetus leucogaster White-bellied Sea-Eagle	Migratory	Breeding known to occur within area
Hirundo rustica Barn Swallow	Migratory	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater	Migratory	Species or species habitat may occur within area
Migratory Wetland Species		
Birds		
Actitis hypoleucos Common Sandpiper	Migratory	Species or species habitat known to occur within area
Ardea alba Great Egret, White Egret	Migratory	Species or species habitat may occur within area
Ardea ibis Cattle Egret	Migratory	Species or species habitat may occur within area
Arenaria interpres Ruddy Turnstone	Migratory	Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper	Migratory	Species or species habitat known to occur within area
Calidris alba Sanderling	Migratory	Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot	Migratory	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper	Migratory	Species or species habitat known to occur within area
Calidris ruficollis Red-necked Stint	Migratory	Species or species habitat known to occur within area
Calidris tenuirostris Great Knot	Migratory	Species or species habitat known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover	Migratory	Species or species habitat known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover	Migratory	Species or species habitat known to occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel	Migratory	Species or species habitat known to occur within area
Glareola maldivarum Oriental Pratincole	Migratory	Species or species habitat known to occur within area
Heteroscelus brevipes Grey-tailed Tattler	Migratory	Species or species habitat known to occur within area
Limicola falcinellus	Migratory	Species or species habitat

Broad-billed Sandpiper		known to occur within area
Limosa lapponica Bar-tailed Godwit	Migratory	Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit	Migratory	Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew	Migratory	Species or species habitat known to occur within area
Numenius phaeopus Whimbrel	Migratory	Species or species habitat known to occur within area
Pluvialis fulva Pacific Golden Plover	Migratory	Species or species habitat known to occur within area
Pluvialis squatarola Grey Plover	Migratory	Species or species habitat known to occur within area
Tringa nebularia Common Greenshank, Greenshank	Migratory	Species or species habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank	Migratory	Species or species habitat known to occur within area
Xenus cinereus Terek Sandpiper	Migratory	Species or species habitat known to occur within area

Migratory Marine Birds

Apus pacificus Fork-tailed Swift	Migratory	Species or species habitat may occur within area
Ardea alba Great Egret, White Egret	Migratory	Species or species habitat may occur within area
Ardea ibis Cattle Egret	Migratory	Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel	Migratory	Species or species habitat may occur within area
Puffinus pacificus Wedge-tailed Shearwater	Migratory	Breeding known to occur within area
Sterna anaethetus Bridled Tern	Migratory	Breeding known to occur within area
Sterna caspia Caspian Tern	Migratory	Breeding known to occur within area

Migratory Marine Species

Mammals

Balaenoptera edeni Bryde's Whale	Migratory	Species or species habitat may occur within area
Balaenoptera musculus Blue Whale	Migratory	Species or species habitat may occur within area
Dugong dugon Dugong	Migratory	Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale	Migratory	Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca	Migratory	Species or species habitat may occur within area

Sousa chinensis Indo-Pacific Humpback Dolphin	Migratory	Species or species habitat may occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations)	Migratory	Species or species habitat likely to occur within area
Reptiles		
Caretta caretta Loggerhead Turtle	Migratory	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle	Migratory	Breeding known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth	Migratory	Species or species habitat likely to occur within area
Eretmochelys imbricata Hawksbill Turtle	Migratory	Breeding known to occur within area
Natator depressus Flatback Turtle	Migratory	Breeding known to occur within area
Sharks		
Rhincodon typus Whale Shark	Migratory	Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species	Status	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper	Listed	Species or species habitat known to occur within area
Apus pacificus Fork-tailed Swift	Listed - overfly marine area	Species or species habitat may occur within area
Ardea alba Great Egret, White Egret	Listed - overfly marine area	Species or species habitat may occur within area
Ardea ibis Cattle Egret	Listed - overfly marine area	Species or species habitat may occur within area
Arenaria interpres Ruddy Turnstone	Listed	Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper	Listed	Species or species habitat known to occur within area
Calidris alba Sanderling	Listed	Species or species habitat known to occur within area

Calidris canutus Red Knot, Knot	Listed - overfly marine area	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper	Listed - overfly marine area	Species or species habitat known to occur within area
Calidris ruficollis Red-necked Stint	Listed - overfly marine area	Species or species habitat known to occur within area
Calidris subminuta Long-toed Stint	Listed - overfly marine area	Species or species habitat known to occur within area
Calidris tenuirostris Great Knot	Listed - overfly marine area	Species or species habitat known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover	Listed	Species or species habitat known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover	Listed	Species or species habitat known to occur within area
Charadrius ruficapillus Red-capped Plover	Listed - overfly marine area	Species or species habitat known to occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel	Listed - overfly marine area	Species or species habitat known to occur within area
Glareola maldivarum Oriental Pratincole	Listed - overfly marine area	Species or species habitat known to occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle	Listed	Breeding known to occur within area
Heteroscelus brevipes Grey-tailed Tattler	Listed	Species or species habitat known to occur within area
Himantopus himantopus Black-winged Stilt	Listed - overfly marine area	Species or species habitat known to occur within area
Hirundo rustica Barn Swallow	Listed - overfly marine area	Species or species habitat may occur within area
Larus novaehollandiae Silver Gull	Listed	Breeding known to occur within area
Limicola falcinellus Broad-billed Sandpiper	Listed - overfly marine area	Species or species habitat known to occur within area
Limosa lapponica Bar-tailed Godwit	Listed	Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit	Listed - overfly marine area	Species or species habitat known to occur within area

Macronectes giganteus Southern Giant-Petrel	Listed	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater	Listed - overfly marine area	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew	Listed	Species or species habitat known to occur within area
Numenius phaeopus Whimbrel	Listed	Species or species habitat known to occur within area
Pandion haliaetus Osprey	Listed	Breeding known to occur within area
Phalaropus lobatus Red-necked Phalarope	Listed	Species or species habitat known to occur within area
Pluvialis fulva Pacific Golden Plover	Listed	Species or species habitat known to occur within area
Pluvialis squatarola Grey Plover	Listed - overfly marine area	Species or species habitat known to occur within area
Puffinus pacificus Wedge-tailed Shearwater	Listed	Breeding known to occur within area
Recurvirostra novaehollandiae Red-necked Avocet	Listed - overfly marine area	Species or species habitat known to occur within area
Sterna anaethetus Bridled Tern	Listed	Breeding known to occur within area
Sterna bergii Crested Tern	Listed	Breeding known to occur within area
Sterna caspia Caspian Tern	Listed	Breeding known to occur within area
Sterna fuscata Sooty Tern	Listed	Breeding known to occur within area
Sterna nereis Fairy Tern	Listed	Breeding known to occur within area
Stiltia isabella Australian Pratincole	Listed - overfly marine area	Species or species habitat known to occur within area
Tringa nebularia Common Greenshank, Greenshank	Listed - overfly marine area	Species or species habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank	Listed - overfly marine area	Species or species habitat known to occur within area
Tringa totanus Common Redshank, Redshank	Listed - overfly marine area	Species or species habitat known to occur within area
Xenus cinereus Terek Sandpiper	Listed - overfly marine area	Species or species habitat known to occur within area

Mammals

Dugong dugon Dugong	Listed	Species or species habitat likely to occur within area

Ray-finned fishes

Acentronura larsonae Helen's Pygmy Pipehorse	Listed	Species or species habitat may occur within area
Bulbonaricus brauni Braun's Pughead Pipefish, Pug-headed Pipefish	Listed	Species or species habitat may occur within area
Campichthys tricarinatus Three-keel Pipefish	Listed	Species or species habitat may occur within area
Choeroichthys brachysoma Pacific Short-bodied Pipefish, Short-bodied Pipefish	Listed	Species or species habitat may occur within area
Choeroichthys latispinosus Muiron Island Pipefish	Listed	Species or species habitat may occur within area
Choeroichthys suillus Pig-snouted Pipefish	Listed	Species or species habitat may occur within area
Doryrhamphus dactyliophorus Banded Pipefish, Ringed Pipefish	Listed	Species or species habitat may occur within area
Doryrhamphus janssi Cleaner Pipefish, Janss' Pipefish	Listed	Species or species habitat may occur within area
Doryrhamphus multiannulatus Many-banded Pipefish	Listed	Species or species habitat may occur within area
Doryrhamphus negrosensis Flagtail Pipefish, Masthead Island Pipefish	Listed	Species or species habitat may occur within area
Festucalex scalaris Ladder Pipefish	Listed	Species or species habitat may occur within area
Filicampus tigris Tiger Pipefish	Listed	Species or species habitat may occur within area
Halicampus brocki Brock's Pipefish	Listed	Species or species habitat may occur within area
Halicampus grayi Mud Pipefish, Gray's Pipefish	Listed	Species or species habitat may occur within area
Halicampus nitidus Glittering Pipefish	Listed	Species or species habitat may occur within area
Halicampus spinirostris Spiny-snout Pipefish	Listed	Species or species habitat may occur within area
Haliichthys taeniophorus Ribboned Pipehorse, Ribboned	Listed	Species or species habitat may occur within area

Seadragon		
Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish	Listed	Species or species habitat may occur within area
Hippocampus angustus Western Spiny Seahorse, Narrow-bellied Seahorse	Listed	Species or species habitat may occur within area
Hippocampus histrix Spiny Seahorse, Thorny Seahorse	Listed	Species or species habitat may occur within area
Hippocampus kuda Spotted Seahorse, Yellow Seahorse	Listed	Species or species habitat may occur within area
Hippocampus planifrons Flat-face Seahorse	Listed	Species or species habitat may occur within area
Micrognathus micronotopterus Tidepool Pipefish	Listed	Species or species habitat may occur within area
Phoxocampus belcheri Black Rock Pipefish	Listed	Species or species habitat may occur within area
Solegnathus hardwickii Pallid Pipehorse, Hardwick's Pipehorse	Listed	Species or species habitat may occur within area
Solegnathus lettiensis Gunther's Pipehorse, Indonesian Pipefish	Listed	Species or species habitat may occur within area
Solenostomus cyanopterus Robust Ghostpipefish, Blue-finned Ghost Pipefish,	Listed	Species or species habitat may occur within area
Solenostomus paegnius Rough-snout Ghost Pipefish	Listed	Species or species habitat may occur within area
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish	Listed	Species or species habitat may occur within area
Trachyrhamphus bicoarctatus Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish	Listed	Species or species habitat may occur within area
Trachyrhamphus longirostris Straightstick Pipefish, Long-nosed Pipefish, Straight Stick Pipefish	Listed	Species or species habitat may occur within area
Reptiles		
Acalyptophis peronii Horned Seasnake	Listed	Species or species habitat may occur within area
Aipysurus apraefrontalis Short-nosed Seasnake	Listed	Species or species habitat likely to occur within area
Aipysurus duboisii Dubois' Seasnake	Listed	Species or species habitat may occur within area
Aipysurus eydouxii	Listed	Species or species habitat may

Spine-tailed Seasnake		occur within area
Aipysurus laevis Olive Seasnake	Listed	Species or species habitat may occur within area
Aipysurus tenuis Brown-lined Seasnake	Listed	Species or species habitat may occur within area
Astrotia stokesii Stokes' Seasnake	Listed	Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle	Listed	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle	Listed	Breeding known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth	Listed	Species or species habitat likely to occur within area
Disteira kingii Spectacled Seasnake	Listed	Species or species habitat may occur within area
Disteira major Olive-headed Seasnake	Listed	Species or species habitat may occur within area
Emydocephalus annulatus Turtle-headed Seasnake	Listed	Species or species habitat may occur within area
Ephalophis greyi North-western Mangrove Seasnake	Listed	Species or species habitat may occur within area
Eretmochelys imbricata Hawksbill Turtle	Listed	Breeding known to occur within area
Hydrelaps darwiniensis Black-ringed Seasnake	Listed	Species or species habitat may occur within area
Hydrophis czeblukovi Fine-spined Seasnake	Listed	Species or species habitat may occur within area
Hydrophis elegans Elegant Seasnake	Listed	Species or species habitat may occur within area
Hydrophis mcdowelli	Listed	Species or species habitat may occur within area
Hydrophis ornatus a seasnake	Listed	Species or species habitat may occur within area
Natator depressus Flatback Turtle	Listed	Breeding known to occur within area
Pelamis platurus Yellow-bellied Seasnake	Listed	Species or species habitat may occur within area
Whales and Other Cetaceans	Status	Type of Presence
Balaenoptera acutorostrata Minke Whale	Cetacean	Species or species habitat may occur within area
Balaenoptera edeni Bryde's Whale	Cetacean	Species or species habitat may occur within area
Balaenoptera musculus Blue Whale	Cetacean	Species or species habitat may occur within area
Delphinus delphis	Cetacean	Species or species habitat may

Common Dophin, Short-beaked Common Dolphin		occur within area
Grampus griseus Risso's Dolphin, Grampus	Cetacean	Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale	Cetacean	Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca	Cetacean	Species or species habitat may occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin	Cetacean	Species or species habitat may occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin	Cetacean	Species or species habitat may occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations)	Cetacean	Species or species habitat likely to occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin	Cetacean	Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin	Cetacean	Species or species habitat may occur within area

Appendix 3 Vegetation Structural Classification* and Condition Rating Scale

Vegetation Structural Classes*

Stratum	Canopy Cover (%)				
	70-100%	**30-70%**	**10-30%**	**2-10%**	**<2%**
Trees over 30 m	Tall closed forest	Tall open forest	Tall woodland	Tall open woodland	Scattered tall trees
Trees 10-30 m	Closed forest	Open forest	Woodland	Open woodland	Scattered trees
Trees under 10 m	Low closed forest	Low open forest	Low woodland	Low open woodland	Scattered low trees
Shrubs over 2 m	Tall closed scrub	Tall open scrub	Tall shrubland	Tall open shrubland	Scattered tall shrubs
Shrubs 1-2 m	Closed heath	Open heath	Shrubland	Open shrubland	Scattered shrubs
Shrubs under 1 m	Low closed heath	Low open heath	Low shrubland	Low open shrubland	Scattered low shrubs
Hummock grasses	Closed hummock grassland	Hummock grassland	Open hummock grassland	Very open hummock grassland	Scattered hummock grasses
Grasses, Sedges, Herbs	Closed tussock grassland / sedgeland /	Tussock grassland / sedgeland / herbland	Open tussock grassland / sedgeland /	Very open tussock grassland / sedgeland /	Scattered tussock grasses /

*Based on (Muir 1977), and Aplin's (1979) modification of the vegetation classification system of Specht (1970):

Aplin T.E.H. (1979). The Flora. Chapter 3 *In* O'Brien, B.J. (ed.) (1979). *Environment and Science.* University of Western Australia Press; Muir B.G. (1977). Biological Survey of the Western Australian Wheatbelt. Part II: Vegetation and habitat of Bendering Reserve. *Records of the Western Australian Museum, Suppl*. No. 3; Specht R.L. (1970). Vegetation. *In The Australian Environment.* 4th edn (Ed. G.W. Leeper). Melbourne.

Vegetation Condition Scale for use on Pilbara surveys*

E = Excellent **(=Pristine of BushForever)**

Pristine or nearly so; no obvious signs of damage caused by the activities of European man.

VG = Very Good (= Excellent of BushForever)

Some relatively slight signs of damage caused by the activities of European man. For example, some signs of damage to tree trunks caused by repeated fire, the presence of some relatively non-aggressive weeds such as **Ursinia anthemoides* or **Briza* spp., or occasional vehicle tracks.

G = Good (= Very Good of BushForever)

More obvious signs of damage caused by the activities of European man, including some obvious impact on the vegetation structure such as that caused by low levels of grazing or by selective logging. Weeds as above, possibly plus some more aggressive ones such as **Ehrharta* spp.

P = Poor (= Good of BushForever)

Still retains basic vegetation structure or ability to regenerate to it after very obvious impacts of activities of European man, such as grazing, partial clearing (chaining) or frequent fires. Weeds as above, probably plus some more aggressive ones such as **Ehrharta* spp.

VP = Very Poor (= Degraded of BushForever)

Severely impacted by grazing, very frequent fires, clearing or a combination of these activities. Scope for some regeneration but not to a state approaching good condition without intensive management. Usually with a number of weed species including very aggressive species.

D = Completely Degraded (= Completely Degraded of BushForever)

Areas that are completely or almost completely without native species in the structure of their vegetation; i.e. areas that are cleared or 'parkland cleared' with their flora comprising weed or crop species with isolated native trees or shrubs.

* Based on Trudgen M.E. (1988). A Report on the Flora and Vegetation of the Port Kennedy Area. Unpublished report prepared for Bowman Bishaw and Associates, West Perth.

Appendix 4: Flora Species Recorded from the Wickham Town Expansion Study Area

Family	Species
Family: Aizoaceae (110)	
	Trianthema turgidifolia
Family: Amaranthaceae (106)	
	**Aerva javanica*
	Ptilotus astrolasius
	Ptilotus calostachyus
	Ptilotus exaltatus
Family: Asteraceae (345)	
	Pluchea ferdinandi-muelleri
	Streptoglossa decurrens
	Streptoglossa liatroides
	**Taraxacum officinale*
Family: Bignoniaceae (317)	
	Dolichandrone heterophylla
Family: Boraginaceae (310)	
	Ehretia saligna
	Heliotropium pachyphyllum
	Trichodesma zeylanicum
Family: Caesalpiniaceae (164)	
	Senna artemisioides subsp. *helmsii*
	Senna artemisioides subsp. *oligophylla*
	Senna glutinosa subsp. glutinosa
	Senna glutinosa subsp. pruinosa
	Senna glutinosa subsp. x *luerssenii*
	Senna notabilis
Family: Chenopodiaceae (105)	
	Atriplex bunburyana
	Enchylaena tomentosa
	Maireana villosa
	Salsola tragus
	Sclerolaena hostilis
	Sclerolaena sp. (indet.)
	Tecticornia auriculata
	Tecticornia halocnemoides subsp. *tenuis*
Family: Convolvulaceae (307)	
	Bonamia linearis
	Bonamia media
	Bonamia rosea
	Ipomoea muelleri
Family: Goodeniaceae (341)	
	Goodenia microptera
	Goodenia stobbsiana
	Scaevola acacioides
	Scaevola sericophylla
	Scaevola spinescens
Family: Gyrostemonaceae (108)	
	Codonocarpus cotinifolius
Family: Lauraceae (131)	
	Cassytha capillaris

Family	Species
Family: Malvaceae (221)	
	Abutilon fraseri
	Abutilon lepidum
	Abutilon otocarpum
	Gossypium australe
	Gossypium robinsonii
	Hibiscus sp. (indet.)
	Hibiscus sturtii
	Sida cardiophylla
	Sida fibulifera
Family: Mimosaceae (163)	
	Acacia ampliceps
	Acacia ancistrocarpa
	Acacia bivenosa
	Acacia colei var. colei
	Acacia coriacea
	Acacia coriacea subsp. *coriacea*
	Acacia coriacea subsp. *pendens*
	Acacia pyrifolia
	Acacia sabulosa
	Acacia sphaerostachya
	Acacia stellaticeps
	Acacia synchronicia
	Acacia trachycarpa
	Acacia tumida
	Acacia tumida var. *pilbarensis*
	Dichrostachys spicata
	Neptunia dimorphantha
Family: Moraceae (087)	
	Ficus brachypoda
Family: Myoporaceae (326)	
	Eremophila longifolia
Family: Myrtaceae (273)	
	Corymbia hamersleyana
	Eucalyptus victrix
	Melaleuca argentea
	Melaleuca lasiandra
Family: Papilionaceae (165)	
	Indigofera monophylla
	Rhynchosia minima
	Sesbania cannabina
	**Stylosanthes hamata*
	Tephrosia rosea var. *clementii*
	Vigna lanceolata
Family: Poaceae (031)	
	Aristida inaequiglumis
	**Cenchrus ciliaris*
	**Cenchrus setiger*
	**Chloris barbata*
	**Cynodon dactylon*
	Eragrostis eriopoda
	Eragrostis falcata
	Eriachne mucronata
	Panicum decompositum
	Triodia epactia

Family	Species
	Triodia schinzii
	Triodia wiseana
Family: Proteaceae (090)	
	Grevillea wickhamii
	Hakea lorea
Family: Santalaceae (092)	
	Santalum lanceolatum
Family: Sapindaceae (207)	
	Diplopeltis eriocarpa
	Dodonaea coriacea
Family: Solanaceae (315)	
	Solanum ferocissimum
	Solanum horridum
Family: Sterculiaceae (223)	
	Keraudrenia velutina
	Waltheria indica
Family: Thymelaeaceae (263)	
	Pimelea ammocharis
Family: Tiliaceae (220)	
	Corchorus crozophorifolius
	Corchorus parviflorus
	Corchorus walcottii
	Triumfetta maconochieana
Family: Violaceae (243)	
	Hybanthus aurantiacus
Family: Zygophyllaceae (173)	
	Tribulus suberosus

Appendix 5: Framework for Conservation Significance Ranking for Flora Species

Legislative Framework for Conservation Significant Flora *Wildlife Conservation Act 1950*

All native flora in Western Australia is protected under the state *Wildlife Conservation Act* 1950. Protected flora which are deemed to be at risk of extinction, rare, or otherwise in need of special protection are listed as "Rare Flora" and published in the *Wildlife Conservation (Rare Flora) Notice 2008*. Specific written approval by the Minister for the Environment is required to take or harm species listed in Schedule 1 or 2 of the *Wildlife Conservation (Rare Flora) Notice 2008*. Flora species which may be rare or threatened in Western Australia but which have not been adequately surveyed for are included in a supplementary conservation list called the Priority Flora List.

In addition to state legislation, some Western Australian native plant species are protected under federal law, namely the Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act). In the Pilbara, two species *Lepidium catapycnon* and *Thryptomene wittweri* are currently listed as "Vulnerable" under the EPBC Act. Proposals that are considered likely to have a significant impact on EPBC Act listed threatened flora are required to be referred to the Federal Minister of Environment for approval.

Categories of conservation significance for flora species under the Wildlife Conservation Act 1950 (Atkins 2006)

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

Declared Rare Flora - Presumed Extinct Taxa- Taxa which have not been collected, or otherwise verified, over the past 50 years despite thorough searching, or of which all known wild populations have been destroyed more recently,

Priority One - Poorly known Taxa- Taxa which are known from one or a few (generally <5) populations which are under threat.

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.

Priority Three - Poorly Known Taxa- Taxa which are known from several populations, and the taxa are not believed to be under immediate threat.

Priority Four - Rare Taxa- Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors.

Environmental Protection and Biodiversity Conservation Act 1999

The Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* affords protection to species, populations and ecological communities threatened at a national level or to species listed as migratory under various international agreements (e.g. CAMBA, JAMBA RoKAMBA, Bonn Convention). Categories relevant to the current study include:

Endangered – Taxa facing a very high risk of extinction in the wild in the near future.

Vulnerable – Taxa facing high risk of extinction in the wild in the medium-term.

Under the EPBC Act, a proposal which is likely to have a significant impact on threatened species, populations or ecological communities or migratory species must be referred to DEWHA for a decision by the Commonwealth Minister for the Environment. A significant impact is determined through application of Significant Impact Criteria (DEWHA 2000).

EPBC Act Significant Impact Criteria

Conservation Code	Significant Impact Criteria
Critically Endangered and Endangered Species	An action is likely to have a significant impact on critically endangered or endangered species if there is a real chance or possibility that it will: 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.

Conservation Code	Significant Impact Criteria
Vulnerable species	An action is unlikely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will: 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 to a vulnerable species becoming established in the vulnerable species habitat, or Interferes substantially with the recovery of the species
Critically endangered and endangered ecological communities	An action is likely to have a significant impact on a critically endangered or endangered ecological community if there is a real chance or possibility that it will: o Reduce the extent of a community, or o Fragment or increase fragmentation of the community, for example by clearing vegetation for roads or transmission lines, or o Adversely affect habitat critical to the survival of an ecological community which consists of, or includes, fauna species, or o Modify or destroy abiotic (non-living) factors)such as water, nutrients, or soil) necessary for the community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns, or o Cause a substantial change in the species composition of an occurrence of an ecological community, including, but not limited to: ▪ Assisting invasive species, that are harmful to the listed ecological community, to become established; and ▪ Causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community; or o Interfere with the recovery of an ecological community

Conservation Code	Significant Impact Criteria
Listed Migratory Species	An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will: ○ Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat of the migratory species, or ○ Result in invasive species that is harmful to the migratory species becoming established in an area of important habitat of the migratory species, or ○ Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of the species.

Appendix 6: Quadrat and releve data collected within the Wickham Town Expansion study area. (see attached Excel spreadsheet)

Rio Tinto

Wickham Town Expansion Flora and Vegetation Survey

Native Vegetation Clearing Permit Supporting Report

October 2010

Department: Environmental Approvals

Report Created by: Anna Rowe & Sam Luccitti

Submitted: October 2010

Rio Tinto Iron Ore (RTIO) comprises wholly owned subsidiaries and joint venture initiatives including iron ore operations in the Pilbara region of Western Australia, owned by Hamersley Iron and Robe River, and managed by Pilbara Iron

Executive Summary

Rio Tinto Iron Ore proposes to expand the Wickham Township to support additional housing and associated infrastructure to accommodate both permanent and Fly-in Fly-out (FIFO) workers who will be required for the expansion of the Cape Lambert port facilities.

The Wickham town expansion study area consists of four polygons totalling 98.7 ha that are situated within and directly north and south of the Wickham Township (Figure 2.1).

A botanical survey was conducted over the study area by Rio Tinto botanist Sam Luccitti from the 28th to 30th of September 2010. The aim of the survey along with desktop studies was to describe the local environment including flora, vegetation, geology, landforms, soils and hydrology in order to support an application for a Native Vegetation Clearing Permit under Part V and/or an Environmental Impact Assessment under Part IV of the *Environmental Protection Act 1986*. The proposal was assessed against the 10 Clearing Principles as defined in Schedule 5 (Principles for Clearing Native Vegetation) of the *Environmental Protection Act 1986.*

Intact native vegetation occupied 79.2 ha of the study area and was typically in Good or better condition. Disturbance was most prevalent where the vegetation bordered cleared urban areas and disturbance was typically related to clearing for tracks and infrastructure. Weeds were common throughout Wickham Survey Polygon (WSP) 1, 2 and 3 and were observed frequently along the northern boundary of WSP 4.

Eleven vegetation units were identified across the study area. None of the 11 vegetation units are listed under the *EPBC Act 1999* nor are any defined as TECs or PECs by the DEC (DEC 2010a; 2010b). Vegetation units associated with sandy plains and aeolian sand dunes were, however, identified as having moderate conservation significance on the basis that such habitats are locally uncommon in the Wickham and Cape Lambert localities.

A total of 97 native vascular plant taxa from 56 genera belonging to 27 families were recorded in the study area. The genera and families represented within the survey area are considered characteristic of coastal Pilbara flora. The total number of vascular flora species (i.e. species richness) present within the study area was considered to be low to moderate; a result which can be attributed to the small size of the area, the dry seasonal conditions, lack of diversity in landforms and coastal location of the study area.

No Declared Rare Flora species or flora species listed under the *EPBC Act 1999* were recorded from the study area, and none would be expected to occur. No Priority flora or flora of conservation significance were recorded in the study area.

Seven introduced flora species were recorded within the study area; *Cenchrus ciliaris* (Buffel Grass), *Cenchrus setiger* (Birdwood Grass), *Aerva javanica* (Kapok Bush), *Chloris barbata* (Purpletop Chloris), *Taraxacum officinale* (Dandelion), *Stylosanthes hamata* (Verano Stylo) and *Cynodon dactylon* (Couch Grass). None of the species are listed as Declared Plants under the *Agriculture and Related Resources Protection Act 1976*; however Kapok Bush (*Aerva javanica*) and the two *Cenchrus* species are considered to be serious environmental weeds.

Consideration of the proposal with regard to the “10 Clearing Principles” as defined in Schedule 5 of the *Environmental Protection Act 1986* found that the proposal is unlikely to be at variance with any of the clearing principles.

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Introduction

1. Project Background

Rio Tinto Iron Ore proposes to expand the Wickham Township to accommodate additional permanent and Fly-in, Fly-out (FIFO) workers required to support the expansion of the Cape Lambert port facilities. The town expansion will require the construction of permanent houses, a FIFO village and associated infrastructure facilities.

1.1 Study Area Location and Description of Proposed Clearing

The Wickham town expansion study area consists of four polygons that are situated in the centre and directly north and south of the Wickham Township, which is located in the Shire of Roebourne, within the Pilbara region (Figure 2.1).

The northern polygon is 11.4 ha (*WSP 1) and along with the southern area which is 78.2 ha (WSP 4) is proposed for the construction of residential housing, while the two smaller areas within the Town centre WSP 2 (6.2 ha) and WSP 3 (2.5 ha) have been designated for the development of a FIFO village and associated infrastructure (Figure 2.1). Together the 4 WSPs total 98.3 ha and are collectively referred to as the study area in this report.

**WSP Wickham Survey Polygons*

1.2 Scope and Objectives of the Study

In September 2010 Rio Tinto undertook flora and vegetation surveys of the Wickham Town Expansion study area.

The survey was planned and implemented as far as practicable (no seasonal sampling component was possible in the timeframe) according to the Environmental Protection Authority (EPA) Position Statement No. 3 “Terrestrial Biological Surveys as an Element of Biodiversity Protection” (EPA 2002) and Guidance Statement No. 51 “Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia” (EPA 2004).

The scope of the botanical survey was to:

- Describe the local environment of the proposed clearing area including flora, vegetation, geology, landforms, soils and hydrology.
- Describe and map the vegetation types occurring within the study area;
- Identify any vegetation types or flora species of particular conservation significance, including Declared Rare Flora (DRF), Priority flora and other flora of interest;
- Describe the potential impacts of the proposal on the local environment through application of the 10 Clearing Principles, as outlined in Schedule 5 of the *Environmental Protection Act 1986*.

- Recommend ways to avoid and/or mitigate impacts of the proposal on areas of conservation significance and on the local environment in general.

This report describes the methodology employed for the flora and vegetation survey of the study area, as well as documenting the results of the survey, in particular identifying vegetation and flora of conservation significance. The intended use of this report is as a supporting document to Rio Tinto Iron Ore's application for a Native Vegetation Clearing Permit (NVCP) as well as a supporting document for the Environmental Impact Assessment process for the proposed project.

2. Review of the Physical and Non-Physical Aspects of the Study Area

2.1 Climate

The closest Meteorological station providing climate data is located in the township of Roebourne; approximately 9 km south of the study area.

The regional climate is semi-arid to semi-tropical with a summer rainfall season and a winter dry season, which varies in frequency and volume from year to year. The summer wet months extend from November to April when temperatures can exceed 47°C. The remainder of the year is moderate to warm with a continental effect resulting in low minimum temperatures below 15°C in June and July.

Annual rainfall is variable with tropical lows producing large regional rainfall events (between 100 mm and 200 mm in a few days) to isolated thunderstorm events in the dry (winter) season. For Roebourne; the mean annual rainfall for the period 1981 to 2010 is 289.2 mm with most precipitation occurring between December and June (coinciding with cyclone season). Rainfall for the 2009/2010 season in the December to May summer/autumn period fell well below average. A total of 53.3 mm of rainfall was recorded in the 8 month period from February to September 2010. The mean total rainfall for the same period from 1981 – 2010 is 225.8 mm. The last significant rainfall event was in the middle of September, with 15 mm of rainfall (BoM, 2010).

Maximum temperatures reflected a moderately warm summer to winter period (BoM, 2010). Temperatures recorded at Roebourne in the 6 months to September 2010 were generally within expected ranges and close to mean maximum temperatures. A lack of significant summer or follow-up winter rainfall has produced a higher number of sunshine days, thereby increasing evaporation rates, reducing soil moisture. This has shown in the vegetation condition across the study area, where very dry conditions were observed. This has also resulted in a reduction of short-lived annual species being recorded within the study area.

2.2 Land Systems

Land Systems (Rangelands) mapping covering the study area has been prepared by the Western Australian Department of Agriculture (van Vreeswyk *et al.* 2004). These are broad units that each consist of a series of "land units" that occur on characteristic physiographic types within the Land System.

The study area is located within 2 of the 107 Land Systems described for the Pilbara Bioregion by van Vreeswyk *et al.* (2004) and Payne *et al*. (1998) (Figure 2.1). The Land Systems and their extent within the study area are presented in Table 2.1 below.

Table 2.1: Land Systems occurring within the study area and their representation in the Pilbara bioregion (van Vreeswyk *et al.* 2004)

Land System (Map Code)	Description (Van Vreeswyk *et al.* 2004)	Extent in the Pilbara (ha)	Extent within study area in hectares (Extent within study area as % of total Land System area)
Ruth (RGERUT)	Hills and ridges of volcanic and other rocks supporting hard spinifex (and occasionally soft spinifex) grasslands.	169,299	3.8 (0.002)
Uaroo (RGEUAR)	Broad sandy plains supporting shrubby hard and soft spinifex grasslands.	987,066	94.5 (0.009)

2.2.1 Uaroo Land System

The Uaroo Land System covers approximately 96% of the study area and is characterised by broad sandy plains with little organised through drainage supporting shrubby hard and soft spinifex grasslands. This Land system occurs extensively around Port Hedland and Onslow but is uncommon in coastal areas surrounding Karratha, Wickham and Cape Lambert. Van Vreeswyk *et al.* (2004) divided the Uaroo land system into 6 land units and of these; the 'Sandy/loamy plains' land unit is the only one to occur within the study area.

2.2.2 Ruth Land System

The Ruth Land System covers the remainder (~4%) of the study area and is characterised by hills and ridges of volcanic and other rocks supporting hard spinifex (and occasionally soft spinifex) grasslands. Van Vreeswyk *et al.* (2004) divided the Ruth land system into 4 land units and of these; the 'hills, ridges and upper slopes', and 'narrow drainage floors, creeklines and channels' land units occur within the study area.

2.3 Geology and Soils

Geologically the study area is dominated by poorly consolidated Quaternary colluvium and alluvium associated with the Uaroo land system. Low rocky hills of volcanic and metamorphosed sedimentary rock rise up from the surrounding plain in the central and western parts of WSP 4 and are associated with the Ruth land system.

Deep red sands and red loamy earths cover the majority of the study area including all of WSPs 1, 2 & 3 and the most of WSP 4. Much shallower red silt loam soils occur in pockets on rocky hills in the central and western parts of WSP 4

2.4 Hydrology

2.4.1 Surface Hydrology

The most prominent drainage features across the study area are located within WSP 4 and consist of narrow, minor flowlines associated with the low rocky hills which rise from the surrounding sandy plain. These flowlines drain in a predominately easterly direction before emptying onto a broad sandy plain. A single minor flowline traverses the sandy plain in the south but overall, drainage across the sand plains within the study area occurs via sheet flow.

2.4.2 Groundwater Hydrology

Groundwater along the Pilbara coast is associated with alluvial aquifers along major rivers (Dept. of Fisheries 2001). In the Cape Lambert area, approximately 8 km to the north east of the study area, groundwater is typically associated with Quaternary alluvial sediments and fractured Precambrian bedrock and is located between 2 m and 8 m below the land surface (Sinclair Knight Mertz 2008).

2.5 Vegetation

2.5.1 IBRA Bioregions and Subregions

The study area is located within the Pilbara (PIL) bioregion as defined in the most recent interim Bioregionalisation of Australia (IBRA) Report (Environment Australia 2000). The Pilbara bioregion has been divided into 4 subregions; described by Environment Australia (2000) as;

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

- Fortescue Plains (PIL2): alluvial plains and river frontages with salt marsh, Mulga-bunch grass and short grass communities on alluvial plains and River Gum woodlands fringing drainage lines;

- Hamersley (PIL3): mountainous area of Proterozoic ranges and plateaux with low Mulga (*Acacia aneura*) woodland over bunch grasses on fine textured soils, and Snappy Gum over *Triodia brizoides* on the skeletal sandy soils of the ranges; and

- Roebourne Plains (PIL4): quaternary alluvial plains with a grass savanna and shrub steppe of *Acacia translucens* over *Triodia pungens* and marine alluvial flats with Samphire, *Sporobolus* and Mangal.

The majority of the study area lies within the Chichester subregion, with a small area in the south-eastern section of the study area mapped as part of the Roebourne Plains subregion.

2.5.2 Beard's Regional Vegetation Mapping

The study area lies within the Fortescue Botanical District of the Eremaean Botanical Province as defined by Beard (1975). The vegetation of this province is typical of arid landscapes; including bunch grasslands, spinifex, wattles and eucalypts. The study area falls within two vegetation mapping units, which are described by Beard (1975) in broad scale (1:1,000,000) mapping of the Pilbara region.

The study area is mapped by Beard (1975) as;

- **Abydos Plain/Chichester – 157** –Hummock grasslands, grass steppe; hard spinifex, *Triodia wiseana.*
- **Abydos Plain/Roebourne – 589** - Mosaic of short bunch grassland - savanna / grass plain (Pilbara) / hummock grasslands, grass steppe; soft spinifex.

The extent of these Beard (1975) vegetation mapping units within the study area is presented in Table 2.2 below.

2.5.3 Pre-European Vegetation Extent

The pre-European and current extent of native vegetation associations in Western Australia has been interpreted by Shepherd *et al.* (2002) using data from Beard (1975) regional vegetation mapping and other vegetation mapping activities as well as satellite imagery and orthophoto interpretation.

Shepherd *et al.* (2002) identified the Pilbara Bioregion as having native vegetation largely intact owing to the absence of intensive agricultural land use practices. Although the extent of the vegetation associations remain largely intact, their floristic composition and structural characteristics are likely to have been substantially altered since European settlement by grazing and inappropriate fire regimes (Shepherd *et al.* 2002). Table 2.2 presents the pre-European and current extent of the mapping units (largely 100% of their original extent) across their range and their extent within the study area.

Table 2.2: Beard (1975) mapping units occurring within the study area, their current and pre-European extent (following Shepherd *et al*. 2002) and their extent across the study area

Beard (1975) Mapping Units	Pre-European extent (Shepherd *et al*. 2002)	Current extent within Hamersley subregions (Shepherd *et al*. 2002)	Extent within the Study Area (% of current extent)

Abydos Plain/Roebourne 589	848,201 ha	848,201 ha	23.9 ha (0.003%)
Abydos Plain/Roebourne 157	542,861 ha	542,861 ha	74.7 ha (0.01%)

2.6 Conservation Areas and Environmentally Sensitive Areas (ESA)

The DEC online Native Vegetation Map Viewer was used to identify the location of environmentally sensitive areas as declared by a Notice under section 51B of the *Environmental Protection Act 1986.*

The study area does not occur within any environmentally sensitive areas including reserves or conservation areas. The northern boundary of the Millstream-Chichester National Park is located approximately 52 km south east of the study area and is the closest existing conservation area to the study area. The proposal is unlikely to directly or indirectly impact the Millstream-Chichester National Park.

There are also several C-class nature reserves on islands off the coast to the north-west of Cape Lambert; however they are not relevant given the nature of this project.

The study area does lie within Schedule 1 Area 2325; a 2 km band which follows the coastline. No other Schedule 1 areas occur within or adjacent to the study area

2.7 Threatened Ecological Communities (TECs) and Priority Ecological Communities (PECs)

Threatened Ecological Communities (TECs) are communities which have been found to fit into one of the following categories; “presumed totally destroyed”, “critically endangered”, “endangered” or “vulnerable”. TECs are informally listed by the DEC as they are not formally listed under WA legislation. While some TECs for WA are also listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999,* this does not apply to any currently describe from the Pilbara bioregion.

There are no TECs listed by the DEC for the Chichester subregion.

Possible threatened ecological communities that do not meet survey criteria for listing as TECs are added to DEC’s Priority Ecological Community (PEC) Lists under Priorities 1, 2 and 3. Ecological Communities that are adequately known, are rare but not threatened, or meet criteria for Near Threatened, or 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

No PECs occur within the study area nor are any likely to be directly or indirectly impacted on by the current proposal. There closest PECs to the study area are;

(Priority 1) Roebourne Plains coastal grasslands with gilgai microrelief on deep cracking clays

"The Roebourne Plains coastal grasslands with gilgai micro-relief occur on deep cracking clays that are self mulching and emerge on depositional surfaces. The Roebourne Plains gilgai grasslands occur on microrelief of deep cracking clays, surrounded by clay plains/flats and sandy coastal and alluvial plains. The gilgai depressions supports ephemeral and perennial tussock grasslands dominated by *Sorghum* sp. and *Eragrostis xerophila* (Roebourne Plains grass) along with other native species including *Astrebla pectinata* (Barley Mitchell Grass), *Eriachne benthamii* (Swamp Wanderrie Grass), *Chrysopogon fallax* (Golden Beard Grass) and *Panicum decompositum* (Native Millet).

Restricted to the Karratha area, this community differs from the surrounding clay flats of the Horseflat land system which are dominated by *Eragrostis xerophila* and other perennial tussock grass species (*Eragrostis* spp. mostly)."

(Priority 3) Horseflat land system of the Roebourne Plains
This PEC is described in (DEC 2010) as *"The remainder of the Horseflat land system – not including the Roebourne Plains gilgai grasslands and the Chenopod association of the Roebourne Plains area. Extent- from Cape Preston to Balla Balla (Whim Creek)."*

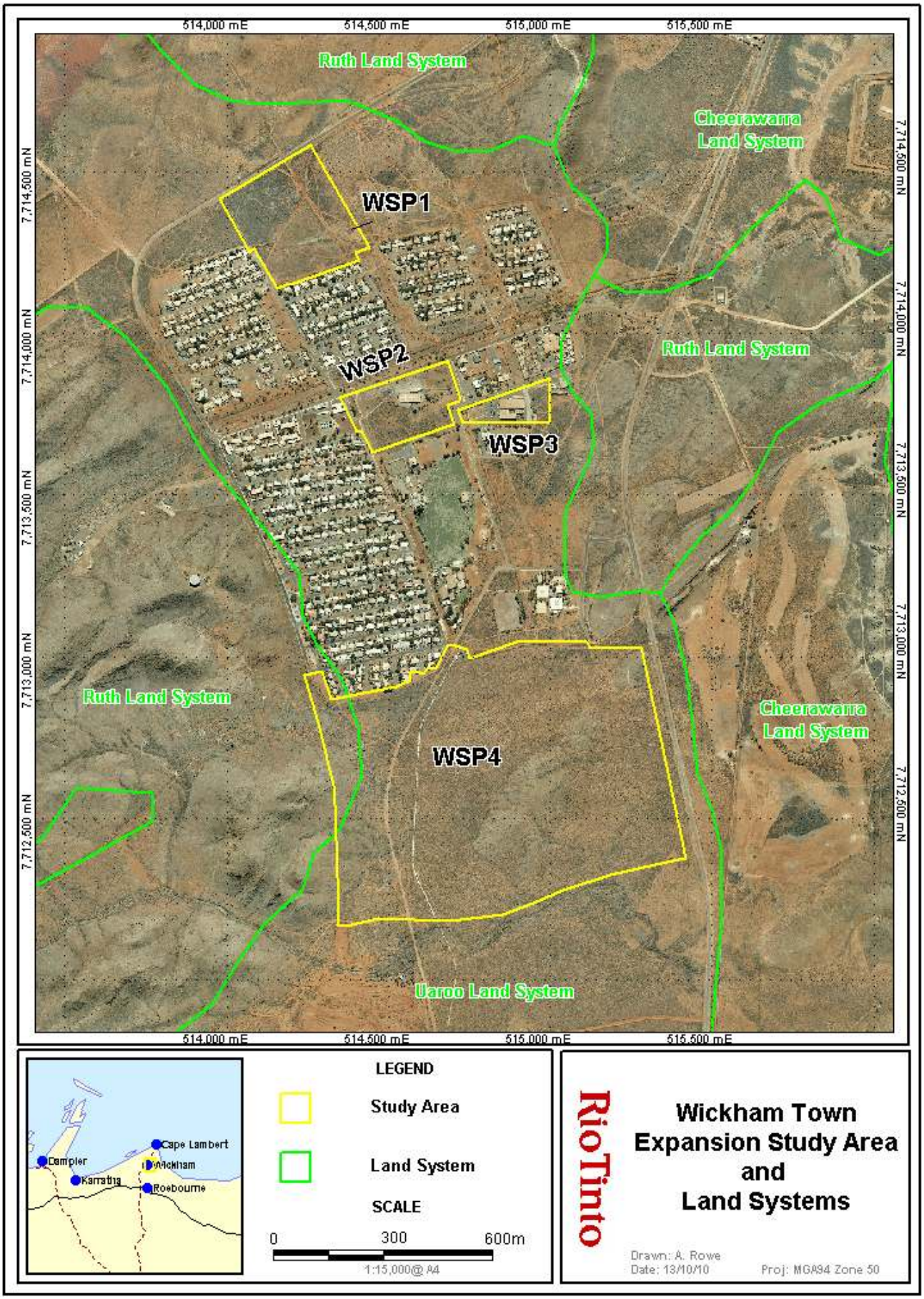

Figure 2.1: Wickham Town Expansion Study Area and Land Systems.

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3. Desktop Study and Field Survey

3.1 Literature review

The study area had not been previously surveyed for flora, or vegetation. However several previous botanical studies in the vicinity of the study area were reviewed to provide site-specific data (Table 3.1).

A fauna assessment and short range endemic (SRE) fauna survey for the study area was undertaken by Biota Environmental Sciences (Biota 2010) in order to provide site specific fauna information required to address Clearing Principle 6.1.2 (see Appendix 1).

Table 3.1: Summary of biological surveys conducted within the vicinity of the Wickham Town Expansion study area.

Survey Reference	Survey Date
Biota (2008a) *Karratha to Cape Lambert Transmission Line Corridor: Native Vegetation Clearing Permit Report*. Unpublished report prepared for Rio Tinto Iron Ore Pty Ltd.	July, 2008
Biota (2008b) *A Vegetation and Flora Survey of the Rio Tinto Rail Duplication Project – Cape Lambert to Emu Siding*. Unpublished report prepared for Rio Tinto Iron Ore Pty Ltd.	April, 2008
Biota (2008c) *Cape Lambert Port B Development: Flora and Vegetation Survey*. Unpublished report prepared for Pilbara Iron Pty Ltd.	July, 2008
Biota (2008d). *7 Mile Power Station and Ancillary Works NVCP*. Unpublished report prepared for Rio Tinto Iron Ore.	March & April, 2008
Rio Tinto (2009) *Dampier 7-Mile to Cape Lambert 220 kV Transmission Line Corridor Additional Areas Native Vegetation Clearing Permit Supporting Report* Unpublished internal report for Rio Tinto Iron Ore.	April, 2009
GHD (2008) *Report for 320 Mt Marshalling Yards, Maintenance Workshop and Quarry – Flora and Fauna Assessment*. Unpublished report prepared for Rio Tinto Iron Ore Pty Ltd.	November, 2008
Biota (2010) *Wickham Town Expansion Level 1 Fauna Assessment and SRE Fauna Survey*. Unpublished report prepared for Rio Tinto Iron Ore Pty Ltd.	September, 2010

3.2 Database Searches

Databases maintained by the WA DEC and WA Herbarium were searched in October 2010 for Declared Rare and Priority Flora, and Threatened Ecological Communities (Appendix 2). The searches encompassed a central point between the coordinates (GDA94) 503,102mE 7,698,381mN (SW corner) and 526,548mE 7,723,236mN (NE corner), with a 50 km radial buffer.

The Commonwealth Department of Sustainability, Environment, Water, Population and Communities (DSEWPC) (formerly the Department of Environment, Water, Heritage and the Arts) administered *Environmental Protection and Biodiversity Conservation Act, 1999* (EPBC Act) Protected Matters Search Tool was searched in October 2010 for Matters of National Environmental Significance encompassing an area of a 50 km radius around the study area (-20 40.40 °S 117.08.20 °E (WGS 84)).

Spatial data for rare flora held and maintained by Rio Tinto Iron Ore was also searched as part of the desk top study. Any Ecologically Sensitive Areas (ESA), Reserves and/or conservation areas within or surrounding the study area were also identified using relevant GIS layers held by Rio Tinto Iron Ore.

3.3 Field Survey Timing and Effort

The flora and vegetation of the study area was surveyed by Rio Tinto botanist Sam Luccitti from the 28th to the 30th of September 2010. A number of survey methods including relevés and quadrat sampling were employed in order to map the vegetation across the study area and to obtain an inventory of flora species inhabiting the survey area.

3.4 Vegetation Description and Mapping

Vegetation units within the study area were described based on the height and estimated percentage foliage cover of the dominant plant species within the vegetation unit. The description of each vegetation unit was based on the structural classification system of Muir (1977) and Aplin (1979) adapted from Specht (1970) (see Appendix 3).

During the field survey the boundaries of each vegetation unit were mapped using a combination of aerial photograph interpretation and hand-held GPS units. Where a vegetation unit boundary could not be confidently discerned on aerial photographs, representative points were marked along the vegetation boundary using a hand-held GPS. These points were then uploaded into a GIS software package.

The vegetation boundaries were digitised on-screen using the MapInfo Professional 10.0 GIS software package. Digitising followed either vegetation boundaries discernible from geo-referenced aerial photographs or points collected by hand-held GPS unit as described above.

3.5 Assessment of Floristic Quadrats & Relevés

A total of 14 detailed flora-recording quadrats were surveyed across the study area (Figure 4.1 & 4.2). The locations of the quadrats were chosen to capture the main vegetation units occurring within the study area. In the majority of cases, the approximate locations of the quadrats were chosen prior to the field survey with the aid of aerial photographs.

The dimensions of most quadrats were 50 m x 50 m. The 50 m x 50 m quadrat has become somewhat of a standard quadrat size for vegetation surveys conducted in the Pilbara bioregion as it is thought to provide a good indication of the shrub and grass layer

vegetation structure for most vegetation types. In some instances the quadrat dimensions were altered in order to accommodate vegetation associated with linear habitats (e.g. creeklines). Where quadrat dimensions were altered, every effort was made to maintain the overall area (i.e. 2,500 m2) of the quadrat.

The following parameters were recorded for each quadrat:

1. **Location** – recorded using a hand-held GPS unit (WGS84 datum) at the north-west corner of each quadrat.

2. **Aspect** – N, NNE, NE, E etc.

3. **Slope** – estimated to nearest 5°.

4. **Soil physical properties** - texture, colour and estimated depth (Deep, shallow or skeletal).

5. **Habitat** – description of landform and habitat.

6. **Vegetation Description** - based on the height and estimated percentage foliage cover of the dominant plant species within the vegetation unit (see Section 2.3 above).

7. **Disturbance details** – observed disturbance such as Clearing, grazing, feral animals, weeds and too frequent fire. The condition of vegetation was assessed using the vegetation condition scale of Trudgen (1988) (see Appendix 3).

8. **Percentage foliage cover and height** – estimated for each plant species recorded within the quadrat.

In some instances the vegetation was not extensive enough to warrant quadrat-based survey. In such cases, relevés were conducted. Each relevé survey consisted of a random meander through vegetation during which all plant species encountered were recorded. A subset of variables recorded during quadrat based sampling (see points above) was also recorded during relevé surveys. Overall, 16 relevés were conducted across the study area (Figure 4.1 & 4.2).

Opportunistic sampling of the flora within the study area was also used in order to supplement relevé and quadrat surveys.

3.6 Specimen Identification, Nomenclature and Data Entry

All vascular plants encountered during traverses were recorded. Plants not readily identifiable in the field were collected, pressed and assigned a unique specimen code for later identification.

Plant specimens collected in the field were identified using relevant published taxonomic keys and by comparison with collections held within the Rio Tinto reference herbarium.

Botanical data was entered into the Max3 database and nomenclature therefore follows the current listing of scientific names recognised by the Western Australian Herbarium.

3.7 Study Limitations

There are a number of limitations to the current study which must be taken into consideration when reviewing and applying the results of this study. Limitations of the current study include:

- Fungi and non-vascular flora (e.g. algae, mosses and liverworts) were not systematically sampled during field survey.
- The study area was surveyed once only over a single season. The single phase survey was conducted in early spring following a dry summer and autumn with generally below average rainfall in the months leading up to the survey. It is therefore likely that some ephemeral and cryptic plant taxa which occur at the site were not recorded. Multiple surveys over several seasons would be required in order to compile an exhaustive list of species that occur within the study area.
- All vegetation types were traversed during the survey with targeted searches for DRF and Priority flora undertaken in representative areas of suitable habitat. However, the entire study area was not systematically searched and as such, the inventory of plant species recorded within the study area should be considered as indicative rather than exhaustive.
- No quantitative statistical analysis was undertaken of data collected within survey quadrats and relevés. All vegetation units have been derived by qualitative assessment of vegetation data.

4. Vegetation of the Study Area

A total of 11 vegetation units were recorded across the study area covering 79.2 ha. The remaining 19.5 ha of the study area was categorised as 'Heavily Disturbed' and lacked any discernible native vegetation.

The 11 vegetation units were recorded from 4 habitat types which dominated the locality (Table 4.1). These broad habitats were:

- Plains of red sand including areas with saline influence
- Low aeolian red sand dunes
- Low rocky volcanic and metamorphosed sedimentary hills
- Minor narrow drainage channels of rocky hills and surrounding red sand plains

The distribution of these broad habitats closely followed the spatial distribution of land systems across the study area. The sand dune and sand plain habitats described above occurred exclusively on the colluvial and alluvial deposits associated with the Uaroo land system while the low rocky volcanic and sedimentary hills were consistent with the Ruth land system.

The overall vegetation condition within the study area was Very Good however the condition of vegetation varied in response to proximity to infrastructure related to the Wickham Township. Weeds such as Buffel Grass (*Cenchrus ciliaris*) were predominately recorded around the perimeter of each of the 4 Wickham survey polygons (WSPs) and along the edges of the numerous unsealed tracks which traversed the study area. Weeds were also common in drainage channels. Patches of WSPs 1, 2 and 3 had been recently burnt and it is possible that the vegetation in these areas had been impacted by the passage of too frequent fires.

Table 4.1: Summary of vegetation units recorded within the Wickham Town Expansion study area

Vegetation Code	Vegetation Description	Hectares
Vegetation of red sand plains including areas with saline influence		
SP-1	*Acacia stellaticeps* low open heath over *Triodia schinzii, Triodia epactia* hummock grassland	*36.4*
SP-2	*Grevillea wickhamii* tall open shrubland over *Santalum lanceolatum*, *Acacia bivenosa* open shrubland over *Acacia stellaticeps*, *Diplopeltis eriocarpa* low open shrubland over *Triodia schinzii*, *Triodia epactia* open hummock grassland.	*2.8*
SP-3	*Dolichandrone heterophylla*, *Acacia bivenosa* shrubland over *Acacia stellaticeps*, *Scaevola spinescens* shrubland to low open heath over *Triodia schinzii*, *Triodia epactia* hummock grassland.	2.1
SP-4	*Grevillea wickhamii*, *Acacia tumida* var. *pilbarensis* tall open shrubland to tall open scrub over *Acacia tumida* var. *pilbarensis*, *Acacia bivenosa*, *Acacia ancistrocarpa* shrubland over *Acacia stellaticeps* open scattered shrubs over *Triodia schinzii*, *Triodia epactia* hummock grassland.	7.4
SP-5	*Corymbia hamersleyana* scattered low trees over *Acacia trachycarpa* tall open shrubland over *Acacia stellaticeps* scattered low shrubs over *Triodia epactia* hummock grassland over *Cenchrus ciliaris* very open tussock grassland.	3.2
SP-6	*Acacia synchronicia* open shrubland to tall open shrubland over *Pluchea ferdinandi-muelleri* low open heath over *Triodia epactia* hummock grassland and *Cenchrus ciliaris* very open tussock grassland over *Trianthema turgidifolia*, *Streptaglossa liatroides* herbland.	2.4
SP-7	*Atriplex bunburyana*, *Tecticornia halocnemoides* subsp. *tenuis*, *Tecticornia auriculata* low open heath over *Triodia epactia* scattered hummock grasses.	1.1
Vegetation of low aeolian red sand dunes		
SD-1	*Acacia sabulosa* tall open shrubland over *Acacia sabulosa*, *Santalum lanceolatum* shrubland over *Acacia stellaticeps*, *Diplopeltis eriocarpa*, *Scaevola sericophylla* low shrubland over *Triodia schinzii* open hummock grassland.	8.2
Vegetation of low rocky hills		
LH-1	*Grevillea wickhamii* tall scattered shrubs over *Acacia bivenosa*, *Acacia ancistrocarpa*, *Hakea lorea* open shrubland over *Triodia wiseana*, *Triodia epactia* hummock grassland.	11.7

Vegetation Code	Vegetation Description	Hectares
Vegetation of minor narrow drainage channels of rocky hills and surrounding red sand plains		
MF-1	*Acacia tumida* var. *pilbarensis*, *Grevillea wickhamii* open scrub over *Acacia stellaticeps*, *Scaevola spinescens* low scattered shrubs over *Triodia schinzii* scattered hummock grasses.	0.4
MF-2	*Corymbia hamersleyana* scattered low trees over *Acacia tumida* var. *pilbarensis*, *Grevillea wickhamii* tall open shrubland over *Acacia tumida* var. pilbarensis, *Eremophila longifolia* open shrubland over *Acacia stellaticeps*, *Scaevoila spinescens* low open shrubland over *Triodia epactia* open hummock grassland.	3.5

4.1 Vegetation Units of the Study Area

4.1.1 Vegetation of deep red sand plains

SP-1 *Acacia stellaticeps* low open heath over *Triodia schinzii*, *Triodia epactia* hummock grassland

This vegetation unit was the dominant unit on the deep red sand plains of the Uaroo land system and occupied the greatest total area within the study area (36.4 ha, 37%). Large tracts occurred across WSP 4 with smaller areas mapped in WSP 2 and 3. The vegetation was in Excellent condition in WSP 4 but was disturbed in WSP 2 and 3 due mainly to weed encroachment and possibly too frequent fires. SP-1 vegetation within WSP 2 and 3 was assessed as being in Good condition.

Plant species associated with this vegetation unit included *Pimelea ammocharis*, *Scaevola spinescens*, *S. sericophylla*, *Diplopeltis eriocarpa*, *Bonamia rosea*, *B. linearis*, *Senna glutinosa* subsp. *glutinosa*, *S. artemisioides* subsp. *helmsii*, *A. bivenosa*, *A. sphaerostachya*, *Santalum lanceolatum, Cassytha capillaris* and *Grevillea wickhamii*.

SP-2 *Grevillea wickhamii* tall open shrubland over *Santalum lanceolatum, Acacia bivenosa* open shrubland over *Acacia stellaticeps, Diplopeltis eriocarpa* low open shrubland over *Triodia schinzii, Triodia epactia* open hummock grassland.

This vegetation unit occupied two relatively small areas totalling 2.8 ha (2.8%) in the north and south-east of WSP 4. The vegetation appeared to be associated with slight run-on areas of the sandy plain. Overall the vegetation was in Excellent condition with no obvious signs of disturbance.

Plant species associated with this vegetation unit included Bonamia rosea, *Senna glutinosa* subsp. *luerssenii*, *Acacia pyrifolia*, *A. coriacea*, *A. tumida* var. *pilbarensis*, *A. sphaerostachya*, *Indigofera monophylla*, *Scaevola spinescens* and *Diplopeltis eriocarpa*.

SP-3 *Dolichandrone heterophylla, Acacia bivenosa* shrubland over *Acacia stellaticeps, Scaevola spinescens* shrubland to low open heath over *Triodia schinzii, Triodia epactia* hummock grassland.

This vegetation unit was recorded from two small areas totalling 2.1 ha in the west of WSP 2 and north-east of WSP 4. The vegetation within WSP 4 was in Excellent condition while in WSP 2 the vegetation was assessed as being in Poor condition due to the apparent history of soil disturbance and consequent invasion by Buffel Grass (*Cenchrus ciliaris*).

Plant species associated with this vegetation unit included *Bonamia rosea*, *Indigofera monophylla*, *Santalum lanceolatum*, *Corymbia hamersleyana*, *Hakea lorea*, *Senna glutinosa* subsp. *pruinosa*, *Acacia pyrifolia* and *Hibiscus sturtii*.

SP-4 *Grevillea wickhamii, Acacia tumida* var. *pilbarensis* tall open shrubland to tall open scrub over *Acacia tumida* var. *pilbarensis, Acacia bivenosa, Acacia ancistrocarpa* shrubland over *Acacia stellaticeps* open scattered shrubs over *Triodia schinzii, Triodia epactia* hummock grassland.

This vegetation unit occupied 7.4 ha of land in the central and western parts of WSP 4 and was associated with areas of increased soil moisture at the base of low rocky hills. The vegetation was typically in Excellent condition though some areas in the south west had been cleared for track construction and the extraction of borrow material.

Plant species associated with this vegetation unit included *Scaevola spinescens*, *Hakea lorea*, *Acacia pyrifolia*, *Indigofera monophylla*, *Senna glutinosa* subsp. *glutinosa*, *Diplopeltis eriocarpa*, *Dodonaea coriacea*, *Acacia sphaerostachya*, *Bonamia rosea*, *Ptilotus astrolasius*, *P. calostachyus*, *Goodenia stobbsiana*, *Hybanthus aurantiacus*, and *Santalum lanceolatum*.

SP-5 *Corymbia hamersleyana* scattered low trees over *Acacia trachycarpa* tall open shrubland over *Acacia stellaticeps* scattered low shrubs over *Triodia epactia* hummock grassland over *Cenchrus ciliaris* very open tussock grassland.

This vegetation unit was recorded from the north western corner of WSP 1 and a small area in the north west of WSP 4. Overall SP-5 vegetation covered 3.2 ha of the study area. Weeds were a feature in both the WSP 1 and WSP 4 examples of this vegetation unit and are a consequence of historic and on-going soil disturbance and vegetation clearing within the study area. Overall the vegetation unit was assessed as being in Good to Very Good condition.

Plant species associated with the SP-5 vegetation unit included *Senna artemisioides* subsp. *helmsii*, *Diplopeltis eriocarpa*, *Acacia coriacea* subsp. *pendens*, *A. ancistrocarpa*, *A. sphaerostachya*, *A. bivenosa*, *A. pyrifolia*, *Grevillea wickhamii*, *Pimelea ammocharis*, *Trichodesma zeylanicum*, *Abutilon lepidum*, *A. fraseri*, *Enchylaena tomentosa*, *Solanum horridum*, *Bonamia linearis*, *Cassytha capillaris*, *Panicum decompositum* and *Waltheria indica*.

SP-6 *Acacia synchronicia* open shrubland to tall open shrubland over *Pluchea ferdinandi-muelleri* low open heath over *Triodia epactia* hummock grassland and *Cenchrus ciliaris* very open tussock grassland over *Trianthema turgidifolia, Streptoglossa liatroides* herbland.

This vegetation unit was restricted to sand plain habitat within WSP 1 and covered 2.4 ha of the study area. Parts of this vegetation unit had been recently burnt and *Pluchea ferdinandi-muelleri* formed dense stands approaching monocultures in the burnt patches. Numerous tracks had been cut through this vegetation unit and Buffel Grass was common and widespread within the groundcover stratum. Overall the vegetation was in Good condition according to the condition rating scale of Trudgen (1988).

Other plant species associated with the SP-6 vegetation unit included *Panicum decompositum*, *Sclerolaena hostilis*, *Neptunia dimorphantha*, *Maireana villosa*, *Cassytha capillaris*, *Scaevola acacioides*, *Acacia coriacea* subsp. *pendens*, *Enchylaena tomentosa*, *Eragrostis falcata* and *Atriplex bunburyana*.

SP-7 *Atriplex bunburyana, Tecticornia halocnemoides* subsp*. tenuis, Tecticornia auriculata* low open heath over *Triodia epactia* scattered hummock grasses*.*

This vegetation unit was recorded from the eastern boundary of WSP 1 on parts of the sandy plain with obvious saline influence given the dominance of the halophytic low shrubs; *Atriplex bunburyana, Tecticornia halocnemoides* subsp*. tenuis* and *Tecticornia auriculata*. This vegetation occurred within the mapped extent of the Uaroo land system but is probably more closely associated with vegetation of the nearby Cheerawarra land system. The vegetation was in Good condition.

Plant species associated with the SP-7 vegetation unit included *Scaevola acacioides*, *Neptunia dimorphantha* and *Maireana villosa*.

4.1.2 Vegetation of low aeolian red sand dunes

SD-1 *Acacia sabulosa tall* open shrubland over *Acacia sabulosa, Santalum lanceolatum* shrubland over *Acacia stellaticeps, Diplopeltis eriocarpa, Scaevola sericophylla* low shrubland over *Triodia schinzii* open hummock grassland*.*

This vegetation unit was recorded from an aeolian sand dune feature that ran in a roughly east-west direction and dominated the northern part of WSP 4 (8.3% of study area). A small patch of this unit was also recorded in the south of WSP 4 on a localised sandy rise. Soil disturbance and subsequent minor erosion related to an old telecommunications easement was the most notable disturbance observed within the vegetation unit, however overall, this vegetation was in Excellent condition. This vegetation unit is likely to be susceptible to erosion if the vegetation cover is removed.

Plant species associated with this vegetation unit included *Bonamia rosea*, *Eragrostis eriopoda*, *Acacia tumida* var. *pilbarensis*, *Grevillea wickhamii*, *Scaevola spinescens* and *Triodia epactia*.

Plate 1: Vegetation Unit SP-1

Plate 4: Vegetation Unit SP-4

Plate 2: Vegetation Unit SP-2

Plate 5: Vegetation Unit SP-5

Plate 3: Vegetation Unit SP-3

Plate 6: Vegetation Unit SP-6

Plate 7: Vegetation Unit SP-7

Plate 10: Vegetation Unit MF-1

Plate 8: Vegetation Unit SD-1

Plate 11: Vegetation Unit MF-2

Plate 9: Vegetation Unit LH-1

4.1.3 Vegetation of low rocky hills

LH-1 *Grevillea wickhamii* tall scattered shrubs over *Acacia bivenosa, Acacia ancistrocarpa, Hakea lorea* open shrubland over *Triodia wiseana, Triodia epactia* hummock grassland.

This vegetation unit occupied the lower slopes of rocky hills along the western boundary of WSP 4 as well as a low hill which rose several metres above the sandy plain in the central part of WSP 4. The rocky hills are associated with the Ruth land system and consist of volcanic rocks as well as sedimentary strata of chert, jaspilite, shale and siltstone. The LH-1 vegetation unit occupied a total area of 11.7 ha and was in Excellent condition.

Plant species associated with this vegetation unit included *Senna glutinosa* subsp. *pruinosa*, *S. glutinosa* subsp. *glutinosa*, *Acacia synchronicia*, *Ptilotus exaltatus*, *Ptilotus calostachyus*, *Ficus brachypoda*, *Goodenia stobbsiana*, *Dodonaea coriacea*, *Acacia tumida* var. *pilbarensis*, *Hybanthus aurantiacus*, *Eriachne mucronata*, *Corymbia hamersleyana*, *Corchorus parviflorus* and *Tribulus suberosus*.

4.1.4 Vegetation of minor narrow drainage channels of rocky hills and surrounding red sand plains

MF-1 *Acacia tumida* var. *pilbarensis, Grevillea wickhamii* open scrub over *Acacia stellaticeps, Scaevola spinescens* low scattered shrubs over *Triodia schinzii* scattered hummock grasses.

This vegetation was recorded from two minor flowlines which drained the low rocky hill in the centre of WSP 4 and covered 0.4 ha of the study area. The MF-1 unit was in Excellent condition with no evidence of past disturbance observed.

Plant species associated with the MF-1 vegetation unit included *Corymbia hamersleyana*, *Acacia bivenosa*, *Triodia wiseana*, *Acacia ancistrocarpa* and *Keraudrenia velutina*.

MF-2 *Corymbia hamersleyana* scattered low trees over *Acacia tumida* var. *pilbarensis, Grevillea wickhamii* tall open shrubland over *Acacia tumida* var. *pilbarensis, Eremophila longifolia* open shrubland over *Acacia stellaticeps, Scaevola spinescens* low open shrubland over *Triodia epactia* open hummock grassland.

This vegetation unit was recorded from minor flowlines draining the rocky hills in the west of WSP 4 and also within a minor flowline traversing the sandy plain along the southern boundary of WSP 4. Overall the MF-2 vegetation unit occupied 3.5 ha within the study area. The condition of the vegetation was generally Very Good however some areas

located close to urban development in the north-west corner of WSP 4 were in Poor condition. Buffel Grass was recorded from all areas of this vegetation unit.

Plant species associated with this vegetation unit included *Hakea lorea*, *Solanum horridum*, *Indigofera monophylla*, *Bonamia rosea*, *Santalum lanceolatum*, *Trichodesma zeylanicum*, *Acacia pyrifolia*, *Abutilon lepidum* and *Diplopeltis eriocarpa*.

HD Heavily Disturbed Ground

A relatively large proportion of the study area (~20%) did not contain any intact native vegetation and was therefore mapped as 'Heavily Disturbed' ground. These areas included unsealed tracks, infrastructure related to the township of Wickham (e.g. buildings, carparks, roads, powerline easements), an old borrow pit (WSP 4) and previously disturbed vegetation subsequently dominated by weeds such as Buffel Grass.

4.2 Probable distribution of the Vegetation Units Based on their Correspondence with Land Systems

Vegetation within the study area was closely associated with the distribution of land systems. Vegetation of the sandy plains and aeolian red sand dunes were restricted to the Uaroo land system while vegetation of the low rocky hills and minor drainage lines typically occurred within areas mapped as the Ruth land system (van Vreeswyk *et al.* 2004).

The Uaroo land system is common and distributed widely across the western Pilbara with extensive areas around Onslow and Port Hedland. However, this land system is relatively uncommon in the Karratha, Wickham and Cape Lambert areas. On the basis of the distribution of the Uaroo land system, vegetation of the sandy plains and aeolian dunes recorded within the study area are likely to be locally uncommon but widespread in coastal areas of the Roebourne Plains and Chichester sub-regions of the Pilbara bioregion. This interpretation appears to be supported by previous studies with only small areas of similar vegetation having been recorded sporadically throughout the Karratha, Wickham and Cape Lambert locality (see Biota 2008a).

On the basis of the distribution of the Ruth land system and the widespread nature of the dominant plant species within the study area; vegetation units associated with the Ruth land system within the study area are likely to be common and widespread in the western Pilbara.

4.3 Conservation Significance of Vegetation Units

None of the vegetation units identified within the study area are consistent with any TECs or PECs as defined by the DEC (DEC 2010a; 2010b). Moreover, none of the vegetation units qualify for legislative protection under the EPBC Act. Several vegetation units were considered to have moderate conservation significance at a local scale (see Section 4.3.1) while the remaining vegetation within the study area is though to have low conservation significance.

4.3.1 Vegetation Units of Moderate Conservation Significance

Vegetation units associated with the Uaroo land system within the study area may be locally uncommon and are therefore considered to have moderate conservation significance. These vegetation units include SP-1 to SP-7 and SD-1. Unnecessary disturbance to these vegetation types should be kept to a minimum and areas of Poor condition should be cleared in preference to areas of Very Good or Excellent condition.

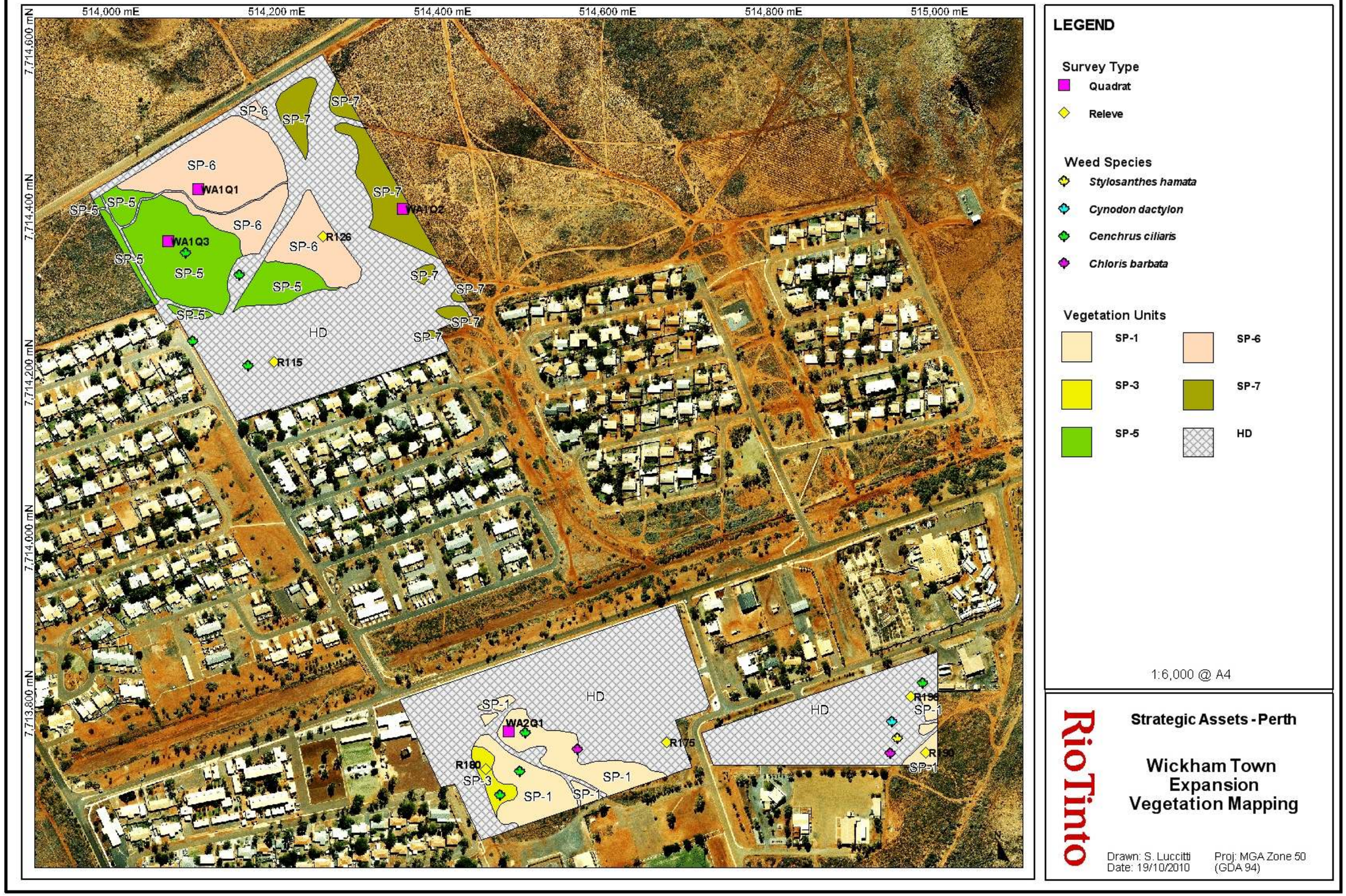

Figure 4.1: Vegetation mapping within the northern WSPs (WSP 1, 2 & 3) of the proposed Wickham Town Expansion study area.

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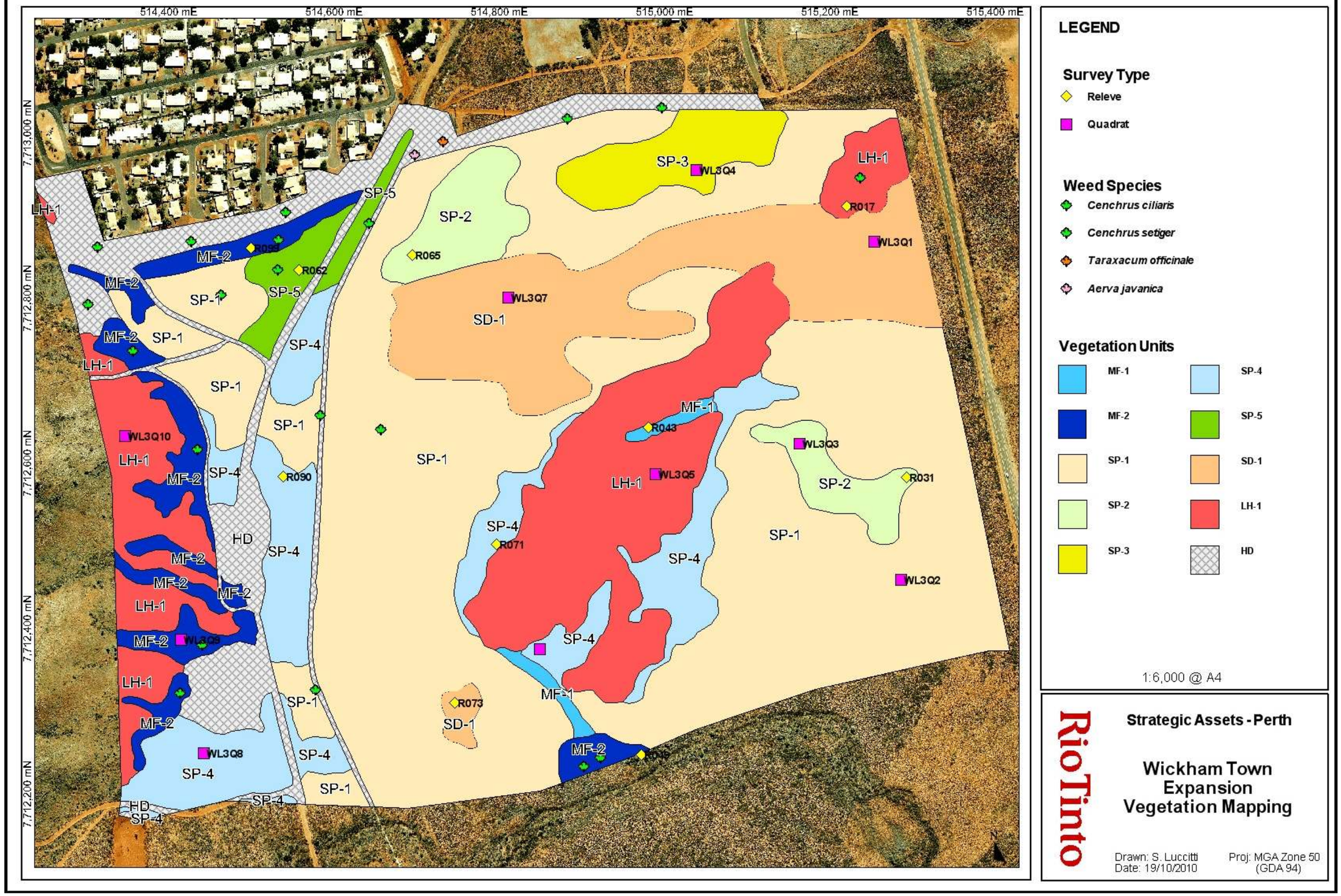

Figure 4.2: Vegetation mapping within the southern WSP (WSP 4) of the proposed Wickham Town Expansion study area.

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5. Flora of the Study Area

5.1 Native flora within the Study Area

A total of 97 native vascular plant taxa from 56 genera belonging to 27 families were recorded in the study area (Appendix 4). No Declared Rare Flora (DRF) or Priority flora species were recorded during the survey (Section 5.2.1). In addition, 7 weed species were recorded (Section 5.2.3).

The study area is considered to have a species richness value within the range expected for its size when compared to results obtained by other studies in the Wickham/Cape Lambert locality (Table 5.1). Biota (2008c) have noted that coastal areas in the Pilbara bioregion typically do not have high levels of specie richness due to; (a) the general paucity of the flora of the coastal environments within the Roebourne and Chichester subregions, and (b) the harshness of many habitats to plant growth (e.g. saline clay flats).

The number of species recorded during the current study is partly a function of the number of habitat types within the study area as well as the amount of rainfall received by the locality. Conditions were very dry at the time of survey and it is likely that a number of ephemeral species were overlooked during the current study.

Table 5.1: The number of native plant species, genera and families recorded during the current survey and by previous surveys in the vicinity of the Wickham Town Expansion survey area.

	Current Survey	Biota (2008a)	Biota (2008c)	Biota (2008e)	Pilbara Iron (2005)	GHD (2008)
Study area (ha)	98	1078	602	465	24	1793
# Native species	97	221	183	153	94	156
# Native genera	56	116	98	89	63	Not reported
# Native families	27	41	42	40	29	34

The families and genera within the study area with the greatest number of taxa are indicative of the plant groups which typically dominate survey areas in the coastal Pilbara locality. Mimosaceae (17 taxa), Malvaceae (9 taxa), Chenopodiaceae (8 taxa) and Poaceae (8 taxa) were the most species rich families recorded across the study area, while *Acacia* and *Senna* were the best represented genera within the study area.

5.2 Conservation Significant Flora Recorded During the Field Survey

5.2.1 Declared Rare Flora Occurring in the Locality

No Declared Rare Flora listed under the Commonwealth *EPBC Act 1999* or listed by the WA DEC were recorded within the study area, and none would be expected to occur on the basis of available habitats.

Lepidium catapycnon and *Thryptomene wittweri* are the only DRF species that occur within the Pilbara region. Ideal habitat for *Thryptomene wittweri* is restricted to mountain crests in high altitude areas (i.e. >1,000 m above sea level) and such habitat was not represented within the study area. Therefore this species is not expected to occur within or adjacent to the study area.

Lepidium catapycnon is known to occur on stony hills habitat in the Hamersley Ranges; with a distribution extending broadly from Tom Price across to east of Newman. Given the distribution of this species and lack of suitable habitat, it would not be expected to occur in the study area.

5.2.2 Priority Flora Occurring in the Locality

No Priority flora species or other flora of conservation significance were recorded within the study area.

Database searches undertaken during the desktop study identified 11 Priority flora as potentially occurring in the study area. A brief description of each Priority flora species and the likelihood of occurrence within the study area are presented in Table 5.2 below.

Table 5.2: Priority flora returned by database searches for a 50 km radius around the study area.

Scientific Name	Conservation Listing		Likelihood of Occurrence within the Study Area	Habitat and Discussion
	WCA	EPBCA		
Acacia glaucocaesia	P3	N/A	Low	Large shrub to small tree found on red loam, sandy loam and clay soils on floodplains. While suitable habitat exists, no individuals were observed
Rhynchosia bungarensis	P4	N/A	Low	Twining herb or creeper with resinous, sticky glands. Occurs in large creeks/rivers and gorges. No suitable habitat exists within the study area.
Gymnanthera cunninghamii	P3	N/A	Low	Shrub to 2m, recorded amongst rockpiles of the Dampier Archipelago. No records from the Cape Lambert/Wickham vicinity. Species unlikely occur.
Schoenus punctatus	P3	N/A	Low	Small sedge growing in muddy creek on the Burrup Peninsula. No suitable habitat occurs within the study area.
Stackhousia clementii	P3	N/A	Low	Cryptic taxa, little is known of the habitat requirements for this species. Has been recorded on saline soils in King Bay on the Burrup Peninsula. No records from the Cape Lambert/Wickham vicinity however this species could occur within the study area.

Scientific Name	Conservation Listing		Likelihood of Occurrence within the Study Area	Habitat and Discussion
	WCA	EPBCA		
Tephrosia bidwillii	P3	N/A	Low	Shrub. Recorded in the Karratha locality. No specimens have been recorded despite extensive surveying efforts across the Cape Lambert/Wickham area. Despite this, this species may potentially occur in the study area.
Terminalia supranitifolia	P3	N/A	Low	Spreading tangled tree or shrub growing among basalt rocks. No records from the Cape Lambert/Wickham area despite extensive surveying efforts.
Themeda sp. Hamersley Station (M.E. Trudgen 11431)	P3	N/A	Low	Recorded on cracking clay associated with mixed tussock grasslands of the Roebourne grasslands plains community. No habitat for this species exists within the study area.
Vigna sp. Rockpiles (R. Butcher et al. RB 1400)	P3	N/A	Low	Twining herb or climber, recorded on the Burrup peninsula. No records from Cape Lambert/Wickham vicinity, unlikely to be recorded in the study area.
Helichrysum oligochaetum	P1	N/A	Low	Herb growing to 25 cm known from scattered records in the Pilbara and Gascoyne. Growing in the Cape Lambert locality on red clay. Extensive surveys undertaken within and adjacent to the study area, no new records have been recorded. No areas of red clay occur within the study area.
Nicotiana heterantha	P1	N/A	Low	Decumbent, short-lived annual or perennial, herb, to 0.5 m high, forming low, spreading colonies. Was recorded by Biota (2008d) on a broad loamy plain in a floodout of the Harding Dam. Broad floodout habitats are absent from the study area.

The majority of the 11 Priority flora species returned by the database searches are considered unlikely to inhabit the study area due to the fact that:

1. Available habitats within the study area are not suitable, and/or
2. The species is perennial and readily identifiable in the field and therefore unlikely to have been overlooked during the survey.

The majority of Priority flora species returned by database searches are associated with habitats such as rock piles, cracking clay plains or large creeklines; none of which occurred within the study area.

The study area provides potential habitat for two Priority 3 plant species, *Stackhousia clementii* and *Tephrosia bidwillii* however neither of these two species have been recorded in the Cape Lambert locality. Both *S. clementii* and *T. bidwillii* are only known from locations approximately 25-30 km west of the study area. Given the dearth of local records for these species, it is unlikely that they would be significantly impacted under the current proposal.

5.2.3 Introduced Flora Occurring within the Study Area

Seven introduced flora species were recorded within the study area (Figure 4.1 & 4.2; Table 5.3). None of the species are listed as Declared Plants under the *Agriculture and*

Related Resources Protection Act 1976; however Kapok Bush (*Aerva javanica*) and the two *Cenchrus* species are considered to be serious environmental weeds.

Cenchrus ciliaris (Buffel Grass) is a tufted perennial which was widely planted throughout pastoral regions of WA as a pasture grass and has since become a major weed of roadsides, creeklines and river edges (Hussey *et al.* 2007). Buffel Grass was the most common weed species encountered within the study area and was most prevalent along disturbed vegetation edges.

Cenchrus setiger (Birdwood Grass) has a similar form and habit to its congener, Buffel Grass and was similarly established in north west Australia as a fodder species in pastoral areas. As is the case for Buffel Grass, this species has established itself as a major weed of watercourses and disturbed areas. Birdwood Grass was recorded from a minor flowline which skirted the southern boundary of WSP 4.

Aerva javanica (Kapok Bush) is a common and widespread weed of disturbed areas in the Pilbara. This species was recorded in low numbers from heavily disturbed areas within the study area, particularly road and track verges.

Chloris barbata (Purpletop Chloris) is an annual grass, or herb that prefers growing on sand dunes and river levees (Florabase). This species was recorded sporadically from a heavily disturbed, artificial drainage swale in the north of WSP 4.

****Taraxacum officinale*** (Dandelion) is a rosetted perennial herb that is a weed of lawns, roadsides and waste places (Florabase). Individuals of this species were recorded sporadically from heavily disturbed areas in the north of WSP 4.

Stylosanthes hamata (Verano Stylo) is a perennial herbaceous pea which grows to approximately 30 cm. It was imported in to Australia as a fodder crop for tropical regions and has become naturalised in the Kimberley and coastal areas of the Pilbara bioregion. Verano Stylo was recorded from a heavily disturbed area in the east of WSP 3.

Cynodon dactylon (Couch Grass) is a prostrate, perennial grass, which spreads by rhizomes and stolons which root at the nodes (Florabase). It grows in sandy, loamy or clay soils and is widely planted as a lawn grass. The species was recorded from a heavily disturbed area in the east of WSP 3.

Table 5.3: Representative locations of introduced flora recorded within the proposed Wickham Town Expansion study area. Projection: MGA Zone 50 (GDA 94).

Species Name	Common Name	Easting	Northing
Aerva javanica	Kapok Bush	514700	7712972
Cenchrus ciliaris	Buffel Grass	514093	7714343
Cenchrus ciliaris	Buffel Grass	514101	7714237
Cenchrus ciliaris	Buffel Grass	514158	7714317
Cenchrus ciliaris	Buffel Grass	514472	7713688
Cenchrus ciliaris	Buffel Grass	514495	7713716
Cenchrus ciliaris	Buffel Grass	514981	7713823
Cenchrus ciliaris	Buffel Grass	514502	7713763
Cenchrus ciliaris	Buffel Grass	514168	7714207
Cenchrus ciliaris	Buffel Grass	514316	7712862
Cenchrus ciliaris	Buffel Grass	514885	7713016
Cenchrus ciliaris	Buffel Grass	514999	7713030
Cenchrus ciliaris	Buffel Grass	514442	7712379
Cenchrus ciliaris	Buffel Grass	514416	7712321
Cenchrus ciliaris	Buffel Grass	514437	7712616
Cenchrus ciliaris	Buffel Grass	514465	7712803
Cenchrus ciliaris	Buffel Grass	514534	7712833
Cenchrus ciliaris	Buffel Grass	514535	7712870
Cenchrus ciliaris	Buffel Grass	514359	7712735
Cenchrus ciliaris	Buffel Grass	514304	7712792
Cenchrus ciliaris	Buffel Grass	514924	7712243
Cenchrus ciliaris	Buffel Grass	515239	7712945
Cenchrus ciliaris	Buffel Grass	514658	7712640
Cenchrus ciliaris	Buffel Grass	514645	7712890
Cenchrus ciliaris	Buffel Grass	514585	7712657
Cenchrus ciliaris	Buffel Grass	514579	7712325
Cenchrus ciliaris	Buffel Grass	514429	7712868
Cenchrus ciliaris	Buffel Grass	514544	7712903
Cenchrus setiger	Birdwood Grass	514905	7712233
Chloris barbata	Purpletop Chloris	514565	7713743
Chloris barbata	Purpletop Chloris	514943	7713738
Cynodon dactylon	Couch	514944	7713776
Stylosanthes hamata	Verano Stylo	514951	7713756
Taraxacum officinale	Dandelion	514734	7712989

6. Statement Addressing the 10 Clearing Principles

Under Part V Division 2 of the Environmental Protection Act 1986, clearing of 1 ha or more of native vegetation requires a permit 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 ESA.

The Department of Mines and Petroleum (DMP) has responsibility for the administration, assessment and approval of clearing permit applications relating to mineral and petroleum activities in Western Australia. The DMP is required to assess applications for clearing permits against the 10 "Clearing Principles", as defined in Schedule 5 of the Environmental Protection Act 1986.

Section 6.1 provides an assessment of the proposed project against the "10 Clearing Principles" to determine whether it is at variance to the Principles. Assessment against the Principles identified clearing within the survey area is unlikely to be at variance with any of the clearing principles.

6.1 Clearing Principles

6.1.1 Comprises a high level of biological diversity

Native vegetation should not be cleared if it comprises a high level of biological diversity.

6.1.1.1 Ecosystem level

The study area lies within the Uaroo and Ruth land systems. The Ruth land system is the least extensive of the two within the Pilbara bioregion however neither is particularly restricted in their distribution.

The study area contains a moderate diversity of landforms including low rocky hills, sandy plains, low sand dunes and minor watercourses. While the sand plains and sand dunes within the study area are possibly locally uncommon, these landforms are widespread in the coastal areas of the Pilbara to the north and south.

Eleven intact vegetation units were identified from the various habitats within the study area. None of the vegetation units are consistent with any listed TECs or PECs and none are listed as threatened under the Commonwealth EPBC Act. Moreover, none of the vegetation units recorded within the study area is thought to be restricted to the study area or broader Wickham/Cape Lambert locality. Vegetation associated with the sandy plains and sand dunes may be locally uncommon but such vegetation would occur extensively in other areas of the Uaroo land system.

The condition of vegetation units ranged from Poor to Excellent with most units assessed as Good to Excellent condition. None of the 11 vegetation units were considered to be particularly rich in native flora.

6.1.1.2 Species level

The study area did not contain a particularly high diversity of native flora at the time of survey. A total of 97 native plant taxa were identified within the study area from 56 genera belonging to 27 plant families. Species richness within families and genera were considered typical for the Pilbara bioregions as was the types of families and genera represented.

The study area was surveyed in September, 2010 following poor summer and winter rainfall and, as such, some annual and short-lived perennial plant species are likely to have been overlooked. As a result the tally of native species recorded during the survey probably underestimates the plant species richness within the study area. Additional ephemeral species would be expected to occur following good winter and/or summer rainfall. It is unlikely however, given the habitats present, that additional survey effort would dramatically increase the number of species recorded such that the study area was considered to contain a high diversity of plant species.

Fauna habitats identified within the study area are considered to be well represented both locally and regionally and the study area is unlikely to contain a high diversity of fauna species (Biota 2010).

6.1.2 Potential impact to any significant habitat for fauna indigenous to Western Australia

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 to Western Australia.

A Level 1 fauna assessment of the Wickham town expansion study area was conducted by Biota Environmental Sciences in 2010 (Biota 2010). The level 1 assessment was conducted using searches of the DSEWPC Protected Matters Database, the DEC NatureMap Database, Biota Environmental Sciences Internal Database, and a review of previous fauna surveys in the area and other relevant literature (Biota 2010). A targeted survey for Short-range Endemic (SRE) invertebrates and a habitat assessment was conducted by Biota in September 2010 at various locations both within and adjacent to the study area (Biota 2010).

Biota identified seven broad fauna habitat types occurring within the Wickham study area. The majority of the fauna habitats in the study area were considered by Biota to be degraded and were not considered to be significant from a conservation perspective. The remaining fauna habitats in the study area were considered to be widespread and well represented elsewhere in the region (Biota, 2010)

Federal and State government database searches, and searches of the Biota internal database in combination with literature reviews yielded a potential total of 199 avifauna species, 40 native mammal species, seven introduced mammals species, six frog species and 92 reptile species occurring within the Wickham study area (Biota 2010).

In addition, the database searches indicated that 18 species of threatened fauna could potentially occur within the study area (Biota 2010). However an assessment of each species found that habitat within the study area was unlikely to support fauna of elevated

conservation significance and, the small scale and the nature of the development indicated that the conservation status of fauna species listed under Federal or State legislation is unlikely to be adversely affected (Biota 2010).

Similarly Biota stated that the potential impact on invertebrate taxa is considered negligible and the potential SRE species that were recorded within the proposed development area during the survey were also recorded outside the impact area (Biota 2010.

6.1.3 Potential impact to any rare flora

Native vegetation should not be cleared if it includes, or is necessary for the continued existence of rare flora.

The study area was traversed by a Rio Tinto botanist from the 28th to the 30th of September 2010. No Declared Rare Flora or any EPBC Act listed threatened flora were observed within the study area and none would be expected to occur.

No Priority Flora listed species were recorded in the study area, however two Priority 3 species could occur (see Section 5.2.2). It is unlikely the proposal will impact on the conservation status of either of the two species.

6.1.4 Presence of any Threatened Ecological Communities

Native vegetation should not be cleared if it comprises the whole or part of, or is necessary for the maintenance of a threatened ecological community (TEC).

No Threatened Ecological Communities (TEC) or Priority Ecological Communities (PECs) occur within the study area nor are any likely to be directly or indirectly impacted on by the proposal (see Section 2.7).

6.1.5 Significance as a remnant of native vegetation in the area that has been extensively cleared

Native vegetation should not be cleared if it is significant as remnant vegetation in an area that has been extensively cleared.

The majority of the Pilbara region, including the Chichester subregion, has never been extensively cleared, however grazing, inappropriate fire regimes and weed invasion have greatly altered the vegetation in some areas.

Native vegetation within the study area is consistent with Beard (1975) mapping units;

- **Abydos Plain/Chichester - 157** Hummock grasslands, grass steppe; hard spinifex*, Triodia wiseana* and;
- **Abydos Plain/Roebourne – 589** -Mosaic of short bunch grassland - savanna / grass plain (Pilbara) / hummock grasslands, grass steppe; soft spinifex.

According to Shepherd *et al.* (2002) there are approximately 100% of these vegetation types remaining. These vegetation associations are widely represented within the Chichester bioregion and would not be considered remnant vegetation.

6.1.6 Impact on any watercourses and/or wetlands

Native vegetation should not be cleared if it is growing in, or in association with, an environment associated with a watercourse or wetland.

No permanent watercourses or wetlands are found within the study area however the study area does contain numerous minor, ephemeral watercourses. The current proposal may, therefore, result in the loss of vegetation associated with a watercourse.

The proposed clearing is likely to have a negligible impact on minor watercourses and creeklines within and outside the study area. The loss of vegetation is not likely to significantly increase runoff or sediment transport to the watercourses nor is removal of riparian vegetation likely to destabilise creek banks or lead to significant erosion of riparian zones.

6.1.7 Potential to cause appreciable land degradation

Native vegetation should not be cleared if the clearing of vegetation is likely to cause appreciable land degradation.

Vegetation within the study area occurs on the Uaroo and Ruth land systems; neither of which are considered to be susceptible to erosion or vegetation degradation (van Vreeswyk *et al.* 2004). Some small areas of soil erosion were noted within WSP 4 however these were associated with extensive soil disturbance (i.e. borrow pit excavation) as well as vegetation clearing. The removal of vegetation from the sand dune feature in the north of WSP 4 has the potential to exacerbate erosion within the study area.

Clearing of vegetation within the study area is unlikely to result in acidification, salinisation, water-logging or nutrient export within or outside the study area.

Weeds are already common across the study area and it is unlikely that the proposal will greatly exacerbate the spread of weeds in the local area.

Strict weed hygiene measures together with adequate sediment and erosion control procedures will minimise potentially adverse impacts of the proposal such that the proposal is unlikely to lead to appreciable land degradation.

6.1.8 Potential to impact on the environmental values of any adjacent or nearby conservation areas

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.

The nearest land-based, non-marine DEC conservation estate, Millstream-Chichester National Park is located approximately 52 km south east of the study area. The proposal would therefore not impact on the environmental values of the National Park, or any other conservation area.

6.1.9 Potential deterioration in the quality of surface or underground water

Native vegetation should not be cleared if the clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water.

The study area is not located within a Public Drinking Water Source Area (PDWSA) (GIS Database).

The proposal is unlikely to significantly impact on the quality of surface or groundwater resources in the area.

Drainage lines within the study area are ephemeral and would only hold surface water for short durations following significant rainfall events. Sediment loads are typically high in flowlines at such times and therefore any increase to the sediment load caused by the proposal is likely to be negligible. The proposal is unlikely to alter other chemical or physical water quality parameters.

Given the small scale of proposed clearing there is no reason to expect the proposal will have any impact on the quantity or quality of groundwater in the local area.

6.1.10 Potential of clearing to cause, or exacerbate, the incidence or intensity of flooding

Native vegetation should not be cleared if the clearing of vegetation is likely to cause, or exacerbate, the incidence of flooding.

Local flooding occurs seasonally in the Pilbara region as a result of cyclonic activity and sporadic thunderstorm activity. It is likely the ephemeral drainage lines within the study area would experience natural seasonal flooding during times of intense rainfall. However, the small area to be cleared (98.3 ha) is not likely to lead to an increase in flood height or duration.

Conservation Significance Summary

Intact native vegetation occupied 79.2 ha of the study area and was typically in Good or better condition. Disturbance was most prevalent where the vegetation bordered cleared urban areas and disturbance was typically related to clearing for tracks and infrastructure. Weeds were common throughout WSP 1, 2 and 3 and were observed frequently along the northern boundary of WSP 4.

Eleven vegetation units were identified across the study area. None of the 11 vegetation units are listed under the *EPBC Act 1999* nor are any defined as TECs or PECs by the DEC (DEC 2010a; 2010b). Vegetation units associated within sandy plains and aeolian sand dunes were, however, identified as having moderate conservation significance on the basis that such habitats are locally uncommon in the Wickham and Cape Lambert localities.

No DRF or Priority flora were recorded during the field survey nor have any been recorded previously within the study area. The study area may provide suitable habitat for the Priority 3 species *Stackhousia clementii* and *Tephrosia bidwillii* however the proposed development of the Wickham Town Expansion project is unlikely to impact the conservation significance of this species.

An assessment of fauna habitats and SRE fauna survey undertaken by Biota (2010) found that habitat within the study area was unlikely to support fauna of elevated conservation significance and, the small scale and the nature of the development indicated that the conservation status of fauna species listed under Federal or State legislation is unlikely to be adversely affected (Biota 2010). Similarly Biota (2010) found that the potential impact on invertebrate taxa is considered negligible and the potential SRE species that were recorded within the proposed development area during the survey were also recorded outside the impact area (Biota 2010).

Recommendations

The following recommendations are made to minimise impacts to the vegetation, flora and fauna within and surrounding the study area.

- Disturbance to SP-1, SP-2, SP-3, SP-4, SP-5, SP-6, SP-7 & SD-1 vegetation in Excellent condition should be minimised wherever possible.
- Clearing of vegetation unit SD-1, where necessary, should be undertaken in a manor commensurate with the erosion risk posed by this vegetation unit.
- Strict weed hygiene protocols are to be implemented during clearing of vegetation and subsequent earth works to minimise the spread of weeds.
- All topsoil from cleared areas is to be collected and stockpiled for use in any rehabilitation programs within the study area or surrounding areas.
- As a general rule, disturbance to the soil and vegetation should be kept to a minimum.

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Appendix 1: Biota Environmental Sciences (2010) *Wickham Town Expansion Level 1 Fauna Assessment and SRE Fauna Survey*. Unpublished report prepared for Rio Tinto Iron Ore, October 2010.

Appendix 2: Results of DEC Flora Searches and EPBC Act Protected Matters Database Search

SHEET	SPNAME	CONSVCODE	POPID1	GDA94LAT	GDA94LONG	OWNERDATE
Threatened Flora Database Search Results						
29320	Acacia glaucocaesia	3	4	-20.7845	117.14383	18/07/2004
29318	Acacia glaucocaesia	3	6	-20.72489	117.01611	5/10/2004
28289	Stackhousia clementii	3	4	-20.62942	116.78422	30/04/2002
28290	Stackhousia clementii	3	5	-20.61761	116.78939	14/06/2003
19026	Terminalia supranitifolia	3	1	-20.609	116.78259	6/12/1978
19027	Terminalia supranitifolia	3	2	-20.65856	116.74411	12/12/1971
19028	Terminalia supranitifolia	3	3	-20.627	116.79939	1/05/1983
19029	Terminalia supranitifolia	3	4	-20.68334	116.74411	1/12/1986
19030	Terminalia supranitifolia	3	5	-21.05723	116.8042	6/07/1986
19032	Terminalia supranitifolia	3	7	-20.61678	116.78697	30/10/2001
19033	Terminalia supranitifolia	3	7	-20.61284	116.79272	31/10/2001
WA Herbarium Search Results						
PERTH 06492347	Acacia glaucocaesia	P3		-20.72339	117.01623	05 07 2003
PERTH 00152897	Acacia glaucocaesia	P3		-20.78333	116.96667	07 1979
PERTH 00669423	Acacia glaucocaesia	P3		-20.78333	116.96667	11 1979
PERTH 06492339	Acacia glaucocaesia	P3		-20.72358	117.01753	05 07 2003
PERTH 00872148	Acacia glaucocaesia	P3		-20.66666	116.70306	26 07 1987
PERTH 00153397	Acacia glaucocaesia	P3		-20.73972	116.84806	09 1961

SHEET	SPNAME	CONSVCODE	POPID1	GDA94LAT	GDA94LONG	OWNERDATE
PERTH 00808458	Acacia glaucocaesia	P3		-20.66666	116.70306	07 1986
PERTH 07871929	Acacia glaucocaesia	P3		-20.78333	117.16667	18 08 1983
PERTH 07161263	Acacia glaucocaesia	P3		-20.7845	117.14384	18 07 2004
PERTH 06926940	Acacia glaucocaesia	P3		-20.72488	117.01611	05 10 2004
PERTH 08253293	Rhynchosia bungarensis	P4		-20.53011	116.83526	27 06 2000
PERTH 02907690	Rhynchosia bungarensis	P4		-20.50805	116.84	05 06 1962
PERTH 08158886	Rhynchosia bungarensis	P4		-20.53011	116.83526	27 06 2000
PERTH 08158908	Rhynchosia bungarensis	P4		-20.48741	116.83286	29 05 2000
PERTH 08158851	Rhynchosia bungarensis	P4		-20.53011	116.83526	27 06 2000
PERTH 08158878	Rhynchosia bungarensis	P4		-20.53011	116.83526	27 06 2000
PERTH 08158894	Rhynchosia bungarensis	P4		-20.50267	116.8268	29 05 2000
PERTH 08158983	Rhynchosia bungarensis	P4		-20.50267	116.8268	29 05 2000
PERTH 08158991	Rhynchosia bungarensis	P4		-20.57404	116.8051	26 06 2000
PERTH 08159009	Rhynchosia bungarensis	P4		-20.61269	116.78227	22 05 2000
PERTH 08159017	Rhynchosia bungarensis	P4		-20.53496	116.81955	27 05 2000
PERTH 08131090	Rhynchosia bungarensis	P4		-20.60637	116.75697	26 05 2000
PERTH 08159025	Rhynchosia bungarensis	P4		-20.53371	116.81913	27 05 2000
PERTH 08131104	Rhynchosia bungarensis	P4		-20.61543	116.75805	26 05 2000

SHEET	SPNAME	CONSVCODE	POPID1	GDA94LAT	GDA94LONG	OWNERDATE
PERTH 08131120	Rhynchosia bungarensis	P4		-20.53369	116.83808	27 05 2000
PERTH 08131139	Rhynchosia bungarensis	P4		-20.56604	116.82089	05 06 2000
PERTH 08131147	Rhynchosia bungarensis	P4		-20.54908	116.84486	25 05 2000
PERTH 08131155	Rhynchosia bungarensis	P4		-20.64027	116.77736	20 05 2000
PERTH 08131163	Rhynchosia bungarensis	P4		-20.54632	116.82824	25 05 2000
PERTH 08131171	Rhynchosia bungarensis	P4		-20.63894	116.78666	20 05 2000
PERTH 08159041	Rhynchosia bungarensis	P4		-20.64576	116.76178	21 05 2000
PERTH 08159068	Rhynchosia bungarensis	P4		-20.69183	116.72146	28 05 2000
PERTH 08159076	Rhynchosia bungarensis	P4		-20.64895	116.75974	21 05 2000
PERTH 08159084	Rhynchosia bungarensis	P4		-20.56679	116.81918	05 06 2000
PERTH 07271484	Rhynchosia bungarensis	P4		-20.78333	116.76667	21 09 1983
PERTH 06298400	Schoenus punctatus	P3		-20.56589	116.82356	10 07 1999
PERTH 06404146	Stackhousia clementii	P3		-20.63026	116.78416	30 04 2002
PERTH 02923017	Tephrosia bidwillii	P3		-20.73972	116.84806	08 1982
PERTH 01026828	Tephrosia bidwillii	P3		-20.71666	116.76667	
PERTH 1061763	Terminalia supranitifolia	P3		-20.63333	116.75	06 12 1978
PERTH 07195958	Terminalia supranitifolia	P3		-20.6704	116.757	02 11 1998
PERTH 07195923	Terminalia supranitifolia	P3		-20.66687	116.76439	28 11 1998

SHEET	SPNAME	CONSVCODE	POPID1	GDA94LAT	GDA94LONG	OWNERDATE
PERTH 07196075	Terminalia supranitifolia	P3		-20.65143	116.79218	08 11 1998
PERTH 07195966	Terminalia supranitifolia	P3		-20.66859	116.76342	02 11 1998
PERTH 07195907	Terminalia supranitifolia	P3		-20.64303	116.76777	28 11 1998
PERTH 07195842	Terminalia supranitifolia	P3		-20.6543	116.7784	24 11 1998
PERTH 07196040	Terminalia supranitifolia	P3		-20.66073	116.77171	03 11 1998
PERTH 07196008	Terminalia supranitifolia	P3		-20.6587	116.77505	03 11 1998
PERTH 07196229	Terminalia supranitifolia	P3		-20.64153	116.79626	12 11 1998
PERTH 07196091	Terminalia supranitifolia	P3		-20.63861	116.79376	10 11 1998
PERTH 07195796	Terminalia supranitifolia	P3		-20.6452	116.77981	22 11 1998
PERTH 07196016	Terminalia supranitifolia	P3		-20.65839	116.77965	05 11 1998
PERTH 07196067	Terminalia supranitifolia	P3		-20.65249	116.78715	08 11 1998
PERTH 07196113	Terminalia supranitifolia	P3		-20.63536	116.79939	10 11 1998
PERTH 07196164	Terminalia supranitifolia	P3		-20.64244	116.78226	20 11 1998
PERTH 07196148	Terminalia supranitifolia	P3		-20.63373	116.78594	20 11 1998
PERTH 07195761	Terminalia supranitifolia	P3		-20.64068	116.77855	22 11 1998
PERTH 07196180	Terminalia supranitifolia	P3		-20.64676	116.78322	18 11 1998
PERTH 07195826	Terminalia supranitifolia	P3		-20.65611	116.77323	24 11 1998
PERTH 07195885	Terminalia supranitifolia	P3		-20.64257	116.77326	26 11 1998

SHEET	SPNAME	CONSVCODE	POPID1	GDA94LAT	GDA94LONG	OWNERDATE
PERTH 07195869	Terminalia supranitifolia	P3		-20.65113	116.77254	26 11 1998
PERTH 1061771	Terminalia supranitifolia	P3		-21.05	116.8	06 07 1986
PERTH 1061755	Terminalia supranitifolia	P3		-20.66666	116.7	12 1986
PERTH 1155059	Terminalia supranitifolia	P3		-20.63333	116.8	05 1983
PERTH 1061798	Terminalia supranitifolia	P3		-20.66666	116.7	12 1971
PERTH 07288999	Terminalia supranitifolia	P3		-20.66666	116.75	21 07 2004
PERTH 07469713	Terminalia supranitifolia	P3		-20.63333	116.8	11 03 1983
PERTH 07469721	Terminalia supranitifolia	P3		-20.63333	116.8	11 03 1983
PERTH 07469748	Terminalia supranitifolia	P3		-20.63333	116.8	11 03 1983
PERTH 07469756	Terminalia supranitifolia	P3		-20.78333	116.76667	10 02 1982
PERTH 07469764	Terminalia supranitifolia	P3		-20.63597	116.7917	15 11 1998
PERTH 07469772	Terminalia supranitifolia	P3		-20.64153	116.79625	12 11 1998
PERTH 07469780	Terminalia supranitifolia	P3		-20.67039	116.757	02 11 1998
PERTH 07196202	Terminalia supranitifolia	P3		-20.63597	116.7917	15 11 1998
PERTH 3144909	Themeda sp. Hamersley Station (M.E. Trudgen 11431)	P3		-20.72916	116.76222	20 08 1992
PERTH 08141339	Vigna sp. rockpiles (R. Butcher et al. RB 1400)	P3		-20.60913	116.782	21 05 2000
PERTH 08141355	Vigna sp. rockpiles (R. Butcher et al. RB 1400)	P3		-20.6487	116.75917	21 05 2000
PERTH 08141363	Vigna sp. rockpiles (R. Butcher et al. RB 1400)	P3		-20.58063	116.79481	22 05 2000

SHEET	SPNAME	CONSVCODE	POPID1	GDA94LAT	GDA94LONG	OWNERDATE
PERTH 08145105	Vigna sp. rockpiles (R. Butcher et al. RB 1400)	P3		-20.649	116.75947	21 05 2000
PERTH 08091382	Vigna sp. rockpiles (R. Butcher et al. RB 1400)	P3		-20.9824	117.1054	04 06 2000
PERTH 08091404	Vigna sp. rockpiles (R. Butcher et al. RB 1400)	P3		-21.03497	117.10456	04 06 2000
PERTH 07905513	Vigna sp. rockpiles (R. Butcher et al. RB 1400)	P3		-20.64661	116.76061	29 05 2009
PERTH 07905718	Vigna sp. rockpiles (R. Butcher et al. RB 1400)	P3		-20.98286	117.10189	28 05 2009
PERTH 07905726	Vigna sp. rockpiles (R. Butcher et al. RB 1400)	P3		-20.68711	117.00811	26 05 2009
PERTH 08217661	Vigna sp. rockpiles (R. Butcher et al. RB 1400)	P3		-20.68864	117.00667	14 05 2004
PERTH 08217653	Vigna sp. rockpiles (R. Butcher et al. RB 1400)	P3		-20.68864	117.00667	10 09 2004
PERTH 08217645	Vigna sp. rockpiles (R. Butcher et al. RB 1400)	P3		-20.68864	117.00667	23 08 2005

EPBC Act Protected Matters Search Results

Search Type:	Point
Buffer:	50 km
Coordinates:	-20.71111,116.7527

Commonwealth Lands:	**2**
Commonwealth Heritage Places:	**None**
Places on the RNE:	**29**
Listed Marine Species:	**99**
Whales and Other Cetaceans:	**12**
Critical Habitats:	**None**
Commonwealth Reserves:	**None**

Threatened Species	Status	Type of Presence
Birds		
Macronectes giganteus Southern Giant-Petrel	Endangered	Species or species habitat may occur within area
Mammals		
Balaenoptera musculus Blue Whale	Endangered	Species or species habitat may occur within area
Dasycercus cristicauda Mulgara	Vulnerable	Species or species habitat likely to occur within area
Dasyurus hallucatus Northern Quoll	Endangered	Species or species habitat known to occur within area
Macrotis lagotis Greater Bilby	Vulnerable	Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale	Vulnerable	Species or species habitat known to occur within area
Rhinonicteris aurantia (Pilbara form) Pilbara Leaf-nosed Bat	Vulnerable	Species or species habitat likely to occur within area
Reptiles		
Caretta caretta Loggerhead Turtle	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle	Vulnerable	Breeding known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth	Endangered	Species or species habitat likely to occur within area
Eretmochelys imbricata Hawksbill Turtle	Vulnerable	Breeding known to occur within area
Liasis olivaceus barroni Olive Python (Pilbara subspecies)	Vulnerable	Species or species habitat may occur within area
Natator depressus Flatback Turtle	Vulnerable	Breeding known to occur within area
Sharks		
Pristis clavata Dwarf Sawfish, Queensland Sawfish	Vulnerable	Species or species habitat may occur within area

Rhincodon typus Whale Shark	Vulnerable	Species or species habitat may occur within area
Migratory Species	Status	Type of Presence
Migratory Terrestrial Species		
Birds		
Haliaeetus leucogaster White-bellied Sea-Eagle	Migratory	Breeding known to occur within area
Hirundo rustica Barn Swallow	Migratory	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater	Migratory	Species or species habitat may occur within area
Migratory Wetland Species		
Birds		
Actitis hypoleucos Common Sandpiper	Migratory	Species or species habitat known to occur within area
Ardea alba Great Egret, White Egret	Migratory	Species or species habitat may occur within area
Ardea ibis Cattle Egret	Migratory	Species or species habitat may occur within area
Arenaria interpres Ruddy Turnstone	Migratory	Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper	Migratory	Species or species habitat known to occur within area
Calidris alba Sanderling	Migratory	Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot	Migratory	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper	Migratory	Species or species habitat known to occur within area
Calidris ruficollis Red-necked Stint	Migratory	Species or species habitat known to occur within area
Calidris tenuirostris Great Knot	Migratory	Species or species habitat known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover	Migratory	Species or species habitat known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover	Migratory	Species or species habitat known to occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel	Migratory	Species or species habitat known to occur within area
Glareola maldivarum Oriental Pratincole	Migratory	Species or species habitat known to occur within area
Heteroscelus brevipes Grey-tailed Tattler	Migratory	Species or species habitat known to occur within area
Limicola falcinellus	Migratory	Species or species habitat

Broad-billed Sandpiper		known to occur within area
Limosa lapponica Bar-tailed Godwit	Migratory	Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit	Migratory	Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew	Migratory	Species or species habitat known to occur within area
Numenius phaeopus Whimbrel	Migratory	Species or species habitat known to occur within area
Pluvialis fulva Pacific Golden Plover	Migratory	Species or species habitat known to occur within area
Pluvialis squatarola Grey Plover	Migratory	Species or species habitat known to occur within area
Tringa nebularia Common Greenshank, Greenshank	Migratory	Species or species habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank	Migratory	Species or species habitat known to occur within area
Xenus cinereus Terek Sandpiper	Migratory	Species or species habitat known to occur within area

Migratory Marine Birds

Apus pacificus Fork-tailed Swift	Migratory	Species or species habitat may occur within area
Ardea alba Great Egret, White Egret	Migratory	Species or species habitat may occur within area
Ardea ibis Cattle Egret	Migratory	Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel	Migratory	Species or species habitat may occur within area
Puffinus pacificus Wedge-tailed Shearwater	Migratory	Breeding known to occur within area
Sterna anaethetus Bridled Tern	Migratory	Breeding known to occur within area
Sterna caspia Caspian Tern	Migratory	Breeding known to occur within area

Migratory Marine Species

Mammals

Balaenoptera edeni Bryde's Whale	Migratory	Species or species habitat may occur within area
Balaenoptera musculus Blue Whale	Migratory	Species or species habitat may occur within area
Dugong dugon Dugong	Migratory	Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale	Migratory	Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca	Migratory	Species or species habitat may occur within area

Sousa chinensis Indo-Pacific Humpback Dolphin	Migratory	Species or species habitat may occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations)	Migratory	Species or species habitat likely to occur within area
Reptiles		
Caretta caretta Loggerhead Turtle	Migratory	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle	Migratory	Breeding known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth	Migratory	Species or species habitat likely to occur within area
Eretmochelys imbricata Hawksbill Turtle	Migratory	Breeding known to occur within area
Natator depressus Flatback Turtle	Migratory	Breeding known to occur within area
Sharks		
Rhincodon typus Whale Shark	Migratory	Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species	Status	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper	Listed	Species or species habitat known to occur within area
Apus pacificus Fork-tailed Swift	Listed - overfly marine area	Species or species habitat may occur within area
Ardea alba Great Egret, White Egret	Listed - overfly marine area	Species or species habitat may occur within area
Ardea ibis Cattle Egret	Listed - overfly marine area	Species or species habitat may occur within area
Arenaria interpres Ruddy Turnstone	Listed	Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper	Listed	Species or species habitat known to occur within area
Calidris alba Sanderling	Listed	Species or species habitat known to occur within area

Calidris canutus Red Knot, Knot	Listed - overfly marine area	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper	Listed - overfly marine area	Species or species habitat known to occur within area
Calidris ruficollis Red-necked Stint	Listed - overfly marine area	Species or species habitat known to occur within area
Calidris subminuta Long-toed Stint	Listed - overfly marine area	Species or species habitat known to occur within area
Calidris tenuirostris Great Knot	Listed - overfly marine area	Species or species habitat known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover	Listed	Species or species habitat known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover	Listed	Species or species habitat known to occur within area
Charadrius ruficapillus Red-capped Plover	Listed - overfly marine area	Species or species habitat known to occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel	Listed - overfly marine area	Species or species habitat known to occur within area
Glareola maldivarum Oriental Pratincole	Listed - overfly marine area	Species or species habitat known to occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle	Listed	Breeding known to occur within area
Heteroscelus brevipes Grey-tailed Tattler	Listed	Species or species habitat known to occur within area
Himantopus himantopus Black-winged Stilt	Listed - overfly marine area	Species or species habitat known to occur within area
Hirundo rustica Barn Swallow	Listed - overfly marine area	Species or species habitat may occur within area
Larus novaehollandiae Silver Gull	Listed	Breeding known to occur within area
Limicola falcinellus Broad-billed Sandpiper	Listed - overfly marine area	Species or species habitat known to occur within area
Limosa lapponica Bar-tailed Godwit	Listed	Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit	Listed - overfly marine area	Species or species habitat known to occur within area

Macronectes giganteus Southern Giant-Petrel	Listed	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater	Listed - overfly marine area	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew	Listed	Species or species habitat known to occur within area
Numenius phaeopus Whimbrel	Listed	Species or species habitat known to occur within area
Pandion haliaetus Osprey	Listed	Breeding known to occur within area
Phalaropus lobatus Red-necked Phalarope	Listed	Species or species habitat known to occur within area
Pluvialis fulva Pacific Golden Plover	Listed	Species or species habitat known to occur within area
Pluvialis squatarola Grey Plover	Listed - overfly marine area	Species or species habitat known to occur within area
Puffinus pacificus Wedge-tailed Shearwater	Listed	Breeding known to occur within area
Recurvirostra novaehollandiae Red-necked Avocet	Listed - overfly marine area	Species or species habitat known to occur within area
Sterna anaethetus Bridled Tern	Listed	Breeding known to occur within area
Sterna bergii Crested Tern	Listed	Breeding known to occur within area
Sterna caspia Caspian Tern	Listed	Breeding known to occur within area
Sterna fuscata Sooty Tern	Listed	Breeding known to occur within area
Sterna nereis Fairy Tern	Listed	Breeding known to occur within area
Stiltia isabella Australian Pratincole	Listed - overfly marine area	Species or species habitat known to occur within area
Tringa nebularia Common Greenshank, Greenshank	Listed - overfly marine area	Species or species habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank	Listed - overfly marine area	Species or species habitat known to occur within area
Tringa totanus Common Redshank, Redshank	Listed - overfly marine area	Species or species habitat known to occur within area
Xenus cinereus Terek Sandpiper	Listed - overfly marine area	Species or species habitat known to occur within area

Mammals

Dugong dugon Dugong	Listed	Species or species habitat likely to occur within area

Ray-finned fishes

Acentronura larsonae Helen's Pygmy Pipehorse	Listed	Species or species habitat may occur within area
Bulbonaricus brauni Braun's Pughead Pipefish, Pug-headed Pipefish	Listed	Species or species habitat may occur within area
Campichthys tricarinatus Three-keel Pipefish	Listed	Species or species habitat may occur within area
Choeroichthys brachysoma Pacific Short-bodied Pipefish, Short-bodied Pipefish	Listed	Species or species habitat may occur within area
Choeroichthys latispinosus Muiron Island Pipefish	Listed	Species or species habitat may occur within area
Choeroichthys suillus Pig-snouted Pipefish	Listed	Species or species habitat may occur within area
Doryrhamphus dactyliophorus Banded Pipefish, Ringed Pipefish	Listed	Species or species habitat may occur within area
Doryrhamphus janssi Cleaner Pipefish, Janss' Pipefish	Listed	Species or species habitat may occur within area
Doryrhamphus multiannulatus Many-banded Pipefish	Listed	Species or species habitat may occur within area
Doryrhamphus negrosensis Flagtail Pipefish, Masthead Island Pipefish	Listed	Species or species habitat may occur within area
Festucalex scalaris Ladder Pipefish	Listed	Species or species habitat may occur within area
Filicampus tigris Tiger Pipefish	Listed	Species or species habitat may occur within area
Halicampus brocki Brock's Pipefish	Listed	Species or species habitat may occur within area
Halicampus grayi Mud Pipefish, Gray's Pipefish	Listed	Species or species habitat may occur within area
Halicampus nitidus Glittering Pipefish	Listed	Species or species habitat may occur within area
Halicampus spinirostris Spiny-snout Pipefish	Listed	Species or species habitat may occur within area
Haliichthys taeniophorus Ribboned Pipehorse, Ribboned	Listed	Species or species habitat may occur within area

Seadragon		
Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish	Listed	Species or species habitat may occur within area
Hippocampus angustus Western Spiny Seahorse, Narrow-bellied Seahorse	Listed	Species or species habitat may occur within area
Hippocampus histrix Spiny Seahorse, Thorny Seahorse	Listed	Species or species habitat may occur within area
Hippocampus kuda Spotted Seahorse, Yellow Seahorse	Listed	Species or species habitat may occur within area
Hippocampus planifrons Flat-face Seahorse	Listed	Species or species habitat may occur within area
Micrognathus micronotopterus Tidepool Pipefish	Listed	Species or species habitat may occur within area
Phoxocampus belcheri Black Rock Pipefish	Listed	Species or species habitat may occur within area
Solegnathus hardwickii Pallid Pipehorse, Hardwick's Pipehorse	Listed	Species or species habitat may occur within area
Solegnathus lettiensis Gunther's Pipehorse, Indonesian Pipefish	Listed	Species or species habitat may occur within area
Solenostomus cyanopterus Robust Ghostpipefish, Blue-finned Ghost Pipefish,	Listed	Species or species habitat may occur within area
Solenostomus paegnius Rough-snout Ghost Pipefish	Listed	Species or species habitat may occur within area
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish	Listed	Species or species habitat may occur within area
Trachyrhamphus bicoarctatus Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish	Listed	Species or species habitat may occur within area
Trachyrhamphus longirostris Straightstick Pipefish, Long-nosed Pipefish, Straight Stick Pipefish	Listed	Species or species habitat may occur within area
Reptiles		
Acalyptophis peronii Horned Seasnake	Listed	Species or species habitat may occur within area
Aipysurus apraefrontalis Short-nosed Seasnake	Listed	Species or species habitat likely to occur within area
Aipysurus duboisii Dubois' Seasnake	Listed	Species or species habitat may occur within area
Aipysurus eydouxii	Listed	Species or species habitat may

Spine-tailed Seasnake		occur within area
Aipysurus laevis Olive Seasnake	Listed	Species or species habitat may occur within area
Aipysurus tenuis Brown-lined Seasnake	Listed	Species or species habitat may occur within area
Astrotia stokesii Stokes' Seasnake	Listed	Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle	Listed	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle	Listed	Breeding known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth	Listed	Species or species habitat likely to occur within area
Disteira kingii Spectacled Seasnake	Listed	Species or species habitat may occur within area
Disteira major Olive-headed Seasnake	Listed	Species or species habitat may occur within area
Emydocephalus annulatus Turtle-headed Seasnake	Listed	Species or species habitat may occur within area
Ephalophis greyi North-western Mangrove Seasnake	Listed	Species or species habitat may occur within area
Eretmochelys imbricata Hawksbill Turtle	Listed	Breeding known to occur within area
Hydrelaps darwiniensis Black-ringed Seasnake	Listed	Species or species habitat may occur within area
Hydrophis czeblukovi Fine-spined Seasnake	Listed	Species or species habitat may occur within area
Hydrophis elegans Elegant Seasnake	Listed	Species or species habitat may occur within area
Hydrophis mcdowelli	Listed	Species or species habitat may occur within area
Hydrophis ornatus a seasnake	Listed	Species or species habitat may occur within area
Natator depressus Flatback Turtle	Listed	Breeding known to occur within area
Pelamis platurus Yellow-bellied Seasnake	Listed	Species or species habitat may occur within area
Whales and Other Cetaceans	Status	Type of Presence
Balaenoptera acutorostrata Minke Whale	Cetacean	Species or species habitat may occur within area
Balaenoptera edeni Bryde's Whale	Cetacean	Species or species habitat may occur within area
Balaenoptera musculus Blue Whale	Cetacean	Species or species habitat may occur within area
Delphinus delphis	Cetacean	Species or species habitat may

Common Dophin, Short-beaked Common Dolphin		occur within area
Grampus griseus Risso's Dolphin, Grampus	Cetacean	Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale	Cetacean	Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca	Cetacean	Species or species habitat may occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin	Cetacean	Species or species habitat may occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin	Cetacean	Species or species habitat may occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations)	Cetacean	Species or species habitat likely to occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin	Cetacean	Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin	Cetacean	Species or species habitat may occur within area

Appendix 3 Vegetation Structural Classification* and Condition Rating Scale

Vegetation Structural Classes*

Stratum	Canopy Cover (%)				
	70-100%	**30-70%**	**10-30%**	**2-10%**	**<2%**
Trees over 30 m	Tall closed forest	Tall open forest	Tall woodland	Tall open woodland	Scattered tall trees
Trees 10-30 m	Closed forest	Open forest	Woodland	Open woodland	Scattered trees
Trees under 10 m	Low closed forest	Low open forest	Low woodland	Low open woodland	Scattered low trees
Shrubs over 2 m	Tall closed scrub	Tall open scrub	Tall shrubland	Tall open shrubland	Scattered tall shrubs
Shrubs 1-2 m	Closed heath	Open heath	Shrubland	Open shrubland	Scattered shrubs
Shrubs under 1 m	Low closed heath	Low open heath	Low shrubland	Low open shrubland	Scattered low shrubs
Hummock grasses	Closed hummock grassland	Hummock grassland	Open hummock grassland	Very open hummock grassland	Scattered hummock grasses
Grasses, Sedges, Herbs	Closed tussock grassland / sedgeland /	Tussock grassland / sedgeland / herbland	Open tussock grassland / sedgeland /	Very open tussock grassland / sedgeland /	Scattered tussock grasses /

*Based on (Muir 1977), and Aplin's (1979) modification of the vegetation classification system of Specht (1970):

Aplin T.E.H. (1979). The Flora. Chapter 3 *In* O'Brien, B.J. (ed.) (1979). *Environment and Science.* University of Western Australia Press; Muir B.G. (1977). Biological Survey of the Western Australian Wheatbelt. Part II: Vegetation and habitat of Bendering Reserve. *Records of the Western Australian Museum, Suppl*. No. 3; Specht R.L. (1970). Vegetation. *In The Australian Environment.* 4th edn (Ed. G.W. Leeper). Melbourne.

Vegetation Condition Scale for use on Pilbara surveys*

E = Excellent **(=Pristine of BushForever)**

Pristine or nearly so; no obvious signs of damage caused by the activities of European man.

VG = Very Good (= Excellent of BushForever)

Some relatively slight signs of damage caused by the activities of European man. For example, some signs of damage to tree trunks caused by repeated fire, the presence of some relatively non-aggressive weeds such as **Ursinia anthemoides* or **Briza* spp., or occasional vehicle tracks.

G = Good (= Very Good of BushForever)

More obvious signs of damage caused by the activities of European man, including some obvious impact on the vegetation structure such as that caused by low levels of grazing or by selective logging. Weeds as above, possibly plus some more aggressive ones such as **Ehrharta* spp.

P = Poor (= Good of BushForever)

Still retains basic vegetation structure or ability to regenerate to it after very obvious impacts of activities of European man, such as grazing, partial clearing (chaining) or frequent fires. Weeds as above, probably plus some more aggressive ones such as **Ehrharta* spp.

VP = Very Poor (= Degraded of BushForever)

Severely impacted by grazing, very frequent fires, clearing or a combination of these activities. Scope for some regeneration but not to a state approaching good condition without intensive management. Usually with a number of weed species including very aggressive species.

D = Completely Degraded (= Completely Degraded of BushForever)

Areas that are completely or almost completely without native species in the structure of their vegetation; i.e. areas that are cleared or 'parkland cleared' with their flora comprising weed or crop species with isolated native trees or shrubs.

* Based on Trudgen M.E. (1988). A Report on the Flora and Vegetation of the Port Kennedy Area. Unpublished report prepared for Bowman Bishaw and Associates, West Perth.

Appendix 4: Flora Species Recorded from the Wickham Town Expansion Study Area

Family	Species
Family: Aizoaceae (110)	
	Trianthema turgidifolia
Family: Amaranthaceae (106)	
	**Aerva javanica*
	Ptilotus astrolasius
	Ptilotus calostachyus
	Ptilotus exaltatus
Family: Asteraceae (345)	
	Pluchea ferdinandi-muelleri
	Streptoglossa decurrens
	Streptoglossa liatroides
	**Taraxacum officinale*
Family: Bignoniaceae (317)	
	Dolichandrone heterophylla
Family: Boraginaceae (310)	
	Ehretia saligna
	Heliotropium pachyphyllum
	Trichodesma zeylanicum
Family: Caesalpiniaceae (164)	
	Senna artemisioides subsp. *helmsii*
	Senna artemisioides subsp. *oligophylla*
	Senna glutinosa subsp. glutinosa
	Senna glutinosa subsp. pruinosa
	Senna glutinosa subsp. x *luerssenii*
	Senna notabilis
Family: Chenopodiaceae (105)	
	Atriplex bunburyana
	Enchylaena tomentosa
	Maireana villosa
	Salsola tragus
	Sclerolaena hostilis
	Sclerolaena sp. (indet.)
	Tecticornia auriculata
	Tecticornia halocnemoides subsp. *tenuis*
Family: Convolvulaceae (307)	
	Bonamia linearis
	Bonamia media
	Bonamia rosea
	Ipomoea muelleri
Family: Goodeniaceae (341)	
	Goodenia microptera
	Goodenia stobbsiana
	Scaevola acacioides
	Scaevola sericophylla
	Scaevola spinescens
Family: Gyrostemonaceae (108)	
	Codonocarpus cotinifolius
Family: Lauraceae (131)	
	Cassytha capillaris

Family	Species
Family: Malvaceae (221)	
	Abutilon fraseri
	Abutilon lepidum
	Abutilon otocarpum
	Gossypium australe
	Gossypium robinsonii
	Hibiscus sp. (indet.)
	Hibiscus sturtii
	Sida cardiophylla
	Sida fibulifera
Family: Mimosaceae (163)	
	Acacia ampliceps
	Acacia ancistrocarpa
	Acacia bivenosa
	Acacia colei var. colei
	Acacia coriacea
	Acacia coriacea subsp. *coriacea*
	Acacia coriacea subsp. *pendens*
	Acacia pyrifolia
	Acacia sabulosa
	Acacia sphaerostachya
	Acacia stellaticeps
	Acacia synchronicia
	Acacia trachycarpa
	Acacia tumida
	Acacia tumida var. *pilbarensis*
	Dichrostachys spicata
	Neptunia dimorphantha
Family: Moraceae (087)	
	Ficus brachypoda
Family: Myoporaceae (326)	
	Eremophila longifolia
Family: Myrtaceae (273)	
	Corymbia hamersleyana
	Eucalyptus victrix
	Melaleuca argentea
	Melaleuca lasiandra
Family: Papilionaceae (165)	
	Indigofera monophylla
	Rhynchosia minima
	Sesbania cannabina
	**Stylosanthes hamata*
	Tephrosia rosea var. *clementii*
	Vigna lanceolata
Family: Poaceae (031)	
	Aristida inaequiglumis
	**Cenchrus ciliaris*
	**Cenchrus setiger*
	**Chloris barbata*
	**Cynodon dactylon*
	Eragrostis eriopoda
	Eragrostis falcata
	Eriachne mucronata
	Panicum decompositum
	Triodia epactia

Family	Species
	Triodia schinzii
	Triodia wiseana
Family: Proteaceae (090)	
	Grevillea wickhamii
	Hakea lorea
Family: Santalaceae (092)	
	Santalum lanceolatum
Family: Sapindaceae (207)	
	Diplopeltis eriocarpa
	Dodonaea coriacea
Family: Solanaceae (315)	
	Solanum ferocissimum
	Solanum horridum
Family: Sterculiaceae (223)	
	Keraudrenia velutina
	Waltheria indica
Family: Thymelaeaceae (263)	
	Pimelea ammocharis
Family: Tiliaceae (220)	
	Corchorus crozophorifolius
	Corchorus parviflorus
	Corchorus walcottii
	Triumfetta maconochieana
Family: Violaceae (243)	
	Hybanthus aurantiacus
Family: Zygophyllaceae (173)	
	Tribulus suberosus

Appendix 5: Framework for Conservation Significance Ranking for Flora Species

Legislative Framework for Conservation Significant Flora *Wildlife Conservation Act 1950*

All native flora in Western Australia is protected under the state *Wildlife Conservation Act* 1950. Protected flora which are deemed to be at risk of extinction, rare, or otherwise in need of special protection are listed as "Rare Flora" and published in the *Wildlife Conservation (Rare Flora) Notice 2008*. Specific written approval by the Minister for the Environment is required to take or harm species listed in Schedule 1 or 2 of the *Wildlife Conservation (Rare Flora) Notice 2008*. Flora species which may be rare or threatened in Western Australia but which have not been adequately surveyed for are included in a supplementary conservation list called the Priority Flora List.

In addition to state legislation, some Western Australian native plant species are protected under federal law, namely the Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act). In the Pilbara, two species *Lepidium catapycnon* and *Thryptomene wittweri* are currently listed as "Vulnerable" under the EPBC Act. Proposals that are considered likely to have a significant impact on EPBC Act listed threatened flora are required to be referred to the Federal Minister of Environment for approval.

Categories of conservation significance for flora species under the Wildlife Conservation Act 1950 (Atkins 2006)

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

Declared Rare Flora - Presumed Extinct Taxa- Taxa which have not been collected, or otherwise verified, over the past 50 years despite thorough searching, or of which all known wild populations have been destroyed more recently,

Priority One - Poorly known Taxa- Taxa which are known from one or a few (generally <5) populations which are under threat.

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.

Priority Three - Poorly Known Taxa- Taxa which are known from several populations, and the taxa are not believed to be under immediate threat.

Priority Four - Rare Taxa- Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors.

Environmental Protection and Biodiversity Conservation Act 1999

The Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* affords protection to species, populations and ecological communities threatened at a national level or to species listed as migratory under various international agreements (e.g. CAMBA, JAMBA RoKAMBA, Bonn Convention). Categories relevant to the current study include:

Endangered – Taxa facing a very high risk of extinction in the wild in the near future.

Vulnerable – Taxa facing high risk of extinction in the wild in the medium-term.

Under the EPBC Act, a proposal which is likely to have a significant impact on threatened species, populations or ecological communities or migratory species must be referred to DEWHA for a decision by the Commonwealth Minister for the Environment. A significant impact is determined through application of Significant Impact Criteria (DEWHA 2000).

EPBC Act Significant Impact Criteria

Conservation Code	Significant Impact Criteria
Critically Endangered and Endangered Species	An action is likely to have a significant impact on critically endangered or endangered species if there is a real chance or possibility that it will: 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.

Conservation Code	Significant Impact Criteria
Vulnerable species	An action is unlikely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will: 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 to a vulnerable species becoming established in the vulnerable species habitat, or Interferes substantially with the recovery of the species
Critically endangered and endangered ecological communities	An action is likely to have a significant impact on a critically endangered or endangered ecological community if there is a real chance or possibility that it will: o Reduce the extent of a community, or o Fragment or increase fragmentation of the community, for example by clearing vegetation for roads or transmission lines, or o Adversely affect habitat critical to the survival of an ecological community which consists of, or includes, fauna species, or o Modify or destroy abiotic (non-living) factors)such as water, nutrients, or soil) necessary for the community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns, or o Cause a substantial change in the species composition of an occurrence of an ecological community, including, but not limited to: ▪ Assisting invasive species, that are harmful to the listed ecological community, to become established; and ▪ Causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community; or o Interfere with the recovery of an ecological community

Conservation Code	Significant Impact Criteria
Listed Migratory Species	An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will: ○ Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat of the migratory species, or ○ Result in invasive species that is harmful to the migratory species becoming established in an area of important habitat of the migratory species, or ○ Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of the species.

Appendix 6: Quadrat and releve data collected within the Wickham Town Expansion study area. (see attached Excel spreadsheet)