12 November 2008

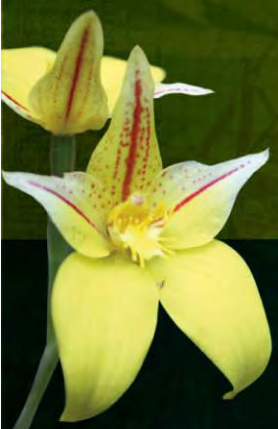


# BHP Billiton Iron Ore

# RAPID GROWTH PROJECT 5 (RGP5)

# CHICHESTER DEVIATION VEGETATION AND FLORA REPORT

**Version 3**



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## EXECUTIVE SUMMARY

BHP Billiton Iron Ore Pty Ltd (BHPBIO) is currently proposing to implement a range of projects to expand the capacity of its existing Western Australia Iron Ore operations.

One of the projects includes the construction of a new 23 km section of rail line (Chichester Deviation) through the southern slope of the Chichester Range adjacent to BHPBIO's existing Newman to Port Hedland rail line.

The project area is located approximately 210 km south of Port Hedland and 150 km north-west of Newman in the Pilbara. The proposed Chichester Deviation is located on pending Miscellaneous license L45/147. L45/147 is approximately 23 km long and 1 km wide and deviates up to 6 km west of the existing line between chainage 220, just south of Shaw Siding, and chainage 237, just south of Hesta Siding.

Following appropriate consultation with relevant stakeholders, BHPBIO and Calibre Engenium commissioned *ecologia* Environment (*ecologia*) to undertake a two-phase biological survey of the vegetation and flora of the project area.

The first phase of the survey was carried out in October 2007 and the second in May 2008. Systematic and opportunistic sampling methods were used to assess the flora and vegetation. Forty-one sites were assessed during phase 1 of the survey and 43 sites during phase 2, nine of these sites were assessed during both phases of the survey. Thirteen of the sites surveyed during phase 1 were in areas that were subsequently burnt (as a result of fires started by lightning), and four of these were resurveyed during phase 2. During the phase 2 survey eight new sites were established in the burnt areas. In addition, opportunistic samples of plants not recorded in the quadrats were taken while traversing from site to site.

The Chichester Deviation crosses six of the land systems that have been mapped in the Pilbara - the Christmas (1.8 km), Jamindie (4.3 km), Newman (6.2 km), McKay (6.8 km), Capricorn (0.9 km) and Wona (2.9 km) Land Systems.

The vegetation of the Chichester Deviation survey area was mapped using the data recorded during the phase one survey, as a bush fire, caused by lightning, affected approximately 50-60% of the area in November 2007.

The vegetation of the survey area was mapped into nine vegetation types, with some types further classified into subtypes on the basis of structure and species composition of the dominant strata and on landform. The vegetation types mapped were associated with the following landforms: rocky hill slopes, minor drainage channels on the hill slopes, creeklines, floodplains, gilgai plains and hard clay plains. These vegetation types are listed below:

- *Astrebla pectinata* tussock grassland on the gilgai plains (Vegetation Type 1).
- *Acacia xiphophylla* open scrubland on the drainage areas of the gilgai plains (Vegetation Type 2).
- *Acacia aneura* low woodland on the hard clay pans (Vegetation Type 3).
- *Acacia aneura* low open forest (Vegetation Type 4a).
- *Acacia ayersiana* and *Acacia aneura* low open forest on the drainage areas of the foot slope (Vegetation Type 4b).
- *Acacia citrinoviridis* open low forest on the creek lines of the flat areas (Vegetation Type 5).

- *Acacia citrinoviridis* and *Corymbia hamersleyana* low woodland on the creek lines / floodplains of the flat areas (Vegetation Type 6).
- *Eucalyptus victrix* open forest, over *Melaleuca glomerata* shrubland (Vegetation Type 7a).
- *Petalostylis labicheoides* and mixed *Acacia* spp. high shrubland (Vegetation Type 7b).
- *Corymbia* spp. and *Hakea chordophylla* low open woodland on the creek lines of the Chichester Ranges (Vegetation Type 7c).
- *Eucalyptus leucophloia* low open woodland, over *Triodia basedowii* hummock grassland (Vegetation Type 8a).
- *Acacia aneura* low woodland (Vegetation Type 8b).
- *Acacia rhodophloia* high shrubland on the rocky hill slopes (Vegetation Type 8c).
- Mixed *Acacia* spp. open heath (Vegetation Type 9a).
- *Acacia aneura* low open forest on the drainage channels of the rocky hill slopes (Vegetation Type 9b).

A total of 306 taxa resulted from the combined records for both phases of the survey (including opportunistic collections but excluding affinities, and forms). These taxa included 47 families and 125 genera. Of this combined total, 204 taxa from 37 families and 96 genera were recorded during the first phase of the survey and 261 from 44 families and 110 genera during the second.

Diversity at the survey area was slightly higher than that recorded at other areas of a similar size surveyed along BHPBIO's rail line.

No Declared Rare Flora taxa were recorded in the area surveyed. One Priority Flora species was recorded during the survey, *Goodenia nuda* (Priority Three), at five of the sites surveyed.

Results of database searches carried out indicate that no Declared Rare Flora taxa have been collected within 20 km of the survey area. Ten Priority Flora taxa have been recorded within 20 km of the survey area and these are: *Eremophila spongiocarpa* and *Josephinia* ?sp. Marandoo (Priority One), *Ischaemum albovillosum*, *Paspalidium retiglume* and *Scaevola* sp. Hamersley Range Basalts (Priority Two), *Goodenia nuda, Hibiscus brachysiphonius, Polymeria* sp. Hamersley and *Themeda* sp. Hamersley Station (Priority Three), and *Eremophila youngii* subsp. *lepidota* (Priority Four).

Database searches indicate that no theatened ecological communities occur within 20 km of the Chichester Deviation survey area. However, the recently listed Priority 3(iii) priority ecological community - "Plant assemblages of the Wona Land System." - occurs in the survey area.

No declared weeds were recorded during the survey. A combined total of six general weed species was recorded over the two phases of the survey: **Aerva javanica*, **Bidens bipinnata*, **Cenchrus ciliaris*, **Cucumis melo* subsp. *agrestis, *Malvastrum americanum* and **Vachellia farnesiana.*

Conformance of the Project to relevant EPA statements is addressed in Table S.1 of this summary while the conservation significance of the vegetation and flora of the project area, an assessment of potential impacts, and management recommendations are discussed in the body of the report.

**Table S.1 – Conformance of Project to relevant EPA statements**

| Requirement | EPA STATEMENT | RELEVANCE TO PROJECT | PROJECT COMPLIANCE |
|---|---|---|---|
| Impact on Biodiversity | Position Statement No. 3 | Where impact on biodiversity cannot be avoided, the proponent must demonstrate that the impact will not result in unacceptable loss. | One species of conservation significance was recorded during the survey, *Goodenia nuda* (Priority 3). It was recorded at five sites that were associated with drainage lines and minor channels. Project will not disturb all populations identified and impact is unlikely to result in unacceptable loss to the species. |
| State, National and International Agreements, Legislation and Policy on Biodiversity | Position Statement No. 3 | Information gathered for environmental impact assessment in Western Australia meets State, National and International Agreements, Legislation and Policy in regard to biodiversity conservation. | Impacts to species listed under relevant legislature are addressed in Sections 4, 5 and 6. The relevance of the project to principles outlined in the *Environmental Protection Act 1986* is discussed in Section 6. |
| EPA Standards, Requirements and Protocols | Position Statement No. 3 | The quality of information and scope of field surveys meets the standards, requirements and protocols as determined and published by the EPA. | The current survey conforms to a Level 2 survey, comprising a reconnaissance survey, a comprehensive two phase flora and vegetation survey and mapping of the vegetation of the area, as per EPA Guidance Statement 51. |
| Biodiversity Conservation and Ecological Function Values | Position Statement No. 3 | Sufficient information is provided to address biodiversity conservation and ecological function values. | Impacts to biodiversity and ecological function are discussed (sections 4 and 5). The value of the vegetation associations occurring in the project area is also discussed in a bioregional context. |
| State Biological Databases | Position Statement No. 3 | Terrestrial biological surveys will be made publicly available and will contribute to the bank of data available for the region. | Voucher specimens of the Priority Flora species collected will be lodged at the WA Herbarium. Information collated from this survey will be included in public documents available for use by others. |
| Sampling design and intensity at two levels – regional and area specific | Guidance Statement No. 51 | Sites were assessed at the area specific level. | Data was collected on an area specific level. Adequate regional data is available from other surveys undertaken in the area. Two surveys were carried out and 75 quadrats were assessed along the proposed corridor (nine sites were surveyed in both phases). |

| Requirement | EPA STATEMENT | RELEVANCE TO PROJECT | PROJECT COMPLIANCE |
|---|---|---|---|
| Landform – scale, rarity, heterogeneity | Guidance Statement No. 51 | Sites should be established in the different landforms occurring across the study area. | Sites were selected from aerial photography before going to the field. While in the field ground-truthing of the vegetation types occurring in the different landforms occurring in the corridor took place and sites were assessed depending on their representation in the area. |
| Habitat – scale, rarity, heterogeneity | Guidance Statement No. 51 | Sites should be established in the different habitats occurring across the study area. | Sites were selected from aerial photography before going to the field and while in the field ground-truthing of the vegetation types occurring in the different habitats took place and sites were added or removed depending on their representation in the area. |
| Potential for conservation significant flora to occur, based on habitat analysis | Guidance Statement No. 51 | Sufficient information is to be provided to indicate the potential for significant flora to occur based on habitats in the area. | Lists of conservation significant taxa recorded in the vicinity of the project area are provided in section 3. An analysis has been carried out on the likelihood of these taxa occurring in the area. Habitats where conservation significant taxa could potentially occur were targeted during the field surveys. |
| Information on adjacent areas – previous surveys and herbarium records | Guidance Statement No. 51 | Adequate information was already available on the wider project area, as other surveys have been undertaken in the area. | Information was requested from relevant government databases and also was collated from reports undertaken in the vicinity of the project area. |
| Vegetation structure, diversity and seasonality | Guidance Statement No. 51 | Sufficient information is to be provided in the report on vegetation structure, diversity and seasonality. | The report details the results of a vegetation mapping exercise carried out over the survey area. It involved multivariate analysis of the data and digital mapping of the vegetation associations identified from the statistical analyses. The two phases of the survey were carried out in different seasons. The first in October 2007 and the second in May 2008 following a moderate rainfall season. The two different times of survey ensured that the diversity and seasonality in the flora present in the project area was represented in the species list. To illustrate this, 29 annual species were recorded during the October survey and 38 during the May survey. |

| Requirement | EPA STATEMENT | RELEVANCE TO PROJECT | PROJECT COMPLIANCE |
|---|---|---|---|
| Results including species/area curves, species and ecosystem diversity and heterogeneity | Guidance Statement No. 51 | Adequate information is provided in the report to comply with this requirement. | Details on the flora of the project area are included in this report. A vegetation map and detailed vegetation descriptions are provided for the project area. |

# 1 INTRODUCTION

BHP Billiton Iron Ore Pty Ltd (BHPBIO) is currently proposing to implement a range of projects to expand the capacity of its existing Western Australian Iron Ore operations.

One of the projects includes the construction of a new 23 km section of rail line (Chichester Deviation) through the southern slope of the Chichester Range adjacent to BHPBIO's existing Newman to Port Hedland rail line.

## 1.1 PROJECT LOCATION

The project area is located approximately 210 km south of Port Hedland and 150 km north-west of Newman in the Pilbara (Figure 1.1). The existing rail line is located on Special Lease 3116/3687 and the proposed new corridor on pending Miscellaneous Lease L45/147. The proposed rail corridor through the Chichester Range is approximately 23 km long and 1 km wide and starts at chainage 220 just south of Shaw Siding and ends at chainage 237, just south of Hesta Siding.

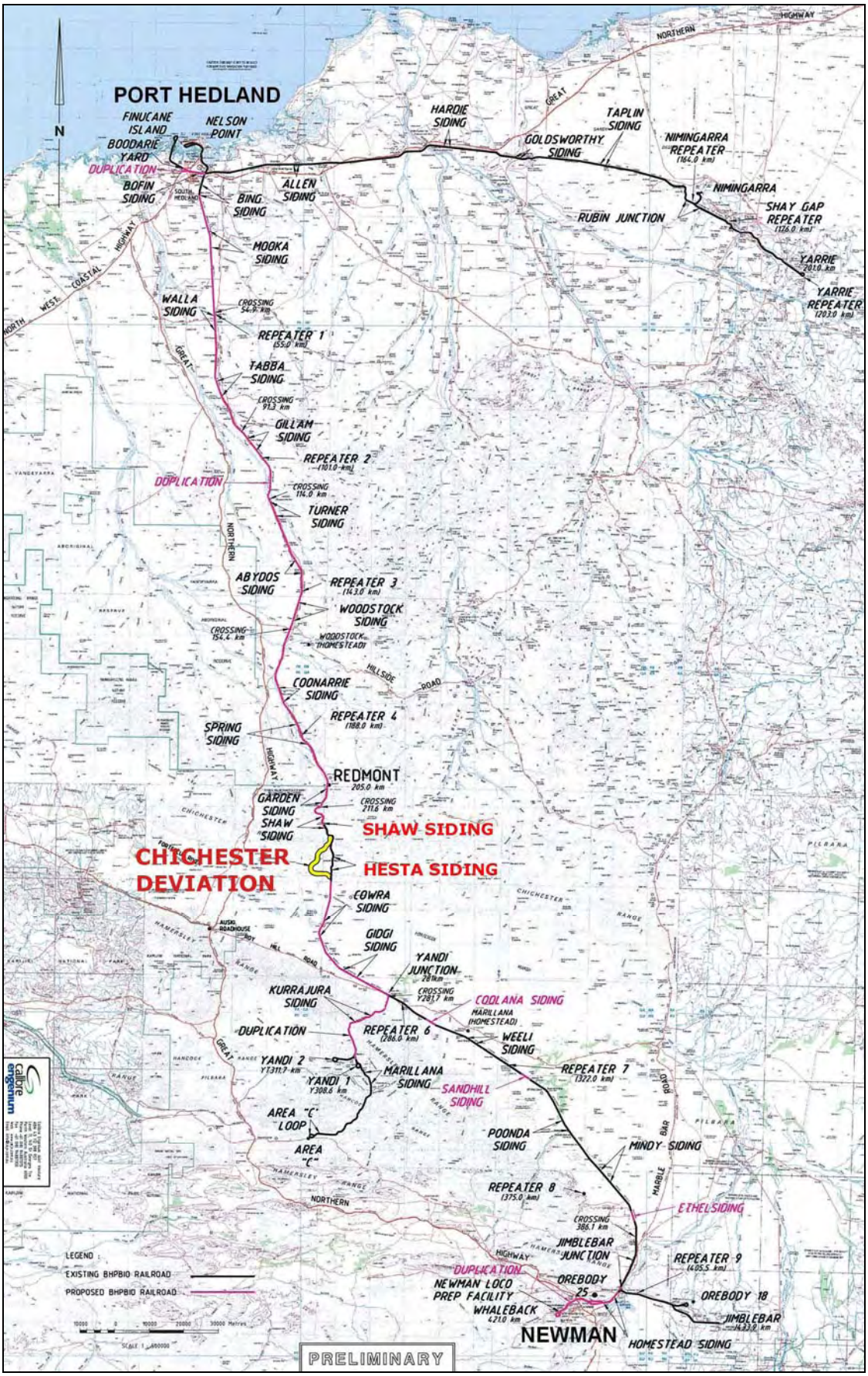


**Figure 1.1 – Location of the survey area**

## 1.2 LEGISLATIVE FRAMEWORK

Federal and State legislation applicable to the conservation of native flora and fauna includes, but is not limited to, the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), the *Wildlife Conservation Act 1950* (WC Act), and the *Environmental Protection Act 1986* (EP Act). Section 4a of the *Environmental Protection Act 1986* requires that developments take into account the following principles applicable to native flora and fauna:

The Precautionary Principle

Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.

The Principle of Intergenerational Equity

The present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.

The Principle of the Conservation of Biological Diversity and Ecological Integrity

Conservation of biological diversity and ecological integrity should be a fundamental consideration.

Native flora and fauna in Western Australia are protected at a Federal level under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and at a State level under the *Wildlife Conservation Act 1950* (WC Act).

The EPBC Act was developed to provide for the protection of the environment, especially those aspects of the environment that are matters of national environmental significance, to promote ecologically sustainable development through the conservation and ecologically sustainable use of natural resources; and to promote the conservation of biodiversity. The EPBC Act includes provisions to protect native species (and in particular, to prevent the extinction and promote the recovery of threatened species) and to ensure the conservation of migratory species. In addition to the principles outlined in Section 4a of the EP Act, Section 3a of the EPBC Act includes a principle of ecologically sustainable development dictating that decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations.

The WC Act was developed to provide for the conservation and protection of wildlife in Western Australia. Under Section 14 of this Act, all fauna and flora within Western Australia is protected; however, the Minister may, via a notice published in the *Government Gazette*, declare a list of flora taxa identified as likely to become extinct, or as rare, or otherwise in need of special protection. The current listing was gazetted on the 22nd January 2008.

Biological surveys undertaken as part of the Environmental Impact Assessment process in Western Australia are required to address the Environmental Protection Authority's (EPA's) Position Statement No. 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection (EPA, 2002), Guidance Statement No. 51: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia (EPA, 2004a) and Guidance Statement No. 56: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia (EPA, 2004b).

## 1.3 SURVEY OBJECTIVES

Following appropriate consultation with relevant stakeholders, BHPBIO and Calibre Engenium commissioned *ecologia* Environment (*ecologia*) to undertake a two-phase biological survey of the vegetation and flora of the study area detailed above as part of the environmental impact assessment process for the project.

The EPA's objectives with regards to management of native flora and vegetation are to:

- Avoid adverse impacts on biological diversity comprising the different plants and animals and the ecosystems the form, at the levels of genetic, species and ecosystem diversity.
- Maintain the abundance, species diversity, geographic distribution and productivity of vegetation communities.
- Protect Declared Rare Flora consistent with the provisions of the *Wildlife Conservation Act 1950*.
- Protect other flora species of conservation significance.

Hence, the primary objective of this study was to provide sufficient information to the EPA to assess the impact of the project on the vegetation and flora of the area, thereby ensuring that these objectives are upheld.

Specifically, the objectives of this survey were to undertake a survey that satisfies the requirements documented in EPA Guidance Statement 51 and Position Statement No. 3, thus providing:

- A review of background information (including literature and database searches).
- An inventory of vegetation types and flora species occurring in the study area, incorporating recent published and unpublished records.
- An inventory of species of biological and conservation significance recorded or likely to occur within the project area and surrounds.
- A map and detailed description of vegetation types occurring in the study area.
- A description of the characteristics of the vegetation types.
- An appraisal of the current knowledge base for the area, including a review of previous surveys conducted in the area which are relevant to the current study.
- A review of regional and biogeographical significance, including the conservation status of species recorded in the project area.

# 2 EXISTING ENVIRONMENT

## 2.1 CLIMATE

Climate data for the project area is based on records from the nearest weather stations at Wittenoom, approximately 70 km west (Table 2.1 and Figure 2.1), and Nullagine, approximately 120 km east (Table 2.2 and Figure 2.1) of the project area (Bureau of Meteorology, 2008). The region has an arid, low rainfall climate, with hot summers and mild winters. The average annual rainfall at Wittenoom is 458.8 mm and at Nullagine 334.7 mm; peak rainfall occurs in January and February. However, considerable annual variation in rainfall is noted in this region, with an average of 45 rain days for Wittenoom and 37 rain days for Nullagine spread throughout the year. The area can receive heavy summer downpours from northern tropical cyclones or lighter rain during thunderstorms associated with southern anticyclone activity and light winter rains from extensive cold fronts that move easterly across the state and occasionally reach the Pilbara. The Chichester and Hamersley Ranges receive approximately 100 to 150 mm more rainfall than surrounding areas within the Pilbara Region (Newman 310.2 mm).

January is the hottest month with an average maximum temperature of 39.6°C and a minimum of 26.0°C at Wittenoom and 39.4°C and 24.2°C at Nullagine. Winters are mild with July temperatures reaching a maximum of 24.2°C and a minimum of 11.5°C at Wittenoom and 24.2°C and 7.5°C at Nullagine.

**Table 2.1 – Climatic averages for Wittenoom**

| **Latitude: 22.24 S** | | | **Longitude: 118.34 E** | | | **Commenced: 1949** | | **Last record: 2008** | | | **Elevation: 463 m** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** | **Annual** |
| Mean daily max. temp (°C) | | | | | | | | | | | | |
| **39.6** | 37.8 | 36.7 | 33.0 | 27.6 | 24.4 | **24.2** | 26.7 | 31.1 | 35.2 | 38.0 | 39.5 | 32.8 |
| Mean daily min. temp (°C) | | | | | | | | | | | | |
| **26.0** | 25.3 | 24.3 | 21.1 | 16.1 | 12.8 | **11.5** | 13.2 | 16.8 | 20.6 | 23.6 | 25.4 | 19.7 |
| Mean 9 am relative humidity (%) | | | | | | | | | | | | |
| 39 | 46 | 39 | 39 | 43 | 48 | 44 | 37 | 28 | 24 | 25 | 30 | 37 |
| Mean 9 am wind speed (km/hr) | | | | | | | | | | | | |
| 9.6 | 9.7 | 10.6 | 10.9 | 10.6 | 10.5 | 11.4 | 13.2 | 13.1 | 12.1 | 10.7 | 9.9 | 11.0 |
| Mean monthly rainfall (mm) | | | | | | | | | | | | |
| 102.6 | 109.8 | 73.0 | 29.7 | 28.3 | 29.0 | 14.5 | 9.1 | 2.4 | 3.7 | 7.9 | 49.5 | **458.8** |
| Mean no. of rain days | | | | | | | | | | | | |
| 8.6 | 8.9 | 5.9 | 3.7 | 3.6 | 2.9 | 2.0 | 1.5 | 0.7 | 0.9 | 1.8 | 4.8 | **45.3** |
| Highest monthly rainfall (mm) | | | | | | | | | | | | |
| 358.4 | 422.6 | 371.0 | 225.2 | 176.5 | 188.5 | 105.9 | 72.7 | 28.6 | 40.6 | 34.5 | 509.5 | |

Source: Bureau of Meteorology, January 2008

**Table 2.2 – Climatic averages for Nullagine**

| Latitude: 21.89 S | | | Longitude: 120.11 E | | | Commenced: 1897 | | Last record: 2004 | | | Elevation: 380 m | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Annual |
| Mean daily max. temp (°C) | | | | | | | | | | | | |
| 39.4 | 38.3 | 36.7 | 33.1 | 28.0 | 24.2 | **24.0** | 26.8 | 31.3 | 35.0 | 38.3 | **39.7** | 32.9 |
| Mean daily min. temp (°C) | | | | | | | | | | | | |
| **24.2** | 23.7 | 21.9 | 17.3 | 12.5 | 8.9 | **7.5** | 9.3 | 12.7 | 16.9 | 21.1 | 23.3 | 16.6 |
| Mean 9 am relative humidity (%) | | | | | | | | | | | | |
| 43 | 45 | 40 | 40 | 50 | 53 | 50 | 41 | 31 | 29 | 27 | 31 | 40 |
| Mean 9 am wind speed (km/hr) | | | | | | | | | | | | |
| 9.8 | 9.2 | 9.2 | 10.0 | 9.7 | 9.8 | 10.5 | 12.3 | 13.2 | 13.0 | 11.2 | 10.9 | 10.7 |
| Mean monthly rainfall (mm) | | | | | | | | | | | | |
| 69.4 | 69.9 | 50.4 | 23.4 | 20.4 | 24.5 | 11.2 | 6.8 | 1.6 | 4.2 | 12.4 | 38.7 | **334.7** |
| Mean no. of rain days | | | | | | | | | | | | |
| 6.7 | 6.3 | 4.2 | 2.0 | 2.4 | 2.3 | 1.4 | 1.1 | 0.3 | 0.6 | 1.8 | 4.1 | **33.2** |
| Highest monthly rainfall (mm) | | | | | | | | | | | | |
| 298.5 | 235.0 | 255.4 | 183.8 | 156.7 | 185.1 | 91.0 | 76.6 | 36.1 | 80.8 | 95.5 | 263.3 | |

Source: Bureau of Meteorology, January 2008.

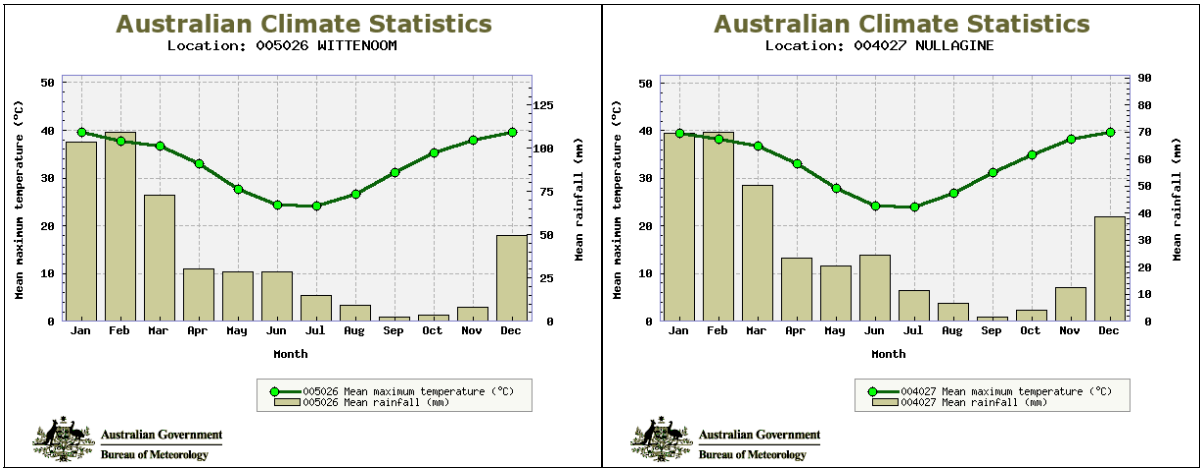


**Figure 2.1 – Climate statistics for Wittenoom and Nullagine**

Wittenoom's total annual rainfall for 2007 (273.7 mm, Table 2.3) was 184.9 mm lower than average (458.8). In the four months before the phase 1 vegetation and flora survey (carried out in October 2007) 12.5 mm of rain was recorded compared with the long-term average of 54.9 mm for the same four months. In the four months before the phase 2 survey (carried out in May 2008) 264.8 mm of rain was recorded compared with the long-term average of 315.9 mm for those same four months. (N.B. Nullagine station closed in 2004 and data are not available for 2007/2008).

**Table 2.3 – Wittenoom monthly rainfalls 07/08 compared with long-term averages**

| Rainfall (mm) | Jan | Feb | Mar | Apr | May | Jun | July | Aug | Sep | Oct | Nov | Dec | Total (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **2007** | 37.0 | 37.8 | 148.8 | 21.8 | **0.0** | 0.0 | 12.5 | 0.0 | 0.0 | **6.2** | 1.0 | 8.6 | 273.7 |
| **2008** | 44.2 | 139.1 | 72.3 | 9.2 | | | | | | | | | |
| Average | 102.6 | **109.8** | 73.0 | 29.7 | 28.3 | 29.0 | 14.5 | 9.1 | **2.4** | 3.7 | 7.9 | 49.5 | **458.8** |

Elevation: 463 m Location: 22°24'S 118°34'E Source: Bureau of Meteorology, August 2008.

## 2.2 GEOLOGY

The Pilbara region comprises a portion of the ancient continental Western Shield, which dominates the geology of Western Australia. The Western Shield comprises pre-Cambrian Proterozoic and Archaean rocks. The Pilbara Craton dates back to the Archaean and is overlain by Proterozoic rocks deposited in the Hamersley and Bangemall Basins. Hamersley Basin rocks give rise to high, rounded hills, plateaus, and strike ridges (Thorne & Tyler, 1997). The Hamersley Basin, which occupies most of the southern part of the Pilbara Craton, can be divided into three stratigraphic groups; the Fortescue, Hamersley, and Turee Creek Groups (Beard, 1975).

Of these three groups the Hamersley and Fortescue Groups outcrop within the project area. Fortescue Group rocks outcrop in the Chichester Range, are about 1.8 km thick and consist of low-grade volcanic and sedimentary rocks (Thorne & Tyler, 1997). The Jeerinah Formation is in the Fortescue group and comprises a basal quartz sandstone (Woodiana Member) overlain by carbonaceous pelite, chert, and minor thin-bedded sandstone.

The Hamersley Group is generally 2.5 km thick and contains both the Brockman Iron Formation and the Marra Mamba Iron Formation; together these provide most of the known major iron ore deposits in the Pilbara region. The Marra Mamba Iron Formation is represented in the project survey area, it is the lowest unit of the Hamersley Group and discontinuously overlies the Jeerinah Formation.

The Chichester Range separates the Fortescue and Shaw drainage systems. The Fortescue River valley, in the southern section of the project area, is the largest extensive area of Cainozoic deposits and forms gently sloping plains and broad valleys between the main outcrop areas.

The geology of the project area has been mapped and described in detail by Thorne & Tyler (1997). A summary of the main geological elements follows:

- The Jeerinah Formation of the Fortescue Group features to the north of Hesta Siding in the northern section of the Chichester Ranges. This Formation is composed of pelite, chert and thin-bedded meta-sandstone.
- The Marra Mamba Iron Formation of the Hamersley Group features to the south of Hesta Siding in the southern section of the Chichester Ranges. This Formation is composed of chert, banded iron stone and pelite.
- Extensive areas of Cainozoic sedimentary deposits of the Fortescue River Valley are seen in the southern section of the project area and in the Shaw drainage system in the northern-most section of the project area. These formations comprise; alluvium and colluvium, red-brown sandy and clayey soil on low slopes and sheetwash areas; colluvium, unconsolidated quartz and rock fragments in the soil; and alluvium, unconsolidated silt, sand, and gravel, in the drainage channels and floodplains.

- Brecciated siliceous caprock over dolomitic rock features in the Fortescue River Valley in the south of the project area. This Formation features angular chert fragments in a chet matrix and overlies the Wittenoom Formation.

## 2.3 LANDFORMS

In their survey of the Pilbara region of Western Australia, Van Vreeswyk *et al*. (2004), developed land system classifications using landform, soil and vegetation features. Based on these land systems, several distinct landform units have been identified within the project area. These landform units are detailed below for the survey area (Table 2.4).

**Table 2.4 – Landform types occurring in the survey area**

| Landform Type | Description |
|---|---|
| Plateaux, ridges, mountains and hills | Mountain tracts, plateaux and strike ridges, relief up to 400 m. Level or rounded plateaux summits and mountain crests, ridges and indented escarpments, with vertical upper cliff faces and moderately inclined to very steep upper scree slopes. |
| Lower slopes | Gently inclined concave slopes usually less than 400 m in extent, mantles of ironstone pebbles and cobbles. |
| Stony plains | Gently undulating lower plains and interfluves up to 500 m in extent, mantles of ironstone pebbles. |
| Narrow drainage floors with channels | Almost level floors up to 400 m wide but usually much less in valleys. Mantles of ironstone pebbles and channels up to 200 m wide with cobble bed loads. |
| Hills, ridges and plateaux remnants | Rounded hill and ridge crests, level to gently inclined plateaux surfaces, moderately inclined to very steep upper slopes. Surface mantles of pebbles, cobbles and stones of shale, chert, ironstone, sandstone or dolomite, also rock outcrop, relief up to 100 m. |
| Breakaways | Indurated mesa caps of ironstone or laterite, vertical breakaway faces up to 15 m high over weathered parent rock. Short, moderately inclined to steep slopes below mantles of ironstone gravels. |
| Lower footslopes | Very gently inclined slopes extending for up to 500 m, mantles of pebbles of mixed lithology. |
| Drainage floors | Dendritic floors less than 100 m wide, channels incised in narrow valleys in upper parts of system becoming broader (up to 250 m wide). Channels up to 50 m wide further downstream. |
| Ridges, hills and upper slopes | Rocky summits, hills and ridges extending for many kilometres with moderately inclined to very steep upper slopes. Surface mantles of pebbles, cobbles and stones, frequent exposures of bedrock, relief up to 150 m. |
| Stony alluvial plains | Level to gently inclined plains extending up to 5 km, subject to sheet flow. Surface mantles of ironstone pebbles and cobbles, with occasional gilgai microrelief. |
| Groves and drainage foci | Groves up to 150 m long by 50 m wide and diffuse foci 20-150 m in diameter, receiving run-off from adjacent plains. Surface mantles of ironstone pebbles and gilgai microrelief. |
| Stony gilgai plains | Level plains up to 600 m in extent, surface mantles of ironstone pebbles and gilgai microrelief. |
| Drainage tracts | Level tracts up to 2.5 km wide, drainage corridors through stony alluvial plains. Surface mantles of ironstone pebbles. |

| Landform Type | Description |
|---|---|
| Low basalt hills | Isolated hills up to 20 m high and 500 m long, short gently to moderately inclined slopes. Surface mantles of basalt pebbles and cobbles. |
| Stony gilgai upland plains | Level to very gently inclined plains up to 4 km in extent with gilgai microrelief. Surface mantles of basalt pebbles and cobbles. |
| Stony plains and slopes | Very gently inclined plains, short gently inclined to steep benched slopes, leading to incised drainage. Surface mantles of basalt pebbles and cobbles. |
| Drainage lines | Narrow (<300 m wide), shallow drainage floors and small channels, also more incised channels to 15 m wide in narrow valleys. Gently inclined to steep stony marginal slopes. |
| Low ridges and hills | Up to 25 m high and 1.5 km long, gently inclined footslopes. Mantles of pebbles and cobbles, some rock outcrop. |
| Stony upper plains and low rises | Gently undulating plains up to 3 km in extent, surface mantles of ironstone pebbles and cobbles. |
| Hardpan plains | Almost level plains up to 8 km in extent by 4-5 km wide between shallow drainage tracts. Surface mantles of ironstone and chert pebbles, subject to sheet overland flow. |
| Groves | Accurate drainage foci up to 400 m long and 20 m wide (commonly much less), on hardpan plains. |
| Gilgai plains | Level plains less than 1 km in extent, associated with drainage tracts or as isolated areas, with gilgai microrelief. |
| Sandy banks | Banks up to 0.5 m high, mostly less than 100 m long and 10-20 m wide. |
| Channels and banks | Channels 5-50 m wide, finely incised 1-2 m in hardpan on broad plains, up to 5 m in lower parts. |
| Low basalt hills | Isolated hills up to 20 m high and 500 m long, short gently to moderately inclined slopes. Surface mantles of basalt pebbles and cobbles. |
| Stony gilgai upland plains | Level to very gently inclined plains up to 4 km in extent, with gilgai microrelief. Surface mantles of basalt pebbles and cobbles. |
| Stony plains and slopes | Very gently inclined plains, short gently inclined to steep benched slopes, leading to incised drainage. Surface mantles of basalt pebbles and cobbles. |
| Drainage lines | Narrow (<300 m wide), shallow drainage floors and small channels, also more incised channels to 15 m wide in narrow valleys. Gently inclined to steep stony marginal slopes. |

N.B. These landform types occur along the proposed Chichester Deviation between and west of chainages 238 and 220.

## 2.4 SOILS

The project area lies across two soil-landscape zones as described by Tille (2006); the Chichester Ranges Zone to the north, and the Fortescue Valley Zone to the south.

The Chichester Ranges Zone features hills and dissected plateaux (with some stony plains) on basalt and sedimentary rocks of the Hamersley Basin. The soils comprise stony soils with some red shallow loams and hard cracking clays.

The Fortescue Valley Zone features alluvial plains, hardpan wash plains and sandplains (with stony plains, floodplains and some salt lakes) on alluvial deposits over sedimentary rocks of the Hamersley Basin. Soils comprise red deep sands, red loamy earths and red/brown non-cracking clays with some red shallow loams and hard cracking clays.

The soils of the project area have been classified by Bettenay *et al*. (1967) into three main soil types: hard-setting loamy soils with red clayey subsoils; highly calcareous loamy earths; and an area of coherent and porous clays on the southern boundary in the Fortescue drainage area.

## 2.5 LAND SYSTEMS CLASSIFICATION

The project area lies in a region with a diverse range of land types and is represented by six land systems that have been mapped by Van Vreeswyk *et al.* (2004). These land systems are described in Table 2.5 and mapped along with the existing and proposed rail lines in Figure 2.2.

**Table 2.5 – Land type and land system descriptions for the survey area**

| **Land Type** | **Land System** and description |
|---|---|
| Alluvial plains with Snakewood shrublands | **Christmas:** Stony alluvial plains supporting Snakewood and mulga shrublands with sparse tussock grasses |
| Wash plains on hardpan with groved mulga shrublands (sometimes with spinifex understorey) | **Jamindie:** Stony hardpan plains and rises supporting groved mulga shrublands, occasionally with spinifex understorey |
| Hills and ranges with spinifex grasslands | **Newman:** Rugged jaspilite plateaux, ridges and mountains supporting hard spinifex grasslands |
| | **McKay:** Hills, ridges, plateaux remnants and breakaways of meta sedimentary and sedimentary rocks supporting hard spinifex grasslands |
| | **Capricorn:** Hills and ridges of sandstone and dolomite supporting shrubby hard and soft spinifex grasslands |
| Stony gilgai plains with tussock grasslands and spinifex grasslands | **Wona:** Basalt upland gilgai plains supporting tussock grasslands and minor hard spinifex grasslands |

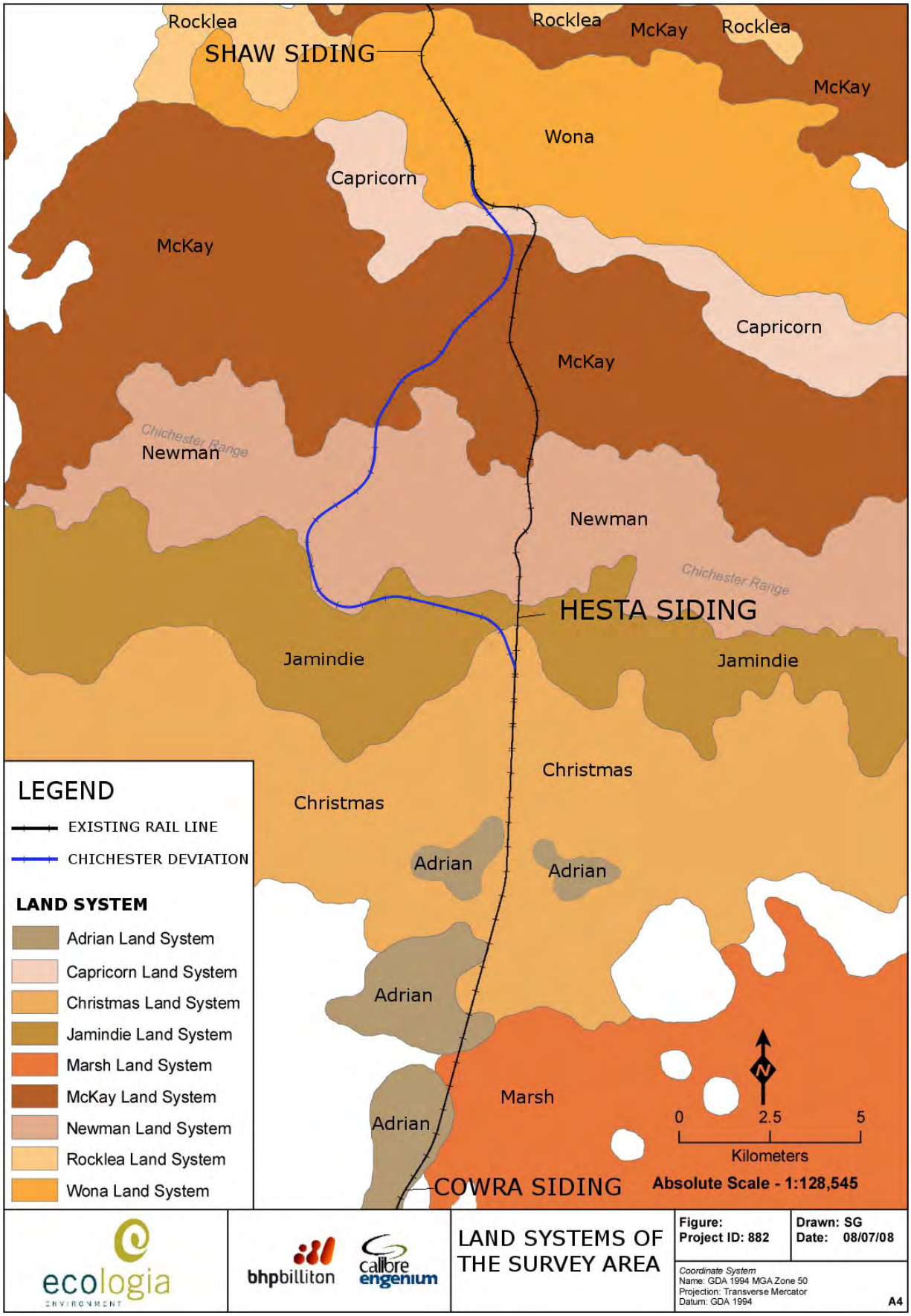


**Figure 2.2 – Land systems of the survey area**

The Chichester Deviation runs through six land systems; Christmas, Jamindie, Newman, McKay, Capricorn and Wona.

Table 2.6 details the extent of each of these land systems in the Pilbara, the condition of vegetation in each, and an estimate of the proposed impact on each based on the length of the rail corridor in each. Greatest potential impact will be to the Christmas Land System, because it is one of the smaller land systems of the Pilbara region. However, 0.66 km of the proposed Chichester Deviation corridor coincides with the existing Mainline corridor that crosses the Christmas Land System and 1.14 km is new corridor for the Chichester Deviation. Therefore potential impact to the Christmas Land System would be 0.057% along the existing Mainline corridor and 0.098% along the new Chichester Deviation corridor.

Similarly, 1.5 km of the Chichester Deviation corridor that crosses the Wona Land System coincides with the existing Mainline corridor and 1.4 km occurs within the new Chichester Deviation corridor. Therefore potential impact to the Wona Land System would be 0.017% along the existing Mainline corridor and 0.015% along the new Chichester Deviation corridor.

**Table 2.6 – Potential impact to land systems of the survey area**

| Land System | Extent in Pilbara ($km^2$) | Average condition (vegetation and erosion) | Potential impact | | Rail section |
|---|---|---|---|---|---|
| | | | Length in rail corridor (km) | % | |
| Christmas | 232 | Mostly poor | 1.8 | 0.155 | Southern |
| Existing Mainline corridor | | | 0.7 | 0.057 | Southern |
| New Chichester Deviation corridor | | | 1.1 | 0.098 | |
| Jamindie | 2 074 | Fair | 4.3 | 0.041 | Central |
| Newman | 14 580 | Very good | 6.2 | 0.009 | Central |
| McKay | 4 202 | Very good | 6.8 | 0.032 | Central |
| Capricorn | 5 296 | Very good | 0.9 | 0.003 | Central |
| Wona | 1 815 | Good | 2.9 | 0.032 | Northern |
| Existing Mainline corridor | | | 1.5 | 0.017 | Northern |
| New Chichester Deviation corridor | | | 1.4 | 0.015 | |

Note: Potential impact indicates the proportion of each land system that could be affected by the project; it has been calculated using a 200 m wide corridor.

## 2.6 PILBARA BIOGEOGRAPHIC REGION

The project area lies in the Pilbara Biogeographic Region of the Interim Biogeographic Regionalisation for Australia (IBRA) (Environment Australia, 2000). The Pilbara IBRA region is further subdivided into the Hamersley, Fortescue Plains, Chichester and Roebourne Subregions (Figure 2.3). Chainage 220 to chainage 228.5 occurs in the Chichester Subregion, and a larger section, from chainage 228.5 to chainage 237, occurs in the Fortescue Plains Subregion.

The Chichester Subregion of the IBRA Pilbara Botanical Region comprises the northern section of the Pilbara Craton. This subregion is described by Kendrick and McKenzie (2001) as undulating Archaean granite and basalt plains including significant areas of basaltic ranges. Typical vegetation of the area is shrub steppe on basalt plains characterised by *Acacia inaequilatera* over *Triodia wiseana* hummock grasslands, while *Eucalyptus leucophloia* tree steppes occur on basaltic ranges (Kendrick & McKenzie, 2001).

The Fortescue Plains Subregion is located in a narrow band to the south of the Chichester Subregion on the Pilbara Craton. The Fortescue Plains Subregion is described by Kendrick (2001b) as alluvial plains and river frontage, with extensive salt marsh, mulga-bunch grass and short grass communities on alluvial plains in the east. River gum woodlands fringe the drainage lines. It is also the northern limit of mulga (*Acacia aneura*). The Fortescue Marsh which runs to the south of the project area is described as an extensive, episodically inundated samphire marsh, approximately 100 km long and 10 km wide (Kendrick, 2001b). Chainage 237, the southern-most point of the Chichester Deviation is approximately 11 km from chainage 248 where the existing Mainline corridor crosses the western end of the Fortescue Marsh.

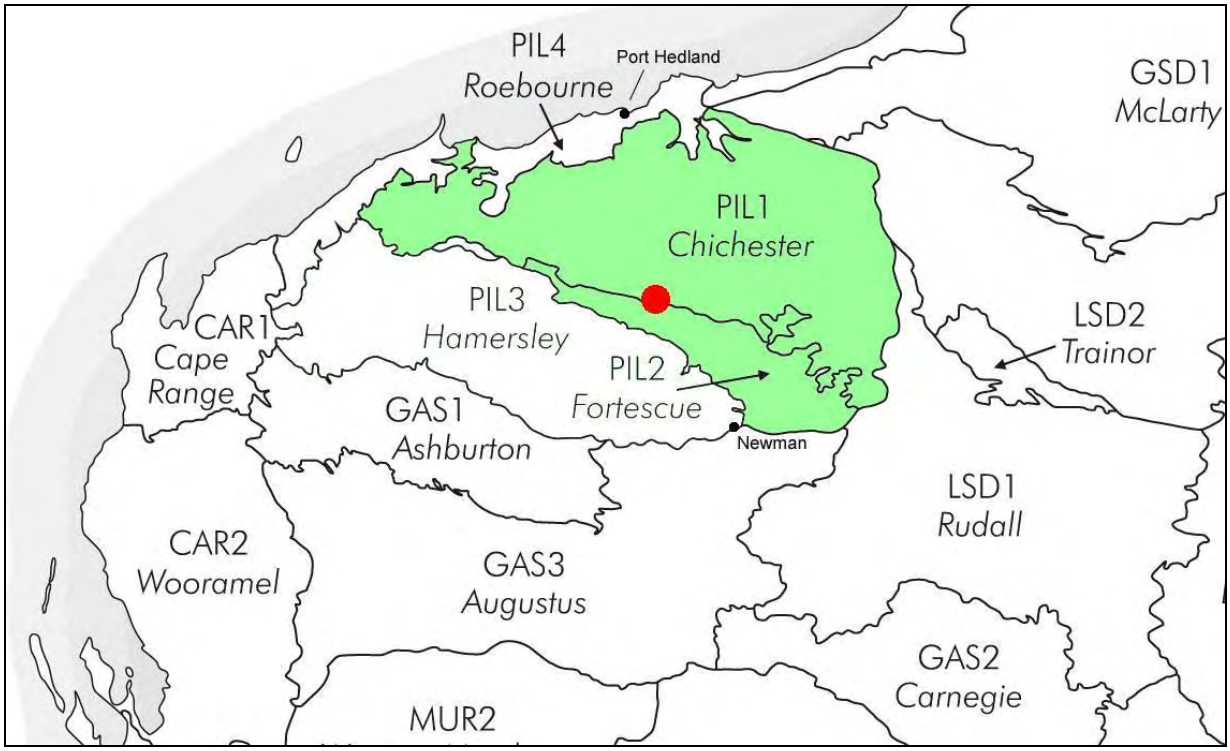


**Figure 2.3 – IBRA v6.1 Biogeographical subregions of north Western Australia (DEH, 2004)(red spot represents survey area)**

With an area of 179, 287 km$^2$, the Pilbara Bioregion is one of the largest bioregions. Others vary from 2,372 to 423,751 km$^2$ (Thackway and Cresswell, 1995), most being between 14,000 and 200,000 km$^2$. However, the size of the Pilbara Bioregion is fairly typical of bioregions situated in remote arid and semi-arid areas. Dominant limiting factors and constraints for the Pilbara Bioregion include extinction of critical weight range (CWR) mammals, wildfire, feral animals (in particular the cat and fox), weeds, and grazing or pastoral activities. The reservation status of the Pilbara Bioregion is 7.75% (Kendrick, 2001a). This is relatively low as the reservation status of some bioregions is more than 10% (Thackway and Cresswell 1995), while the Hamersley Subregion has 14.1% of its area reserved (Kendrick 2001a).

Shepherd *et al*. (2002) indicate that of the 17 944 694 ha in the Pilbara Bioregion very little of the vegetation has been cleared and these authors state that 10.1 to 30% of the Pilbara Bioregion is reserved in the conservation estate.

The nearest conservation reserve to the project area is Karijini National Park, the north-eastern boundary of which is approximately 40 km south-west of the centre of the project

area. Mangaroona Range Nature Reserve is north-west of the project area and its south-eastern boundary is approximately 52 km from the centre of the project area.

## 2.7 LANDUSE HISTORY

The mineral exploration history of the Pilbara began in 1888 when gold was found in the Pilbara Creek. Although this did not prove productive, more consistent deposits were subsequently discovered at Marble Bar. Tin was discovered in 1899 and manganese and asbestos have also been mined in the Pilbara.

Massive iron-ore deposits were discovered and mining expanded immensely in the 1960s when the commonwealth embargo on exporting iron-ore was relaxed (Beard, 1975). Subsequently, the construction of several mining towns, including Newman, was undertaken. Newman was developed in the early 1970s to provide accommodation for workers at the Mt. Whaleback iron-ore mine. Ports, such as Port Hedland and Dampier, and standard gauge railways from Mt. Tom Price and Paraburdoo to Dampier, Pannawonica to Cape Lambert and Mt. Goldsworthy and Mt. Newman to Port Hedland, were also constructed. BHPBIO rail, formerly the Mt Newman Railroad, was constructed between 1967-68 to deliver ore mined at Newman to Port Hedland for export.

The development of the iron ore industry has resulted in activity within the Pilbara increasing from cattle and sheep stations and small coastal ports to a large mining economic base with a commensurate increase in population. Tourism is a smaller but rapidly developing industry within the region.

# 3 VEGETATION AND FLORA

## 3.1 SURVEY METHODS

The EPA *Guidance for the Assessment of Environmental Factors No. 51: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia* (Environmental Protection Authority 2004a), and EPA *Position Statement No. 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection* (Environmental Protection Authority, 2002) were taken into consideration when survey methods were developed.

Before carrying out the surveys, a search of the DEC's Threatened Flora Database (which lists species protected under the WC Act, the EPBC Act and DEC Priority Flora) was undertaken to determine species of conservation significance previously recorded in the area.

Detailed methods employed during the flora survey are provided in Sections 3.1.2 to 3.1.3 below.

### 3.1.1 Survey Timing

The survey was carried out in two phases. The first phase was undertaken between October 4th and October 9th 2007 (12 person days). The survey was carried out following below average summer rainfall in early 2007 and a below average, dry winter of 2007. Rainfall totalled 12.5 mm at Wittenoom over June, July, August and September of 2007, and the long-term average total for those months is 54.9 mm. The second phase was undertaken between May 6th and May 10th 2008 (10 person days). Rainfall in the four preceding months was 264.8 mm, which compares with a long-term average total rainfall of 315.9 mm for the same four months. Therefore, rainfall was below average before both phases of the survey were carried out.

A large part of the northern section of the deviation corridor was burnt (as a result of fires starting from lightning strikes) in November 2007 and mature vegetation was resprouting and many herbs and grasses were evident during the second phase survey.

### 3.1.2 Survey Sites

The survey involved systematic flora sampling using quadrats and some transects. Sites were either 50 x 50 m quadrats in large areas of similar vegetation or of an equivalent area (2500 $m^2$) along drainage lines or in irregularly shaped patches of vegetation. This quadrat size/area is standard for flora survey work carried out in the Pilbara Bioregion.

The number of sites established was determined by the size and the heterogeneity of the area. Fires that occurred in the project area in November 2007 affected the distribution of sites during the second phase of the survey.

Forty-one sites were assessed during phase 1 of the survey and 43 sites during phase 2; nine of these sites were assessed during both phases of the survey (Redo sites = R) (Figure 3.1). Thirteen of the sites surveyed during phase 1 were in areas that were subsequently burnt and four of these were resurveyed during phase 2; during the phase 2 survey eight new sites were established in the burnt areas. A long transect was walked through the recently burnt areas during the second phase to verify the extent of the burn and to collect any species that may not have been collected in quadrats surveyed in the burnt areas.

The sampling sites were established to provide a comprehensive list of flora species occurring in the project area, and to allow adequate data to be collected on the vegetation

types, life-form strata, percentage cover of individual species, surface soil type, litter cover and disturbances occurring in the area. Sampling sites were chosen by means of aerial photography, topographical features and field observations so that the vegetation types occurring across the survey area were represented in the data collected. Sites were surveyed in both burnt and unburnt sections of the proposed rail corridor during the second phase of the survey. Before carrying out the second phase survey pre and post-burn aerial photography was used to locate sites in unburnt vegetation that appeared to represent the vegetation units occurring in those areas that had been burnt.

The following parameters were recorded at each survey site:

- Location details, including GPS co-ordinates.
- Site parameters such as topography, soils, and surface lithology.
- Structural information describing the vegetation unit, including the height, cover, form and dominant species within each layer.
- Maximum height and foliage projective cover for each species within the site, including introduced species.
- Vegetation condition.
- An estimate of time since the last fire at the site.

Plant species were either identified in the field, or specimens were collected for later identification and verification. Vegetation type, life-form strata and percentage cover of each stratum were recorded based upon Muir's (1977) classification system. The condition of each site was evaluated with respect to the extent of disturbance and weed invasion. Nomenclature and taxonomy follow the conventions currently adopted by the Western Australian Herbarium (2008). Data collected at individual sites are included electronically as Appendix A.1.

### 3.1.3 Opportunistic Collections

While traversing from site to site the botanists made opportunistic collections of any taxa not already collected at discrete quadrat sites. This ensured that a more comprehensive species list was produced for the project area.

### 3.1.4 Vegetation Mapping

Vegetation mapping is the delineation of plant communities into groups or associations. The distinctive characteristics that these groups or associations share include features such as species dominance, stratum structure and species composition (Heddle *et al.,* 1980). Data collected within quadrats was analysed using the multivariate statistical programme PATN$^{TM}$, using presence/absence and density (cover) records with Pearson complete linkage analysis to produce a dendrogram to statistically show the similarities between sites. This method provides an objective means of defining boundaries between vegetation types when mapping; however, it is constrained by the limited number of quadrats that can be surveyed and this information was supplemented by notes made on vegetation community boundaries while in the field.

The phase one survey data were used in the statistical analyses, as the quadrats were more widely distributed (because the fire affected placement of sites during the second phase survey). Presence/absence, rather then density (cover) data provided greater resolution of vegetation communities, and was used to map the vegetation associations using 1:10,000 aerial photography of the survey area.

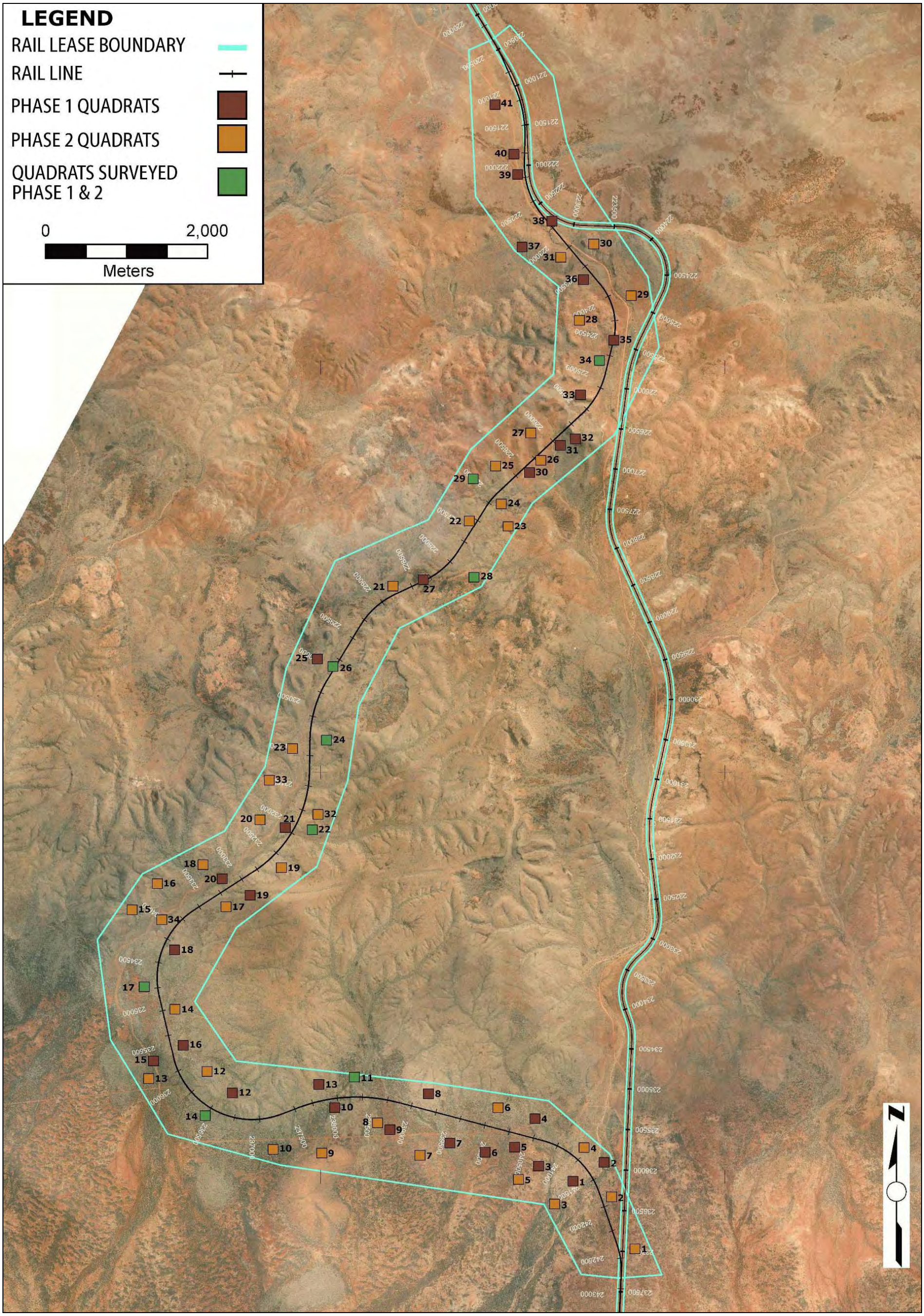


**Figure 3.1 – Quadrats surveyed**

### 3.1.5 Survey Limitations and Constraints

Table 3.1 details an assessment of survey limitations and constraints, as identified by the EPA's Guidance Statement for Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia (EPA, 2004a).

**Table 3.1 – Flora and vegetation survey limitations**

| Aspect | Comment |
|---|---|
| Sources of information and availability of contextual information *(i.e.* pre-existing background versus new material) | Several surveys have been carried out within ~ 50 - 100 km of the project area. Surveys of the Hope Downs and Fortescue Metals Group rail corridors (Biota and Trudgen, 2002; Biota, 2004 a & b) and surveys carried out by *ecologia* on other sections of the rail line (*ecologia*, 2007a & b; *ecologia* 2008a, b, c, d, & e). Many other botanical surveys associated with mining activities have been completed in the surrounding area and the eastern Pilbara region generally. |
| The scope *(i.e*. what life forms were sampled) | The vascular flora of the project area was sampled during both phases of the assessment. The survey scope was prepared in consultation with the relevant government agencies (via BHPBIO/CEJV), and was designed to comply with EPA requirements. |
| Proportion of flora collected and identified (based on sampling, timing and intensity) | Approximately 1307 voucher specimens were collected during the two phases of this survey and the following identifications were made from these specimens.<br>Taxa identified to species, subspecies and variety, (excluding forms and affinities): 306.<br>Identified to family only: 2 taxa.<br>Identified to genus only: 10 taxa.<br>From the 620 voucher specimens collected during the first phase of the survey in October 2007 a species list of 204 taxa resulted. The second phase survey was carried out in May 2008 following the summer rains, and 261 taxa were recorded from the 687 voucher specimens collected. Twenty nine annual or weakly perennial species were recorded during phase 1 of the survey and 38 during phase 2. |
| Completeness and further work which might be needed *(e.g.* was the relevant area fully surveyed) | Aerial photography was used to determine different areas to be sampled during the survey. This ensured that all areas displaying potentially different or unique vegetation were visited during the survey. In addition, the botanists undertaking the survey ground-truthed the vegetation associations occurring in the sites chosen from the aerial photography, and added or removed sites depending on the vegetation encountered while traversing the survey areas. Fires (caused by lightning strikes) affected the phase 2 survey, as they swept through parts of the proposed corridor in late 2007. The second phase of the survey was carried out in May after the summer rains. Burnt and unburnt sites were assessed during the second phase of the survey. Further work may be needed to identify and mark populations of Priority Flora once the final alignment of the rail line is known. |

| Aspect | Comment |
|---|---|
| Mapping reliability | Good aerial imagery was used to select sites to be sampled during the survey and to produce a digitized map of the vegetation associations occurring in the study area. As the first phase data was used for mapping some of the identifications were made from sterile specimens. This could have affected the analysis and mapping of the vegetation types. |
| Timing/weather/season/cycle | Rainfall recorded at Wittenoom in the four months preceding the first phase of the survey (October 2007) was 12.5 mm compared with a long-term average of 55 mm for the same four months. Rainfall in the four months preceding the second phase of the survey was 264.8 mm – 50.3 mm below the average for those four months. Approximately 13 weeks of good growing time occurred between the start of significant rains (139.1 mm in February 2008) and the second survey. |
| Disturbances *(e.g.* fire, flood, accidental human intervention) | Fires affected areas of vegetation along the proposed new rail corridor through the Chichester Range. In late 2007 lightning strike resulted in approximately 50 - 60% of the northern section of the corridor being burnt. Because of this, pre and post-fire aerial imagery was compared before carrying out the second phase of the survey. Sites were selected in unburnt areas that appeared to represent the vegetation of the burnt areas; quadrats were surveyed in the burnt areas so that they too were represented in the results. |
| Intensity (in retrospect, was the intensity adequate?) | The intensity of these surveys was adequate and will add to existing knowledge on the vegetation and flora in the vicinity of the project area. Twenty two person days were spent on the survey. Two vegetation types occurring in the survey area were sampled only once. All other vegetation units were surveyed more than once. Seventy-five quadrats were assessed over the two phases of the survey. |
| Resources | Resources were adequate for the botanical survey as 22 person days were invested in the field. An experienced taxonomist / botanist, was responsible for plant specimen determination/taxonomy and *ecologia's* Principal Botanist with more than 18 years of experience in vegetation mapping supervised data analysis and interpretation prior to production of the vegetation map. |
| Access problems | Some tracks were available along the southern section of the proposed new corridor and areas where no tracks were available were accessed by foot. Distribution of sites in these areas was good despite the lack of tracks (see Figure 3.1). |
| Experience levels (*e.g.* degree of expertise in plant identification to taxon level) | The field botanists carrying out the surveys had more than one years experience of carrying out botanical surveys of this type. The supervising botanists had carried out many surveys in the Pilbara Biogeographic Region. Plant specimens were collected from each quadrat assessed. The taxonomist contracted to identify the specimens collected during the two phases of the survey has more than seven years of experience in taxonomy of the flora of the Pilbara. |

## 3.2 VEGETATION ASSEMBLAGES

### 3.2.1 Vegetation Described by Previous Surveys

Beard (1975) classified the vegetation of the project area into four main types as shown in Figure 3.2 and listed below.

- *Acacia aneura* (mulga) in groved patterns with an understorey of *Triodia pungens* on the lower slopes.
- Tree steppe of snappy gum *Eucalyptus leucophloia* and *Triodia wiseana* hummock grass on the hill slopes with *Acacia aneura* (mulga) low woodland in the valleys.
- Shrub steppe of *Acacia pyrifolia* (kanji) and mixed hummock grasses including *Triodia pungens and T. wiseana* on the gentler basalt slopes and flats.
- Short tussock grassland of mixed species on the gilgai plains of cracking clay.

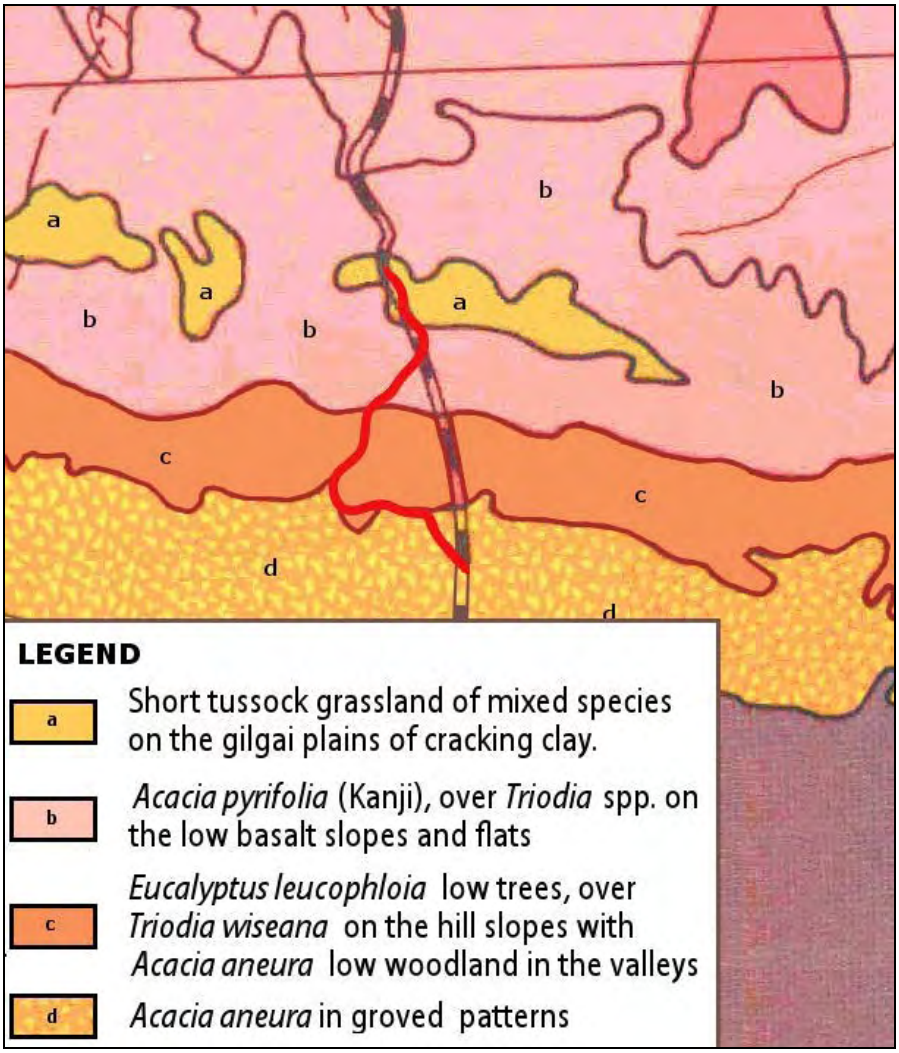


**Figure 3.2 – Beard (1975) vegetation map with survey area overlay**

Other surveys have been carried out by *ecologia* in the vicinity of the project area and these include the Cowra and Redmont Camp vegetation and flora surveys (*ecologia*, 2007a and 2008a). Cowra Camp is located approximately 13 km south of the project area and nine vegetation types were recorded at that area (Table 3.2). Redmont Camp is located approximately 15 km north of the survey area and four vegetation types were recorded during that survey (Table 3.3).

**Table 3.2 – Vegetation units of Cowra Camp area**

| Landform | Vegetation |
|---|---|
| **Flat / plain** | *Triodia longiceps* and *Triodia epactia* hummock grassland, with scattered *Acacia* spp. (*Acacia bivenosa*, *Acacia adsurgens*, *Acacia sclerosperma*, *Acacia synchronicia* and *Acacia ancistrocarpa)* medium shrubs. |
| | *Acacia aneura* low woodland, over mixed *Acacia* spp. (*Acacia ancistrocarpa*, *Acacia bivenosa* and *Acacia sclerosperma* subsp. *sclerosperma*) high shrubland, over mixed **Cenchrus ciliaris* and *Aristida* spp. tussock and *Triodia longiceps* and *Triodia brizoides* hummock grassland. |
| | Moderately dense *Triodia longiceps* hummock grassland, with scattered *Acacia bivenosa* and *Acacia adsurgens* shrubs. |
| | Disturbed vegetation - mixed, occasionally moderately dense, *Acacia* spp., over mixed **Cenchrus ciliaris* and hummock grasses. |
| **Salt Plain** | Moderately dense mixed low *Halosarcia* spp. shrubland, with scattered *Acacia eriopoda* and *Acacia sclerosperma* subsp. *sclerosperma* shrubs. |
| **Drainage Channel on midslope** | Sparse to open *Eucalyptus gamophylla* low mallee trees, over *Acacia monticola*, sometimes with sparse *Grevillea wickhamii* subsp. *hispidula*, *Acacia rhodophloia* and *Acacia maitlandii* open heath, over *Acacia arrecta* low shrubland, sometimes over *Eriachne mucronata* (arid form) tussock grassland and *Triodia brizoides*, *Triodia basedowii* hummock grassland. |
| **Hill slope** | *Acacia rhodophloia* low woodland, over scattered *Eremophila latrobei* subsp. *filiformis* shrubs, over sparse *Aristida contorta* very open tussock grassland and *Triodia basedowii* hummock grassland. |
| | Moderately dense *Triodia basedowii* hummock grassland, with scattered *Acacia* spp. and *Eucalyptus* spp. shrubs. |
| **Floodplain** | *Acacia xiphophylla* low woodland, over scattered *Senna glutinosa* subsp. *pruinosa* and *Eremophila cuneifolia* shrubs, over *Maireana triptera, Maireana carnosa* and *Maireana georgei* low shrubland, over *Triodia longiceps, Triodia brizoides* hummock grassland. |

**Table 3.3 – Vegetation units of Redmont Camp**

| Landform | Vegetation |
|---|---|
| **Flat / Plain** | *Acacia ancistrocarpa* and *Acacia bivenosa* shrubland, over *Triodia pungens* hummock grassland. |
| | Scattered *Hakea lorea* subsp. *lorea* low trees, over *Acacia stellaticeps* and *Pluchea tetranthera* low open shrubland, with a mixed tussock grassland and *Triodia epactia* hummock grassland. |
| | Scattered *Corymbia hamersleyana* and *Acacia eriopoda* low trees, over *Acacia inaequilatera* and *Acacia bivenosa* high shrubland, over mixed *Acacia* and *Senna* spp., low shrubland, over a moderately dense *Triodia epactia* hummock grassland. |
| | Scattered *Corymbia hamersleyana* low trees, over *Acacia bivenosa* open shrubland, over *Acacia stellaticeps* low shrubland, with *Triodia epactia* hummock grassland. |

Biota (2004a) mapped the vegetation for the Stage A Fortescue Metals Group (FMG) rail corridor and this included a corridor of vegetation in the Chichester Range overlapping BHPBIO's proposed Chichester Deviation corridor. Fourteen vegetation units were mapped as occurring in this area and these are detailed in Table 3.4. The vegetation units mapped in Biota's report included information from sites surveyed for the Hope Downs rail corridor also (Biota and Trudgen, 2002).

**Table 3.4 – Vegetation units decribed by Biota (2004a) for the FMG Stage A rail corridor**

| Region | Habitat | Vegetation Type |
|---|---|---|
| **Chichester Range** | **Stony plains and hills** | *Acacia inaequilatera*, *Cassia* spp. scattered tall shrubs over *Triodia epactia* mid-dense hummock grassland. |
| | | *Cassia glutinosa* scattered shrubs over *Triodia brizoides*, *T. epactia* mid-dense hummock grassland. |
| | | *Corymbia hamersleyana* scattered low trees over *Acacia arida*, *A. ptychophylla* low open heath over *Triodia lanigera* closed hummock grassland. |
| | | *Corymbia deserticola* scattered low trees over *Acacia aneura* high open shrubland over *Triodia lanigera* closed hummock grassland. |
| | | *Corymbia deserticola* scattered low trees over *Acacia aneura* high shrubland to low woodland over *Triodia lanigera* closed hummock grassland. |
| | | *Eucalyptus leucophloia* scattered low trees over *Triodia* aff. *basedowii* hummock grassland. |
| | **Minor creeklines and floodplains** | *Acacia coriacea* open woodland over *Petalostylis labicheoides*, *Acacia acradenia*, *A. bivenosa* high open shrubland over *Themeda triandra* open tussock grassland. |
| | | *Eucalyptus victrix*, *Corymbia hamersleyana* scattered low trees over *Acacia tumida*, *Petalostylis labicheoides* open scrub over *Triodia epactia* mid-dense hummock grassland. |
| | | *Eucalyptus victrix* low woodland over *Melaleuca linophylla* open shrubland over *Sorghum plumosum* open tussock grassland and *Triodia longiceps* very open hummock grassland. |
| | | *Eucalyptus victrix* scattered low trees over *Acacia bivenosa* open heath over *Triodia epactia* mid-dense hummock grassland and patches of *Themeda triandra* tussock grassland. |
| | **Cracking clays** | *Acacia xiphophylla* open to closed scrub over *Rhagodia eremaea* open shrubland. |
| **Fortescue Valley** | **Clayey / sandy plains** | *Acacia aneura* open scrub to low open forest over *Dodonaea petiolaris*, *Eremophila forrestii* subsp. *forrestii*, *Cassia helmsii*, *Sida calyxhymenia* open heath with *Enneapogon polyphyllus* annual very open grassland. |
| | | *Acacia aneura* low woodland over *A. aneura*, *A. atkinsiana* high open shrubland over *Eremophila forrestii* subsp. *forrestii* open shrubland over *Triodia epactia* mid-dense hummock grassland. |
| | | *Acacia xiphophylla*, *A. aneura* high open shrubland to low woodland over *Acacia victoriae*, *Eremophila forrestii* subsp. *forrestii*, *Cassia* spp. open shrubland to open heath over *Aristida latifolia* grassland with *Enneapogon polyphyllus*, *Aristida contorta* annual grassland. |

### 3.2.2 Vegetation Units of the Survey Area

Vegetation units for the survey area were assessed alongside units from a Level 1 assessment to the south of the current survey area (between chainage 237 to chainage 250). The dendrogram produced by PATN$^{TM}$ analysis is included as Figure 3.2. Based on this the vegetation of the current survey area was mapped at a scale of 1:10,000 (Figure 3.3). Not all vegetation communities visible at ground level and grouped by the multivariate analysis could be reliably discriminated on the aerial photography. Therefore the boundaries between some community subtypes (for example the various *Acacia aneura* woodland areas) could not be reliably extrapolated to areas not ground truthed and were not mapped as discrete units, despite being described below.

Given the limitations of mapping large areas based on information collected in quadrats, it is likely that further community subtypes, not readily discernible using aerial photography, are present within the survey area. However, the scope of the survey and scale of aerial photography available for interpretation was sufficient to enable all major community types to be adequately described.

The vegetation of the survey area was mapped into nine vegetation types, with some types further classified into subtypes based on structure and species composition of the dominant strata (Table 3.5 and Figure 3.4). The vegetation descriptions are based on the vegetation structural table included as Appendix A.2. The original table was created by Specht (1970), modified by Aplin (1979) and again by Trudgen in 2008.

**Table 3.5 – Vegetation Units recorded during the Chichester Deviation survey.**

| VEGETATION DESCRIPTION | ASSOCIATED SPECIES | PRIORITY FLORA RECORDED? | QUADRATS SURVEYED | PHOTOGRAPH |
|---|---|---|---|---|
| **GILGAI PLAINS: RED-BROWN CRACKING CLAY** | | | | |
| **1: *Astrebla pectinata* tussock grassland** | | | |  |
| *Hakea lorea* subsp. *lorea* and *Acacia tetragonophylla* scattered shrubs, over *Sida fibulifera* low open shrubland, over *Astrebla pectinata* closed tussock grassland. | *Enneapogon caerulescens*<br>*Senna artemisioides* subsp. *helmsii*<br>*Senna artemisioides* subsp. *oligophylla* | No | Phase 1<br>39 & 41<br><br>Phase 2<br>35 | |
| **2: *Acacia xiphophylla* open scrubland** | | | |  |
| *Acacia xiphophylla* open scrub, over *Senna sericea* and *Senna artemisioides* subsp. *oligophylla* low open shrubland, over *Astrebla pectinata* open tussock grassland. | *Eriachne mucronata*<br>*Panicum decompositum* | No | Phase 1<br>40<br><br>Phase 2<br>24 | |

| VEGETATION DESCRIPTION | ASSOCIATED SPECIES | PRIORITY FLORA RECORDED? | QUADRATS SURVEYED | PHOTOGRAPH |
|---|---|---|---|---|
| **PLAIN: OPEN BARE AREAS OF HARD CLAY PANS, WITH COMMON FERROUS PEBBLES** | | | | |
| **3: *Acacia aneura* low woodland** | | | |  |
| *Acacia aneura* var. *aneura* low woodland, over varying *Dodonaea petiolaris* and *Sida* sp. unisexual (N.H. Speck 574) shrubland, over *Aristida contorta* open tussock and *Triodia pungens* very open hummock grassland. | *Acacia pruinocarpa*<br>*Acacia tetragonophylla*<br>*Eremophila forrestii* subsp. *forrestii*<br>*Eremophila latrobei* subsp. *filiformis*<br>*Psydrax latifolia* | No | Phase 1<br>3, 5, 6, 7, 9 & 17 | |
| | | | Phase 2<br>1, 2, 5, 6, 8 & R17 | |
| **DRAINAGE AREAS AT THE BASE OF THE FOOTSLOPE** | | | | |
| **4a: *Acacia aneura* low open forest** | | | |  |
| *Acacia aneura var. aneura* low woodland, with *Corymbia deserticola* subsp. *deserticola* scattered low trees, over *Petalostylis labicheoides*, *Sida* sp. unisexual (N.H. Speck 574) and *Grevillea wickhamii* subsp. *aprica* shrubland, over *Indigofera monophylla, Corchorus lasiocarpus*, *Streptoglossa bubakii*, *Solanum phlomoides* and *Goodenia stobbsiana* low shrubland, over *Triodia basedowii* and *Triodia pungens* open hummock grassland, with *Aristida contorta* and *Enneapogon caerulescens* very open tussock grassland. | *Acacia ayersiana*<br>*Acacia marramamba*<br>*Acacia pruinocarpa*<br>*Psydrax latifolia*<br>*Pterocaulon sphaeranthoides* | No | Phase 1<br>10, 14 & 16 (moderately burnt) | |
| | | | Phase 2<br>R14 | |

| VEGETATION DESCRIPTION | ASSOCIATED SPECIES | PRIORITY FLORA RECORDED? | QUADRATS SURVEYED | PHOTOGRAPH |
|---|---|---|---|---|
| **4b: *Acacia ayersiana* and *Acacia aneura* low open forest** | | | |  |
| *Acacia ayersiana* and *Acacia aneura* var. *aneura* low open forest, over *Acacia marramamba* and *Eremophila forestii* open shrubland, over *Triodia basedowii* and *Triodia pungens* open hummock grassland. | *Acacia tetragonophylla*<br>*Solanum phlomoides* | No | Phase 1<br>27 & 35 | |
| | | | Phase 2<br>7, 10, 14 & 23 | |
| **MAJOR CREEK LINES OF THE FLAT AREAS** | | | | |
| **5: *Acacia citrinoviridis* low open forest** | | | |  |
| *Acacia citrinoviridis* open low forest, over *Ehretia saligna* low woodland, over Acacia synchronicia and *Ehretia saligna* open scrubland, over *Enneapogon caerulescens*, *Eriachne mucronata* and *Cymbopogon ambiguus* tussock and *Triodia pungens* hummock grassland. | *Acacia pyrifolia* var. *morrisonii*<br>*Dodonaea petiolaris*<br>*Indigofera monophylla*<br>*Senna artemisioides* subsp. *helmsii*<br>*Themeda triandra* | No | Phase 1<br>1 | |
| | | | Phase 2<br>3 | |

| VEGETATION DESCRIPTION | ASSOCIATED SPECIES | PRIORITY FLORA RECORDED? | QUADRATS SURVEYED | PHOTOGRAPH |
|---|---|---|---|---|
| **6: *Acacia citrinoviridis* and *Corymbia hamersleyana* low woodland** | | | |  |
| *Acacia citrinoviridis* and *Corymbia hamersleyana* low woodland, over *Acacia pyrifolia* var. *morrisonii*, *Petalostylis labicheoides* and *Acacia aneura* var. *aneura* high shrubland, over *Themeda triandra* tussock and *Triodia pungens* open hummock grassland. | *Cymbopogon ambiguus*<br>*Eriachne mucronata*<br>*Pterocaulon sphaeranthoides* | No | Phase 1<br>2, 4 | |
| **MAJOR CREEK LINES OF THE CHICHESTER RANGES** | | | | |
| **7a: *Eucalyptus victrix* open forest, over *Melaleuca glomerata* shrubland** | | | |  |
| *Eucalyptus victrix open* forest, over *Melaleuca glomerata* shrubland, over *Stemodia grossa* low open shrubland, over *Cyperus vaginatus* very open sedges, with *Sorghum plumosum, Eriachne* aff. *mucronata, *Cenchrus ciliaris* and *Panicum decompositum* tussock grassland. | *Pluchea rubelliflora*<br>*Cymbopogon ambiguus* | No | Phase 1<br>38 | |

| VEGETATION DESCRIPTION | ASSOCIATED SPECIES | PRIORITY FLORA RECORDED? | QUADRATS SURVEYED | PHOTOGRAPH |
|---|---|---|---|---|
| **7b: *Petalostylis labicheoides* and mixed *Acacia* spp. high shrubland** | | | |  |
| *Eucalyptus victrix* open woodland, over *Grevillea wickhamii* subsp. *aprica*, *Petalostylis labicheoides*, *Acacia pyrifolia* var. *pyrifolia* and *Acacia tumida* var. *pilbarensis* high shrubland, over *Tephrosia rosea* var. *glabrior* and *Rulingia luteiflora* low shrubland, over *Themeda triandra* and *Eriachne mucronata* tussock grassland, with *Triodia pungens* very open hummock grassland. | *Gossypium robinsonii*<br>*Jasminum didymum* subsp. *lineare*<br>*Isotropis atropurpurea* | Yes | Phase 1<br>11, 15, 20 & 34<br><br>Phase 2<br>**21**, 4, 13, 21, 26, 28, 34, R11 & **R34** | |
| **7c: *Corymbia* spp. and *Hakea chordophylla* low open woodland** | | | |  |
| *Corymbia hamersleyana, Corymbia opaca* and *Hakea chordophylla* low open woodland, over *Acacia bivenosa*, *Acacia ancistrocarpa* and *Acacia tumida* var. *pilbarensis* shrubland, over *Pterocaulon sphaeranthoides* low open shrubland, over *Triodia pungens*, occasionally with *Triodia basedowii* hummock grassland, with *Cymbopogon ambiguus* and *Themeda triandra* very open grassland. | *Acacia aneura*<br>*Indigofera monophylla*<br>*Ptilotus astrolasius* var. *astrolasius*<br>*Senna glutinosa* subsp. *glutinosa* | Yes | Phase 1<br>26, 30 & 31<br><br>Phase 2<br>**26**, **34**, 9, 16 & **R26** | |

| VEGETATION DESCRIPTION | ASSOCIATED SPECIES | PRIORITY FLORA RECORDED? | QUADRATS SURVEYED | PHOTOGRAPH |
|---|---|---|---|---|
| **ROCKY HILL SLOPES: STONES AND BOULDERS OF IRONSTONE** | | | | |
| **8a: *Eucalyptus leucophloia* low open woodland, over *Triodia basedowii* hummock grassland** | | | |  |
| *Eucalyptus leucophloia* subsp. *leucophloia* low open woodland, over a mixed low open heath dominated by *Goodenia stobbsiana*, over *Triodia basedowii* hummock grassland. | *Acacia arida*<br>*Hakea chordophylla*<br>*Ptilotus calostachyus* var. *calostachyus*<br>*Senna glutinosa* subsp *glutinosa*<br>*Senna glutinosa* subsp. *pruinosa*<br>*Solanum phlomoides* | No | Phase 1<br>8, 13, 18, 23, 24, 25, 29.<br><br>Phase 2<br>11, 12, 15, 17, 19, 22, 25, 27, 30, 31, 33, R24 & R29 | |
| **8b: *Acacia aneura* low woodland** | | | |  |
| *Acacia aneura* var. ?*microcarpa* low woodland, over varying *Senna glutinosa* subsp. *glutinosa*, *Eremophila latrobei* subsp. *filiformis* and *Ptilotus obovatus* var. *obovatus* scattered low shrubs, over *Triodia basedowii* and *Triodia pungens* hummock grassland, with *Eriachne mucronata* and *Cymbopogon ambiguus* scattered tussock grasses. | *Eremophila latrobei* subsp. *filiformis*<br>*Eucalyptus leucophloia* subsp. *leucophloia*<br>*Ptilotus obovatus* var. *obovatus*<br>*Senna glutinosa* subsp. *glutinosa* | No | Phase 1<br>28, 32 & 33<br><br>Phase 2<br>R28 | |

| VEGETATION DESCRIPTION | ASSOCIATED SPECIES | PRIORITY FLORA RECORDED? | QUADRATS SURVEYED | PHOTOGRAPH |
|---|---|---|---|---|
| **8c: *Acacia rhodophloia* high shrubland** | | | |  |
| Sparse *Acacia pruinocarpa* medium to low trees over open *Acacia rhodophloia* tall to medium shrubs over open *Acacia pruinocarpa* medium shrubs over sparse to open *Corchorus lasiocarpus* subsp. *lasiocarpus* and *Solanum phlomoides* low to very low shrubs over sparse *Aristida contorta* tussock grass over open *Triodia basedowii* hummock grassland. | *Acacia maitlandii*<br>*Eremophila latrobei* subsp. *filiformis*<br>*Goodenia stobbsiana*<br>*Senna artemisioides* subsp. *helmsii* | No | Phase 1<br>12 | |
| **DRAINAGE CHANNEL ON ROCKY HILL SLOPES: STONES AND BOULDERS OF IRONSTONE** | | | | |
| **9a: Mixed *Acacia* spp. open heath** | | | |  |
| *Eucalyptus leucophloia* subsp. *leucophloia* scattered trees to low woodland, over varying *Grevillea wickhamii* subsp. *aprica*, *Acacia monticola*, *Acacia maitlandii* and *Acacia pyrifolia* var. *morrisonii* open heath, over a low shrubland dominated by *Goodenia stobbsiana*, over *Triodia pungens* hummock grassland, with very open *Cymbopogon ambiguus* and *Eriachne lanata* tussock grassland. | *Corchorus lasiocarpus*<br>*Dampiera candicans*<br>*Indigofera monophylla*<br>*Solanum phlomoides*<br>*Triodia basedowii* | No | Phase 1<br>21, 22 & 36 37<br><br>Phase 2<br>18, 20, 29 & R22 | |

| VEGETATION DESCRIPTION | ASSOCIATED SPECIES | PRIORITY FLORA RECORDED? | QUADRATS SURVEYED | PHOTOGRAPH |
|---|---|---|---|---|
| **9b: *Acacia aneura* low open forest** | | | | |
| Scattered *Eucalyptus leucophloia* subsp. *leucophloia* tall to medium trees, over *Acacia aneura* var.?*intermedia* low open forest, over *Dodonaea petiolaris* open heath, over a *Eriachne mucronata* tussock grassland. | *Acacia ancistrocarpa*<br>*Goodenia stobbsiana*<br>*Indigofera monophylla* | No | Phase 1<br>19<br><br>Phase 2<br>32 |  |

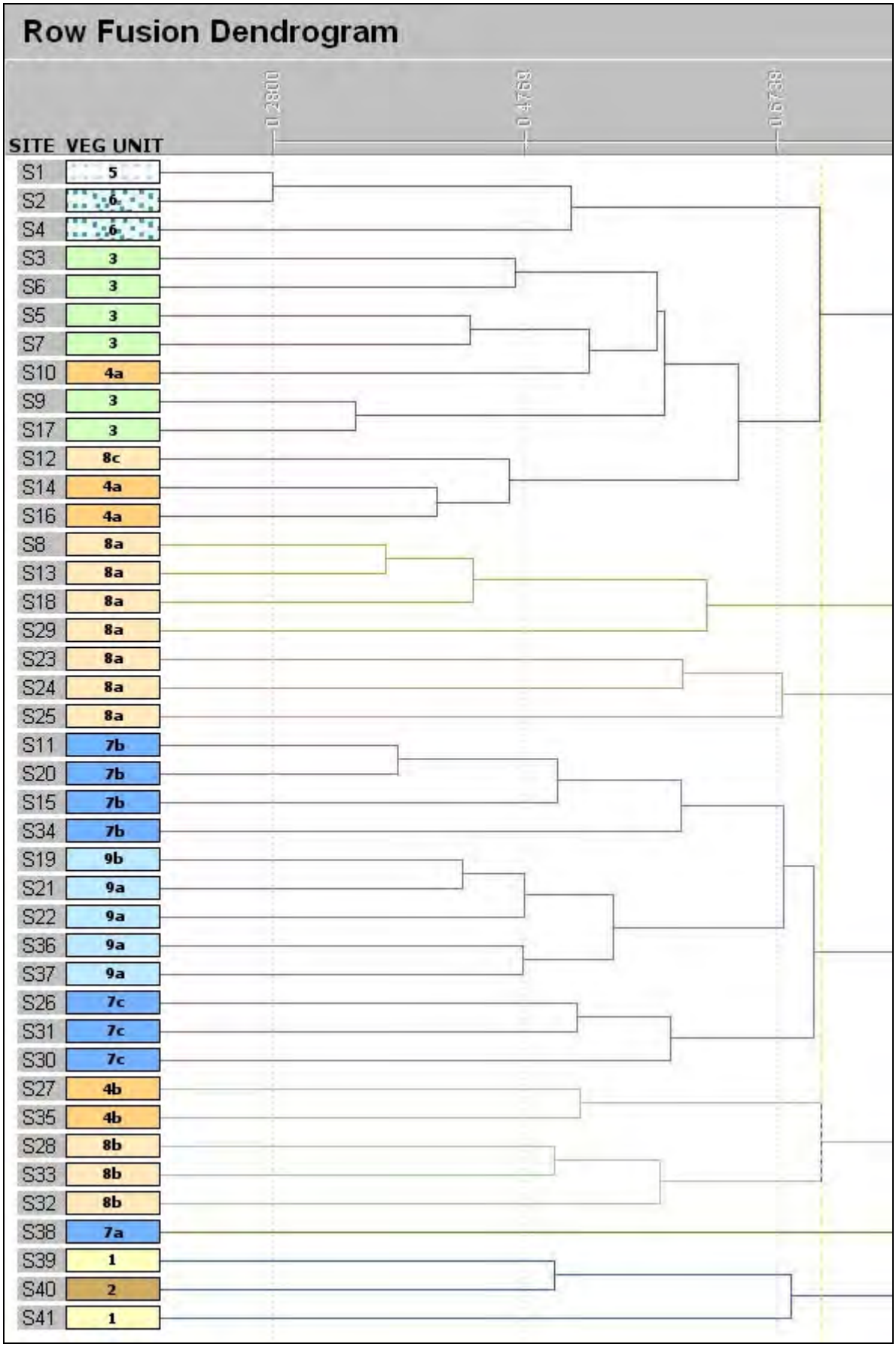


**Figure 3.3 – Dendrogram produced by PATN™ analysis**

702500 705000 707500 710000 712500

7552500 7550000 7547500 7545000 7542500 7540000 7537500

**Legend**

1: *Astrebla pectinata* tussock grassland on the gilgai plains.

2: *Acacia xiphophylla* open scrubland on the drainage areas of the gilgai plains.

3: *Acacia aneura* low woodland on the clay flats.

4: a) *Acacia aneura* low open forest;
b) *Acacia ayersiana* and *Acacia aneura* low open forest on the drainage areas at the base of the footslope.

5: *Acacia citrinoviridis* open low forest on major creek lines of the flat areas.

6: *Acacia citrinoviridis* and *Corymbia hamersleyana* low woodland on major creek lines of the flat areas.

7: a) *Eucalyptus victrix* open forest, over *Melaleuca glomerata* shrubland;
b) *Petalostylis labicheoides* and mixed *Acacia* spp. high shrubland;
c) *Corymbia* spp. and *Hakea chordophylla* low open woodland on major creek lines and gullies of the Chichester Ranges.

8: a) *Eucalyptus leucophloia* low open woodland, over *Triodia basedowii* hummock grassland;
b) *Acacia aneura* low woodland on the steeper rocky hill slopes;
c) *Acacia rhodophloia* high shrubland on the rocky hill slopes.

9: a) Mixed *Acacia* spp. open heath;
b) *Acacia aneura* low open forest on the rocky drainage channels of the midslope.

N

0 1 2

Kilometers

**Absolute Scale - 1:45,690**

ecologia ENVIRONMENT

bhpbilliton

calibre engenium

**Chichester Deviation**
**Vegetation Classifications**

**Figure:**
**Project ID: 871**

**Drawn: SG**
**Date: 21/10/08**

*Coordinate System*
Name: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

**A3**

### 3.2.3 Burnt Vegetation in the Survey Area

Fifty to 60 percent of the survey area was affected by fire in November 2007 (started by lightning strike) prior to the second phase assessment. The burn scar is shown in Figure 3.5 and was verified by walking a transect through the area, any unburnt remnant vegetation was surveyed. Twelve sites were assessed in the burnt areas during phase two and, while not statistically analysed, two vegetation units associated with two landform types - a creek bank and a rocky hill slope - were distinguished, these are described below.

**Creek line re-growth vegetation**

1. Scattered *Eucalyptus victrix* and *Corymbia hamersleyana* low to medium trees, over a *Petalostylis labicheoides* regrowth shrubland, over *Cleome viscosa, Senna notabilis, Indigofera monophylla, Tephrosia rosea* var. *glabrior* and *Corchorus lasiocarpus* subsp. *lasiocarpus* low shrubland, over *Chrysopogon fallax* and *Themeda triandra* tussock grassland, sometimes with a *Triodia epactia* hummock grassland on the creek banks (Plate 3.1).

**Plate 3.1 – Burnt vegetation of the creek beds/banks**

**Rocky hill slope re-growth vegetation**

2. Scattered *Eucalyptus victrix* and *Corymbia hamersleyana* low to medium trees, over *Petalostylis labicheoides* regrowth shrubland, over *Cleome viscosa, Senna notabilis, Indigofera monophylla, Tephrosia rosea* var. *glabrior* and *Corchorus lasiocarpus* subsp. *lasiocarpus* low shrubland, over *Chrysopogon fallax* and *Themeda triandra* tussock grassland, sometimes with a *Triodia epactia* hummock grassland (Plate 3.2).

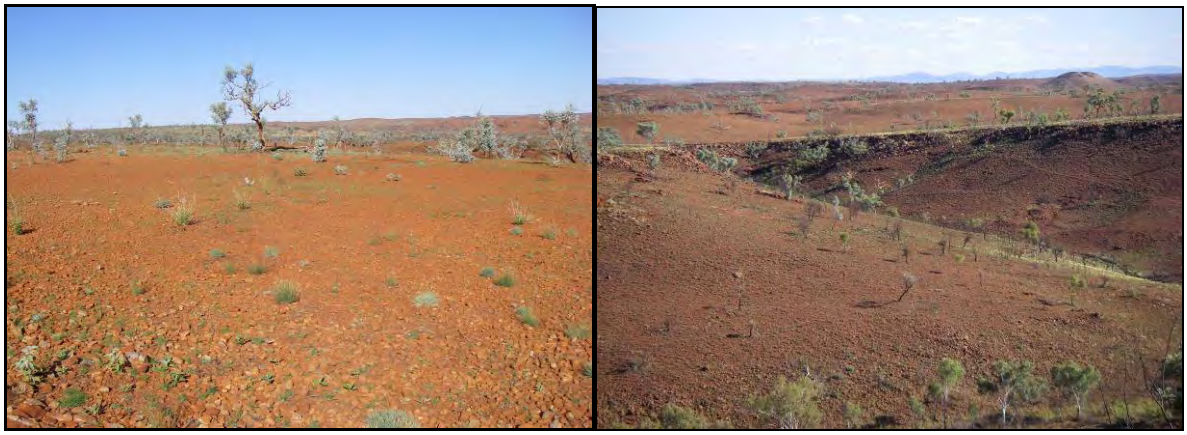

**Plate 3.2 – Burnt vegetation on the rocky hill slopes**

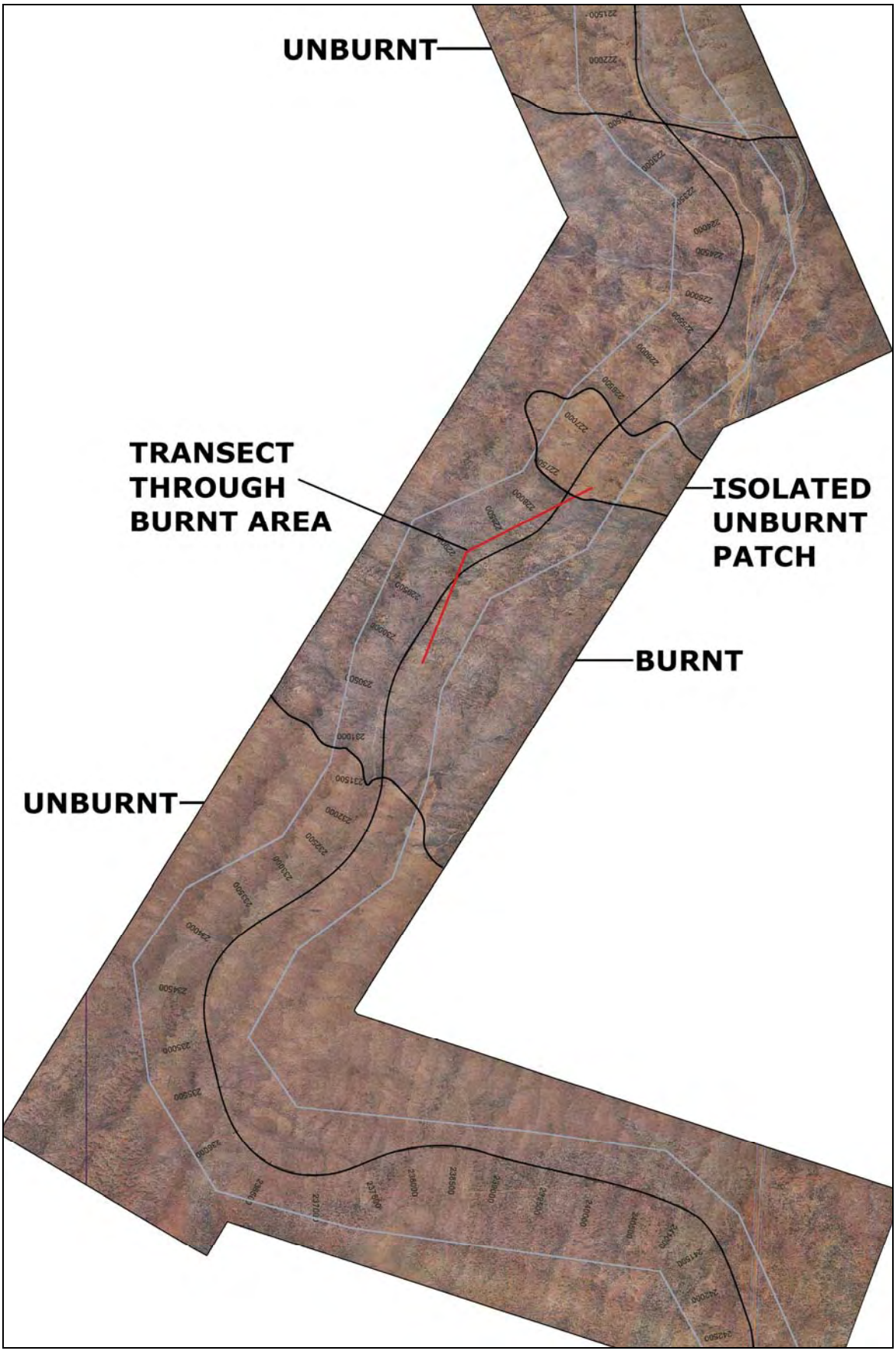


**Figure 3.5 – Chichester Deviation survey area with burnt areas indicated**

### 3.2.4 Mulga in the Survey Area

The *Acacia aneura* (mulga) low woodland unit represents a major vegetation type in the survey area, particularly in the southern section of the Chichester Deviation (see Figure 3.4).

Mulga is a bushy shrub or tree ranging in height from 2-10 m, and comprises a range of taxa with considerable variation in growth form and phyllode morphology. Mulga communities are defined as those that contain and are frequently dominated by mulga (Fortech, 1999). These communities may occur in patches in valleys, in sheltered sites associated with hills and breakaways, or in distinctive grove arrangements. Mulga occurs on a variety of soils and in a variety of habitats across the semi-arid shrublands of Australia (Paczkowska and Chapman, 2000). Mulga in this area of the Pilbara is approaching its northernmost extent in Western Australia (Kendrick, 2001b). Beard's 'mulga in groved patterns' unit mapped in the south of the study area marks the most northerly boundary of this large unit of vegetation.

Mulga has a root system that is adapted for taking up water from thin surface soils and has adaptations that concentrate soil water near the plant and conserve water within the plant. Consequently, the distribution and abundance of mulga is particularly influenced by soil moisture and the pattern of surface drainage (Paczkowska and Chapman, 2000).

A potential indirect impact of the rail line construction is disturbance to surface hydrology. Surface water is important for stands of mulga. Construction of the railroad through the Chichester Range may have an adverse effect on the mulga communities in this area unless adequate measures are taken to maintain current surface water flow.

### 3.2.5 Bamboo Springs

A small area of vegetation was noted on the far eastern boundary of the new Chichester Deviation rail corridor during the vertebrate fauna assessment (Plate 3.3). This vegetation was not surveyed during the vegetation and flora survey as the flora sites were focused towards the centre of the proposed new rail corridor. In addition *ecologia* was asked not to enter any heritage sites indicated on the maps provided: the bamboo springs were marked as a heritage area on the maps used during the surveys.

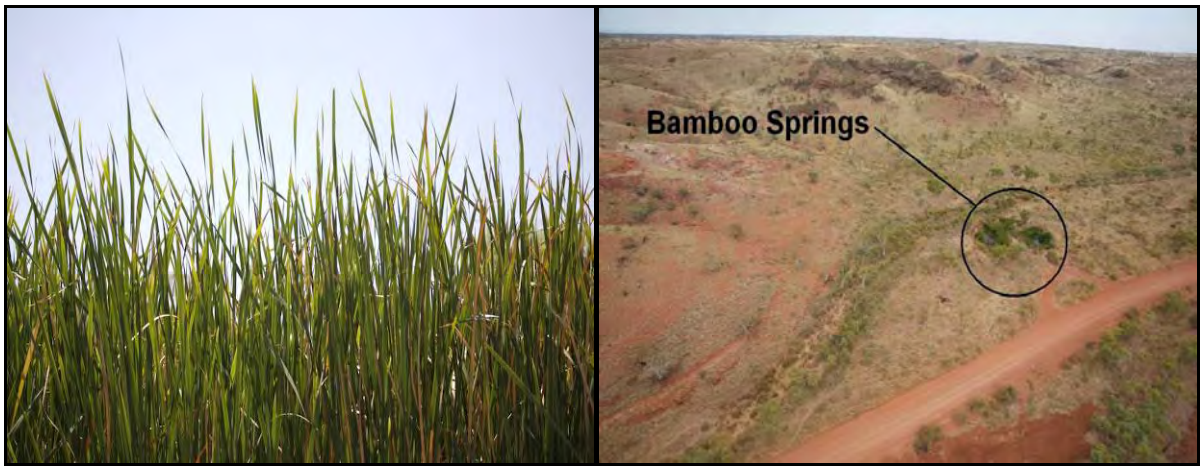


**Plate 3.3 – Vegetation at and aerial photograph of the spring**

### 3.2.6 Vegetation Condition

Vegetation condition is noted in the field using the disturbance levels indicated below (Table 3.6). Factors taken into consideration when determining these levels of disturbance are the presence of weeds, tracks and litter and any evidence of grazing and general ground disturbance.

**Table 3.6 – Vegetation condition assessment**

| Vegetation condition | Level of disturbance |
|---|---|
| Pristine | None |
| Excellent | Minimal |
| Good | Moderate |
| Poor | Significant |
| Degraded | Very high |

Vegetation condition along the proposed new Chichester Deviation has been classified as excellent. There are few tracks in the area and grazing and weed abundance is generally low (weed locations are shown in Appendix A.5 and a discussion of each weed and their densities/cover is included in Section 3.7).

## 3.3 ECOLOGICAL COMMUNITIES

### 3.3.1 State and Nationally Recognised Threatened and Priority Ecological Communities

Ecological communities are naturally occurring biological assemblages associated with a particular type of habitat. At a national level, flora and threatened ecological communities (TECs) are protected under the EPBC Act. TECs are listed as Critically Endangered, Endangered or Vulnerable (Appendix A.3). No federally listed TECs occur in the vicinity of the survey area.

The DEC maintains a list of TECs that are Presumed Totally Destroyed, Critically Endangered, Endangered or Vulnerable; no state-listed TECs occur in the vicinity of the survey area.

Potential TECs that do not meet survey criteria, or that are not adequately defined, are added by the DEC to a list of priority ecological communities (PECs; see Appendix A.3 for definition). Communities are placed in this category while consideration can be given to their declaration as a TEC. One Priority 3(iii) state listed PEC "Plant Assemblages of the Wona Land System" occurs in the survey area. Priority 3(iii) PECs are defined as:

"Communities made up of large, and/or widespread occurrences that may or not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, and inappropriate fire regimes.

Communities may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and/or are not well defined, and known threatening processes exist that could affect them."

There will be no impact to any TEC as a result of the proposed Chichester Deviation works.

Impact to the Wona Land System PEC will occur as a result of the proposed Chichester Deviation works. The calculated proposed impact from 2.9 km of rail corridor crossing this land system is low (0.032%). In addition,, 1.5 km of the 2.9 km of corridor crossing this land system falls within the Mainline corridor that already contains an existing rail line and associated access tracks. Potential impact to this section of the corridor amounts to 0.017%. The remaining 1.4 km occurs in the proposed new Chichester Deviation corridor and the potential impact to the land system from this section of the corridor is 0.015%.

## 3.4 FLORA

### 3.4.1 Results from the Current Survey

A total of 306 taxa resulted from the combined records for both phases of the survey, including opportunistic collections (excluding affinities and forms). These taxa belong to 47 families and 125 genera. Two collections were identified to family level only and 10 to genus level only. Eighteen families and 71 genera were represented by a single taxon. A complete species list is located in Appendix A.4.

Of this combined total, 204 taxa from 37 families and 96 genera were recorded during the first phase of the survey and 261 taxa from 44 families and 110 genera during the second phase. Twenty nine annual (or weakly perennial) taxa were recorded during phase 1 of the survey and 38 during phase 2, while 16 annual taxa were recorded in both phases of the survey. A list of the taxa recorded during the two phases of the survey is included as Appendix A.3.

The families represented by the greatest number of species in the combined species list were the Poaceae (47 taxa), Mimosaceae (41 taxa) and Malvaceae (29 taxa). Genera represented by the greatest number of species were *Acacia* (40 taxa), *Sida* (13 taxa), *Senna* and *Ptilotus* (12 taxa each), *Goodenia* (eight taxa), and *Abutilon* and *Triodia* (seven taxa each).

The most commonly recorded species at the Phase 1 sites surveyed were *Triodia pungens* (at 29 sites), *Cymbopogon ambiguus* and *Indigofera monophylla* (both at 23 sites), *Acacia pruinocarpa* (21 sites), *Acacia tetragonophyll*a and *Eucalyptus leucophloia* subsp. *leucophloia* (both at 20 sites), and *Senna glutinosa* subsp. *glutinosa* and *Pterocaulon sphaeranthoides* (each at 19 sites).

The most commonly recorded species at Phase 2 sites surveyed were *Indigofera monophylla* (at 27 sites), *Goodenia stobbsiana* (24 sites), and *Senna glutinosa* subsp. *glutinosa*, *Corchorus lasiocarpus* subsp. *lasiocarpus* and *Solanum phlomoides* (each at 23 sites).

Phase 1 sites with the highest species richness were sites 01 (41 species recorded), 12 (39 species), 19 (38 species), and 04, 16 and 22 (37 species). Those with the lowest species richness were sites 25, 27 and 41 (each with nine species recorded), 24 and 33 (each with 13 species), and 35 (14 species). Species richness reflects the locations of the quadrats in the landscape, as sites 01, 12, 19, 04, 16 and 22 are generally low in the landscape and are associated with areas of higher water availability, such as drainage lines and floodplains. Sites 25, 27, 41, 24, 33 and 35 were associated with areas expected to have low species diversity such as, dense shrublands providing minimal light for the understorey, and rocky / exposed areas including mid slopes and hill crests.

Sites having the highest species richness in Phase 2 were R26 (58 species), 34 and 21 (both with 53 species), 8 (48 species), and 23 (42 species). The sites with the lowest species richness were 10 (11 species), 25 and 35 (14 species) and 19 (17 species). Again, these

results reflect the locations of the quadrats in the landscape, as sites R26, 34, 21, 8 and 23 are generally low in the landscape and are associated with areas of higher water availability. However, sites 10, 25, 35 and 19 are located in open clay pan areas, open ridgetops and mid slopes.

### 3.4.2 Comparison of Current Results with those from other Surveys in the Area

The number of families, genera and taxa recorded during this survey can be compared with information recorded during other surveys either in the vicinity of the Chichester Deviation survey area or along the existing BHPBIO rail corridor. This comparative information is provided in Table 3.7 below.

**Table 3.7 – Flora records from previous surveys**

| Location | Time of year of survey | Area surveyed (ha) | Number of Species Recorded | Reference |
|---|---|---|---|---|
| FMG Stage A Rail corridor | March / April, 2004 | 51.5 | 599 | Biota, 2004a |
| Yandi Mine Extension Phase 2 | June, 2008 | 15.50 | 261 | *ecologia,* 2008f |
| Yandi Mine Extension Phase 1 | November, 2007 | 14.00 | 212 | *ecologia,* 2008f |
| **Chichester Deviation Phase 1** | October, 2007 | 10.00 | 204 | This report |
| **Chichester Deviation Phase 2** | May, 2008 | 10.75 | 261 | This report |
| Cowra to Kurrajurra | October, 2007 | 9.00 | 206 | *ecologia*, 2007a |
| Walla to Turner Sidings | April, 2008 | 7.00 | 205 | *ecologia*, 2008a |
| Walla to Bing Sidings | April, 2008 | 4.00 | 153 | *ecologia*, 2008b |
| Cowra Camp Site | October, 2007 | 5.25 | 144 | *ecologia*, 2007a |
| Redmont Camp Site | October, 2007 | 1.50 | 82 | *ecologia* 2008c |

While these other survey areas are not in exactly the same land systems and botanical regions as the Chichester Deviation survey area, they enable broad comparisons to be made on botanical diversity. Diversity recorded during both phases of the survey of the Chichester Deviation area is slightly higher than that recorded at other areas of a similar size.

### 3.4.3 Sampling Adequacy

Species accumulation curves provide a theoretical basis for understanding the relationship between sampling effort and the accumulation of species, and hence provide a means of estimating survey adequacy. As sampling effort increases with a corresponding increase in survey area and time, the rate at which new species are recorded is reduced and the total record levels out (i.e. becomes asymptotic). At this point, where there is a diminishing return with regards to increases in species richness with sampling effort, the survey size is deemed sufficient.

Flora sampling adequacy for each phase of the current survey was estimated using species accumulation curves and extrapolation of each curve to the asymptote using Michaelis-Menten Mean modelling (Colwell, 2005) (Figures 3.6 and 3.7). Estimates from these data indicate that approximately 88.7% of the vascular flora taxa potentially present within the Chichester Deviation study area were recorded during Phase 1, and 88.3% during Phase 2. The data used for plotting take into account only the species found per site, however opportunistic collections were made outside of the sites; along tracks and adjacent to

quadrats. These were not included in the species accumulation curves but were included in the overall results discussed in Section 3.4.1. The addition of these taxa increases the recorded species richness of the area to above that predicted by the Michaelis-Menten Mean modelling.

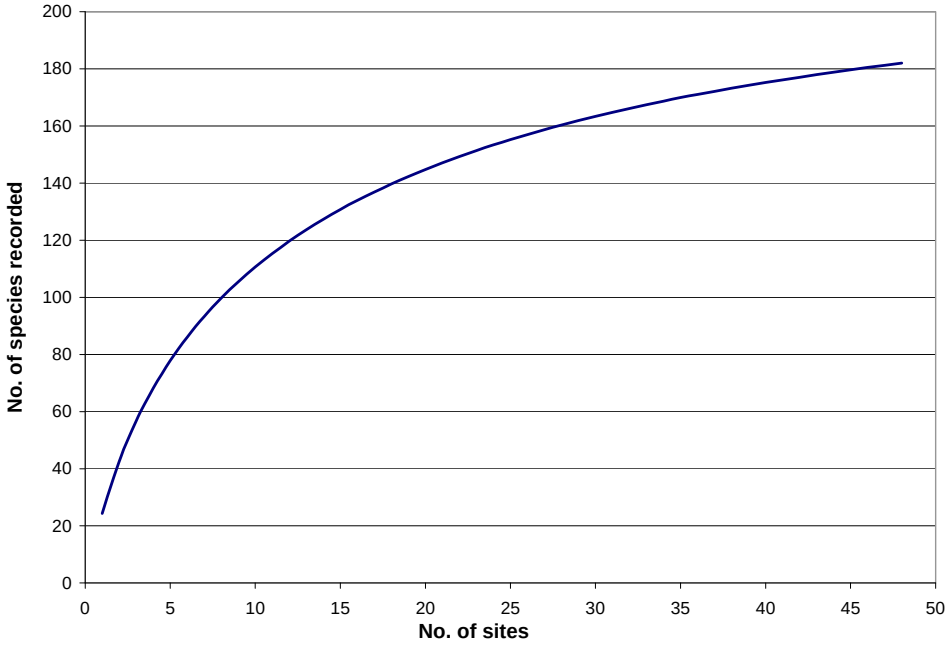


**Figure 3.6 – Species accumulation curve for Phase 1 of the Chichester Deviation Vegetation and Flora Survey**

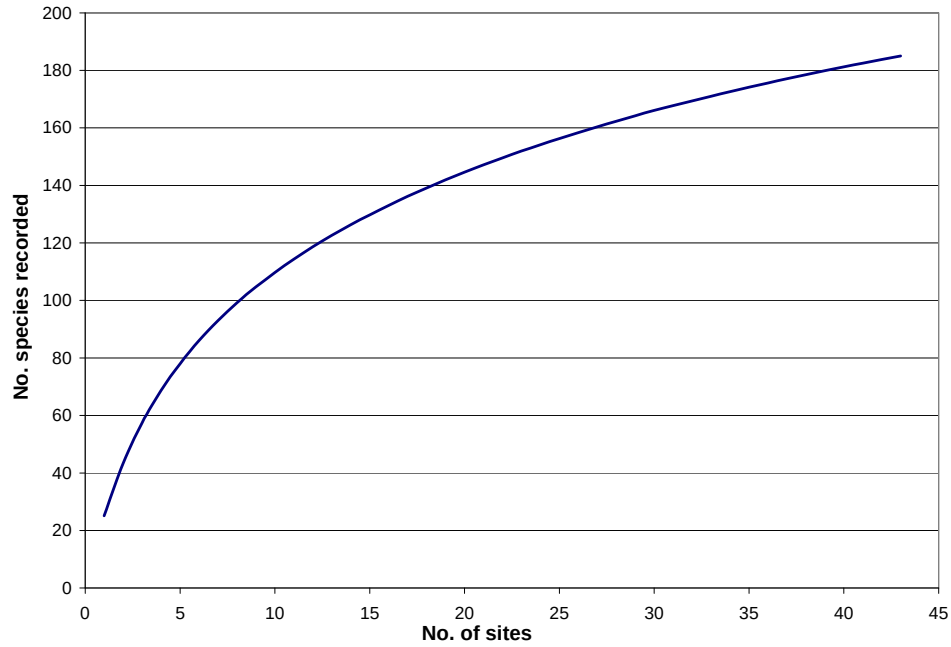


**Figure 3.7 – Species accumulation curve for Phase 2 of the Chichester Deviation Vegetation and Flora Survey**

## 3.5 FLORA OF CONSERVATION SIGNIFICANCE

### 3.5.1 Statutory Framework

Flora species are protected at a national level under the Commonwealth EPBC Act. The Act contains a list of species that are considered Critically Endangered, Endangered, Vulnerable, Conservation Dependent, Extinct or Extinct in the Wild (for definitions of categories, see Appendix A.3). Two flora taxa occurring in the Pilbara region are protected by this Act – *Lepidium catapycnon* and *Thryptomene wittweri* - and both are listed as Vulnerable.

Flora of conservation significance within Western Australia are protected under the WC Act and termed Declared Rare Flora (DRF). The current DRF list is published in the *Western Australian Wildlife Conservation (Rare Flora) Notice 2008(2)*. DRF taxa are defined as "taxa which have been adequately searched for and deemed to be either rare, in danger of extinction, or otherwise in need of special protection in the wild". Two DRF taxa occurring in the Pilbara region are protected by this Act - *Lepidium catapycnon* and *Thryptomene wittweri.*

The DEC also maintains a list of Priority Flora taxa, which are considered poorly known, uncommon, or under threat, but for which there is insufficient justification based on known distribution and population sizes for inclusion on the DRF schedule. Priority Flora taxa are assigned to one of four priority categories – Priority 1 to Priority 4 (Atkins, 2008(2)) (for a full definition of categories see Appendix A.3).

Currently, 97 Priority Flora taxa are listed on FloraBase as occurring in the Pilbara Bioregion (Western Australian Herbarium, October 2008). Based on known habitat preferences and currently recorded distributions within 20 km of the survey area (Atkins, 2008(2)), it is considered that one Declared Rare and 17 Priority Flora taxa could potentially occur in the survey area. These species, their distribution and preferred habitat are summarized in Table 3.8.

**Table 3.8 – Flora of conservation significance having the potential to occur within the study area**

| Species | Seasonality | Cons. Status | Distribution (nearest named location) | No of records | Preferred Habitat |
|---|---|---|---|---|---|
| *Lepidium catapycnon* (Brassicaceae) | Perennial | R | Wittenoom, Weeli Wolli Creek, Newman | 9 | Stony hill slopes |
| *Acacia leeuweniana* (Mimosaceae) | Perennial | P1 | Obstinate Creek, Woodstock turnoff, Mount Francisco, Spear Hill, Port Hedland, Marble Bar | 24 | Skeletal gritty red-grey soil, granitic outcrops and boulder fields |
| *Acacia levata* (Mimosaceae) | Perennial | P1 | Wittenoom, Woodstock turnoff, Port Hedland, Marble Bar | 14 | Granitic sand among granitic rocks, stony clay-loam on flats, low hilly country in skeletal soil |
| *Goodenia* sp. East Pilbara (A.A. Mitchell PRP 727) (Goodeniaceae) | Annual/ biennual | P1 | Outside mining lease, ca 90 km NW of Newman, | 7 | Red-brown clayey pan, swamp on major river floodplain |
| *Gonocarpus ephemerus* (Haloragaceae) | Annual and Perennial | P2 | Trugallenden Pool, Cloud Break mine lease | 22 | Granite outcrop, red silty sand – clay, rocky outcrop, sandstone |
| *Ischaemum albovillosum* | Perennial | P2 | Approximately 21 km S of Port Hedland on Great | 19 | Cracking clay, Gilgai |

| Species | Seasonality | Cons. Status | Distribution (nearest named location) | No of records | Preferred Habitat |
|---|---|---|---|---|---|
| (Poaceae) | | | Northern Highway on Chichester Plateau, near Fortescue River | | |
| *Stylidium weeliwolli* (Stylidiaceae) | Annual | P2 | Weeli Wolli Springs, Weeli Wolli Creek, Mount Augustus | 17 | Red sand at edge of shallow spring, on bank of shallow drainage above gorge, drainage line |
| *Acacia subtiliformis* (Mimosaceae) | Perennial | P3 | Newman, Munjina | 7 | Calcrete |
| *Bulbostylis burbidgeae* (Cyperaceae) | Annual | P3 | Abydos / Woodstock Reserve, Cloud Break mine lease | 9 | Soil pockets on granite outcrop |
| *Cynanchum* sp. Hamersley (M. Trudgen 2302) (Asclepidiaceae) | Perennial | P3 | Woodstock Station, Barlee Station | 8 | Rocky gullies, bottom of gorges, low in landscape, dark moist soil |
| *Dampiera metallorum* ms (Goodeniaceae) | Perennial | P3 | Mount Robinson, Weeli Wolli Spring, Packsaddle Hill | 19 | Summit of hill, high in landscape, steep slope, skeletal red brown gritty soil over banded ironstone |
| *Goodenia nuda* (Goodeniaceae) | Annual | P3 | Weeli Wolli Creek, Roy Hill, Wittenoom, Mulga Downs, Marillana Creek, Yandi Eastern Pit 2 | 13 | Plain. Dry, red sand; Bare river sand in dry scoured river bed |
| *Gymnanthera cunninghamii* (Asclepidiaceae) | Perennial | P3 | Boodarie Landing, Boodarie Homestead, Woodstock Station, Tom Price | 13 | Brown red sand, major drainage, limestone rise, creekline, river sand |
| *Hibiscus brachysiphonius* (Malvaceae) | Perennial | P3 | 10 km S of Redmont rail camp, adjacent to W side of Port Hedland - Norseman rail line at 219 km chainage | 15 | Red loam over basalt, hard setting red clay pan on limestone, Gilgai within clayey plain |
| *Rhynchosia bungarensis* (Papilionaceae) | Perennial | P3 | Munjina (Auski) Roadhouse, 115 km NW of Newman, Skull Springs, Bungaroo Creek | 22 | Floodplain with deep gorge, creekline within deep gorge, river channels, summit of hill, steep slope, skeletal red stony soil |
| *Tephrosia* sp. Cathedral Gorge (F.H. Mollemans 2420) (Papilionaceae) | Perennial | P3 | Cathedral Gorge, Newman- Packsaddle road turnoff, Paraburdoo | 5 | Stony hill slope, ridge crest, skeletal loam, gentle drainage depression |
| *Triumfetta leptacantha* (Tiliaceae) | Perennial | P3 | Marillana BHP BIO Mining Lease, Yandi Iron Ore Mine, Ministers North, Yandicoogina Creek, Packsaddle Range, Munjina (Auski) Roadhouse | 36 | Red clay over boulder, red loam, fluviatile gravel, rocky breakaway, steep rock slopes, skeletal soil |
| *Eremophila youngii* | Perennial | P4 | Roy Hill-Munjina Road, | 19 | Stony red sandy |

| Species | Seasonality | Cons. Status | Distribution (nearest named location) | No of records | Preferred Habitat |
|---|---|---|---|---|---|
| subsp. *lepidota* (Myoporaceae) | | | Mulga Downs Station, Newman | | loam. Flats plains, floodplains, sometimes semi-saline, clay flats. |

N.B. Conservation status indicated in column three is defined in Appendix A.3.

### 3.5.2 Database Records of Priority Flora Previously Recorded in the Chichester Deviation Area

Searches of the Department of Environment and Water Resources' Protected Matters Database, and The DEC's Threatened Flora Database (DEFL), Declared Rare Flora and Priority Flora Database (FloraBase), WA Herbarium Database (WAHERB) were undertaken.

Search co-ordinates used to cover the project area were 21˚55'16.47" S, 112˚49'11.28" E (NW corner) and 22˚30'03.59" S, 119˚14'08.76" E (SE corner) (GDA94). This encompasses an area extending to 20 km either side of the rail line and to the north and south of Shaw and Cowra Sidings respectively.

These searches produced records for four Priority Flora taxa (11 records) from locations in the vicinity of the survey area (Table 3.9); these are marked by asterisks in Table 3.9.

### 3.5.3 Declared Rare and Priority Flora Recorded during Surveys Undertaken in the vicinity of the Chichester Deviation Survey Area

An additional six Priority Flora species have been recorded during other flora and vegetation surveys associated with projects in the vicinity of the survey area and these have been included in Table 3.9.

**Table 3.9 – Priority Flora recorded in the vicinity of the Chichester Deviation project area**

| Conservation Status | Species | Seasonality | Area Found | Non DEC Survey Record | DEC Record |
|---|---|---|---|---|---|
| **P1** | *Eremophila spongiocarpa* | Perennial | Immediately north of Cowra Camp | Biota, 2004a | * |
| | *Josephinia* ?sp. Marandoo | Weakly perennial | 5 km north of Cowra Camp | Biota, 2004a | |
| **P2** | *Ischaemum albovillosum* | Perennial | Adjacent to Shaw Siding | Biota, 2004a | * |
| | *Paspalidium retiglume* | Annual | Adjacent to Shaw Siding | Biota, 2004a | |
| | *Scaevola* sp. Hamersley Range basalts | Perennial | 6 km west of the survey area | *ecologia*, 2005 | |
| **P3** | *Goodenia nuda* | Annual | Vicinity of the survey area | Biota & Trudgen, 2002 | |
| | *Hibiscus brachysiphonius* | Perennial | Adjacent to Shaw Siding, Quarry 8 | Biota, 2004a; *ecologia*, 2008d; | * |

| Conservation Status | Species | Seasonality | Area Found | Non DEC Survey Record | DEC Record |
|---|---|---|---|---|---|
| | | | | *ecologia*, 2008d | |
| | *Polymeria* sp. Hamersley | Weakly perennial | 8 km north of Cowra Camp | Biota, 2004a | |
| | *Themeda* sp. Hamersley Station | Perennial | Adjacent to Shaw Siding | Biota, 2004a | |
| **P4** | *Eremophila youngii* subsp. *lepidota* | Perennial | 2.5 km north-west of Cowra Camp | N/A | * |

N.B. Conservation status indicated in column one is defined in Appendix A.3.

### 3.5.4 Rare and Priority Flora Recorded During the Current Survey

No Declared Rare Flora (DRF) taxa were collected during the Chichester Deviation survey. One Priority Flora taxon, *Goodenia nuda* (Priority 3), was collected during the current survey.

#### *Goodenia nuda* (Goodeniaceae) - Priority 3

*Goodenia nuda* is an erect to ascending annual herb that grows to 0.5 m tall and produces yellow flowers from April to August (Western Australian Herbarium, 2008). *G. nuda* is usually found in dry scoured river beds, spinifex grassland or mulga scrub (Plate 3.4).

Thirteen records are currently listed for this species on FloraBase and a selection of these records includes locations at Weeli Wolli Creek, Roy Hill, Wittenoom, Mulga Downs, Marillana Creek and Yandi (Western Australian Herbarium, 2008).

The populations found at each site were small (with a cover of less than 10%), and at one site there were fewer than 10 plants. As a Priority 3 taxon, its conservation status is defined as “poorly known, from several populations, at least some of which are not believed to be under any immediate threat, either due to the number of known populations (generally greater than five) or known populations being large and either widespread or protected” (Western Australian Herbarium, 2008).

*Goodenia nuda* was recorded at five sites during the phase 2 survey of the area (R26, R34, 21, 26 and 34). These sites were in areas with higher water availability associated with gullies, creeks and minor channels and four of the five had been burnt in November 2007. The sites occur in one of the mapped vegetation units, associated with the creek lines of the Chichester Ranges and two of the sub-units; 7b) *Petalostylis labicheoides* and mixed *Acacia* spp. high shrubland and 7c) *Corymbia* spp. and *Hakea chordophylla* low open woodland. Their locations are mapped and listed in Appendix A.5.

**Plate 3.4 – *Goodenia nuda* (Priority 3)**

Voucher forms for the Priority Flora specimens collected at the Chichester Deviation survey area are included as Appendix A.6.

## 3.6 OTHER FLORA TAXA OF CONSERVATION INTEREST

Some genera occurring in the Pilbara are poorly collected and described and as a consequence a number of taxa cannot be identified to species level, despite the plant specimen usually being adequate. These plants are assigned as having an affinity (*aff*.) with another species if they are similar to them. Eight taxa collected during the survey were identified as having an affinity with another species; *Acacia* aff*. ayersiana* (MET 16 088), *Acacia* aff*. ayersiana* (narrow form; MET 15,786), *Eriachne* aff*. mucronata*, *Hybanthus* aff*. aurantiacus, Melhania* aff. *oblongifolia, Sida* aff. *echinocarpa* (MET 15,350), *Sida* aff*. fibulifera* and *Cucumis* aff. *maderaspatanus.*

## 3.7 INTRODUCED FLORA SPECIES

Weeds that are, or have the potential to become, pests to agriculture may be formally declared under the *Agriculture and Related Resources Protection Act, 1976* (ARRP Act). Declared Plants under this act are listed with Standard Control Codes that outline the requirements for their control. Five Priority groupings exist (P1, P2, P3, P4 or P5) and more than one Priority may be placed on a weed species. Landholders having declared weeds on their property are obliged to control them at their own expense, and are encouraged to follow the Standard Control Codes. Details of these codes are provided in Appendix A.3.

The Australian Weeds Strategy (2007) defines a weed as “a plant which has, or has the potential to have, a detrimental effect on economic, social or conservation values”. Weeds that have proliferated in bushland without direct human intervention or assistance are also

referred to as naturalized alien species. A search was conducted of the list of Declared Plants under the ARRP Act for any declared weed species that potentially could be found within the project area. The search identified five Declared Plants; *Opuntia* spp. (P1, P2, P4), **Parkinsonia aculeata* (P1, P2), *Prosopis* spp. (P1, P3, P4), **Salvinia molesta* (P1, P2) and **Tamarix aphylla* (P1) that could potentially occur in the East Pilbara, and a search of the Western Australian Herbarium database for weeds occurring in the Pilbara region confirmed that they have been recorded in the area (Western Australian Herbarium, 2008).

One declared weed, **Tamarix aphylla,* has been recorded south of the survey area at the proposed Cowra Camp (*ecologia*, 2007a); however, no declared weeds were recorded during the survey.

Ninety species of naturalized alien flora are currently known to occur in the Pilbara region and of these, 18 species have been collected in previous work carried out by *ecologia* in the vicinity of this section of the rail line (**Acetosa vesicaria, *Aerva javanica*, **Argemone ochroleuca, *Bidens bipinnata*, **Cenchrus ciliaris, *Cenchrus setiger, *Citrullus colocynthis, *Cucumis melo, *Cynodon dactylon, *Digitaria ciliaris, *Echinochloa colona *Malvastrum americanum, *Passiflora foetida, *Portulaca oleracea *Setaria verticillata*, **Sonchus oleraceus, *Tribulus terrestris* and **Vachellia farnesiana*). These weeds are not listed as declared plants; however, they can pose a threat to indigenous biota. For this reason populations should be carefully managed to contain them to their present occurrences and prevent their proliferation.

A combined total of six general weed species was recorded during the two phases of the survey. Five were recorded during phase 1 of the survey - **Aerva javanica* (at one location), **Bidens bipinnata* (at three locations), **Cenchrus ciliaris* (at one location), **Malvastrum americanum* (at three locations) and **Vachellia farnesiana* (at two locations) - and five during phase two - **B. bipinnata* (at 11 locations), **C. ciliaris* (at 12 locations), **Cucumis melo* subsp. *agrestis* (at one location), **M. americanum* (at nine locations) and **V. farnesiana* (at two locations). These weed species are described below. Information on each one has been sourced from FloraBase (Western Australian Herbarium, 2008) and Hussey *et al*. (1997). The locations of all weed species collected during the survey are shown and listed in Appendix A.5.

### ***Aerva javanica* (Kapok Bush), Amaranthaceae**

**Aerva javanica* is an erect, multi-branched, perennial herb growing to 1.6 m high. It grows on sandy soils along drainage lines, and produces white flowers from January to October. This species has a greyish appearance due to a dense coverage of short, branched hairs (Plate 3.5). Native to northern Africa and south west Asia, Kapok Bush was originally introduced to Western Australia to assist with the revegetation of degraded rangelands. However, it is now widespread in many vegetation types from Carnarvon to the Kimberley. **Aerva javanica* was recorded at one location in the survey area, and there were less than 10 plants.

**Plate 3.5 – *Aerva javanica***

### ****Bidens bipinnata* (Bipinnate Beggartick), Asteraceae**

***Bidens bipinnata* is an erect, annual herb, growing from 0.1 to 0.9 m in height (Plate 3.6). Its flowers are yellow and are produced from March to September. It is commonly found in alluvium, clay, loam over sandstone, limestone and along rivers, creeks, coastal areas and rocky hillsides. **B. bipinnata* is found throughout the northern end of Western Australia, including Kalbarri, Newman and the Kimberley. **B. bipinnata* was recorded at 14 locations in the survey area, generally at a sparse (< 2%) cover, reaching to 10 – 30% in some areas.

**Plate 3.6 – *Bidens bipinnata***

### ****Cenchrus ciliaris* (Buffel Grass), Poaceae**

**Cenchrus ciliaris* is a tufted, perennial grass growing to 1 m in height (Plate 3.7). It was widely planted in pastoral regions as a pasture grass, and has since become a widespread weed of roadsides, creeklines, river edges and most vegetation types from Shark Bay to the Pilbara and adjacent desert. **C. ciliaris* is native to Africa and India and continues to spread throughout the state both naturally and through deliberate establishment. **C. ciliaris* was the most widespread weed recorded at 14 locations in the survey area. Its cover was sparse to open (between 2 – 30 %).

**Plate 3.7 – *Cenchrus ciliaris***

### ****Cucumis melo* subsp. *agrestis* (Ulcardo Melon), Cucurbitaceae**

**Cucumis melo* subsp. *agrestis* is a trailing annual herb or climber. Its yellow flowers are produced from February to June and September to October. It is distributed widely throughout Western Australia. **C. melo* subsp. *agrestis* was recorded (< 10 plants) at one location in the survey area.

### ***Malvastrum americanum* (Spiked Malvastrum), Malvaceae**

**Malvastrum americanum* (Plate 3.8) is an erect, hairy, perennial herb or shrub growing to between 0.5 and 1.3 m in height. Native to America, **M. americanum* is a weed of river and creek margins, wastelands, and many arid zone habitats from the Nullarbor to the Pilbara and Kimberley Regions of Western Australia. **M. americanum* was recorded at 12 locations in the survey area, each at a sparse (< 2 %) cover.

**Plate 3.8 – *Malvastrum americanum***

### ***Vachellia farnesiana* (Mimosa Bush), Mimosaceae**

**Vachellia farnesiana* is an erect, spreading, thicket-forming, thorny tree or shrub growing to 4 m in height (Plate 3.9). Its bark is dark grey and rough. Its leaves are pinnate while its flowers are yellow and are produced from June to August. Mimosa bush is common in low-lying areas, river and creek banks and disturbed sites. It is widely distributed in Western Australia, particularly west of a line linking between Perth and Halls Creek. **Vachellia farnesiana* was recorded at four locations in the survey area, each record was for less than 10 individuals.

**Plate 3.9 – *Vachellia farnesiana***

# 4 CONSERVATION SIGNIFICANCE

The significance of the biota of the project area has been assessed at four spatial scales; national, state, regional and local.

## 4.1 NATIONAL SIGNIFICANCE

National significance refers to those features of the environment which are recognised under legislation as being of importance to the Australian community. Flora species and TECs listed under the EPBC Act are regarded as nationally significant.

### 4.1.1 Vegetation and Flora

No flora species or TECs of national significance were recorded during the vegetation and flora survey at the project area.

## 4.2 STATE SIGNIFICANCE

State significance refers to those features of the environment that are recognised under State legislation as being of importance to the Western Australian community, in particular, species scheduled/listed as rare flora under the WC Act.

### 4.2.1 Vegetation and Flora

No TECs or DRF of State significance were recorded in the project area. One Priority 3(iii) State listed PEC "Plant Assemblages of the Wona Land System" occurs in the survey area and is of State significance.

## 4.3 REGIONAL SIGNIFICANCE

Regional significance addresses the representation of species and habitats at a biogeographic regional level. Species or habitat types that are endemic to the Pilbara Bioregion and whose distributions are limited or unknown are considered regionally significant.

### 4.3.1 Vegetation

The conservation significance of the vegetation of the region has been assessed based upon three sources of information: land systems of the survey area, Beard's vegetation mapping of the survey area and the mapping of vegetation along other proposed rail corridors in the area.

**Land Systems Analysis**

The survey area crosses the Capricorn, Christmas, Jamindie, McKay, Newman and Wona Land Systems. An estimated percentage impact to each of these land systems has been calculated using the length of the corridor in each and a 200 m wide lease.

Approximately 1.8 km of the Chichester Deviation corridor crosses the eastern portion of the **Christmas Land System** (232 $km^2$). This is a small, single unit land system and because of this it has high regional conservation significance. Based on a 200 m wide corridor, potential

impact to this land system would be 0.155%. However, 0.66 km of the proposed Chichester Deviation corridor coincides with the existing Mainline corridor that crosses the Christmas Land System and 1.14 km is new corridor. Therefore potential impact to the Christmas Land System would be 0.057% along the existing Mainline corridor and 0.098% along the new Chichester Deviation corridor. The vegetation of the corridor in this land system was mapped as one unit - *Acacia aneura* var. *aneura* high scrubland on the hardpan plains (mapped as Unit 3); which is similar to that mapped in the Christmas Land System in the inventory and condition survey of the Pilbara.

The **Jamindie Land System** is of moderate size (2,074 km$^2$). Approximately 4.3 km of the survey area passes through the centre of the wide, northern (Fortescue Valley) band of this land system. Maximum impact to this land system from the construction of the new rail corridor would be 0.041%. The vegetation in the rail corridor running through this land system was mapped into a number of different units (3, 4, 5, 6 and 7) including large areas of mulga shrubland, units associated with hillslopes and their drainage lines and flat plains, and large drainage lines; because of this diversity the land system is ranked as having moderate to high regional conservation significance.

The **Newman Land System** is the second largest in the Pilbara region (14,580 km$^2$) and a narrow band of it is mapped through the Chichester Range. Approximately 6.2 km of the Chichester Deviation will cross the centre of this band and will impact 0.009% of the land system. Four vegetation units were mapped in this land system (3, 7, 8 and 9) and these were – *Acacia aneura* low woodland on the clay flats, *Eucalyptus leucophloia* subsp. *leucophloia* low woodland, over a *Triodia basedowii* hummock grassland on the hill slopes (Unit 8); scattered *Eucalyptus victrix* medium to low trees, over *Petalostylis labicheoides, Grevillea wickhamii* subsp. *aprica* open low heath, over a mixed tussock grassland in creeklines (Unit 7); and, mixed *Acacia* spp. open heath, over open *Triodia pungens* hummock grassland on rocky drainage channels (Unit 9).

Given the large area of the Newman Land System and the relatively common vegetation units mapped in it, it is considered to have low regional conservation significance.

The **McKay Land System** (4,202 km$^2$) is mapped over the hilly areas of the Chichester Deviation project area. It is distributed quite widely to the east and west of the Pilbara region and to a lesser extent to the north and south. A section of the proposed Chichester Deviation crosses a northerly area of this land system. Five vegetation units were mapped in this section of the corridor (2, 3, 4, 7 and 8). The 6.8 km of proposed rail corridor will affect 0.032% of this land system. Given the large area of this land system, the relatively common vegetation units occurring within it and the low impact level, this land system has low regional conservation value.

The **Capricorn Land System** (5,296 km$^2$) occurs in the northern hilly areas of the Chichester Range. This land system is moderately sized and is distributed quite widely in the Pilbara. The proposed Chichester Deviation crosses an isolated section of this land system and three vegetation units were mapped within it (7, 8 and 9). The 0.9 km of proposed rail line through this land system will affect 0.003% of the total area of the Capricorn Land System. As the proposed impact to this land system is the lowest calculated for all land systems that the Deviation rail corridor traverses, and the vegetation units and habitats mapped as occurring within it are quite common, it is rated as having low regional conservation significance.

The gilgai plains in the northern section of the rail corridor occur in the **Wona Land System**. This is a relatively small land system (1,815 km$^2$) that trends northwest - southeast through the western to central areas of the Pilbara. The Chichester Deviation survey area occurs in the largest discrete block of this land system, almost at its easternmost extent. The 2.9 km of rail corridor that crosses through the land system will potentially impact 0.032% of its total area in the Pilbara. The vegetation in the area was mapped as three units (1, 2 and 7) - the

largest of these were: *Astrebla pectinata* tussock grassland on the gilgai plains (1) and *Acacia xiphophylla* open scrubland on the gilgai drainage areas (2).

The Wona Land System has been listed as a Priority 3(iii) PEC and therefore has high conservation significance. While the proportion of this land system to be impacted is comparatively low, this impact is further divided between the Mainline rail corridor (0.017%), which is already impacted by the existing rail line and access track, and the new Chichester Deviation corridor (0.015%).

**Beard Mapping Analysis**

The survey area (approximately 23 km) lies in the Chichester Plateau subdivision of Beard's Fortescue Botanical District. This area was mapped by Beard as Savanna or bunch grassland (xGc), shrub steppe on basalt with grassy flats ($a_2$Sr.$t_1$ or $_3$Hi) and tree steppe with mulga in valleys ($e_{16}$Lr.$t_3$Hi/$a_1$Li).

The northern section of the survey area occurs on Beard's savanna bunch grassland (indicated by 'a' in Figure 3.2) and is an area of cracking clays; it is mapped as Vegetation Units 1, 2 and 7 in this report. Beard mapped a number of areas of bunch grass trending in a line mostly northwest of the survey area. The Chichester Deviation corridor intersects a small section of one of these areas. They are not as large as other vegetation units mapped by Beard, and because of this could be considered to be of medium conservation significance.

The area of the rail corridor where Beard's "shrub steppe on basalt with grassy flats" occurs (indicated by 'b' in Figure 3.2) has been mapped as six main vegetation units during this analysis (2, 3, 4, 7, 8 and 9; see Section 3.2.2 for full descriptions of these vegetation units). Large areas of this shrub steppe are mapped by Beard in the Pilbara Region and based on this the vegetation unit is not considered to be highly conservation significant. However the corridor occurs on the southern boundary of this unit's occurrence and could be viewed as being more significant because of this.

The majority of the survey area crosses through an area of Beard's tree steppe with mulga in valleys ((indicated by 'c' in Figure 3.2) and was mapped during this study as Vegetation Units 3,4, 7, 8 and 9; see Section 3.2.2 for full descriptions of these vegetation units). Beard maps large areas of tree steppe as occurring in the Pilbara Region and the project area is located at the centre of its distribution. Based on this, the vegetation in this section of the corridor would not be regarded as being of high conservation significance.

The section of the Chichester Deviation corridor within the "mulga in groved patterns" unit (indicated by 'd' on Figure 3.2) has been mapped as mostly comprising *Acacia aneura* low woodland (Unit 3), and smaller areas of *Acacia citrinoviridis* open low forest (Unit 5) and *Acacia citrinoviridis* and *Corymbia hamersleyana* low woodland (Unit 6). Beard mapped relatively large areas of mulga in groved patterns in the Pilbara but the project area sits almost at the northern-most extent of this unit and as such can be viewed as having moderate to high conservation significance.

**Analysis based on finer scale mapping carried out in the area**

FMG commissioned vegetation and flora surveys of its proposed Stage A and Stage B rail corridors in the Pilbara (Biota 2004a and b). The Stage A report includes mapping of the vegetation in the vicinity of the Chichester Deviation survey area, while the report produced for the Stage B Rail Corridor (Biota 2004b) includes an assessment of the regional significance of the vegetation units mapped during these and other surveys.

*ecologia* and Biota's mapping does not agree exactly. This is to be expected given the differences in the number of quadrats established through the survey area, the location of those quadrats and the method used for and interpretation of the statistical analyses of the data collected at the survey sites.

Four of the vegetation types identified as having high conservation significance by Biota (Cx4, Cx5, Ch9 and Ch10; Biota, 2004a) occur within the area surveyed by *ecologia*. Their conservation significance was rated as high for a number of reasons. These reasons included the following factors: they are probably uncommon in the region, have limited distribution and are probably restricted to the Chichester Range, they can be edaphically restricted, variable and support restricted flora including restricted mulga taxa (Biota, 2004a).

Two of the four (Cx4 and Cx5) – *Astrebla pectinata, Aristida latifolia* tussock grassland on gilgai plains and *Acacia xiphophylla* open to closed scrub over *Rhagodia eremaea* open shrubland on cracking clays - are similar to (but not exactly the same as) units described by *ecologia* as occurring in the same area – *Astrebla pectinata* tussock grassland on the gilgai plains (Unit 1) and *Acacia xiphophylla* open scrubland on the drainage areas of the gilgai plains (Unit 2). Differences in floristics probably reflect the positioning of quadrats in the heterogenous vegetation of the area.

Biota's vegetation types Ch9 (*Corymbia deserticola* scattered low trees over *Acacia aneura* high open shrubland over *Triodia lanigera* closed hummock grassland) and Ch10 (*Corymbia deserticola* scattered low trees over *Acacia aneura* high shrubland to low woodland over *Triodia lanigera* closed hummock grassland) were not mapped by *ecologia* even though 14 quadrats were assessed during the first phase of the survey in the general area where Ch9 and Ch10 were mapped. The vegetation types mapped by *ecologia* in the same areas included *Eucalyptus leucophloia* low woodland over *Triodia basedowii* hummock grassland on the hill slopes (Unit 8a) with patches of *Acacia aneura* low woodland (Unit 8b), and these vegetation types are not considered to be of high conservation value.

One area of vegetation mapped by *ecologia* was not common in the survey area – *Acacia ayersiana* and *Acacia aneura* low open forest on the drainage areas at the base of the footslope (Unit 4b). Two patches of this vegetation unit were mapped in the survey area and because of this it is considered to be locally conservation significant. In Biota's analysis of the regional vegetation for the Stage B project (2004b) this vegetation type is assessed as having moderate regional conservation significance.

### 4.3.2 Flora

As discussed in Section 3.5, one Priority Flora taxon of regional significance was recorded in the project area; *Goodenia nuda* (Priority 3).

Thirteen records are listed for *G. nuda* on FloraBase. Its distribution is relatively widespread, as it is found from the northern coastal area of the Pilbara, across the west to east Pilbara and south approximately 700 km to the Little Sandy Desert (Figure 4.1). In the current survey *G. nuda* was restricted to the moister habitats as discussed in Section 3.5.4. Current records on FloraBase indicate that *G. nuda's* habitat requirements are not this specific and plants have also been found in other habitats including spinifex grasslands, midslopes and mulga scrub. Because of this, the individuals recorded in the survey area are deemed to have a low to moderate regional conservation value.

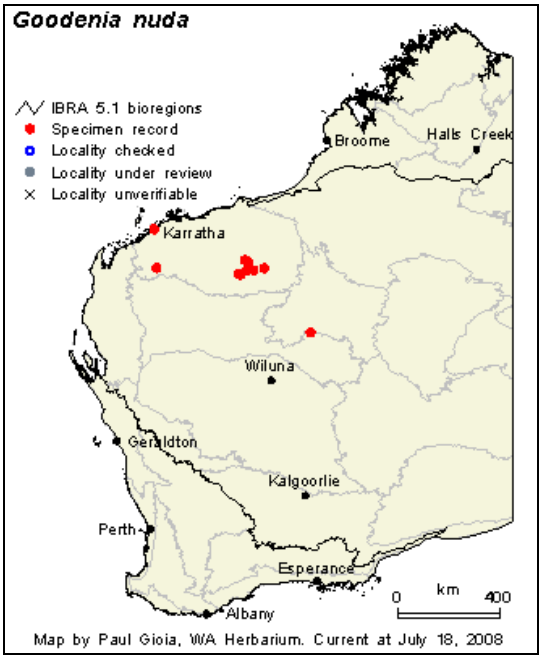


**Figure 4.1 – Distribution Range of *G. nuda* in Western Australia**

Mapping by Paul Gioia. Image used with the permission of the Western Australian Herbarium, Department of Environment and Conservation (http://florabase.dec.wa.gov.au/help/copyright). Accessed on Wednesday, 13 August 2008.

## 4.4 LOCAL SIGNIFICANCE

Species are of local significance when their presence is confined to a specialised habitat type that is not common within the local area and whose disturbance or removal may lead to local extinction.

### 4.4.1 Vegetation and Flora

Based on information presented in Section 4.3.1, vegetation units having high local conservation significance were the tussock grasslands (Unit 1) and *Acacia xiphophylla* scrubland on cracking clays (Unit 2) and the moderately dense *Acacia ayersiana* and *Acacia aneura* woodland (Unit 4b). Vegetation units 1 and 2 occur in the Wona Land System, which is a Priority 3(iii) PEC.

During the survey *G. nuda* was recorded at five locations (its cover ranging between 2 and 10%), the five collections were from drainage areas; gullies, creek beds and minor drainage channels. These habitats are not locally restricted and *G. nuda*'s distribution range is quite wide in the Pilbara. Because of this, if the individuals located during the Chichester Deviation survey were to be impacted, it is considered unlikely to lead to the local extinction of the species.

## 4.5 BIODIVERSITY

Australia has an international obligation to maintain biodiversity. The Commonwealth government has initiated the National Strategy for the Conservation of Biological Diversity, which incorporates elements of the National Strategy for Ecologically Sustainable Development (NSESD). Biological diversity (biodiversity) relates to the richness of the biota at a local, regional, state, national or even global level, and includes all components of the environment, from bacteria to insects, plants, and vertebrate fauna. Biodiversity can be thought of as existing at several levels, including genetic, population and species (or taxon)

diversity. This study examines biodiversity at the species and population level, and places it within a local, regional and national context.

# 5 ENVIRONMENTAL IMPACTS

Many of the vegetation associations, habitats and landforms found in the project area (and within the proposed disturbance footprint) are not considered to be of national, state, regional or local conservation significance and are well represented across the Pilbara Biogeographic Region. This implies that at a regional scale impact to most of the vegetation associations, habitat types and landforms found in the project area will not constitute a significant loss to biodiversity.

However, potential impacts of rail construction and associated activitites on vegetation and flora of the project area include:

- Impact to the Wona Land System, a Priority 3(iii) PEC;
- Impact to the perennial tussock grassland communities associated with the gilgai plains;
- Impact to the *Acacia xiphophylla* open scrubland on the gilgai plains;
- Impact to individuals of the Priority Three taxon *Goodenia nuda;*
- Impact to mulga units of the survey area;
- Impact to general vegetation and flora through clearing; and,
- Indirect impact to vegetation and flora from infrastructure and ongoing practices e.g. mulga degradation from alteration of surface water flow, dust from tracks, weed infestation and human activities.

Vegetation clearing can have direct and indirect effects on the vegetation and flora.

### Clearing: Direct loss of vegetation and flora

The most substantial environmental impacts arising from the proposed project would be the clearing of native vegetation, the potential loss of areas of the Wona Land System and associated vegetation, and the loss of individuals of the Priority Three taxon *Goodenia nuda*.

The two vegetation units having highest conservation value occur in the north of the proposed corridor on the flat gilgai plains of the Wona Land System. The currently indicated rail line alignment should not directly impact the *Acacia xiphophylla* open scrubland (Unit 2), and a relatively short length of new rail line (1.4 km) is planned to go through new areas of the tussock grassland on the gilgai flats and plains (Unit 1), as approximately 1.5 km of the Chichester Deviation overlaps the existing rail corridor and predicted impact in this area is an overestimate of the probable impact.

Clearing of vegetation in the Christmas and Jamindie Land Systems will impact these relatively small land systems. Impact to each is calculated to be 0.155% and 0.041% of currently mapped areas (respectively). Also, the calculated impact to the Christmas Land System will probably be less than the predicted 0.155%, as 0.7 km of the 1.8 km of the Deviation rail corridor crossing this land system coincides with the existing Mainline corridor that is already impacted by the existing rail line and associated tracks.

The moderately dense mixed *Acacia ayersiana* and *Acacia aneura* woodland over varying shrubs and grasses (Unit 4b), which is of moderate conservation significance occurs in two patches. The smaller of these two patches should not be impacted by the rail corridor while a narrow section of the second and larger patch of this vegetation unit is crossed in the southern section of the Chichester Deviation corridor.

**Clearing: Indirect loss of vegetation and flora**

Flora habitats can be impacted indirectly by increased activity in an area leading to increased dust, fire and the introduction and/or spread of weeds.

Implementation of the project has the potential to introduce new weed species or spread weed species already in the area. Six general environmental weeds, with potential to spread were recorded during survey, these were: **Aerva javanica* (Kapok Bush), **Bidens bipinnata* (Bipinnate Beggartick), **Cenchrus ciliaris* (Buffel Grass), **Cucumis melo* subsp. *agrestis* (Ulcardo Melon*), *Malvastrum americanum* (Spiked Malvastrum) and **Vachellia farnesiana* (Mimosa Bush).

Another potential indirect impact of the rail road construction is disturbance to surface hydrology. Surface water flow is important for stands of mulga and as a result, the construction of the railroad through the Chichester Range may have an adverse effect on these communities; this will need to be managed appropriately.

Dust degradation of native vegetation may occur with increased vehicular traffic and will need to be managed appropriately.

# 6 MANAGEMENT RECOMMENDATIONS

## DESIGN LEVEL

### RECOMMENDATION 1

Minimise impact to the Plant Assemblages of the Wona Land System, especially where the new section of the corridor is to be constructed.

### RECOMMENDATION 2

Vegetation clearing and earth works should be carried out at an appropriate time of year to minimise deterioration in surface water flow and/or appropriate soil stabilisation methods should be used in areas where increased sedimentation could be expected.

Culverts and bridges should be constructed as necessary to maintain surface water flow to vegetation (particularly mulga) down stream of the proposed rail corridor.

### RECOMMENDATION 3

Borrow areas should be surveyed for rare and priority flora before clearing commences.

### RECOMMENDATION 4

Minimise vegetation clearing to that which is absolutely necessary.

### RECOMMENDATION 5

In areas allocated for temporary clearing and rehabilitation, minimise the amount of topsoil removed when clearing vegetation. Minimal topsoil disturbance will encourage natural regeneration due to retention of the seed store and microbiological activity, which is largely confined to the topsoil. Achieving minimum disturbance will also discourage weeds and other species which proliferate following disturbance.

### RECOMMENDATION 6

Minimise the height of stockpiles of soil and cleared vegetation. Multiple smaller stockpiles, dispersed at regular intervals along the length of the edges of cleared areas, are preferable to a single stockpile. Lower stockpiles allow greater retention of biological activity within the soil (bacteria, fungi and lichen), which improves seed germination rates once the soil is reused.

### RECOMMENDATION 7

Rehabilitate any areas that have been impacted by earthworks but are not needed for long-term infrastructure as soon as practicable after completion of works. This will promote soil stabilisation by plant roots and help to discourage weed proliferation in these areas.

### RECOMMENDATION 8

Avoid or minimise disturbance to vegetation associated with drainage lines whenever possible. Removing vegetation associated with drainage lines can lead to the accelerated erosion of soil or the alteration of surface water flow.

### RECOMMENDATION 9

Avoid disturbance of significant fauna habitat. Including impact to living and dead standing trees, fallen logs and rock material should be minimised whenever possible.

**MANAGEMENT LEVEL**

**RECOMMENDATION 10**

Implement existing environmental procedures for staff and contractors. These include, but are not limited to, managing the risk of fire, the spread of weeds and encouraging general environmental impact awareness.

# 7 STUDY TEAM

The survey described in this document was planned, coordinated and executed by:

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WEST PERTH WA 6005

| **Project Staff** | | |
|---|---|---|
| Christina Cox | BSc. (Honours), PhD | Manager Botany |
| Melissa Hay | BSc. (Honours) | Botanist |
| Jeremy Naaykens | BSc. (Honours) | Botanist |
| Joshua Gilovitz | BSc. (Honours) | Botanist |
| Zoe Benham | BSc. (Honours) | Botanist |
| Marisa Fulton | BSc. | Botanist |
| Sharnya Thomson | BSc. (Honours) | Plant Taxonomist |

| **Licences - "Licence to take flora for scientific purposes"** | | |
|---|---|---|
| These surveys were conducted under the authorisation of the following licences issued by the Department of Environment and Conservation: | | |
| | **Permit Number** | **Valid Until** |
| Jeremy Naaykens | SL007795 | 30th April 2009 |
| Melissa Hay | SL007712/SL008100 | 30th April 2009 |
| Joshua Gilovitz | SL008094 | 30th April 2009 |

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## A.1 SITE INFORMATION (TO BE INCLUDED ELECTRONICALLY)

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## A.2 VEGETATION STRUCTURAL TABLE USED IN VEGETATION DESCRIPTIONS

**Vegetation structure**

| Life form and height | Foliage cover as % | Description |
|---|---|---|
| **Trees over 30 metres** | 70 -100 | High closed forest |
| | 30 -70 | High open forest |
| | 10 - 30 | High woodland |
| | 2 -10 | High open woodland |
| | under 2 | Scattered tall trees |
| **Trees 10 - 30 metres** | 70 -100 | Closed forest |
| | 30 -70 | Open forest |
| | 10 - 30 | Woodland |
| | 2 -10 | Open woodland |
| | under 2 | Scattered trees |
| **Trees under 10 metres** | 70 -100 | Low closed forest |
| | 30 - 70 | Low open forest |
| | 10 - 30 | Low woodland |
| | 2 -10 | Low open woodland |
| | under 2 | Scattered low trees |
| **Shrubs over 2 metres** | 70 - 100 | Closed scrub |
| | 30 - 70 | Open scrub |
| | 10 - 30 | High shrubland |
| | 2 -10 | High open shrubland |
| | under 2 | Scattered tall shrubs |
| **Shrubs 1 - 2 metres** | 70 - 100 | Closed heath |
| | 30 - 70 | Open heath |
| | 10 - 30 | Shrubland |
| | 2 -10 | Open shrubland |
| | under 2 | Scattered shrubs |
| **Shrubs under 1 metre** | 70 - 100 | Low closed heath |
| | 30 - 70 | Low open heath |
| | 10 - 30 | Low shrubland |
| | 2 -10 | Low open shrubland |
| | under 2 | Low scattered shrubs |
| **Herbs/Sedges/Grasses** | 70 - 100 | Closed herb, sedge, grassland |
| | 30 - 70 | Herb, sedge, grassland |
| | 10 - 30 | Open herb, sedge, grassland |
| | 2 -10 | Very open herb, sedge, g'land |
| | under 2 | Scattered herbs sedges, grasses |

**Grasslands are then divided into:**

- Tussock grasslands (perennial tussock species, e.g. *Eragrostis* species).
- Hummock grasslands (Triodia and *Plectrachne* species that form hummocks).
- Curly spinifex grassland (*Plectrachne pungens*, which does not form hummocks).
- Annual tussock grassland (e.g. annual *Sorghum species*).

## A.3 CONSERVATION SIGNIFICANCE AND WEED CODES

**Explanation of codes for Threatened Ecological Communities (TEC)**

| Code | Definition |
|---|---|
| PD: Presumed Totally Destroyed | An ecological community that has been adequately searched for but for which no representative occurrences have been located. The community has been found to be totally destroyed or so extensively modified throughout its range that no occurrence of it is likely to recover its species composition and/or structure in the foreseeable future. An ecological community will be listed as presumed totally destroyed if there are no recent records of the community being extant |
| CR: Critically Endangered | An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or that was originally of limited distribution and is facing severe modification or destruction throughout its range in the immediate future, or is already severely degraded throughout its range but capable of being substantially restored or rehabilitated. An ecological community will be listed as *Critically Endangered* when it has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future. |
| EN: Endangered | An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or was originally of limited distribution and is in danger of significant modification throughout its range or severe modification or destruction over most of its range in the near future. An ecological community will be listed as *Endangered* when it has been adequately surveyed and is not Critically Endangered but is facing a very high risk of total destruction in the near future. |
| VU: Vulnerable | An ecological community that has been adequately surveyed and is found to be declining and/or has declined in distribution and/or condition and whose ultimate security has not yet been assured and/or a community that is still widespread but is believed likely to move into a category of higher threat in the near future if threatening processes continue or begin operating throughout its range. An ecological community will be listed as *Vulnerable* when it has been adequately surveyed and is not Critically Endangered or Endangered but is facing a high risk of total destruction or significant modification in the medium to long-term future. |

**Explanation of codes for Priority Ecological Communities (PEC)**

| Code | Definition |
|---|---|
| P1: Priority One | Ecological communities with apparently few, small occurrences, all or most not actively managed for conservation (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) and for which current threats exist. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range. |
| P2: Priority Two | Communities that are known from few small occurrences, all or most of which are actively managed for conservation (e.g. within national parks, conservation parks, nature reserves, State forest, unallocated Crown land, water reserves, etc.) and not under imminent threat of destruction or degradation. Communities may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under threat from known threatening processes. |
| P3: Priority Three | (i) Communities that are known from several to many occurrences, a |

| Code | Definition |
|---|---|
| | significant number or area of which are not under threat of habitat destruction or degradation or:<br>(ii) Communities known from a few widespread occurrences, which are either large or within significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat, or;<br>(iii) Communities made up of large, and/or widespread occurrences, that may or not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, and inappropriate fire regimes.<br>Communities may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and/or are not well defined, and known threatening processes exist that could affect them. |
| P4: Priority Four | Ecological communities that are adequately known, *Rare* but not threatened or meet criteria for *Near Threatened*, or that have been recently removed from the threatened list. These communities require regular monitoring.<br>(a) *Rare*. Ecological communities known from few occurrences that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These communities are usually represented on conservation lands.<br>(b) *Near Threatened*. Ecological communities that are considered to have been adequately surveyed and that do not qualify for *Conservation Dependent*, but that are close to qualifying for *Vulnerable*.<br>(c) Ecological communities that have been removed from the list of threatened communities during the past five years. |
| P5: Priority Five | Ecological communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years. |

**Definition of threatened flora species categories under the EPBC Act**

| Conservation Category | Description |
|---|---|
| Extinct | A species is extinct if there is no reasonable doubt that the last member of the species has died. |
| Extinct in the wild | A species is categorized as extinct in the wild if it is only known to survive in cultivation, in captivity or as a naturalized population well outside its past range; or if it has not been recorded in its known/expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form. |
| Critically Endangered | The species is facing an extremely high risk of extinction in the wild in the immediate future. |
| Endangered | The species is likely to become extinct unless the circumstances and factors threatening its abundance, survival or evolutionary development cease to operate; or its numbers have been reduced to such a critical level, or its habitats have been so drastically reduced, that it is in immediate danger of extinction. |
| Vulnerable | Within the next 25 years, the species is likely to become endangered unless the circumstances and factors threatening its abundance, survival or evolutionary development cease to operate. |

| Conservation Category | Description |
|---|---|
| Conservation Dependent | The species is the focus of a specific conservation program, the cessation of which would result in the species becoming vulnerable, endangered or critically endangered within a period of 5 years. |

**Definition of Declared Rare and Priority Flora categories**

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

**Control codes for Declared Weeds in Western Australia**

| Priority | Requirements |
|---|---|
| P1<br>Prohibits movement | The movement of plants or their seeds is prohibited within the State. This prohibits the movement of contaminated machinery and produce including livestock and fodder. |
| P2<br>Aim is to eradicate infestation | Treat all plants to destroy and prevent propagation each year until no plants remain. The infested area must be managed in such a way that prevents the spread of seed or plant parts on or in livestock, fodder, grain, vehicles and/or machinery. |
| P3<br>Aims to control infestation by reducing area and/or density of infestation | The infested area must be managed in such a way that prevents the spread of seed or plant parts within and from the property on or in livestock, fodder, grain, vehicles and/or machinery.<br><br>Treat to destroy and prevent seed set for all plants:-<br>Within 100 metres inside of the boundaries of the infestation.<br>Within 50 metres of roads and high-water mark on waterways.<br>Within 50 metres of sheds, stock yards and houses.<br>Treatment must be done prior to seed set each year.<br><br>Of the remaining infested area:- |

| Priority | Requirements |
|---|---|
| | Where plant density is 1-10 per hectare treat 100% of infestation.<br>Where plant density is 11-100 per hectare treat 50% of infestation.<br>Where plant density is 101-1000 per hectare treat 10% of infestation.<br><br>Properties with less than 2 hectares of infestation must treat the entire infestation.<br><br>Additional areas may be ordered to be treated. |
| P4<br>Aims to prevent infestation spreading beyond existing boundaries of infestation | The infested area must be managed in such a way that prevents the spread of seed or plant parts within and from the property on or in livestock, fodder, grain, vehicles and/or machinery.<br><br>Treat to destroy and prevent seed set all plants:-<br>Within 100 metres inside of the boundaries of the infested property<br>Within 50 metres of roads and high-water mark on waterways<br>Within 50 metres of sheds, stock yards and houses<br>Treatment must be done prior to seed set each year. Properties with less than 2 hectares of infestation must treat the entire infestation.<br><br>Additional areas may be ordered to be treated.<br><br>Special considerations<br>In the case of P4 infestations where they continue across property boundaries there is no requirement to treat the relevant part of the property boundaries as long as the boundaries of the infestation as a whole are treated. There must be agreement between neighbours in relation to the treatment of these areas. |
| P5 | Infestations on public lands must be controlled. |

## A.4 FLORA RECORDED DURING THE CHICHESTER DEVIATION SURVEY

| FAMILY | NAME | Phase 1 | Phase 2 |
|---|---|---|---|
| Acanthaceae | *Dicladanthera forrestii* | ● | ● |
| Adiantaceae | *Cheilanthes sieberi* subsp. *sieberi* | ● | ● |
| Aizoaceae | *Trianthema glossostigma* | | ● |
| Amaranthaceae | ****Aerva javanica*** | ● | |
| | *Alternanthera nana* | | ● |
| | *Gomphrena cunninghamii* | | ● |
| | *Gomphrena kanisii* | | ● |
| | *Ptilotus astrolasius* var. *astrolasius* | ● | ● |
| | *Ptilotus auriculifolius* | | ● |
| | *Ptilotus calostachyus* var. *calostachyus* | ● | ● |
| | *Ptilotus clementii* | ● | ● |
| | *Ptilotus exaltatus* var. *exaltatus* | ● | ● |
| | *Ptilotus fusiformis* var. *fusiformis* | | ● |
| | *Ptilotus gomphrenoides* | ● | ● |
| | *Ptilotus incanus* var. *incanus* | | ● |
| | *Ptilotus obovatus* var. *obovatus* | ● | ● |
| | *Ptilotus polystachyus* var. *polystachyus* | ● | |
| | *Ptilotus rotundifolius* | ● | ● |
| | *Ptilotus schwartzii* | ● | ● |
| Apiaceae | *Trachymene oleracea* subsp. *oleracea* | ● | ● |
| Apocynaceae | *Carissa ?lanceolata* | | ● |
| Asclepiadaceae | *Sarcostemma viminale* subsp. *australe* | | ● |
| Asteraceae | ****Bidens bipinnata*** | ● | ● |
| | *Centipeda minima* subsp. *macrocephalus* | ● | |
| | *Flaveria australasica* | ● | |
| | *Leiocarpa semicalva* subsp. *semicalva* | | ● |
| | *Pluchea dentex* | ● | ● |
| | *Pluchea dunlopii* | ● | |
| | *Pluchea rubelliflora* | ● | |
| | *Pluchea tetranthera* | ● | ● |
| | *Pterocaulon sphaeranthoides* | ● | ● |
| | *Rutidosis helichrysoides* subsp. *helichrysoides* | ● | ● |
| | *Streptoglossa bubakii* | ● | ● |
| | *Streptoglossa decurrens* | ● | ● |
| | *Streptoglossa tenuiflora* | | ● |
| | *Vittadinia obovata* | ● | |
| Boraginaceae | *Ehretia saligna* | ● | ● |
| | *Heliotropium cunninghamii* | | ● |
| | *Heliotropium inexplicitum* | | ● |
| | *Heliotropium tenuifolium* | | ● |
| | *Trichodesma zeylanicum* | ● | |
| | *Trichodesma zeylanicum* var. *zeylanicum* | | ● |
| Caesalpiniaceae | *Petalostylis labicheoides* | ● | ● |
| | *Senna artemisioides* subsp. *helmsii* | ● | ● |
| | *Senna artemisioides* subsp. *oligophylla* | ● | ● |
| | *Senna artemisioides* subsp. *oligophylla* x *helmsii* | ● | ● |
| | *Senna artemisioides* subsp. x *artemisioides* | ● | |
| | *Senna glaucifolia* | ● | ● |
| | *Senna glutinosa* subsp. *glutinosa* | ● | ● |

| FAMILY | NAME | Phase 1 | Phase 2 |
|---|---|---|---|
| Caesalpiniaceae Continued | *Senna glutinosa* subsp. *pruinosa* | ● | ● |
| | *Senna glutinosa* subsp. *pruinosa* x *glutinosa* | | ● |
| | *Senna glutinosa* subsp. x *luerssenii* | ● | ● |
| | *Senna notabilis* | ● | ● |
| | *Senna sericea* | ● | |
| | *Senna ?stricta* | | ● |
| Capparaceae | *Capparis lasiantha* | ● | |
| | *Capparis spinosa* var. *nummularia* | ● | |
| | *Capparis umbonata* | ● | ● |
| | *Cleome viscosa* | ● | ● |
| Caryophyllaceae | *Polycarpaea corymbosa* var. *corymbosa* | | ● |
| | *Polycarpaea holtzei* | | ● |
| | *Polycarpaea longiflora* | ● | ● |
| Celastraceae | *Maytenus* sp. *Mt Windell* (S. van Leeuwen 846) | | ● |
| Chenopodiaceae | *Atriplex amnicola* | ● | |
| | *Dysphania kalpari* | ● | |
| | *Dysphania rhadinostachya* subsp. *rhadinostachya* | ● | ● |
| | *Enchylaena tomentosa* var. *tomentosa* | ● | |
| | *Maireana planifolia* | ● | ● |
| | *Maireana* sp. | ● | ● |
| | *Maireana villosa* | ● | ● |
| | *Rhagodia eremaea* | ● | ● |
| | *Salsola australis* | ● | ● |
| | *Salsola tragus* subsp. *tragus* | ● | |
| | *Sclerolaena cornishiana* | ● | ● |
| Commelinaceae | *Commelina ensifolia* | | ● |
| Convolvulaceae | *Bonamia media* var. *villosa* | | ● |
| | *Bonamia rosea* | ● | ● |
| | *Duperreya commixta* | ● | ● |
| | *Evolvulus alsinoides* var. *decumbens* | | ● |
| | *Evolvulus alsinoides* var. *villosicalyx* | ● | ● |
| | *Ipomoea muelleri* | ● | |
| | *Operculina aequisepala* | ● | |
| | *Polymeria ambigua* | ● | ● |
| Cucurbitaceae | *Cucumis* aff. *maderaspatanus* | ● | |
| | *Cucumis maderaspatanus* | ● | ● |
| | ****Cucumis melo* subsp. *agrestis*** | | ● |
| Cyperaceae | *Bulbostylis barbata* | | ● |
| | *Cyperus ?blakeanus* | ● | |
| | *Cyperus blakeanus* | | ● |
| | *Cyperus iria* | | ● |
| | *Cyperus vaginatus* | ● | |
| | *Fimbristylis rara* | | ● |
| | *Fimbristylis simulans* | | ● |
| Elatinaceae | *Bergia pedicellaris* | | ● |
| Euphorbiaceae | *Euphorbia australis* | ● | ● |
| | *Euphorbia boophthona* | | ● |
| | *Euphorbia coghlanii* | | ● |
| | *Euphorbia schultzii* | ● | |
| | *Euphorbia tannensis* subsp. *eremophila* (Panorama form) | | ● |

| FAMILY | NAME | Phase 1 | Phase 2 |
|---|---|---|---|
| Euphorbiaceae Continued | *Euphorbia wheeleri* | | ● |
| | *Phyllanthus erwinii* | | ● |
| | *Phyllanthus maderaspatensis* | ● | ● |
| Goodeniaceae | *Dampiera candicans* | ● | ● |
| | *Goodenia cusackiana* | ● | ● |
| | *Goodenia forrestii* | ● | |
| | *Goodenia lamprosperma* | | ● |
| | *Goodenia microptera* | | ● |
| | *Goodenia muelleriana* | | ● |
| | ⚐***Goodenia nuda* (P3)** | | ● |
| | *Goodenia* sp. | ● | |
| | *Goodenia stobbsiana* | ● | ● |
| | *Goodenia tenuiloba* | | ● |
| | *Scaevola browniana* subsp. *browniana* | | ● |
| | *Scaevola parvifolia* | | ● |
| Gyrostemonaceae | *Codonocarpus cotinifolius* | ● | ● |
| Haloragaceae | *Haloragis gossei* var. *gossei* | | ● |
| Lauraceae | *Cassytha capillaris* | | ● |
| Malvaceae | *Abutilon cryptopetalum* | | ● |
| | *Abutilon cunninghamii* | ● | ● |
| | *Abutilon dioicum* | | ● |
| | *Abutilon fraseri* | ● | ● |
| | *Abutilon lepidum* | | ● |
| | *Abutilon macrum* | | ● |
| | *Abutilon otocarpum* | ● | ● |
| | *Gossypium australe* | ● | ● |
| | *Gossypium robinsonii* | ● | ● |
| | *Hibiscus burtonii* | | ● |
| | *Hibiscus coatesii* | ● | ● |
| | *Hibiscus gardneri* | | ● |
| | *Hibiscus leptocladus* | ● | ● |
| | *Hibiscus ?sturtii* var. *campylochlamys* | ● | |
| | *Hibiscus sturtii* var. *campylochlamys* | ● | ● |
| | *Hibiscus sturtii* var. *platychlamys* | ● | ● |
| | ****Malvastrum americanum*** | ● | ● |
| | *Sida* aff. *echinocarpa* (MET 15,350) | ● | |
| | *Sida arenicola* | ● | ● |
| | *Sida echinocarpa* | | ● |
| | *Sida ectogama* | | ● |
| | *Sida* aff. *fibulifera* | ● | |
| | *Sida fibulifera* | ● | ● |
| | *Sida pilbarensis* | ● | ● |
| | *Sida pilbarensis* (ferrugenous form) R.M. Barker ms | ● | ● |
| | *Sida* sp. | | ● |
| | *Sida* sp. articulation below (A.A. Mitchell PRP 1605) | | ● |
| | *Sida* sp. dark green fruit (S. Van Leeuwen 2260) | | ● |
| | *Sida* sp. Excedentifolia (J.L. Egan 1925) | ● | ● |
| | *Sida* sp. golden calyces glabrous (H.N. Foote 32) | | ● |
| | *Sida* sp. spiciform panicles (E. Leyland s.n. 14/8/1990) | ● | ● |
| | *Sida* sp. unisexual (N.H. Speck 574) | ● | |

| FAMILY | NAME | Phase 1 | Phase 2 |
|---|---|---|---|
| Mimosaceae | *Acacia adoxa* var. *adoxa* | ● | ● |
| | *Acacia ?adsurgens* | | ● |
| | *Acacia adsurgens* | ● | |
| | *Acacia* ?aff. *ayersiana* | ● | |
| | *Acacia* aff. *ayersiana* (MET 16 088) | ● | |
| | *Acacia* aff. *ayersiana* (narrow form; MET 15,786) | ● | |
| | *Acacia ?ancistrocarpa* | ● | |
| | *Acacia ancistrocarpa* | ● | ● |
| | *Acacia aneura* | ● | |
| | *Acacia aneura* var. ? | ● | ● |
| | *Acacia aneura* var. ?*aneura* | ● | |
| | *Acacia aneura* var. *aneura* | ● | ● |
| | *Acacia aneura* var. ?*intermedia* | ● | ● |
| | *Acacia aneura* var. *intermedia* | ● | |
| | *Acacia aneura* var. ?*microcarpa* | ● | ● |
| | *Acacia aneura* var. *microcarpa* | ● | |
| | *Acacia ?aneura* x *ayersiana* | | ● |
| | *Acacia arida* | ● | ● |
| | *Acacia atkinsiana* | ● | ● |
| | *Acacia ayersiana* | ● | ● |
| | *Acacia bivenosa* | ● | ● |
| | *Acacia ?catenulata* | | ● |
| | *Acacia ?citrinoviridis* | ● | ● |
| | *Acacia citrinoviridis* | ● | |
| | *Acacia coriacea* subsp. *pendens* | ● | ● |
| | *Acacia distans* | | ● |
| | *Acacia elachantha* | ● | |
| | *Acacia ?eriopoda* | ● | |
| | *Acacia eriopoda* | ● | ● |
| | *Acacia hilliana* | ● | |
| | *Acacia inaequilatera* | ● | |
| | *Acacia maitlandii* | ● | ● |
| | *Acacia marramamba* | ● | ● |
| | *Acacia monticola* | ● | ● |
| | *Acacia nervosa* | ● | |
| | *Acacia pruinocarpa* | ● | ● |
| | *Acacia ptychophylla* | ● | ● |
| | *Acacia pyrifolia* var. *morrisonii* | ● | ● |
| | *Acacia pyrifolia* var. *pyrifolia* | ● | ● |
| | *Acacia rhodophloia* | ● | ● |
| | *Acacia sericophylla* | | ● |
| | *Acacia ?sibirica* | ● | |
| | *Acacia sibirica* | | ● |
| | *Acacia* sp. | ● | ● |
| | *Acacia* sp. hybrid | ● | ● |
| | *Acacia stenophylla* | ● | |
| | *Acacia synchronicia* | | ● |
| | *Acacia tenuissima* | ● | ● |
| | *Acacia tetragonophylla* | ● | ● |
| | *Acacia trachycarpa* | ● | ● |

| FAMILY | NAME | Phase 1 | Phase 2 |
|---|---|---|---|
| Mimosaceae Continued | *Acacia tumida* var. *pilbarensis* | ● | ● |
| | *Acacia xiphophylla* | ● | ● |
| | ****Vachellia farnesiana*** | ● | ● |
| Molluginaceae | *Mollugo molluginea* | ● | ● |
| Moraceae | *Ficus brachypoda* | | ● |
| Myoporaceae | *Eremophila cuneifolia* | | ● |
| | *Eremophila forrestii* subsp. *forrestii* | ● | ● |
| | *Eremophila lanceolata* | | ● |
| | *Eremophila latrobei* subsp. *filiformis* | ● | ● |
| | *Eremophila longifolia* | ● | ● |
| Myrtaceae | *Corymbia deserticola* subsp. *deserticola* | ● | ● |
| | *Corymbia ?hamersleyana* | ● | |
| | *Corymbia hamersleyana* | ● | ● |
| | *Corymbia ?opaca* | ● | |
| | *Corymbia opaca* | ● | |
| | *Corymbia* sp. | | ● |
| | *Eucalyptus gamophylla* | ● | ● |
| | *Eucalyptus leucophloia* subsp. *leucophloia* | ● | ● |
| | *Eucalyptus* sp. | | ● |
| | *Eucalyptus victrix* | ● | ● |
| | *Melaleuca glomerata* | ● | |
| | *Melaleuca linophylla* | ● | |
| Nyctaginaceae | *Boerhavia* sp. | | ● |
| Oleaceae | *Jasminum didymum* subsp. *lineare* | ● | ● |
| Papilionaceae | *Crotalaria novae-hollandiae* subsp. *novae-hollandiae* | | ● |
| | *Cullen leucochaites* | ● | |
| | *Cullen pogonocarpum* | | ● |
| | *Glycine canescens* | ● | ● |
| | *Gompholobium karijini* | ● | ● |
| | *Indigofera monophylla* | ● | ● |
| | *Indigofera trita* | ● | |
| | *Isotropis atropurpurea* | ● | ● |
| | *Kennedia prorepens* | ● | |
| | PAPILIONACEAE sp. | ● | |
| | *Rhynchosia minima* | | ● |
| | *Sesbania cannabina* | ● | |
| | *Tephrosia clementii* | ● | |
| | *Tephrosia rosea* var. *clementii* | ● | |
| | *Tephrosia rosea* var. *glabrior* | ● | ● |
| | *Tephrosia* sp. Bungaroo Creek (M.E. Trudgen 11601) | | ● |
| | *Tephrosia virens* | | ● |
| Poaceae | *Amphipogon sericeus* | ● | ● |
| | *Aristida contorta* | ● | ● |
| | *Aristida holathera* var. *holathera* | ● | ● |
| | *Aristida inaequiglumis* | ● | |
| | *Aristida latifolia* | ● | ● |
| | *Aristida obscura* | ● | ● |
| | *Astrebla pectinata* | ● | |
| | ****Cenchrus ciliaris*** | ● | ● |
| | *Chrysopogon fallax* | ● | ● |

| FAMILY | NAME | Phase 1 | Phase 2 |
|---|---|---|---|
| Poaceae Continued | *Cymbopogon ambiguus* | ● | ● |
| | *Dactyloctenium radulans* | | ● |
| | *Digitaria brownii* | ● | ● |
| | *Digitaria ctenantha* | | ● |
| | *Enneapogon caerulescens* | ● | |
| | *Enneapogon cylindricus* | | ● |
| | *Enneapogon ?polyphyllus* | ● | |
| | *Enneapogon polyphyllus* | ● | ● |
| | *Enneapogon ?robustissimus* | ● | |
| | *Enneapogon robustissimus* | | ● |
| | *Eragrostis cumingii* | | ● |
| | *Eragrostis eriopoda* | ● | ● |
| | *Eragrostis setifolia* | | ● |
| | *Eragrostis* sp. | ● | |
| | *Eragrostis tenellula* | | ● |
| | *Eriachne benthamii* | | ● |
| | *Eriachne helmsii* | ● | |
| | *Eriachne lanata* | ● | ● |
| | *Eriachne* aff. *mucronata* | ● | ● |
| | *Eriachne mucronata* | ● | ● |
| | *Eriachne mucronata* (typical form) | ● | |
| | *Eriachne pulchella* subsp. *dominii* | | ● |
| | *Eulalia aurea* | ● | ● |
| | *Iseilema vaginiflorum* | | ● |
| | *Panicum decompositum* | ● | |
| | *Panicum effusum* var. *effusum* | | ● |
| | *Paraneurachne muelleri* | | ● |
| | *Paspalidium basicladum* | | ● |
| | *Perotis rara* | | ● |
| | POACEAE sp. | | ● |
| | *Setaria ?dieslii* | | ● |
| | *Sorghum plumosum* | ● | |
| | *Sorghum timorense* | | ● |
| | *Sporobolus australasicus* | ● | ● |
| | *Themeda* sp. Mt Barricade (M.E. Trudgen 2471) | ● | ● |
| | *Themeda ?triandra* | ● | |
| | *Themeda triandra* | ● | ● |
| | *Triodia ?basedowii* | ● | |
| | *Triodia basedowii* | ● | ● |
| | *Triodia brizoides* | | ● |
| | *Triodia epactia* | | ● |
| | *Triodia ?lanigera* | | ● |
| | *Triodia longiceps* | | ● |
| | *Triodia pungens* | ● | |
| | *Triodia* sp. | | ● |
| | *Triodia wiseana* | | ● |
| | *Triraphis mollis* | ● | |
| Polygonaceae | *Muehlenbeckia florulenta* | ● | |
| Proteaceae | *Grevillea berryana* | ● | ● |
| | *Grevillea stenobotrya* | | ● |

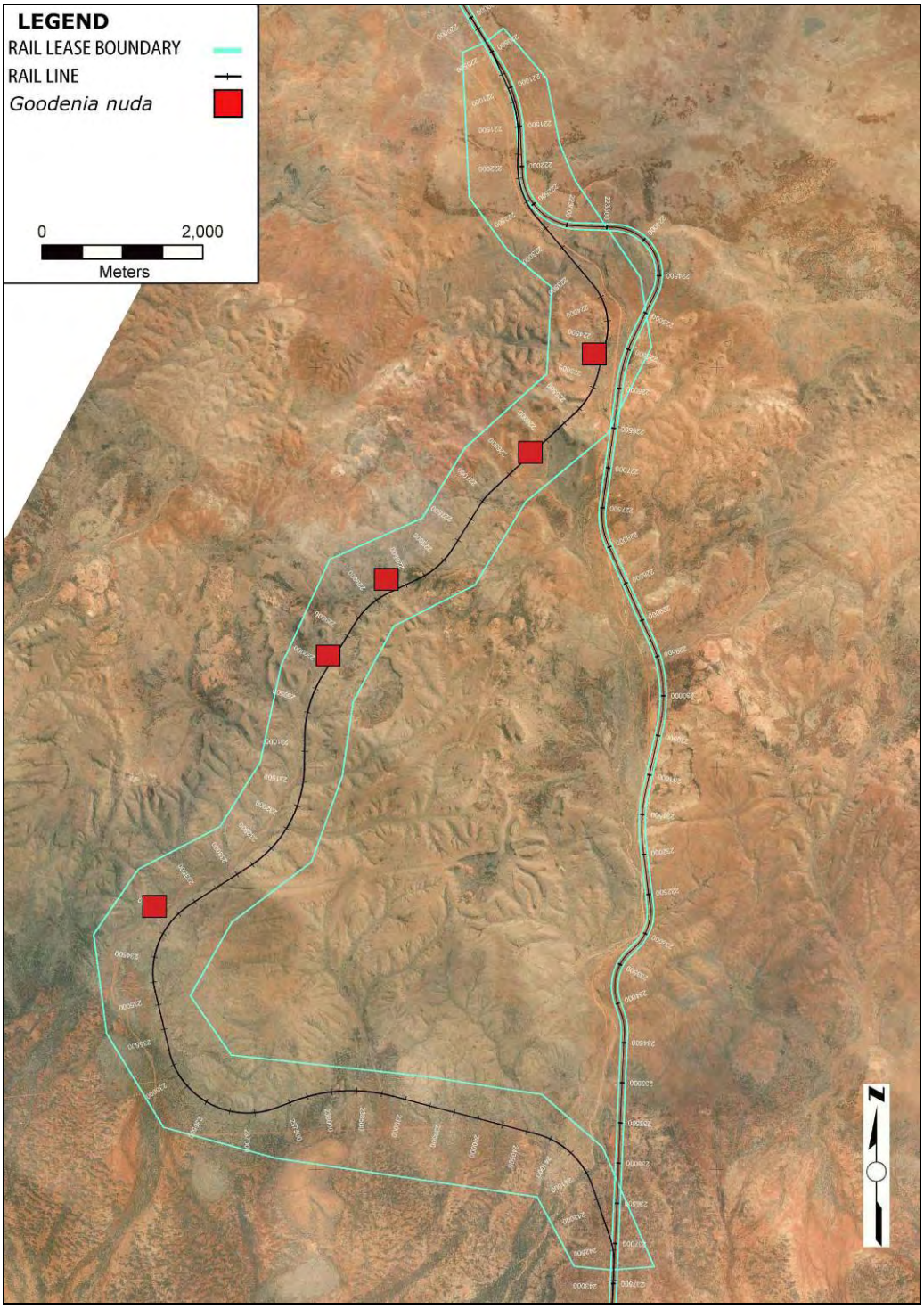
| FAMILY | NAME | Phase 1 | Phase 2 |
|---|---|---|---|
| Proteaceae Continued | *Grevillea wickhamii* subsp. *aprica* | ● | ● |
| | *Grevillea wickhamii* subsp. *hispidula* | | ● |
| | *Hakea chordophylla* | ● | ● |
| | *Hakea lorea subsp. lorea* | ● | ● |
| Rubiaceae | *Oldenlandia crouchiana* | | ● |
| | *Psydrax latifolia* | ● | ● |
| | *Psydrax rigidula* | | ● |
| | *Psydrax suaveolens* | ● | ● |
| Santalaceae | *Anthobolus leptomerioides* | ● | ● |
| | *Exocarpos aphyllus* | | ● |
| | *Santalum ?lanceolatum* | ● | |
| | *Santalum lanceolatum* | ● | ● |
| Sapindaceae | *Atalaya hemiglauca* | ● | ● |
| | *Dodonaea coriacea* | ● | ● |
| | *Dodonaea petiolaris* | ● | ● |
| Scrophulariaceae | *Stemodia grossa* | ● | ● |
| | *Stemodia kingii* | ● | |
| | *Stemodia viscosa* | | ● |
| Solanaceae | *Solanum diversiflorum* | | ● |
| | *Solanum ellipticum* | ● | ● |
| | *Solanum horridum* | | ● |
| | *Solanum lasiophyllum* | ● | ● |
| | *Solanum phlomoides* | ● | ● |
| Stackhousiaceae | *Stackhousia ?intermedia* | ● | |
| Sterculiaceae | *Keraudrenia nephrosperma* | ● | ● |
| | *Keraudrenia ?velutina* subsp. *elliptica* | | ● |
| | *Keraudrenia velutina* subsp. *elliptica* | ● | |
| | *Melhania* aff. *oblongifolia* | | ● |
| | *Rulingia luteiflora* | ● | ● |
| | *Waltheria indica* | ● | ● |
| | *Waltheria virgata* | | ● |
| Tiliaceae | *Corchorus lasiocarpus* subsp. *lasiocarpus* | ● | ● |
| | *Corchorus lasiocarpus* subsp. *parvus* | ● | ● |
| | *Corchorus sidoides* | ● | |
| | *Triumfetta chaetocarpa* | | ● |
| | *Triumfetta maconochieana* | | ● |
| | *Triumfetta ramosa* | | ● |
| Verbenaceae | *Clerodendrum floribundum* | ● | |
| | *Clerodendrum floribundum* var. *angustifolium* | ● | ● |
| Violaceae | *Hybanthus aff. aurantiacus* | | ● |
| | *Hybanthus aurantiacus* | ● | ● |
| Zygophyllaceae | *Tribulus hirsutus* | | ● |
| | *Tribulus macrocarpus* | | ● |
| | *Tribulus suberosus* | ● | ● |

Key: ⚐ indicates a species of interest, P3 = Priority 3 flora taxon, * = Introduced species. Bold font indicates conservation significant or weed species.
Classification and nomenclature according to the Western Australian Herbarium, 2008 (FloraBase).

## A.5 PRIORITY FLORA AND WEED LOCATIONS

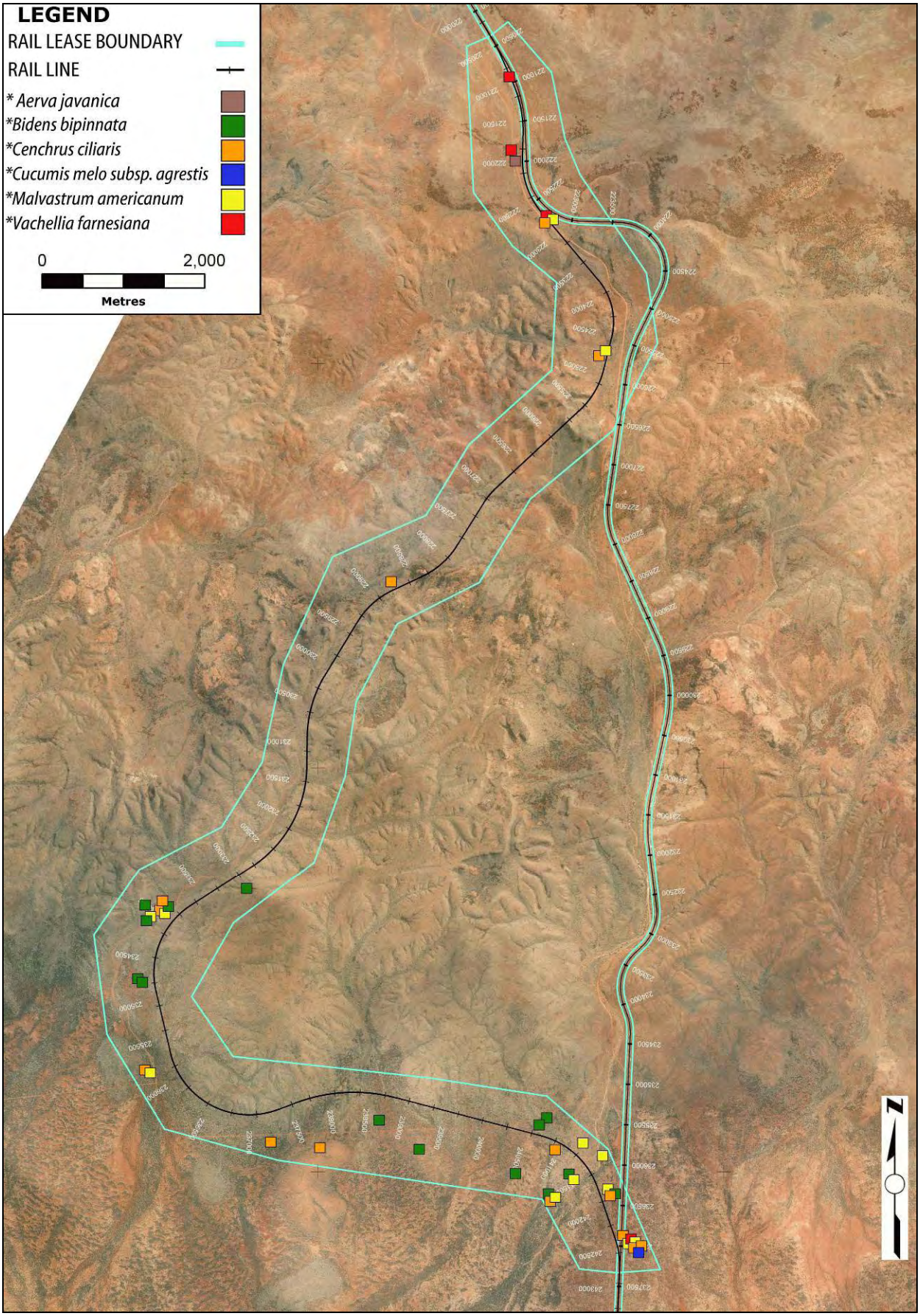
**Locations of Priority Flora taxa recorded during the survey. Datum = WGS84, error = +/- 5.0 m.**

| Species | Phase | Quadrat | Zone | Easting (mE) | Northing (mN) |
|---|---|---|---|---|---|
| ***Goodenia nuda* (P3)** | 2 | R26 | 705130 | 7546312 | <2% |
| | | R34 | 708461 | 7550082 | <10% |
| | | 34 | 703011 | 7543186 | <10 plants |
| | | 21 | 705897 | 7547299 | <10% |
| | | 26 | 707688 | 7548843 | <2% |



**Locations of Introduced flora taxa recorded during the survey. Datum = WGS84, error = +/- 5.0 m.**

| Species | Phase | Quadrat | Zone | Easting (mE) | Northing (mN) |
|---|---|---|---|---|---|
| ***Aerva javanica** | Phase 1 | 39 | 50 K | 707430 | 7552367 |
| ***Bidens bipinnata** | Phase 1 | 1 | 50 K | 708127 | 7539948 |
| | | 17 | 50 K | 702819 | 7542340 |
| | | 19 | 50 K | 704113 | 7543493 |
| | Phase 2 | 2 | 50 K | 708588 | 7539746 |
| | | 3 | 50 K | 707871 | 7539660 |
| | | 5 | 50 K | 707451 | 7539968 |
| | | 7 | 50 K | 706252 | 7540265 |
| | | 8 | 50 K | 705746 | 7540621 |
| | | 34 | 50 K | 703011 | 7543186 |
| | | R17 | 50 K | 702819 | 7542340 |
| | | Opp Coll | 50 K | 702914 | 7543246 |
| | | Opp Coll | 50 K | 702927 | 7543173 |
| | | Opp Coll | 50 K | 707770 | 7540617 |
| | | Opp Coll | 50 K | 707742 | 7540556 |
| ***Cenchrus ciliaris** | Phase 1 | 38 | 50 K | 707862 | 7551800 |
| | Phase 2 | 1 | 50 K | 708868 | 7539109 |
| | | 2 | 50 K | 708588 | 7539746 |
| | | 3 | 50 K | 707871 | 7539660 |
| | | 9 | 50 K | 705026 | 7540286 |
| | | 11 | 50 K | 704411 | 7540337 |
| | | 13 | 50 K | 702900 | 7541224 |
| | | 21 | 50 K | 705897 | 7547299 |
| | | 34 | 50 K | 703011 | 7543186 |
| | | 34 | 50 K | 703011 | 7543186 |
| | | R34 | 50 K | 708461 | 7550082 |
| | | Opp Coll | 50 K | 707935 | 7540286 |
| | | Opp Coll | 50 K | 708765 | 7539177 |
| | | Opp Coll | 50 K | 708863 | 7539114 |
| ***Cucumis melo* subsp. *agrestis** | Phase 2 | 1 | 50 K | 708868 | 7539109 |
| ***Malvastrum americanum** | Phase 1 | 1 | 50 K | 708127 | 7539948 |
| | | 2 | 50 K | 708502 | 7540185 |
| | | 38 | 50 K | 707862 | 7551800 |
| | Phase 2 Phase 2 | 1 | 50 K | 708868 | 7539109 |
| | | 2 | 50 K | 708588 | 7539746 |
| | | 3 | 50 K | 707871 | 7539660 |
| | | 4 | 50 K | 708261 | 7540352 |
| | | 13 | 50 K | 702900 | 7541224 |
| | | 34 | 50 K | 703011 | 7543186 |
| | | R34 | 50 K | 708461 | 7550082 |
| | | Opp Coll | 50 K | 702927 | 7543173 |
| | | Opp Coll | 50 K | 708863 | 7539114 |
| ***Vachellia farnesiana** | Phase 1 | 40 | 50 K | 707381 | 7552629 |
| | | 38 | 50 K | 707862 | 7551800 |
| | Phase 2 | 1 | 50 K | 708868 | 7539109 |
| | | 35 | 50 K | 707362 | 7553533 |


LEGEND
RAIL LEASE BOUNDARY
RAIL LINE
* Aerva javanica
*Bidens bipinnata
*Cenchrus ciliaris
*Cucumis melo subsp. agrestis
*Malvastrum americanum
*Vachellia farnesiana
0
2,000
Metres
N

## A.6 PRIORITY FLORA VOUCHER FORMS

Department of Environment and Conservation

# *RARE FLORA REPORT FORM*

**TAXON:** ***Goodenia nuda*** **DEFL POPULATION No.:** _____
DRF ❒ **Priority P3** Partial Survey ❒ Full Survey ❒ New Population ❒
**FROM:** ***ecologia*** **Environment** **TITLE**: _____ **SURVEY DATE: 8 October 2007**
**REGION: Pilbara, Fortescue Plains IBRA subregion** **DISTRICT:** **SHIRE:**
**LOCATION: Approximatly 6 km west of Hesta Siding (of the BHPBIO rail line), approx 250 km south of Port Hedland**
**Reserve No**: _____

**GPS location: 50K 1 - 708461 mE, 7550082 mN; 705897 mE, 7547299mN; 707688 mE, 7548843 mN; 703011mE, 7543186 mN**

**GPS DATUM:** AGD84 ❒ GDA94 ❒ GDA94-Compatible (e.g. **WGS84)** ☑ Unknown ❒ None ❒

**LAND STATUS:** Nature Reserve ❒ Private ❒ Gravel Res. MRD ❒ Rail Reserve ☑
National Park ❒ Pastoral Lease ❒ Gravel Res. Shire ❒ Rd. Verge Shire ❒
State Forest ❒ UCL ❒ Other Shire Res. ❒ Rd. Verge MRD ❒
Water Reserve ❒ Other ❒ Specify: _____
Landowner/manager present during inspection: ❒

**LANDFORM:** Hilltop ❒ Cliff ❒ Slope ❒ Valley ❒ Swamp ❒
Outcrop ❒ Breakaway ❒ Low Plain ❒ Gully ❒ Riverbank ❒
Ridge ❒ Sand Dune ❒ Flat ❒ **Drainageline** ☑ Lake Edge ❒
Firebreak ❒Other ❒Seasonal Wetland

**ROCK TYPE:** Laterite ❒ Granite ❒ Dolerite ❒ Limestone ❒ Other: **Ferrous**_____
**ROCK FORM:** Sheet ❒ Boulder ❒ Fluviatile Gravel ❒ Concretionary Gravel ❒
**SOIL TYPE:** **Sand** ☑ Loam ❒ **Clay** ☑ Peat ❒ Gravel ❒
**SOIL COLOUR:** **Red** ☑ Brown ❒ Yellow ❒ White ❒ Grey ❒
**SOIL CONDITION:** Moist ❒ Inundated ❒ Dry ❒ Saline ❒ Other:
_____

**VEGETATION CLASSIFICATION** (Muir's): Sparse low trees of *Eucalyptus victrix* over scattered high shrubs of *Petalostylis labicheoides* over open moderate shrubs of *Petalostylis labicheoides* over open low shrubs of *Triumfetta ramosa* over moderately dense low shrubs of *Polymeria ambigua* over sparse *Chrysopogon fallax* tussock grass.

**No. of PLANTS:** M**ature: _<20 in each area**___Seedlings: _____ Dead**:** _____ Actual ❒Estimate ❒
(Leave blank if unable to observe, or no attempt made to count plants)
**REPRODUCTIVE STATE:** Clonal ❒ Flower bud ❒ **Flower** ☑ Immat. fruit ❒ Fruit ❒ Old Fruit ❒ **Vegetative** ☑
**POLLINATORS:** Native bees ❒ Honey bees ❒ Other insects ❒ Birds ❒ Mammals ❒
Other observations: _____
**CONDITION OF POPULATION:** Healthy ❒ Moderate ☑ Poor ❒ Disturbed ❒ Comment:
_____
**POTENTIAL THREATS:** Firebreaks ❒ Mining ❒ Recreation ❒ Roadworks ❒ Grazing ❒ Weeds ❒
Salinity ❒ Disease ❒ Prescribed Burning ❒ Other ❒ Comment:_ **Rail Construction** _
**FIRE HISTORY: none evident** Burnt in ____ Summer ❒ Autumn ❒ Winter ❒ Spring ❒
**FENCING:** Not Required ❒ Fenced ❒ Required ❒ Replace/Repair ❒
**ROADSIDE MARKERS:** Not Required ❒ Present ❒ Required ❒ Replace ❒ Reposition ❒

**OTHER COMMENTS** (include action taken/required):_____
_____
**VOUCHER SPECIMEN:** Regional Herb. ❒ District Herb. ❒ **WA Herb.** ☑ Other ❒
_____
**ATTACHED**: Map ❒ Mudmap ❒ Illustration ❒ Photo ❒ Field Notes ❒
**COPY SENT TO:** Regional Office ❒ District Office ❒ Other ❒ Specify: _____

**Signed: Melissa Hay** ***ecologia*** **Environment (871-MH-03)**

*NOTE: Map or further information may be attached or given on the back of this form.*
Please return completed form to Director General, DEC, Locked Bag 104, BENTLEY DELIVERY CENTRE WA 6983
**RECORDS: PLEASE FORWARD TO ADMINISTRATIVE OFFICER, FLORA, SPECIES AND COMMUNITIES BRANCH**

Department of Environment and Conservation

# *RARE FLORA REPORT FORM*

**TAXON:** ***Goodenia nuda*** **DEFL POPULATION No.:** _____
DRF ❒ **Priority P3** Partial Survey ❒ Full Survey ❒ New Population ❒
**FROM:** ***ecologia*** **Environment** **TITLE**: _____ **SURVEY DATE: 8 October 2007**
**REGION: Pilbara, Fortescue Plains IBRA subregion** **DISTRICT:** **SHIRE:**
**LOCATION: Approximatly 6 km west of Hesta Siding (of the BHPBIO rail line), approx 250 km south of Port Hedland**
**Reserve No**: _____

**GPS location: 50K 705130 mE, 7546312 mN**

**GPS DATUM:** AGD84 ❒ GDA94 ❒ GDA94-Compatible (e.g. **WGS84)** ☑ Unknown ❒ None ❒

**LAND STATUS:** Nature Reserve ❒ Private ❒ Gravel Res. MRD ❒ Rail Reserve ☑
National Park ❒ Pastoral Lease ❒ Gravel Res. Shire ❒ Rd. Verge Shire ❒
State Forest ❒ UCL ❒ Other Shire Res. ❒ Rd. Verge MRD ❒
Water Reserve ❒ Other ❒ Specify: _____
Landowner/manager present during inspection: ❒

**LANDFORM:** Hilltop ❒ Cliff ❒ Slope ❒ Valley ❒ Swamp ❒
Outcrop ❒ Breakaway ❒ Low Plain ❒ Gully ❒ Riverbank ❒
Ridge ❒ Sand Dune ❒ Flat ❒**Drainageline on rocky midslope** ☑
Lake Edge ❒ Firebreak ❒Other ❒Seasonal Wetland

**ROCK TYPE:** Laterite ❒ Granite ❒ Dolerite ❒ Limestone ❒ Other: **Ferrous**_____
**ROCK FORM:** Sheet ❒ Boulder ❒ Fluviatile Gravel ❒ Concretionary Gravel ❒
**SOIL TYPE:** **Sand** ☑ Loam ❒ **Clay** ☑ Peat ❒ Gravel ❒
**SOIL COLOUR:** **Red** ☑ Brown ❒ Yellow ❒ White ❒ Grey ❒
**SOIL CONDITION:** Moist ❒ Inundated ❒ Dry ❒ Saline ❒ Other:
_____

**VEGETATION CLASSIFICATION** (Muir's): *Corymbia hamersleyana* over scattered low trees of *Eucalyptus leucophloia* subsp. *leucophloia* over open regenerating high shrubs over open moderate shrubs of *Petalostylis labicheoides* re growth over open low shrubs of *Senna notabilis* and *Indigofera monophylla* and *Corchorus lasiocarpus* subsp. *lasiocarpus* over open tussock grasses dominated by *Themeda triandra* and *Chrysopogon fallax*.

**No. of PLANTS:** M**ature: _<20** ___Seedlings: _____ Dead**:** _____ Actual ❒ Estimate ❒
(Leave blank if unable to observe, or no attempt made to count plants)
**REPRODUCTIVE STATE:** Clonal ❒ Flower bud ❒ **Flower** ☑ Immat. fruit ❒ Fruit ❒ Old Fruit ❒ **Vegetative** ☑
**POLLINATORS:** Native bees ❒ Honey bees ❒ Other insects ❒ Birds ❒ Mammals ❒
Other observations: _____
**CONDITION OF POPULATION:** Healthy ☑ Moderate ❒ Poor ❒ Disturbed ❒ Comment:
_____
**POTENTIAL THREATS:** Firebreaks ❒ Mining ❒ Recreation ❒ Roadworks ❒ Grazing ❒ Weeds ❒
Salinity ❒ Disease ❒ Prescribed Burning ❒ Other ❒ Comment:_ **Rail Construction** _
**FIRE HISTORY: none evident** Burnt in ____ Summer ❒ Autumn ❒ Winter ❒ Spring ❒
**FENCING:** Not Required ❒ Fenced ❒ Required ❒ Replace/Repair ❒
**ROADSIDE MARKERS:** Not Required ❒ Present ❒ Required ❒ Replace ❒ Reposition ❒

**OTHER COMMENTS** (include action taken/required):_____
_____
**VOUCHER SPECIMEN:** Regional Herb. ❒ District Herb. ❒ **WA Herb.** ☑ Other ❒
_____
**ATTACHED**: Map ❒ Mudmap ❒ Illustration ❒ Photo ❒ Field Notes ❒
**COPY SENT TO:** Regional Office ❒ District Office ❒ Other ❒ Specify: _____

**Signed: Joshua Gilovitz** ***ecologia*** **Environment (871-JG-03)**

*NOTE: Map or further information may be attached or given on the back of this form.*
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