RUTILA RESOURCES RAILWAY CORRIDOR FLORA AND VEGETATION ASSESSMENT

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- pastoral station leasees and managers.

ACRONYMS AND ABBREVIATIONS

ACRONYMS AND ABBREVIATIONS	
ARRP Act 1976	Western Australian *Agriculture and Related Resource Protection Act 1976* (superseded by the *BAM Act 1997*)
BAM Act 2007	Western Australian *Biosecurity and Agriculture Management Act 2007*
BoM	Bureau of Meteorology
C1, C2, C3	Declared Pest categories under the *BAM Act 2007*
CALM	Department of Conservation and Land Management (prior to becoming DEC)
DAFWA	Department of Agriculture and Food Western Australia
DEC	Department of Environment and Conservation (now, in part, DPaW)
DPaW	Western Australian Department of Parks and Wildlife
DoE	Commonwealth Department of the Environment
DSEWPaC	Commonwealth Department of Sustainability, Environment, Water, Population and Communities (now DoE)
Ecoscape	Ecoscape (Australia) Pty Ltd
EP Act 1986	Western Australian *Environmental Protection Act 1986*
EPA	Western Australian Environmental Protection Authority
EPBC Act 1999	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
Flinders	Flinders Mines Ltd
FMG	Fortescue Metals Group Ltd
GDA 94	Geographic Datum of Australia 1994
GDE	Groundwater Dependent Ecosystem
GPS	Global Positioning System
IBRA	Interim Biogeographic Regionalisation for Australia
IDE	Inflow Dependent Ecosystem
MGA	Map Grid of Australia
NHT	National Heritage Trust
NVIS	National Vegetation Inventory System
PEC	Priority Ecological Community
PF	Priority Flora
PIL1, 2, 3, 4	Pilbara biogeographic subregions
PIOP	Flinders Mines Pilbara Iron Ore Project
PMST	Protected Matters Search Tool
P1, P2, P3, P4, P5	Priority, used for PF and PEC rankings
Rutila	Rutila Resources Pty Ltd
sens. lat.	(Latin) *sensu lato*, in the broad sense
SFDV	Sheet Flow Dependent Vegetation
sp.	Species (generally referring to an unidentified taxon or when a phrase name has been applied)
subsp.	Subspecies (infrataxon)
TEC	Threatened Ecological Community
TF	Threatened Flora (formerly termed Declared Rare Flora, DRF, in Western Australia)
var.	Variety (infrataxon)
WAH	Western Australian Herbarium
WAOL	Western Australian Organism List
WC Act 1950	Western Australian *Wildlife Conservation Act 1950*

ACRONYMS AND ABBREVIATIONS	
WONS	Weeds of National Significance
*	Introduced species

SUMMARY

Rutila Resources Pty Ltd has been granted State and Commonwealth approvals to develop the Balla Balla Mine and Port, including port facilities, near Whim Creek in the Pilbara Region of Western Australia. In order to increase the Port's viability, Rutila is investigating the possibility of connecting the proposed port to stranded mineral resources in the Hamersley Range via a new railway line. The proposed railway is approximately 200 km in length. The survey covers an average 2 km wide alignment, plus all proposed borrow pits, water and access points.

Ecoscape (Australia) Pty Ltd has been appointed to undertake a Level 2 flora and vegetation survey of the 570.63 km^2 (57 063 ha) study area. A reconnaissance survey was undertaken in May 2014, and Level 2 flora and vegetation surveys in July and July-August 2014.

The desktop assessment identified:

- most of the alignment had not been subject to previous environmental surveys
- eighty one conservation significant flora species had potential to occur within the study area, based on the results of database searches and Ecoscape experience
- an undescribed (new to science), unnamed *Josephinia* sp., recorded from within the Flinders Mines tenement (but not within the proposed alignment) was considered to be significant by the Environmental Protection Authority, and is also included for targeted searches
- two Priority Ecological Communities (PECs), P1-P3 'Four plant assemblages of the Wona Land System' and P3 'Horseflat Land System of the Roebourne Plains', have previously been mapped within the study area alignment, or their buffers occur within it
- Groundwater Dependent Ecosystems (GDEs) are known within the study area
- Sheet Flow Dependent Vegetation (SFDV Mulga communities) may occur within the study area.

The flora and vegetation field survey included establishment and scoring of 156 unmarked quadrats and detailed relevès, mapping and describing the vegetation types and vegetation condition, and conducting targeted searches for conservation significant flora. The field surveys consisted of a reconnaissance survey in May and a single phase Level 2 survey conducted in July and August, 2014.

The Level 2 flora and vegetation assessment identified:

- 474 vascular flora taxa including:
    - nine Priority Flora; P1 taxa *Abutilon* sp. Pritzelianum (S. van Leeuwen 5095), *Helichrysum oligochaetum*, *Heliotropium muticum,* P2 taxon *Pentalepis trichodesmoides* subsp. *hispida,* P3 taxa *Indigofera* sp. Bungaroo Creek (S. van Leeuwen 4301), *Oldenlandia* sp. Hamersley Station (A.A. Mitchell PRP 1479), *Sida* sp. Barlee Range (S. van Leeuwen 1642), P4 taxa *Goodenia nuda*, *Rhynchosia bungarensis*
    - two taxa having a significant range extension (*Gyrostemon tepperi* and *Sid*a sp. Rabbit Flat (B.J. Carter 626))
    - one potentially new to science undescribed species, known as *Acacia* sp. in this report that was, at times, a dominant component of the mid stratum
    - 16 introduced species, none of which were Declared Pest plants or listed on any weed register
- 58 vegetation types plus one mosaic, including:
    - one vegetation type considered to represent the P3 'Horseflat Land System of the Roebourne Plains' PEC (vegetation type **Ex_1**), and another four vegetation types that may represent other subtypes of this PEC (vegetation types **Te(1)**, **Tw(1)**, Mattiske **FPg1**, and **Cc_2AbEb**)
    - one vegetation type that may represent the P1 'Cracking clays of the Chichester and Mungaroona Range' subtype of the 'Four plant assemblages of the Wona land system' PEC

(vegetation type **Sb**), although an area mapped as being the PEC may be within the buffer, but not the PEC as the vegetation doesn't match the PEC descriptions

- three vegetation types that represent a Groundwater Dependent Ecosystem, being characterised by *Eucalyptus camaldulensis* and/or *Melaleuca argentea* (vegetation types **EvMlCv**, **MaMgCv** and **MaMlCi**) and vegetation that may represent a GDE, characterised by *Eucalyptus victrix* (vegetation types **EvApCc$_1$**, **EvApTe**, **EvAt1Te**, **EvCb** and **EvMgEb**)
- other vegetation types that may be significant according to *Guidance Statement No. 51*. due to having small representation/restricted distribution (vegetation types (**ElAa3Tm**, **FbGpEm** and **AmEe**)
- vegetation types having an association with poorly represented land systems (**AmEe** and **As$_3$** associated with the Gregory land system)
- vegetation types having an association with a poorly represented pre-European vegetation association (**AiTe(1)**, **AiTe(3)**, **AiTw(3)**, **AmEe**, **ChAa$_1$Ta**, **MaMgCv** and **Ta**, although all vegetation associations have more than 95% of their original extent remaining in the Pilbara)
- similar to vegetation considered significant in other areas (vegetation types **ElEgTw**)

- 90.64% of the vegetation was assessed as being in Excellent condition, with areas mapped in lesser condition impacted by cattle grazing and weed invasion.

1.0 INTRODUCTION

1.1 PROJECT OVERVIEW

Rutila Resources Pty Ltd (Rutila) has been granted State and Commonwealth approvals to develop the Balla Balla Mine and Port, near Whim Creek in the Pilbara Region of Western Australia.

To increase the Port's viability, Rutila is investigating the potential to connect the port to 'stranded' third party miners via a new rail line. The proposed railway (known in this report as 'Rutila rail') connects the Flinders Mines Ltd (Flinders) Blacksmith tenement in the Hamersley Range to the Balla Balla Port stockpile area; a distance of approximately 200 km.

Preston Consulting has been appointed to gather and manage the planning, preparation and submission of approvals documents for the proposed railway, and in turn appointed Ecoscape (Australia) Pty Ltd (Ecoscape) to undertake a Level 2 flora and vegetation assessment of the alignment as part of the Western Australian and Commonwealth environmental approvals process.

In October 2014 Preston Consulting requested a desktop review of an alternative alignment through the Chichester Range, in the central portion of the rail corridor. This is presented at the end of this document.

1.1.1 Study Area Location

The proposed Rutila railway is located in the Pilbara region of Western Australia, between Balla Balla on the coast and the Flinders Blacksmith tenement, also known as the Pilbara Iron Ore Project (PIOP), in the Hamersley Range, northwest of Tom Price. The proposed alignment traverses a number of pastoral leases and areas of Unallocated Crown Land through the Shires of Ashburton and Roebourne.

The proposed railway alignment is approximately 200 km in length. The flora and vegetation survey area (the study area) covers an average 2 km-wide alignment that includes all rail, borrow pit, water and access within its boundaries, totalling 570.63 km^2 (57 063 ha).

The location of the study area is shown in **Figure 1**.

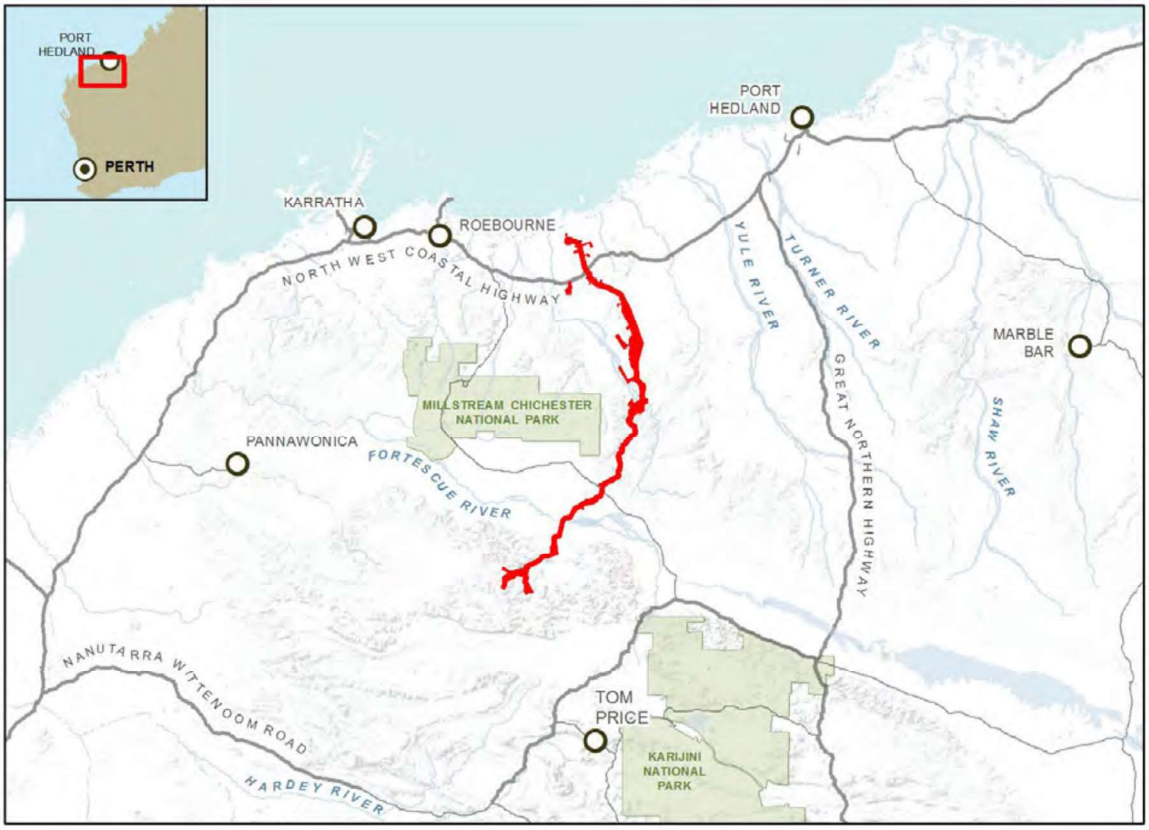

Figure 1: Study area

1.2 PROJECT OBJECTIVES

This report includes the results of a desktop, reconnaissance and single season field survey that comprise a Level 2 flora and vegetation assessment. The works were conducted to:

- be compliant with the Environmental Protection Authority (EPA) expectations of a Level 2 survey
- provide sufficient information to allow for an assessment of potential impacts
- follow *Guidance Statement No. 51 – Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessments in Western Australia* (EPA 2004)
- follow *Position Statement No.* 3 *– Terrestrial Biological Surveys as an Element of Biodiversity Protection* (EPA 2002).

It is anticipated, based on the results included in this report, that the EPA will provide guidance in regard to the requirement for a second season of field survey that is frequently required in order to fully satisfy the requirements of a Level 2 survey.

1.3 LEGISLATION AND POLICIES

This assessment was conducted in accordance with Commonwealth and State legislation and guidelines:

- Commonwealth *Environment Protection and Biodiversity Conservation (EPBC) Act 1999*
- Western Australian *Environmental Protection (EP) Act 1986*
- Western Australian *Wildlife Conservation (WC) Act 1950*

- Department of Environment Water Heritage and the Arts (2009) *Matters of National Environmental Significance. Significant impact guidelines 1.1 - Environment Protection and Biodiversity Conservation Act 1999*.

In addition to those listed above, the assessment complied with the EPA requirements for environmental survey and reporting in Western Australia, as outlined in:

- EPA (2000) *Position Statement No. 2: Environmental Protection of Native Vegetation in Western Australia*
- EPA (2008) *Guidance Statement No. 33: Environmental Guidance for Planning and Development*
- EPA (2004) *Guidance Statement No. 51: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessments in Western Australia*, known as *Guidance Statement No. 51*
- EPA (2003) *Guidance Statement No. 55: Implementing Best Practice in Proposals Submitted to the Environmental Impact Assessment Process.*

1.4 PERMITS

The flora and vegetation surveys were conducted under the following permits issued by the Western Australian Department of Parks and Wildlife (DPaW):

- flora collecting permit SL010883 (JK Nelson)
- flora collecting permit SL010888 (LJ Atkins)
- flora collecting permit SL010884 (AD Fry)
- flora collecting permit SL010878 (SO Kern)
- flora collecting permit SL010887 (SM Bateman)
- flora collecting permit SL010882 (JD Scanlon).

1.5 PREVIOUS SURVEYS

Flora and vegetation survey reports and other documents from the northern and southern ends were reviewed to gather background information relating to the study area. These reports and documents are listed or referenced in **Section 3.3.7**.

2.0 PHYSICAL ENVIRONMENT

The results of the desktop assessment relating to the physical environment are included below.

2.1 CLIMATE

The study area traverses much of the Pilbara region that experiences an arid climate, which is influenced by two air masses, the Indian tropical maritime air moving in from the west or north-west, and the tropical continental air from the inland. During the warmer part of the year, there is a hot low-pressure system over the region resulting in clear skies and very high temperatures from November to February with average maximum temperatures generally between 35°C and 40°C. During the winter months the average maximum temperature generally falls to between 22°C and 30°C, the range of which is generally greater in inland areas away from the moderating effects of onshore winds common in coastal areas (Australian Natural Resources Atlas 2009).

The Pilbara lies south of the area normally penetrated by the northwest monsoon in the summer months, and is only occasionally influenced by weather systems of the westerly circulation in the winter months. Rainfall is therefore low and variable. The majority of rainfall occurs between December and March, as the result of moist tropical storms and cyclones originating in the north, with a pronounced dry period between August and November (Australian Natural Resources Atlas 2009).

According to the Köppen-Geiger climate classification, the study area is considered as having a dry climate, Class B, subclasses BWh and BSh (Sustainable Development Department & Food and Agricultural Organisation of the United Nations 1999). Class B climates are arid regions where annual evaporation exceeds annual precipitation; subclass BWh is a desert climate and subclass BSh is a steppe climate where the average temperatures exceeds 18°. Only a small portion of the study area, near the coast is considered to be BSh.

The nearest Bureau of Meteorology (BoM) station to the northern end of the study area alignment is Whim Creek, however there are significant data gaps for this station. The nearest northern BoM station with continuous long-term data is Roebourne (004035), 60 km to the west. The nearest BoM station with continuous long-term data to the southern end of the study area alignment is Wittenoom (005026), 90 km to the east. Roebourne BoM station has been active since 1919; Wittenoom BoM station has been active since 1951.

Mean rainfall and mean daily maxima and minima for these BoM stations are shown in **Figure 2** (BoM 2014b; 2014c). December is the hottest month at both stations; Roebourne has an annual mean maximum temperature of 34.0° whilst Wittenoom's annual mean maximum temperature is 32.9°, 1.1° cooler. July is the coolest month at both stations; Roebourne has a mean July minimum of 20.5° whilst Wittenoom's mean July minimum is 19.7°, 0.8° cooler. Mean rainfall for the two stations differ significantly.

The annual mean rainfall for the Roebourne station is 315.6 mm, whilst the annual mean for the Wittenoom station is 465.6 mm, a difference of 150 mm annually. Wittenoom is located approximately 180 km to the south east of Roebourne. Rains occur following the same seasonal pattern at both locations with majority of rainfall occurring from December to March.

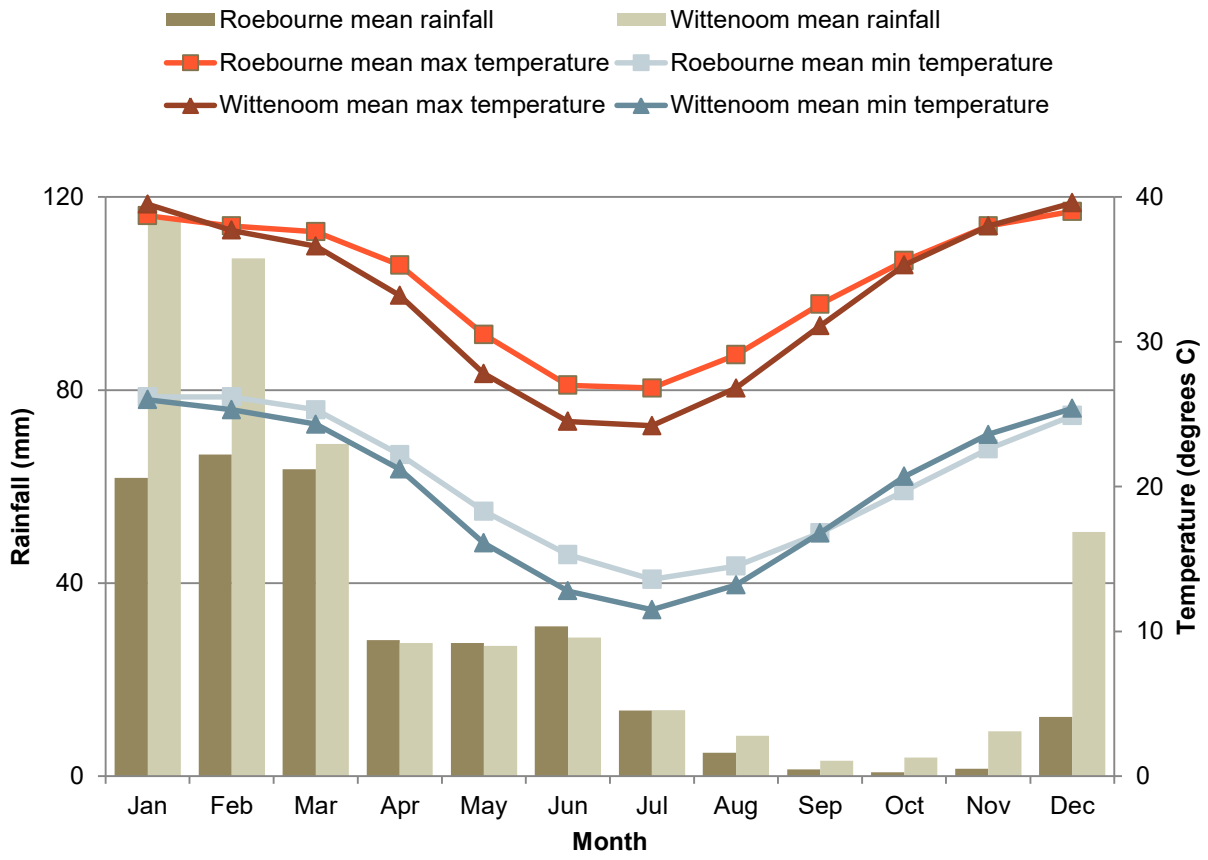

Figure 2: Monthly rainfall and daily maxima and minima for Roebourne and Wittenoom (BoM 2014b; 2014c)

2.2 GEOLOGY

There are 67 geological units mapped by the Geological Survey of Western Australia within the study area (Hickman & Smithies 2000; Smithies & Hickman 2004; Thorne *et al*. 1996), shown in **Table 21** in **Appendix Two**.

2.3 LAND SYSTEMS

As part of the rangeland resource surveys, the then-Department of Agriculture comprehensively described and mapped the biophysical resources of the Pilbara, together with an evaluation of the condition of the soils and vegetation (from an agricultural perspective) (Van Vreeswyk et al. 2004). As part of this process an inventory of land types, land systems and land units with particular use capabilities, habitats or conservation values were established to assist in land use planning. According to this mapping, 11 land types and 24 land systems (grouped according to land type on the basis of a combination of landform, soil, vegetation, and drainage characteristics) intersect with the study area (**Table 22** in **Appendix Two**). **Map 1** shows the land systems intersecting with the study area.

The extent of these land systems are shown in **Table 1**.

Table 1: Extent of land systems within the study area and regional representation (Van Vreeswyk *et al*. 2004)

LAND SYSTEM	EXTENT WITHIN STUDY AREA (KM^2)	PROPORTION OF STUDY AREA (%)	PILBARA EXTENT (KM^2)	PROPORTION OF TOTAL WITHIN THE STUDY AREA (%)
Black	4.79	0.84	165.00	2.90
Boolaloo	20.38	3.57	1502.00	1.36
Boolgeeda	116.51	20.42	7748.00	1.50
Calcrete	3.86	0.68	1444.00	0.27
Capricorn	4.68	0.82	5296.00	0.09
Coolibah	1.77	0.31	1014.00	0.17
Granitic	15.92	2.79	4020.00	0.40
Gregory	5.26	0.92	113.00	4.65
Hooley	0.15	0.03	590.00	0.02
Horseflat	14.20	2.49	1261.00	1.13
Jurrawarrina	3.68	0.65	664.00	0.55
Macroy	18.37	3.22	13095.00	0.14
Mallina	33.03	5.79	2557.00	1.29
McKay	12.87	2.25	4202.00	0.31
Newman	37.41	6.56	14580.00	0.26
River	29.53	5.18	4088.00	0.72
Rocklea	68.13	11.94	22993.00	0.30
Ruth	46.52	8.15	346.00	13.45
Satirist	4.71	0.83	377.00	1.25
Sherlock	0.34	0.06	192.00	0.18
Uaroo	101.73	17.83	7681.00	1.32
Urandy	25.14	4.41	1311.00	1.92
Wona	1.67	0.29	1815.00	0.09
TOTAL	**570.65**	**100**		

2.4 DRAINAGE

The northern portion of the study area alignment is associated with the Sherlock River, crossing the river and corresponding with its floodplain and tributaries. A portion of the study area corresponds with Nunyerry Creek, which is a tributary of the Sherlock River.

Towards the south of the study area the alignment crosses the Fortescue River. The southern portion of the study area is associated with Weelumurra Creek and its tributaries that flow into the Fortescue River.

3.0 BIOLOGICAL ENVIRONMENT

The results of the desktop assessment relating to the biological environment are detailed below.

3.1 BIOGEOGRAPHIC REGION

Biogeographic regions are delineated on the basis of similar climate, geology, landforms, vegetation and fauna and are defined in the Interim Biogeographical Regionalisation for Australia (IBRA) (Department of Sustainability Environment Water Population and Communities (DSEWPaC) 2011).

The study area is located entirely within the Pilbara biogeographic region that includes four subregions; Chichester, Fortescue Plains, Hamersley and Roebourne (Thackway & Cresswell 1995), all of which the study area intersect with (**Map 2**). These subregions are described in the 2002 Biodiversity Audit of Western Australia's 53 Biogeographical Subregions (McKenzie *et al.* 2003) as:

Chichester (PIL1, Kendrick & McKenzie 2002):

> *The Chichester subregion comprises the northern section of the Pilbara Craton. Undulating Archaean granite and basalt plains include significant areas of basaltic ranges. Plains support a shrub steppe characterised by* Acacia inaequilatera *over* Triodia wiseana *(formerly* Triodia pungens*) hummock grasslands, while* Eucalyptus leucophloia *tree steppes occur on ranges. The climate is Semi-desert-tropical and receives 300 mm of rainfall annually. Drainage occurs to the north via numerous rivers (e.g. De Grey, Oakover, Nullagine, Shaw, Yule, Sherlock). Subregional area is 9 044 560 ha.*

Fortescue Plains (PIL2, Kendrick 2002a):

> *Alluvial plains and river frontage. Extensive salt marsh, mulga-bunch grass, and short grass communities on alluvial plains in the east. Deeply incised gorge systems in the western (lower) part of the drainage. River Gum woodlands fringe the drainage lines. Northern limit of Mulga (*Acacia aneura*). An extensive calcrete aquifer (originating within a palaeo-drainage valley) feeds numerous permanent springs in the central Fortescue, supporting large permanent wetlands with extensive stands of River Gum and Cadjeput* Melaleuca *woodlands. Climatic conditions are semi desert tropical, with average rainfall of 300 mm, falling mainly in summer cyclonic events. Drainage occurs to the north-west. Subregional area is 2 041 914 ha.*

Hamersley (PIL3, Kendrick 2002b):

> *Mountainous area of Proterozoic sedimentary ranges and plateaux, dissected by gorges (basalt, shale and dolerite). Mulga low woodland over bunch grasses on fine textured soils in valley floors, and* Eucalyptus leucophloia *over* Triodia brizoides *on skeletal soils of the ranges. The climate is semi-desert tropical, average 300 mm rainfall, usually in summer cyclonic or thunderstorm events. Winter rain is not uncommon. Drainage into either the Fortescue to the north, the Ashburton to the south, or the Robe to the west. Subregional area is 6 215 092 ha.*

Roebourne (PIL4, Kendrick & Stanley 2002):

> *Quaternary alluvial and older colluvial coastal and subcoastal plains with a grass savannah of mixed bunch and hummock grasses, and dwarf shrub steppe of* Acacia stellaticeps *or* A. pyrifolia *and* A. inaequilatera. *Uplands are dominated by* Triodia *hummock grasslands.*

Ephemeral drainage lines support Eucalyptus victrix *or* Corymbia hamersleyana *woodlands. Samphire,* Sporobolus *and mangal occur on marine alluvial flats and river deltas. Resistant linear ranges of basalts occur across the coastal plains, with minor exposures of granite. Islands are either Quaternary sand accumulations, or composed of basalt or limestone, or combinations of any of these three. Climate is arid (semi-desert) tropical with highly variable rainfall, falling mainly in summer. Cyclonic activity is significant, with several systems affecting the coast and hinterland annually. Subregional area is 2 008 983 ha.*

3.2 FLORA

3.2.1 Conservation Significant Flora

For the purposes of this report, conservation significant flora species are those that are listed by the DPaW, as Threatened Flora (TF) and Priority Flora (PF). Flora species are classified as TF or listed as PF where populations are geographically restricted or threatened by local processes.

TF species (previously known in Western Australian as Declared Rare Flora (DRF)) are listed by the DPaW and are protected under the Western Australian *WC Act 1950.* Rare flora species, as they are termed in the *WC Act*, are gazetted under Sub-section 2 of Section 23F, thereby making it an offence to remove or damage rare flora without Ministerial approval.

Some TF species have additional legislative protection by being listed under the Commonwealth *EPBC Act 1999*. Definitions of the Commonwealth *EPBC Act* categories are provided in **Table 14** in **Appendix One**.

There are seven categories covering State-listed TF and PF species (DPaW 2013), which are outlined in **Table 15** in **Appendix One**. PF for Western Australia are regularly reviewed by the DPaW whenever new information becomes available, with species status altered or removed from the list when data indicates that they no longer meet the requirements outlined in **Table 15**.

3.2.2 Commonwealth Protected Matters Search

A Commonwealth Department of the Environment (DoE) online database search (*Protected Matters Search Tool* (*PMST*, Australian Government and DoE 2014)) was conducted and Commonwealth *Species Profile and Threats Database* (DoE 2014) lists were reviewed to identify threatened flora with Commonwealth protection nearby.

The *PMST* search of an early version of the study area and 25 km buffer identified one species that is known to occur within the search area or have habitat that is likely to occur; *Lepidium catapycnon*, listed as Vulnerable under the *EPBC Act 1999*. The nearest record of this species, estimated using the *NatureMap* (Department of Parks and Wildlife [DPaW] 2007-2014) measuring tool, is approximately 50 km south of the study area.

The *PMST* result is included incorporated **Table 23** in **Appendix Two**.

3.2.3 DPaW Threatened and Priority Flora Database Search

A DPaW Threatened Flora database search (DPaW reference 20-0514FL) of an early version of the study area and 40 km buffer identified 78 vascular conservation significant taxa (species, subspecies and varieties) with validated populations within the search area buffer, shown on **Map 3** and included in **Table 23**. These conservation significant flora include two TF, 23 P1, 16 P2, 32 P3 and five P4 taxa. The taxa previously identified within 10 km of the current study area are:

- P1 taxa *Helichrysum oligochaetum*, *Heliotropium muticum* and *Sida* sp. Hamersley Range (K. Newbey 10692)

- P1 taxon *Josephinia* sp. Marandoo (M.E. Trudgen 1554) (P1), although the specimen is identified as being questionable on *FloraBase* (Western Australian Herbarium [WAH] 2014)
- P2 taxon *Paspalidium retiglume*
- P3 taxa *Acacia daweana*, *Indigofera* sp. Bungaroo Creek (S. van Leeuwen 4301), *Iotasperma sessilifolium* and *Rostellularia adscendens* var. *latifolia*
- P4 taxon *Goodenia nuda*, recorded from within the study area.

The DPaW Threatened Flora database search does not identify other significant flora species, described in *Guidance Statement No. 51* (EPA 2004) as including keystone or relictual species, those having anomalous features, range extremities, range extensions, population outliers, restricted subtaxa and hybrids, local endemics or poorly reserved species.

3.2.4 NatureMap Search

NatureMap (DPaW 2007-2014) was reviewed to identify conservation significant flora species that have been recorded from within and near the study area using a simplified version of the early study area and 25 km buffer (**Figure 7**). The *NatureMap* search, conducted in May 2014, identified 22 conservation significant flora species, 21 of which were also identified by the DPaW database search (**Section 3.2.3** above). The *NatureMap* search results are incorporated in **Table 23**.

3.2.5 Significant Species According to Guidance Statement No. 51

Other significant flora species, as described in *Guidance Statement No. 51* (EPA 2004), include keystone or relictual species, those having anomalous features, range extremities, range extensions, population outliers, restricted subtaxa and hybrids, local endemics or poorly reserved species.

Undescribed (new to science) species can also considered as significant according to *Guidance Statement No. 51* (e.g. EPA 2012b). Additionally, Saunders *et al.* (1998), in the Commonwealth *State of the Environment* report, includes undescribed species as having significance as a biodiversity indicator.

Flora and vegetation survey reports from nearby were reviewed to identify any species considered to be significant for reasons other than being listed as TF or PF.

An unnamed *Josephinia* sp. was recorded from a number of locations close to the southern terminus of the study area (Ecoscape 2011a; 2012b; 2012k). Whilst there has been no progress in relation to applying a phrase name to this species, it was considered of significance by the EPA during the Flinders Mines environmental approvals process (EPA 2012b). This species is also included in **Table 23**.

Flora and vegetation survey reports from the northern (Balla Balla) end of the study area alignment were also reviewed to identify if there were any other significant species. None, other than Priority Flora species that were also recorded by the database searches, were identified as significant according to these reports (Astron Environmental Services 2005; Mattiske Consulting Pty Ltd 2006; 2008; 2013a).

3.2.6 Ecoscape Experience

Ecoscape has undertaken a number of flora and vegetation surveys in the Pilbara, including several near the southern end of the study area (e.g. Ecoscape 2011a; 2012a; 2012b; 2012d; 2012f; 2013e) and in near-coastal areas close to Karratha/Roebourne and Port Hedland (Ecoscape 2012j; 2013a; 2013d). Ecoscape considers that *Abutilon* sp. Pritzelianum (S. van Leeuwen 5095) (P1) and *Vigna* sp. rockpiles (R. Butcher et al. RB 1400) (P3) may also occur in the study area; neither were identified by any of the database searches, but have been included in **Table 23**.

3.2.7 Introduced Species

The Western Australian Organism List (WAOL; Department of Agriculture and Food [DAFWA] 2013) details organisms listed as Declared Pests under the *Biosecurity and Agriculture Management (BAM) Act 2007* that replaces the *Agriculture and Related Resources Protection (ARRP) Act 1976*. Under the *BAM Act 2007*, Declared Pests are listed as one of three categories:

- C1 (exclusion), that applies to pests not established in Western Australia; control measures are to be taken to prevent their entry and establishment
- C2 (eradication), that applies to pests that are present in Western Australia but in low numbers or in limited areas where eradication is still a possibility
- C3 (management), that applies to established pests where it is not feasible or desirable to manage them in order to limit their damage.

Some of the more invasive introduced species are also included in a number of other weed lists maintained by DoE and Weeds Australia, including Weeds of National Significance (WONS, Weeds Australia 2012b), the National Environmental Alert List (DSEWPaC 2012a), Sleeper Weeds (DSEWPaC 2012b), Species Targeted for Eradication (DSEWPaC 2012c) and Target Species for Biological Control (Weeds Australia 2012a).

Introduced species (weeds) are commonly recorded, particularly in disturbed areas including those targeted for grazing by stock. Plants are regarded as introduced if they are listed as 'alien' on *FloraBase* (WAH 1998-2014). *FloraBase* (WAH 1998-2014) lists 112 introduced species as having been collected within the Pilbara bioregion, 49 within the Chichester (PIL1) subregion, 31 within the Fortescue Plains (PIL2) subregion, 61 within the Hamersley (PIL3) subregion, 70 within the Roebourne (PIL4) subregion, 47 within the Shire of Roebourne and 78 within the Shire of Ashburton.

3.3 VEGETATION AND ECOLOGICAL COMMUNITIES

3.3.1 Vegetation Association Mapping

During the 1970s, John Beard and associates conducted a systematic survey of native vegetation, describing the vegetation systems in Western Australia at a scale of 1:250 000 in the south-west and at a scale of 1:1 000 000 in less developed areas. The vegetation survey of Western Australia maps and explanatory memoirs (1974-1981) are credited to J.S. Beard (or Beard with various co-authors).

Beard's vegetation maps attempt to depict the native vegetation as it was presumed to be at the time of settlement, and is known as the pre-European vegetation type and extent. They have since been developed in digital form by Shepherd *et al.* (2002), and updated by the Department of Agriculture and Food Western Australia (DAFWA 2012).

The pre-European vegetation associations identified from the study area (DAFWA 2012) and their pre-European and current extents are listed in **Table 2** (Government of Western Australia 2013) and shown on **Map 2**. The total extent of the Pilbara bioregion is 17 808 657.06 ha.

Table 2: Pre-European vegetation associations within the study area (Government of Western Australia 2013)

VEGETATION ASSOCIATION	PILBARA BIOREGION			EXTENT WITHIN THE STUDY AREA	
	PRE-EUROPEAN EXTENT (ha)	CURRENT EXTENT (ha)	% REMAINING	EXTENT (ha)	PROPORTION (%)
82	2,563,583.23	2,550,898.98	99.51	3,566.51	0.14
93	3,042,114.29	3,038,471.70	99.88	18,508.89	0.61
173	1,752,520.89	1,747,677.63	99.72	1,389.12	0.08
175	507,860.18	507,466.82	99.92	3,465.84	0.68
565	108,956.73	108,945.16	99.99	5,195.78	4.77
569	59,337.69	59,337.69	100.00	1,458.30	2.46
587	580,728.60	580,696.99	99.99	6,962.94	1.20
589	728,768.20	724,695.82	99.44	1,400.74	0.19
607	120,789.19	120,599.81	99.84	1,622.66	1.34
626	117,724.44	117,198.13	99.55	2,874.57	2.44
641	18,327.78	18,327.73	100.00	1,016.26	5.54
644	27,199.82	27,068.69	99.52	2,674.53	9.83
645	84,670.25	84,658.03	99.99	565.83	0.67
647	195,859.95	191,710.98	97.88	3,198.19	1.63
649	40,364.42	40,178.20	99.54	3,163.18	7.84

3.3.2 Threatened and Priority Ecological Communities

Threatened Ecological Communities (TECs) are categorised at both Commonwealth (Commonwealth of Australia 1999) and State (DEC 2010) level, whilst Priority Ecological Communities (PECs) are categorised at State level (DEC 2010). The definitions of Commonwealth and State categories are summarised in **Table 16** and **Table 17** respectively in **Appendix One**.

Review of the DPaW TEC list (DPaW Species & Communities Branch 2014a) indicates that the only TEC in the Pilbara defined by vegetation is the vulnerable '*Themeda* grasslands on cracking clay (Hamersley Station, Pilbara)'.

There are no Commonwealth-listed TECs within the Pilbara bioregion (DoE 2014), consequently none were identified by the *PMST* search (Australian Government and DoE 2014).

There are 30 PECs known from the Pilbara DPaW region; review of the DPaW list (DPaW Species & Communities Branch 2014b) indicates that a number of these occur on land systems that intersect with the study area and may occur within it.

3.3.2.1 DPaW Ecological Communities Database Search

A DPaW Ecological Communities database search (reference 21-0514EC) was conducted for an earlier version of the study area and a 40 km buffer. The search results are shown on **Map 3**.

The search identified the TEC '*Themeda* grasslands on cracking clays (Hamersley Station, Pilbara)' as occurring within the 40 km search buffer area. This TEC was identified as occurring in two areas, one approximately 22 km to the south and the other 25 km to the south east of the southernmost branches of the study area. The study area is outside the administrative buffer associated with the TEC.

The PECs identified by the database search are described below (DPaW Species & Communities Branch 2014b).

Two PECs are mapped as occuring within the study area; the P1-P3 'Four plant assemblages of the Wona Land System' (previously 'Cracking clays of the Chichester and Mungaroona Range') and the P3 'Horseflat Land System of the Roebourne Plains', described below.

The 'Four plant assemblages of the Wona Land System' PEC is located in the vicinity of Mt Florance homestead and extends approximately 150 m into the study area, with the 500 m administrative buffer extending further into it. It is described as:

> *a system of basalt upland gilgai plains with tussock grasslands occurs throughout the Chichester Range in the Chichester-Millstream National Park, Mungaroona Range Nature Reserve and on adjacent pastoral leases. There are a series of community types identified within the Wona Land System gilgai plains that are considered susceptible to known threats such as grazing or have constituent rare/restricted species, as follows:*
>
> *P1 Cracking clays of the Chichester and Mungaroona Range. This grassless plain of stony gibber community occurs on the tablelands with very little vegetative cover during the dry season, however during the wet a suite of ephemerals/annuals and short-lived perennials emerge, many of which are poorly known and range-end taxa*
>
> *P1 Annual Sorghum grasslands on self mulching clays. This community appears very rare and restricted to the Pannawonica-Robe valley end of Chichester Range*
>
> *P3(iii) Mitchell grass plains (*Astrebla *spp.) on gilgai*
>
> *P3(iii) Mitchell grass and Roebourne Plain grass (*Eragrostis xerophila*) plain on gilgai (typical type, heavily grazed).*

The P3 'Horseflat Land System of the Roebourne Plains' PEC is mapped as occurring across all of the northern 20 km of the study area. The PEC is described as:

> *extensive, weakly gilgaied clay plains dominated by tussock grasslands on mostly alluvial non-gilgaied, red clay loams or heavy clay loams. Perennial tussock grasses include* Eragrostis xerophila *(Roebourne Plains grass) and other* Eragrostis *spp.,* Eriachne *spp. and* Dichanthium *spp. The community also supports a suite of annual grasses including* Sorghum *spp. and rare* Astrebla *spp. The community extends from Cape Preston to Balla Balla surrounding the towns of Karratha and Roebourne. This community incorporates Unit 3 (Gilgai plains), Unit 5 (Alluvial Plains) with some Unit 7 (Drainage Depressions) described in Van Vreeswyk* et al. *2004.*

Two PECs were identified as occurring within the search area buffer but outside the study area; P1 'Brockman Iron cracking clay communities of the Hamersley Range' and P4 'Invertebrate assemblages (Errawallana Spring type) Coolawanya Station'. Only the former is described in terms of vegetation, and is within the scope of this survey.

The 'Brockman Iron cracking clay communities of the Hamersley Range' occurs approximately 17 km to the south of the southern end of the study area. The PEC is described as:

> *rare tussock grassland dominated by* Astrebla lappacea *in the Hamersley Range, on the Newman land system. Tussock grassland on cracking clays-derived in valley floors, depositional floors. This is a rare community and the landform is rare. Known from near West Angeles, Newman, Tom Price and boundary of Hamersley and Brockman Stations*

3.3.3 Groundwater Dependent Ecosystems

3.3.3.1 Groundwater Definition

Groundwater is water that is found in the saturated zone of the soil, where all soil pores are filled with water. It occurs below the water table in an unconfined aquifer or may be held under pressure in a confined aquifer. Groundwater may also occur as a perched aquifer where is located above unsaturated rock formations as a result of a discontinuous permeable layer (Goulburn-Murray Water 2010).

3.3.3.2 Groundwater Dependent Ecosystems Definition

Groundwater Dependent Ecosystems (GDEs) have been defined as ecosystems that are dependent on groundwater for their survival at some stage or stages of their lifecycle, however groundwater use cannot be equated with groundwater dependence (Eamus 2009b).

Hatton and Evans (1998) identified four types of GDEs based on their geographic setting: terrestrial vegetation (vegetation communities and dependent fauna that have seasonal or episodic dependence on groundwater), river base flow systems (aquatic and riparian ecosystems that exist in or adjacent to streams that are fed by groundwater base flow), aquifer and cave ecosystems, and wetlands.

Eamus *et al.* (2006) identified three primary classes based on type of groundwater reliance:

1. Aquifer and cave ecosystems.
2. All ecosystems dependent on the surface expression of groundwater:
    a) river base flows
    b) wetlands, swamplands
    c) seagrass beds in estuaries
    d) floodplains
    e) mound springs
    f) riparian vegetation
    g) saline discharge to lakes
    h) low lying forests.
3. All ecosystems dependent on the subsurface presence of groundwater, often accessed via the capillary fringe (non-saturated zone above the water table) when roots penetrate this zone:
    a) River Red Gum (*Eucalyptus camaldulensis*) forests
    b) Banksia woodlands
    c) Riparian vegetation in the wet/dry tropics.

GDEs in the Pilbara are generally determined to be vegetation associated with riparian areas. GDEs dependent on the surface expression of groundwater (Eamus *et al*. 2006 class 2) includes vegetation associated with wetlands (permanent or semi-permanent pools) within riparian areas, and generally includes *Melaleuca argentea* in association with other species described below. GDEs associated with the subsurface presence of groundwater (Eamus *et al*. 2006 class 3) includes riparian vegetation characterised by the phreatophytic species described below.

3.3.3.3 Phreatophytic Species

Phreatophytic species rely on groundwater sources for water intake (e.g. Maunsell Australia Pty Ltd 2006); essentially the water requirements of phreatophytes are greater than can be provided from the surface soil profile (e.g. riparian vegetation) or they are dependent on free water availability (e.g. wetland species). They frequently show low tolerance to extended water stress due to a lack of physiological and/or morphological adaptation to drought, and respond to significant water deficit by a decline in health and eventual death (*ibid.*).

Obligate phreatophytes are dependent on free access to water (i.e. they are wetland species) whereas facultative phreatophytes can switch their water source between the soil surface profile in times of rain, to groundwater in times of drought when the soil surface profile (vadosphere) is depleted (Grierson 2010).

Phreatophytic species that are known from nearby are:

- *Eucalyptus camaldulensis* subsp. *refulgens*, which is regarded as a facultative phreatophyte that is dependent on groundwater for part of its lifecycle and/or in times of drought. This species has been reported to be tolerant of groundwater falls of up to 4 m per year (Maunsell Australia Pty Ltd 2006), has both lateral and sinker roots and is tolerant of waterlogging (Grierson 2010).
- *Eucalyptus victrix*, which may be regarded as a facultative phreatophyte. It is considered to be relatively drought tolerant and likely to be tolerant of gradual declines to the water table (to a degree) (Maunsell Australia Pty Ltd 2006). *Eucalyptus victrix* has lateral and sinker roots (i.e. a dimorphic root system) but is not tolerant of waterlogging (Grierson 2010). There is some conjecture that this species is actually a vadophyte (i.e. relies on water from within the soil surface profile, and is independent of groundwater) or, at best, weakly phreatophytic (Resource and Environmental Management Pty Ltd 2007).

Vegetation containing *Eucalyptus camaldulensis* subsp. *refulgens* and *Eucalyptus victrix* are considered to represent GDEs.

It should be noted, however, that there is supporting evidence that, at least in some circumstances (Batini 2009; Eamus 2009a; EPA and Hamersley Iron Pty Ltd 2010; Resource and Environmental Management Pty Ltd 2007), *Eucalyptus victrix* does not always depend on groundwater. Therefore vegetation containing this species may not always be definitive of a GDE.

3.3.3.4 Atlas of Groundwater Dependent Ecosystems

The *Atlas of Groundwater Dependent Ecosystems* (BoM 2014a) was interrogated to determine the presence of known GDEs and Inflow Dependent Ecosystems (IDEs) within the study area.

An Inflow Dependent Ecosystem is one in which the vegetation within the landscape is likely to be accessing water in addition to rainfall, from soil or surface water or groundwater, assessed using remotely sensed data. The likelihood of a landscape using additional water is rated from one to 10 (low to high), with a rating above six indicating that a landscape is likely to be inflow dependent (BoM 2014a).

The *Atlas* was interrogated using a polygon covering the study area and an adequate buffer. Interrogation of the *Atlas* identified several areas within the study area either mapped in previous desktop surveys as being a GDE or being identified as having a high potential for groundwater interaction due to association with major drainages. The type of GDE and the geomorphology associated with these ecosystem types, which are likely to be encountered within the study area are described below in **Table 3**.

Table 3: Type of GDE, likelihood and associated geomorphology potentially occurring within the study area (BoM 2014a)

NAME	POTENTIAL FOR GDE	IDE LIKELIHOOD	LANDSCAPE POSITION	GEOMORPHOLOGY
Ecosystem Type: River				
Weelumurra Creek	High potential for groundwater interaction	10	Low Lying	Mainly alluvial lowland with hardpan wash plains and sandplain, possibly a graben.
Fortescue River	High potential for groundwater interaction	8-10	Low Lying	Mainly alluvial lowland with hardpan wash plains and sandplain, possibly a graben.
Sherlock River	High potential for groundwater interaction	7	Low Lying	Dissected flat-topped hills of granitic, volcanic and metamorphic rocks; interspersed by stony plains on granite.
Sherlock River	High potential for groundwater interaction	10	Low Lying	Floodplains and deltaic plains with stony plains and sandplains; tidal flats and some metamorphic, volcanic and granitic hills and islands.
Sherlock River	High potential for groundwater interaction	8	Low Lying	Narrow range of hills and dissected plateaus on basalt and sedimentary rocks.
Ecosystem Type: Permanent Pools				
Pool	Identified in previous study: desktop	9-10	Low Lying	Dissected flat-topped hills of granitic, volcanic and metamorphic rocks; interspersed by stony plains on granite.
Ecosystem Type: Pool				
Pool	Identified in previous study: desktop	6-10	Low Lying	Dissected flat-topped hills of granitic, volcanic and metamorphic rocks; interspersed by stony plains on granite.
Pool	Identified in previous study: desktop	7-10	Low Lying	Floodplains and deltaic plains with stony plains and sandplains; tidal flats and some metamorphic, volcanic and granitic hills and islands.
Pool	Identified in previous study: desktop	5-10	Low Lying	Narrow range of hills and dissected plateaus on basalt and sedimentary rocks.
Pool	**Identified in previous study: desktop**	**9-10**	**Slope**	**Dissected bold plateaus and ranges of flat lying or moderately folded sandstone, quartzite and volcanic rocks.**

3.3.4 Mulga Communities

Mulga is the common name for a group of closely related *Acacia* species that were formerly known as *Acacia aneura* and its subtaxa. A recent taxonomic review (Maslin & Reid 2012) has resulted in a revision of this group, and Mulga now includes *Acacia aneura*, *A. aptaneura*, *A. ayersiana*, *A. caesaneura*, *A. craspedocarpa*, *A. fuscaneura*, *A. incurvaneura*, *A. macraneura*, *A. minyura*, *A. mulganeura*, *A. paraneura* and *A. pteraneura*, although not all are present in the Pilbara.

Mulga community types can be considered as significant, and are recognised as such in a number of publications including the *Biodiversity Audit of Western Australia's 53 Biogeographical Subregions in 2002* (Department of Conservation and Land Management [CALM] 2002) – see below, and various EPA approvals documents where environmental objectives are set or conditions imposed to restrict impacts on Mulga vegetation (e.g. EPA 2010; 2012a). Despite being recognised as a significant, there is currently no statutory protection for any Mulga community.

Sheet Flow Dependent Mulga (also known more generally as Sheet Flow Dependent Vegetation, SFDV) occurs in groves or bands and can be inferred from species composition, community structure and topography. SFDV relies on overland (sheet) flow of water across a relatively flat landscape to regenerate (Muller 2005; The University of Western Australia *et al*. 2012), and as such changes in topography caused by mining or infrastructure, including roads and railways, can have a significant impact.

3.3.5 Ecosystems at Risk

'Ecosystems at Risk' were identified by regional ecologists and others as part of the *Biodiversity Audit of Western Australia's 53 Biogeographical Subregions in 2002* (CALM 2002), however they do not have any formal legislative protection. Some have since been identified as TECs or PECs.

'Ecosystems at Risk' identified from the Chichester subregion (PIL1) of the Pilbara (Kendrick & McKenzie 2002) that may occur in or near the study area are now included in the 'Four plant assemblages of the Wona Land System' PEC.

'Ecosystems at Risk' identified from the Fortescue Plains subregion (PIL2) of the Pilbara (Kendrick 2002a) that may occur in or near the study area include:

- 'Perennial grassland communities in the Fortescue Valley'; no status given.

'Ecosystems at Risk' identified from the Hamersley subregion (PIL3) of the Pilbara bioregion (Kendrick 2002b) that may occur in or near the study area include:

- the vulnerable 'Grove/inter-grove mulga, eastern Hamersley Range' ecosystem
- the vulnerable 'Valley floor mulga' ecosystem
- the vulnerable 'All major ephemeral water courses'.

No 'Ecosystems at Risk' were identified from the Roebourne subregion (Kendrick & Stanley 2002) that may occur in or near the study area (other than those now considered to represent a PEC).

3.3.6 Significant Vegetation According to Guidance Statement No. 51

Guidance Statement No. 51 (EPA 2004) also lists a number of reasons why vegetation may of conservation interest, in addition to being listed as a TEC or PEC or because the extent is below a minimum threshold. These reasons, which may apply at a number of scales but are not defined in detail, include scarcity, unusual species, novel combinations of species, role as a refuge, role as a key habitat for threatened species or large populations representing a significant proportion of the local to regional total population of a species, being representative of the range of a unit (particularly a good local and/or regional example of a unit in 'prime' habitat, at the extremes of range, recently discovered range extension or isolated outliers of the main range) and restricted distribution.

Flora and vegetation reports from nearby areas were reviewed to identify vegetation that was considered significant according to *Guidance Statement No. 51*. A number of vegetation types having restricted distributions were identified as being locally significant including:

- riparian vegetation in the Flinders Blacksmith tenement (Ecoscape 2011a), Fortescue Metals Group (FMG) Central Pilbara Project Area (Ecoscape 2012b) and Balla Balla Vanadium project area (Mattiske Consulting 2006), characterised by *Eucalyptus victrix* and/or *E. camaldulensis*
- vegetation characterised by *Carissa spinarum* (now known as *C. lanceolata*) over *Triodia wiseana* and *T. epactia* in the Balla Balla Vanadium project area (Mattiske Consulting 2006)
- vegetation restricted to gorges in the Flinders Blacksmith tenement (Ecoscape 2011a) and FMG Central Pilbara Project Area (Ecoscape 2012b)
- vegetation restricted to high hilltops, characterised by *Eucalyptus kingsmillii* and *E. gamophylla*, in the FMG Central Pilbara Project Area (Ecoscape 2012b)

- *Acacia maitlandii* Shrubland on low hills in the Flinders Blacksmith tenement (Ecoscape 2011a)
- *Acacia orthocarpa* (atypical form) Shrubland in the Flinders Blacksmith tenement (Ecoscape 2011a)
- sheet flow dependent Mulga in the FMG Central Pilbara Project Area (Ecoscape 2012b).

3.3.7 Previous Surveys

There are very few known (publicly available) flora and vegetation surveys that have been conducted in areas corresponding with or close to the study area. Reports associated with previous surveys from areas close to the northern (Balla Balla) and southern (Flinders Blacksmith tenement and Fortescue Metals Group Solomon Project) ends of the study area that have been reviewed in association with this project are:

- Balla Balla:
    - Mattiske Consulting (2013a) *Flora and vegetation survey of the Balla Balla export facilities, proposed infrastructure corridor within L47/690*
    - Mattiske Consulting (2008) *Flora and vegetation survey of the Balla Balla pipeline*
    - Mattiske Consulting (2006) *Flora and vegetation survey of the Balla Balla Vanadium Project*
    - Astron Environmental Services (2005) *Balla Balla Vanadium Project Vegetation and Flora Survey*
- Flinders Blacksmith tenement:
    - WorleyParsons (2010) *Pilbara Iron Ore Project: Preliminary Desktop Environmental Study at E47/882*
    - Ecoscape (2011a) *Pilbara Iron Ore Project – Blacksmith Flora and Vegetation Survey*
    - Ecoscape (2012d) *Groundwater Dependent Ecosystem Mapping*
- Fortescue Metals Group Solomon Project:
    - Coffey Environments (2010b) *Flora and Vegetation Assessment, Solomon Rail Project - Volume 1*
    - Ecoscape (2010a) *Level Two Flora and Vegetation Assessment, Firetail Mining Area*
    - Ecoscape (2010c) *Solomon Project Airstrip Flora and Vegetation Assessment*
    - Ecoscape (2010d) *Solomon Project Rail Re-alignment Flora and Vegetation Assessment*
    - ENV Australia (2010) *Solomon Project: Kings Flora and Vegetation Assessment.*

Ecoscape has also undertaken a number of unpublished surveys near the southern end of the study area and has received survey reports from other consultants as reference material for these:

- Ecoscape (2013b) *Delphine Level 2 Flora and Vegetation Survey (Phase 2)*
- Ecoscape (2013c) *Eliwana and Flying Fish Level 2 Flora and Vegetation Survey (Phase 2)*
- Ecoscape (2013e) *Western Hub Rail Link Level 2 Flora and Vegetation Survey*
- Ecoscape (2012a) 'Themeda *Grasslands on Cracking Clay' TEC Assessment*
- Ecoscape (2012b) *Central Pilbara Project Level 2 Flora and Vegetation Assessment*
- Ecoscape (2012e) *Groundwater Dependent Ecosystem Mapping and Conservation Significant Flora Survey*
- Ecoscape (2012f) *Level 1 Vegetation, Flora and Fauna Assessment, and Targeted Conservation Significant Flora and Fauna Survey: Mt Macleod West*
- Ecoscape (2012h) *Mt Farquhar Phase One Flora and Vegetation Survey*
- Ecoscape (2012k) *Vegetation, Flora and Fauna Assessment, and Targeted Conservation Significant Flora and Fauna Survey: Raven*
- Coffey Environments (2010a) *Flora and Vegetation Assessment, Solomon Project and Investigator - Volume 1*
- Coffey Environments (2011) *Robe pisolite assessment and targeted Gompholobium karijini (P2) survey, Solomon Mine Project.*

Ecoscape has also undertaken flora and vegetation surveys near the northern end of the study area alignment, largely in the Karratha/Roebourne and Port Hedland areas:

- Ecoscape (2013a) *Cape Lambert to Wickham 33kV Line: Targeted Flora and Fauna Surveys*
- Ecoscape (2013d) *Pilbara Vegetation Asset Intersect Review*
- Ecoscape (2012j) *Pippingarra Quarry Priority Flora Survey and Delineation*
- Ecoscape (2011b) *Pippingarra Quarry Vascular Flora and Vegetation Survey*
- Ecoscape (2010b) *Port Hedland Water Supply Flora and Vegetation Assessment.*

Results of these surveys are confidential however the reports have been reviewed for relevant information.

3.3.7.1 Environmental Approval Documentation

Environmental approvals documents for the Balla Balla and Flinders Blacksmith areas include:

- EPA (2009) *Report and recommendations of the Environmental Protection Authority: Balla Balla Magnetite Project, Ferro Metals Australia Pty Ltd. Report 1309*
- EPA (2012b) *Report and recommendations of the Environmental Protection Authority: Flinders Pilbara Iron Ore Project - Stage 1. Report 1456*
- EPA (2013) *Report and recommendations of the Environmental Protection Authority: Balla Balla Export Facilities, Forge Resources Swan Pty Ltd. Report 1481*.

The EPA (2013) report identified the following as being significant in relation to the Balla Balla Export Facility, although there were no environmental conditions set in response:

- no TF or TECs were identified from the study area
- P1 *Heliotropium muticum* had previously been recorded from close to the survey area, although there was no indication that it was recorded from within it
- parts of the study area resemble the P3 'Horseflat land system of the Roebourne Plains' PEC, however the proportion of the PEC as a whole that may be impacted was small.

The EPA (2009) report identified the following as being significant in relation to the Balla Balla Magnetite Mine, however no environmental conditions were set in response as the proponent had taken steps to minimise impacts:

- no TF or TECs were identified from the study area
- there may have been Priority Flora species within the survey area however they could not be identified with certainty as they were in vegetative condition; the EPA considered that, even if the potential species were PF, that the impacts would be low
- there may have been vegetation representative of the P3 'Roebourne Plains coastal grassland' PEC, however this could not be confirmed due to grazing and fire impacts; the EPA considered that the proposed clearing would not impact on the conservation status of the PEC
- impacts to groundwater dependent vegetation would be minimal.

The EPA (2012b) report identified the following as being significant in relation to the Flinders Blacksmith tenement, with some conditions set as listed below:

- no TF, TECs or PECs were identified from the study area
- three P3 and two P4 species were recorded
- an undescribed *Josephinia* sp. was identified from study area however it was recorded in an area outside the impact zone; the EPA supports additional surveys but did not impose them as a condition
- a groundwater dependent vegetation monitoring and management plan would be required
- residual impacts management measures and offset conditions were imposed.

4.0 METHODS

4.1 FLORA AND VEGETATION ASSESSMENT

The Rutila rail survey was conducted as a single season Level 2 flora and vegetation assessment that, as much as possible, complied with the guidelines listed in **Section 1.3** and the vegetation condition rating scale included in EPA and DEC (2012) *Draft Technical Guide - Flora and Vegetation Surveys for Environmental Impact Assessment. Version 1, February 2012*. The EPA is anticipated to provide guidance if a second season of survey will be required, based on the results of this assessment.

Level 2 surveys incorporate background research and a reconnaissance survey as preparation for a more intensive and detailed survey conducted over one or more visits in the main flowering season, followed by visits in other seasons. Level 2 surveys also involve replication of the survey, greater coverage than a Level 1 survey and displacement of plots over the target area.

Data collected during the field survey was used to:

- describe and map the vegetation types of the study area to indicate the distribution and relative abundance of each vegetation type
- document the vascular flora of the study area and provide a measure of the overall floristic richness
- identify species and vegetation types of particular conservation significance.

4.1.1 Reconnaissance Survey

The reconnaissance survey was undertaken by Lyn Atkins and Jared Nelson during May 26-29, 2014. The purposes of this survey were to:

- identify access opportunities and constraints for future flora and vegetation surveys
- commence vegetation type assessment and mapping to identify potential representative floristic quadrat locations and potentially significant vegetation types
- commence ground truthing of habitat types of conservation significant flora to better target future searches.

The survey was undertaken by driving to and, where possible, along the study area alignment and recording relevant information, however between the reconnaissance survey and Level 2 survey part of the proposed alignment changed.

A preliminary conservation significant flora likelihood assessment was undertaken (see **Section 4.2.2** below) following the reconnaissance survey to identify target areas for conservation significant flora searches during the Level 2 survey. The final conservation significant flora likelihood assessment included in **Appendix Nine** was conducted following the field surveys.

4.1.2 Level 2 Flora and Vegetation Survey

The Level 2 field surveys were undertaken over two separate field trips.

The first field survey, undertaken during July 7-17 2014, assessed the northern end of the alignment, south to the Nunyerry Gap at the northern edge of the Chichester Range. The field personnel were:

- Lyn Atkins B.App.Sc. (Multi. Sc.)
- Richard Daniel B.Sc. (Env. Biol.)
- Andrew Fry B.Sc. (Env. Sc., Hons)
- Sonya Bateman B.Sc. (Geog., Hons).

The second field survey, undertaken during July 28-August 7 2014, assessed the alignment south of the Nunyerry Gap. The field personnel were:

- Jared Nelson B.Sc (Agric., Hons)
- Stephen Kern B.Sc. (Plant Sc., Hons)
- Andrew Fry (as above)
- John Scanlon B.Sc.(Biol., Hons.), PhD.

The field survey included:

- establishing and scoring floristic quadrats (abbreviated to 'quadrats') and some detailed relevès (unbounded areas) where the location was not appropriate regularly-shaped quadrats
- collection of an opportunistic flora inventory (species within the study area that were not recorded in quadrats)
- preliminary vegetation type mapping
- vegetation condition assessment and mapping
- targeted conservation significant flora searches and recording opportunistic observations.

DPaW flora collecting permits are listed in **Section 1.4**.

4.1.2.1 Floristic Survey

Vegetation and floristic data were collected and described from 152 quadrats 50 m x 50 m in dimension or equivalent area if linear (e.g. along a drainage line), which is in line with the DPaW's (Department of Conservation and Land Management [CALM] 2003) *Draft Botanical Survey Requirements for the Pilbara Region* and EPA (2004) *Guidance Statement No. 51*. Four detailed relevès were also recorded in areas where it was not possible to accurately measure area (e.g. a rocky knoll), however the survey intensity was comparatable to quadrats thus the level of detail was equivalent.

Floristic, biological and physical data were collected and recorded from each of these quadrats and relevès. The flora records provide the names used in the vegetation descriptions and contribute to the flora species lists and frequency of occurrence data. Various parameters relating to the individual quadrats were used to assist in both the description of vegetation types and the determination of flora distribution, particularly in terms of defining associated landforms.

The quadrats and relevès were spatially distributed over the study area in areas of representative vegetation, as determined during the reconnaissance survey, with additional quadrats and relevès added as necessary to represent less common vegetation types identified during the field survey.

At the request of one of the pastoralists the quadrats were not marked in any way, however their area was accurately measured (**Plate 1**). Quadrats were oriented in a north-south and east-west direction, except where they were located in linear vegetation types (e.g. drainage lines). Quadrats and most relevès were numbered using the protocol of R14xxx, where R = Rutila, 14 =2014 and xxx represents the three digit quadrat number. One relevè was numbered R14R1.

Plate 1: Measured quadrat example

The following parameters were recorded at each quadrat and relevè:

- MGA coordinates recorded in GDA 94 datum using a hand-held Global Positioning System (GPS), to an accuracy usually within 5 m
- National Vegetation Inventory System (NVIS) vegetation description based on the height and estimated cover of dominant species (National Heritage Trust [NHT] 2003); **Table 18** and **Table 19** in **Appendix One**
- an inventory of all species, with estimated maximum height and percent foliage cover
- description of landform and habitat
- broad description of surface soil type and stony surface mantle
- percentage of litter cover and depth
- percentage of bare ground
- evidence of grazing, mining exploration activities, weed invasion, frequent fires etc. Fire effects were only considered a negative impact if they were caused by repeated burning (e.g. for pastoral purposes).

Photographs of the vegetation at each site were taken from the north-west corner (or nearest equivalent for linear quadrats) of each quadrat.

Flora species were also opportunistically recorded on traverses between quadrat locations.

4.1.2.2 Flora Identification and Data Entry

Voucher specimens were collected of all species that could not be identified with confidence in the field and at least one specimen of each potential conservation significant flora species. Each voucher specimen was assigned a unique number to facilitate tracking of data, and pressed in the field. Specimens collected were dried and treated in accordance with the requirements of the WAH.

These voucher specimens were identified by Ecoscape (mostly Stephen Kern) to infrataxa (subspecies, variety, affinity or hybrid) level where possible, using appropriate publications, and comparison with pressed specimens housed at the WAH. The identification of all suspected conservation significant flora and various other taxonomically complex species were verified by ME Trudgen.

Nomenclature was checked against the current listing of scientific names recognised by the WAH and listed on *FloraBase* (WAH 1998-2014) and updated as necessary.

All raw site data was entered into a Microsoft Access database, with species names entered following formal identification of the collected specimens.

4.1.2.3 Conservation Significant Flora Searches

Due to the size of the study area, no systematic grid search of the study area for conservation significant flora was undertaken. However, when traversing between sites, every opportunity was taken to search for conservation significant flora species, especially where preferred habitats were encountered. The search spacing between surveyors was approximately 20-30 m (i.e. when walking between sites, the two surveyors walked parallel lines, searching either side of the walked line for species identified by the database searches).

Targeted searches were also conducted in areas identified by the conservation significant flora likelihood assessment conducted following the reconnaissance survey.

In order to assist with identification in the field, survey teams had access to literature (including images) of conservation significant species identified by the database searches. Specimens of all PF species were collected for identification purposes. Locations and population estimates were recorded for all populations of PF identified during the field survey.

4.1.2.4 Significant Flora

TF and PF are considered to be conservation significant. Other significant flora are considered such according to *Guidance Statement No. 51* (EPA 2004). Significant flora includes species that are:

- a range extension, defined as a new population/s or occurrence/s more than 100 km from the nearest vouchered specimen included in the WAH, or where it occurs in a new IBRA subregion, irrespective of distance
- a range edge or end of the extreme continuous distribution limit of vouchered specimens
- a disjunct population or outlier that is more than 100 km from the outer limits of the main vouchered continuus distribution
- endemics that are confined to a particular area, in most case a Biogeographical region
- narrow endemics that are restricted to a range of less than 150 km.

No specific searches for significant flora searches (other than for conservation significant flora) were conducted.

4.1.2.5 Introduced Species

Flora species were considered to be introduced (weeds) if they are listed as 'alien' on *FloraBase* (WAH 1998-2014).

No specific searches were conducted for introduced species; they were recorded as a cover value where they were recorded within quadrats, or recorded opportunistically.

Declared Pest plants listed under the *BAM Act 2007* had their locations recorded.

4.1.2.6 Vegetation Descriptions

Vegetation was described from each of the quadrats using the height and estimated cover of dominant and characteristic species of each stratum based on NVIS (2003) (**Table 18** and **Table 19** in **Appendix One**), recorded at Level V. Up to three species per stratum from each stratum (upper, mid and ground) were used to formulate vegetation descriptions for each quadrat and each vegetation type.

Vegetation codes are formulated using initials for dominant and characteristic species in each strata. For example the (not real) vegetation code '**ElAs$_4$Te(1)**' has *Eucalyptus leucophloia subsp. leucophloia* ('El') as the most dominant species of the upper stratum, *Acacia arida* ('As$_4$') as the most dominant species of the mid stratum, *Triodia epactia* (Te) as the most dominant species of the ground stratum and (1) to represent that this is the first vegetation type with the same combination of dominant species. Not all strata may be present in all vegetation types.

4.1.2.7 Vegetation Condition

The vegetation condition at quadrats was assessed using the adapted Keighery Vegetation Condition Scale for Eremaean and Northern Botanical Provinces included in the *Draft Technical Guide – Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA & DEC 2012). This rating scale is outlined in **Table 20** in **Appendix One**.

The vegetation condition of the study area was assessed by extrapolating the value recorded for each quadrat and applying the condition to the vegetation type in the vicinity and from 'spot' evaluations recorded during traverses through the study area.

4.2 FLORA AND VEGETATION SIGNIFICANCE

4.2.1 Determination of Flora Significance

Flora taxa are significant if they are listed as TF or PF (conservation significant), or are significant according to *Guidance Statement No. 51* (EPA 2004).

All flora taxa recorded during the field survey are assessed for significance.

4.2.2 Conservation Significant Flora Likelihood Assessment

Whilst both targeted and opportunistic searches for conservation significant flora species were undertaken during the field survey, it was not possible to access all areas to carry out intensive searches. Therefore, whilst some species identified by the database searches (**Table 23** in **Appendix Two**) were recorded during the survey, some of the remaining listed potential species may occur. In order to achieve a better understanding of the likelihood of conservation significant species occurring within the study area, a likelihood assessment of possible taxa was undertaken (**Table 29** in **Appendix Ten**).

The likelihood of a species occurring in the study area is based on the following attributes, as listed on *FloraBase* (WAH 1998-2014; 2014) and tailored to Pilbara populations and including information from recent nearby surveys. The attributes were:

- broad soil type usually associated with the species
- broad landform usually associated with the species
- usual vegetation (characteristic species) with which the species is usually associated
- species having previously been recorded from within approximately 50 km of the study area (considered as 'nearby').

The likelihood rating is assigned using the following categories:

- Known (recorded): it does occur within the study area and was recorded during the field survey or there are reliable historical records of it occurring in the study area
- Possible: it may occur within the study area (but was not recorded); broadly, 2-4 of the required attributes (but always including records from nearby) are present in the study area
- Unlikely: it could occur but is not expected; 1-3 of the required attributes are present in the study area but:
    - it is not known from nearby, or
    - it is known from nearby but has no other required attributes, or

- it is known from nearby but has at least one well-defined attribute that does not occur in the study area (e.g. it is associated with a specific landform or soil type that does not occur in the study area)

- Highly Unlikely: the species characteristics include none of the required attributes of soil, landform, associated vegetation and having previously been recorded nearby, or a critical element (often landform) is not within the study area and as such it almost certainly does not occur within the study area.

The conservation significant flora likelihood assessment was initially conducted following the reconnaissance survey to identify potential habitat areas for targeted searches. The assessment was then reviewed following the field survey using more detailed information to identify the likelihood of species occurring in the study area.

4.2.3 Vegetation Significance Assessment

A calculation matrix was developed to assess local and regional vegetation significance. Vegetation was considered as potentially significant if it was confirmed or considered likely to be representative of a TEC or PEC, if it was significant according to *Guidance Statement No. 51*, was considered significant in other nearby areas, or had other significant attributes. Ecoscape's interpretation of these attributes is given below.

Significant According to *Guidance Statement No. 51*

The vegetation of the study area was assessed to determine if it meets any of the criteria for significance listed in *Guidance Statement No. 51* (see **Section 3.3.6**). For this assessment, the *Guidance Statement No. 51 (GS51)* criteria were interpreted to include:

- 'scarcity' and 'restricted distribution' are included in 'small extent within the study area'
- 'role of refuge' and 'role as key habitat' are included in 'supports PF/new spp.' and other specific habitat attributes ('restricted landform', 'riparian' and 'Mulga')
- 'unusual species' are defined as species interpreted to occur in areas other than their usual habitat, and included in 'significant according to *GS51*'
- 'novel combination of species' is interpreted as being a combination of species that the senor botanist did not expect, given their experience, and included in 'significant according to *GS51* or significant nearby'
- 'being representative of a range of a unit/good example' is interpreted, based on the senior botanist's experience, as being a particularly good representative of a vegetation type or a range edge, extension or outlier of a vegetation type, and included 'significant according to *GS51* or significant nearby'.

Significant in Nearby Areas

The vegetation types recorded from the study area were compared with those considered as significant in nearby areas (see **Section 3.3.7**). This comparison was based on both species composition and landscape position/landform, where known.

Vegetation considered similar to significant vegetation from nearby is included in 'significant according to *GS51* or significant nearby'.

4.2.4 Floristic Analysis

PATN© software (Belbin & Collins 2006) was used to undertake statistical analysis to generate floristic groups using the data collected from the floristic quadrats detailed relevès, in order to better understand local significance of floristic units. PATN analysis has been used for several local floristic analyses including Gibson *et al.* (1994) for the Swan Coastal Plain, and is routinely used for regional floristic analysis in the Pilbara by ME Trudgen and E Griffin (e.g. Ecoscape 2010a; 2011a).

PATN is a multivariate analysis tool that generates estimates of association (resemblance, affinity, distance) between sets of objects described by a suite of variables (attributes), and classifies the objects into groups and condenses the information and displays the patterns in the data graphically.

PATN offers a choice of data transformations prior to multivariate analysis.

Floristic groups, identified using a dendrogram output of the analysis, are used as a tool to inform vegetation type groups at various levels and scales. Floristic quadrat data is used for the analysis.

Prior to conducting the floristic analysis the data is 'cleaned' to 'remove noise' by deleting singletons (i.e. species that only occurred in one quadrat) and any species where there was doubt that it was unique. For this analysis, the Kulczynski similarity coefficient was the appropriate association to use as it has proven to be a good estimation of association for ecological applications (Belbin & Collins 2006). This was followed by Flexible UPMGA (Un-weighted Pair Group Using Arithmetic Averaging) fusion to produce clusters of related objects (species); these are the floristic groups that are displayed as a dendrogram.

Interpretation of these purely floristic groups into recognisable and mappable on-ground units is a tool used to identify vegetation types. Generally, quadrats that are closely floristically related on the dendrogram form identifiable vegetation units, however, as presence-absence data is usually used in the analysis and there is no weighting given to dominant species, at times the floristic groups are not easily related to on-ground vegetation types. Vegetation types are therefore determined as a combination of floristic analysis and on-ground interpretation using dominant and characteristic species.

4.3 ADEQUACY OF SAMPLING

In order to demonstrate adequacy of sampling, a species accumulation curve was generated by the computer programme Species Diversity and Richness (Pisces Conservation Ltd 2007) using five random selections of sample order, and using only quadrat data.

A taxa by area plot was also created using floristic quadrat data for the study area and nearby. This plot gives an indication of relative species richness, and can also provide an indication of survey adequacy.

Adequacy of sampling is also assessed in terms of representation of various attributes, including vegetation types and representation of land systems.

5.0 RESULTS

5.1 FLORA ASSESSMENT

5.1.1 Flora Inventory

Quadrat and relevè details are included in **Appendix Four**, and the complete flora inventory (**Table 26**) in **Appendix Five**. The quadrat and relevè species matrix (**Table 27**) is included in **Appendix Six**.

A total of 474 vascular flora taxa (including species, subspecies, varieties, hybrids, affinities and forms, including native and introduced species) were recorded from the 156 quadrats and relevès, opportunistic observations and conservation significant flora searches. Of these, nine were of conservation significance (**Section 5.1.2.3**) and 16 were introduced (**Table 5**).

Due to lack of reproductive material, 23 taxa could only be identified to genus level and one to family level, totalling 5% of taxa. It is possible that some of the unidentified taxa are represented as a named taxon in the flora inventory. One (*Acacia* sp.) was identified as potential unidentified (new to science) taxa.

Sixty three families and 189 genera are represented in the study area. The most commonly represented families are:

- Fabaceae; 106 taxa (one introduced)
- Poaceae; 68 taxa (four introduced)
- Malvaceae; 57 taxa (two introduced)
- Amaranthaceae; 23 taxa (one introduced)
- Asteraceae; 20 taxa (four introduced).

The most commonly represented genera are *Acacia* (40 taxa), *Sida* (16 taxa), *Ptilotus* (15 taxa), *Senna* (15 taxa), *Goodenia* (11 taxa) and *Euphorbia* (10 taxa).

The most commonly encountered taxa were *Triodia epactia*, recorded from 119 quadrats and relevès, *Acacia pyrifolia* var. *pyrifolia* (75), *Indigofera monophylla* (73), *Triodia wiseana* (64), *Corchorus tectus* (58), *Corymbia hamersleyana* (58), *Acacia ancistrocarpa* (56), *Ptilotus astrolasius* (56), *Acacia inaequilatera* (45) and *Rhynchosia minima* (45).

5.1.2 Conservation Significant Flora

5.1.2.1 Environment Protection and Biodiversity Conservation Act 1999

No plant taxon recorded in the study area is listed as Threatened under the *EPBC Act 1999*.

5.1.2.2 Wildlife Conservation Act 1950

No plant taxon recorded in the survey is gazetted as a TF pursuant to Subsection 2 of Section 23F of the *WC Act 1950*.

5.1.2.3 Priority Flora

Nine PF were recorded from the study area: three P1, one P2, three P3 and two P4. The PF were:

- *Abutilon* sp. Pritzelianum (S. van Leeuwen 5095) (P1)
- *Goodenia nuda* (P4)
- *Helichrysum oligochaetum* (P1)
- *Heliotropium muticum* (P1)

- *Indigofera* sp. Bungaroo Creek (S. van Leeuwen 4301) (P3)
- *Oldenlandia* sp. Hamersley Station (A.A. Mitchell PRP 1479) (P3)
- *Pentalepis trichodesmoides* subsp. *hispida* (P2)
- *Rhynchosia bungarensis* (P4)
- *Sida* sp. Barlee Range (S. van Leeuwen 1642) (P3)

Targeted searches were conducted in areas of potential habitat as identified by the conservation significant flora likelihood assessment.

Despite targeted searches being conducted at the interface between granite or basalt rocks and the surrounding landform in the northern portion of the study area, there was no transitional habitat or vegetation observed in these areas, except that shrubs were frequently larger or slightly more dense, but of the same species as in the surrounding area, and the immediately adjacent area was frequently more weedy (e.g. **Cenchrus ciliaris*, **Aerva javanica*).

Priority Flora Descriptions

***Abutilon* sp. Pritzelianum (S. van Leeuwen 5095) (P1)**

Abutilon sp. Pritzelianum (S. van Leeuwen 5095) (**Plate 2**) is a shrub to 3m high. According to *FloraBase* (WAH 1998-2014) it is associated with predominantly sandy soils, on plains and dunes. There are 29 records listed on *NatureMap* (DPaW 2007-2014), mainly in the Pilbara and Carnarvon bioregions. Most Pilbara records are from the area south to southwest of Port Hedland, within 70 km of the town.

One population consisting of 181 individuals of *Abutilon* sp. Pritzelianum (S. van Leeuwen 5095) was recorded during the field surveys, on sandy soil to the east of Croydon outstation. The area where this taxon was recorded was disturbed, probably as a result of lightning strike rather human disturbance,

Plate 2: *Abutilon* sp. Pritzelianum (S. van Leeuwen 5095) habit

***Goodenia nuda* (P4)**

Goodenia nuda (**Plate 3**) is a herb to 50 cm high. According to *FloraBase* (WAH 1998-2014) it is associated with clay loam and ironstone soils, mostly on floodplains and outwash areas but occasionally on hills. There are 84 records listed on *NatureMap* (DPaW 2007-2014), mostly in the Pilbara bioregion associated with the Hamersley Range or Fortescue River floodplain.

Goodenia nuda was widely, but sporadically, distributed with a total of 150 plants recorded from 24 populations encountered across the entire length of the rail corridor. It was generally associated with broad drainage and outwash areas.

Plate 3: *Goodenia nuda*

***Helichrysum oligochaetum* (P1)**

Helichrysum oligochaetum (**Plate 4** and **Plate 5**) is a herb to 25 cm high. According to *FloraBase* (WAH 1998-2014) it is occurs on clay soils, on plains or associated with drainage lines. There are 10 records listed on *NatureMap* (DPaW 2007-2014), in the Pilbara and Gascoyne bioregions.

A single population of *Helichrysum oligochaetum* with an estimated 56 individuals was recorded during the field surveys. Within the study area, this population was confined to the riverbed of the Fortescue River, which differed to other drainage lines of the study area in having soils with high clay content. The population

Plate 4: *Helichrysum oligochaetum* flower

Plate 5: *Helichrysum oligochaetum* habit

was observed to extend outside of the study area along the river. Due to the specific habitat within which this *Helichrysum oligochaetum* was recorded, it is not considered likely to occur elsewhere across the study area.

***Heliotropium muticum* (P1)**

Heliotropium muticum (**Plate 6** and **Plate 7**) is a herb to 30 cm high. According to *FloraBase* (WAH 1998-2014) it is associated with plains, with a variety of soil types. There are 13 records listed on *NatureMap* (DPaW 2007-2014), all in the Pilbara bioregion, including near Whim Creek and south to southeast of Port Hedland.

Approximately 14 populations comprising 540 individuals of *Heliotropium muticum* were recorded from sandy plains in the northern quarter of the survey corridor. Populations of this species were more dense in disturbed (e.g. recently burnt) areas, indicating that it may be a disturbance opportunist.

Plate 6: *Heliotropium muticum* flowers

Plate 7: *Heliotropium muticum* habit

***Indigofera* sp. Bungaroo Creek (S. van Leeuwen 4301) (P3)**

Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301) (**Plate 8** and **Plate 9**) is a shrub to 2.3 m high. According to *FloraBase* (WAH 1998-2014) it is associated with creeks and gorges. There are 24 records listed on *NatureMap* (DPaW 2007-2014), all in the Pilbara bioregion and within or close to the western part of the Hamersley Range.

Six populations comprising approximately 140 individuals of *Indigofera* sp. Bungaroo Creek (S. van Leeuwen 4301) were recorded during the field surveys, within creeklines and gorge areas of the Hamersley Range

Plate 8: *Indigofera* sp. Bungaroo Creek (S. van Leeuwen 4301) flower and foliage

Plate 9: *Indigofera* sp. Bungaroo Creek (S. van Leeuwen 4301) habit

Oldenlandia sp. Hamersley Station (A.A. Mitchell PRP 1479) (P3)

Oldenlandia sp. Hamersley Station (A.A. Mitchell PRP 1479) (**Plate 10**) is a low, spreading annual herb. According to *FloraBase* (WAH 1998-2014) it is associated with cracking clay soils. There are 13 records listed on *NatureMap* (DPaW 2007-2014), all in the Pilbara bioregion, most of which are associated with the Hamersley Range.

One population of *Oldenlandia* sp. Hamersley Station (A.A. Mitchell PRP 1479) with an estimated 140 individuals was recorded during the field surveys, from associated with cracking clay of the Wona land system.

Plate 10: *Oldenlandia* sp. Hamersley Station (A.A. Mitchell PRP 1479)

***Pentalepis trichodesmoides* subsp. *hispida* (P2)**

Pentalepis trichodesmoides subsp. *hispida* (**Plate 11**) is a form to m high. According to *FloraBase* (WAH 1998-2014) it is associated with cracking clay and basalt soils. There are six records listed on *NatureMap* (DPaW 2007-2014), all in the Pilbara bioregion. This taxon has only recently been described (Orchard & Cross 2012). It is relatively under-collected as the species *sens. lat* is easily identified and, prior to the circumscription, there was no need for botanists to collect it for identification purposes. Ecoscape has collected this subsp. from two of its study areas in the western Hamersley Range ((Ecoscape 2014a; 2014b, both assessed in 2013) and considers it more common than its listing as P2 suggests.

One population (of a single individual plant) of *Pentalepis trichodesmoides* subsp. *hispida* was recorded during the field surveys, on basalt-derived soils of the Rocklea land system. It is considered likely that additional plants may be scattered at low density within this land system elsewhere within the study area.

Plate 11: *Pentalepis trichodesmoides* subsp. *hispida*

***Rhynchosia bungarensis* (P4)**

Rhynchosia bungarensis (**Plate 12** and **Plate 13**) is a sticky shrub to 50 cm high, but frequently close to prostrate. According to *FloraBase* (WAH 1998-2014) it is associated with drainage lines and gorges. There are 69 records listed on *NatureMap* (DPaW 2007-2014), mostly in the Pilbara bioregion, associated with the Hamersley Range or Burrup Peninsula Dampier Archipelago.

Approximately 450 individuals of *Rhynchosia bungarensis* were recorded from eight populations associated with gorge areas within the Hamersley Range.

Plate 12: *Rhynchosia bungarensis* flower and foliage

Plate 13: *Rhynchosia bungarensis* habit

Sida sp. Barlee Range (S. van Leeuwen 1642) (P3)

Sida sp. Barlee Range (S. van Leeuwen 1642) (**Plate 14** and **Plate 15**) is a spreading shrub to 50 cm high. According to *FloraBase* (WAH 1998-2014) it occurs on skeletal soils associated with slopes and gullies There are 34 records listed on *NatureMap* (DPaW 2007-2014), mostly in the Pilbara bioregion, associated with the Hamersley Range.

Two populations with an approximate total of 15 individuals of *Sida* sp. Barlee Range (S. van Leeuwen 1642) were recorded during the field surveys, from sheltered, south-facing gorges near the southern western extent of the study area.

Plate 14: *Sida* sp. Barlee Range (S. van Leeuwen 1642) flower and foliage

Plate 15: *Sida* sp. Barlee Range (S. van Leeuwen 1642) habit

5.1.3 Other Significant Flora

5.1.3.1 Range Extension, Range Edges and Outlier Populations

Based on the records included on *NatureMap* (DPaW 2007-2014), the taxa shown in **Table 4**, none of which are of conservation significance, are recorded as being range extensions. Two of these (highlighted) are considered significant range extensions of 100 km or greater. Range extensions were assessed using the *NatureMap* (DPaW 2007-2014) distance measuring tool. The potential significance of range extensions, many of which are considered a result of a paucity of records from the area rather than true range extensions is discussed in **Section 6.1.3.1**.

Table 4: Range extensions and other significant attributes of flora taxa

TAXON	RANGE EXTENSION
Acacia monticola x tumida var. *pilbarensis*	This hybrid is only recorded from approximately 200 km to the northeast. However the parent species of this hybrid are widespread in the Pilbara and commonly co-occur
Eragrostis speciosa	Poorly collected in the region and fills in a range gap
Goodenia armitiana	Poorly collected in the Pilbara and fills in a range gap
Gyrostemon tepperi	Western range extension of greater than 200 km. Most populations occur to the east of the Pilbara bioregion
Hibiscus sturtii var. *grandiflorus*	Poorly collected in the Pilbara and several hundred km from nearest record, but known to be more abundant than this
Sida sp. Rabbit Flat (B.J. Carter 626)	Western range extension of approximately 100 km
Tephrosia remotiflora	Only known from one record in the Pilbara bioregion which is broadly close to the study area, with most records from the Kimberley
Zornia albiflora	Poorly collected in the region and fills in a range gap
Zornia muelleriana	**Southern range extension of up to 90 km**

5.1.3.2 New (Undescribed) Species

A species of *Acacia* (listed as '*Acacia* sp.' in data), **Plate 16**, was collected from vegetation types (**AiTw(3)**, **EIAs$_2$Te(1)** and **EIAs$_2$Te(2)**) associated with the Granitic, Capricorn and McKay land systems near Mt Florance Station in the Chichester Range. It was recorded from seven quadrats (R14088, R14090, R14091, R14092, R14095, R14101 and R14156). Its range therefore encompasses approximately 13 km linear length of the study area. It was typically recorded as a dominant species of the mid-stratum (**Plate 17**).

Specimens were examined by Malcolm Trudgen who is an expert with Pilbara Flora. He has not encountered this taxon before and could not assign the identification to any known species. Trudgen recommends that this unknown species requires further study, additional collections with fruiting material would be ideal. Bruce Maslin, WAH's *Acacia* specialist, is currently on extended leave and could not be contacted for advice.

Plate 16: Scan of Ecoscape collection of *Acacia* sp.

Plate 17: Quadrat R14101 showing the form and habitat of *Acacia* sp.

5.1.3.3 Significant According to Guidance Statement No. 51

***Acacia trachycarpa* (dwarf variant)**

A low habit form of *Acacia trachycarpa* was recorded from 10 quadrats towards the southern end of the study area. This form is recognised as 'dwarf variant' by Maslin *et al.* (2010), but considered unworthy of any formal rank. Typical *Acacia trachycarpa* was also recorded from the study area. Apart from being an unusual form, this taxon has no formal conservation significance.

5.1.3.4 Introduced Flora

Sixteen introduced species were recorded during the field surveys. Their locations are shown on **Map 6**.

There were no Declared Pest plants as listed for the relevant local areas under the *BAM Act 2007*.

The introduced flora recorded from the study area are shown in **Table 5** with their ratings against the lists in **Section 3.2.7**.

Table 5: Introduced flora ratings

SPECIES	DP	WONS	DEC WEED PRIORITIZATION RANK+			ALERT LIST	SLEEPER	TARGET. ERADIC.	BIOL. CONTROL	PERMITTED ENTRY
			Ecol. Impact	Invasive-ness	Control					
**Acetosa vesicaria*	-	-	H	R	H	-	-	-	-	-
**Aerva javanica*	-	-	H	R	H-M	-	-	-	-	-
**Argemone ochroleuca* subsp. *ochroleuca*	-	-	L	R	L	-	-	-	-	-
**Bidens bipinnata*	-	-	U	R	L	-	-	-	-	-
**Cenchrus ciliaris*	-	-	H	R	L	-	-	-	-	-
**Cenchrus setiger*	-	-	H	R	L	-	-	-	-	-
**Cucumis melo*	Not in any list									
**Cynodon dactylon*	-	-	H	R	L	-	-	-	-	-
**Flaveria trinervia*	Not in any list									
**Malvastrum americanum*	-	-	H	R	L	-	-	-	-	-
**Melochia pyramidata*	-	-	L	S	U	-	-	-	-	-
**Passiflora foetida* var. *hispida*	-	-	H	R	U	-	-	-	-	-
**Setaria verticillata*	-	-	H	R	L	-	-	-	-	-
**Sigesbeckia orientalis*	-	-	U	R-M	L	-	-	-	-	-
**Sonchus oleraceus*	-	-	L	R	L	-	-	-	-	-
**Vachellia farnesiana*	-	-	H	R	L	-	-	-	-	-

+DEC Weed Prioritization Rank (DEC 2011a; 2011b):

- Ecological Impact: High, Medium, Low, Unknown
- Invasiveness: Rapid, Moderate, Slow, Unknown
- Feasibility of Control: High, Medium, Low, Unknown.

Brief descriptions of the introduced flora are provided below.

**Acetosa vesicaria* (Ruby Dock) is a fleshy annual herb to 1 m high (WAH 1998-2014) but usually smaller, found over much of Western Australia except the far southern, far northern and desert regions. It is readily identified by its bright red fruit. **Acetosa vesicaria* was recorded from one quadrat and one opportunistic observation, associated with drainage lines.

**Aerva javanica* (Kapok Bush) is a perennial herb to 1.6 m high (WAH 1998-2014) but was usually closer to 0.5 m high, and has white fluffy flowers and fruit on elongated branches. It occurs over much of the northern parts of Western Australia. Within the study area it was recorded from five quadrats, relevès and opportunistically, preferring alluvial soils. **Aerva javanica* was observed more commonly in grazed or otherwise disturbed areas, including along drainage lines and tracks.

**Argemone ochroleuca* subsp. *ochroleuca* (Mexican Poppy) is a spiny, grey leaved annual herb to 1 m high (WAH 1998-2014) but was smaller (juvenile) in the study area. It occurs from near Perth northwards, particularly in the Gascoyne, Carnarvon and Pilbara bioregions. It was recorded from one quadrats and one opportunistic observation, and was associated with a riparian areas.

**Bidens bipinnata* (Bipinnate Beggartick) is a dived-leaved annual herb to 1.5 high (WAH 1998-2014) but was typically less than 0.5 m high in the study area. It is found throughout much of northern Western Australia. **Bidens bipinnata* was recorded from two quadrats and was associated with clay drainage lines in the Fortescue River valley.

**Cenchrus ciliaris* (Buffel Grass) is a perennial tussock-forming grass to 1.5 m high (WAH 1998-2014) but usually grazed to a lower height. It is found throughout much of Western Australia. Within the study area it was recorded from 40 quadrats and relevès and opportunistically observed along almost all drainage lines and more sparsely in grasslands on clay soils. **Cenchrus ciliaris* was either deliberately planted for pasture

or accidently introduced (Van Vreeswyk *et al*. 2004), and has been known from the Pilbara bioregion since the early 1900s (Keighery 2010).

**Cenchrus setiger* (Birdwood Grass) is a perennial tussock-forming grass to 0.5 m high found throughout much of northern Western Australia (WAH 1998-2014). Within the study area it was recorded from two quadrats and was associated with drainage lines, generally growing with Buffel Grass.

Cucumis melo* subsp. *agrestis* (Ulcardo Melon) is a climbing or sprawling annual herb found over much of the northern part of Western Australia (WAH 1998-2014). Within the study area it was recorded from two quadrats and was associated with clay soils. **Cucumis melo* subsp. *agrestis* is listed as 'alien' on *FloraBase* (WAH 1998-2014) however it is not included on the DEC Weed Prioritization list (DEC 2011a; 2011b) nor any other list in **Section 3.2.7, nor in Hussey *et al.* (2007) indicating there is doubt that it is introduced. Recent taxonomy (Telford *et al*. 2011) considers the subspecies to be irrelevant and the species (*Cucumis melo sens. lat.*) to be native.

**Cynodon dactylon* (Couch) is a stoloniferous, rhizomatous perennial grass found over much of Western Australia (WAH 1998-2014). Within the study area it was recorded from two quadrats and was associated with drainage lines.

Flaveria trinervia* (Speedy Weed) is an annual herb with distinctive red stems and three-veined leaves, found over much of northern Western Australia. Within the study area it was recorded from one quadrat and was associated with a broad drainage lines in the Hamersley Range. **Flaveria trinervia* is listed as 'alien' on *FloraBase* (WAH 1998-2014) however it is not included on the DEC Weed Prioritization list (DEC 2011a; 2011b) nor any other list in **Section 3.2.7, nor in Hussey *et al.* (2007) or the WAOL (DAFWA 2014), indicating there is doubt that it is introduced.

**Malvastrum americanum* (Spiked Malvastrum) is a perennial herb or shrub to 1.3 m high (WAH 1998-2014), although it was generally less than 0.5 m high in the study area. It is found over much of northern Western Australia. Within the study area **Malvastrum americanum* was recorded from 20 quadrats and relevès/opportunistic observations and was associated with drainage lines.

**Melochia pyramidata* is an annual or perennial herb or shrub to 1.5 m high (WAH 1998-2014); within the study area it was a shrub over 1 m high when associated with a clay drainage of the Fortescue River, and elsewhere, when associated with the Sherlock River, was more herbaceous. Its known distribution includes the Pilbara and Kimberley bioregions.

**Passiflora foetida* var. *hispida* is a woody climber (WAH 1998-2014); within the study area it was recorded from one quadrat and was associated with the major drainage line through the northern portion of the rail corridor; the Sherlock River. Its known distribution includes the Pilbara, Kimberley and Gascoyne bioregions.

**Setaria verticillata* (Whorled Pigeon Grass) is an annual grass to 1 m high although usually less, and is found over much of Western Australia (WAH 1998-2014). Within the study area **Setaria verticillata* was recorded from five quadrats and relevès/opportunistic observations and was associated with drainage lines.

**Sigesbeckia orientalis* (Indian Weed) is an erect annual herb with yellow flowers to 1 m high. It has several disjunct occurrences within Western Australia, including the Pilbara (WAH 1998-2014). Within the study area **Sigesbeckia orientalis* was recorded from one opportunistic observation and was associated with drainage lines.

**Sonchus oleraceus* (Common Sowthistle) is an erect annual herb to 1.5 m high, found over much of Western Australia (WAH 1998-2014). Within the study area **Sonchus oleraceus* was recorded from one quadrats and was associated with drainage lines.

**Vachellia farnesiana* (Mimosa Bush) is a thorny shrub or tree to 4 m high, found over much of Western Australia except southern and eastern parts (WAH 1998-2014). Within the study area **Vachellia farnesiana* was recorded from 14 quadrats and relevès/opportunistic observations and was associated with grazed drainage lines and flat clay areas.

5.2 VEGETATION ASSESSMENT

5.2.1 Vegetation Types

Fifty eight vegetation types, plus a mosaic of two of these, were recorded from the study area, including one that was identified earlier by Mattiske Consulting (2006). Their extents are detailed in **Table 6** and species codes in **Table 7**. Detailed descriptions of each vegetation type are presented in **Appendix Eight**.

Some areas could not be mapped because they had been recently burnt. A small area on the Hooley land system could not be accessed at the time of survey; this too is unmapped.

Table 6: Vegetation types and their extents within the study area

CODE	VEGETATION TYPE	QUADRATS	AREA (HA)	PROPORTION OF STUDY AREA (%)
Aa_3Te	*Acacia ancistrocarpa, Acacia bivenosa* and *Acacia arida* tall-mid open to scattered shrubland over *Triodia epactia* and *Triodia wiseana* mid-low open hummock grassland	R14006, R14009, R14010, R14012, R14019, R14057	3,656.28	6.41
Aa_3Tl	*Acacia ancistrocarpa, Acacia inaequilatera* and *Acacia pyrifolia* var. *pyrifolia* tall-mid open-sparse shrubland over *Triodia lanigera, Triodia epactia* and *Acacia stellaticeps* mid-low hummock grassland/shrubland with occasional *Corymbia hamersleyana* and *Corymbia deserticola* subsp. *deserticola* low scattered trees	R14017, R14018, R14020, R14021, R14023, R14024, R14029, (R14030), R14032, R14034, R14035, R14036, R14037, R14038, R14042, R14048, R14049, R14064, R14071	15,385.36	26.97
Aa_3Tl/Ts	Mosaic of: *Acacia ancistrocarpa, Acacia inaequilatera* and *Acacia pyrifolia* var. *pyrifolia* tall-mid open-sparse shrubland over *Triodia lanigera, Triodia epactia* and *Acacia stellaticeps* mid-low hummock grassland/shrubland with occasional *Corymbia hamersleyana* and *Corymbia deserticola* subsp. *deserticola* low scattered trees And *Triodia secunda, Triodia wiseana* and *Triodia epactia* mid hummock grassland		13.32	0.02
Aa_4As_3	*Acacia arida* mid sparse shrubland over *Acacia stellaticeps, Triodia epactia* and *Bonamia erecta* low shrubland/hummock grassland with *Corymbia hamersleyana* scattered low trees	R14007	40.91	0.07
Aa_4Tl	*Acacia arida* and *Acacia ancistrocarpa* mid open shrubland over *Triodia lanigera, Acacia spondylophylla* and *Triodia epactia* mid (low) hummock grassland/shrubland	R14050, R14054	802.41	1.41

CODE	VEGETATION TYPE	QUADRATS	AREA (HA)	PROPORTION OF STUDY AREA (%)
Aa_5Tw	*Acacia atkinsiana, Hakea chordophylla* and *Acacia ancistrocarpa* tall-mid sparse shrubland over *Triodia wiseana* and *Triodia epactia* low hummock grassland with *Corymbia hamersleyana* and *Eucalyptus leucophloia* subsp. *leucophloia* low scattered trees	R14115, R14129, R14138	964.74	1.69
Ac_1ApTe	*Acacia citrinoviridis* low woodland or tall to mid shrubland over *Acacia pyrifolia* var. *pyrifolia*, *Acacia trachycarpa* and *Acacia pruinocarpa* tall-mid shrubland over *Triodia epactia* mid hummock grassland	R14086, R14104, R14130	605.61	1.06
Ac_1Te	*Acacia citrinoviridis* and *Corymbia hamersleyana* low woodland over *Triodia epactia, Themeda triandra* and *Chrysopogon fallax* mid-low hummock grassland/tussock grassland	R14105, R14141	115.05	0.20
AiTe(1)	*Acacia inaequilatera* and *Acacia acradenia* tall sparse shrubland over *Triodia epactia* and *Triodia wiseana* mid tussock grassland	R14043	880.28	1.54
AiTe(2)	*Acacia inaequilatera* and *Acacia ancistrocarpa* tall-mid sparse-scattered shrubland over *Triodia epactia* mid hummock grassland	R14110, R14145	1,167.65	2.05
AiTe(3)	*Acacia inaequilatera* and *Acacia trachycarpa* mid sparse shrubland over *Triodia epactia* and *Pluchea tetranthera* mid(low) hummock grassland/shrubland with *Corymbia hamersleyana* low scattered trees	R14135	75.53	0.13
AiTw(1)	*Acacia inaequilatera* tall sparse or scattered shrubland over *Triodia wiseana* and *Triodia epactia* mid-low hummock grassland	R14096, R14155	344.92	0.60
AiTw(2)	*Acacia inaequilatera, Acacia pyrifolia* var. *pyrifolia* and *Hakea lorea* subsp. *lorea* tall sparse shrubland over *Triodia wiseana, Triodia epactia* and *Triodia brizoides* mid-low hummock grassland	R14051, R14052, R14072, R14077, R14078, R14083, R14131	6,158.36	10.79
AiTw(3)	*Acacia inaequilatera, Grevillea pyramidalis* subsp. *leucadendron* and *Acacia* sp. tall sparse shrubland over *Triodia wiseana, Triodia epactia* and *Triodia* aff. *melvillei* hummock grassland with *Corymbia hamersleyana* low scattered trees	R14084, R14087, R14090, R14091	1,430.74	2.51
AmEe	*Acacia melleodora* tall open shrubland over *Eragrostis eriopoda* and *Aristida holathera* var. *holathera* mid open tussock grassland	R14063	26.42	0.05
AoTe	*Acacia orthocarpa* and *Acacia pyrifolia* var. *pyrifolia* tall open shrubland over *Triodia epactia, Indigofera monophylla* and *Triodia wiseana* mid hummock grassland/shrubland	R14060	273.36	0.48
ApTe	*Acacia pyrifolia* var. *pyrifolia, Acacia trachycarpa* and *Petalostylis labicheoides* tall-mid open shrubland over *Triodia epactia, *Cenchrus ciliaris* and **Aerva javanica* mid-low tussock grassland/hummock grassland/shrubland	R14056, R14058, R14074, R14080, R14111	1,101.31	1.93
ApTw	*Acacia pyrifolia* var. *pyrifolia, Acacia ancistrocarpa* and *Acacia inaequilatera* tall sparse shrubland over *Triodia wiseana* and *Triodia epactia* mid hummock grassland	R14014, R14016, R14025, R14027, R14028, R14031, R14041	4,204.61	7.37
As_1Cf	*Acacia sclerosperma* subsp. *sclerosperma* and *Carissa lanceolata* tall shrubland over *Chrysopogon fallax, Eragrostis xerophila* and **Cenchrus ciliaris* mid tussock grassland	R14001, R14002, R14003	25.53	0.05

CODE	VEGETATION TYPE	QUADRATS	AREA (HA)	PROPORTION OF STUDY AREA (%)
As_3	*Acacia stellaticeps* and *Triodia schinzii* low shrubland/mid hummock grassland	R14022	122.33	0.21
AxSb	*Acacia xiphophylla* tall shrubland over *Streptoglossa bubakii, Stemodia kingii* and *Triodia wiseana* low open shrubland/hummock grassland	R14098, R14100	61.92	0.11
Cc_2AbBe	*Corymbia candida* mid woodland over *Acacia bivenosa* and *Acacia elachantha* tall open shrubland over *Bothriochloa ewartiana, Themeda triandra* and *Chrysopogon fallax* low sparse tussock grassland	R14116	17.69	0.03
Cc_2Eb	*Corymbia candida* low open woodland over *Eriachne benthamii, Triodia epactia* and *Chrysopogon fallax* mid tussock grassland/hummock grassland with *Acacia inaequilatera* and *Acacia pyrifolia* var. *pyrifolia* tall scattered shrubs	R14067	12.76	0.02
$CdAa_5Te$	*Corymbia deserticola* subsp. *deserticola, Corymbia hamersleyana* and *Eucalyptus xerothermica* low open woodland over *Acacia atkinsiana* and *Grevillea wickhamii* tall open shrubland over *Triodia epactia* mid hummock grassland	R14076, R14113, R14132	2,667.85	4.68
$ChAa_1Ta$	*Corymbia hamersleyana* low open woodland over *Acacia acradenia, Acacia ancistrocarpa* and *Acacia inaequilatera* tall sparse shrubland over *Triodia angusta* and *Triodia epactia* low hummock grassland	R14065	156.86	0.27
$ChAa_5Te$	*Corymbia hamersleyana, Eucalyptus gamophylla and Eucalyptus xerothermica low open woodland over Acacia atkinsiana, Grevillea wickhamii and Acacia ancistrocarpa mid open-sparse shrubland over Triodia epactia and Eulalia aurea mid-low hummock grassland/tussock grassland*	R14133, R14136, R14137	1,828.65	3.21
ChAbTw	*Corymbia hamersleyana* and *Grevillea pyramidalis* subsp. *leucadendron* low open woodland or scattered trees over *Acacia bivenosa* and *Acacia arida* tall-mid sparse shrubland over *Triodia wiseana, Triodia epactia* and *Triodia angusta* mid open tussock grassland	R14011, R14039, R14040	214.20	0.38
ChAeTt	*Corymbia hamersleyana* and *Eucalyptus xerothermica* low open woodland over *Acacia elachantha* and *Maytenus* sp. Mt Windell (S. van Leeuwen 846) mid sparse shrubland over *Themeda triandra*, *Eulalia aurea* and *Chrysopogon fallax* mid tussock grassland	R14121	111.09	0.19
ChAiCf	*Corymbia hamersleyana* low open woodland over *Acacia inaequilatera, Acacia pyrifolia* var. *pyrifolia* and *Eremophila longifolia* tall open shrubland over *Chrysopogon fallax, Triodia epactia* and *Themeda triandra* mid tussock grassland/hummock grassland	R14123	83.10	0.15
$ChAt_2Te$	*Corymbia hamersleyana* low open woodland over *Acacia tumida* var. *pilbarensis* and *Acacia pyrifolia* var. *pyrifolia* tall-mid sparse shrubland over *Triodia epactia, Themeda triandra* and *Paraneurachne muelleri* mid hummock grassland/tussock grassland	R14126, R14143, R14148, R14149, R14152, R14157	570.52	1.00

CODE	VEGETATION TYPE	QUADRATS	AREA (HA)	PROPORTION OF STUDY AREA (%)
EgAa$_5$Te	*Eucalyptus gamophylla* and *Corymbia hamersleyana* low open mallee shrubland/woodland over *Acacia atkinsiana, Acacia inaequilatera* and *Acacia trachycarpa* (dwarf variant) tall-mid open-sparse shrubland over *Triodia epactia, Paraneurachne muelleri* and *Triodia wiseana* mid-low hummock grassland/tussock grassland	R14122, R14124, R14125, R14128, R14139	2,663.71	4.67
ElAa$_3$Tm	*Eucalyptus leucophloia* subsp. *leucophloia* and *Corymbia deserticola* subsp. *deserticola* low open woodland over *Acacia ancistrocarpa* mid sparse shrubland over *Triodia* aff. *melvillei* and *Amphipogon sericeus* mid-low hummock grassland/tussock grassland	R14127, R14151	262.36	0.46
ElAs$_2$Te	*Eucalyptus leucophloia* subsp. *leucophloia* and *Corymbia hamersleyana* low open woodland or scattered trees over *Acacia* sp., *Acacia inaequilatera* and *Acacia tumida* subsp. *pilbarensis* tall sparse shrubland over *Triodia epactia* low hummock grassland	R14088, R14092, R14095	125.06	0.22
ElEgTw	*Eucalyptus leucophloia* subsp. *leucophloia* low open woodland over *Eucalyptus gamophylla, Acacia pyrifolia* var. *pyrifolia* and *Acacia maitlandii* low open mallee shrubland/tall open shrubland over *Triodia wiseana* and *Waltheria virgata* low hummock grassland/shrubland	R14150	11.11	0.02
ElTe	*Eucalyptus leucophloia* subsp. *leucophloia* mid open woodland to scattered trees over *Triodia epactia, Triodia brizoides* and *Triodia wiseana* hummock grassland	R14101, R14102	612.24	1.07
ElTw(1)	*Eucalyptus leucophloia* subsp. *leucophloia* and *Corymbia hamersleyana* low open woodland over *Triodia wiseana* and *Eriachne mucronata* mid-low hummock grassland/tussock grassland with *Grevillea wickhamii* and *Hakea chordophylla* tall-mid scattered shrubs	R14114, R14118, R14119, R14120, R14153	2,766.68	4.85
ElTw(2)	*Eucalyptus leucophloia* subsp. *leucophloia* and *Corymbia hamersleyana* low open woodland over *Triodia wiseana* and *Triodia epactia* mid-low hummock grassland	R14093, R14144, R14146	948.73	1.66
EvApCc$_1$	*Eucalyptus victrix, Corymbia hamersleyana* and *Acacia coriacea* subsp. *pendens* mid-low open woodland over *Acacia pyrifolia* var. *pyrifolia* tall sparse shrubland over **Cenchrus ciliaris, Triodia angusta* and *Triodia epactia* low tussock grassland/hummock grassland	R14045	448.15	0.79
EvApTe	*Eucalyptus victrix* and *Corymbia hamersleyana* mid open woodland-scattered trees over *Acacia pyrifolia* var. *pyrifolia* and *Acacia tumida* var. *pilbarensis* tall shrubland-scattered shrubs over *Triodia epactia, Tephrosia rosea* var. Fortescue creeks (M.I.H Brooker 2186) and **Cenchrus ciliaris* mid-low open hummock grassland/shrubland/tussock grassland	R14081, R14082, R14109, R14112, R14117	541.99	0.95
EvAt$_1$Te	*Eucalyptus victrix* mid woodland-open woodland over *Acacia trachycarpa, Acacia ampliceps* and *Acacia pyrifolia* var. *pyrifolia* tall shrubland-sparse shrubland over *Triodia epactia* and **Cenchrus ciliaris* mid open hummock grassland/tussock grassland	R14015, R14026, R14068	396.58	0.70

CODE	VEGETATION TYPE	QUADRATS	AREA (HA)	PROPORTION OF STUDY AREA (%)
EvCb	*Eucalyptus victrix* low open woodland over *Cyperus bifax* and *Eriachne benthamii* low sedgeland/tussock grassland with **Vachellia farnesiana* tall scattered shrubs	R14107	28.90	0.05
EvMgEb	*Eucalyptus victrix* and *Acacia citrinoviridis* mid woodland over *Melaleuca glomerata* and **Vachellia farnesiana* tall sparse shrubland over *Eriachne benthamii* and *Cyperus bifax* low open tussock grassland/sedgeland	R14108	37.00	0.06
EvMlCv	*Eucalyptus victrix, Eucalyptus camaldulensis* subsp. *refulgens* and *Acacia coriacea* subsp. *pendens* mid-low woodland over *Melaleuca linophylla, Melaleuca glomerata* and *Acacia trachycarpa* tall open shrubland over *Cyperus vaginatus, Triodia epactia* and **Cenchrus ciliaris* mid open sedgeland/hummock grassland/tussock grassland	R14059, R14061, R14073, R14075, R14089, R14094, R14103	632.39	1.10
Ex_1	*Eragrostis xerophila, Dichanthium sericeum* subsp. *humilius* and *Vigna* sp. Hamersley Clay (A.A. Mitchell PRP 113) low tussock grassland/vineland	R14004, R14005, R14066, R14070	1,091.38	1.89
FbGpEm	*Ficus brachypoda* low open woodland over *Grevillea pyramidalis* subsp. *leucadendron* and *Tephrosia rosea* var. *clementii* mid sparse shrubland over *Eriachne mucronata, Triodia wiseana* and *Triodia epactia* mid open tussock grassland/hummock grassland	R14R1	2.48	0.004
FPg1 Mattiske	*Triodia epactia, Eragrostis xerophila* and *Eriachne benthamii* mid-low hummock grassland with tall *Acacia inaequilatera* and *Carissa lanceolata* scattered clumps of shrubs	(Mattiske Consulting Pty Ltd 2006)	82.69	0.14
HcTe	*Hakea chordophylla* and *Grevillea pyramidalis* subsp. *leucadendron* tall sparse shrubland over *Triodia epactia* and **Cenchrus ciliaris* mid hummock grassland/tussock grassland	R14044	357.14	0.62
MaMgCv	*Melaleuca argentea* and *Eucalyptus camaldulensis* subsp. *refulgens* mid open forest-open woodland over *Melaleuca glomerata, Acacia ampliceps* and *Acacia coriacea* subsp. pendens tall sparse shrubland-scattered shrubs over *Cyperus vaginatus* and *Stemodia grossa* mid open sedgeland/forbland	R14079, R14085	39.79	0.07
MaMlCi	*Melaleuca argentea* and *Eucalyptus camaldulensis* subsp. *refulgens* low open woodland over *Melaleuca linophylla* tall open shrubland over *Cyperus ixiocarpus* mid sparse sedgeland	R14033	271.08	0.47
Sb	*Streptoglossa bubakii, Sida fibulifera* and *Stemodia kingii* low open shrubland/herbland	R14097, R14099	31.81	0.06
Ta	*Triodia angusta* and *Triodia epactia* mid hummock grassland	R14013	231.73	0.40
Tb	*Triodia brizoides* and *Triodia epactia* mid-low hummock grassland with *Eucalyptus leucophloia* subsp. *leucophloia* and *Corymbia hamersleyana* low scattered trees	R14106, R14142, R14156	981.68	1.72
Te(1)	*Triodia epactia* and *Triodia secunda* low hummock grassland	R14008	32.05	0.06

CODE	VEGETATION TYPE	QUADRATS	AREA (HA)	PROPORTION OF STUDY AREA (%)
Te(2)	*Triodia epactia* and *Triodia wiseana* low hummock grassland with *Corymbia hamersleyana* low scattered trees over *Acacia elachantha* tall scattered shrubs	R14140	162.96	0.28
Te(3)	*Triodia epactia, Sclerolaena hostilis* and *Triodia angusta* mid-low open hummock grassland/chenopod shrubland with occasional low *Acacia xiphophylla* scattered trees	R14046, R14047	57.57	0.10
Te(4)	*Triodia epactia, Triodia angusta* and *Triodia lanigera* mid hummock grassland with scattered low *Acacia xiphophylla* trees	R14053, R14055	352.55	0.61
Ts	*Triodia secunda, Triodia wiseana* and *Triodia epactia* mid hummock grassland	R14062	9.34	0.02
Tw(1)	*Triodia wiseana* and *Eragrostis xerophila* mid hummock grassland/tussock grassland	R14069	12.24	0.02
Tw(2)	*Triodia wiseana* and *Triodia epactia* low open hummock grass with *Corymbia hamersleyana* low scattered trees over *Acacia inaequilatera* mid scattered shrubs	R14134	317.26	0.55
Burnt	Recently burnt; not able to be mapped		136.77	0.24
Rock	Rock outcrop (not vegetated)		272.43	0.47
n/a	Not assessed; not accessible		18.23	0.03
Total			**57,055.44**	

The floristics dendrogram that was used to inform vegetation type groupings is included in **Appendix Nine**.

Table 7: Species codes used in vegetation type descriptions

CODE	FIRST LISTED SPECIES	CODE	FIRST LISTED SPECIES
Aa_1	*Acacia acradenia*	**Cb**	*Cyperus bifax*
Aa_2	*Acacia ampliceps*	**Ci**	*Cyperus ixiocarpus*
Aa_3	*Acacia ancistrocarpa*	**Cv**	*Cyperus vaginatus*
Aa_4	*Acacia arida*	**Eb**	*Eriachne benthamii*
Aa_5	*Acacia atkinsiana*	**Em**	*Eriachne mucronata*
Ab	*Acacia bivenosa*	**Eg**	*Eucalyptus gamophylla*
Ac_1	*Acacia citrinoviridis*	**El**	*Eucalyptus leucophloia* subsp. *leucophloia*
Ac_2	*Acacia coriacea* subsp. *pendens*	**Ev**	*Eucalyptus victrix*
Ae	*Acacia elachantha*	**Ex_1**	*Eragrostis xerophylla*
Ai	*Acacia inaequilatera*	**Ex_2**	*Eucalyptus xerothermica*
Am	*Acacia melleodora*	**Fb**	*Ficus brachypoda*
Ao	*Acacia orthocarpa*	**Gp**	*Grevillea pyramidalis* subsp. *leucadendron*
Ap	*Acacia pyrifolia* var. *pyrifolia*	**Ma**	*Melaleuca argentea*
As_1	*Acacia sclerosperma* subsp. *sclerosperma*	**Mg**	*Melaleuca glomerata*
As_2	*Acacia* sp.	**Ml**	*Melaleuca linophylla*
As_3	*Acacia stellaticeps*	**Sb**	*Streptoglossa bubakii*
At_1	*Acacia trachycarpa*	**Tm**	*Triodia* aff. *melvillei*
At_2	*Acacia tumida* var. *pilbarensis*	**Ta**	*Triodia angusta*
Ax	*Acacia xiphophylla*	**Tb**	*Triodia brizoides*
Cc_1	*Cenchrus ciliaris*	**Te**	*Triodia epactia*
Cc_2	*Corymbia candida*	**Tl**	*Triodia lanigera*
Cf	*Chrysopogon fallax*	**Ts**	*Triodia secunda*
Ch	*Corymbia hamersleyana*	**Tw**	*Triodia wiseana*

5.2.2 Vegetation Significance

5.2.2.1 Threatened Ecological Communities

None of the vegetation types recorded within the study area are considered likely to represent a TEC based on a comparison with current TEC listings for Western Australia (DPaW Species & Communities Branch 2014a). No TECs have been previously known to occur within the study area; the nearest known TEC is more than 20 km from the study area.

5.2.2.2 Priority Ecological Communities

Brockman PEC

No vegetation considered likely to represent the P1 'Brockman Iron cracking clay communities of the Hamersley Range' PEC was recorded during the field survey. This PEC was identified by the DPaW database search as occurring nearby, but not within the study area.

Wona PEC

Vegetation that may represent one of the four community types that form the P1-P3 'Four plant assemblages of the Wona Land System' PEC was recorded during the field survey. Little information is publicly available except the description '*P1 Cracking clays of the Chichester and Mungaroona Range. This grassless plain of*

stony gibber community occurs on the tablelands with very little vegetative cover during the dry season, however during the wet a suite of ephemerals/annuals and short-lived perennials emerge, many of which are poorly known and range-end taxa' (DPaW Species and Communities Branch 2014b). Two vegetation types were recorded on the Wona land system; one, **AxSb**, is unlikely to represent the above PEC subtype (or any of the other subtypes) as it has a significant perennial plant component, however vegetation type **Sb**, described as *Streptoglossa bubakii, Sida fibulifera* and *Stemodia kingii* low open shrubland/herbland, may be representative.

Additional survey following the wet season, and consultation with relevant DPaW authorities, will be required before accurate determination is possible. Vegetation type **Sb** occupied 31.81 ha, and was located to the north of Roebourne Wittenoom Road (**Map 4-7**). It does not correspond with previously mapped areas of the PEC; the previously mapped occurrence of the PEC that slightly overlaps the rail corridor is dominated by *Acacia xiphophylla* (vegetation type **AxSb**) and may be erroneously attributed to the PEC.

Horseflat PEC

Vegetation considered to represent the P3 'Horseflat Land System of the Roebourne Plains' PEC was recorded in the northern portion of the study area. According to the PEC description (DPaW Species and Communities Branch 2014b), Units 3, 5 and 7 described in Van Vreeswyk *et al.* (2004), constitute the PEC. These units, their descriptions and the Ecoscape and Mattiske Consulting (2006) vegetation types considered to represent them (based on a combination of landform and species) are shown in **Table 8**. Land system units that are not included in the PEC are unit 1 (stony rises and hills with *Triodia* spp.), unit 2 (calcrete plains with *Triodia wiseana*), unit 4 (non-gilgaied plains with *Acacia xiphophylla* and tussock and hummock grasses), unit 6 (dissected slopes with *Acacia xiphophylla* and tussock and hummock grasses) and unit 8 (channels and river terraces with fringing woodlands).

Vegetation type **Ex_1** is considered to represent the PEC subtype 3; vegetation types **Te(1)** and **Tw(1)** most likely represent uncommon variations of subtype 5, potentially with Mattiske (2006) vegetation unit **FPg1**. Vegetation type **Cc_2Eb**, in drainage depressions may represent subtype 7. Most, but not all, of these vegetation types occurred on the Horseflat land system with a small proportion associated with the Mallina land system.

Table 8: Horseflat land system units (Van Vreeswyk *et al*. 2004) and Ecoscape equivalent vegetation types

HORSEFLAT LAND SYSTEM UNIT	VAN VREESWYK *ET AL*. DESCRIPTION	ECOSCAPE VEGETATION TYPE	VEGETATION DESCRIPTION	EXTENT IN RAIL CORRIDOR (HA)
3	Mostly tussock grasslands dominated by *Eragrostis xerophila* (Roebourne Plains grass) (ARPG) but also other grasses such as *Chrysopogon fallax* (ribbon grass) and *Eriachne benthamii* (swamp grass) (APRG, APSG). Occasional patches of very scattered to scattered mid height shrublands of *Acacia xiphophylla* (snakewood) with tussock grasses (SSTS). (on gilgaied plains)	**Ex_1**	*Eragrostis xerophila, Dichanthium sericeum subsp. humilius* and *Vigna* sp. Hamersley Clay (A.A. Mitchell PRP 113) low tussock grassland/vineland	1,091.38 (1,051.07 on the Horseflat land system)
5	Tussock grasslands with *Eragrostis xerophila, Eriachne benthamii, Chrysopogon fallax, Cenchrus ciliaris* (buffel grass) (APXG, ARPG); also tussock grasslands with shrub *Atriplex bunburyana* (silver saltbush) (PCGS). Occasionally *Triodia* spp. (spinifex) hummock grasslands. (on alluvial plains)	**Te(1), Tw(1)** **Potentially FPg1 (Mattiske 2006)**	*Triodia epactia* and *Triodia secunda* low hummock grassland, *Triodia wiseana* and *Eragrostis xerophila* mid hummock grassland/tussock grassland	32.05, 12.24 82.69 (22.13, 10.40, 77.99 on Horseflat land system respectively)
7	Dense tussock grasslands including *Eriachne benthamii, Chrysopogon fallax* with occasional eucalypt trees and shrubs such as *Acacia* (now *Vachellia*) *farnesiana* (mimosa bush) (APXG, APRG, DEGW). (associated with drainage depressions)	**Potentially Cc_2Eb**	*Corymbia candida* low open woodland over *Eriachne benthamii, Triodia epactia* and *Chrysopogon fallax* mid tussock grassland/hummock grassland with *Acacia inaequilatera* and *Acacia pyrifolia* var. *pyrifolia* tall scattered shrubs	12.76
Total Extent (ha)				**1,2221.21**

Mattiske Consulting (2013a) considers its vegetation unit G8 (Open tussock grassland of *Aristida contorta, Eragrostis xerophila, Chrysopogon fallax*, (occasionally with *Triodia pungens*), *Eriachne helmsii* with mixed low shrubs and herbs, on redbrown cracking clay plains) to represent this PEC. This vegetation unit is similar to Ecoscape's **Ex_1** however no Mattiske equivalents were recorded for the other Ecoscape vegetation types considered to represent the PEC.

There is no overlap in survey areas that include this vegetation type between Ecoscape and Mattiske (2013a), however there is overlap between an earlier Mattiske (2006) survey area that contained similar vegetation. However, this was not identified as a PEC at that time, and this vegetation is considered 'well represented in either the Horseflat land system or the Pilbara region' (*ibid*.).

5.2.2.3 Groundwater Dependent Ecosystems

Vegetation types with the phreatophytic species *Eucalyptus camaldulensis* subsp. *refulgens* or *Melaleuca argentea* are considered to represent a GDE. Vegetation types are **EvMlCv**, **MaMgCv** and **MaMlCi** have these as either dominant or characteristic species, and are therefore considered as GDEs. Respectively these vegetation types occupied 632.39 ha (1.10% of the study area), 39.79 ha (0.07%) and 271.08 ha (0.47%).

Vegetation characterised by *Eucalyptus victrix* that is considered either a vadophyte or only weakly phreatophytic (see **Section 3.3.3**) also occurred in the study area. Vegetation types **EvApCc$_1$**, **EvApTe**, **EvAt$_1$Te**, **EvCb** and **EvMgEb,** characterised by *Eucalyptus victrix* but without the above species, may represent a GDE. Respectively these vegetation types occupied 448.15 ha (0.79% of the study area), 541.99 ha (0.95%), 396.58 ha (0.70%), 28.90 ha (0.05%) and 37.00 ha (0.06%).

5.2.2.4 Mulga Communities

There was no vegetation that had Mulga as a dominant or characteristic species, although Mulga (*Acacia aptaneura*) occurred sparsely within the study area. There was no SFDV.

5.2.2.5 'Ecosystems at Risk'

No vegetation was considered to represent an 'Ecosystem at Risk', except vegetation that is now considered to represent a PEC or GDE.

5.2.2.6 Other Significant Vegetation

Significant according to *Guidance Statement No. 51*

Vegetation having a restricted distribution can be considered significant according to *Guidance Statement No. 51* (EPA 2004).

Ecoscape (2010a; 2011a; 2012b; 2014b) considers vegetation type **ElAa$_3$Tm** that occupied 125.06 ha to have a restricted distribution within the central Hamersley Range.

Vegetation type **FbGpEm** was restricted to a quartz hill near the northern end of the rail corridor, occupying 2.48 ha; no landform nor similar vegetation was observed within the rail corridor nor in the close vicinity.

Vegetation type **AmEe** occupied a large Aeolian dune on the Gregory land system, near the northern end of the study area. No similar vegetation was recorded elsewhere, nor did the other areas of the same land system have the same landform (they were low undulating dunes). Vegetation type **AmEe** occupied 26.42 ha.

These vegetation types may be of significance according to *Guidance Statement No. 51*.

Although a number of vegetation types occupied only small extents, none were considered of restricted distribution, nor satisfied any other listed criteria, and are therefore not of significance according to *Guidance Statement No. 51* (EPA 2004).

Land System Representation

Van Vreeswyk *et al.* (2004) lists 102 land systems as occurring in the 181 674 km^2 in the Pilbara. Of these, 25 occupy less than 200 km^2. The Black land system occupies 165 km^2, the Gregory land system occupies 113 km^2 and the Sherlock land system occupies 192 km^2 within the Pilbara, and 4.79 km^2, 5.26 km^2 and 0.34 km^2 within the study area respectively. Vegetation confined, or largely confined, to these can also be considered of significance.

No vegetation types were confined to the Black or Sherlock land systems.

Vegetation types **AmEe** and **As$_3$** were largely confined to the Gregory land system; respectively these occupied 26.42 ha and 122.33 ha.

Pre-European Vegetation Representation

All pre-European vegetation associations within the rail corridor have more than 95% of their original extent remaining (**Table 2**).

Five pre-European vegetation associations currently occupy less than 1 000 km^2 within the Pilbara bioregion; 569 (occupying 593.38 km^2), 641 (183.28 km^2), 644 (270.69 km^2), 645 (846.58 km^2) and 649 (401.78 km^2). Vegetation confined, or largely confined to these, can also be considered of significance.

Pre-European vegetation association 569 has nine vegetation types associated with it; vegetation type **AiTe(3)** is wholly confined to it; vegetation types **AiTw(3)** and **MaMgCv** are largely confined to it.

Pre-European vegetation association 641 has 12 vegetation types associated with it; none are confined to it or largely confined to it.

Pre-European vegetation association 644 has 10 vegetation types associated with it; vegetation type **AiTe(1)** is largely confined to it.

Pre-European vegetation association 645 has four vegetation types associated with it; none are confined to it or largely confined to it.

Pre-European vegetation association 649 has 10 vegetation types associated with it; vegetation type **$ChAa_1Ta$** is wholly confined to it; vegetation types **AmEe** and **Ta** are largely confined to it.

Vegetation types **AiTe(1)**, **AiTe(3)**, **AiTw(3)**, **AmEe**, **$ChAa_1Ta$**, **MaMgCv** and **Ta** therefore have a degree of significance due to their association with poorly represented pre-European vegetation associations.

Vegetation Considered of Significance from Nearby

Available flora and vegetation survey reports from nearby areas were reviewed to identify vegetation considered of significance in these areas (**Section 3.3.7**). Similar vegetation considered significant in these, and also occurring in the rail corridor are:

- riparian vegetation characterised by *Eucalyptus victrix* or *Eucalyptus camaldulensis* (Ecoscape 2011a; 2012b; Mattiske Consulting Pty Ltd 2006); a number of vegetation types are characterised by these species
- vegetation restricted to high hilltops, characterised by *Eucalyptus kingsmillii* and *E. gamophylla*, in the FMG Central Pilbara Project Area (Ecoscape 2012b); the latter species characterises vegetation type **ElEgTw** that was only found on the highest hill within the rail corridor, however it is improbable that any railway construction will impact on this area.

Similar riparian vegetation types in the rail corridor are **$EvApCc_1$**, **EvApTe**, **$EvAt_1Te$**, **EvCb**, **EvMgEb**, **EvMlCv**, **MaMgCv** and **MaMlCi**. These are discussed above as GDEs in **Section 5.2.2.3**.

5.2.2.7 Floristic Analysis

The floristic analysis resulted in a dendrogram that, for many vegetation types, assisted with interpretation (**Appendix Nine**). Floristic relationships of each vegetation type are included in the vegetation type descriptions in **Appendix Eight**.

At 1.02 separation, the floristics dendrogram separated the quadrats and relevès (sites) into nine supergroups that broadly described the vegetation types in terms of their association with substrate and landform, and also, in many cases, IBRA subregion. These supergroups are described below.

Supergroup 1 consisted of nine sites; all occurred on the Horseflat land system towards the northern end or the rail corridor in the Roebourne IBRA subregion. Four vegetation types were interpreted from this supergroup, with the floristics agreeing with the field assessment. Three of these vegetation types are considered to represent subtypes of the P3 'Horseflat Land System of the Roebourne Plains' PEC.

Supergroup 2 consisted of six sites; all were associated with clay soils of the Wona land system and Fortescue River in the Chichester and Fortescue IBRA subregions. Four vegetation types were interpreted from this supergroup, including one that may represent the P1 'Cracking clays of the Chichester and Mungaroona Range' subtype of the 'Four plant assemblages of the Wona Land System' PEC.

Supergroup 3 consisted of five sites; all were associated with clay soils of the Horseflat, Satirist and Sherlock land systems in the northern portion of the rail corridor, in the Roebourne IBRA subregion. Three vegetation types were interpreted from this supergroup, including one that is considered to represent a subtype of the P3 'Horseflat Land System of the Roebourne Plains' PEC.

Supergroup 4 consisted of 27 sites; most were associated with low hills or areas with granite outcrops in the northern portion of the study area in the Roebourne IBRA subregion. Eleven vegetation types were interpreted from this supergroup, although some of the more broad vegetation types that could not be mapped as separate units also included sites from supergroup 6 or, less frequently, supergroup 5.

Supergroup 5 consisted of 16 sites; most were associated with basalt or granite derived soils, generally rocky areas, largely in the Chichester Range (Chichester IBRA subregion). Seven vegetation types were interpreted from this supergroup, and mostly confined to it.

Supergroup 6 consisted of 19 sites; all from the northern portion of the study area in the Roebourne IBRA subregion, largely on sandy soils. Five vegetation types, some of which also had representatives from supergroup 4, were interpreted for this vegetation type.

Supergroup 7 consisted of 31 sites, largely from the Hamersley IBRA subregion but some sites were located in the Fortescue and Chichester subregions. They were all associated with valleys (in the Hamersley and Fortescue subregions) or slopes and hills (in the Hamersley and Chichester subregions). Nine vegetation types were interpreted from this supergroup, most confined to it.

Supergroup 8 consisted of 29 sites; most were from the Hamersley IBRA subregion, and most were associated with alluvial soils of floodplains and less significant drainage lines. Thirteen vegetation types were interpreted from this supergroup; most were confined to it.

Supergroup 9 consisted of 14 sites; all were associated with the larger rivers and creeks of the study area through all IBRA subregions. Five vegetation types were interpreted from this supergroup; all were confined to it.

5.3 VEGETATION CONDITION

The vegetation condition of the quadrats and relevès and the overall study area is shown on **Map 7** and displayed in **Table 9**.

Most (90.64%) of the study area was assessed as being in Excellent condition.

Much of the study area was grazed by cattle, particularly the northern end (where the Horseflat land system grasslands were particularly heavily grazed) and towards the southern end. The central portion through the Chichester Range, which is largely Unallocated Crown Land, was less impacted by cattle or feral animal grazing and trampling. Vegetation associated with rocky soils, particularly upland areas, was less disturbed,

and at times no human-derived impacts were detected. Drainage lines were also heavily impacted by grazing, with the creek and river banks frequently covered with Buffel Grass (**Cenchrus ciliaris*) that is favoured for grazing, and the stream beds used to traverse between areas. There was also some localised impact around watering points (wells) however the scale of this impact was too small to be mapped.

Grazing impacts (trampling and soil disturbance) and weed invasion were the main reasons for assessing vegetation condition as lower than Excellent. There were few roads or tracks or other direct human impacts in the study area.

Table 9: Vegetation condition

VEGETATION CONDITION	EXTENT (ha)	EXTENT (%)
Excellent	51,717.74	90.64
Very Good	3,556.48	6.23
Good	972.52	1.70
Poor	427.03	0.75
Completely Degraded	0	0
Burnt	136.77	0.24
Rock	244.90	0.43

5.4 ADEQUACY OF SAMPLING

5.4.1 Species Accumulation Curve

A species accumulation curve (**Figure 3**) was generated to display adequacy of sampling: if the curve has reached (or nearly reached) an asymptote, it is considered likely that most species have been recorded from the study area.

The species accumulation curve for the study area suggests that additional survey would increase the number of species that may occur in the study area. However, as the line in **Figure 3** is close to asymptote, it is likely that most species (i.e. only approximately 10 additional species) occurring would have been recorded when taking opportunistic and targeted search observations. Additionally, as this survey was undertaken during the dry season, survey following rainfall would also increase the number of species recorded.

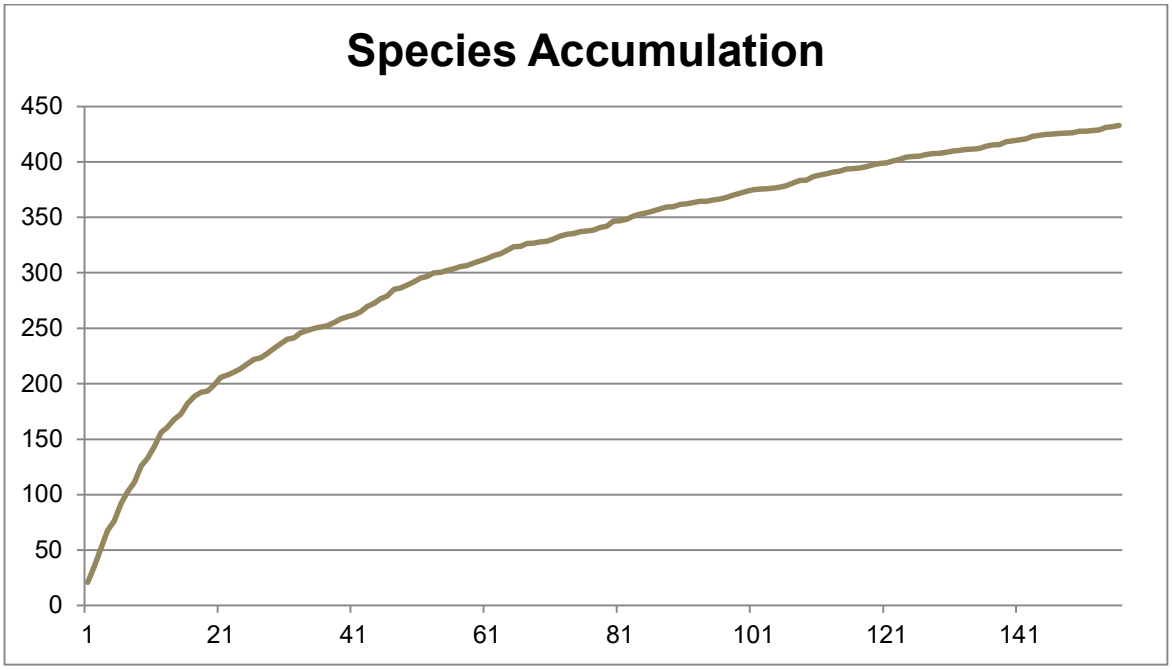

Figure 3: Species accumulation curve

5.4.2 Taxa Area Plot

Adequacy of sampling can also be illustrated by comparing the number of taxa recorded per unit area (km^2) from the study area (i.e. species richness) with the same data from nearby. **Figure 4** shows the taxa area plot for the study area and nearby areas. The references for this data are listed in **Table 10**.

The taxa area plot indicates that the species richness of the Rutila Rail Corridor is similar to, but slightly lower than, similar sized rail corridor survey areas, perhaps as a result of the survey being conducted during the dry season.

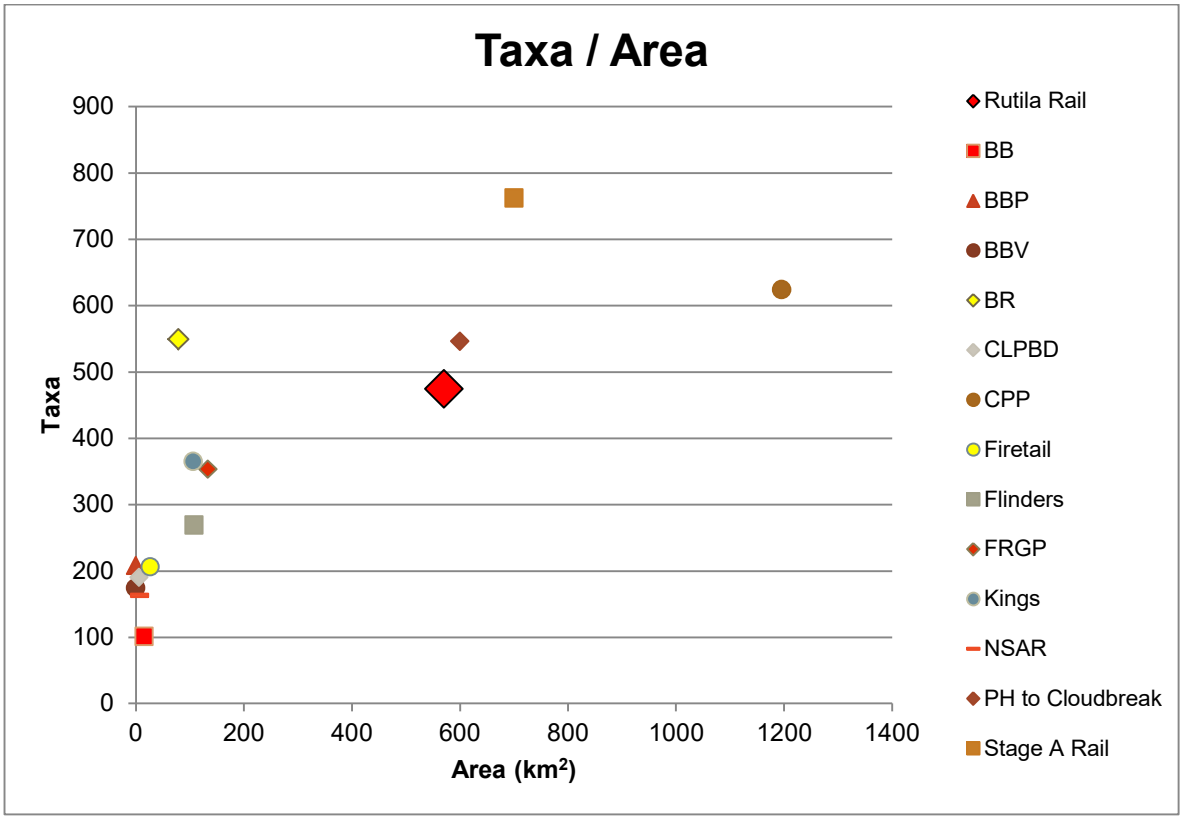

Figure 4: Taxa area plot

Table 10: Taxa numbers recorded for various Pilbara surveys

SURVEY	LEGEND ABBREVIATION	AREA (KM^2)	TAXA	REFERENCE
This survey	Rutila Rail	570.63	474	This report
Balla Balla export facilities	BB	Undefined	100	(Mattiske Consulting Pty Ltd 2013a)
Balla Balla Pipeline	BBP	Undefined	208	(Mattiske Consulting Pty Ltd 2008)
Balla Balla Vanadium (Mattiske)	BBV	Undefined	174	(Mattiske Consulting Pty Ltd 2006)
Brockman Rail	BR	79	549	(Ecologia Environment 2012a)
Cape Lambert Port B Development	CLPBD	6.02	190	(Biota Environmental Sciences Pty Ltd 2008)
Central Pilbara Project and regional survey area	CPP	1195.44	624	(Ecoscape 2012b)
Firetail	Firetail	26.7	206	(Ecoscape 2010a)
Flinders Blacksmith	Flinders	107.81	269	(Ecoscape 2011a)
Fortescue River Gas Pipeline	FRGP	133.38	353	(Mattiske Consulting Pty Ltd 2013b)
Kings	Kings	106.45	365	(ENV Australia Pty Ltd 2010)
North Star Access corridor	NSAR	7.04	163	(Ecologia Environment 2012b)
Port Hedland to Cloudbreak Rail, Borrow Pits & Infrastructure Area	PH to Cloudbreak	600	546	(Coffey Environments 2007)
Stage A Rail Corridor	Stage A Rail	700	762	(Biota Environmental Sciences Pty Ltd 2004)

5.4.3 Representation

Survey adequacy can also be assessed by representation of sample points recorded from within each vegetation type. The number of sample points from each vegetation type ranged from one (in 24 of the 58 vegetation types; 47%) to 19. For some of these vegetation types the low number of sample points was due to the small extent of the vegetation type, however in most cases it was due to lack of accessibility or that a vegetation type was not identified as being discrete until after the data had been analysed. Survey adequacy is therefore considered variable when using this metric.

The number of sample points recorded from each land system can also indicate survey adequacy (**Table 11**). In general, representation is in proportion to the extent of the land system. Except for the Hooley land system that was not accessible at the time of survey, all land systems are considered to be adequately represented.

Table 11: Land system representation

LAND SYSTEM	NO. SITES	EXTENT (HA)	LAND SYSTEM	NO. SITES	EXTENT (HA)
Black	2	478.89	Mallina	8	3303.05
Boolaloo	3	2037.30	McKay	5	1286.57
Boolgeeda	29	11651.33	Newman	10	3740.71
Calcrete	3	386.17	River	12	2951.97
Capricorn	5	467.21	Rocklea	12	6813.14
Coolibah	2	177.27	Ruth	10	4650.52
Granitic	7	1591.50	Satirist	3	471.18
Gregory	3	525.19	Sherlock	3	34.11
Hooley	0	14.57	Uaroo	9	10168.74
Horseflat	10	1420.13	Urandy	8	2514.20
Jurrawarrina	2	368.40	Wona	4	166.52
Macroy	6	1836.78			

5.5 BOTANICAL LIMITATIONS

5.5.1.1 Field Survey Timing

The single season field survey was conducted during July-August 2014 over two 11 day survey periods. The optimal (required) period for conducting Pilbara flora and vegetation surveys, as outlined in *Guidance Statement No. 51* (EPA 2004), is in the season following rain i.e. March-May. Whilst this survey did not comply with this optimal period, the survey occurred during a period when most conservation significant flora species were flowering (**Table 25**) and therefore identifiable.

Seasonal conditions during the surveys were considered by Ecoscape to be good (average) for the time of year (BoM 2014d; 2014e). According to the rainfall data shown in **Figure 5**, Roebourne (the closest long term BoM station to the northern end of the study area) experienced wetter than average December 2013 and May 2014 rainfall but below average for other months, and Wittenoom (the closest long-term BoM station to the southern end of the study area) experienced wetter than average December 203, January 2014 and June 2014, and below average for the other months.

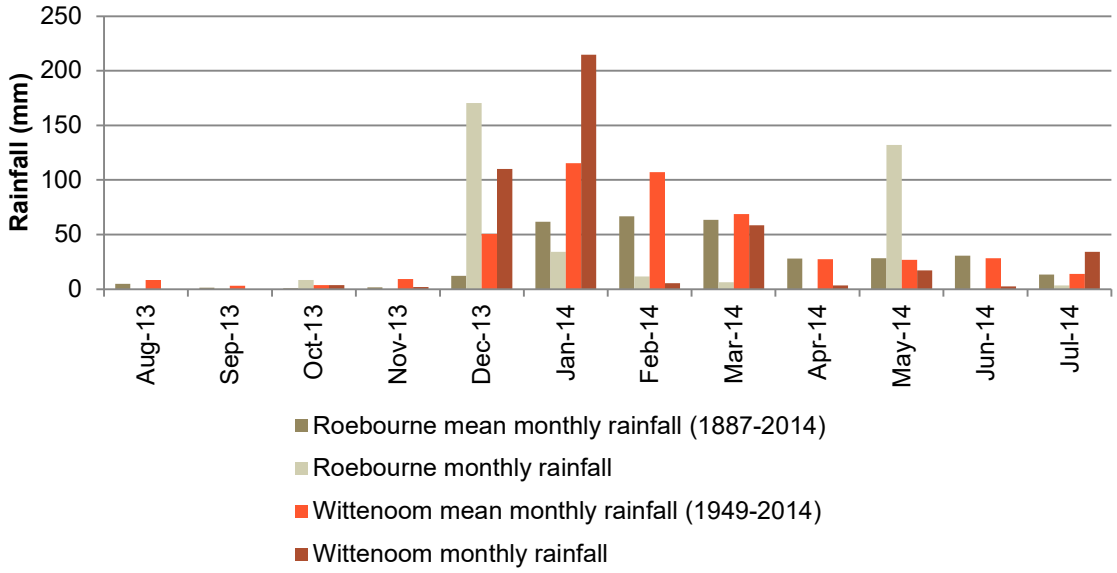

Figure 5: Rainfall data for Roebourne and Wittenoom (BoM 2014d; 2014e)

Figure 6 (BoM 2014f) indicates the rainfall of the study area was considered slightly below average for the six months prior to the field survey for the northern portion of the study area, and average for the southern portion. Due to the considerably above average rainfall recorded at Roebourne for May 2014 (132 mm, compared with the long term average of 28.4 mm (BoM 2014d)), there was no on-ground indication that the vegetation had been impacted by lower than average rainfall.

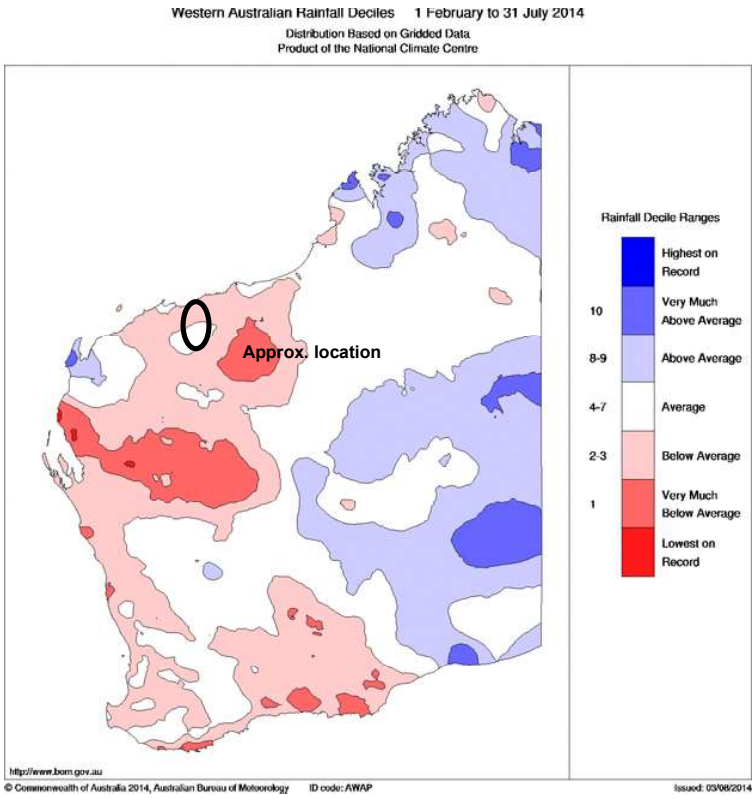

Figure 6: Western Australian rainfall deciles (BoM 2014f)

Table 12: Botanical limitations

POSSIBLE LIMITATIONS	CONSTRAINTS (YES/NO): SIGNIFICANT, MODERATE OR NEGLIGIBLE	COMMENT
Competency/experience of the consultant conducting the survey	No	The field team leaders conducting the field surveys have considerable experience conducting flora and vegetation surveys in the Pilbara. Stephen Kern has been conducting Pilbara botanical surveys since 2005 (10 years), Jared Nelson and Lyn Atkins since 2008 (seven years) and Richard Daniel since 2010 (four years).
Proportion of the flora identified	Negligible	474 flora taxa were recorded from the study area. Twenty four (5%) could not be identified to species level due to lack of reproductive material, however none were potentially of known conservation significance. The lack of reproductive material was most likely a result of the season of survey (July).
Proportion of the task achieved and further work that may need to be undertaken	Negligible (in main part of corridor) Moderate (in some areas largely away from the main corridor)	Almost all of the study area was accessible during the field surveys, with only some small sections, generally outside the main alignment (i.e. borrow pits etc), not readily accessible. There were negligible constraints in terms of the ability to determine vegetation types in these areas despite the lack of survey adequacy in these areas, and negligible constraints in terms of searches for conservation significant flora in these areas. Conservation significant vegetation is considered adequately surveyed in terms of representation but not in terms of season of survey. A second season of survey would target inaccessible areas and vegetation types with lower representation.
Timing/weather/season/cycle	Moderate-negligible (timing) Negligible/none (weather, season, cycle)	The field survey was conducted in July-August which is outside the optimal period for Pilbara botanical surveys as outlined in *Guidance Statement No. 51*. There were moderate constraints in this regard in some areas and some vegetation types that had a significant annual or ephemeral component (i.e. grasslands not dominated by *Triodia* spp.). However for most areas and vegetation types the constraint was considered to be negligible as most species were identifiable. There were negligible constraints in the ability to find and identify conservation significant flora as a majority were likely to be flowering at the time of survey or were otherwise identifiable. Weather conditions during the field surveys were ideal to conduct botanical surveys, with no constraints. Seasonal conditions were considered good for the time of year due to average rainfall in the southern portion of the study area, and out of season rainfall (in May) prior to the field survey in the northern portion of the study area. Constraint were considered to be none/negligible in this regard as the flora did not appear to be suffering from undue water stress.
Intensity of survey (e.g. In retrospect was the intensity adequate?)	Negligible	Most of the study area was accessible during the field survey. The sample point distribution was adequate to identify vegetation types and coverage adequate for conservation significant flora searches. As above, some outer areas outside the main alignment would benefit from additional survey, however overall the intensity of the survey is considered adequate.

POSSIBLE LIMITATIONS	CONSTRAINTS (YES/NO): SIGNIFICANT, MODERATE OR NEGLIGIBLE	COMMENT
Completeness (e.g. Was relevant area fully surveyed?)	Negligible	As above.
Resources (e.g. Degree of expertise available for plant identification)	No	There is adequate information available to identify significant vegetation and flora of the area. The senior taxonomist has considerable experience identifying Pilbara flora.
Remoteness and/or access problems	Negligible	Some portions of the study area were not directly accessible, however the access was adequate to describe the vegetation of the area and assess the likelihood of conservation significant flora occurring in them.
Availability of contextual (e.g. bioregional) information for the survey area	No	There is adequate contextual information in regard to the flora of the study area.

6.0 DISCUSSION

6.1 FLORA SIGNIFICANCE

A total of 474 vascular flora taxa were identified during the field survey, 5% of which could not be identified to species level. The relatively high proportion of taxa that could not be identified with certainty is most likely a result of the season of survey (July-August), when many plants did not have reproductive material.

The species accumulation curve, when taking into account opportunistic observations and plants collected during targeted searches for conservation significant flora, suggests that most species were likely to have been recorded during the field surveys. Despite this finding, it is likely that a survey conducted in the season following rain would result in additional ephemeral species being recorded, despite the seasonal conditions being considered as average (at least in the southern portion of the rail alignment). Heavily grazed areas, especially on the Horseflat land system in the north, are likely to have additional species present earlier in the season, before there are significant impacts of grazing and trampling.

Surveys have been conducted in nearby areas in the north, associated with the Balla Balla project (Astron Environmental Services 2005; Mattiske Consulting Pty Ltd 2006; 2008; 2013a), however only one report detailing these provides survey area extent. It is therefore not possible to compare species richness with Ecoscape's 2014 survey in a similar locality, however, review of these reports suggests that most species recorded were also recorded in 2014. Species richness is therefore likely to be similar between the areas.

A number of surveys have been undertaken in nearby areas at the southern end of the rail corridor (Coffey Environments 2010b; Ecoscape 2010a; 2010d; 2011a; 2012c; 2012d; 2012e; ENV Australia Pty Ltd 2010). The species richness of the Rutila rail corridor is considered similar to that recorded in the Flinders Blacksmith tenement, which overlaps with the southern end of the alignment (Ecoscape (Australia) Pty Ltd 2011a), but slightly less than for other linear surveys. Again, this is likely to be result of season of survey rather than lower species richness or inadequate survey.

There is no available comparative information available for the majority of the alignment, thus it is not possible to make an assessment in regard to species richness and adequacy of survey for most of the alignment.

It is Ecoscape's opinion that the significance of the flora within the rail corridor is comparable with the surrounding area.

6.1.1 Conservation Significant Flora

There were no flora taxa listed as TF under either the Commonwealth *EPBC Act 1999* or Western Australian *WC Act 1950* recorded from the study area.

Nine PF taxa were recorded from the study area:

- P1 taxa *Abutilon* sp. Pritzelianum (S. van Leeuwen 5095), *Helichrysum oligochaetum*, *Heliotropium muticum*
- P2 taxon *Pentalepis trichodesmoides* subsp. *hispida*
- P3 taxa *Indigofera* sp. Bungaroo Creek (S. van Leeuwen 4301), *Oldenlandia* sp. Hamersley Station (A.A. Mitchell PRP 1479), *Sida* sp. Barlee Range (S. van Leeuwen 1642)
- P4 taxa *Goodenia nuda, Rhynchosia bungarensis*

The potential impacts on each of these are discussed below. Whilst there is no statutory protection for PF, in general, for clearing applications in Western Australia, proponents are expected to provide evidence that removal of PF cannot be avoided and efforts have been made to minimise impacts on populations of these species. On occasion buffers of 20 m around P1 and P2 have been applied as a condition of vegetation clearing.

P1 *Abutilon* sp. Pritzelianum (S. van Leeuwen 5095); one population of this taxon was recorded, in a disturbed area that is likely to be a result of lightning strike rather than human disturbance. Ecoscape has previously recorded this taxon in disturbed areas associated with tracks (Ecoscape 2013d) and considers it likely to be a disturbance opportunist. Therefore, whilst some individuals or populations may be removed as a result of developing the rail corridor, any disturbance is likely to result in an overall increase in the species population thus significant impacts are unlikely.

P1 *Helichrysum oligochaetum*; a single population of this species was recorded in the clay bed of the Fortescue River. Based on specimen records listed on *FloraBase* (WAH 2014) the habitat of this species is likely to be specific, however it is an annual herb and populations could fluctuate between years. Additionally, the taxon has a wide east to west distribution of close to 500 km (assessed using the *NatureMap* measuring tool; DPaW 2007-2014). Therefore long-term impacts of removing some individual plants are unlikely to be significant, although efforts to avoid known populations may be required.

P1 *Heliotropium muticum*; a number of populations of this species were recorded near the northern end of the rail corridor. Plant density was greatest in disturbed areas, following fire or associated with tracks. Ecoscape has also recorded this species during previous surveys close to Port Hedland (Ecoscape 2010b; 2011b; 2012j), with the same observation and therefore considers it most likely to be a disturbance opportunist. Therefore, whilst some individuals or populations may be removed as a result of developing the rail corridor, any disturbance is likely to result in an overall increase in the species population thus significant impacts are unlikely.

P2 *Pentalepis trichodesmoides* subsp. *hispida*; a single plant of this taxon was recorded from the study area. Ecoscape has previously recorded this taxon in nearby areas (Ecoscape 2014a; 2014b, both assessed in 2013) and considers it more common than its listing as P2 suggests. It is Ecoscape's opinion that the impact of removing a single plant (or small population if additional plants occur nearby) is unlikely to have a significant impact on the taxon as a whole.

P3 *Indigofera* sp. Bungaroo Creek (S. van Leeuwen 4301); this taxon was recorded from the southern end of the alignment. Ecoscape has recorded this taxon during a number of surveys in the central and western Hamersley Range (Ecoscape 2011a; 2012c; 2012g; 2012k; 2013e; 2014a; 2014b) and considers it to be locally common, although, in the rail corridor, at the edge of its known range (DPaW 2007-2014). Therefore, removal of a small number of individuals is unlikely to have a significant impact on this taxon's population as a whole.

P3 *Oldenlandia* sp. Hamersley Station (A.A. Mitchell PRP 1479) was recorded on the Wona land system on cracking clay soil. Whilst this is likely to be a new population, this poorly known taxon has a north to south and east to west range of close to 200 km (assessed using the *NatureMap* measuring tool; DPaW 2007-2014) thus impacts on the taxon's population are unlikely to be significant if development proceeds.

P3 *Sida* sp. Barlee Range (S. van Leeuwen 1642); one population of this taxon was recorded from a gorge near the southern end of the rail corridor. Whilst this population is at the northern edge of its known extent, the taxon as a whole has an east to west range of over 350 km (assessed using the *NatureMap* measuring tool; DPaW 2007-2014) thus impacts on the taxon's population are unlikely to be significant if development proceeds.

P4 *Goodenia nuda*; a number of individuals and populations of this species was recorded along the length of the alignment. Ecoscape has recorded this species from most of the surveys it has conducted in the Pilbara region, and considers it to be sparsely distributed but not uncommon. It has a wide extent (assessed using the *NatureMap* measuring tool; DPaW 2007-2014) and is unlikely to be under threat thus impacts on the species as a whole are unlikely to be significant if development proceeds.

P4 *Rhynchosia bungarensis*; this species has an east to west extent of over 500 km (assessed using the *NatureMap* measuring tool; DPaW 2007-2014), and therefore the impact of removing a small number of plants is unlikely to be significant in terms of the species' population as a whole.

Overall; two of the three P1 taxa recorded during the field survey are considered likely to be disturbance opportunists and developing the rail corridor is unlikely to have a negative impact on their population as a whole. The third species, *Helichrysum oligochaetum*, is also unlikely to be significantly impacted in the context of its population as a whole, however DPaW would be required to make a determination if additional surveys would be required before development, however, as the entire rail corridor width will not be developed, it is likely that the population can be avoided.

Significant impacts on the overall population of P2 taxon *Pentalepis trichodesmoides* subsp. *hispida* are also unlikely to be significant as only one individual plant was recorded.

6.1.2 Conservation Significant Flora Likelihood Assessment

As it is not possible to search all of the study area, there remains a possibility that some conservation significant flora may occur within the study area but were not located. The conservation significant flora likelihood assessment identified the following as 'possible' to occur in the study area, however the probability of their occurrence varies. Many are associated with pools or clay flats. Discussion in relation to extent below uses *NatureMap* and its measuring tool (DPaW 2007-2014).

P1 taxa:

- associated with pools, drainage lines and floodplains:
    - *Josephinia* sp. Marandoo (M.E. Trudgen 1554); a specimen identified as *Josephinia* ?sp. Marandoo (M.E. Trudgen 1554) on *NatureMap* is known from within 10 km of the rail alignment, indicating some doubt in relation to its identity. It is therefore not possible to determine the actual likelihood of this taxon occurring in the rail corridor.
    - *Nicotiana heterantha*; is known from 10-20 km from the rail corridor in the Fortescue River valley. It is possible that it occurs in the rail corridor
- associated with clay soils:
    - *Brachyscome* sp. Wanna Munna Flats (S. van Leeuwen 4662); known from 20-50 km distance from the rail corridor but largely within the Hamersley Range to the south. Therefore, despite the possibility that it may occur, the probability of it occurring is likely to be low.
    - *Euphorbia inappendiculata* var. *queenslandica*; also known from 20-50 km distance from the rail corridor, and also to the south within the Hamersley Range. Therefore, despite the possibility that it may occur, the probability of it occurring within the rail corridor is likely to be low.
- associated with other habitat types:
    - *Sida* sp. Hamersley Range (K. Newbey 10692), associated with scree and skeletal soil, gorges and cliffs. This taxon is known from <10 km from the rail corridor. Whilst it is possible that it may occur within the rail corridor survey area, development of a rail corridor in the Hamersley Range portion of the study area is, for practical reasons, is unlikely to occur on areas associated with gorges and cliffs. Therefore, whilst the probability of this taxon occurring in the rail corridor survey area is moderate, the likelihood of it occurring in an impact area is low.

P2 taxa:

- associated with pools, drainage lines and floodplains:
    - *Cladium procerum*; known from 10-20 km distance from the rail corridor. It is possible that this species occurs in the study area.
    - *Oxalis* sp. Pilbara (M.E. Trudgen 12725); Ecoscape has collected this taxon from 50-100 km to the southwest of the rail corridor, although this record has not yet been verified by the WAH. The habitat of this taxon appears to be very specific (damp, sheltered areas in gorges), therefore the probability of this specific habitat occurring in the Hamersley Range within the rail corridor is low, and the probability of the taxon occurring is correspondingly low.
- associated with clay soils:
    - *Euphorbia australis* var. *glabra*; known from 20-50 km from the rail corridor in the Hamersley Range and Fortescue River Valley. It is possible that this taxon occurs in the study area, however, due to the difficulty of identifying this genus in the field almost all representatives are collected for later confirmation. Therefore the probability of it having been overlooked in the areas that have been adequately surveyed is low.
    - *Euphorbia inappendiculata* var. *inappendiculata*; known from 20-50 km from the rail corridor in the Hamersley Range and also occurs in other scattered areas. Whilst there remains a possibility of this taxon occurring in the study area, the probability is low as the known associated vegetation types occur only rarely, and not in the areas of known populations.
    - *Paspalidium retiglume*; known from <10 km from the study area on the edge of the Chichester Range, and Fortescue River valley. It is possible that this species occurs in the study area.
    - V*igna* sp. central (M.E. Trudgen 1626); known from 10-20 km from the rail corridor in the Hamersley Range. Although this taxa is associated with clay soils, this Hamersley Range record was collected by Ecoscape in 2011 in similar habitat to the southern end of the rail corridor and such it is possible that it may occur.
- associated with other habitat types:
    - *Spartothamnella puberula*; this taxon has recently been revised (published August 2014, but not yet appearing on *FloraBase* or *NatureMap*) and no longer occurs in Western Australia; it is now known as *Spartothamnella canescens* (Thiele & Shepherd 2014), and not of conservation significance.
    - *Trianthema* sp. Python Pool (G.R. Guerin & M.E. Trudgen GG 1023); this taxon is known from 50-100 km from the rail corridor associated with sand and gibber plains on the edges of the Chichester Range and as such the probability of it occurring is low.

P3 taxa:

- associated with pools, drainage lines and floodplains:
    - *Eragrostis crateriformis*; known from 50-100 km from the rail corridor; there is a low probability that this species may occur
    - *Fimbristylis sieberiana*; known from 20 – 50 km from the rail corridor in the Hamersley Range; there is potential that this species may occur
    - *Gymnanthera cunninghamii*; known from 20 – 50 km from the rail corridor in the Hamersley and Chichester Ranges; there is potential that this species may occur
- associated with clay soils:
    - *Astrebla lappacea*; known from 10-20 km from the rail corridor; there is potential that this species may occur
    - *Eragrostis surreyana*; known from 20-50 km from the rail corridor; there is potential that this species may occur
    - *Glycine falcata*; known from 20-50 km from the rail corridor in the Hamersley Range; there is potential that this species may occur

- *Goodenia* sp. East Pilbara (A.A. Mitchell PRP 727); 20-50 km from the rail corridor in the Hamersley Range and Fortescue River valley; there is potential that this species may occur
- *Iotasperma sessilifolium*; although this species is known within 10 km of the rail corridor in the Hamersley Range, the specific habitat is not common therefore there is a low probability that this species may occur
- *Polymeria distigma*; although known from 20-50 km from the study area in the Hamersley Range, the specific habitat is not common therefore there is a low probability that this species may occur
- *Solanum albostellatum*; known from within 10 km of the rail corridor in the Hamersley Range and also from the Fortescue River floodplain; there is potential that this species may occur
- *Stackhousia clementii*; known from 10-20 km from the rail corridor in the Hamersley Range and Fortescue River floodplain; there is potential that this species may occur
- *Swainsona thompsoniana*; known from 10-20 km from the rail corridor in the Hamersley and Chichester Ranges; there is potential that this species may occur
- *Themeda* sp. Hamersley Station (M.E. Trudgen 11431); known from 20-50 km from the rail corridor; there is potential that this species may occur

- associated with other habitat types:
  - *Acacia daweana*; known from a variety of habitat types within 10 km of the rail corridor; there is potential that this species may occur
  - *Calotis latiuscula*; known from a variety of habitats 20-50 km from the study area; there is potential that this species may occur
  - *Geijera salicifolia*; known from rocky scree and gorges 50-100 km from the rail corridor; there is a very low probability that this species may occur as the specific habitat is uncommon in rail corridor
  - *Ptilotus subspinescens*; although known from 20-50 km from the study area, it only occurs in a very localised area and as such there is a low probability that this species may occur
  - *Rhagodia* sp. Hamersley (M. Trudgen 17794); known from 20-50 km from the study area however Ecoscape's experience with this taxa indicates there is only a low probability of occurrence
  - *Rostellularia adscendens* var. *latifolia*; known from within 10 km of the rail corridor; there is potential that this species may occur.

P4 taxa; none are considered as having potential to occur in the study area.

Other significant taxa; an unnamed *Josephinia* sp. was previously recorded from within 10 km of the rail corridor in the Flinders Blacksmith tenement (Ecoscape 2011a). The specific habitat is unlikely to occur within the rail corridor and as such there is only a low probability of occurrence.

Following the above assessment, 17 taxa have potential to occur in the study area but have not been recorded (**Table 13**). Most are associated with clay soils.

Table 13: Priority flora that have potential to occur in the rail corridor

PRIORITY	POOLS/RIPARIAN	CLAY SOILS	OTHER HABITATS
P1	*Nicotiana heterantha*		
P2	*Cladium procerum*	*Paspalidium retiglume*	
		Vigna sp. central (M.E. Trudgen 1626)	
P3	*Fimbristylis sieberiana*	*Astrebla lappacea*	*Acacia daweana*
	Gymnanthera cunninghamii	*Eragrostis surreyana*	*Calotis latiuscula*
		Glycine falcata	*Rostellularia adscendens* var. *latifolia*
		Goodenia sp. East Pilbara (A.A. Mitchell PRP 727)	
		Solanum albostellatum	
		Stackhousia clementii	
		Swainsona thompsoniana	
		Themeda sp. Hamersley Station (M.E. Trudgen 11431)	

6.1.3 Other Significant Flora

6.1.3.1 Range Extension, Range Edges and Outlier Populations

The flora taxa that are considered to represent a range extension, range edge or outlier population are listed in Table 4. Two of these are significant range extensions; *Gyrostemon tepperi* with a western range extension of over 200 km, and *Sida* sp. Rabbit Flat (B.J. Carter 626) with a western range extension of approximately 100 km. Both were recorded on the Gregory land system, which is composed of aeolian dunes, in the northern portion of the study area in the Roebourne IBRA subregion.

6.1.3.2 New (Undescribed) Species

A potentially new (undescribed species) *Acacia* species was recorded as a dominant species from the rail corridor, in the Chichester Range. As WAH's *Acacia* specialist is on extended leave, it has not been possible to confirm if the specimen is known or not. Further surveys, preferably collecting specimens with reproductive material would, in any case, most likely be required for clarification.

6.1.3.3 Significant According to Guidance Statement No. 51

Acacia trachycarpa (dwarf variant) is described as an uncommon form that appears to have several disjunct populations (*Wattles of the Pilbara* Maslin *et al.* 2010). It was recorded in the southern portion of the study area in a number of vegetation types, and may be considered significant according to *Guidance Statement No. 51* (EPA 2004). Whilst uncommon, there is a 1981 record of this form occurring approximately 30 km to the northwest of the study area (DPaW 2007-2014; WAH 2014). Whilst of interest, it is unlikely that this species is of conservation or any other significance.

No specimens of the unnamed *Josephinia* sp. (EPA 2012b) that was identified as significant during the desktop assessment were recorded.

6.1.3.4 Locally Significant

No other flora taxa were considered to be locally significant.

6.1.4 Introduced Flora

Sixteen introduced flora (weeds) were recorded in the study area, although for two of these (**Cucumis melo* subsp. *agrestis* and **Flaveria trinervia*) there is some doubt in regard to their alien status. None are Declared Pest plants listed under the *BAM Act 2007* for the relevant local government areas.

None of the introduced species recorded in the study area are included on any of the weed lists maintained by DoE and Weeds Australia (see **Section 3.2.7**).

According to the DEC (2011a) *Pilbara Region – Environmental Weed List*, **Acetosa vesicaria*, **Aerva javanica*, **Cenchrus ciliaris*, **C. setiger*, **Cynodon dactylon*, **Malvastrum americanum*, **Setaria verticillata* and **Vachellia farnesiana* have high ecological impact, defined as *causes acute disruption of ecological processes, dominates and/or significantly alters vegetation structure and function of ecosystems* (DEC 2011b). They also have rapid invasiveness and (except for **Acetosa vesicaria* and **Aerva javanica*) low feasibility of control; feasibility of control is related to the time required to achieve the desired goal and cost involved, and considers how widespread a weed is, the ease of finding infestations, the cost of controlling infestations, difficulty of limiting the weed's dispersal, willingness of landholders and governments to control the weed, and the commercial use of the plant *(ibid.)*.

There are no requirements for control of any of these introduced species in the rail corridor area, however a management plan to restrict their spread during any future construction is potentially a requirement of environmental approvals.

6.2 VEGETATION SIGNIFICANCE

6.2.1 Vegetation Types

Fifty eight vegetation types were recorded within the study area. Twenty four of these had only quadrat or relevè recorded from them, largely as a result of lack of accessibility. Other reasons for lack of representation include the vegetation type not being recognised as a discrete vegetation type during the field survey and the vegetation type having a small extent. One vegetation type, previously identified by Mattiske Consulting (2006) had no quadrats recorded in it, however it was adequately described by Mattiske Consulting.

The significance of the vegetation types are discussed below.

6.2.2 Threatened Ecological Communities

There were no TECs recorded from within the study area. No TECs are likely to be impacted by any clearing or other proposed activities as the nearest TEC is more than 20 km from the study area, and downstream of any activities.

6.2.3 Priority Ecological Communities

The P3 'Horseflat Land System of the Roebourne Plains' PEC occurs in the northern portion of the rail corridor. This PEC occurs from near Cape Preston (west of Karratha), eastwards to Balla Balla; approximately 160 km apart.

The 'Horseflat Land System of the Roebourne Plains' PEC includes three subtypes (land system units) described in Van Vreeswyk *et al.* (2004). Land system unit 3 is represented by vegetation type **Ex_1** that occupies 1 091.38 ha in the rail corridor, on gilgaied plains. Land unit 5 may be represented by vegetation types **Te(1)**, **Tw(1)** and Mattiske **FPg1**, occupying a total of 126.98 ha; these vegetation types occur on alluvial plains. Land unit 7 may be represented by vegetation type **Cc_2Eb** occupying 12.76 ha in drainage

depressions. Locations of these vegetation types that may represent the different subtypes of the PEC are shown on **Map 5**. DPaW advice will be required to determine if the latter vegetation types are representative of the PEC however, the overall impact on the PEC by construction of a rail corridor is unlikely to be significant, given that the PEC occurs over such a wide area (160 km east to west). Since Ecoscape conducted the reconnaissance field survey, Rutila has already moved the proposed alignment in this portion of the corridor, and has reduced the potential impact on the PEC, including avoiding an area to the south of North West Coastal Highway.

The P1 'Cracking clays of the Chichester and Mungaroona Range' subtype of the 'Four plant assemblages of the Wona land system' PEC may be represented by vegetation type **Sb** that occupies 31.81 ha near the central portion of the rail corridor (see **Map 5**). Advice from the DPaW Species and Communities Branch and additional survey in the season following rain is likely to be required before the inclusion of this vegetation type in the PEC can be confirmed. Another area considered to represent the PEC, or at least occurring within the buffers of the area considered to represent the PEC (south of the Roebourne Wittenoom Rd) does not represent the PEC as it is a shrubland, not a grassland or herbland that define the four plant assemblages.

6.2.4 Groundwater Dependent Ecosystems

In the northern portion of the study area the proposed railway alignment crosses the Sherlock River and a major tributary, and occupies part of its floodplain. Through the Nunyerry Gap, in the Chichester Range, part of the alignment corresponds with Nunyerry Creek (itself a tributary of the Sherlock River). In the southern portion of the study area the proposed railway alignment crosses the Fortescue River and follows the course of its tributary, Weelumurra Creek. GDEs are associated with all major drainage lines, and are likely to be impacted by the proposed works.

The study area includes areas that are considered to represent Class 2 and Class 3 GDES.

GDEs characterised by *Eucalyptus camaldulensis* and/or *Melaleuca argentea*, including vegetation types **EvMlCv**, **MaMgCv** and **MaMlCi** that occupy 943.26 ha (1.65% of the study area), may represent Class 2 GDEs that are dependent on the surface expression of groundwater (i.e. vegetation associated with pools) or Class 3 GDEs that are dependent on the subsurface expression of groundwater (Eamus *et al*. 2006). These species generally co-occurred within the rail corridor but were not always associated with pools, although it was likely that the groundwater was close to the surface.

Class 3 GDEs include riparian vegetation; in this case Ecoscape considers riparian vegetation to include *Eucalyptus victrix* (as well as the above species). *Eucalyptus victrix* may be phreatophytic however this has not been determined absolutely and is likely to be dependent on local factors (see **Section 3.3.3**). Vegetation types that may be included as Class 3 GDEs include **EvApCc$_1$**, **EvApTe**, **EvAt$_1$Te**, **EvCb** and **EvMgEb** that occupy 1 512.9 ha (2.65% of the study area).

It will not be possible to determine impact extents on GDEs until a final rail corridor has been determined, however, given the requirement for a railway to be located on as flat land as possible, impacts are inevitable.

6.2.5 Mulga Communities

No vegetation types were considered to represent a Mulga Community.

There was no SFDV within the study area, and none identified from nearby that is likely to be impacted by the proposed works.

6.2.6 'Ecosystems at Risk'

No vegetation likely to represent an 'Ecosystem at Risk', except vegetation now considered to represent a PEC and GDEs, was recorded in the study area. These are discussed above.

6.2.7 Other Significant Vegetation

Vegetation having a restricted distribution can be significant according to *Guidance Statement No. 51* (EPA 2004).

Ecoscape has undertaken a number of flora and vegetation surveys in the Hamersley Range (Ecoscape 2010a; 2011a; 2012b; 2012i; 2013b; 2013e; 2014a; 2014b). Only four of these study areas (Ecoscape 2010a; 2011a; 2012b; 2014b) have recorded restricted areas of vegetation characterised by a species known as *Triodia* aff. *melvillei*. Ecoscape is therefore of the opinion that this vegetation type, known in this report as **ElAa$_3$Tm**, is of significance as it has a restricted distribution, being confined to the low undulating hills in the valleys of the central Hamersley Range. Vegetation type **ElAa$_3$Tm** occupied 125.06 ha in the rail corridor.

Vegetation type **FbGpEm**, occupying 2.48 ha in the rail corridor, was confined to a small quartz hill. No similar landform or vegetation type was recorded elsewhere in the study area, nor observed nearby. Therefore this vegetation type has a restricted distribution within the rail corridor and surrounds.

Vegetation type **AmEe**, occupying 26.42 ha in the rail corridor, was confined to a large aeolian dune, largely in the Gregory land system. No similar vegetation nor landform were recorded elsewhere; other representations of the Gregory land system were undulating dunes. Therefore this vegetation type has a restricted distribution within the rail corridor.

A number of other vegetation types in the rail corridor have restricted distributions (i.e. small extents or confined to a particular, restricted landform or geographic location), however none were considered of significance.

Vegetation types can have significance if they are confined to or largely confined to poorly represented land systems. Only one land system meets this criteria; Gregory. Vegetation types **AmEe** and **As$_3$** were largely confined to the Gregory land system and therefore are considered of significance.

Vegetation types can also have significance if they are confined to or largely confined to poorly represented pre-European vegetation associations. Vegetation types **AiTe(1)**, **AiTe(3)**, **AiTw(3)**, **AmEe**, **ChAa$_1$Ta**, **MaMgCv** and **Ta** are confined or largely confined to pre-European vegetation associations with low representation, however all pre-European vegetation associations have more than 95% of their pre-European extent remaining in the Pilbara.

6.2.8 Vegetation Similarity to Nearby Areas

Ecoscape is aware of a number of flora and vegetation reports associated with areas close to the far northern end of the rail corridor (Astron Environmental Services 2005; Mattiske Consulting Pty Ltd 2006; 2008; 2013a). In most cases (except vegetation type **FbGpEm**), the vegetation recorded during this survey is largely similar to vegetation recorded previously. Only riparian vegetation was considered of significance according to Mattiske Consulting (2006) and also recorded by Ecoscape during this survey. Riparian vegetation is considered of significance as it represents a GDE, and is discussed in **Section 6.2.4** above.

Ecoscape has conducted a number of surveys towards the southern end of the study area and is aware of other nearby surveys (see **Section 3.3.7**). In general, the vegetation of the rail corridor is considered similar to that recorded during these previous surveys. Vegetation associated with high hills (similar to vegetation

type **ElEgTw**) was considered of significance in a number of these areas (Ecoscape 2010a; 2012b; 2012g; 2014b). Therefore this vegetation type is likely to be of some significance, however it is unlikely to be impacted by any future development of the rail corridor due to its location on a high hill. Aside from GDE vegetation, and vegetation type **ElAa$_3$Tm** discussed above, no other vegetation similar to that recorded dring this survey was considered of significance.

Ecoscape is not aware of any previous flora and vegetation surveys conducted on the bulk of the rail corridor study area, largely from south of North West Coastal Highway to Weelamurra Creek, towards the south of the rail corridor. Vegetation that may be considered significant in this portion of the study area is discussed above, however, as a general statement, most of the vegetation appeared similar to large areas surrounding the rail corridor that were traversed in order to get to the corridor during the field survey.

6.2.9 Floristic Analysis

No regional floristic analysis was conducted.

Study area floristic analysis provided a reasonable correlation between vegetation types as observed during the field survey and floristic groups.

6.3 VEGETATION CONDITION

Most (90.64%) of the study area was assessed as being in Excellent condition. Those areas assessed in lesser condition were generally impacted by cattle grazing, and perhaps to some degree feral animal grazing, and weed invasion, largely Buffel Grass (**Cenchrus ciliaris*).

Impacts of grazing, particularly damage to the soil surface and weeds, were most common on the Horseflat land system and associated with drainage lines.

7.0 SUMMARY AND CONCLUSIONS

The vast majority of the rail corridor is not significant in terms of flora and vegetation. The significant aspects are:

- conservation significant flora, particularly P1 and P2 flora taxa;
    - P1 taxa *Abutilon* sp. Pritzelianum (S. van Leeuwen 5095), *Helichrysum oligochaetum*, *Heliotropium muticum*
    - P2 taxon *Pentalepis trichodesmoides* subsp. *hispida*
- vegetation considered to represent, or potentially represent, two PECs;
    - P3 'Horseflat Land System of the Roebourne Plains' PEC
    - P1 'Cracking clays of the Chichester and Mungaroona Range' subtype of the 'Four plant assemblages of the Wona land system'.

A number of other vegetation types may be significant according to other attributes, including representing a GDE or significant due to its association with poorly represented land systems or pre-European vegetation associations, or be significant according to Guidance Statement No. 51 (generally of a restricted distribution).

7.1 RECOMMENDATIONS IN RELATION TO GUIDANCE STATEMENT NO. 51

Guidance Statement No. 51 (EPA 2004) states that a Level 2 survey requires:

1. one or more visit/s in the main flowering season and visit/s in other seasons
2. replication of plots in vegetation units, and greater coverage and displacement of the plots over the target area (relative to a Level 1 survey).

Ecoscape considers this survey has largely satisfied the second requirement, however the survey was conducted over only one season, not in the main flowering season. Therefore the first requirement of a Level 2 survey has not been met.

The EPA is anticipated to provide guidance if it considers that a second survey is required.

Ecoscape considers that the Rutila Rail flora and vegetation survey has:

- adequately described and mapped most vegetation units within the study area
- adequately identified significant vegetation types
- adequately described the perennial flora of the study area
- adequately searched the study area for conservation significant flora
- adequately assessed and mapped the vegetation condition of the study area
- discussed the flora and vegetation values of the study area.

Ecoscape considers that a second season of survey, conducted in the season following rain that is considered to represent the main flowering season, would:

- provide a larger flora inventory as many more annual and ephemeral plants are likely to be flowering (or, at least, have had a greater opportunity to have not yet been grazed)
- provide greater certainty in regard to the presence of conservation significant flora that flower earlier in the year
- provide an opportunity to target the few areas not considered adequately surveyed (generally off the main alignment but also including the Wona, Hooley and Gregory land systems within the main alignment)
- provide an opportunity to record additional data required for a determination in relation to possible PEC subtype on the Wona land system.

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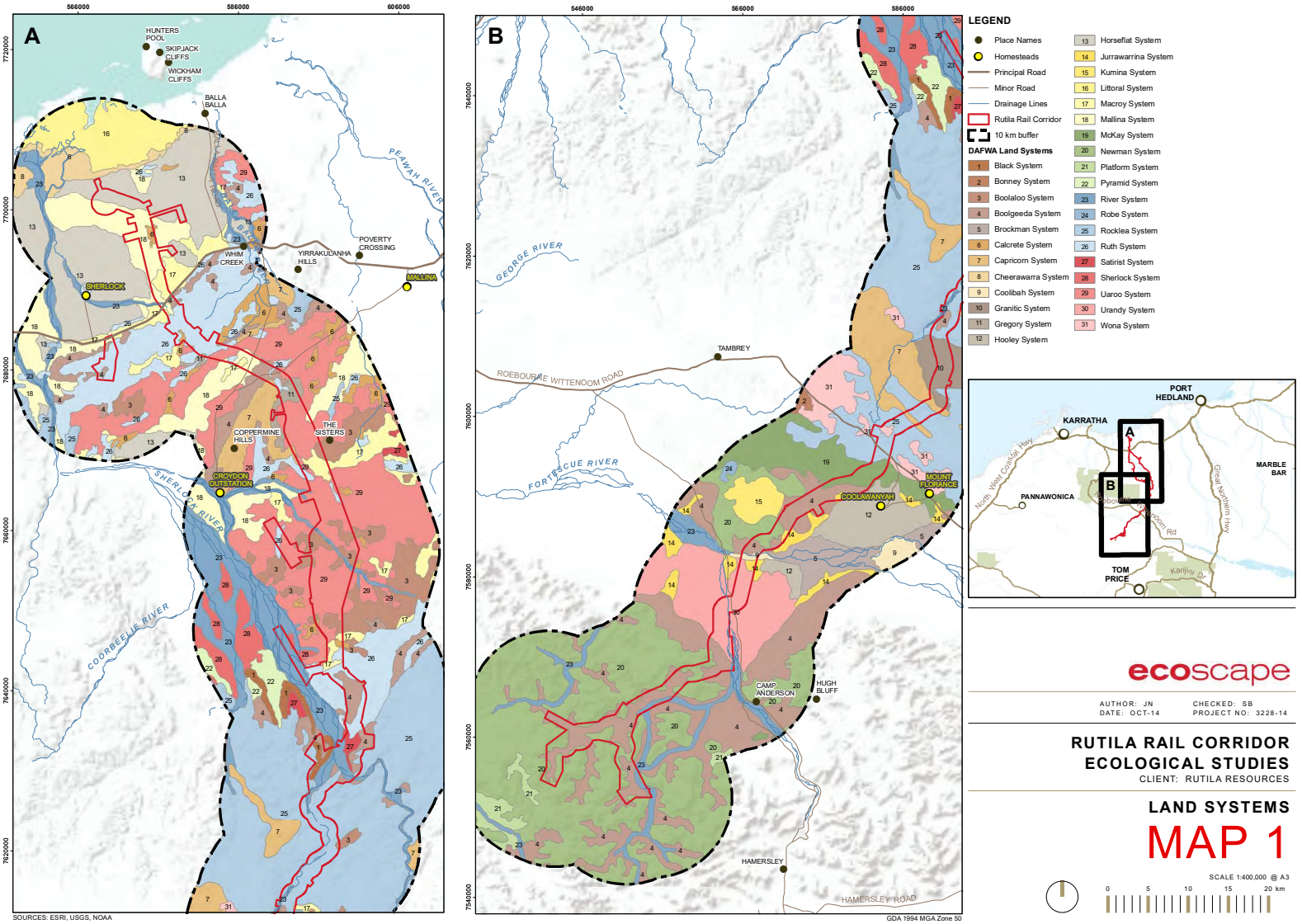
REPORT MAPS



SOURCES: ESRI, USGS, NOAA

GDA 1994 MGA Zone 50

LEGEND

- Place Names
- Homesteads
- Principal Road
- Minor Road
- Drainage Lines
- Rutila Rail Corridor
- 10 km buffer

DAFWA Land Systems

1 Black System
2 Bonney System
3 Boolaloo System
4 Boolgeeda System
5 Brockman System
6 Calcrete System
7 Capricorn System
8 Cheerawarra System
9 Coolibah System
10 Granitic System
11 Gregory System
12 Hooley System
13 Horseflat System
14 Jurrawarrina System
15 Kumina System
16 Littoral System
17 Macroy System
18 Mallina System
19 McKay System
20 Newman System
21 Platform System
22 Pyramid System
23 River System
24 Robe System
25 Rocklea System
26 Ruth System
27 Satirist System
28 Sherlock System
29 Uaroo System
30 Urandy System
31 Wona System

ecoscape

AUTHOR: JN
DATE: OCT-14
CHECKED: SB
PROJECT NO: 3228-14

RUTILA RAIL CORRIDOR ECOLOGICAL STUDIES

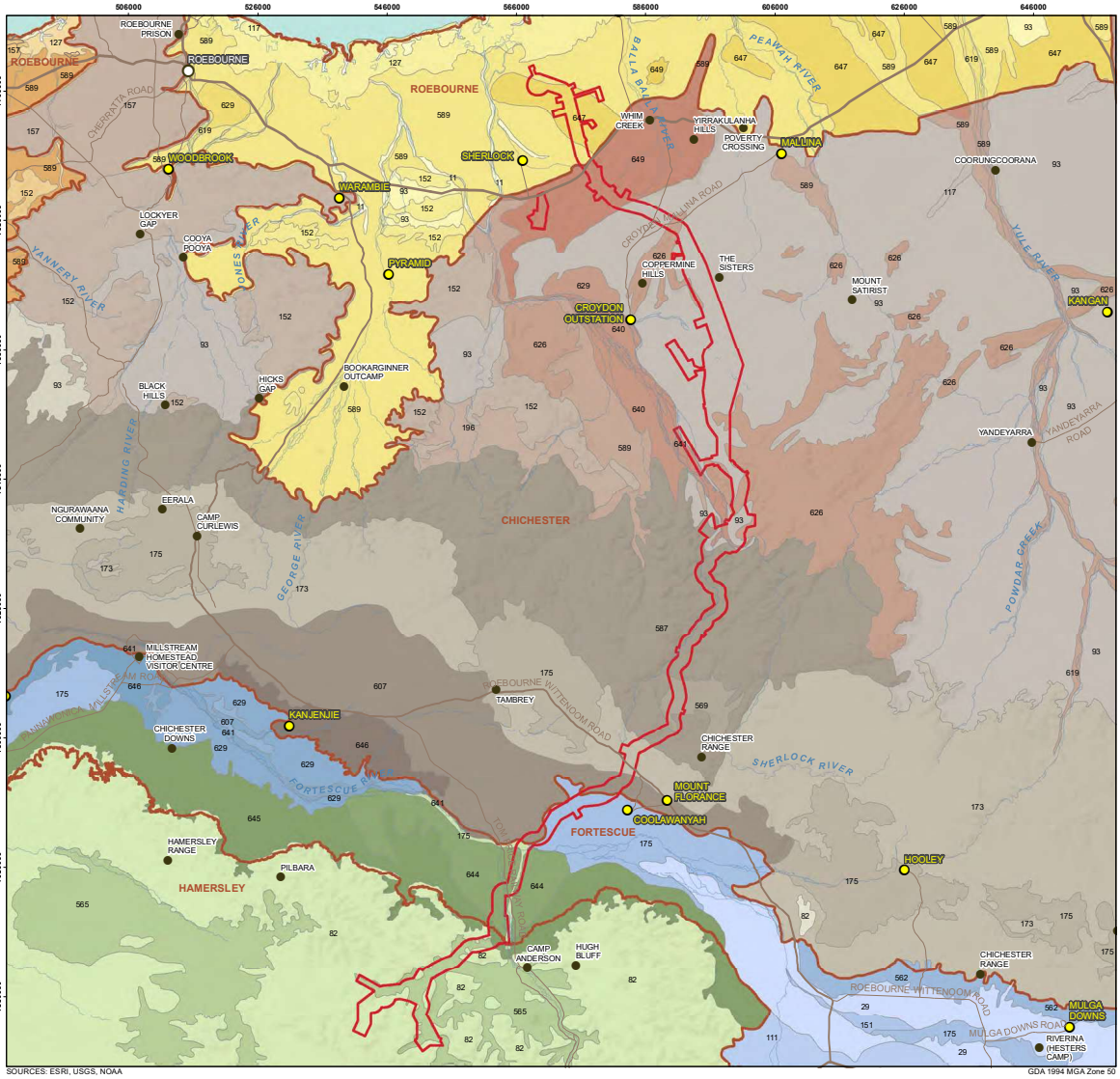
CLIENT: RUTILA RESOURCES

LAND SYSTEMS

MAP 1

SCALE 1:400,000 @ A3

0 5 10 15 20 km



SOURCES: ESRI, USGS, NOAA

GDA 1994 MGA Zone 50

LEGEND

- Populated Places
- Homesteads
- Place Names
- Principal Road
- Secondary Road
- Minor Road
- Drainage Lines
- Rutila Rail Corridor
- IBRA Version7 Subregions

PreEuropean Vegetation Associations within Corridor

Abydos Plain - Chichester System

- 93: Hummock grasslands, shrub steppe; kanji over soft spinifex
- 626: Hummock grasslands, shrub-steppe; kanji over soft spinifex and *Triodia brizioides*
- 641: Medium woodland; coolabah & river gum
- 649: Sedgeland; Various sedges with very sparse snakewood

Abydos Plain System

- 589: Mosaic: Short bunch grassland - savanna / grass plain (Pilbara) / Hummock grasslands, grass steppe; soft spinifex
- 647: Hummock grasslands, dwarf-shrub steppe; *Acacia translucens* over soft spinifex

Chichester System

- 173: Hummock grasslands, shrub steppe; kanji over soft spinifex and *Triodia wiseana* on basalt
- 569: Hummock grasslands, low tree steppe; bloodwood over soft spinifex and *Triodia wiseana*
- 587: Mosaic: Hummock grasslands, open low tree-steppe; snappy gum over *Triodia wiseana* / Hummock grasslands, shrub-steppe; kanji over *Triodia pungens*
- 607: Hummock grasslands, low tree steppe; snappy gum and bloodwood over soft spinifex and *Triodia wiseana*

Hamersley System

- 82: Hummock grasslands, low tree steppe; snappy gum over *Triodia*
- 175: Short bunch grassland - savanna/grass plain (Pilbara)
- 565: Hummock grasslands, low tree steppe; bloodwood over soft spinifex
- 644: Hummock grasslands, open low tree steppe; mulga and snakewood over soft spinifex and *Triodia basedowii*
- 645: Hummock grasslands, shrub steppe; kanji and snakewood over soft spinifex and *Triodia wiseana*

Fortescue System

- 175: Short bunch grassland - savanna/grass plain (Pilbara)

ecoscape

AUTHOR: JN CHECKED: SB
DATE: MAY-14 PROJECT NO: 3228-14

RUTILA RAIL CORRIDOR ECOLOGICAL STUDIES

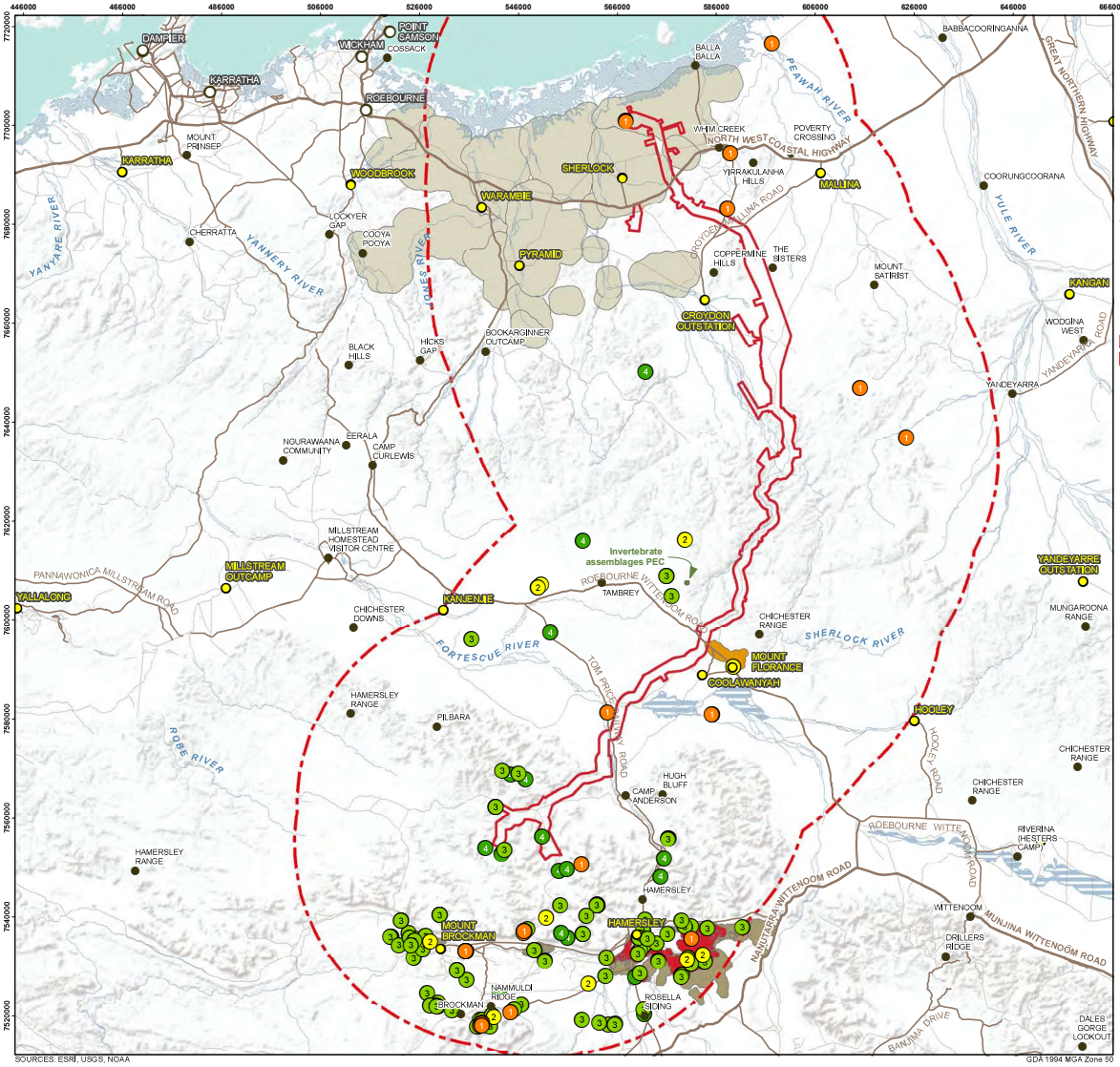
CLIENT: RUTILA RESOURCES

IBRA AND PRE-EURO VEGETATION

MAP 2

SCALE 1:580,000 @ A3

0 10 20 30 km



LEGEND

- Populated Places
- Homesteads
- Place Names

DPaW Flora Databases
Conservation Status

- P1
- P2
- P3
- P4

- Principal Road
- Secondary Road
- Minor Road
- Track
- Drainage Lines
- Land subject to inundation
- Saline coastal flat
- Rutila Rail Corridor
- 40 km search buffer

DPaW Ecological Community Database
Threatened Ecological Communities

- Vulnerable: *Themeda* grasslands on cracking clays (Hamersley Station, Pilbara)

Priority Ecological Communities

- Priority 1: Brockman Iron cracking clay communities of the Hamersley Range
- Priority 1: Four plant assemblages of the Wona Land System (previously 'Cracking clays of the Chichester and Mungaroona Range')
- Priority 3: Horseflat Land System of the Roebourne Plains
- Priority 4: Invertebrate assemblages (Errawallana Spring type) Coolawanya Station

ecoscape

AUTHOR: JN CHECKED: SB
DATE: MAY-14 PROJECT NO: 3228-14

RUTILA RAIL CORRIDOR ECOLOGICAL STUDIES

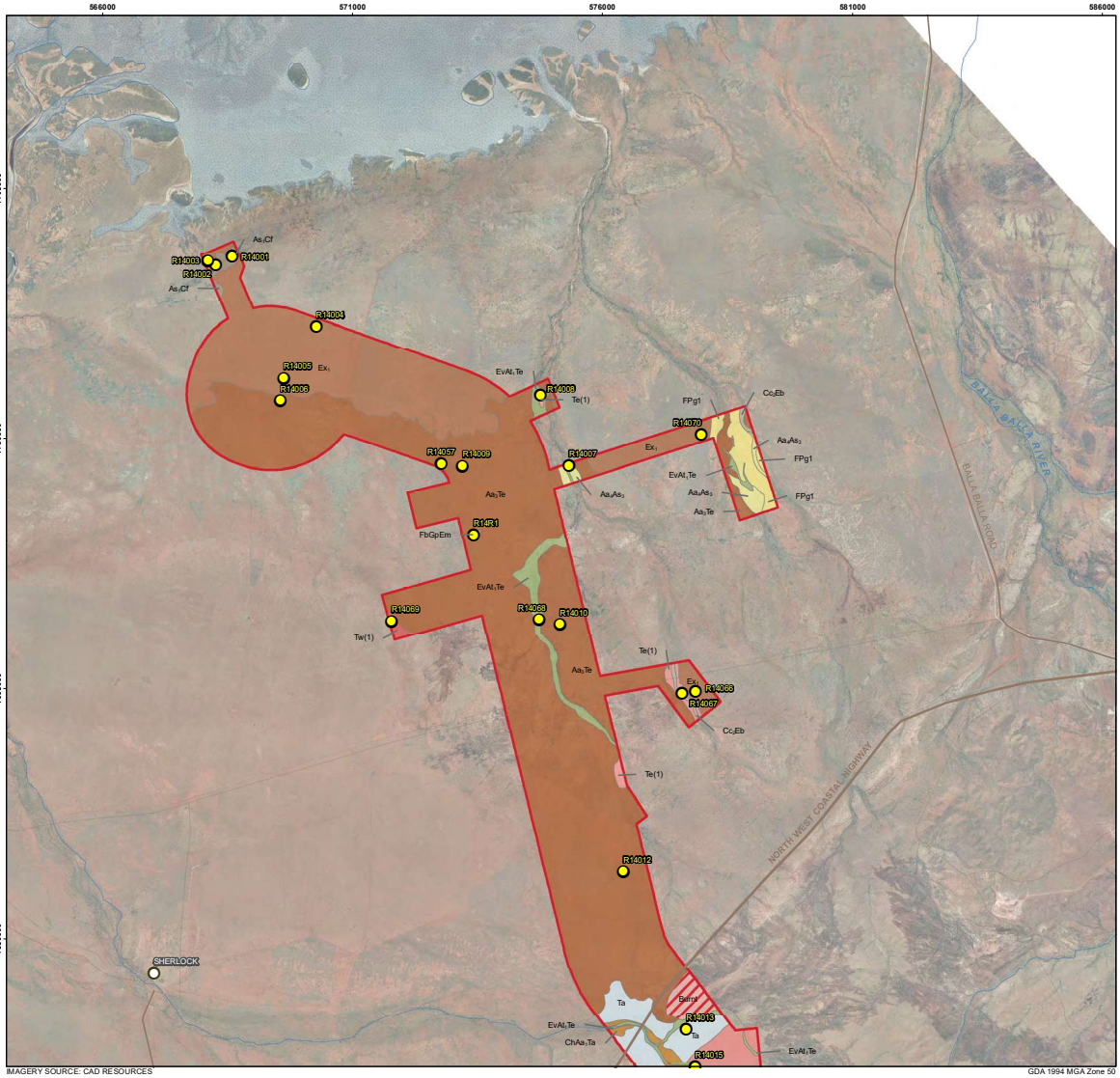
CLIENT: RUTILA RESOURCES

DPAW DATABASE SEARCH RESULTS

MAP 3

SCALE 1:750,000 @ A3

0 10 20 30 40 km

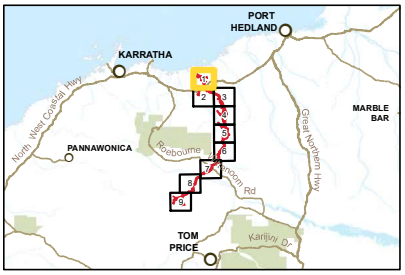


LEGEND

- Quadrats/Detailed Releve
- Homesteads
- Principal Road
- Minor Road
- Track
- Drainage Lines
- Saline coastal flat
- Rutila Rail Corridor

Vegetation Type

- Aa_3Te
- Aa_4As_3
- ApTw
- As_1Cf
- Cc_2Eb
- $ChAa_1Ta$
- $EvAt_1Te$
- Ex_1
- FPg1
- FbGpEm
- Ta
- Te(1)
- Tw(1)
- Burnt



ecoscape

AUTHOR: JN
DATE: OCT-14
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PROJECT NO: 3228-14

RUTILA RAIL CORRIDOR ECOLOGICAL STUDIES

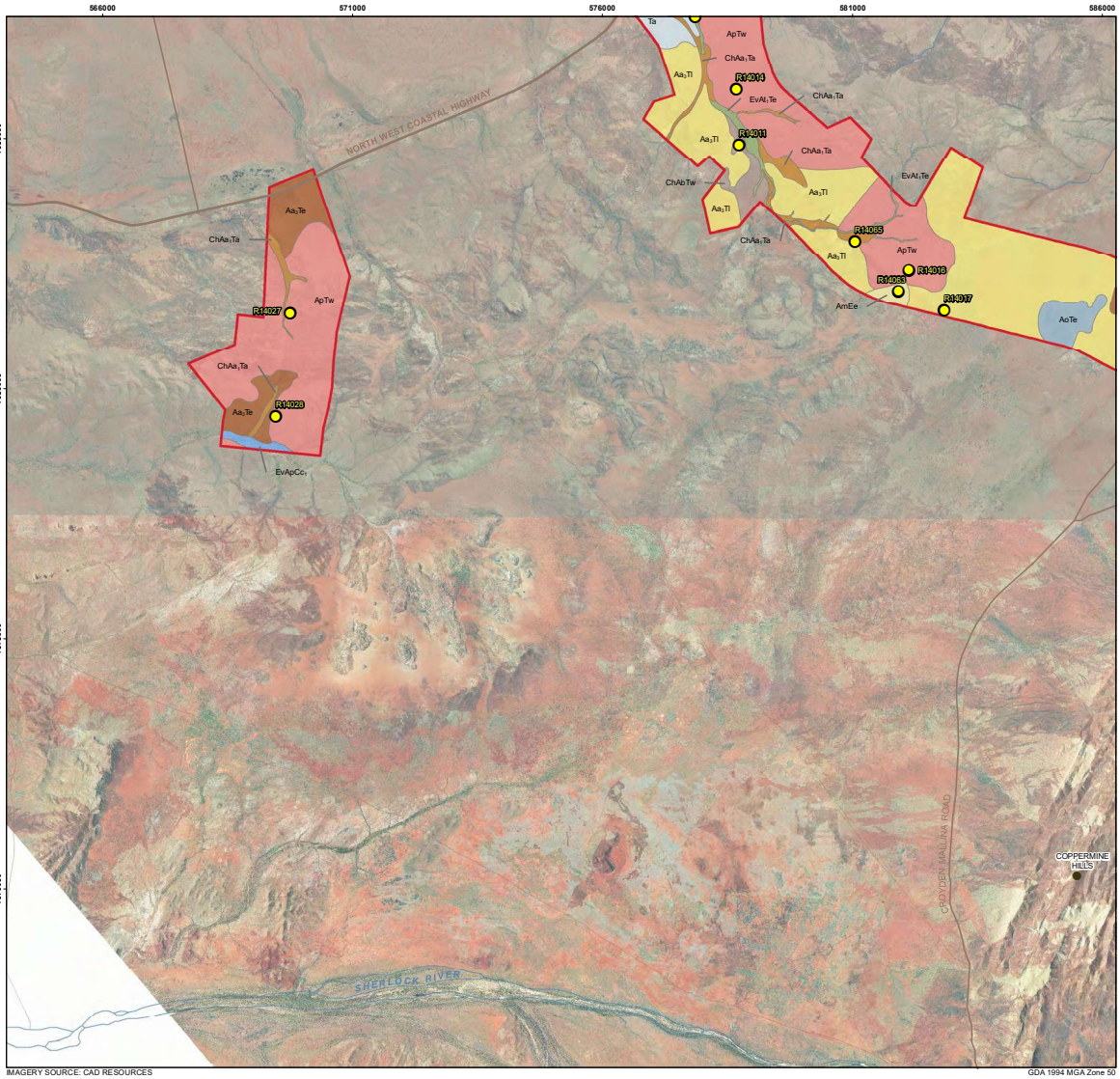
CLIENT: RUTILA RESOURCES

VEGETATION TYPES

MAP 4 - 1

SCALE 1:75,000 @ A3

0 1 2 3 4 km



IMAGERY SOURCE: CAD RESOURCES

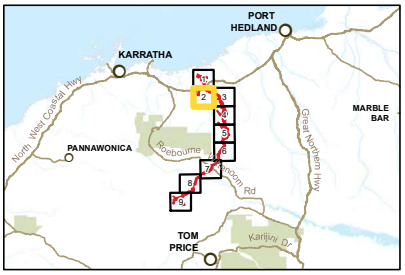
GDA 1994 MGA Zone 50

LEGEND

- Quadrats/Detailed Releve
- Place Names
- Principal Road
- Minor Road
- Track
- Drainage Lines
- Rutila Rail Corridor

Vegetation Type

- Aa_3Te
- Aa_3Tl
- AmEe
- AoTe
- ApTw
- $ChAa_1Ta$
- ChAbTw
- $EvApCc_1$
- $EvAt_1Te$
- Ta



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PROJECT NO: 3228-14

RUTILA RAIL CORRIDOR ECOLOGICAL STUDIES

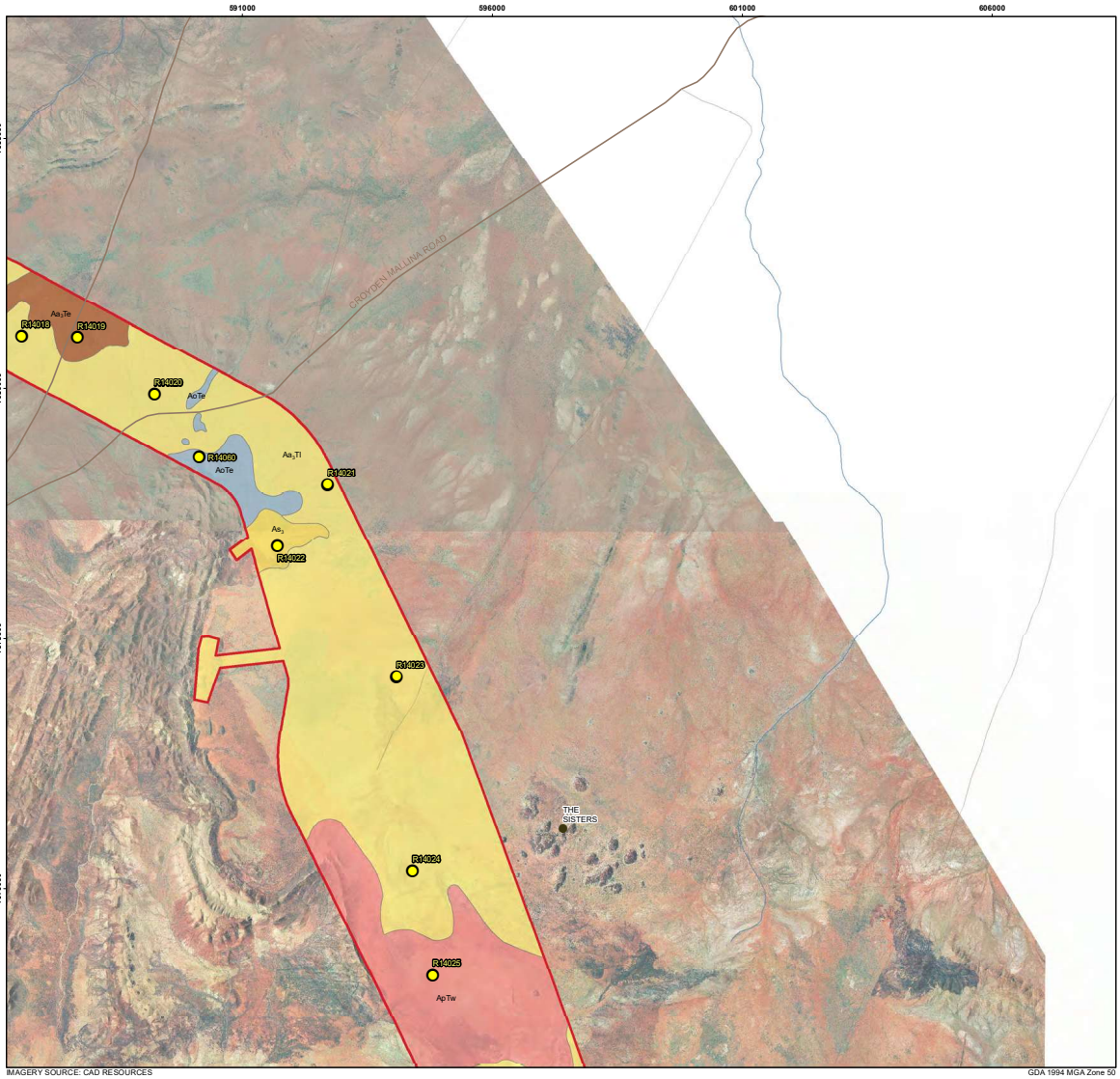
CLIENT: RUTILA RESOURCES

VEGETATION TYPES

MAP 4 - 2

SCALE 1:75,000 @ A3

0 1 2 3 4 km

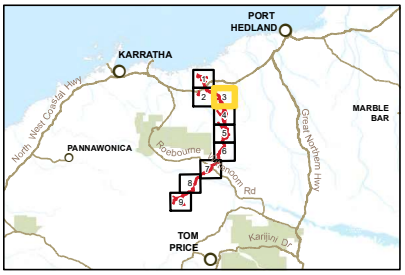


LEGEND

- Quadrats/Detailed Releve
- Place Names
- Minor Road
- Track
- Drainage Lines
- Rutila Rail Corridor

Vegetation Type

- Aa_3Te
- Aa_3Tl
- AoTe
- ApTw
- As_3



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PROJECT NO: 3228-14

RUTILA RAIL CORRIDOR ECOLOGICAL STUDIES

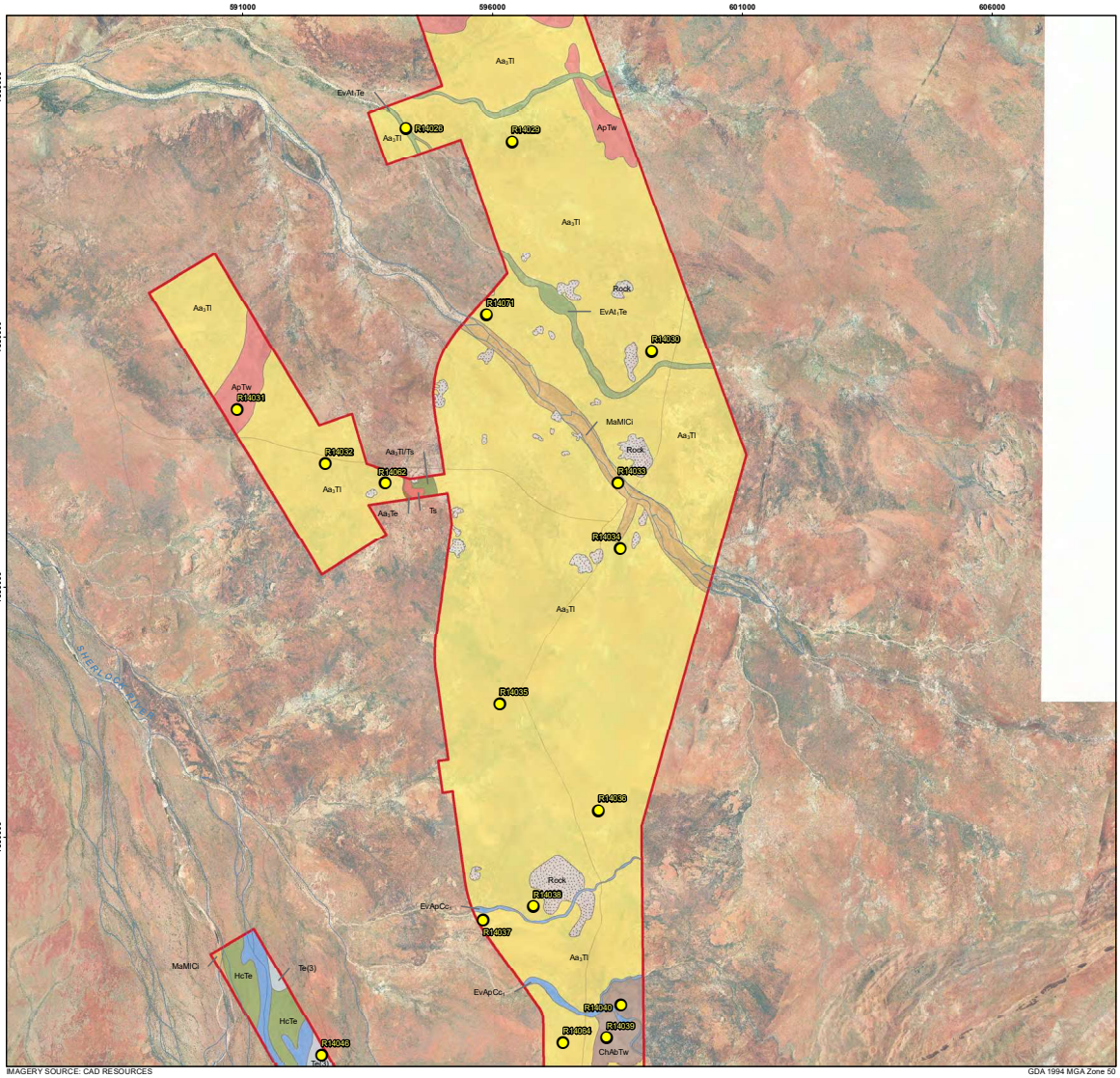
CLIENT: RUTILA RESOURCES

VEGETATION TYPES

MAP 4 - 3

SCALE 1:75,000 @ A3

0 1 2 3 4 km

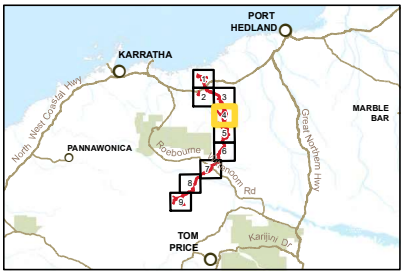


LEGEND

- Quadrats/Detailed Releve
- Track
- Drainage Lines
- Rutila Rail Corridor

Vegetation Type

- Aa3Te
- Aa3Tl
- Aa3Tl/Ts
- ApTw
- ChAbTw
- EvApCc1
- EvAt1Te
- HcTe
- MaMlCl
- Te(3)
- Ts
- Rock



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RUTILA RAIL CORRIDOR ECOLOGICAL STUDIES

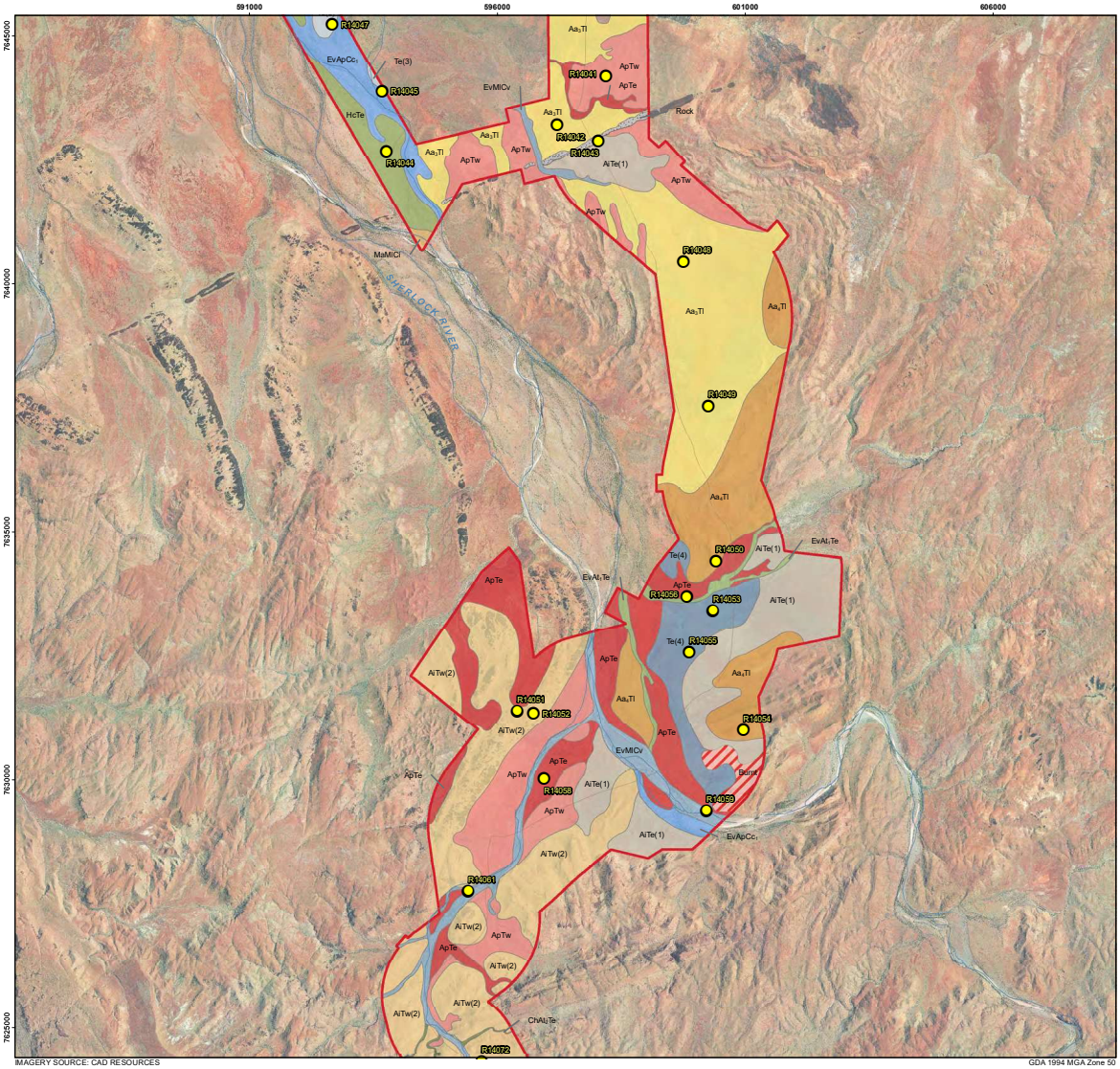
CLIENT: RUTILA RESOURCES

VEGETATION TYPES

MAP 4 - 4

SCALE 1:75,000 @ A3

0 1 2 3 4 km

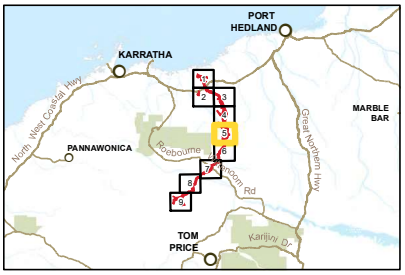


LEGEND

- Quadrats/Detailed Releve
- Track
- Drainage Lines
- Rutila Rail Corridor

Vegetation Type

- Aa3Tl
- Aa4Tl
- AiTe(1)
- AiTw(2)
- ApTe
- ApTw
- ChAbTw
- ChAt2Te
- EvApCc1
- EvAt1Te
- EvMlCv
- HcTe
- MaMlCi
- Te(3)
- Te(4)
- Burnt
- Rock



ecoscape

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PROJECT NO: 3228-14

RUTILA RAIL CORRIDOR ECOLOGICAL STUDIES

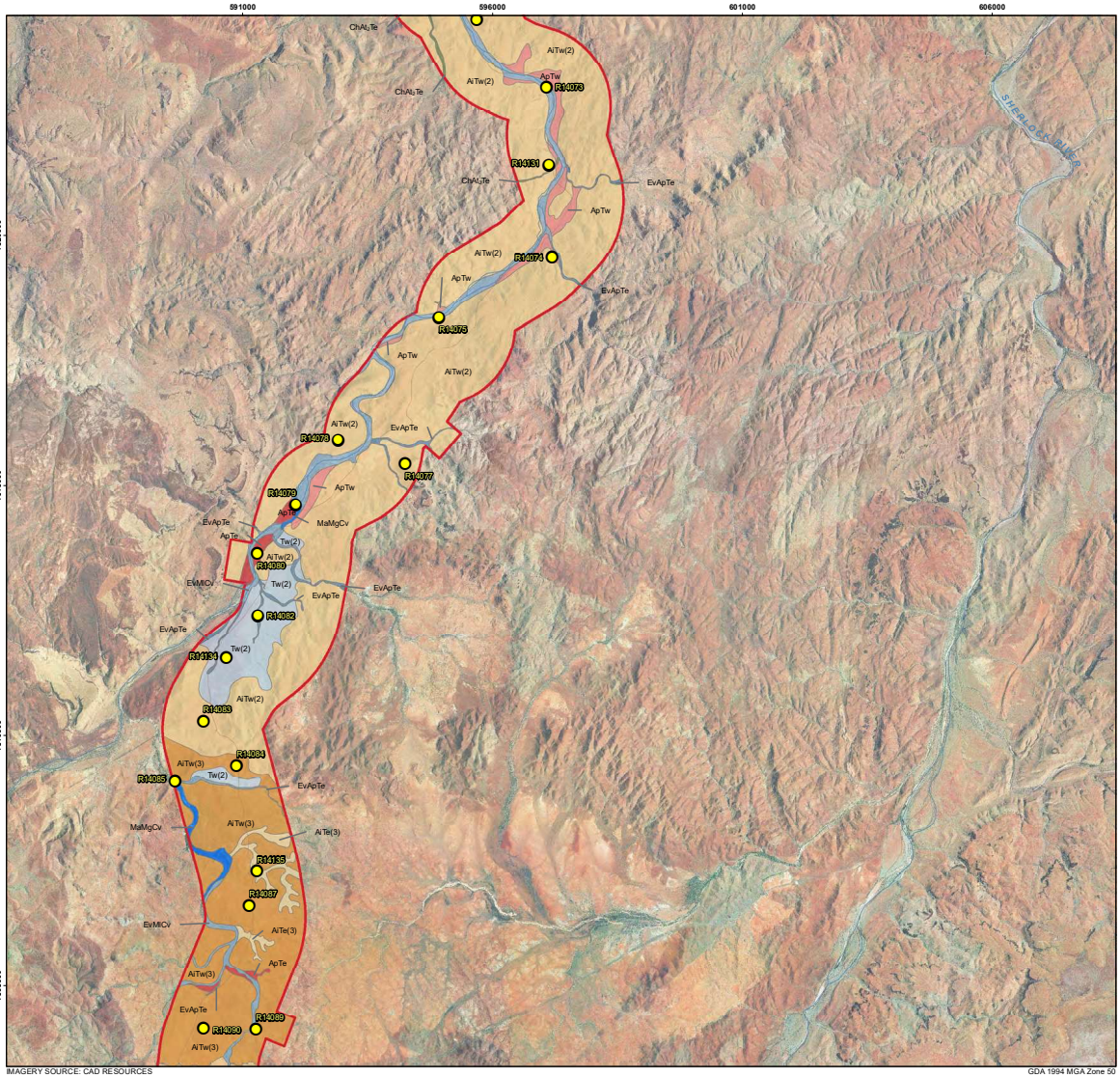
CLIENT: RUTILA RESOURCES

VEGETATION TYPES

MAP 4 - 5

SCALE 1:75,000 @ A3

0 1 2 3 4 km



IMAGERY SOURCE: CAD RESOURCES

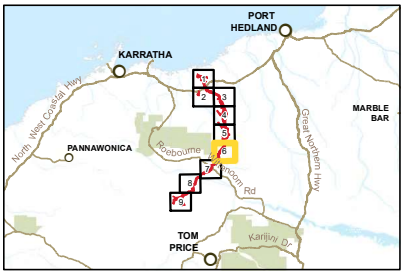
GDA 1994 MGA Zone 50

LEGEND

- Quadrats/Detailed Releve
- Track
- Drainage Lines
- Rutila Rail Corridor

Vegetation Type

- AiTe(3)
- AiTw(2)
- AiTw(3)
- ApTe
- ApTw
- ChAt2Te
- EvApTe
- EvMlCv
- MaMgCv
- Tw(2)



ecoscape

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PROJECT NO: 3228-14

RUTILA RAIL CORRIDOR ECOLOGICAL STUDIES

CLIENT: RUTILA RESOURCES

VEGETATION TYPES

MAP 4 - 6

SCALE 1:75,000 @ A3

0 1 2 3 4 km

IMAGERY SOURCE: CAD RESOURCES

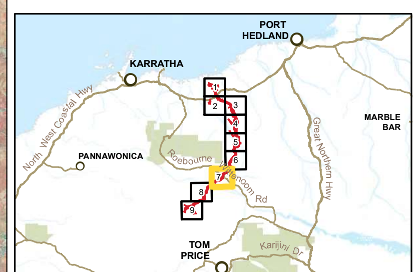
GDA 1994 MGA Zone 50

LEGEND

- Quadrats/Detailed Releve
- Homesteads
- Secondary Road
- Minor Road
- Track
- Drainage Lines
- Land subject to inundation
- Rutila Rail Corridor

Vegetation Type

- Ac$_1$ApTe
- Ac$_1$Te
- AiTw(1)
- AiTw(2)
- AiTw(3)
- AxSb
- CdAa$_5$Te
- ChAa$_5$Te
- ChAt$_2$Te
- ElAs$_2$Te
- ElTe
- EvApTe
- EvMlCv
- EvMvCv
- Sb
- Tb
- Te(2)
- unmapped



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PROJECT NO: 3228-14

RUTILA RAIL CORRIDOR ECOLOGICAL STUDIES

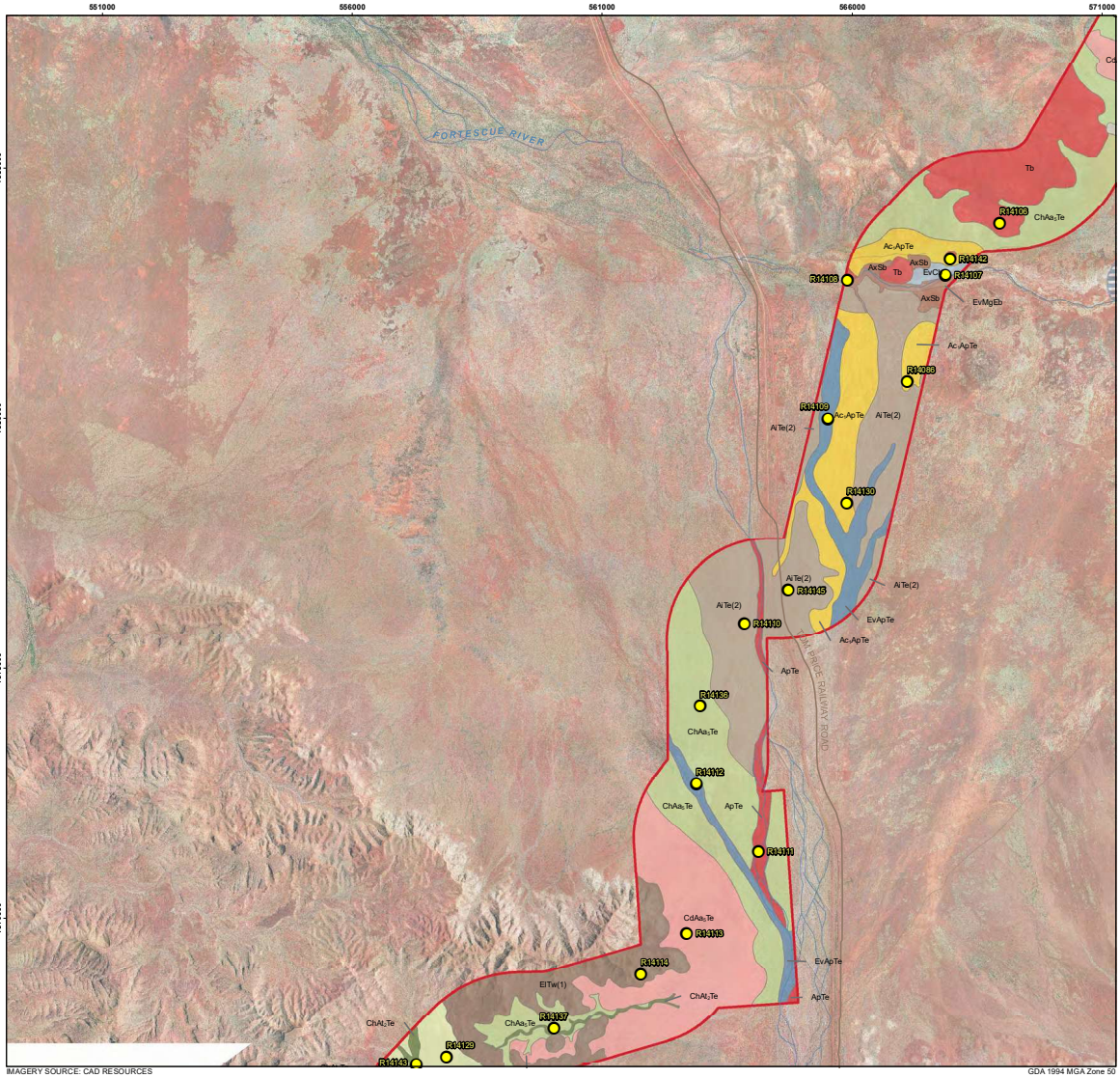
CLIENT: RUTILA RESOURCES

VEGETATION TYPES

MAP 4 - 7

SCALE 1:75,000 @ A3

0 1 2 3 4 km



IMAGERY SOURCE: CAD RESOURCES

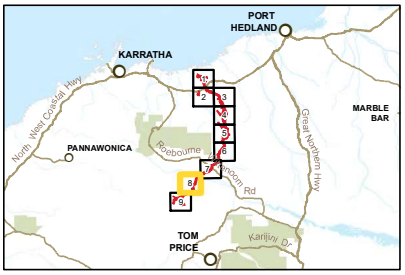
GDA 1994 MGA Zone 50

LEGEND

- Quadrats/Detailed Releve
- Minor Road
- Track
- Drainage Lines
- Land subject to inundation
- Rutila Rail Corridor

Vegetation Type

- Aa_3Tw
- Ac_1ApTe
- Ac_1Te
- AiTe(2)
- ApTe
- AxSb
- $CdAa_3Te$
- $ChAa_3Te$
- $ChAt_2Te$
- ElTw(1)
- EvApTe
- EvCb
- EvMgEb
- Tb



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PROJECT NO: 3228-14

RUTILA RAIL CORRIDOR ECOLOGICAL STUDIES

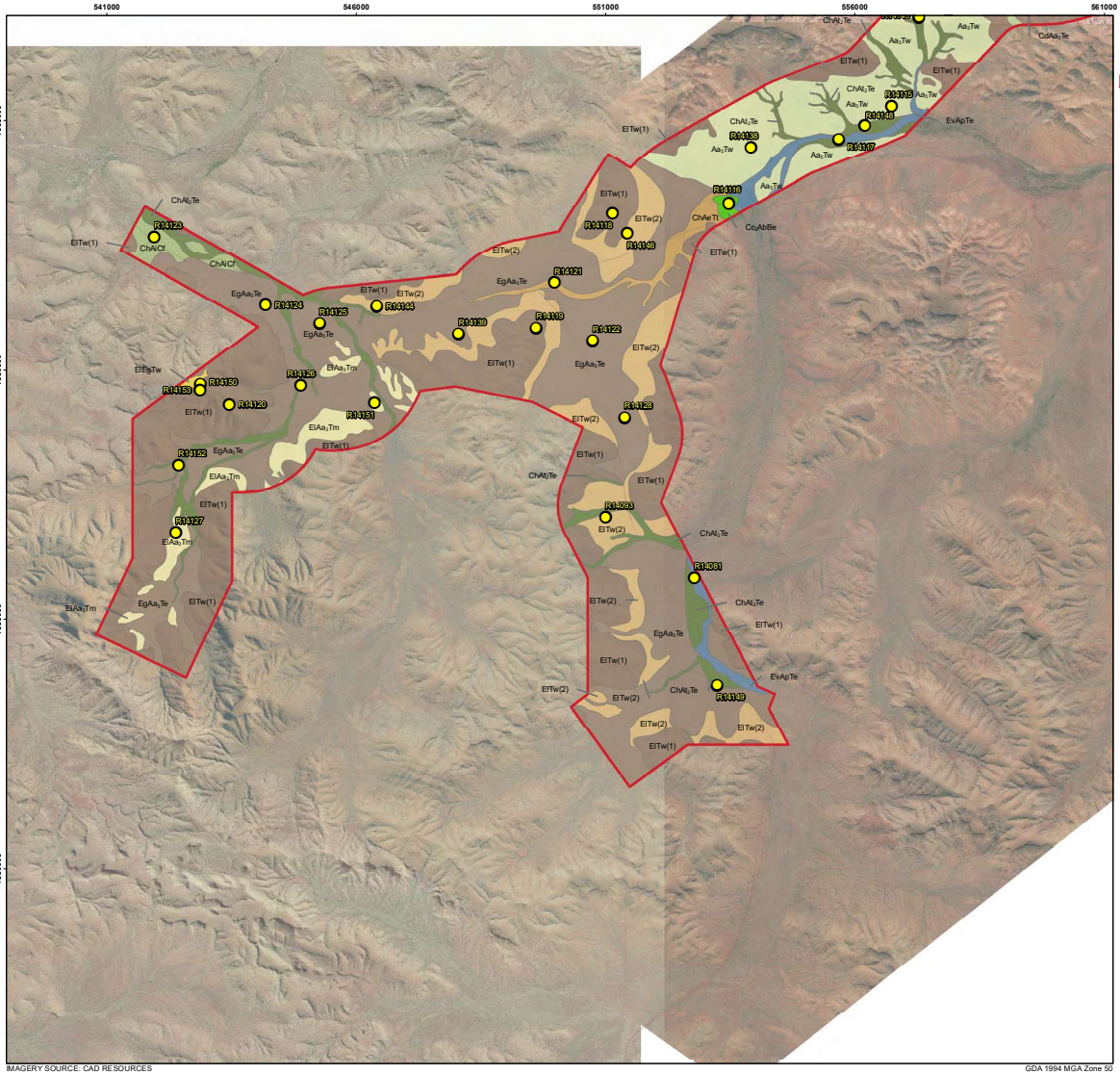
CLIENT: RUTILA RESOURCES

VEGETATION TYPES

MAP 4 - 8

SCALE 1:75,000 @ A3

0 1 2 3 4 km



IMAGERY SOURCE: CAD RESOURCES

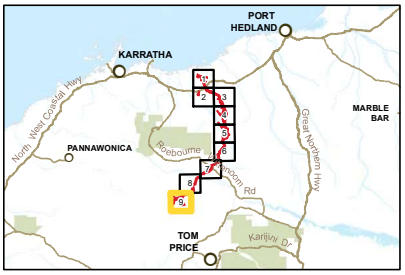
GDA 1994 MGA Zone 50

LEGEND

- Quadrats/Detailed Releve
- Track
- Rutila Rail Corridor

Vegetation Type

- Aa_3Tw
- Cc_2AbBe
- $CdAa_3Te$
- $ChAa_3Te$
- ChAeTl
- ChAiCf
- $ChAl_2Te$
- $EgAa_3Te$
- $ElAa_3Tm$
- ElEgTw
- ElTw(1)
- ElTw(2)
- EvApTe



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PROJECT NO: 3228-14

RUTILA RAIL CORRIDOR ECOLOGICAL STUDIES

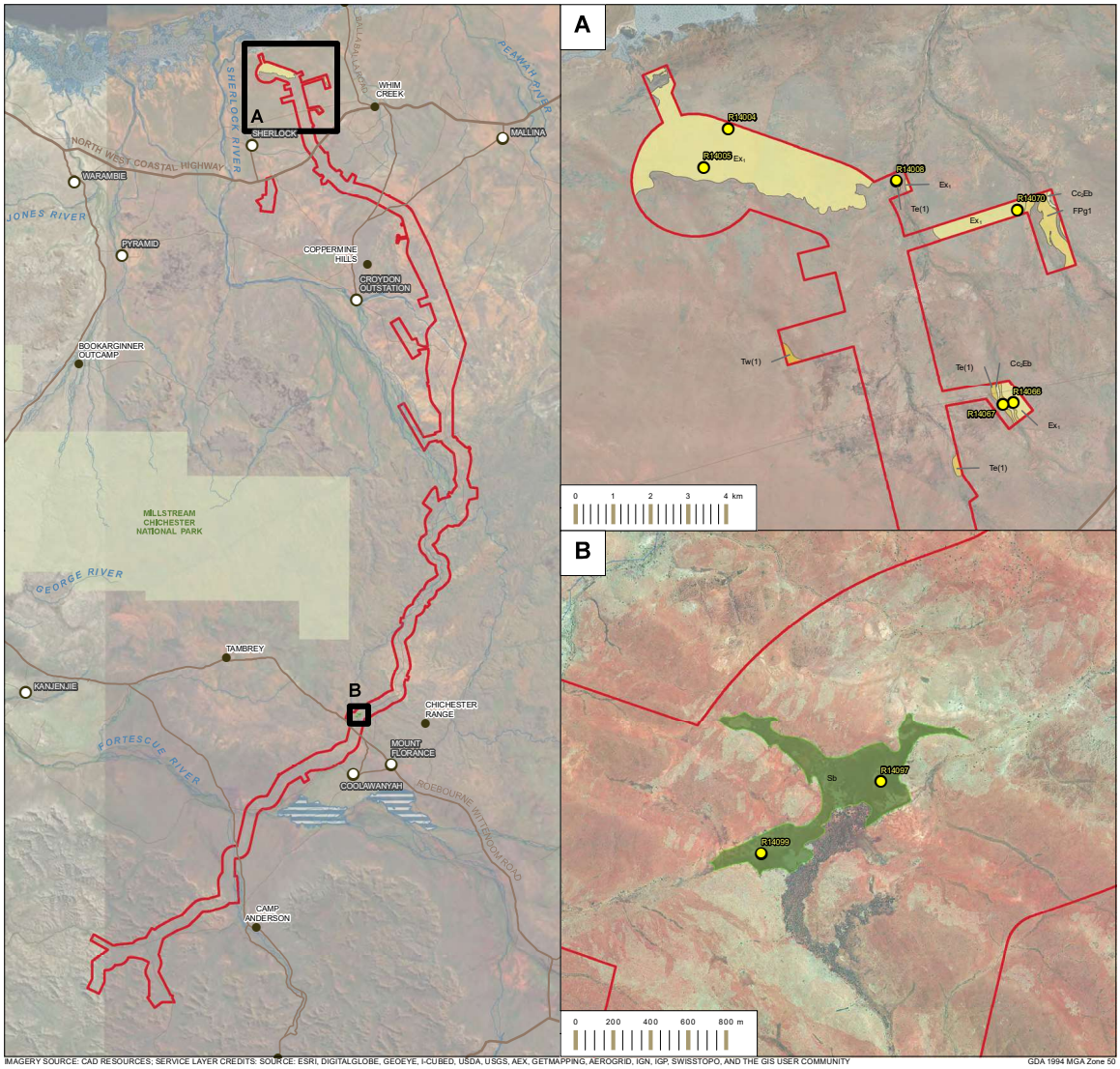
CLIENT: RUTILA RESOURCES

VEGETATION TYPES

MAP 4 - 9

SCALE 1:75,000 @ A3

0 1 2 3 4 km



IMAGERY SOURCE: CAD RESOURCES; SERVICE LAYER CREDITS: SOURCE: ESRI, DIGITALGLOBE, GEOEYE, I-CUBED, USDA, USGS, AEX, GETMAPPING, AEROGRID, IGN, IGP, SWISSTOPO, AND THE GIS USER COMMUNITY

GDA 1994 MGA Zone 50

LEGEND

- Homesteads
- Place Names
- Quadrats/Detailed Releve
- Principal Road
- Secondary Road
- Minor Road
- Drainage Lines
- Rutila Rail Corridor
- Land subject to inundation
- Saline coastal flat
- Watercourse areas
- National Parks

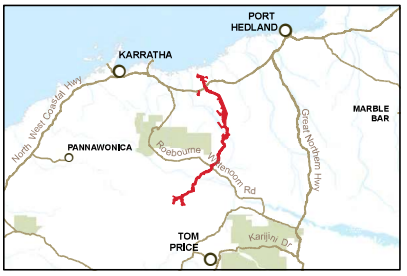
Potential Priority Ecological Communities

'Cracking clays of the Chichester and Mungaroona Range' P1

- Sb

'Horse flat Land System of the Roebourne Plains' P3

- Cc_2Eb
- Ex_1
- FPg1
- Te(1)
- Tw(1)



ecoscape

AUTHOR: JN
DATE: NOV-14
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PROJECT NO: 3228-14

RUTILA RAIL CORRIDOR ECOLOGICAL STUDIES

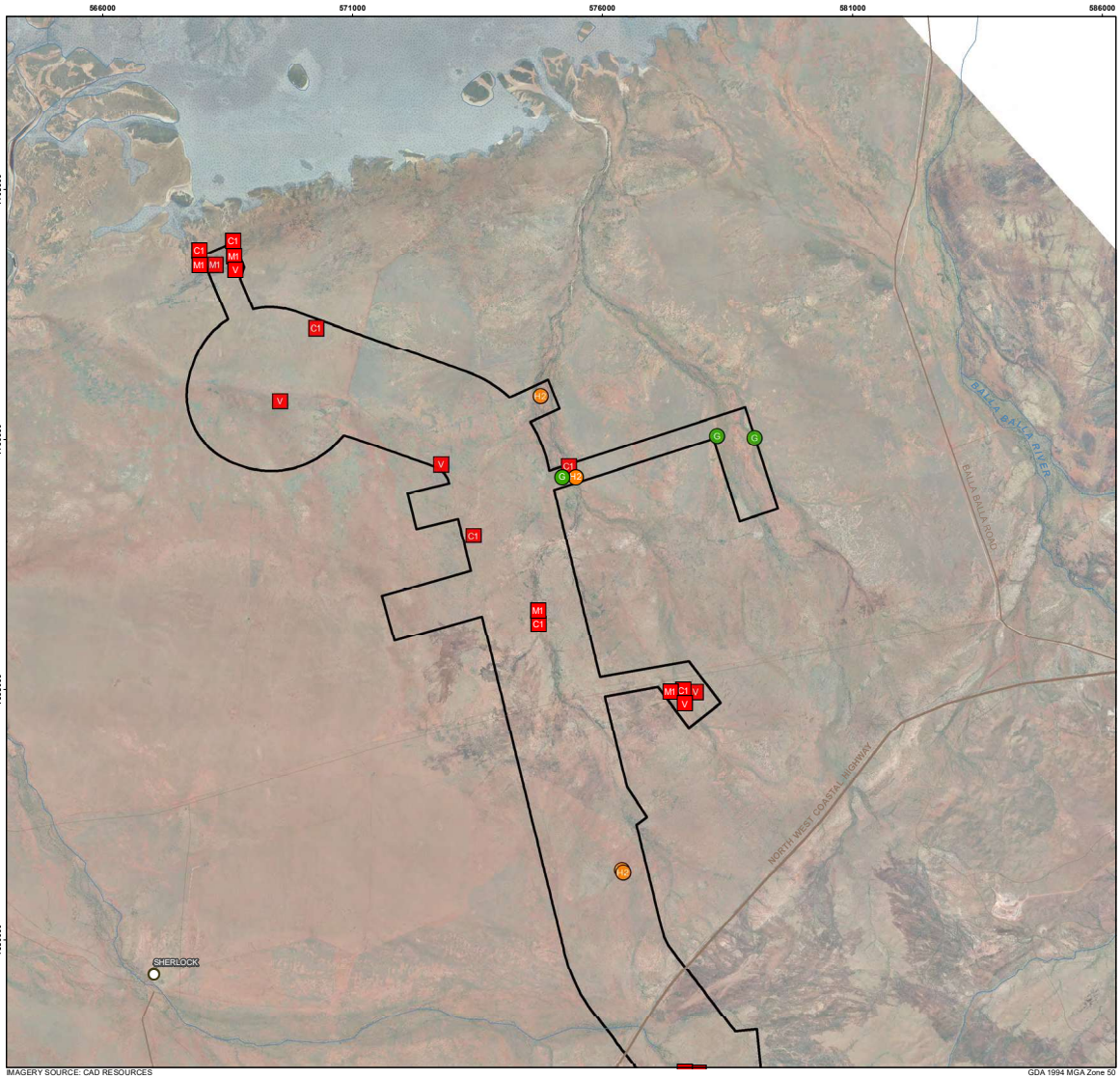
CLIENT: RUTILA RESOURCES

POTENTIAL PEC LOCATIONS

MAP 5

SCALE 1:600,000@ A3

0 10 20 30 km



IMAGERY SOURCE: CAD RESOURCES

GDA 1994 MGA Zone 50

LEGEND

- Homesteads
- Principal Road
- Minor Road
- Track
- Drainage Lines
- Saline coastal flat
- Rutila Rail Corridor

Flora Locations

Priority 1 Flora

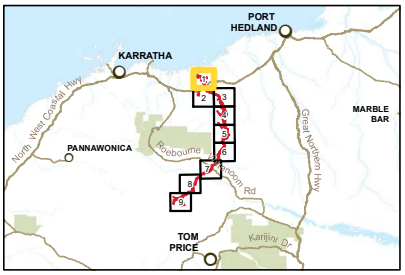
- H2 *Heliotropium muticum*

Priority 4 Flora

- G *Goodenia nuda*

Introduced Flora

- C1 *Cenchrus ciliaris*
- M1 *Malvastrum americanum*
- V *Vachellia farnesiana*



ecoscape

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DATE: OCT-14
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PROJECT NO: 3228-14

RUTILA RAIL CORRIDOR ECOLOGICAL STUDIES

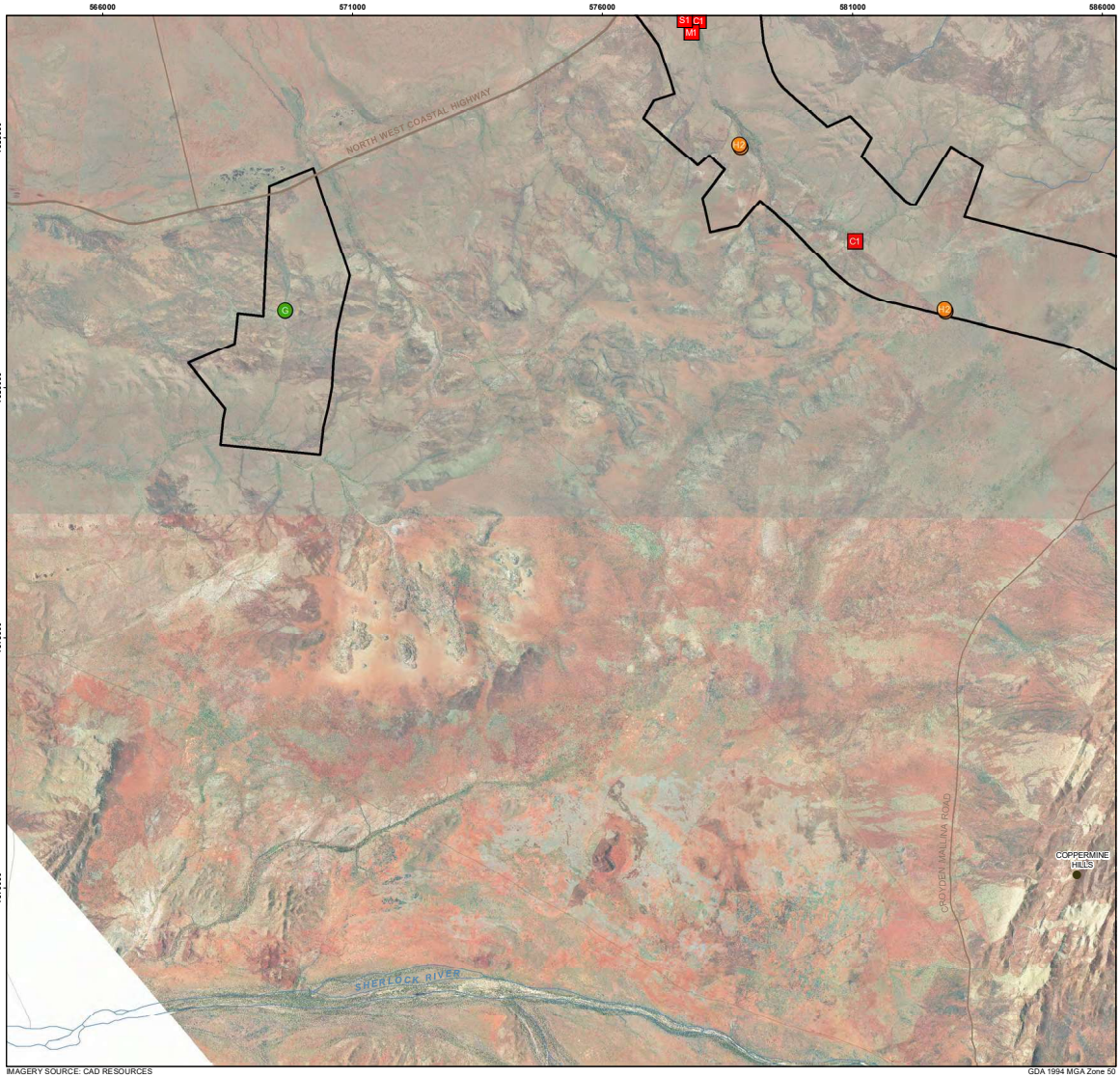
CLIENT: RUTILA RESOURCES

CONSERVATION SIGNIFICANT AND INTRODUCED FLORA

MAP 6 - 1

SCALE 1:75,000 @ A3

0 1 2 3 4 km



IMAGERY SOURCE: CAD RESOURCES

GDA 1994 MGA Zone 50

LEGEND

- Place Names
- Principal Road
- Minor Road
- Track
- Drainage Lines
- Rutila Rail Corridor

Flora Locations

Priority 1 Flora

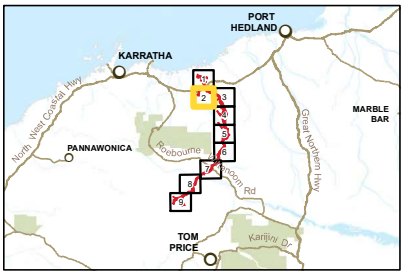
- H2 *Heliotropium muticum*

Priority 4 Flora

- G *Goodenia nuda*

Introduced Flora

- C1 *Cenchrus ciliaris*



ecoscape

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PROJECT NO: 3228-14

RUTILA RAIL CORRIDOR ECOLOGICAL STUDIES

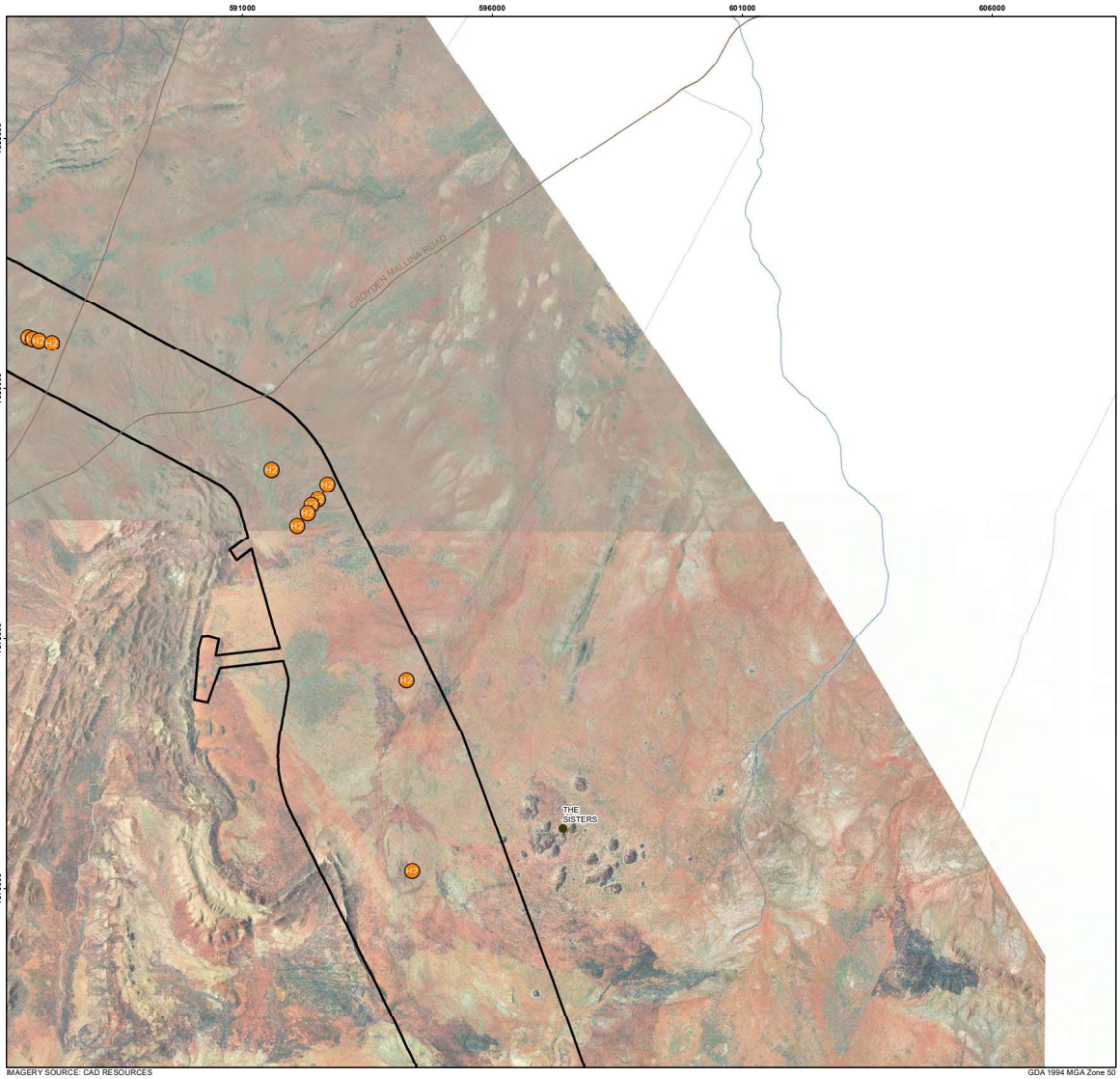
CLIENT: RUTILA RESOURCES

CONSERVATION SIGNIFICANT AND INTRODUCED FLORA

MAP 6 - 2

SCALE 1:75,000 @ A3

0 1 2 3 4 km



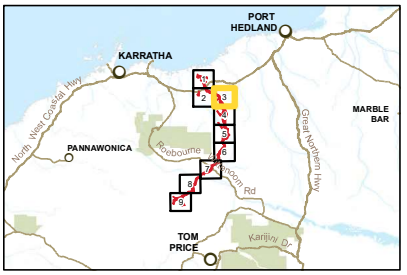
LEGEND

- Place Names
- Minor Road
- Track
- Drainage Lines
- Rutila Rail Corridor

Flora Locations

Priority 1 Flora

- *Heliotropium muticum*



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RUTILA RAIL CORRIDOR ECOLOGICAL STUDIES

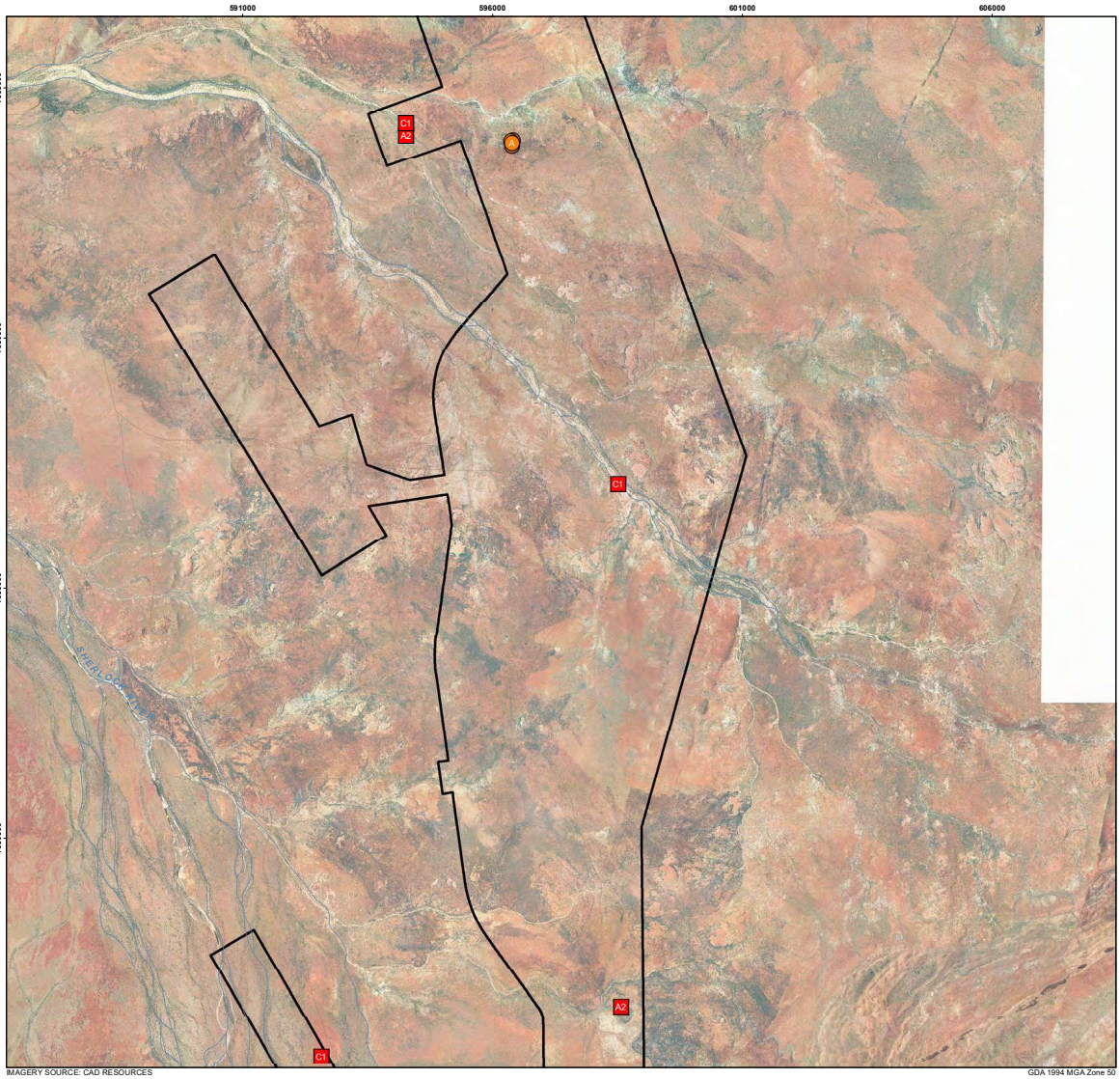
CLIENT: RUTILA RESOURCES

CONSERVATION SIGNIFICANT AND INTRODUCED FLORA

MAP 6 - 3

SCALE 1:75,000 @ A3

0 1 2 3 4 km



IMAGERY SOURCE: CAD RESOURCES

GDA 1994 MGA Zone 50

LEGEND

- Track
- Drainage Lines
- Rutila Rail Corridor

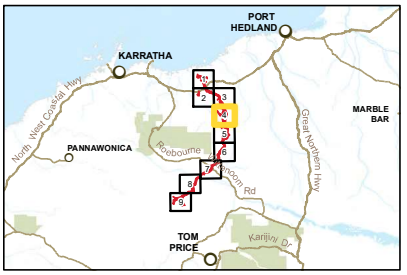
Flora Locations

Priority 1 Flora

- A — *Abutilon* sp. Pritzelianum (S. van Leeuwen 5095)

Introduced Flora

- A2 — *Aerva javanica*
- C1 — *Cenchrus ciliaris*



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RUTILA RAIL CORRIDOR ECOLOGICAL STUDIES

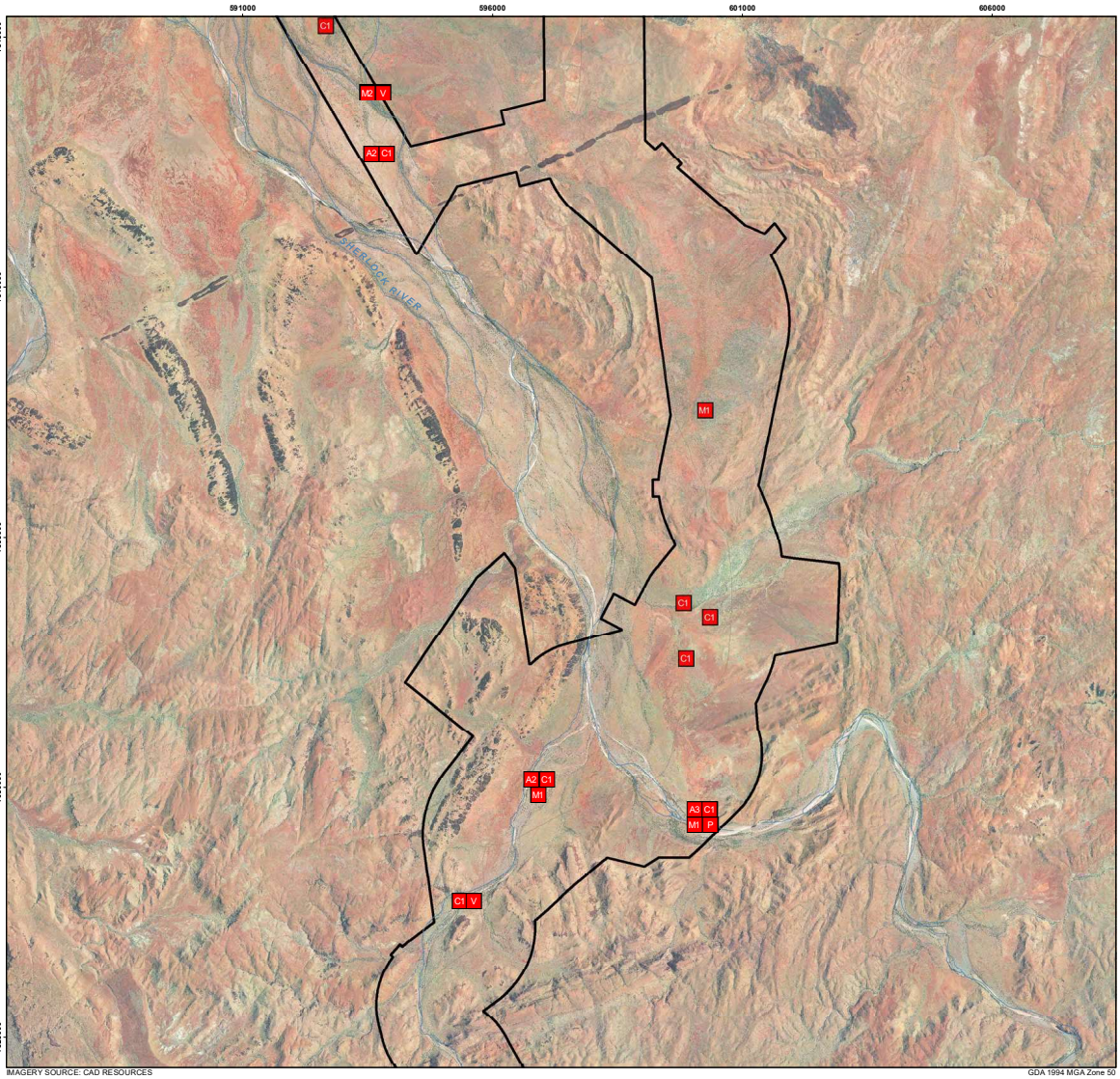
CLIENT: RUTILA RESOURCES

CONSERVATION SIGNIFICANT AND INTRODUCED FLORA

MAP 6 - 4

SCALE 1:75,000 @ A3

0 1 2 3 4 km



IMAGERY SOURCE: CAD RESOURCES

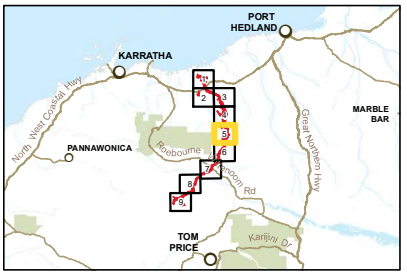
GDA 1994 MGA Zone 50

LEGEND

- Track
- Drainage Lines
- Rutila Rail Corridor

Introduced Flora

- C1 *Cenchrus ciliaris*
- M1 *Malvastrum americanum*



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DATE: OCT-14 PROJECT NO: 3228-14

RUTILA RAIL CORRIDOR ECOLOGICAL STUDIES

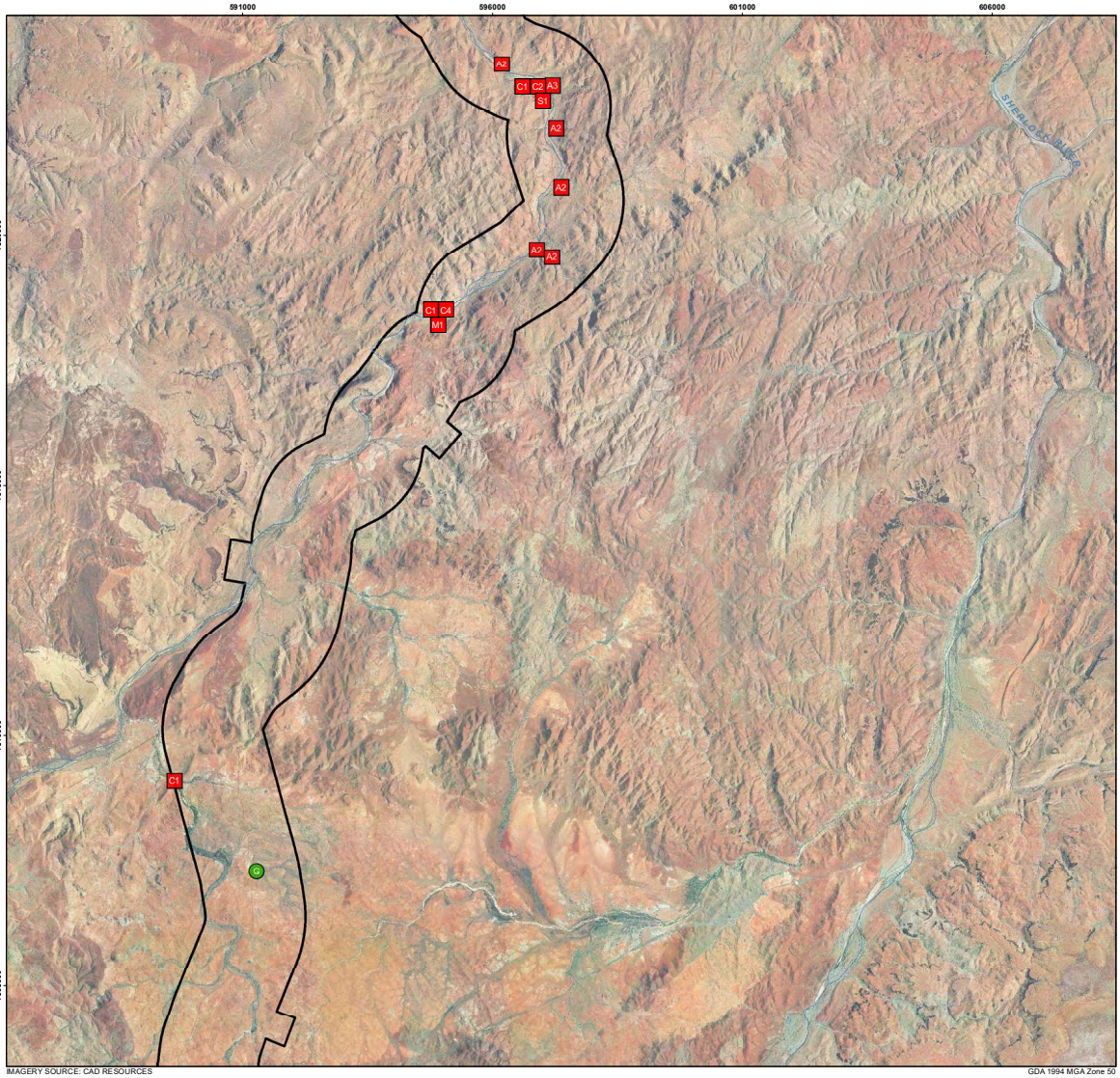
CLIENT: RUTILA RESOURCES

CONSERVATION SIGNIFICANT AND INTRODUCED FLORA

MAP 6 - 5

SCALE 1:75,000 @ A3

0 1 2 3 4 km



IMAGERY SOURCE: CAD RESOURCES

GDA 1994 MGA Zone 50

LEGEND

Track

Drainage Lines

Rutila Rail Corridor

Flora Locations

Priority 4 Flora

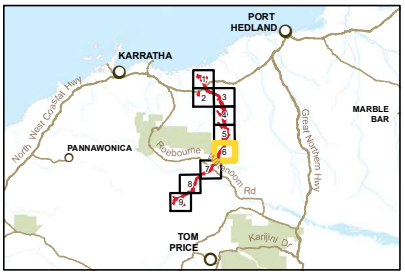
G *Goodenia nuda*

Introduced Flora

A2 *Aerva javanica*

A3 *Argemone ochroleuca*

C1 *Cenchrus ciliaris*



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AUTHOR: JN
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PROJECT NO: 3228-14

RUTILA RAIL CORRIDOR ECOLOGICAL STUDIES

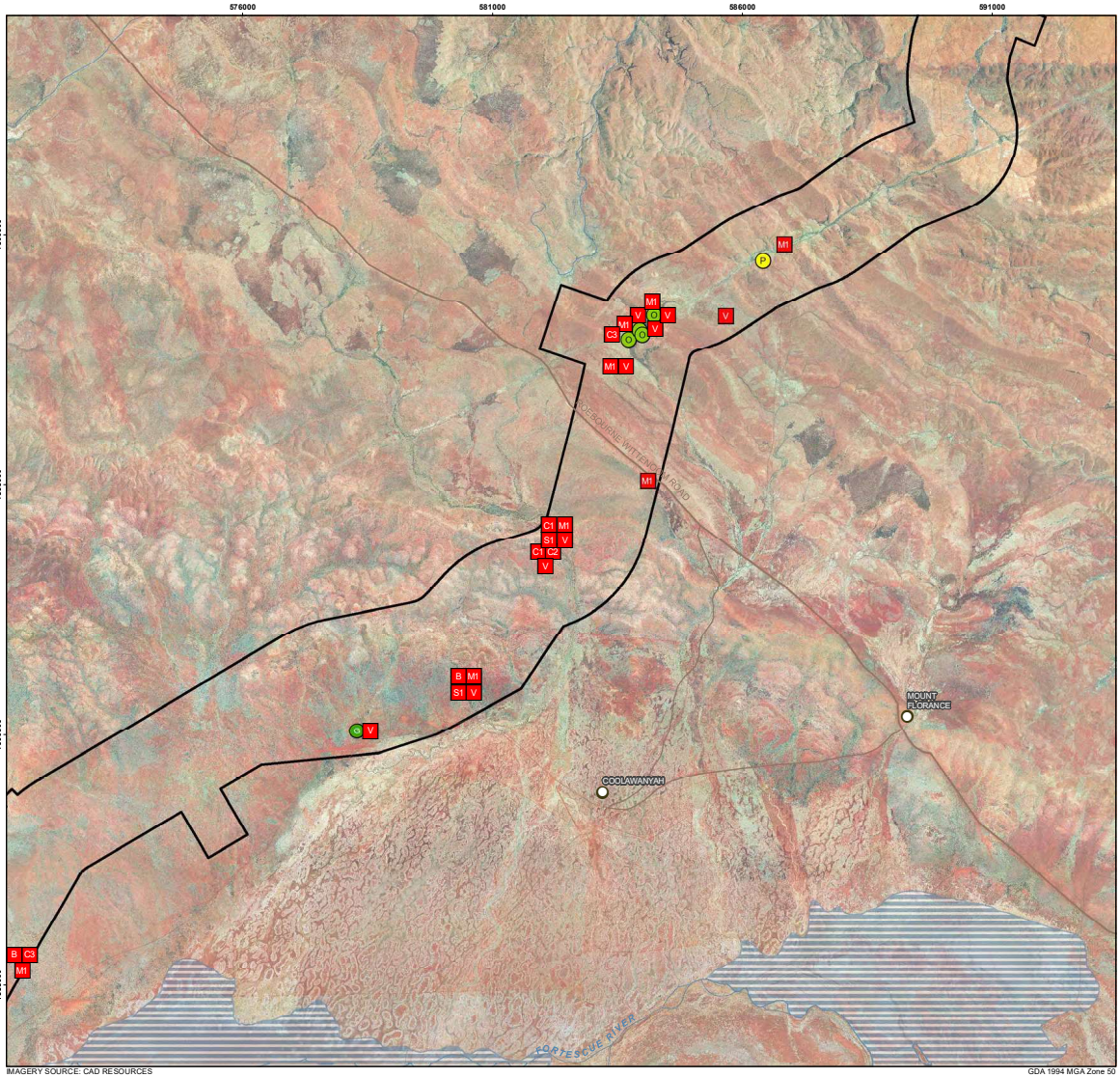
CLIENT: RUTILA RESOURCES

CONSERVATION SIGNIFICANT AND INTRODUCED FLORA

MAP 6 - 6

SCALE 1:75,000 @ A3

0 1 2 3 4 km



LEGEND

- Homesteads
- Secondary Road
- Minor Road
- Track
- Drainage Lines
- Land subject to inundation
- Rutila Rail Corridor

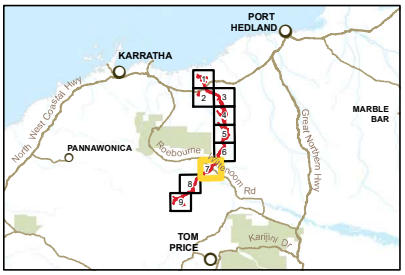
Flora Locations

Priority 2 Flora
- P — *Pentalepis trichodesmoides* subsp. *hispida*

Priority 3 Flora
- O — *Oldenlandia* sp. Hamersley Station (A.A. Mitchell PRP 1479)

Priority 4 Flora
- G — *Goodenia nuda*

Introduced Flora
- M1 — *Malvastrum americanum*
- V — *Vachellia farnesiana*



ecoscape

AUTHOR: JN
DATE: OCT-14
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PROJECT NO: 3228-14

RUTILA RAIL CORRIDOR ECOLOGICAL STUDIES

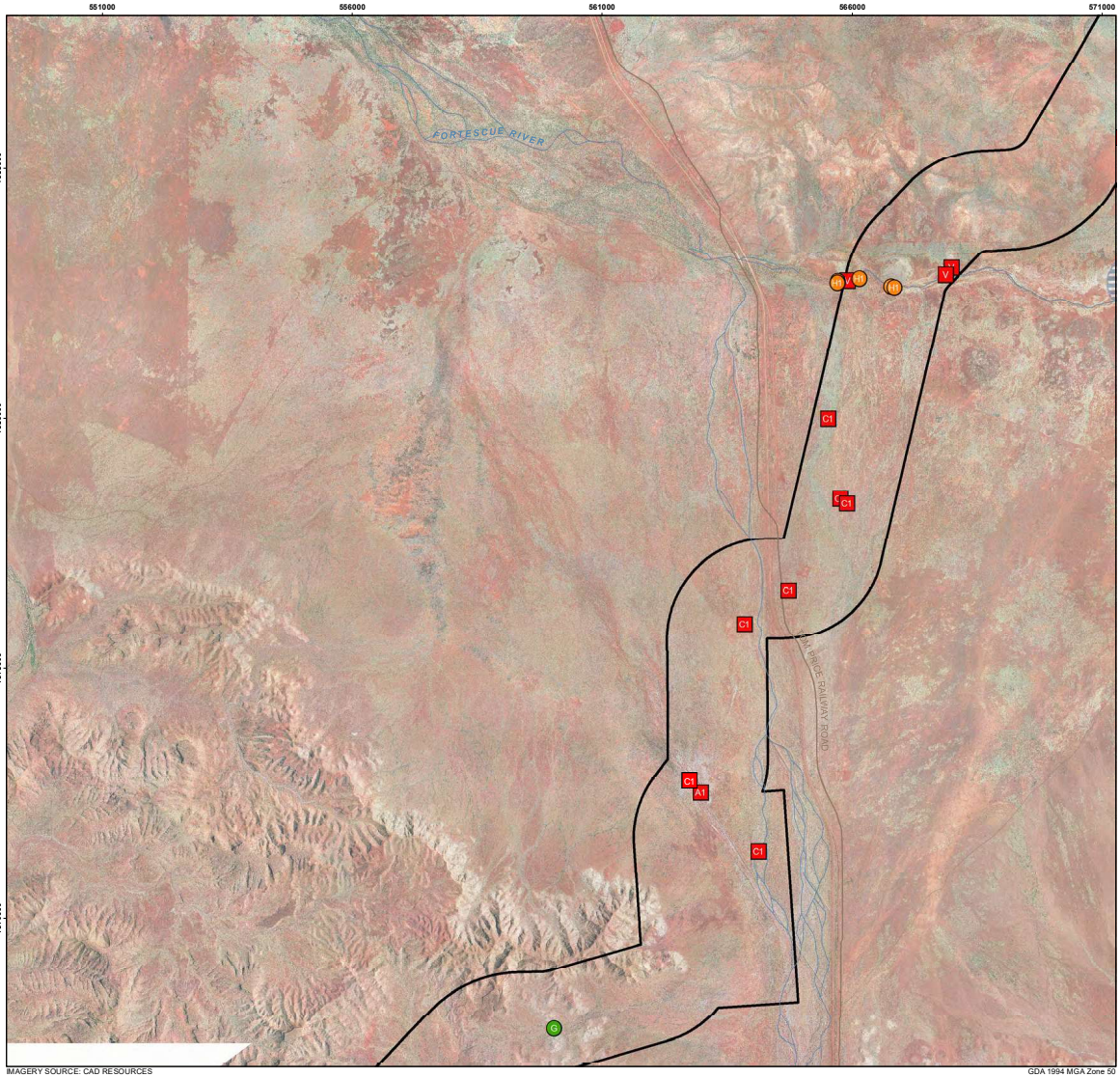
CLIENT: RUTILA RESOURCES

CONSERVATION SIGNIFICANT AND INTRODUCED FLORA

MAP 6 - 7

SCALE 1:75,000 @ A3

0 1 2 3 4 km



IMAGERY SOURCE: CAD RESOURCES

GDA 1994 MGA Zone 50

LEGEND

- Minor Road
- Track
- Drainage Lines
- Land subject to inundation
- Rutila Rail Corridor

Flora Locations

Priority 1 Flora

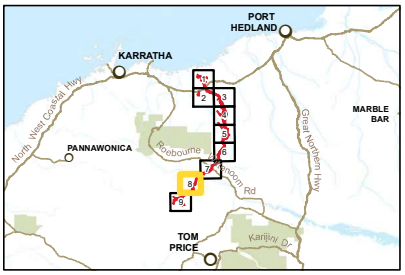
- H1 *Helichrysum oligochaetum*

Priority 4 Flora

- G *Goodenia nuda*

Introduced Flora

- A1 *Acetosa vesicaria*
- C1 *Cenchrus ciliaris*
- V *Vachellia farnesiana*



ecoscape

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DATE: OCT-14
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PROJECT NO: 3228-14

RUTILA RAIL CORRIDOR ECOLOGICAL STUDIES

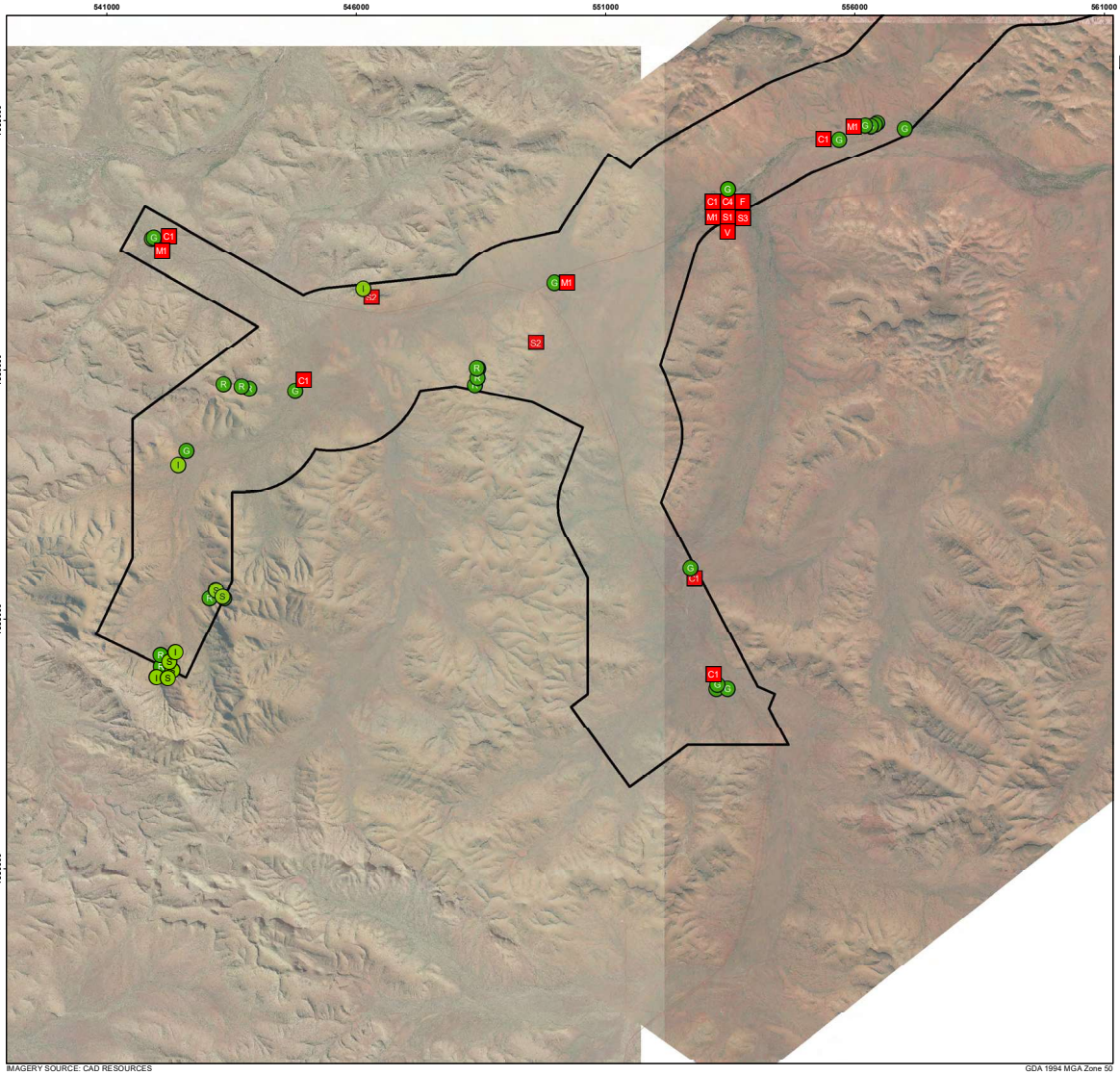
CLIENT: RUTILA RESOURCES

CONSERVATION SIGNIFICANT AND INTRODUCED FLORA

MAP 6 - 8

SCALE 1:75,000 @ A3

0 1 2 3 4 km



IMAGERY SOURCE: CAD RESOURCES

GDA 1994 MGA Zone 50

LEGEND

Track

Rutila Rail Corridor

Flora Locations

Priority 3 Flora

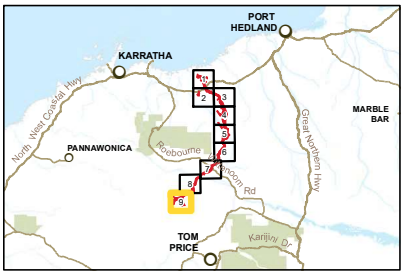
- S — *Sida* sp. Barlee Range (S. van Leeuwen 1642)
- I — *Indigofera* sp. Bungaroo Creek (S. van Leeuwen 4301)

Priority 4 Flora

- G — *Goodenia nuda*
- R — *Rhynchosia bungarensis*

Introduced Flora

- C1 — *Cenchrus ciliaris*
- S2 — *Sigesbeckia orientalis*



ecoscape

AUTHOR: JN
DATE: OCT-14
CHECKED: SB
PROJECT NO: 3228-14

RUTILA RAIL CORRIDOR ECOLOGICAL STUDIES

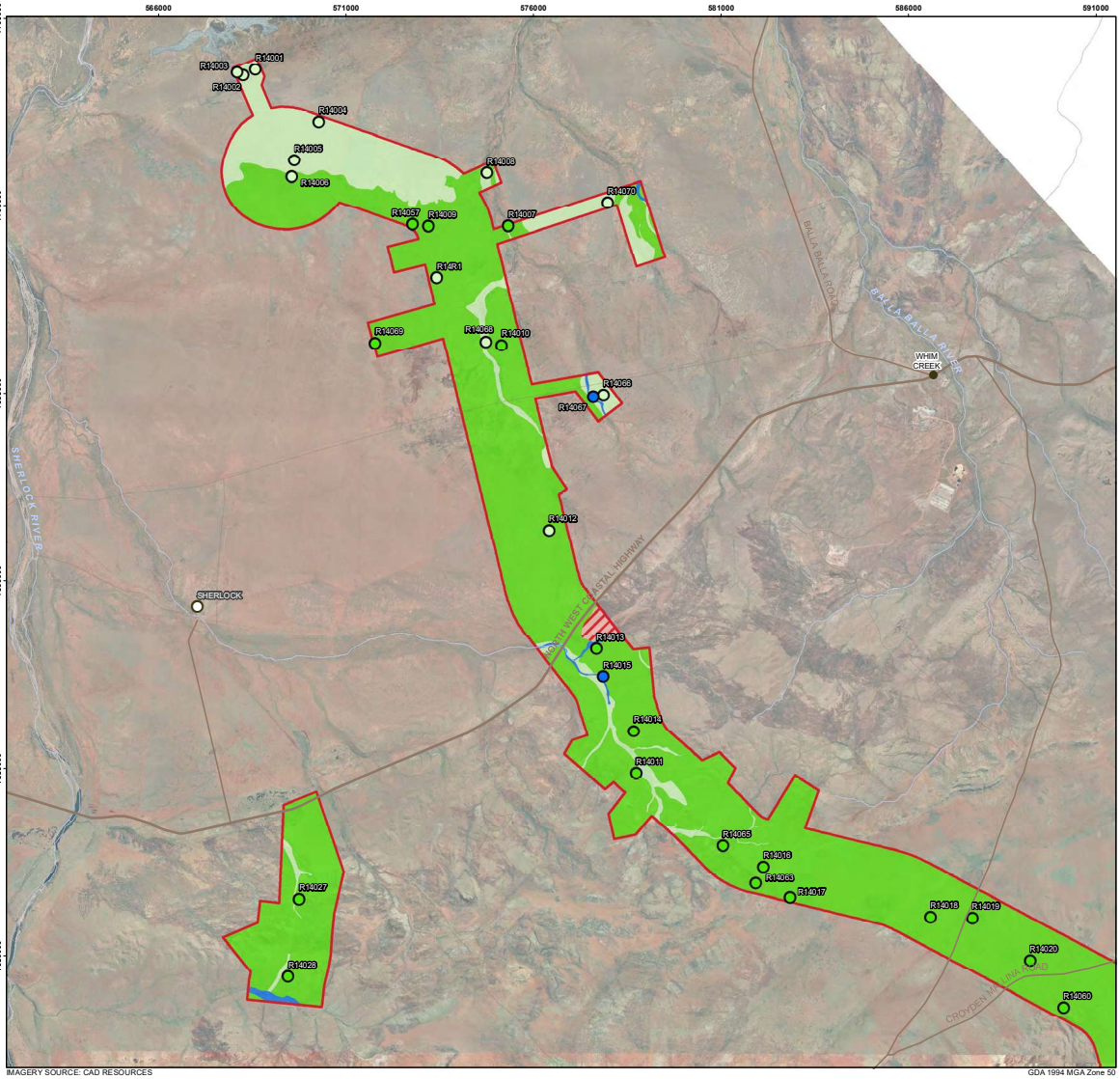
CLIENT: RUTILA RESOURCES

CONSERVATION SIGNIFICANT AND INTRODUCED FLORA

MAP 6 - 9

SCALE 1:75,000 @ A3

0 1 2 3 4 km



IMAGERY SOURCE: CAD RESOURCES

GDA 1994 MGA Zone 50

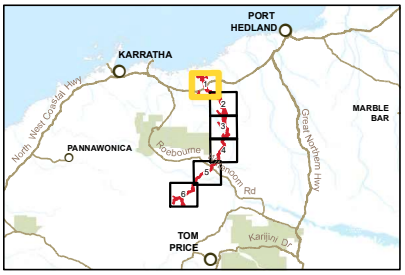
LEGEND

- Homesteads
- Place Names
- Principal Road
- Minor Road
- Track
- Drainage Lines
- Saline coastal flat

Quadrats/Detailed Releve
Vegetation Condition Rating
- Excellent
- Very Good
- Good
- Poor
- Very Poor
- Degraded
- Rutila Rail Corridor

Mapping
Vegetation Condition Rating
- Excellent
- Very Good
- Good
- Poor
- Very Poor
- Degraded

Other
- Rock
- Burnt



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PROJECT NO: 3228-14

RUTILA RAIL CORRIDOR ECOLOGICAL STUDIES

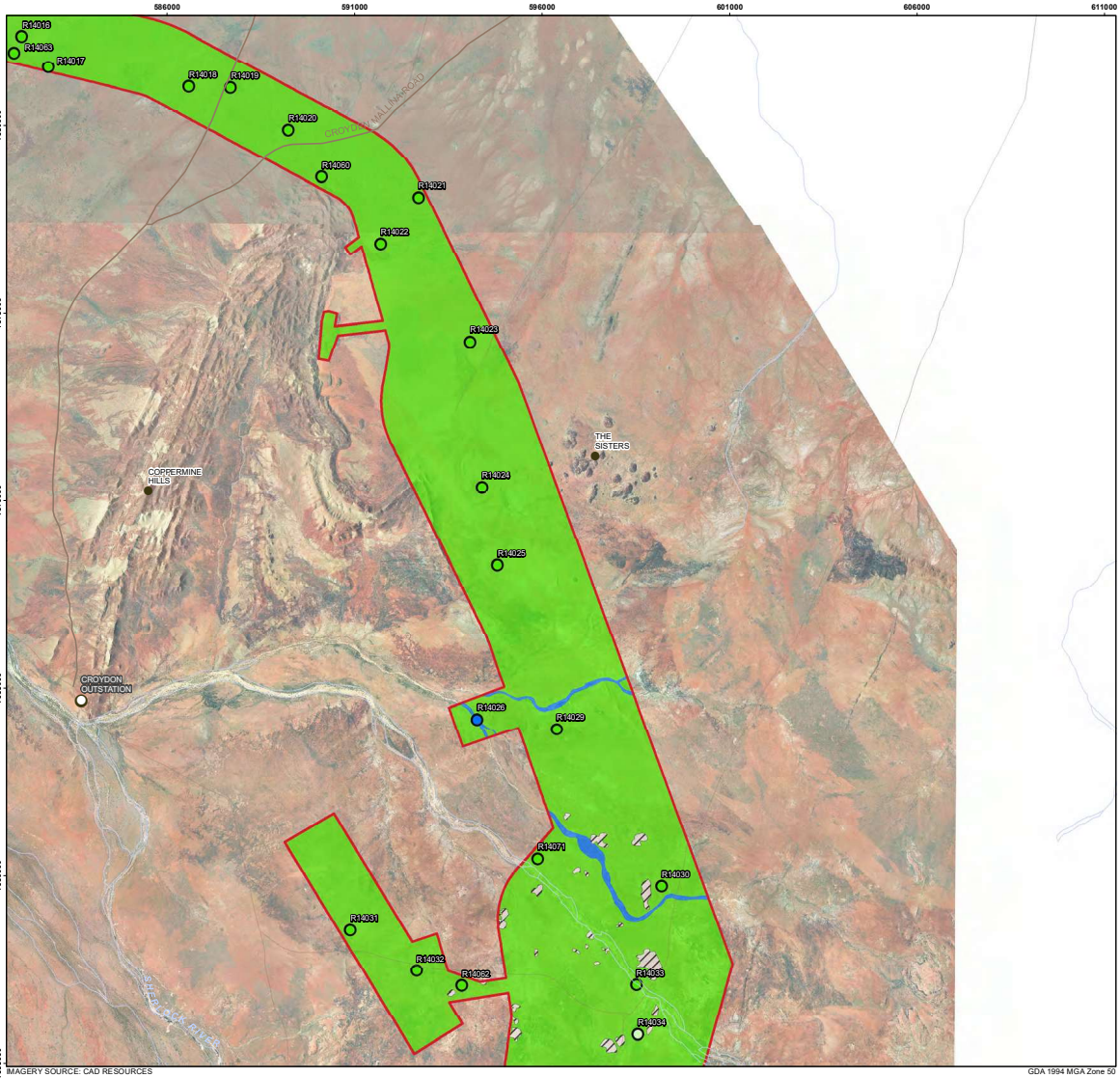
CLIENT: RUTILA RESOURCES

VEGETATION CONDITION

MAP 7 - 1

SCALE 1:100,000 @ A3

0 1 2 3 4 5 km



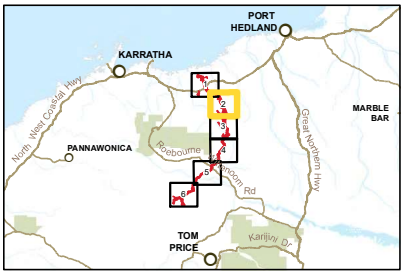
LEGEND

- Homesteads
- Place Names
- Minor Road
- Track
- Drainage Lines

Quadrats/Detailed Releve
Vegetation Condition Rating
- Excellent
- Very Good
- Good
- Poor
- Very Poor
- Degraded
- Rutila Rail Corridor

Mapping
Vegetation Condition Rating
- Excellent
- Very Good
- Good
- Poor
- Very Poor
- Degraded

Other
- Rock
- Burnt



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DATE: OCT-14
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PROJECT NO: 3228-14

RUTILA RAIL CORRIDOR ECOLOGICAL STUDIES

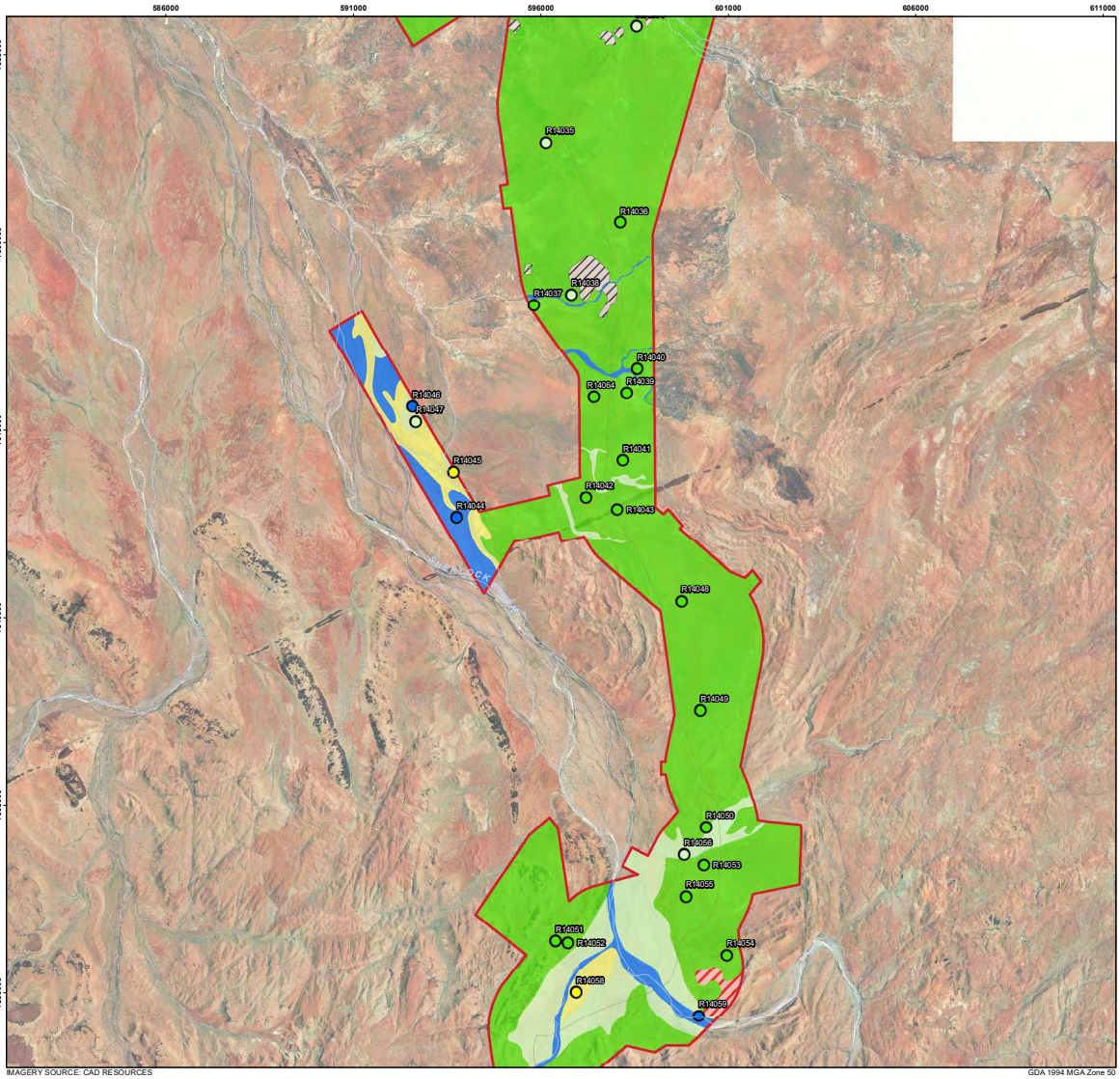
CLIENT: RUTILA RESOURCES

VEGETATION CONDITION

MAP 7 - 2

SCALE 1:100,000 @ A3

0 1 2 3 4 5 km

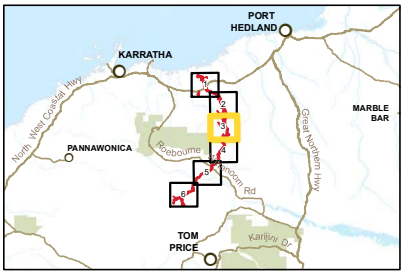


LEGEND

Track

Drainage Lines

Quadrats/Detailed Releve Vegetation Condition Rating	Mapping Vegetation Condition Rating
Excellent	Excellent
Very Good	Very Good
Good	Good
Poor	Poor
Very Poor	Very Poor
Degraded	Degraded
Rutila Rail Corridor	Other
	Rock
	Burnt



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PROJECT NO: 3228-14

RUTILA RAIL CORRIDOR ECOLOGICAL STUDIES

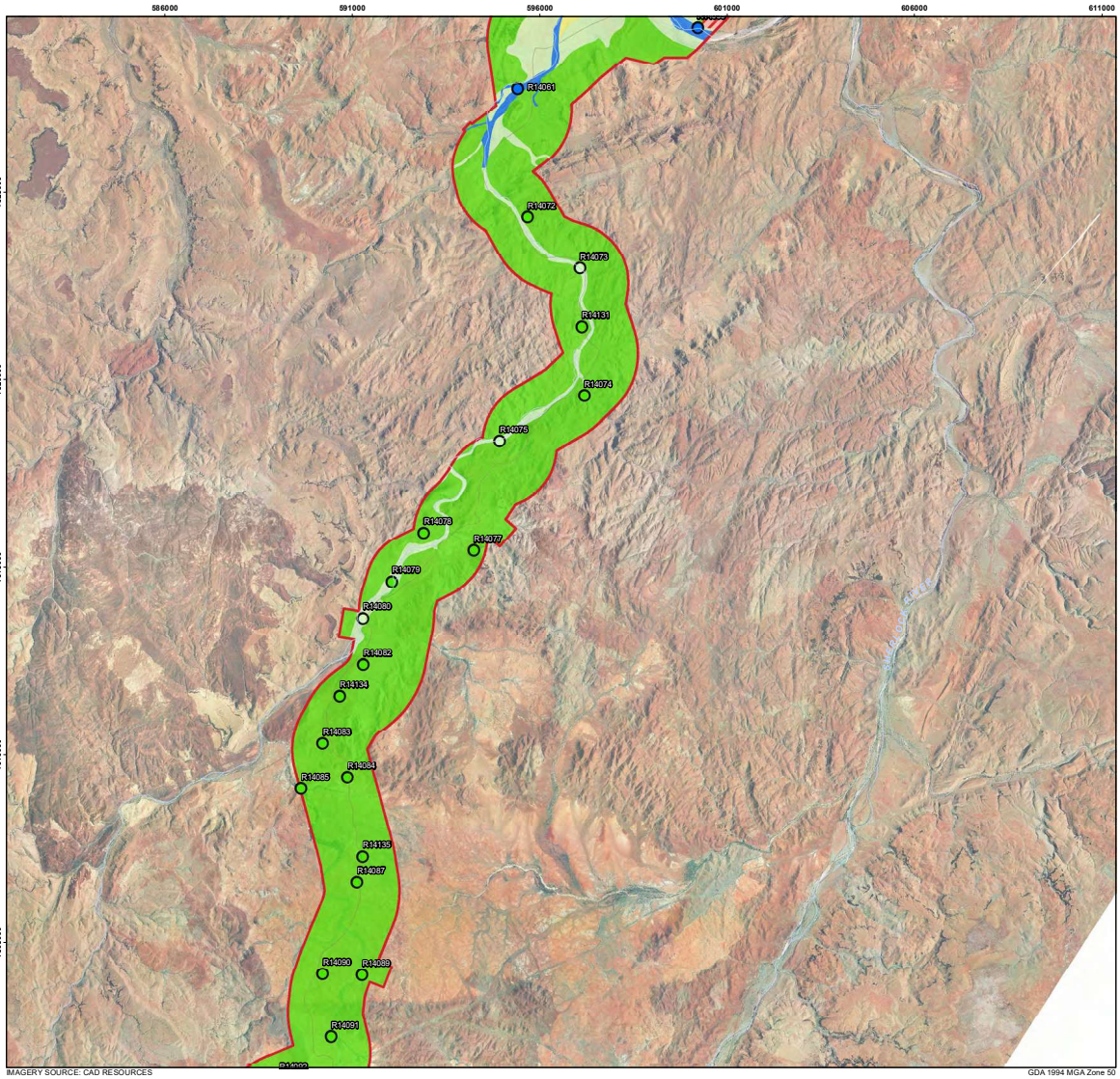
CLIENT: RUTILA RESOURCES

VEGETATION CONDITION

MAP 7 - 3

SCALE 1:100,000 @ A3

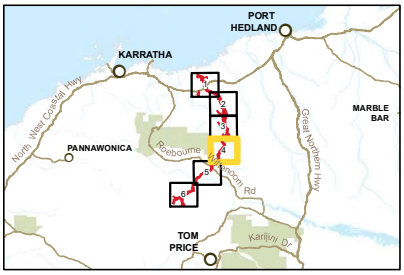
0 1 2 3 4 5 km



LEGEND

- Track
- Drainage Lines
- Rutila Rail Corridor

Quadrats/Detailed Releve Vegetation Condition Rating	Mapping Vegetation Condition Rating
Excellent	Excellent
Very Good	Very Good
Good	Good
Poor	Poor
Very Poor	Very Poor
Degraded	Degraded
	Other
	Rock
	Burnt



ecoscape

AUTHOR: JN
DATE: OCT-14
CHECKED: SB
PROJECT NO: 3228-14

RUTILA RAIL CORRIDOR ECOLOGICAL STUDIES

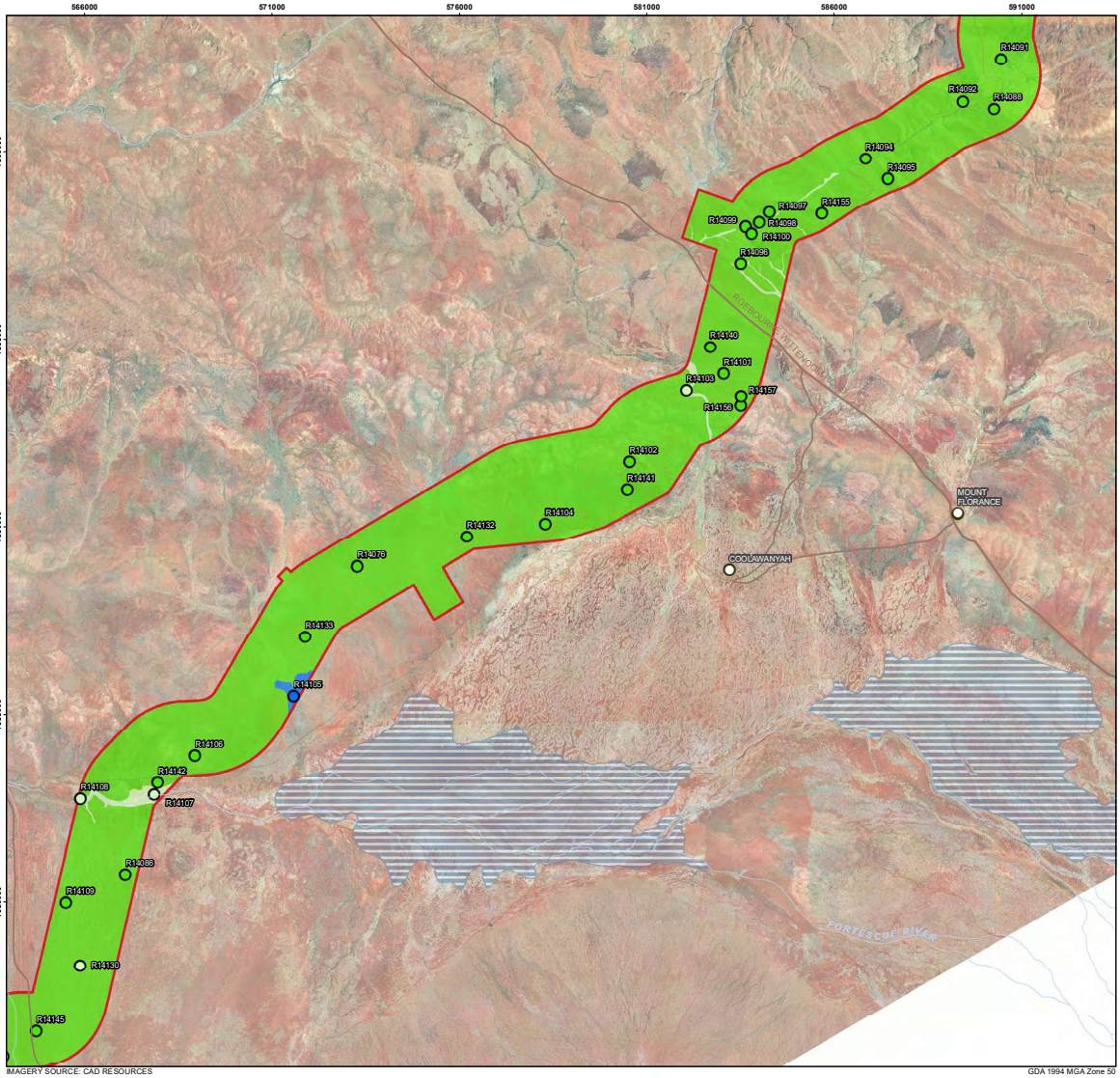
CLIENT: RUTILA RESOURCES

VEGETATION CONDITION

MAP 7 - 4

SCALE 1:100,000 @ A3

0 1 2 3 4 5 km



IMAGERY SOURCE: CAD RESOURCES

GDA 1994 MGA Zone 50

LEGEND

- Homesteads
- Secondary Road
- Minor Road
- Track
- Drainage Lines
- Land subject to inundation

Quadrats/Detailed Releve Vegetation Condition Rating

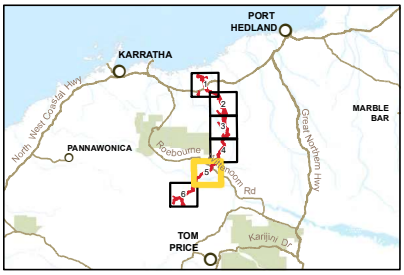
- Excellent
- Very Good
- Good
- Poor
- Very Poor
- Degraded
- Rutila Rail Corridor

Mapping Vegetation Condition Rating

- Excellent
- Very Good
- Good
- Poor
- Very Poor
- Degraded

Other

- Rock
- Burnt



ecoscape

AUTHOR: JN
DATE: OCT-14
CHECKED: SB
PROJECT NO: 3228-14

RUTILA RAIL CORRIDOR ECOLOGICAL STUDIES

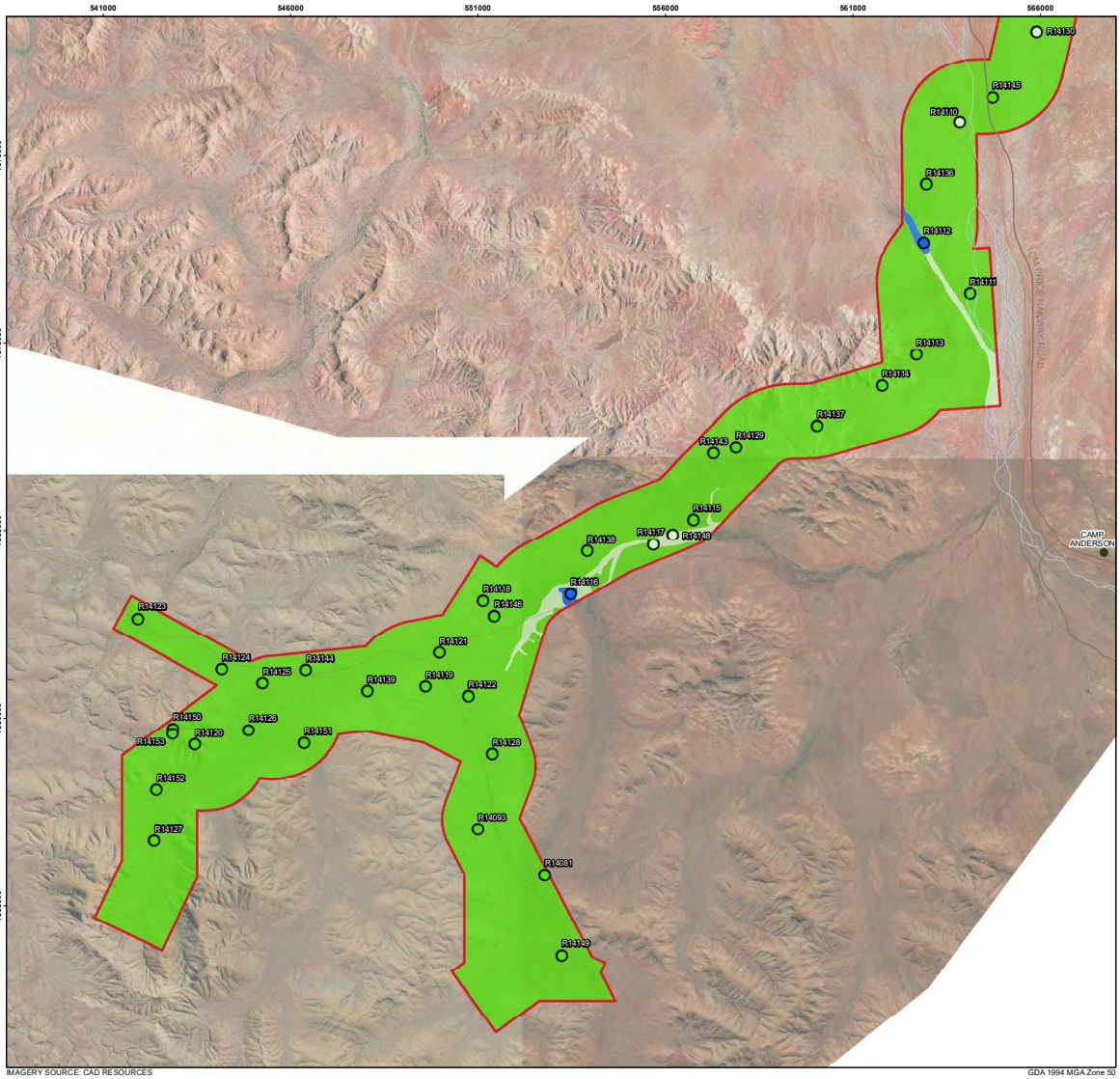
CLIENT: RUTILA RESOURCES

VEGETATION CONDITION

MAP 7 - 5

SCALE 1:100,000 @ A3

0 1 2 3 4 5 km



IMAGERY SOURCE: CAD RESOURCES

GDA 1994 MGA Zone 50

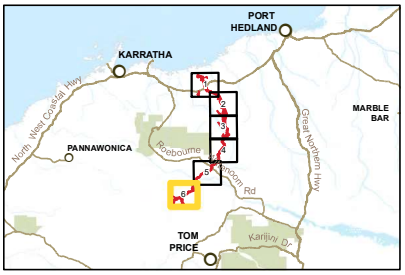
LEGEND

- Place Names
- Minor Road
- Track
- Drainage Lines

Quadrats/Detailed Releve
Vegetation Condition Rating
- Excellent
- Very Good
- Good
- Poor
- Very Poor
- Degraded
- Rutila Rail Corridor

Mapping
Vegetation Condition Rating
- Excellent
- Very Good
- Good
- Poor
- Very Poor
- Degraded

Other
- Rock
- Burnt



ecoscape

AUTHOR: JN
DATE: OCT-14
CHECKED: SB
PROJECT NO: 3228-14

RUTILA RAIL CORRIDOR ECOLOGICAL STUDIES

CLIENT: RUTILA RESOURCES

VEGETATION CONDITION

MAP 7 - 6

SCALE 1:100,000 @ A3

0 1 2 3 4 5 km

APPENDIX ONE: DEFINITIONS AND CRITERIA

Table 14: *EPBC Act 1999* categories for flora and fauna (Commonwealth of Australia 1999)

EPBC ACT CATEGORY	DEFINITION
Extinct	A native species is eligible to be included in the extinct category at a particular time if, at that time, there is no reasonable doubt that the last member of the species has died.
Extinct in the wild	A native species is eligible to be included in the extinct in the wild category at a particular time if, at that time: (a) it is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or (b) it has not been recorded in its known and/or 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 (CE)	A native species is eligible to be included in the critically endangered category at a particular time if, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
Endangered (EN)	A native species is eligible to be included in the endangered category at a particular time if, at that time: (a) it is not critically endangered; and (b) it is facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria.
Vulnerable (VU)	A native species is eligible to be included in the vulnerable category at a particular time if, at that time: (a) it is not critically endangered or endangered; and (b) it is facing a high risk of extinction in the wild in the medium term future, as determined in accordance with the prescribed criteria.
Conservation Dependent	A native species is eligible to be included in the conservation dependent category at a particular time if, at that time: (a) 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; or (b) the following subparagraphs are satisfied: (i) the species is a species of fish; (ii) the species is the focus of a plan of management that provides for management actions necessary to stop the decline of, and support the recovery of, the species so that its chances of long term survival in nature are maximised; (iii) the plan of management is in force under a law of the Commonwealth or of a State or Territory; (iv) cessation of the plan of management would adversely affect the conservation status of the species.

Table 15: Conservation codes for Western Australia flora and fauna (DPaW 2013)

CONSERVATION CODES FOR WESTERN AUSTRALIAN FLORA AND FAUNA	
T	**Threatened species** – Specially protected under the *Wildlife Conservation Act 1950*, listed under Schedule 1 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora (which may also be referred to as Declared Rare Flora). Species* 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. Threatened Fauna and Flora are further recognised by the Department according to their level of threat using IUCN Red List criteria: **CR:** Critically Endangered – considered to be facing an extremely high risk of extinction in the wild. **EN:** Endangered – considered to be facing a very high risk of extinction in the wild. **VU:** Vulnerable – considered to be facing a high risk of extinction in the wild.
X	**Presumed extinct species** – Specially protected under the *Wildlife Conservation Act 1950*, listed under Schedule 2 of the Wildlife Conservation (Specially Protected Fauna) Notice for Presumed Extinct Fauna and Wildlife Conservation (Rare Flora) Notice for Presumed Extinct Flora (which may also be referred to as Declared Rare Flora). Species* which have been adequately searched for and there is no reasonable doubt that the last individual has died, and have been gazetted as such.
IA	**Migratory birds protected under an international agreement** – Specially protected under the *Wildlife Conservation Act 1950*, listed under Schedule 3 of the Wildlife Conservation (Specially Protected Fauna) Notice. Birds that are subject to an agreement between governments of Australia and Japan, China and The Republic of Korea relating to the protection of migratory birds and birds in danger of extinction.
S	**Other specially protected fauna** – Specially protected under the *Wildlife Conservation Act 1950*, listed under Schedule 4 of the Wildlife Conservation (Specially Protected Fauna) Notice.
Taxa that have not yet been adequately surveyed to be listed under Schedule 1 or 2 are added to the Priority Flora and Priority Fauna Lists under Priorities 1, 2 or 3. These three categories are ranked in order of priority for survey and evaluation of conservation status so that consideration can be given to their declaration as threatened flora or fauna. Species that are adequately known, are rare but not threatened, or meet criteria for Near Threatened, or that have been recently removed from the threatened list for other than taxonomic reasons, are placed in Priority 4. These taxa require regular monitoring. Conservation Dependent species are placed in Priority 5.	
P1	**Priority One: Poorly-known species** Species that are known from one or a few collections or sight records (generally less than five), all on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, Shire, rail reserves and Main Roads WA road, gravel and soil reserves, and active mineral leases and under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes.
P2	**Priority Two: Poorly-known species** Species that are known from one or a few collections or sight records, some of which are on lands not under imminent threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, unallocated Crown land, water reserves, etc. Species may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes
P3	**Priority Three: Poorly-known species** Species that are known from collections or sight records from several localities not under imminent threat, or from few but widespread localities with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and known threatening processes exist that could affect them
P4	**Priority Four: Rare, Near Threatened and other species in need of monitoring** (a) Rare. Species 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 species are usually represented on conservation lands. (b) Near Threatened. Species that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. (c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.
P5	**Priority Five: Conservation Dependent species** Species that are not threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years.
*Species includes all taxa (plural of taxon-a classificatory group of any taxonomic rank, e.g. a family, genus, species or any infraspecific category i.e. subspecies, variety or forma).	

Table 16: EPBC Act 1999 categories for TECs (DSEWPaC 2009)

EPBC Act CATEGORY	DEFINITION
Critically Endangered (CR)	If, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future.
Endangered (EN)	If, at that time, it is not critically endangered, and is facing a very high risk of extinction in the wild in the new future.
Vulnerable (VU)	If, at that time, it is not critically endangered or endangered, and is facing a high risk of extinction in the medium-term future.

Table 17: DPaW definitions and criteria for TECs and PECs (DEC 2010)

CRITERIA	DEFINITION
Threatened Ecological Communities	
Presumed Totally Destroyed (PD)	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 and either of the following applies (A or B): A. Records within the last 50 years have not been confirmed despite thorough searches of known or likely habitats or B. All occurrences recorded within the last 50 years have since been destroyed
Critically Endangered (CR)	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. This will be determined on the basis of the best available information, by it meeting any one or more of the following criteria (A, B or C): A. The estimated geographic range, and/or total area occupied, and/or number of discrete occurrences since European settlement have been reduced by at least 90% and either or both of the following apply (i or ii): i. geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is imminent (within approximately 10 years); ii. modification throughout its range is continuing such that in the immediate future (within approximately 10 years) the community is unlikely to be capable of being substantially rehabilitated. B. Current distribution is limited, and one or more of the following apply (i, ii or iii): i. geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the immediate future (within approximately 10 years); ii. there are very few occurrences, each of which is small and/or isolated and extremely vulnerable to known threatening processes; iii. there may be many occurrences but total area is very small and each occurrence is small and/or isolated and extremely vulnerable to known threatening processes. C. The ecological community exists only as highly modified occurrences that may be capable of being rehabilitated if such work begins in the immediate future (within approximately 10 years).

CRITERIA	DEFINITION
Endangered (EN)	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. This will be determined on the basis of the best available information by it meeting any one or more of the following criteria (A, B, or C): A. The geographic range, and/or total area occupied, and/or number of discrete occurrences have been reduced by at least 70% since European settlement and either or both of the following apply (i or ii): i. the estimated geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is likely in the short term future (within approximately 20 years); ii. modification throughout its range is continuing such that in the short term future (within approximately 20 years) the community is unlikely to be capable of being substantially restored or rehabilitated. B. Current distribution is limited, and one or more of the following apply (i, ii or iii): i. geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the short term future (within approximately 20 years); ii. there are few occurrences, each of which is small and/or isolated and all or most occurrences are very vulnerable to known threatening processes; iii. there may be many occurrences but total area is small and all or most occurrences are small and/or isolated and very vulnerable to known threatening processes. C. The ecological community exists only as very modified occurrences that may be capable of being substantially restored or rehabilitated if such work begins in the short-term future (within approximately 20 years).
Vulnerable (VU)	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. This will be determined on the basis of the best available information by it meeting any one or more of the following criteria (A, B or C): A. The ecological community exists largely as modified occurrences that are likely to be capable of being substantially restored or rehabilitated. B. The ecological community may already be modified and would be vulnerable to threatening processes, is restricted in area and/or range and/or is only found at a few locations. C. The ecological community may be still widespread but is believed likely to move into a category of higher threat in the medium to long term future because of existing or impending threatening processes.

CRITERIA	DEFINITION
Priority Ecological Communities	
Priority One	*Poorly known ecological communities* 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.
Priority Two	*Poorly known ecological communities* 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.
Priority Three	*Poorly known ecological communities* i. Communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation or; 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; iii. Communities made up of large, and/or widespread occurrences, that may or may 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.
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. i. 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. ii. 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. iii. Ecological communities that have been removed from the list of threatened communities during the past five years.
Priority Five	*Conservation Dependent Ecological Communities* 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.

Table 18: NVIS structural formation (terrestrial vegetation) (NHT 2003)

	COVER CHARACTERISTICS							
	Foliage cover *	70-100	30-70	10-30	<10	» 0 (scattered)	0-5 (clumped)	unknown
	Cover code	d	c	i	r	bi	bc	unknown
Growth Form	**Height Ranges (m)**	**Structural Formation Classes**						
tree, palm	<10,10-30, >30	closed forest	open forest	woodland	open woodland	isolated trees	isolated clumps of trees	tree, palm
tree mallee	<3, <10, 10-30	closed mallee forest	open mallee forest	mallee woodland	open mallee woodland	isolated mallee trees	isolated clumps of mallee trees	tree mallee
shrub, cycad, grass-tree, tree-fern	<1,1-2,>2	closed shrubland	shrubland	open shrubland	sparse shrubland	isolated shrubs	isolated clumps of shrubs	shrub, cycad, grass-tree, tree-fern
mallee shrub	<3, <10, 10-30	closed mallee shrubland	mallee shrubland	open mallee shrubland	sparse mallee shrubland	isolated mallee shrubs	isolated clumps of mallee shrubs	mallee shrub
heath shrub	<1,1-2,>2	closed heathland	heathland	open heathland	sparse heathland	isolated heath shrubs	isolated clumps of heath shrubs	heath shrub
chenopod shrub	<1,1-2,>2	closed chenopod shrubland	chenopod shrubland	open chenopod shrubland	sparse chenopod shrubland	isolated chenopod shrubs	isolated clumps of chenopod shrubs	chenopod shrub
samphire shrub	<0.5,>0.5	closed samphire shrubland	samphire shrubland	open samphire shrubland	sparse samphire shrubland	isolated samphire shrubs	isolated clumps of samphire shrubs	samphire shrub
hummock grass	<2,>2	closed hummock grassland	hummock grassland	open hummock grassland	sparse hummock grassland	isolated hummock grasses	isolated clumps of hummock grasses	hummock grass
tussock grass	<0.5,>0.5	closed tussock grassland	tussock grassland	open tussock grassland	sparse tussock grassland	isolated tussock grasses	isolated clumps of tussock grasses	tussock grass
other grass	<0.5,>0.5	closed grassland	grassland	open grassland	sparse grassland	isolated grasses	isolated clumps of grasses	other grass
sedge	<0.5,>0.5	closed sedgeland	sedgeland	open sedgeland	sparse sedgeland	isolated sedges	isolated clumps of sedges	sedge
rush	<0.5,>0.5	closed rushland	rushland	open rushland	sparse rushland	isolated rushes	isolated clumps of rushes	rush
herb	<0.5,>0.5	closed herbland	herbland	open herbland	sparse herbland	isolated herbs	isolated clumps of herbs	herb
fern	<1,1-2,>2	closed fernland	fernland	open fernland	sparse fernland	isolated ferns	isolated clumps of ferns	fern
bryophyte	<0.5	closed bryophyte-land	bryophyte-land	open bryophyteland	sparse bryophyteland	isolated bryophytes	isolated clumps of bryophytes	bryophyte
lichen	<0.5	closed lichenland	lichenland	open lichenland	sparse lichenland	isolated lichens	isolated clumps of lichens	lichen
vine	<10,10-30, >30	closed vineland	vineland	open vineland	sparse vineland	isolated vines	isolated clumps of vines	vine

Table 19: NVIS height classes (NHT 2003)

HEIGHT		GROWTH FORM				
Height Class	Height Range (m)	tree, vine (M & U), palm (single-stemmed)	shrub, heath shrub, chenopod shrub, ferns, samphire shrub, cycad, tree-fern, grass-tree, palm (multi-stemmed)	tree mallee, mallee shrub	tussock grass, hummock grass, other grass, sedge, rush, forbs, vine (G)	bryophyte, lichen, seagrass, aquatic
8	>30	tall	NA	NA	NA	NA
7	10-30	mid	NA	tall	NA	NA
6	<10	low	NA	mid	NA	NA
5	<3	NA	NA	low	NA	NA
4	>2	NA	tall	NA	tall	NA
3	1-2	NA	mid	NA	tall	NA
2	0.5-1	NA	low	NA	mid	tall
1	<0.5	NA	low	NA	low	low
Source: (based on Walker & Hopkins 1990)						

Table 20: Vegetation Condition Scale for the Eremaean and Northern Botanical Provinces (adapted from Keighery (1994), included in EPA & DEC (2012))

CONDITION RATING	DESCRIPTION
Excellent	Pristine or nearly so; no obvious signs of damage caused by activities of European man.
Very Good	Some relatively slight signs of damage caused by activities of European man. For example, some signs of damage to tree trunks caused by repeated fire, the presence of some relatively non-aggressive weeds such as **Ursinia anthemoides* or **Briza* spp., or occasional vehicle tracks.
Good	More obvious signs of damage caused by activities of European man, including some obvious signs of impact on the vegetation structure such as that caused by low levels of grazing or by selective logging. Weeds as above, possibly plus some more aggressive ones such as **Ehrharta* spp.
Poor	Still retains basic vegetation structure or ability to regenerate to it after very obvious activities of European man, such as grazing, partial clearing (chaining) or frequent fires. Weeds as above, probably plus some aggressive ones such as **Ehrharta* spp.
Very Poor	Severely impacted by grazing, very frequent fires, clearing or a combination of these activities. Scope for some regeneration but not to a state approaching good condition without intensive management. Usually with a number of weed species including very aggressive species.
Degraded	Areas that are completely or almost completely without native species in the structure of their vegetation; ie areas that are cleared or 'parkland cleared' with their flora comprising weed or crop species with isolated native trees or shrubs.

APPENDIX TWO: DESKTOP ASSESSMENT RESULTS

Table 21: Geological units in the study area (Hickman & Smithies 2000; Smithies & Hickman 2004; Thorne *et al.* 1996)

UNIT	DESCRIPTION
AaM	Millindinna Intrusion: undivided mafic and ultramafic rocks as layered sills; metamorphosed
AaO	Opaline Well Intrusion: fine- to coarse-grained, mafic intrusive rock; includes olivine gabbro and minor pyroxenite and dunite; minor extrusive mafic rock; metamorphosed
AaS	Sherlock Intrusion: fine- to coarse-grained mafic intrusive rock; includes gabbro, olivine gabbro, leucogabbro, and granophyric gabbro; metamorphosed
Abk	Komatiitic basalt, pyroxene spinifex textured, and olivine basalt; metamorphosed
ACc	CISTERN FORMATION: metamorphosed clastic and volcaniclastic rocks, fine- to coarse-grained wacke, siltstone, and volcanolithic sandstone; includes polymictic cobble conglomerate
ACf	MONS CUPRI VOLCANICS: metamorphosed felsic volcanic and volcaniclastic rocks; lavas and pyroclastic rock, with feldspar and quartz phenocrysts; dacite to rhyolite composition; locally spherulitic and
ACr	RUSHALL SLATE: metamorphosed well-laminated shale and siltstone; locally graphitic; minor sandstone; may be equivalent to lower part of MALLINA FORMATION
AD(b)	Basalt and high-Mg basalt; local ironstone, shale, and wacke
ADcq	Quartzite; medium- to coarse-grained; minor graded beds
ADcs	Poorly sorted sandstone and shale; minor graded beds
ADcsc	Conglomerate, pebbly sandstone, and coarse-grained lithic sandstone; metamorphosed
ADcsh	Laminated shale; locally includes minor beds of poorly sorted subarkose, siltstone, ferruginous siltstone, shale, and iron formation; metamorphosed
ADcstf	Poorly sorted subarkose; includes wacke; lesser interbeds of shale; rare graded beds; metamorphosed
ADcsw	Wacke; locally subarkosic; fine to coarse grained; well-developed graded units; minor pebble beds and shale; turbiditic; metamorphosed
ADm	MALLINA FORMATION: interbedded shale, siltstone, and medium-to fine-grained wacke; minor layers of chert; metamorphosed
Ae	LOUDEN VOLCANICS: undivided basalt and high-Mg basalt; interbedded clastic units and chert; metamorphosed
Afdp	Porphyritic dacite; metamorphosed
AFh	Sandstone, conglomerate, siltstone, shale, and felsic pyroclastic rocks
AFhst	Medium- to coarse-grained, poorly sorted sandstone and minor well-laminated siltstone
AFhy	Lyre Creek Member: felsic agglomerate and felsic pyroclastic rocks
AFjo	Woodiana Member: quartz-rich sandstone, chert, chert breccia, and mudstone; locally includes lithic volcaniclastic sandstone
AFjsl	Variegated, light-coloured mudstone and siltstone
AFjslg	Carbonaceous mudstone and siltstone, chert, and local dolomite beds
AFk	KYLENA FORMATION: massive or amygdaloidal basalt, basaltic andesite, and dacite; local komatiitic basalt and rhyolite
AFm	MADDINA FORMATION: massive, vesicular, and amygdaloidal basalt and basaltic andesite
AFr	MOUNT ROE BASALT: massive, vesicular, and glomeroporphyritic basalt
AFrs	Laminated shale, siltstone, and poorly sorted tuffaceous sandstone
AFt	TUMBIANA FORMATION: mafic to felsic volcaniclastic sandstone, pyroclastic rocks, and fine- to medium-grained clastic sedimentary rock; minor basalt, chert, dolomite, and limestone
AFtc	Meentheena Member: dark grey stromatolitic dolomite and limestone, carbonate-rich pyroclastic rocks, mudstone, and siltstone

UNIT	DESCRIPTION
Agja	JALLAGNOONINA GRANODIORITE: tonalite and granodiorite; metamorphosed
AGl	CLEAVERVILLE FORMATION: banded iron-formation, jaspilite, chert, siltstone, shale, and minor felsic volcaniclastic rock; metamorphosed
AGlfv	Felsic volcaniclastic rock, lithic volcaniclastic sandstone, and siltstone; metamorphosed
Agpe	PEAWAH GRANODIORITE: hornblende-biotite high-Mg diorite, granodiorite, and tonalite; metamorphosed
AgR	Granitoid gneiss and foliated granitoid rock
AgRg	BOOKINGARRA GRANITE: medium- to coarse-grained monzogranite to syenogranite; locally strongly foliated; metamorphosed
Agsa	SATIRIST GRANITE: metamorphosed biotite(-hornblende) granite
AgYel	ELLAWARRINA MONZOGRANITE: biotite-bearing monzogranite; metamorphosed
AgYfr	FLAT ROCKS TONALITE: biotite-bearing tonalite; strongly foliated; locally interleaved with abundant massive to weakly foliated, K-feldspar porphyritic monzogranite; metamorphosed
AgYmh	Hornblende-bearing monzogranite to granodiorite, undivided; metamorphosed
AHd	WITTENOOM FORAMTION: metamorphosed thin- to medium-bedded dolomite, dolomitic pelite, chert, and volcanic sandstone
AHm	MARRA MAMBA IRON FORMATION: chert, banded iron-formation, mudstone, and siltstone
AHs	MOUNT McRAE SHALE and MOUNT SYLVIA FORMATION: mudstone, siltstone, chert, banded iron-formation, and dolomite
Aog	Metagabbro, medium to coarse grained
Aoge	Melanogabbro; typically low-Ti tholeiitic; metamorphosed
Aombs	Fine- to medium-grained actinolite-chlorite(-serpentine-plagioclase) schist; boninitic composition
Apto	TOWERANNA PORPHYRY: metamorphosed porphyritic granodiorite; possibly equivalent to PEAWAH GRANODIORITE
At	MOUNT NEGRI VOLCANICS: metamorphosed variolitic and vesicular basalt; undivided
Auk	Serpentine-talc-tremolite rock after komatiite; pseudomorphed olivine spinifex textures
Aus	Serpentinized ultramafic rock
Czc	Colluvium - dissected consolidated clay, silt, sand, and gravel deposits; derived from adjacent rock outcrop
Czcb	Colluvium, dissected by present-day drainage, with gilgai surface in areas of expansive clay
Czcf	Ferruginous colluvium, derived from adjacent iron formation; includes hematite-rich conglomerate (canga) that contains iron ore
Czrk	Residual calcrete; massive, nodular, and cavernous limestone; mainly silicified
d	Dolerite dykes; interpreted from aeromagnetic data where dashed
PLHb	BROCKMAN IRON FORMATION: banded iron-formation, chert, and pelite
Qa	Alluvium - unconsolidated silt, sand, and gravel; in drainage channels and adjacent floodplains
Qaa	Alluvial sand and gravel in rivers and creeks; clay, silt, and sand in channels on floodplains
Qab	Alluvial sand, silt, and clay in floodplains, with gilgai surface in areas of expansive clay
Qao	Alluvial sand, silt, and clay in floodplains adjacent to main drainage channels
Qc	Colluvium - sand, silt, and gravel in outwash fans; scree and talus; proximal mass-wasting deposits; unconsolidated quartz and rock fragments in soil
Qhms	Coastal sand in beach deposits and dunes; chiefly marine sand reworked by wind, but includes some reworked alluvium near deltas; shelly sand contains Anadara granosa
Qs	Eolian sand - red-yellow, wind-blown sand; local ridges
Qw	Low-gradient sheetwash deposits - silt, sand, and pebbles on distal outwash fans; no defined drainage

UNIT	DESCRIPTION
Qwb	Sand, silt, and clay in distal outwash fans, with gilgai surface in areas of expansive clay
Qwc	Sheetwash sand, silt, and clay in distal outwash fans, with numerous claypans and minor clay-filled drainages
Qwf	Ferruginous sheetwash sand, silt, and clay in outwash fans, with clasts of iron formation
Qws	**Sand in distal outwash fans; no defined drainage**

Table 22: Descriptions of land types and systems within the study area (Van Vreeswyk *et al*. 2004)

UNIT	DESCRIPTION
Land type 1	**Hills and ranges with spinifex grasslands**
Black land system	Linear ridges of dolerite or basalt supporting hard spinifex grasslands, with unvegetated boulder slopes and rock piles along summits.
Boolaloo land system	Granite hills, domes, tor fields and sandy plains supporting spinifex grasslands with scattered shrubs.
Capricorn land system	Rugged sandstone hills, ridges, stony footslopes and interfluves supporting low acacia shrublands or hard spinifex grasslands with scattered shrubs.
Granitic land system	Rugged granitic hills supporting shrubby hard and soft spinifex grasslands.
McKay land system	Hills, ridges, plateaux remnants and breakaways of meta sedimentary and sedimentary rocks supporting hard spinifex grasslands with acacias and occasional eucalypts.
Newman land system	Rugged jaspilite plateaux, ridges and mountains supporting hard spinifex grasslands
Rocklea land system	Basalt hills, plateaux, lower slopes and minor stony plains supporting hard spinifex (and occasionally soft spinifex) grasslands
Ruth land system	Hills and ridges of volcanic and other rocks supporting shrubby hard spinifex and occasionally soft spinifex grasslands.
Land type 8	**Stony plains with spinifex grasslands**
Boolgeeda land system	Stony lower slopes and plains below hill systems supporting hard and soft spinifex grasslands or mulga shrublands
Macroy land system	Stony plains and occasional tor fields based on granite supporting hard and soft spinifex shrubby grasslands.
Satirist land system	Stony plains and low rises supporting hard spinifex grasslands, and gilgai plains supporting tussock grasslands.
Land type 9	**Stony gilgai plains with tussock grasslands and spinifex grasslands**
Wona land system	Basalt upland gilgai plains supporting Roebourne Plains grass and Mitchell grass tussock grasslands, minor hard spinifex grasslands or annual grasslands/herbfields.
Land type 11	**Sandplains with spinifex grasslands**
Gregory land system	Linear dunes and restricted sandplains supporting shrubby hard spinifex (and occasionally soft spinifex) grasslands.
Uaroo land system	Broad sandy plains, pebbly plains and drainage tracts supporting hard and soft spinifex hummock grasslands with scattered acacia shrubs.
Land type 12	**Wash plains on hardpan with groved mulga shrublands (sometimes spinifex understory)**
Jurrawarrina land system	Hardpan plains and alluvial tracts supporting mulga shrublands with tussock and spinifex grasses.
Land type 13	**Alluvial plains with soft spinifex grasslands**
Mallina land system	Sandy surfaced alluvial plains supporting soft spinifex grasslands and minor hard spinifex and tussock grasslands.
Urandy land system	Stony plains, alluvial plains and drainage lines supporting shrubby soft spinifex grasslands.
Land type 14	**Alluvial plains with tussock grasslands or grassy shrublands**
Horseflat land system	Gilgaied clay plains supporting Roebourne Plains grass grasslands and minor grassy snakewood shrublands.
Land type 15	**Alluvial plains with snakewood shrublands**

UNIT	DESCRIPTION
Hooley land system	Alluvial clay plains supporting a mosaic of snakewood shrublands and tussock grasslands.
Sherlock land system	Stony alluvial plains supporting snakewood shrublands with patchy tussock grasses and spinifex grasslands
Land type 17	**River plains with grassy woodlands and shrublands, and tussock grasslands**
Coolibah land system	Flood plains with weakly gilgaied clay soils supporting coolibah woodlands with tussock grass understorey.
River land system	Narrow, seasonally active flood plains and major river channels supporting moderately close, tall shrublands or woodlands of acacias and fringing communities of eucalypts sometimes with tussock grasses or spinifex.
Land type 18	**Calcrete drainage plains with shrublands or spinifex grasslands**
Calcrete land system	Low calcrete platforms and plains supporting shrubby hard spinifex grasslands.

APPENDIX THREE: DATABASE SEARCH RESULTS

Table 23: Combined flora database search results

Database searches: 1 = DPaW, 2 = *NatureMap* (**Figure 7**), 3 = *PMST*, 4 = Ecoscape records

SPECIES	DATABASE	*EPBC ACT* STATUS	DPAW STATUS
Abutilon sp. Pritzelianum (S. van Leeuwen 5095)	4	-	P1
Acacia bromilowiana	1	-	P4
Acacia daweana	1,2	-	P3
Acacia leeuweniana	1	-	P1
Acacia subtiliformis	1	-	P3
Adiantum capillus-veneris	1	-	P2
Astrebla lappacea	1,2,4	-	P3
Bothriochloa decipiens var. *cloncurrensis*	1	-	P1
Brachyscome sp. Wanna Munna Flats (S. van Leeuwen 4662)	1	-	P1
Calotis latiuscula	1	-	P3
Calotis squamigera	1	-	P1
Cladium procerum	1,2	-	P2
Dampiera anonyma	1,2,4	-	P3
Dampiera metallorum	1	-	P3
Eragrostis crateriformis	1	-	P3
Eragrostis sp. Mt Robinson (S. van Leeuwen 4109)	1	-	P1
Eragrostis surreyana	1	-	P3
Eremophila forrestii subsp. Pingandy (M.E. Trudgen 2662)	1	-	P2
Eremophila magnifica subsp. *magnifica*	1,2,4	-	P4
Eremophila magnifica subsp. *velutina*	1,2,4	-	P3
Eremophila sp. Hamersley Range (K. Walker KW 136)	1	-	P1
Eremophila sp. Snowy Mountain (S. van Leeuwen 3737)	1	-	P1
Eremophila sp. West Angelas (S. van Leeuwen 4068)	1	-	P1
Eremophila spongiocarpa	1	-	P1
Eucalyptus lucens	1	-	P1
Euphorbia australis var. *glabra*	1	-	P2
Euphorbia inappendiculata var. *inappendiculata*	1	-	P2
Euphorbia inappendiculata var. *queenslandica*	1	-	P1
Fimbristylis sieberiana	1	-	P3
Geijera salicifolia	1	-	P3
Glycine falcata	1,4		P3
Goodenia nuda	1,2,4	-	P4
Goodenia sp. East Pilbara (A.A. Mitchell PRP 727)	1	-	P3
Gymnanthera cunninghamii	1	-	P3

SPECIES	DATABASE	*EPBC ACT* STATUS	DPAW STATUS
Helichrysum oligochaetum	1,2	-	P1
Heliotropium muticum	1,2,4	-	P1
Hibiscus sp. Gurinbiddy Range (M.E. Trudgen MET 15708)	1	-	P2
Hibiscus sp. Mt Brockman (E. Thoma ET 1354)	1	-	P1
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	1,2,4	-	P3
Indigofera sp. Gilesii (M.E. Trudgen 15869)	1	-	P3
Iotasperma sessilifolium	1,2,4	-	P3
Ipomoea racemigera	1	-	P2
Josephinia sp. Marandoo (M.E. Trudgen 1554)	2	-	P1
Lepidium catapycnon	1,3	Vulnerable	T
Livistona alfredii	1	-	P4
Nicotiana heterantha	1,2	-	P1
Oldenlandia sp. Hamersley Station (A.A. Mitchell PRP 1479)	1,2,4	-	P3
Olearia mucronata	1	-	P3
Owenia acidula	1	-	P3
Oxalis sp. Pilbara (M.E. Trudgen 12725)	1	-	P2
Paspalidium retiglume	1,2,4	-	P2
Pentalepis trichodesmoides subsp. *hispida*	1	-	P2
Pilbara trudgenii	1	-	P2
Pleurocarpaea gracilis	1	-	P3
Polymeria distigma	1	-	P3
Ptilotus subspinescens	1	-	P3
Rhagodia sp. Hamersley (M. Trudgen 17794)	1,4	-	P3
Rhynchosia bungarensis	1,2,4	-	P4
Rostellularia adscendens var. *latifolia*	1,2,4	-	P3
Scaevola sp. Hamersley Range basalts (S. van Leeuwen 3675)	1	-	P2
Senna sp. Millstream (E. Leyland s.n. 30/8/1990)	1	-	P1
Sida sp. Barlee Range (S. van Leeuwen 1642)	1,2,4	-	P3
Sida sp. Hamersley Range (K. Newbey 10692)	1,2,4	-	P1
Solanum albostellatum	1,4	-	P3
Solanum kentrocaule	1	-	P3
Spartothamnella puberula	1	-	P2
Sporobolus pulchellus	1	-	P1
Stackhousia clementii	1	-	P3
Swainsona thompsoniana	1,2	-	P3
Tephrosia rosea var. Port Hedland (A.S. George 1114)	1,2,4	-	P1
Tetratheca fordiana	1	-	P1
Teucrium pilbaranum	1	-	P1
Themeda sp. Hamersley Station (M.E. Trudgen 11431)	1,4	-	P3
Thryptomene wittweri	1	Vulnerable	T

SPECIES	DATABASE	*EPBC ACT* STATUS	DPAW STATUS
Trianthema sp. Python Pool (G.R. Guerin & M.E. Trudgen GG 1023)	1	-	P2
Triodia sp. Karijini (S. van Leeuwen 4111)	1	-	P1
Triodia sp. Mt Ella (M.E. Trudgen 12739)	1	-	P3
Triodia sp. Robe River (M.E. Trudgen et al. MET 12367)	1	-	P3
Vigna sp. central (M.E. Trudgen 1626)	1,2,4	-	P2
Vigna sp. rockpiles (R. Butcher et al. RB 1400)	4	-	P3
Vittadinia sp. Coondewanna Flats (S. van Leeuwen 4684)	1	-	P1

Barbula ehrenbergii (P1), identified by the DPaW database search, was removed from the list as it is not a vascular plant and surveys for mosses are not within the scope of the project.

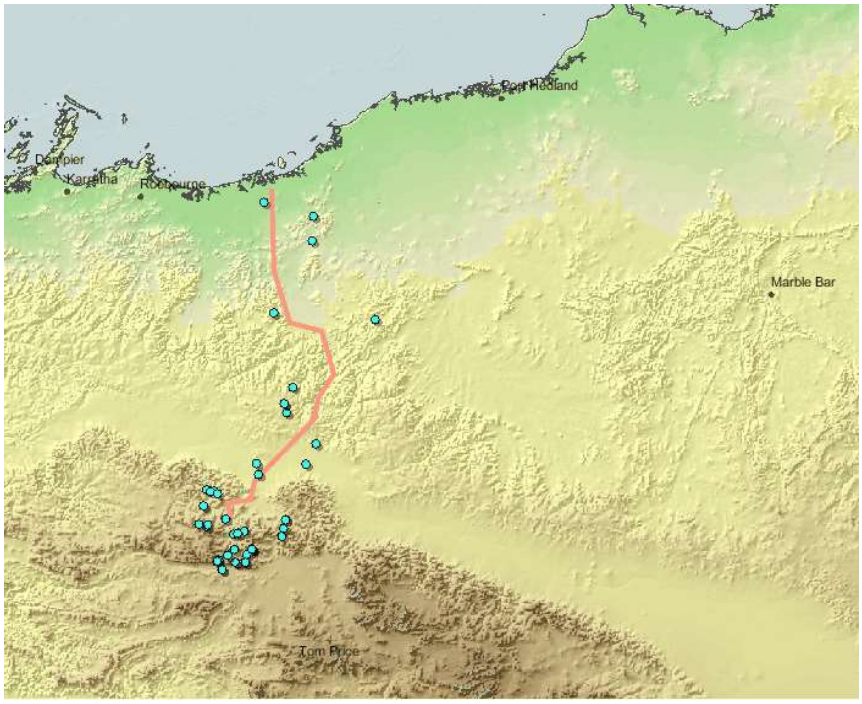


Figure 7: *NatureMap* (DPaW 2007-2014) search area

Table 24: Conservation significant flora details

SPECIES NAME	DESCRIPTION	FL. PERIOD	SOIL	LANDFORM/HABITAT	ASSOCIATED VEGETATION
		T			
Lepidium catapycnon	Open, woody perennial, herb or shrub, 0.2-0.3 m high, stems zigzag, white flowers	Oct	Skeletal	Hillsides	*Triodia wiseana* hummock grassland. With *Acacia bivenosa, A. inaequilatera, A. pruinocarpa, A. pyrifolia, Triodia* sp. Shovelanna Hill
Thryptomene wittweri	Spreading or rounded shrub, 0.5–1.5(–2.1) m high	Apr/Jul/Aug	Skeletal red stony soils	Breakaways, stony creek beds	*Eucalyptus kingsmillii*
		P1			
Abutilon sp. Pritzelianum (S. van Leeuwen 5095)	Erect shrub to 3 m, yellow or orange flowers	Jun-Nov	Orange brown sandy loam, red sand, clay	Sandplain, dunes, floodplain	Grassland, shrubland, *Acacia* shrubland
Acacia leeuweniana	Narrow, obconic tree, to 14 m high, bark minni ritchi	Apr-May	Granitic sandy loam	Granite outcrop high in landscape	*Acacia retivenea, A. tumida, Terminalia canescens*
Bothriochloa decipiens var. *cloncurrensis*	Perennial grass to 1.4 m high	May	Loam, clay	Damp depression, clay pan	*Eucalyptus camaldulensis*, Mulga
Brachyscome sp. Wanna Munna Flats (S. van Leeuwen 4662)	Annual herb to 40 cm, purple/blue/white/pink flowers	Mar-Sep	Clay	Flats	Mulga, grassland
Calotis squamigera	Procumbent annual, herb, to 0.21 m high	Jul	Pebbly loam	Plain	*Acacia xiphophylla*, Mulga
Eragrostis sp. Mt Robinson (S. van Leeuwen 4109)	Tussock-forming perennial, grass-like or herb, to 0.3 m high	Sep	Red-brown skeletal soils, ironstone	Steep slopes, summits	*Eucalyptus kingsmillii*
Eremophila sp. Hamersley Range (K. Walker KW 136)	Shrub to 2 m tall, rounded crowded canopy, Flowers white-cream-yellow-pink-purple	Aug-Sep	Ironstone	Hill crest, cliff top , gorge top	Mulga
Eremophila sp. Snowy Mountain (S. van Leeuwen 3737)	Shrub to 1 m high, rounded	-	Ironstone	High hill	*Eucalyptus leucophloia, Corymbia hamersleyana*, Mulga
Eremophila sp. West Angelas (S. van Leeuwen 4068)	Spindly shrub to 3 m high	Sep	Banded ironstone	High in landscape, hill summit, scree	*Eucalyptus gamophylla, E. kingsmillii*, Mulga
Eremophila spongiocarpa	Compact, succulent-leaved shrub, to 1 m high	May/Sep	Alluvium	Weakly saline alluvial plain on margins of marsh	*Tecticornia* spp., Mulga, *Frankenia* sp.
Eucalyptus lucens	Mallee, to 4.5 m high, bark smooth, white, sometimes slightly powdery; leaves glossy green	Jan-Apr	Ironstone	Rocky slopes and mountain tops, high in the landscape	*Eucalyptus kingsmillii*
Euphorbia inappendiculata var. *queenslandica*	Herb to 2 cm high	May-Jun	Cracking clay	Clay plain, depression	*Eriachne benthamii, Themeda* sp. Hamersley Station, grassland
Helichrysum oligochaetum	Annual herb to 25 cm, yellow flowers	Aug-Nov	Red clay	Alluvial plains, drainage lines	*Eucalyptus camaldulensis, E. victrix*
Heliotropium muticum	Ascending to spreading perennial herb to 0.3 m, white flowers	May-Nov	Sand, clayey sand, granite	Sandplain, floodplain	*Acacia* shrubland, *Acacia stellaticeps, Triodia*
Hibiscus sp. Mt Brockman (E. Thoma ET 1354)	Shrub to 2.5 m high, purple flowers	Jul-Sep	Ironstone	Gorges, crevices, gullies	*Corymbia ferriticola*
Josephinia sp. Marandoo (M.E. Trudgen 1554)	Erect shrub or herb, to 30 cm, pink flowers	Aug	Alluvial	Drainage lines, plains	Mulga, *Acacia* spp.

SPECIES NAME	DESCRIPTION	FL. PERIOD	SOIL	LANDFORM/HABITAT	ASSOCIATED VEGETATION
Nicotiana heterantha	Annual or short-lived perennial herb to 0.5 m. White-cream flowers	Mar-Sep	Black clay, alluvial sand, sandy clay	Seasonally wet flats, floodplain, creeklines	*Tecticornia, Eucalyptus victrix*
Senna sp. Millstream (E. Leyland s.n. 30/8/1990)	Open shrub to 1.2 m high	Aug	Cracking clay	Creek bed	-
Sida sp. Hamersley Range (K. Newbey 10692)	Open shrub to 2 m, yellow flower. Discolorous leaves with white margins	Apr-Oct	Scree, skeletal soil	Gorge, cliff	*Acacia pruinocarpa, Corymbia ferriticola, Eucalyptus gamophylla, E. leucophloia,*
Sporobolus pulchellus	Ephemeral grass to 0.4 m high	Feb-Nov	Sand, sandstone, sandy ironstone	Rocky hills	-
Tephrosia rosea var. Port Hedland (A.S. George 1114)	Erect or sprawling shrub, maroon-red-purple or pink flowers	Mar-Oct	Sand, sandy loam	Coastal dunes, plains	*Acacia coriacea, Triodia epactia, Spinifex longifolius, Acacia stellaticeps, *Cenchrus ciliaris*
Tetratheca fordiana	Dwarf shrub, 0.3–0.4 m high	Jul	Ironstone	Cliff, crest, ridge	*Eucalyptus kingsmillii, Triodia wiseana*
Teucrium pilbaranum	Rounded shrub, to 0.4 m high, white flowers	May-Sep	Clay, calcrete	Crab hole plain in a river floodplain, margin of calcrete table	*Chrysopogon fallax, Eucalyptus victrix, Eriachne benthamii*
Triodia sp. Karijini (S. van Leeuwen 4111)	Hummock grass to 1 m high	May-Sep	Ironstone, banded ironstone	Hilltops, upper slopes, high hills	*Eucalyptus kingsmillii, Eucalyptus leucophloia, Corymbia hamersleyana*
Vittadinia sp. Coondewanna Flats (S. van Leeuwen 4684)	Tall daisy to 1 m , open canopy, in late flower and dehiscing fruit, cream/white flowers	May/Sep	Clay loam	Plain	*Acacia* thicket over mixed grassland. *Acacia aneura, Eucalyptus ?xerothermica, Themeda ?triandra.*
P2					
Adiantum capillus-veneris	Rhizomatous, perennial, herb (fern), 0.1-0.2 m high	-	-	Moist, sheltered sites in gorges and on cliff walls	-
Cladium procerum	Densely tufted perennial, grass-like or herb (sedge), 2 m high	Nov	Alluvium	Perennial pools, coastal swamps, gorges	*Cyperus, Typha*, date palms
Eremophila forrestii subsp. Pingandy (M.E. Trudgen 2662)	Low shrub 0.5 m tall with red or pinky flowers with long exerted stamens	May-Jul	Stony	Slopes, flats, drainage lines	Mulga, *Corymbia hamersleyana*
Euphorbia australis var. *glabra*	Annual herb	-	Alluvium, cracking clay	Flats, drainage lines	*Eucalyptus victrix*, grassland
Euphorbia inappendiculata var. *inappendiculata*	Prostrate annual herb to 5 cm	May-Aug	Clay, cracking clay	Floodplain, plain, high in landscape	*Aristida* and *Astrebla* grasslands, *Acacia xiphophylla*
Hibiscus sp. Gurinbiddy Range (M.E. Trudgen MET 15708)	Spindly upright shrub to 3 m tall, purple flower	May-Aug	Stony soil, Brockman Iron Formation	Hill summits, high in landscape	*Eucalyptus kingsmillii, E, leucophloia & E. gamophylla* over *Acacia aneura, A. rhodophloia* over *Scaevola acacioides, Eremophila latrobei* over *Triodia wiseana*
Ipomoea racemigera	Creeping annual herb, climber, white flowers	Apr	Basalt, ?alluvium	Valley	Grassland
Oxalis sp. Pilbara (M.E. Trudgen 12725)	Small herb to 10 cm tall. Leaves green above, purple below; yellow flowers	May/Sep	Red-brown pebbly/rocky loam amongst boulders	Drainage lines, gullies	Mulga, *Triodia* grassland, *Eucalyptus leucophloia*

SPECIES NAME	DESCRIPTION	FL. PERIOD	SOIL	LANDFORM/HABITAT	ASSOCIATED VEGETATION
Paspalidium retiglume	Annual grass to 0.5 m high	Apr-May	Clay, cracking clay	Plain	Grassland, *Neptunia*
Pentalepis trichodesmoides subsp. *hispida*	Spreading shrub to 1.3 m high x 2 m wide, yellow flowers	Apr-Dec	Basalt, loam, stony clay sand, alluvium	Screes, drainage lines, hills	*Triodia*
Pilbara trudgenii	Gnarled, aromatic shrub, to 1 m high	Sep	Ironstone, skeletal soil	Hill summits, steep slopes, screes, cliff faces	*Corymbia ferriticola*, Mulga, *Eucalyptus kingsmillii, Astrotricha hamptonii*
Scaevola sp. Hamersley Range basalts (S. van Leeuwen 3675)	Shrub, to 1 m high	Jul-Aug.	Skeletal, brown gritty soil over basalt	Summits of hills, steep hills	*Eucalyptus kingsmillii* and *Eucalyptus* aff. *hamersleyana* over *Acacia hamersleyensis* over *Ptilotus rotundifolius* over *Triodia* sp. (SVL 2476).
Spartothamnella puberula	Shrub, 0.35–1.5 m high, blue-white flowers	Sep-Nov	Rocky loam, sandy or skeletal soils, clay	Hills, gorges	*Eucalyptus leucophloia, Corymbia ferriticola*
Trianthema sp. Python Pool (G.R. Guerin & M.E. Trudgen GG 1023)	Low succulent herb with pink-white flowers	Mar-Jul	Sand, gibber plain	Plain	*Triodia longiceps, T. pungens*
Vigna sp. central (M.E. Trudgen 1626)	Prostrate creeper 50 cm high x 50 cm wide	Jan-Oct	Clay, alluvium	Valleys	*Triodia epactia*, Mulga, *Corymbia hamersleyana*
P3					
Acacia daweana	Spreading shrub, 0.3–1.5(–2) m high	Jul-Sep	Stony red loam, colluvium	Low rocky rises, along drainage lines, scree	*Eucalyptus gamophylla, Corymbia deserticola, C. hamersleyana*
Acacia subtiliformis	Spindly, slender, erect shrub, to 3.5 m high	Jun	Calcrete	On rocky calcrete plateau	*Eucalyptus leucophloia, Triodia wiseana, T. basedowii*
Astrebla lappacea	Tufted perennial, grass, 0.1–0.5 m high	Apr	Clay	Plain	*Acacia xiphophylla*, grassland
Calotis latiuscula	Erect herb, to 0.5 m high	Jun-Oct	Sand, loam, clay, calcrete	Rocky hillsides, floodplains, rocky creeks or river beds	*Themeda triandra*, Mulga
Dampiera anonyma	Multistemmed perennial, herb, to 0.5(-1) m high, purple flowers	Jun-Sep	Skeletal red-brown to brown gravelly soil over banded ironstone, basalt, shale and jaspilite	Hill summits, upper slopes	*Eucalyptus leucophloia, E. kingsmillii, Acacia hamersleyensis*
Dampiera metallorum	Rounded, multistemmed perennial, herb, to 0.5 m high	Apr-Oct	Skeletal red-brown gravely soils over banded ironstone	Steep slopes and summits	*Eucalyptus gamophylla, E. kingsmillii, E. leucophloia*
Eragrostis crateriformis	Annual, grass-like or herb, 0.17–0.42 m high	Jan-Jul	Clayey loam or clay	Creek banks, depressions	Grassland, *Acacia* spp, *Triodia* spp., Buffel grass
Eragrostis surreyana	Tufted annual herb 5-8 (-13) cm high	May-Sep	Red-brown clay	Drainage line	*Eucalyptus victrix, E. camaldulensis, Melaleuca*
Eremophila magnifica subsp. *velutina*	Shrub, 0.5–1.5 m high, purple flowers	Aug-Sep	Skeletal soils over ironstone	Summits, hills, rocky areas on slopes	*Eucalyptus leucophloia*
Fimbristylis sieberiana	Shortly rhizomatous, tufted perennial, grass-like or herb (sedge), 0.25–0.6 m high	May-Jun	Mud, skeletal soil pockets	Pool edges, sandstone cliffs	*Cyperus, Eleocharis, Cladium*

SPECIES NAME	DESCRIPTION	FL. PERIOD	SOIL	LANDFORM/HABITAT	ASSOCIATED VEGETATION
Geijera salicifolia	Tree, 1.5–6 m high	Sep	Skeletal soils, stony soils	Massive rock scree, gorges	*Eucalyptus leucophloia, E. xerothermica*
Glycine falcata	Mat-forming perennial, herb, to 0.2 m high. Fl. blue, purple	May-Jul	Black clayey sand	Floodplains. Along drainage depressions in crabhole plains on river	*Eriachne* grassland,
Goodenia sp. East Pilbara (A.A. Mitchell PRP 727)	Open, erect annual or biennial, herb, to 0.2 m high, yellow flowers	Feb-Sep	Red-brown clay soil, calcrete	Low undulating plain, swampy plains	*Melaleuca eleuterostachya, Acacia bivenosa* over *Triodia wiseana, Triodia angusta*
Gymnanthera cunninghamii	Erect shrub 1-2 m high, cream-yellow-green flowers	Jan-Dec	Sand, clay loam	River bed, floodplain	*Eucalyptus victrix, E. camaldulensis*, near Mangroves
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Erect shrub to 2.3 m high, red-pink flowers	Jul-Oct	Alluvium	Creeks and gorges	*Corymbia hamersleyana, Eucalyptus xerothermica, E. victrix*
Indigofera sp. Gilesii (M.E. Trudgen 15869)	Shrub, to 1.5 m high, dull pink flowers	May/Aug	Pebbly loam amongst boulders & outcrops, Brockman Iron Formation	Hills	*Eucalyptus gamophylla, E. leucophloia, Corymbia ferriticola*
Iotasperma sessilifolium	Erect herb. Fl. pink.	May-Sep	Cracking clay, black loam.	Edges of waterholes, plains, drainage line	Herbland, grassland
Oldenlandia sp. Hamersley Station (A.A. Mitchell PRP 1479)	Spreading annual, herb, 0.05–0.1 m high	Mar	Cracking clay, basalt	Gently undulating plain with large surface rocks, flat crabholed plain	*Astrebla, Eriachne* and *Themeda* grasslands
Olearia mucronata	Densely branched, unpleasantly aromatic shrub, 0.6–1 m high. Fl. white, yellow	Aug-Jan	Ironstone	Cliffs, hills, upper slopes	*Eucalyptus leucophloia, Astrotricha hamptonii*, Mulga
Owenia acidula	Small tree to 8 m high, pendulous branches	Apr-Sep	-	Creek	-
Pleurocarpaea gracilis	Rounded shrub, to 0.4 m high	Oct	Skeletal, brown gritty soil over ironstone	Hill summit	*Eucalyptus leucophloia* and *E. gamophylla* over *Senna pruinosa, Acacia bivenosa, A. maitlandii* and *A. pyrifolia* over *A. marramamba* over *Triodia* sp.
Polymeria distigma	Prostrate herb, pink flowers	Apr-Jul	Sandy soil, clay	Coastal plain, floodplain	*Astrebla pectinata*
Ptilotus subspinescens	Compact shrub, to 0.8 m high. Fl. pink	Sep–Oct	Ironstone, basalt, quartz	Gentle rocky slopes, screes and the bases of screes	*Triodia angusta, T. longiceps, T. wiseana, Eucalyptus leucophloia*, Mulga
Rhagodia sp. Hamersley (M. Trudgen 17794)	Erect shrub	Apr-Nov	Sandy loam, alluvium	Floodplain / lower slopes	Mulga, *Eucalyptus leucophloia, E. xerothermica*
Rostellularia adscendens var. *latifolia*	Herb or shrub, 0.1–0.3 m high, purple flowers	Apr-May	Ironstone, calcrete	Near creeks, rocky hills	*Eucalyptus victrix, Corymbia ferriticola*, Mulga, *E. xerothermica, E. kingsmillii*
Sida sp. Barlee Range (S. van Leeuwen 1642)	Spreading shrub, to 0.5 m high	Aug	Skeletal red soils pockets	Steep slope, drainage lines, gullies	*Eucalyptus leucophloia, Acacia citrinoviridis, A. pruinocarpa, Corymbia ferriticola*
Solanum albostellatum	Sub-shrub to 40 cm, mauve flowers	Mar-May	Cracking clay	Plain, floodplain	Grassland

SPECIES NAME	DESCRIPTION	FL. PERIOD	SOIL	LANDFORM/HABITAT	ASSOCIATED VEGETATION
Solanum kentrocaule	Shrub to 1.5 m high, extremely prickly. Purple flowers	Jul-Oct	Ironstone, basalt	Hills, occasionally creeks	*Eucalyptus leucophloia, E. kingsmillii*
Stackhousia clementii	Herb or shrub to 45 cm high, yellow-brown flowers	Apr-Oct	Clay	Floodplain	Grassland (*Themeda* sp. Hamersley Station), *Eucalyptus victrix*
Swainsona thompsoniana	Prostrate annual, herb, to 0.1 m high	Mar	Clay	Flat crabholed plain	Open *Eremophila maculata* shrubland over moderately dense herbs, tussock grassland of *Astrebla pectinata*
Themeda sp. Hamersley Station (M.E. Trudgen 11431)	Tussocky perennial, grass-like or herb, 0.9-1.8 m high	Aug	Red clay	Clay pan, grass plain	*Polymeria* sp. Hamersley (M.E. Trudgen 11353) herbland with *Chrysopogon fallax, Astrebla pectinata, Aristida latifolia* very open tussock grassland
Triodia sp. Mt Ella (M.E. Trudgen 12739)	Perennial, grass-like or herb, 0.4 m high	May-Aug	Light orange-brown, pebbly loam	Amongst rocks & outcrops, gully slopes, scree	*Eucalyptus leucophloia*, Mulga
Triodia sp. Robe River (M.E. Trudgen et al. MET 12367)	Perennial hummock grass to 0.6 m high	Feb-Oct	Ironstone, pisolite (Robe land system)	Rocky hills and mesas	*Eucalyptus leucophloia, Triodia wiseana*
Vigna sp. rockpiles (R. Butcher et al. RB 1400)	Annual climbing herb, yellow flowers	Mar-Jun	Skeletal	Rock piles, scree	*Triodia epactia, T. angusta, Terminalia supranitifolia, Brachychiton acuminatus, Acacia inaequifolia*
P4					
Acacia bromilowiana	Tree or shrub, to 12 m high	Jul-Aug	Red skeletal stony loam, orange-brown pebbly, gravel loam, laterite, banded ironstone, basalt	Rocky hills, breakaways, scree slopes, gorges, creek beds	*Eucalyptus leucophloia, Corymbia hamersleyana*
Eremophila magnifica subsp. *magnifica*	Shrub, 0.5-1.5 m high	Aug-Nov	Skeletal soils over ironstone.	Rocky screes	*Eucalyptus leucophloia, Corymbia hamersleyana*
Goodenia nuda	Erect to ascending herb, to 0.5 m high Fl. yellow	Apr-Aug	Red--brown clay loam, ironstone	Mostly low lying areas (floodplains, outwash areas), occasionally hills	*Acacia tumida* tall shrubland with mixed grass understorey including *Triodia epactia*
Livistona alfredii	Palm to 10 m high	Jun-Sep	-	Edges of permanent pools, with flowing water	*Eucalyptus camaldulensis*
Rhynchosia bungarensis	Compact, prostrate shrub, to 0.5 m high	Mar-Nov	Pebbly, coarse sand	Banks of flow line	*Corymbia hamersleyana, Eucalyptus camaldulensis, Triodia wiseana, E. victrix*
Significant According to *Guidance Statement No. 51*					
Unnamed *Josephinia* sp.	Annual? low rounded hairy shrub 40-50 cm high, pink flowers	May	Rocky outcrops	Hills, gorges	*Acacia monticola, Triodia wiseana, Corymbia hamersleyana, Eucalyptus leucophloia*

Table 25: Conservation significant flora flowering times

Boxed cells indicate the months the field surveys were conducted during.

SPECIES NAME	Description	FL. PERIOD	J	F	M	A	M	J	J	A	S	O	N	D
TF														
Lepidium catapycnon	Open, woody perennial, herb or shrub, 0.2-0.3 m high, stems zigzag, white flowers	Oct												
Thryptomene wittweri	Spreading or rounded shrub, 0.5–1.5(–2.1) m high	Apr/Jul/Aug												
P1														
Abutilon sp. Pritzelianum (S. van Leeuwen 5095)	Erect shrub to 3 m, yellow or orange flowers	Jun-Nov												
Acacia leeuweniana	Narrow, obconic tree, to 14 m high, bark minni ritchi	Apr-May												
Bothriochloa decipiens var. *cloncurrensis*	Perennial grass to 1.4 m high	May												
Brachyscome sp. Wanna Munna Flats (S. van Leeuwen 4662)	Annual herb to 40 cm, purple/blue/white/pink flowers	Mar-Sep												
Calotis squamigera	Procumbent annual, herb, to 0.21 m high	Jul												
Eragrostis sp. Mt Robinson (S. van Leeuwen 4109)	Tussock-forming perennial, grass-like or herb, to 0.3 m high	Sep												
Eremophila sp. Hamersley Range (K. Walker KW 136)	Shrub to 2 m tall, rounded crowded canopy, Flowers white-cream-yellow-pink-purple	Aug-Sep												
Eremophila sp. Snowy Mountain (S. van Leeuwen 3737)	Shrub to 1 m high, rounded	-												
Eremophila sp. West Angelas (S. van Leeuwen 4068)	Spindly shrub to 3 m high	Sep												
Eremophila spongiocarpa	Compact, succulent-leaved shrub, to 1 m high	May/Sep												
Eucalyptus lucens	Mallee, to 4.5 m high, bark smooth, white, sometimes slightly powdery; leaves glossy green	Jan-Apr												
Euphorbia inappendiculata var. *queenslandica*	Prostrate annual herb to 5 cm	May-Aug												
Helichrysum oligochaetum	Annual herb to 25 cm, yellow flowers	Aug-Nov												
Heliotropium muticum	Ascending to spreading perennial herb to 0.3 m, white flowers	May-Nov												
Hibiscus sp. Mt Brockman (E. Thoma ET 1354)	Shrub to 2.5 m high, purple flowers	Jul-Sep												
Josephinia sp. Marandoo (M.E. Trudgen 1554)	Erect shrub or herb, to 30 cm, pink flowers	Aug												
Nicotiana heterantha	Annual or short-lived perennial herb to 0.5 m. White-cream flowers	Mar-Sep												

SPECIES NAME	Description	FL. PERIOD	J	F	M	A	M	J	J	A	S	O	N	D
Senna sp. Millstream (E. Leyland s.n. 30/8/1990)	Open shrub to 1.2 m high	Aug												
Sida sp. Hamersley Range (K. Newbey 10692)	Open shrub to 2 m, yellow flower. Discolorous leaves with white margins	Apr-Oct												
Sporobolus pulchellus	Ephemeral grass to 0.4 m high	Feb-Nov												
Tephrosia rosea var. Port Hedland (A.S. George 1114)	Erect or sprawling shrub, maroon-red-purple or pink flowers	Mar-Oct												
Tetratheca fordiana	Dwarf shrub, 0.3–0.4 m high	Jul												
Teucrium pilbaranum	Rounded shrub, to 0.4 m high, white flowers	May-Sep												
Triodia sp. Karijini (S. van Leeuwen 4111)	Hummock grass to 1 m high	May-Sep												
Vittadinia sp. Coondewanna Flats (S. van Leeuwen 4684)	Tall daisy to 1 m , open canopy, in late flower and dehiscing fruit, cream/white flowers	May/Sep												
P2														
Adiantum capillus-veneris	Rhizomatous, perennial, herb (fern), 0.1-0.2 m high	-												
Cladium procerum	Densely tufted perennial, grass-like or herb (sedge), 2 m high	Nov												
Eremophila forrestii subsp. Pingandy (M.E. Trudgen 2662)	Low shrub 0.5 m tall with red or pinky flowers with long exerted stamens	May-Jul												
Euphorbia australis var. *glabra*	Annual herb	-												
Euphorbia inappendiculata var. *inappendiculata*	Herb to 2 cm high	May-Jun												
Hibiscus sp. Gurinbiddy Range (M.E. Trudgen MET 15708)	Spindly upright shrub to 3 m tall	May-Aug												
Ipomoea racemigera	Creeping annual herb, climber, white flowers	Apr												
Oxalis sp. Pilbara (M.E. Trudgen 12725)	Small herb to 10 cm tall. Leaves green above, purple below; yellow flowers	May/Sep												
Paspalidium retiglume	Annual grass to 0.5 m high	Apr-May												
Pentalepis trichodesmoides subsp. *hispida*	Spreading shrub to 1.3 m high x 2 m wide, yellow flowers	Apr-Dec												
Pilbara trudgenii	Gnarled, aromatic shrub, to 1 m high	Sep												
Scaevola sp. Hamersley Range basalts (S. van Leeuwen 3675)	Shrub, to 1 m high	Jul-Aug.												
Spartothamnella puberula	Shrub, 0.35–1.5 m high, blue-white flowers	Sep-Nov												
Trianthema sp. Python Pool (G.R. Guerin & M.E. Trudgen GG 1023)	Low succulent herb with pink-white flowers	Mar-Jul												
Vigna sp. central (M.E. Trudgen 1626)	Prostrate creeper 50 cm high x 50 cm wide	Jan-Oct												
P3														

SPECIES NAME	Description	FL. PERIOD	J	F	M	A	M	J	J	A	S	O	N	D
Acacia daweana	Spreading shrub, 0.3–1.5(–2) m high	Jul-Sep												
Acacia subtiliformis	Spindly, slender, erect shrub, to 3.5 m high	Jun												
Astrebla lappacea	Tufted perennial, grass, 0.1–0.5 m high	Apr												
Calotis latiuscula	Erect herb, to 0.5 m high	Jun-Oct												
Dampiera anonyma	Multistemmed perennial, herb, to 0.5(-1) m high, purple flowers	Jun-Sep												
Dampiera metallorum	Rounded, multistemmed perennial, herb, to 0.5 m high	Apr-Oct												
Eragrostis crateriformis	Annual, grass-like or herb, 0.17–0.42 m high	Jan-Jul												
Eragrostis surreyana	Tufted annual herb 5-8 (-13) cm high	May-Sep												
Eremophila magnifica subsp. *velutina*	Shrub, 0.5–1.5 m high, purple flowers	Aug-Sep												
Fimbristylis sieberiana	Shortly rhizomatous, tufted perennial, grass-like or herb (sedge), 0.25–0.6 m high	May-Jun												
Geijera salicifolia	Tree, 1.5–6 m high	Sep												
Glycine falcata	Mat-forming perennial, herb, to 0.2 m high. Fl. blue, purple	May-Jul												
Goodenia sp. East Pilbara (A.A. Mitchell PRP 727)	Open, erect annual or biennial, herb, to 0.2 m high, yellow flowers	Feb-Sep												
Gymnanthera cunninghamii	Erect shrub 1-2 m high, cream-yellow-green flowers	Jan-Dec												
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Erect shrub to 2.3 m high, red-pink flowers	Jul-Oct												
Indigofera sp. Gilesii (M.E. Trudgen 15869)	Shrub, to 1.5 m high, dull pink flowers	May/Aug												
Iotasperma sessilifolium	Erect herb. Fl. pink.	May-Sep												
Oldenlandia sp. Hamersley Station (A.A. Mitchell PRP 1479)	Spreading annual, herb, 0.05–0.1 m high	Mar												
Olearia mucronata	Densely branched, unpleasantly aromatic shrub, 0.6–1 m high. Fl. white, yellow	Aug-Jan												
Owenia acidula	Small tree to 8 m high, pendulous branches	Apr-Sep												
Pleurocarpaea gracilis	Rounded shrub, to 0.4 m high	Oct												
Polymeria distigma	Prostrate herb, pink flowers	Apr-Jul												
Ptilotus subspinescens	Compact shrub, to 0.8 m high. Fl. pink	Sep–Oct												
Rhagodia sp. Hamersley (M. Trudgen 17794)	Erect shrub	Apr-Nov												
Rostellularia adscendens var. *latifolia*	Herb or shrub, 0.1–0.3 m high, purple flowers	Apr-May												
Sida sp. Barlee Range (S. van Leeuwen 1642)	Spreading shrub, to 0.5 m high	Aug												
Solanum albostellatum	Sub-shrub to 40 cm, mauve flowers	Mar-May												

SPECIES NAME	Description	FL. PERIOD	J	F	M	A	M	J	J	A	S	O	N	D
Solanum kentrocaule	Shrub to 1.5 m high, extremely prickly. Purple flowers	Jul-Oct							■	■	■	■		
Stackhousia clementii	Herb or shrub to 45 cm high, yellow-brown flowers	Apr-Oct				■	■	■	■	■	■	■		
Swainsona thompsoniana	Prostrate annual, herb, to 0.1 m high	Mar			■									
Themeda sp. Hamersley Station (M.E. Trudgen 11431)	Tussocky perennial, grass-like or herb, 0.9-1.8 m high	Aug				■	■	■	■	■				
Triodia sp. Mt Ella (M.E. Trudgen 12739)	Perennial, grass-like or herb, 0.4 m high	May-Aug					■	■	■	■				
Triodia sp. Robe River (M.E. Trudgen et al. MET 12367)	Perennial hummock grass to 0.6 m high	Feb-Oct		■	■	■	■	■	■	■	■	■		
Vigna sp. rockpiles (R. Butcher et al. RB 1400)	Annual climbing herb, yellow flowers	Mar-Jun			■	■	■	■	■	■	■	■		
P4														
Acacia bromilowiana	Tree or shrub, to 12 m high	Jul-Aug							■	■				
Eremophila magnifica subsp. *magnifica*	Shrub, 0.5-1.5 m high	Aug-Nov								■	■	■	■	
Goodenia nuda	Erect to ascending herb, to 0.5 m high Fl. yellow	Apr-Aug				■	■	■	■	■				
Livistona alfredii	Palm to 10 m high	Jun-Sep						■	■	■	■			
Rhynchosia bungarensis	Compact, prostrate shrub, to 0.5 m high	Mar-Nov			■	■	■	■						
Significant according to *Guidance Statement No. 51*														
Unnamed *Josephinia* sp.	Annual? low rounded hairy shrub 40-50 cm high, pink flowers	May					■							