Ninga
Vegetation and Flora Assessment

April 2013

Prepared for
BHP Billiton Iron Ore Pty Ltd

Astron Environmental Services
129 Royal Street
East Perth WA 6004
Phone: (08) 9421 9600
Fax: (08) 9421 9699
Email: perth@astron.com.au

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Abbreviations

Abbreviation	Definition
Astron	Astron Environmental Services
BAM Act	*Biosecurity and Agriculture Management Act 2007*
BHPBIO	BHP Billiton Iron Ore Pty Ltd
BOM	Bureau of Meteorology
CALM	Department of Conservation and Land Management
DRF	Declared rare flora (listed under State *Wildlife Conservation Act 1950*) also referred to as 'threatened flora'
DEC	Department of Environment and Conservation (Note: the Department of Parks and Wildlife and the Department of Environment Regulation commenced operations on 1 July 2013 following the separation of the former Department of Environment and Conservation)
DSEWPAC	Department of Sustainability, Environment, Water, Population and Communities
EPA	Environmental Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
ESA	Environmentally Sensitive Area
H	High reservation priority (Kendrick 2001)
ha	Hectare
IBRA	Interim Biogeographic Regionalisation for Australia
IPP	Invasive Plant Prioritisation
M	Medium reservation priority (Kendrick 2001)
m	Metres
mm	Millimetres
MNES	Matters of National Environmental Significance
NVIS	Native Vegetation Information System
km	Kilometre
P1	Priority one
P3	Priority three
P4	Priority four
PEC	Priority ecological community
sp.	Species (singular)
spp.	Species (plural)
subsp.	Subspecies
TEC	Threatened ecological community
VU	Vulnerable
WONS	Weeds of National Significance

Executive Summary

BHP Billiton Iron Ore Pty Ltd is planning to undertake exploratory drilling in a project area at the eastern end of the Ophthalmia Range. Some clearing of native vegetation is required for exploration drilling sites.

Astron Environmental Services was commissioned to undertake a Level 2 vegetation and flora survey in a 3898.32 hectare area, located approximately 20 kilometres east of Newman. The survey is within mining lease ML244SA to support an application for a Native Vegetation Clearing Permit prior to the commencement of the drilling program. The field survey was conducted between 14 to 22 April 2013, in accordance with the requirements of the Environmental Protection Authority's *Position Statement 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection* (2002) and *Guidance Statement 51: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia* (2004). The survey was also conducted in accordance with BHP Billiton Iron Ore's (2010) *Guidance for Flora and Vegetation Surveys.*

Numerous vegetation, flora and biological surveys have previously been conducted within, or in close proximity to, the survey area. In this survey, 32 permanent quadrats and eight relevés were sampled from representative vegetation types. Twenty-three vegetation associations from 11 broad floristic formations were mapped within the survey area. No threatened or priority ecological communities listed under state or Federal legislation were recorded within the survey area.

Two vegetation associations analogous to ecosystems listed as being 'at risk - vulnerable' within the Hamersley subregion were recorded in the survey area (Kendrick 2001). These ecosystems were

- Valley floor mulga (analogous to vegetation association 1a and 11c)
- All major ephemeral water courses (analogous to vegetation association 6a).

The survey area contained one major ephemeral watercourse (Fortescue River), containing vegetation considered to be in 'degraded' condition. *Acacia aneura* was recorded from 17 sites in the survey area. This species was recorded from vegetation occurring on broad plains and along creeks and was considered to be in 'excellent' condition. High quality examples of these ecosystems are considered to be at a high risk of deterioration in the Hamersley subregion and are considered to be of high conservation value (Kendrick 2001).

Three vegetation associations recorded in the survey area are analogous to vegetation association/ecosystems described by Beard (1975) as having medium or high reservation priority in the Hamersley subregion:

- Medium woodland; coolibah and river gum (high reservation priority, analogous to vegetation association 6a)
- Low woodland; mulga (*Acacia aneura*) (medium reservation priority, analogous to vegetation association 11c and 1a)
- Hummock grasslands, shrub steppe; kanji over soft spinifex (medium reservation priority, analogous to vegetation association 7b).

Vegetation condition ranged from 'excellent' to 'degraded'. The survey area occurs on a mining lease; is in close proximity to mining operations; and is adjacent to the Marble Bar Road. As such, the survey area has been impacted by historical drilling, clearing for infrastructure, construction camps, weeds and grazing. Sites considered to be in 'degraded' condition were all associated with minor drainage systems, river systems or floodplains.

Below mean annual rainfall was recorded at Newman Aero weather station in the 12 months preceding the survey.

A total of 227 vascular flora species representing 110 genera and 38 families were recorded from the survey area. Species richness per quadrat and relevé ranged from 13 to 63 taxa, and averaged 31 taxa. No flora listed as threatened under state or Federal legislation was recorded in the survey area. Three state-listed priority species have been recorded within the survey area during previous surveys: *Aristida jerichoensis* var. *subspinulifera* (Priority 1) (Outback Ecology Services 2009a), *Gymnanthera cunninghamii* (Priority 3 (P3)) (ENV Australia 2006) and *Isotropis parviflora* (Priority 2) (Ecologia Environment 2004); however none were recorded during the current survey.

Ten introduced flora species were recorded within the survey area: **Bidens bipinnata*, **Cenchrus ciliaris*, **C. setiger*, **Chloris barbata*, **Cynodon dactylon*, **Echinochloa colona, **Malvastrum americanum*, **Setaria verticillata, **Sonchus oleraceus* and **Vachellia farnesiana*. None of these weed species are a Weed of National Significance or a declared pest under the *Biosecurity and Agriculture Management Act* 2007. Eight recorded introduced species are listed as having a high ecological impact and rapid rate of invasiveness within the Pilbara region (DEC 2011).

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1 Introduction

1.1 Project background

BHP Billiton Iron Ore Pty Ltd (BHPBIO) is planning to undertake exploratory drilling in a project area at the eastern end of the Ophthalmia Range. BHPBIO require a Level 2 (one season) vegetation and flora survey to support an application for a Native Vegetation Clearing Permit prior to the commencement of the drilling program.

BHPBIO commissioned Astron Environmental Services (Astron) to undertake the Level 2 survey in a 3898.32 hectare (ha) area, located approximately 20 kilometres (km) east of Newman, within mining lease ML244SA. The proposed project is known as 'Ninga' and is hereafter referred to as the 'survey area' (Figure 1 and Figure 2).

1.2 Scope and Objectives

The scope and objectives of the Ninga vegetation and flora survey are as follows:

1. A comprehensive flora and vegetation literature and database review for the survey area that will determine the likelihood of potential conservation significant species and communities being present, including review of:
    i. threatened flora listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
    ii. declared rare (threatened) flora (DRF) listed under the *Western Australian Wildlife Conservation (Rare Flora) Notice 2012 (2)*
    iii. priority flora recognised by the Department of Environment and Conservation (DEC)
    iv. threatened ecological communities (TECs) listed under State and Federal legislation
    v. priority ecological communities (PECs) recognised by the DEC
    vi. Environmentally Sensitive Areas (ESA) declared under section 51B of the *Environmental Protection Act 1986* recognised by the DEC.

    This will also include a summary of previous flora and vegetation surveys undertaken within, or within the vicinity of, the study area, including those listed in the supporting information.

2. Carry out a targeted survey within the survey area for:
    vii. threatened flora listed under the EPBC Act
    viii. DRF listed under the latest WA *Wildlife Conservation (Rare Flora) Notice 2012 (2)*
    ix. priority flora recognised by the DEC
    x. TECs listed under the EPBC Act
    xi. TECs endorsed by the Western Australian Minister for the Environment
    xii. PECs recognised by the DEC
    xiii. declared pests (weeds) listed under the *Biosecurity and Agriculture Management Act 2007* (BAM Act).

    For each of these recorded, the following will be provided:

xiv. GPS co-ordinate locations (provided as points for individual plants or polygons for populations)

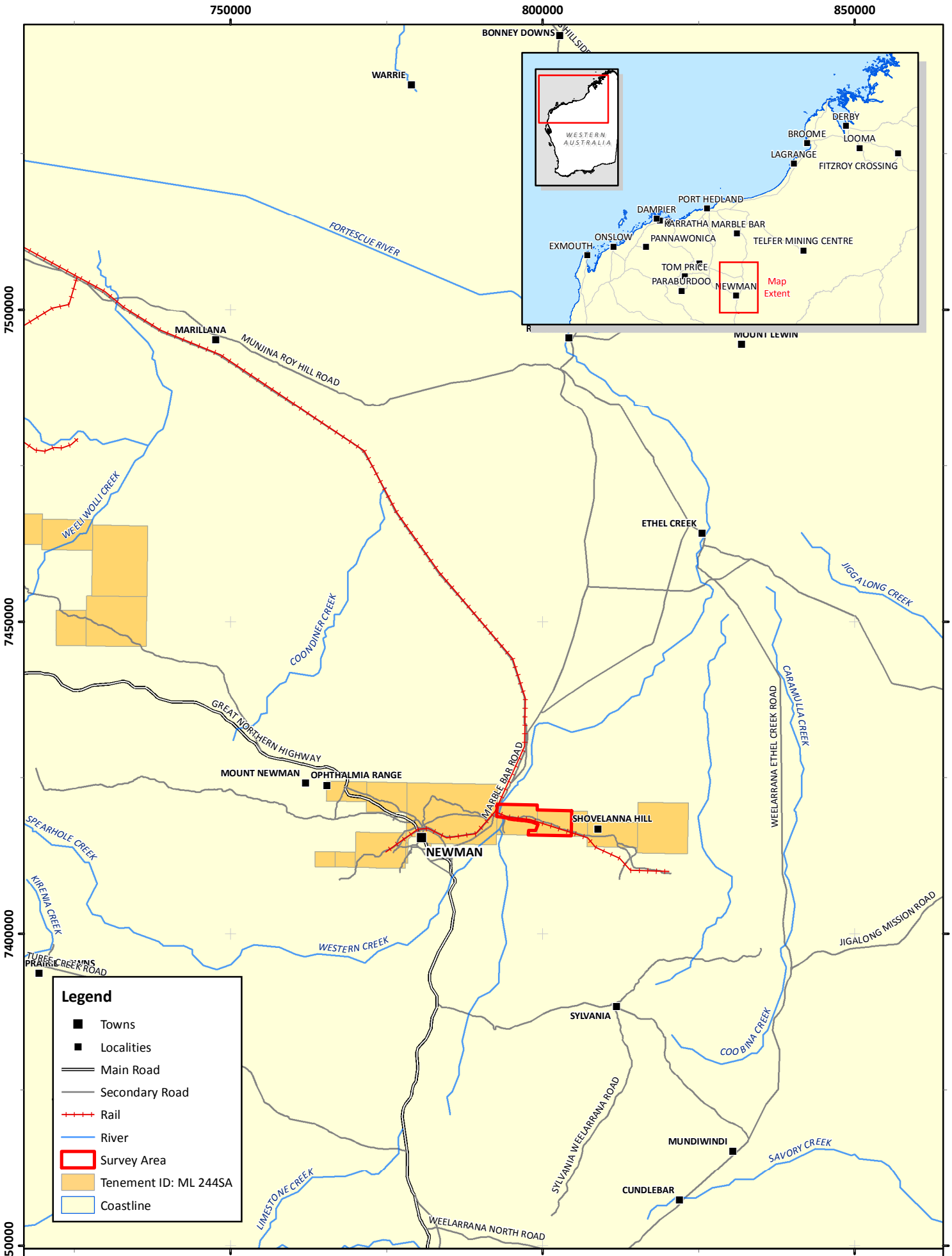
xv. description of vegetation association to Native Vegetation Information System (NVIS) Level V (according to the BHPBIO '*Guidance for Vegetation and Flora Surveys*') in which the species is located

xvi. estimation of population size

xvii. photograph of the plant in situ

xviii. reference specimen, which is to be lodged with the BHPBIO sponsored botanist at the WA Herbarium for verification.

3. Provide details on all conservation significant flora (threatened and priority flora) and weeds recorded in the survey area, including those recorded during previous surveys.
4. Provide a description and map of main vegetation associations present in the survey area, according to the BHPBIO guidelines, including an assessment of the regional distribution of the vegetation association.
5. Describe and map the condition of vegetation of areas using the rating scale in accordance with the Bush Forever Volume 2, Directory of Bush Forever Sites (Government of Western Australia 2000).



BHP Billiton Iron Ore Pty Ltd
Ninga Vegetation and Flora Survey

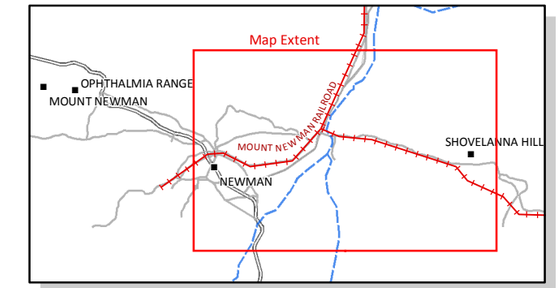
Figure 1: Survey Area Regional Location

astron environmental services

Author: A. Bott	Date: 09-07-2013
Drawn: C. Dyde	Figure Ref: 2438-13-GDR-1RevA_20130709_Fig01_RegLocn

780000 785000 790000 795000 800000 805000 810000

7425000 7420000 7415000 7410000



MOUNT NEWMAN RAILROAD

OREBODY 25 ACCESS RD

COLLEY RD

NEWMAN

GILES AV

NEWMAN DR

DANIELS DR

NANBAISTU

TAMAGAN DR

WELSHPOOL

GUN CLUB RD

GREAT NORTHERN HWY

MARBLE BAR RD

DAM ACCESS RD

FORTESCUE RIVER

BILLABONG ACCESS

DIEWAR AV

WARRAWANDA CREEK

SHOVELANNA HILL

Legend

- Locations
- Road
- Rail
- River
- Survey Area
- Warrawandu Village
- Tenement ID: ML 244SA

BHP Billiton Iron Ore Pty Ltd
Ninga Vegetation and Flora Survey

Figure 2: Survey Area Regional Location

Datum: GDA 1994 - Projection: MGA Zone 50

0 1 2 3 4 5 Kilometres

N

astron environmental services

Author: A. Bott | Drawn: C. Dyde | Date: 09-07-2013 | Figure Ref: 2438-13-GDR-1RevA_20130709_Fig02_Locn

1.3 Environmental Context

1.3.1 Climate

The survey area occurs predominantly in the Pilbara region of Western Australia. The Pilbara has an arid-tropical climate with two distinct seasons; a hot and wet summer from October to April, and a mild and drier season from May to September. Summer rainfall is typically associated with tropical cyclones which develop over warm tropical waters between December and March and often track south-west along the Pilbara coast, or turn inland across the Pilbara bringing destructive winds, widespread rain and flooding (Payne and Tille 1992). Winter rainfall is commonly the result of cold fronts moving north-easterly across the State.

The nearest Bureau of Meteorology (BOM) weather station to the survey area is Newman Aero, located approximately 15 km to the south west of the survey area.

1.3.2 Geology and landforms

The survey area occurs in the Hamersley subregion at the southern end of the Pilbara Craton (Kendrick 2001). The Hamersley subregion consists of mountainous areas of Proterozoic sedimentary ranges and plateaux, dissected by jaspilite, shale and dolerite gorges. The Hamersley Ranges are the most prominent mountainous area in WA and at its eastern end it joins the Ophthalmia Range. The ranges are dominated by skeletal soils (Tille 2006). The survey area is located at the eastern end of the Ophthalmia Range, which is dominated by the Brockman Iron Formation and composed of chert, ferruginous chert and minor shale bands.

1.3.3 Wetlands and Watercourses

Within the Hamersley subregion, drainage flows into the Fortescue River (to the north), the Ashburton River (to the south), or the Robe River (to the west). The Fortescue River dissects the north-west corner of the survey area (Figure 1). The Fortescue River is an ephemeral drainage system that originates in the Ophthalmia Ranges and discharges 760 km away at Mardie Station, 40 km south of Dampier.

One Wetland of National Significance, Karijini (Hamersley Range) Gorges, is listed as occurring in the Hamersley subregion (Kendrick 2001). Karijini National Park is 130 km north-west of the survey area.

The Fortescue Marsh is an episodically inundated samphire marsh that is approximately 100 km long and 10 km wide and represents the terminus of the upper Fortescue River (Kendrick 2001). The survey area is approximately 70 km from the outer edges of the Fortescue Marsh. The Fortescue Marsh is listed in the Directory of Important Wetlands in Australia (Department of Sustainability, Environment, Water, Population and Communities (DSEWPAC) 2011) under categories B4 and B6.

The Warrawandu Creek flows through Ophthalmia Dam on its way to joining the Fortescue River, just south of the survey area. It has no named tributaries but is itself a tributary of the Fortescue River.

The survey area is not part of a Ramsar listed site.

1.3.4 Conservation Reserves

Within the Pilbara bioregion, 7.75% of the land is under some form of conservation tenure, while 14.1% of the Hamersley subregion is set aside for conservation. The subregion contains virtually all of Karijini National Park (except for Dales Gorge because of mining interests), and the eastern half of

the Cane River Conservation Park. The survey area is not within any gazetted conservation reserve. Karijini is the closest gazetted conservation reserve, located 130 km north-west of the survey area.

1.3.5 Land Systems

A land system is an area with a recurring pattern of topography, soils and vegetation (Christian and Stewart 1953). The land system approach to mapping different country types has been used in all Western Australian regional rangelands surveys. The biophysical resources, including soil and vegetation condition, of the Pilbara region were surveyed between 1995 and 1999, resulting in the delineation of 20 land types comprising 102 land systems (van Vreeswyk et al. 2004). Six of these land systems occur within the survey area (Table 1).

Table 1: Distribution of land systems within the survey area and the Pilbara bioregion (van Vreeswyk et al. 2004).

Land system	Total area (ha) in the Pilbara bioregion	Proportion (%) of Pilbara bioregion	Total area within the survey area	Proportion (%) of survey area	Proportion (%) of Pilbara region total area in the survey area
Boolgeeda	961847.05	<0.01	1048.54	26.90	0.11
Divide	436649.20	3.52	0.63	0.02	<0.01
Newman	1994339.47	<0.01	2638.03	67.67	0.13
River	481993.95	<0.01	160.89	4.13	0.03
Rocklea	2880288.28	2.41	4.30	0.11	<0.01
Washplain	66276.09	<0.01	45.92	1.18	0.07

The majority of the survey area (67.67%) is comprised of the Newman land system. A summary of these land systems in relation to geology, soils, landform and vegetation is presented in Table 2. Land systems mapping is presented in Appendix A.

Table 2: Summary of Pilbara region land systems located within the survey area (van Vreeswyk et al. 2004).

Land system	Landforms	Soils	Vegetation
Boolgeeda (stony lower slopes, plains below hill systems)	Low hills and rises	Stony soils and red shallow loams.	Hummock grasslands of *Triodia wiseana* (hard spinifex) and other *Triodia* species (spp.) with very scattered *Acacia* shrubs.
	Stony slopes and upper plains	Red shallow loams or red loamy earths.	Hummock grassland of *Triodia lanigera*, *T. wiseana* (hard spinifex) or scattered shrubs of *Acacia aneura*, *A. ancistrocarpa*, *A. atkinsiana* and other *Acacia* species, occasional eucalypt trees and prominent hard spinifex ground layer.
	Stony lower plains	Red loamy earths.	Hummock grassland of hard *Triodia* spp. Also scattered/moderately closed tall shrubland of *Acacia aneura* and other *Acacia* spp. with hard and soft *Triodia* ground layer.
	Groves	Red loamy earths.	Moderately closed woodland or tall shrubland of *Acacia aneura* with sparse low shrubs and tussock grasses.
	Narrow drainage floors and channels	Red loamy earths and minor self-mulching cracking clays. Channels with river bed soils.	Scattered to close tall shrublands/woodlands of *Acacia aneura*, *A. atkinsiana* and *Corymbia hamersleyana* with sparse low shrubs and hummock/tussock grasses. Occasionally hummock grasslands of *Triodia pungens*.
Divide (sandplains and occasional dunes supporting shrubby hard spinifex grasslands)	Low hills	Stony soils and red shallow sands.	Hummock grasslands of *Triodia* spp. (hard spinifex).
Divide (sandplains and occasional dunes supporting	Sand dunes	Red deep sands.	Hummock grasslands of *Triodia melvillei* (hard spinifex) or *T. schinzii* (soft spinifex) with numerous shrubs including *Grevillea* and *Acacia* spp.

Land system	Landforms	Soils	Vegetation
shrubby hard spinifex grasslands)	Sandplains	Red deep sands and red sandy earths.	Hummock grasslands of *Triodia lanigera, T. basedowii* (hard spinifex) with *Acacia* spp. and other shrubs, occasional mallee eucalypts. Occasionally *T. schinzii* (soft spinifex).
	Plains with thin sand cover	Red shallow sands and shallow gravel soils.	Hummock grasslands of *Triodia lanigera, T. wiseana* (hard spinifex) or scattered to moderately close tall shrublands including *Acacia aneura* (mulga) with hard spinifex ground layer.
	Stony plains	Shallow gravel soils.	Hummock grasslands of *Triodia lanigera, T. wiseana* (hard spinifex) or scattered to moderately close tall shrublands including *Acacia aneura* (mulga) with hard spinifex ground layer.
	Tracts receiving run-on	Red sandy earths with minor river bed soils.	Scattered to close tall shrublands of *Acacia aneura, A. kempeana* (witchetty bush) and low shrubs such as *Eremophila forrestii* (Wilcox bush) and ground layer *Triodia* spp. (spinifex) and *Monachather paradoxa* (broad leaved wanderrie).
Newman (rugged jaspilite plateaux, ridges, mountains)	Plateaux, ridges, mountains and hills	Stony soils and red shallow loams with some red shallow sands.	Hummock grassland of mixed hard *Triodia* with very scattered/scattered shrubs and trees including *Acacia* and *Senna* spp., *Grevillea wickhamii*, and mixed *Eucalyptus*. Occasionally soft hummock grassland.
	Lower slopes	Stony soils on upper margins with red loamy earths on lower margins.	Hummock grassland of mixed hard *Triodia* with very scattered/scattered shrubs and trees including *Acacia* and *Senna* spp., *Grevillea wickhamii*, and mixed *Eucalyptus*.
Newman (rugged jaspilite plateaux, ridges, mountains)	Stony plains	Stony soils with red shallow loams and some red loamy earths.	Hummock grassland of hard *Triodia* with isolated/very scattered shrubs of *Acacia* and *Senna* spp. and occasional *Eucalyptus* trees. Occasionally soft *Triodia* hummock grassland.

Land system	Landforms	Soils	Vegetation
	Narrow drainage floors with channels	Red shallow loams and red loamy earths. Channels with river soils.	Smaller floors support *Triodia* hummock grassland with very scattered shrubs. Larger floors and channels support tall *Acacia* spp. shrublands/woodlands and *Eucalyptus victrix* with tussock or hummock grass understorey.
River (active flood plains and major rivers supporting grassy eucalypt woodlands, tussock grasslands and soft spinifex grasslands)	Sandy levees and sand sheets	Mostly red deep sands with red sandy earths, red loamy earths and some river bed soils.	Hummock grasslands of *Triodia pungens* (soft spinifex) with very scattered to moderately close shrubs such as *Acacia trachycarpa* (miniritchie) and *A. inaequilatera* (kanji). Tussock grasslands of **Cenchrus ciliaris* (buffel grass), *Eragrostis eriopoda* (woolly butt) with very scattered to scattered acacia shrubs and trees or open eucalypt woodlands with grass understorey of **C. ciliaris.*
	Upper terraces	Red deep sands.	Hummock grasslands of *Triodia* spp. (hard spinifex) or *T. pungens* (soft spinifex) frequently with no shrubs, occasionally isolated to very scattered *Acacia* spp. shrubs and trees such as *Hakea suberea* (corkwood).
River (active flood plains and major rivers supporting grassy eucalypt woodlands, tussock grasslands and soft spinifex grasslands)	Flood plains and lower terraces	Deep red/brown non-cracking clays and red loamy earths.	Tussock grasslands of **Cenchrus ciliaris* (buffel grass) or hummock grasslands mainly of *Triodia pungens* (soft spinifex). Also scattered to Moderately close *Eucalyptus victrix* (coolibah) or acacia woodlands/tall shrublands with prominent tussock grass understorey of **C. ciliaris, Chrysopogon fallax* (ribbon grass), *Eulalia aurea* (silky brown top) and others or hummock grass understorey of *Triodia pungens*.
	Stony plains	Red shallow loams and red shallow sands.	Hummock grasslands of *Triodia* spp. (soft and hard spinifex) with very scattered to scattered acacia shrubs. Also woodlands/tall shrublands with *Eucalyptus victrix, Acacia* spp. and tussock and hummock grasses.

Land system	Landforms	Soils	Vegetation
	Minor and major channels	River bed soils.	Channels - no vegetation. Banks - close or closed fringing woodlands with *Eucalyptus camaldulensis* (river red gum), *E. victrix, Melaleuca argentea* (cadjeput), *M. glomerata, Sesbania formosa* (white dragon tree), *Acacia coriacea* (river jam) with understorey of sedges and grasses including *Cyperus vaginatus, *Cenchrus ciliaris* and *Triodia pungens* .
Robe (low limestone mesas and buttes)	Low plateaux, mesas and buttes	Stony soils and shallow gravel soils.	Hummock grasslands of *Triodia pungens* (soft spinifex) with isolated to scattered *Acacia* and *Senna* spp. shrubs and occasional *Eucalyptus leucophloia* (snappy gum) trees.
Robe (low limestone mesas and buttes)	Lower slopes	Red shallow loams and minor calcareous shallow loams.	Hummock grasslands of *Triodia wiseana, T. longiceps* (hard spinifex) with isolated to very scattered *Acacia* and *Senna* spp. shrubs. Occasionally hummock grasslands of *T. pungens* (soft spinifex).
	Gravelly plains	Red loamy earths.	Hummock grasslands of *Triodia wiseana, T. longiceps* (hard spinifex) with isolated to very scattered *Acacia* and *Senna* spp. shrubs. Occasionally hummock grasslands of *T. pungens* (soft spinifex).
	Drainage floors and channels	Red loamy earths. Channels with river bed soils.	Hummock grasslands of *Triodia pungens* with very scattered to moderately close *Acacia* spp. shrubs. Also moderately close eucalypt or acacia woodlands/tall shrublands with *T. pungens* understorey.
Rocklea (basalt hills, plateaux, lower slopes and minor stony plains)	Hills, ridges, plateaux and upper slopes	Stony soils, red shallow loams and calcareous shallow loams.	Hummock grasslands of *Triodia wiseana, Triodia* spp. (hard spinifex) or, less frequently, of *T. pungens* (soft spinifex) with isolated to very scattered shrubs such as *Acacia inaequilatera* (Kanji) and *Senna* spp.

Land system	Landforms	Soils	Vegetation
	Lower slopes	Red shallow loams and red shallow sandy duplex soils.	Hummock grasslands of *Triodia wiseana, Triodia* spp. (hard spinifex) or, less frequently, of *T. pungens* (soft spinifex) with isolated to very scattered shrubs such as *Acacia inaequilatera* (Kanji) and *Senna* spp.
	Stony plains and interfluves	Calcareous shallow loams, red sandy earths and shallow red/brown non-cracking clays.	Hummock grasslands of *Triodia wiseana* or, less frequently, *T. pungens* with isolated to very scattered shrubs such as *Acacia inaequilatera.* Occasionally grassy shrublands with *Acacia, Senna* and *Eremophila* spp.
Rocklea (basalt hills, plateaux, lower slopes and minor stony plains)	Gilgai plains	Self-mulching cracking clays.	Tussock grasslands with *Astrebla pectinata* (barley Mitchell grass), *Eragrostis xerophila* (Roebourne Plains grass) and other perennial grasses.
	Upper drainage lines	Red shallow sands and calcareous shallow loams. Channels with river bed soils.	Hummock grasslands of *Triodia wiseana* or *T. pungens* with very scattered to scattered *Acacia* shrubs and occasional *Corymbia hamersleyana* (Hamersley bloodwood) trees.
	Drainage floors and channels	Red loamy earths with red shallow sandy duplex soils and red/brown non-cracking clays.	Scattered to moderately close tall shrublands or woodlands of *Acacia* and *Eucalyptus* spp. with numerous undershrubs and hummock grass understoreys or tussock grass understoreys.
Washplain (hardpan plains supporting groved mulga shrublands)	Stony plains	Red loamy earths, deep red/brown non-cracking clays and minor self-mulching cracking clays.	Very scattered shrublands of *Acacia aneura* (mulga), *Senna* and *Eremophila* spp. and occasional tussock grasses.
	Alluvial hardpan plains	Red deep sandy duplex and red deep loamy duplex soils.	Herbfields with isolated shrubs or very scattered to scattered shrublands of *Acacia aneura, Eremophila cuneifolia* (royal poverty bush), other *Eremophila spp.*, *Senna* spp. and small *Maireana* spp..

Land system	Landforms	Soils	Vegetation
	Groves	Red loamy earths and deep red/brown non-cracking clays.	Moderately close to closed *Acacia aneura* woodlands or tall shrublands with numerous undershrubs and scattered grasses such as *Chrysopogon fallax* (ribbon grass) and *Digitaria coenicola.*
Washplain (hardpan plains supporting groved mulga shrublands)	Sandplains	Red deep sands.	Hummock grasslands of *Triodia* spp. (soft and hard spinifex) with very scattered or scattered shrubs.
	Tracts receiving more concentrated through flow	Red deep loamy duplex soils and red loamy earths.	Moderately close to closed woodlands or tall shrublands of *Acacia aneura* with scattered low shrubs and occasional perennial grasses.

1.3.6 Bioregional Summaries

Interim Biogeographic Regionalisation for Australia

The Interim Biogeographic Regionalisation for Australia (IBRA) is a landscape-based approach to classifying the land surface, including attributes of climate, geomorphology, landform, lithology, and characteristic flora and fauna. Specialist ecological knowledge combined with appropriate regional and continental scale biophysical datasets were interpreted to define and describe these regions (Thackway and Cresswell 1995), and information about each region is used to help determine which ecosystems are adequately protected in the conservation estate. In 2012 the regionalisation was revised and updated to version 7, which divides the Australian continent into 89 bioregions and 419 subregions (DSEWPAC 2013a). The survey area is largely in the Pilbara bioregion (3780.38 ha or 97% of the survey area) and in the Gascoyne bioregion (118 ha or 3% of the survey area).

The Pilbara bioregion is divided into four subregions, the survey area occurs in the Hamersley subregion. The Hamersley subregion (Pilbara 3) consists of dissected plateaux and ranges of flat lying or moderately folded sandstone and quartzite. Vegetation has been described as mulga (*Acacia aneura*) low woodland over tussock grasses occurring on fine textured soils in valley floors, with snappy gum (*Eucalyptus leucophloia*) scattered over *Triodia brizoides* on the skeletal soils of the ranges (Kendrick 2001).

Biodiversity Audit of Western Australia

As part of the National Land and Water Resources Biodiversity Audit, the DEC (under the former Conservation and Land Management (CALM)) conducted an audit of Western Australia's terrestrial biodiversity (CALM 2002). The audit aimed to assess priority for reservation based on the subregions defined in IBRA version 5.1 (Environment Australia 2000). Approximately 14% of the Hamersley subregion is represented in the national reserve system (Kendrick 2001).

The bioregional summaries (CALM 2002) also identified ecosystems as 'low', 'medium' or 'high' depending on their priority for reservation in the conservation estate and those considered to be 'at risk' within each IBRA subregion. Some of these ecosystems listed as 'at risk' were subsequently formally gazetted as TECs under the *Wildlife Conservation Act 1950*.

1.3.7 Broad-scale Vegetation and Flora

The pre-European vegetation of Western Australia was mapped at a range of scales and summarised by Beard (1990). The vegetation was divided into three botanical provinces, based on geology and climate, and botanical districts utilising natural regions and physiographic units. Beard (1975) had previously mapped the Pilbara region at a scale of 1: 1,000,000.

The survey area occurs within the Eremaean Botanical Province, Pilbara Region (Fortescue Botanical District) which is further subdivided in the Hamersley Plateau unit based on outcropping areas of Lower Proterozoic rock formations (Beard 1975). The broad vegetation units are described as follows:

- tree steppe of snappy gum (*Eucalyptus leucophloia*) and limestone spinifex (*Triodia wiseana*) with numerous small shrubs on the plateau
- mulga (*Acacia aneura*) vegetation on the valley plains
- mulga (*Acacia aneura*) and *Triodia* spp. hummock grasslands on the basalt hills

- patches of open mulga (*Acacia aneura*) and snakewood (*A. xiphophylla*) communities, with open to medium density spinifex (*Triodia* spp.) patches on granite.

The majority of vegetation in the Pilbara is characterised by spinifex (*Triodia* spp.) hummock grasslands as the dominant stratum. Towards the south of the region, there is a transition from the grasslands that dominate in the north to Mulga (*Acacia aneura*) woodlands (Beard 1990).

The survey area comprises five pre-European vegetation associations (Beard 1975), which are summarised in Table 3 and are mapped in Appendix B.

Table 3: Summary of Beard's (1975) vegetation associations, including their extent in the Pilbara and the survey area.

Beard physiographic unit	Beard vegetation association[1]	Vegetation description	Pre-European extent in Hamersley subregion (ha) (Landgate 2011)	Proportion of pre-European extent remaining in the Hamersley subregion (%) (Landgate 2011)	Area within the survey area (ha)	Proportion of pre-European extent Pilbara bioregion in survey area (%)
Fortescue Valley	216	Low woodland; mulga (with spinifex) on rises	7457.04	96.01	1628.23	41.77
	29	Sparse low woodland; mulga, discontinuous in scattered groups	1256.06	100.00	0.11	<0.01
	82	Hummock grasslands, low tree steppe; snappy gum over *Triodia wiseana*	15047.26	98.70	1953.32	50.10
Hamersley	82.3	Hummock grasslands, low tree steppe; snappy gum over *Triodia wiseana*	2158861.81	99.44	146.69	3.76
Kumarina Hills	29	Sparse low woodland; mulga, discontinuous in scattered groups	2388.81	99.29	169.97	4.36

[1]Numbers representing the Beard vegetation association are those which have been assigned by Shepherd et al. (2002).

1.3.8 Vegetation and Flora Conservation Categories

Commonwealth and Western Australian regulatory agencies maintain databases of the locations and conservation status of significant ecological communities and flora species in Western Australia.

The EPBC Act provides a legal framework to protect and manage Matters of National Environmental Significance (MNES) including listed ecological communities and flora species. Listed ecological communities and flora species are allocated a conservation category, which are outlined in Appendices C and D.

A TEC is an ecological community that has been identified by the Minister for the Environment as being subject to processes that threaten to destroy or significantly modify it across much of its range. TECs are listed under one of four categories (DEC 2010) as outlined in Appendix C. The DEC also maintains a list of PECs. PECs are assigned one of four priority rankings according to the criteria outlined in Appendix C. Unlike TECS, PECs are not formally recognised by the Minister for Environment but are taken into consideration during environmental impact assessment by State regulators.

Under Western Australian legislation, all native floras are protected and it is an offence to 'take'. To 'take' includes the removal of seeds or injuring plants. The *Wildlife Conservation Act 1950* also provides for native plant species to be specially protected because they are under identifiable threat of extinction, are rare, or otherwise in need of special protection. Such specially protected flora is considered under the Act to be threatened (declared rare).

Due to the diversity of Western Australia's flora, many species are known from only a few collections or locations, but have not been adequately surveyed. Such flora may be rare or threatened, but cannot be considered for declaration as threatened flora until adequate surveys have been undertaken. These flora species are included on a supplementary conservation list called the Priority Flora List. Three categories of priority flora cover these poorly known species. A fourth category of priority flora includes species that have been adequately surveyed and are considered to be rare but not currently threatened and a fifth category of priority flora includes conservation dependent species. Western Australian flora conservation categories are described in Appendix D.

1.3.9 Introduced Flora Categories

The Australian Weed Strategy (Australian Weeds Committee 2012) identifies 'Weeds of National Significance' (WONS). Weeds of National Significance are invasive with the potential to impact primary industry and/or environmental and social values.

The management of introduced flora (weeds) in Western Australia is primarily regulated through the provisions of the recent BAM Act under which a list of declared pest plants (and other organisms) have been gazetted. Listed species are allocated to one of three 'control categories' and one of three 'keeping categories' to provide effective biosecurity and agriculture management for Western Australia (DAFWA 2013) (Appendix E).

The Invasive Plant Prioritisation process (IPPP) for the DEC (2011) was developed to supersede the Environmental Weed Strategy for Western Australia. The prioritisation process considers both a 'species-led' and a 'site-led' approach to priority setting for weed management on DEC managed lands. The IPP process rating system is presented in Appendix E. The prioritisation results for individual weeds within a DEC region should be utilised as a guide only and does not diminish any other requirements (statutory or otherwise) of land managers or developers, e.g. declared pest requirements under the BAM Act.

The threat and risk posed to site specific biodiversity values, influences to rehabilitation success, primary production or infrastructure assets or human health will differ depending on the unique characteristics of each site and the associated land management practice or operation. Therefore site or project specific weed assessments and priorities will need to be considered accordingly.

1.3.10 Land Tenure and Use

The survey area lies within the Shire of East Pilbara, 20 km east of the nearest town, Newman. It occurs on mining lease ML244SA and Ethel Creek Pastoral Lease and Sylvania pastoral lease (DEC 2013a).

2 Methodology

2.1 Desktop Study

2.1.1 Database Searches

A search for ESAs in the vicinity of the survey area was conducted using the Native Vegetation Map Viewer (DEC 2013b) and Register of the National Estate (spatial database (Australian Weeds Committee 2012)).

Database searches were conducted to identify listed ecological communities and flora species within, or in close proximity to, the survey area that are listed under the *Wildlife Conservation Act 1950* and the EPBC Act. The search details are summarised in Table 4.

Table 4: Details of database searches conducted.

Database name	Date search results requested	Search focus	Search area
Protected Matters Search Tool (DSEWPAC 2013b)	03 April 2013	MNES including both listed ecological communities and flora species.	40 km buffer surrounding a line from -23°17'48.01"S, 119°51'41.00"E to -23°20'25.00"S, 119°58'45.01"E.
DEC NatureMap (DEC 2013a)	03 April 2013	Western Australian listed threatened and priority flora species.	20 km buffer around a rectangle defined by the coordinates: -23°17'48"S,119°51'41"E and -23°20'25"S, 119°58'45"E.

2.1.2 Literature Review

The following reports were provided by BHPBIO and reviewed with particular reference to conservation issues including threatened and priority flora, TECs and PECs. A number of vegetation and flora surveys within the broader Ninga region have previously been conducted. Several of these vegetation and flora surveys were within, or overlapped the Ninga survey area, including:

- Onshore Environmental 2013, *Orebody 17/18 Derived Vegetation Association Mapping*, unpublished report for BHPBIO.
- Onshore Environmental 2012, *Targeted Significant Flora Survey Vegetation Mapping of Homestead Creek-Orebody 25*, unpublished report for BHPBIO.
- Syrinx Environmental 2012, *Wheelarra Hill North - Level 2 Flora and Vegetation Assessment*, unpublished report for BHPBIO.
- ENV Australia 2011a, *Eastern Ridge (OB23/24/25) Flora and Vegetation Assessment*, unpublished report for BHPBIO.
- ENV Australia 2011b, *Orebody 42/43 Flora, Vegetation and Fauna Assessment Summary Letter and Recommendations*, unpublished report for BHP Billiton Iron Pty Ltd.
- Syrinx Environmental 2011a, *BHPBIO Orebody 31 Flora and Vegetation Assessment*, unpublished report for BHPBIO.
- Syrinx Environmental 2011b, *Orebody 37 Flora and Vegetation Assessment*, unpublished report for BHPBIO.

- Outback Ecology Services 2010, *Jimblebar Iron Ore Project Flora and Vegetation Assessment*, unpublished report for BHPBIO.
- ENV Australia 2009, *Jimblebar Spur 2 Flora and Vegetation Assessment'*, unpublished report for BHPBIO.
- Biologic Environmental Science 2009, '*Newman Power Network, Level 2 Flora and Level 1 Fauna Survey*', unpublished report for BHPBIO.
- Outback Ecology Services 2009a, '*Jimblebar Linear Development Flora and Vegetation Assessment*' unpublished report for BHPBIO.
- Outback Ecology Services 2009b, *'Wheelarra Hill Accommodation Camp Flora and Fauna Assessment*', unpublished report for BHPBIO.
- ENV Australia 2008, '*Jimblebar Access Road Flora and Vegetation Assessment'*, unpublished report for BHPBIO.
- GHD 2008a, *'Report for Myopic Project Area, Newman, Flora and Fauna Assessment*, unpublished report for BHPBIO.
- GHD 2008b, *'Ninga Declared Rare and Priority Flora Survey*, unpublished letter report for BHPBIO.
- ENV Australia 2007a, *'Jimblebar Wye Rail Junction (Borrow Areas) Flora and Vegetation Assessment*', unpublished report for BHPBIO.
- ENV Australia 2007b, *'Orebody 18 Flora and Vegetation Assessment Phase 2*, unpublished report for BHPBIO.
- ENV Australia 2007c, *'West Jimblebar Exploration Lease Flora and Vegetation Assessment'*, unpublished report for BHP Billiton Pty Ltd.
- ENV Australia 2006, *'OB24 Flora and Fauna Assessment Phase 2*, unpublished report for BHPBIO.
- Ecologia Environment 2005, '*Jimblebar Wye Rail Junction Priority Flora and Riparian Vegetation Assessment*, unpublished report for BHPBIO.
- Ecologia Environment 2004, *'Eastern Ophthalmia Range Expansion Biological Survey'*, unpublished report for BHPBIO.
- Biota Environmental Sciences 2001, *'Baseline Biological and Soil Surveys and Mapping for ML244SA West of the Fortescue River*', unpublished report for BHPBIO.
- Ecologia Environment 1995, *'Orebody 18 Biological Assessment Survey'*, unpublished report for BHPBIO.

A list of ecosystems considered to be 'at risk' within each IBRA subregion was identified during the biodiversity audit of Western Australia's Biogeographic subregions. The list includes not only ecosystems considered by the DEC to be at risk, but also TECs not formally approved by the Western Australian Minister for Environment. In addition, ecosystems in each subregion were ranked as 'low', 'medium' or 'high' depending on their priority for reservation in the conservation estate (CALM 2002). To determine whether any of the ecosystems listed as being 'at risk' or of reservation priority occurred within the survey area, the vegetation associations (Beard 1975) for the area were mapped and the dominant species and structure of listed ecosystems and vegetation associations were compared to those described for the vegetation recorded within the survey area.

The Pilbara rangelands survey (van Vreeswyk et al. 2004) provided details on land systems and related background information. The Pilbara Biodiversity Audit (McKenzie et al. 2003) provided information on nature conservation issues.

The conservation significant flora listed in the reports above as occurring in close proximity to the survey area, along with those listed in databases searched (Section 2.1.1) were categorised according to the following criteria:

- potential to occur – preferable habitat identified in the survey area and previous records known to occur within the survey area or in the vicinity of the survey area
- unlikely to occur – no preferable habitat identified within the survey area.

Results of this categorisation are presented in Section 3.1.1.

2.2 Field Survey

The field survey was conducted in accordance with the requirements for a single season, Level 2 survey as outlined in the Environmental Protection Authority's (EPA) *Position Statement 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection* (2002) and EPA *Guidance Statement 51: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia* (2004). The survey was also conducted in accordance with BHPBIO's (2010) *Guidance for Flora and Vegetation Surveys.*

Information acquired during the desktop study assisted in the design of the field survey. Pre-survey planning involved the examination of 1: 10,000 scale aerial photography of the survey area. The number and location of sample sites were determined based on the following criteria:

- at least one, and where possible, a duplicate sample site should be included in each vegetation association
- the inclusion of target areas that are prospective for listed ecological communities and flora species identified during the desktop study
- the availability of safe access to the site.

The field survey was conducted over one field visit from 14 to 22 of April 2013. The field team included Alice Bott (Botanist/Team Leader) and Natalie Krawczyk (Botanist). Both Ms Bott and Ms Krawczyk are qualified and experienced in conducting Level 2 vegetation and flora surveys and have experience in the Pilbara region of Western Australia.

A total of 32 permanent quadrats, measuring 50 metres (m) x 50 m, supplemented by eight relevés (unbounded sampled sites) were surveyed in representative vegetation associations within the survey area. The north-west, south-west, north-east and south-east corners of each quadrat were aligned with the aid of an optical square and measuring tapes, and the north-west corners of 25% of the quadrats (as requested by BHPBIO) were marked with a galvanised steel fence dropper. A permanent identifying label was attached to the north-west fence dropper.

Data were recorded using standardised field sheets designed in accordance with BHPBIO Guidance (BHPBIO 2010). The following information was collected at each quadrat:

- **Location** – coordinates measured using a handheld GPS (MGA50, GDA94). One set of coordinates taken at each corner of every quadrat.

- **Recorder and date** – a list of the personnel involved in sampling the quadrat and the survey date.
- **Species** – all vascular plant species present including introduced and priority flora species. To ensure a thorough search, each quadrat was traversed systematically at approximately two metre intervals. Species that could not be identified in the field were collected for later identification at the Astron herbarium or Western Australian Herbarium.
- **Per cent foliar cover and height** – the percentage cover and height was estimated for each species.
- **Vegetation description** – vegetation was described according to Aplin's (1979) modification of the vegetation classification system of Specht (1970) based on height and percentage foliar cover of each of the strata (Appendix F).
- **Vegetation condition** – assessed according to the Vegetation Condition Classification of Keighery (1994) (Appendix F).
- **Disturbance** – any disturbance such as clearing, flooding, vehicular, machinery, tracks or grazing.
- **Fire age –** estimate of time since last fire.
- **Habitat** – a broad description of the surrounding landscape based on landform and topography according to the descriptions outlined in The National Committee on Soil and Water (2009).
- **Soils** – a brief description of soils texture and colour according to the descriptions outlined in The National Committee on Soil and Water (2009).
- **Rock type** – a brief description of rock type and size.
- **Bare ground** – proportion of quadrat that is bare ground.
- **Leaf litter** – proportion of quadrat that is leaf litter.
- **Photographs** – a photograph was taken from the north-west corner of each quadrat.

2.2.1 Vegetation Description and Mapping

Colour aerial photography at a scale of 1: 10,000 was used to locate preselected quadrat locations in the field and to assist in vegetation mapping. Tentative boundaries between vegetation associations were marked onto aerial photographs in the field.

Vegetation was described according to BHPBIO (2010) *Guidance for Vegetation Surveys in the Pilbara* NVIS Level 5: Association level. This categorises vegetation based on dominant growth form, cover, height and three dominant genera for upper, mid and ground strata. Vegetation descriptions were based on a combination of detailed quadrat data and observations made while traversing the survey area.

Vegetation descriptions were grouped to vegetation associations and then ground-truthed boundaries between these were marked onto colour A3 aerial photographs. The A3 maps were scanned, digitised and assigned with vegetation codes according to BHPBIO guidelines (BHPBIO 2010). No floristic analysis was conducted as part of this assessment.

2.2.2 Specimen Identification

Species that could not be positively identified in the field were collected, given a unique collection number, pressed in the field and dried. Care was taken to collect as much informative (vegetative and reproductive) material as possible, including seeds and pods collected from the ground (where possible).

The majority of the dried specimens were subsequently identified by Astron botanists Janelle Atkinson, Alice Bott and Natalie Krawczyk. Specimens that were difficult to identify or were of seasonally poor quality were identified by Steve Dillon, a BHPBIO sponsored botanist at the Western Australian Herbarium. Specimens were identified to the lowest possible classification (i.e. species, subspecies or variant). A BHPBIO Chain of Custody form is provided in Appendix G.

Data from each quadrat were entered into a customised Microsoft Access database. Data entry was completed by Astron botanist Natalie Krawczyk. As the names of some taxa have been revised, the species list generated from the Access database was edited to incorporate current nomenclature.

2.3 Limitations

2.3.1 Seasonal Conditions

The field survey was conducted between 14 and 22 April 2013. Approximately 275 millimetres (mm) of rainfall was received at Newman Aero weather station in the 12 months preceding the field survey; 50.5 mm below the mean annual rainfall of 325.9 mm (Figure 3) (BOM 2013). For the three months preceding the survey, Newman Aero received 64.2 mm, compared with the long term average (1971-2013) of 135.8 mm for the same period, representing rainfall 47% below average (Figure 3).

The average annual maximum daily temperature for Newman Aero is 31.9°C. For the three months preceding the field survey, 36.86°C was the average daily maximum temperature recorded at Newman Aero; 2.46°C above the long-term (1971-2013) average of 34.4°C for the same period (Figure 3) (BOM 2013).

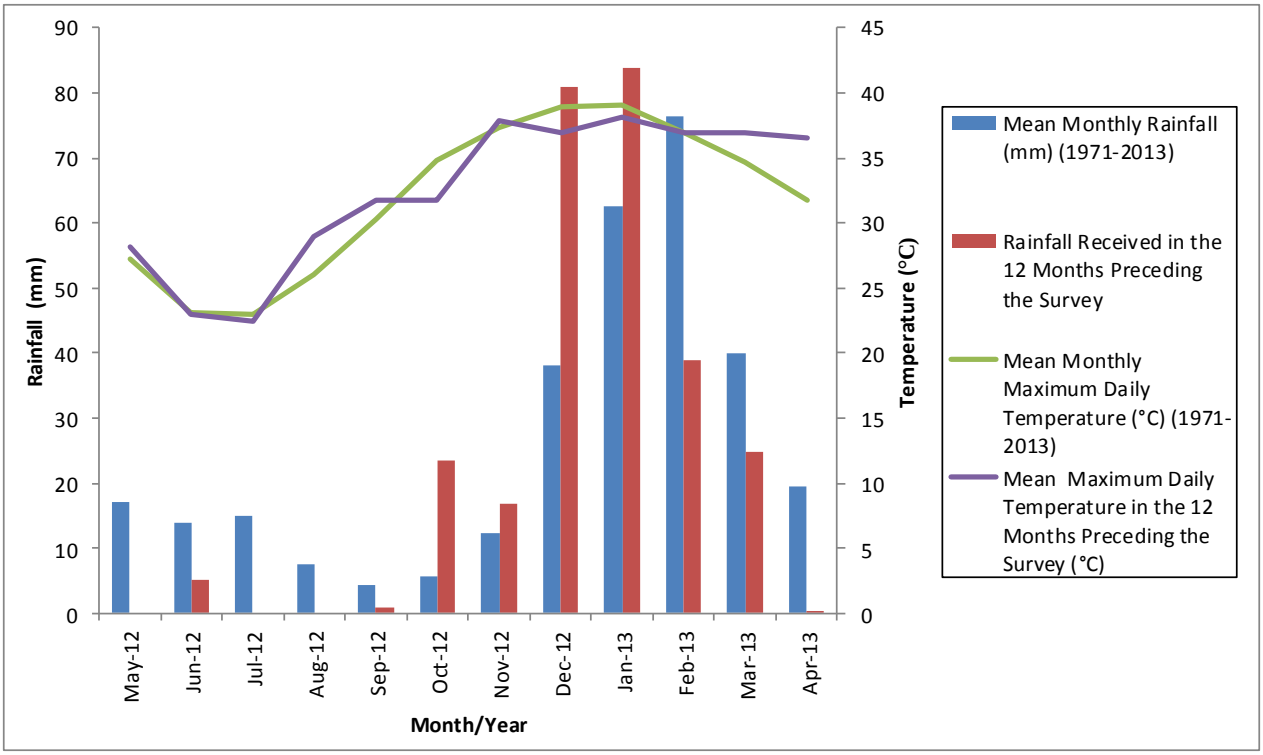


Figure 3: Long-term (1971-2013) mean monthly rainfall (mm) and actual rainfall (mm) recorded at the Newman Aero weather station in the 12 months preceding the field survey (BOM 2013).

2.3.2 Statement of Limitations

The EPA (2004) lists a number of possible limitations and constraints that may affect the adequacy of a vegetation and flora survey. These potential limitations have been addressed in relation to the current survey in Table 5.

Table 5: Statement of limitations for the vegetation and flora survey.

Potential limitation	Statement regarding potential limitation
(i) Sources of information and availability of contextual information. Is the region well documented?	Contextual information is available from IBRA (Kendrick 2001) and Beard (1975) mapping. Numerous consultants' reports reviewed within the survey area and broader area (Section 2.1.2). Contextual information is therefore not a limiting factor for this survey.
(ii) Scope. The level of survey and detail required to undertake the survey. Was there adequate time to complete the survey to the desired standard?	There was adequate time to complete the Level 2 survey; complete vegetation mapping and conduct opportunistic searches for threatened and priority flora throughout the survey area. Time was not considered a limiting factor.

Potential limitation	Statement regarding potential limitation
(iii) Proportion of flora collected and identified. Was the survey sampling, timing and intensity considered adequate? Was the survey conducted at what was considered an appropriate time of the year for plant collection? Were any taxonomic groups considered to be underrepresented?	Some flora species, such as annuals, are only identifiable at certain times (such as when they are flowering or fruiting). Additionally, climatic and stochastic events (such as fire) can affect the presence and absence of some plant species. As a result of these factors, species that are in a very low abundance in the survey area are more difficult to locate. Taxonomic groups recorded within the survey area were considered to be well represented, including annual and/or herbaceous groups such as the Asteraceae family. Of the 227 flora species recorded, 13% (30) are annuals and 12% (27) can be either annuals or perennials. Most taxonomic groups had collections of high quality specimens which assisted in their identification. Only four collections were lacking flowering or fruiting material and therefore could only be identified to the genus level. It is unlikely that these indeterminate collections represent flora of conservation significance or introduced flora species. The annual rainfall in the year preceding the survey (275.5 mm) was 50.5 mm below the long term average of 325.9 mm (Figure 3) (BOM 2013). As this followed on from a four month period, from October 2012 to January 2013, of above average rainfall, conditions were generally good (Figure 3). Therefore, intensity was not considered a limiting factor.
(iv) Completeness. Is there further work which may be required i.e. was the relevant area fully surveyed?	The survey area is considered adequately surveyed for a Level 2, single season assessment.
(v) Mapping reliability. Were the aerial photographs, satellite images and site maps available considered adequate to fully understand the area surveyed? Was the mapping generated considered to have a high degree of reliability?	Colour aerial photography at a scale of 1:10,000 was used to assist in navigation and delineation of vegetation association boundaries. The aerial photographs were dated July 2008 and conditions had changed slightly on the ground since this date.
(vi) Timing. When was the survey conducted in terms of season, rainfall, severe weather events etc? Was the survey conducted at an appropriate time for access?	The timing of the survey was not considered a limiting factor and did not restrict access or the ability to complete the survey.
(vii) Disturbance. Had the survey area been impacted by any disturbance which may have limited the survey, i.e. fire, flood, accidental human intervention etc?	There was no significant disturbance noted during the field survey.
(viii) Intensity. In retrospect, was the intensity considered to be adequate?	The quadrat and relevé sites were positioned adequately to sample the extent and diversity of vegetation types within the survey area. The sampling density for the survey area is considered sufficient, with 1.02 quadrats or relevés sampled per hectare. Intensity was not considered a limiting factor.

Potential limitation	Statement regarding potential limitation
(ix) Resources. Were the appropriate tools and materials available to complete the task effectively?	Resources were adequate to complete the field survey.
(x) Access. Were there any factors limiting access to the survey area?	The survey area was able to be accessed along the rail access road, exploration tracks and various drill lines. The large majority of the survey area to the north of the exploration track could, however, only be accessed on foot.
(xi) Experience. Were personnel undertaking the field survey and plant identification trained and/or experienced in undertaking the required tasks?	The botanists responsible for undertaking the field survey are experienced in conducting Level 2 surveys in the Pilbara region. Specimen identifications were completed by botanists experienced in taxonomic identification of Western Australian flora species.

3 Results

3.1 Desktop Study

3.1.1 Literature Review

Twenty-three vegetation and flora surveys have previously been conducted adjoining, wholly or partially within the survey area. The results of these previous surveys were reviewed for this survey, with particular reference to survey size, seasonal conditions, sampling size, total number of taxa recorded, introduced flora species, threatened and priority flora and vegetation of conservation significance (the classification of which may have changed recently i.e. changes in priority ranking may have taken place)(summarised in Table 6).

In 2008, GHD conducted a DRF and priority flora survey of the Ninga project area (GHD 2008b). No TECs, PECs or flora of conservation significance were recorded during that survey (Table 6). Other previous surveys by Ecologia Environment (2004), ENV Australia (2006) and Outback Ecology Services (2009a) recorded three priority species, *Isotropis parviflora* (Priority two (P2)), *Aristida jerichoensis* var. *subspinulifera* (P1) and *Gymnanthera cunninghamii* (Priority three (P3)) within the survey area.

Table 6: Details of previous biological and flora and vegetation surveys conducted in the vicinity of the Ninga survey area.

Author (year)	Survey area	Survey size (ha)	Survey focus	Seasonal conditions	Sampling size	Number of flora taxa	TECs, PECs and flora of conservation significance recorded	Introduced flora species
Onshore Environmental (2013)	Orebody 17/18.	45	Desktop assessment	N/A	N/A	N/A	*Aristida* ?*jerichoensis* var. *subspinulifera* (P1) – poor specimen *Goodenia nuda* (Priority 4 (P4)) No TECs or PECs	N/A
Onshore Environmental (2012)	Homestead creek and Orebody 25, approximately 5 km east-northeast of Newman.	Not listed	Targeted survey	Above average	Not listed	N/A	*Eremophila magnifica* subspecies *(*subsp.) *velutina* (P3) No TECs or PECs	**Cenchrus ciliaris* **Cenchrus setiger*
Syrinx (2012)	Wheelarra Hill North, 40 km east of Newman.	4,972	Level 2 vegetation and flora survey (two seasons)	Not listed	83 quadrats; 19 relevés	411	*Aristida* ? *jerichoensis* var. *subspinulifera* (P1) No TECs or PECs	**Bidens bipinnata* **Cenchrus ciliaris* **Malvastrum americanum* **Portulaca oleracea*

Author (year)	Survey area	Survey size (ha)	Survey focus	Seasonal conditions	Sampling size	Number of flora taxa	TECs, PECs and flora of conservation significance recorded	Introduced flora species
ENV Australia (2011a)	Eastern Ridge and Orebody 23/24/25, 8 km east of Newman.	8,831	Level 2 vegetation and flora survey (two seasons)	Season one (2006): above average; Season two (2011): average	51 quadrats	422	*Calotis latiuscula* (P3) *Aristida jerichoensis* var. *subspinulifera* (P1) *Eremophila magnifica* var. *velutina* (P3) No TECs or PECs	**Acetosa vesicaria* **Aerva javanica* **Agave americana* **Bidens bipinnata* **Cenchrus ciliaris* **Cenchrus setiger* **Cucumis melo* subspecies *agrestis* **Cynodon dactylon* **Cyperus involucratus* **Echinochloa colona* **Flaveria trinervia* **Lactuca serriola* **Malvastrum americanum* **Portulaca oleracea* **Solanum nigrum* **Symphyotrichum squamatum* **Tamarix aphylla* **Vachellia farnesiana*
ENV Australia (2011b)	Orebody 42/43, 15 km north-east of Newman.	1,549.36	Level 2 vegetation and flora survey, Level 1 fauna survey (one season)	Above average	28 quadrats, 16 relevés	145	No flora of conservation significant recorded No TECs or PECs	**Cenchrus ciliaris* **Cynodon dactylon* **Malvastrum americanum* **Vachellia farnesiana*

Author (year)	Survey area	Survey size (ha)	Survey focus	Seasonal conditions	Sampling size	Number of flora taxa	TECs, PECs and flora of conservation significance recorded	Introduced flora species
Syrinx (2011a)	Orebody 31, 40 km east of Newman.	3,000	Level 2 vegetation and flora survey (one season)	Above average	29 quadrats	206	No flora of conservation significant recorded No TECs or PECs	**Bidens bipinnata* **Cenchrus ciliaris* **Malvastrum americanum* **Portulaca oleracea*
Syrinx (2011b)	Orebody 37, 1.5 km east-northeast of Newman.	2,862	Level 2 vegetation and flora survey (one season)	Good to ideal	30 quadrats	310	*Goodenia nuda* (P4) No TECs or PECs	**Acetosa vesicaria* **Aerva javanica* **Bidens bipinnata* **Cenchrus ciliaris* **Cenchrus setiger* **Chloris virgata* **Citrullus lanatus* **Conyza bonariensis* **Cucumis melo* **Cynodon dactylon* **Echinochloa colona* **Malvastrum americanum* **Portulaca oleracea* **Setaria verticillata* **Sisymbrium orientale* **Solanum nigrum* **Sonchus oleraceus* **Vachellia farnesiana*

Author (year)	Survey area	Survey size (ha)	Survey focus	Seasonal conditions	Sampling size	Number of flora taxa	TECs, PECs and flora of conservation significance recorded	Introduced flora species
Outback Ecology Services (2010)	Wheelarra Hill mine, 40 km east of Newman, M266SA.	4,616	Level 2 vegetation and flora survey (two seasons)	Season one (2008): below average, Season two (2009) above average	128 quadrats	326	*Goodenia nuda* (P4) *Josephinia* species (sp.) Marandoo (P1) *Aristida jerichoensis* var. *subspinulifera* (P1) No TECs or PECs	**Bidens bipinnata* **Cenchrus ciliaris* **Cucumis melo* subsp. *agrestis*
ENV Australia (2009)	Jimblebar Spur 2, 30 km east of Newman.	153	Level 1 vegetation and flora survey (one season)	Average	10 quadrats, 3 relevés	152	No flora of conservation significant recorded No TECs or PECs	**Bidens bipinnata* **Cenchrus ciliaris* **Malvastrum americanum*
Biologic Environmental Science (2009)	Newman town linking to various satellite mines including Mt Whaleback.	316,800	Level 2 vegetation and flora survey, Level 1 fauna survey	Average	Not listed	319	*Goodenia nuda* (P3)	**Acetosa vesicaria* **Aerva javanica* **Argemone ochroleuca* **Bidens bipinnata* **Cenchrus ciliaris* **Cenchrus setiger* **Cucumis lanatus* **Cynodon dactylon* **Datura leichardtii* **Malvastrum americanum* **Schinus molle* **Solanum nigrum* **Sonchus oleraceus* **Vachellia farnesiana*

Author (year)	Survey area	Survey size (ha)	Survey focus	Seasonal conditions	Sampling size	Number of flora taxa	TECs, PECs and flora of conservation significance recorded	Introduced flora species
Outback Ecology Services (2009a)	15 km east of Newman, between Marble Bar Road and the Jimblebar Lease (M266SA).	Not listed	Level 2 vegetation and flora survey (two seasons)	Season one (2008): below average, Season two (2009) above average	66 quadrats; 17 relevés	275	*Aristida jerichoensis* var. *subspinulifera* (P1) No TECs or PECs	**Aerva javanica* **Bidens bipinnata* **Cenchrus ciliaris* **Cucumis melo* subsp. *agrestis* **Cynodon dactylon* **Echinochloa colona* **Malvastrum americanum* **Setaria verticillata* **Vachellia farnesiana* **Tribulus terrestris*
Outback Ecology Services (2009b)	Wheelarra Hill Accommodation Camp, 10 km from the Wheelarra Hill mine and 30 km east of Newman.	493	Flora, fauna and vegetation survey (one season)	Below average	15 quadrats	115	No flora of conservation significant recorded No TECs or PECs	No introduced flora species recorded
ENV Australia (2008)	Jimblebar Access Road, 15 km east of Newman.	470	Level 2 vegetation and flora survey (one season)	Below average	22 quadrats	112	No flora of conservation significant recorded No TECs or PECs	**Aerva javanica* **Cenchrus ciliaris* **Citrullus lanatus*

Author (year)	Survey area	Survey size (ha)	Survey focus	Seasonal conditions	Sampling size	Number of flora taxa	TECs, PECs and flora of conservation significance recorded	Introduced flora species
GHD (2008a)	10 km north of Newman, on the northern side of the Great Northern Highway.	3,600	Level 2 vegetation and flora survey, Level 1 fauna survey	Below average	119 quadrats; 22 relevés	321	*Brunonia* sp. Long Hairs (P1) No TECs or PECs	*?*Arundo donax* **Acetosa vesicaria* **Aerva javanica* **Cenchrus ciliaris* **Citrullus* sp. **Cylindropuntia* sp. **Cynodon dactylon* **Malvastrum americanum* **Merremia dissecta* **Pennisetum setaceum* **Portulaca oleracea* **Tamarix aphylla* **Tribulus terrestris* **Vachellia farnesiana*
GHD (2008b)	Ninga, on the Eastern Opthalmia Range, 20 km east of Newman.	Not listed	Priority Flora survey	Not listed	N/A	Not listed	No flora of conservation significant recorded No TECs or PECs	Not listed
ENV Australia (2007a)	Borrow Areas – Jimblebar Wye Rail Junction, 15 km east of Newman.	130.1	Level 2 vegetation and flora survey (one season)	Below average	20 quadrats	123	No flora of conservation significant recorded No TECs or PECs	**Cynodon dactylon* **Cenchrus ciliaris* **Vachellia farnesiana*
ENV Australia (2007b)	Orebody 18, 32 km east of Newman.	1,500	Level 2 vegetation and flora survey (second season)	Above average	71 quadrats	276	No flora of conservation significant recorded No TECs or PECs	**Acetosa vesicaria* **Cenchrus ciliaris*

Author (year)	Survey area	Survey size (ha)	Survey focus	Seasonal conditions	Sampling size	Number of flora taxa	TECs, PECs and flora of conservation significance recorded	Introduced flora species
ENV Australia (2007c)	West Jimblebar Exploration Lease project area, 30 km east of Newman on mining lease tenement E52/745, 5 south of Orebody 18 minesite and adjacent to Jimblebar tenement AM70/266.	Not listed	Level 2 vegetation and flora survey (one season)	Not listed	29 quadrats	318	*Goodenia nuda* (P4) No TECs and PECs	**Bidens bipinnata* **Cenchrus ciliaris* **Malvastrum americanum*
ENV Australia (2006)	Orebody 24, with the Opthalmia Ranges approximately 10 km north-east of Newman.	Not listed	Level 2 vegetation and flora survey (second season)	Above average	48 quadrats; 26 relevés	413	*Abutilon trudgenii* (P3)* *Eremophila magnifica* subsp. *velutina* (P3) *Gymnanthera cunninghamii* (P3) *Triumfetta leptacantha* (P3)* No TECs or PECs	**Acetosa vesicaria* **Bidens bipinnata* **Cenchrus ciliaris* **Cynodon dactylon* **Echinochloa colona* **Malvastrum americanum* **Setaria verticillata* **Solanum nigrum*
Ecologia Environment (2005)	South-east of Orebody 25.	1.62	Priority flora mapping, documenting the distribution of riparian vegetation	Not listed	N/A	Not listed	*Gymnanthera cunninghamii* (P3)	**Acetosa vesicaria* **Argemone ochroleuca* **Bidens bipinnata*
Ecologia Environment (2004)	ML244SA, Eastern Opthalmia Range between the Fortescue River and Orebody 18.	Not Listed	Level 2 vegetation, flora and fauna survey (one season)	Optimal	46 quadrats	248	*Isotropis parviflora* (P2) No TECs or PECs	**Cenchrus ciliaris* **Bidens bipinnata*

Author (year)	Survey area	Survey size (ha)	Survey focus	Seasonal conditions	Sampling size	Number of flora taxa	TECs, PECs and flora of conservation significance recorded	Introduced flora species
Biota (2001)	ML244SA, west of the Fortescue River	17,060	Baseline survey	Below average	60 quadrats	380	No flora of conservation significant recorded No TECs or PECs	**Cenchrus ciliaris* **Cenchrus echinatus* **Cenchrus setiger* **Conyza bonariensis* **Cynodon dactylon* **Hypochaeris glabra* **Malvastrum americanum* **Pseudognaphalium luteoalbum* **Sisymbrium erysimoides* **Solanum nigrum* **Sonchus oleraceus* **Vachellia farnesiana*
Ecologia Environment (1995)	Orebody 18, 32 km east of Newman.	2,400	Reconnaissance survey (one season)	Above average	32 quadrats	250	*Triumfetta maconochieana* (Priority 2)* No information available for TECs or PECs	**Sonchus oleraceus* **Rumex vesicarius* (current name *Acetosa vesicaria*) **Bidens bipinnata*

*Flora species previously recorded with a conservation rating, but has been delisted to 'not threatened'.

3.1.2 Results of Database Searches

Environmentally Sensitive Areas

An ESA is located approximately 610 m west of the survey area. Details of this ESA are not available (DEC 2013b).

Matters of National Environmental Significance

A search of the Protected Matters Search Tool (DSEWPAC 2013b) listed no World Heritage Properties, national heritage places, Wetlands of International Importance, TECs or commonwealth reserves within 40 km of the survey area. Two threatened flora species, *Lepidium catapycnon* and *Pityrodia augustensis*, both listed as vulnerable under the EPBC Act, were recorded within 40 km of the survey area.

Western Australian Threatened and Priority Ecological Communities

There is only one terrestrial TEC listed for the Hamersley subregion (PIL3): '*Themeda* grasslands on cracking clays (Hamersley Station, Pilbara). Grassland plains dominated by the perennial *Themeda* (kangaroo grass) and many annual herbs and grasses'. This community is listed as Vulnerable (VU); 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 (DEC 2010). This community is located 240 km north-west of the survey area. There are 22 terrestrial PECs listed for the Pilbara region (DEC 2013c).

Ecosystems 'at risk' and of Reservation Priority

Of the 15 ecosystems listed by Kendrick (2001) as being 'at risk' in the Hamersley subregion, the ecosystems that may be relevant to the vegetation and/or flora of the survey area are listed below:

- valley floor Mulga (VU)
- all major ephemeral water courses (VU).

Threatened Flora and Priority Flora

Conservation significant flora listed in the reports reviewed, along with those listed in databases searched (Section 2.1.1); and the likelihood of them occurring in the survey area are presented in Table 7. Three of these species have previously been recorded within the survey area.

Table 7: The likelihood of threatened and priority flora occurring in the survey area based on the Protected Matters Search Tool (DSEWPAC 2013b) and previous surveys in the survey area vicinity.

Species	Rank	Life form	Flowering time	Habitat	Potential occurrence in survey area*
Lepidium catapycnon	T	An open, woody perennial herb or shrub with zigzag stems. It grows 0.20 to 0.30 m in height.	It produces white flowers in October.	Occurs on hillsides in skeletal soils.	Potential
Pityrodia augustensis	T	A bushy shrub that grows up to 1.00 m in height.	It produces purple/purple-red flowers from August to September.	Occurs amongst rocks on slopes or in drainage lines.	Not likely – previous records in the vicinity of Mt Augustus, approximately 315 km southwest of Newman.
Aristida jerichoensis var. *subspinulifera*	P1	A compactly tufted perennial, grass-like or herb with lemma groove muricate. It grows 0.30 to 0.80 in height.	No information available.	Occurs on hardpan plains.	Previously recorded
Brunonia sp. Long Hairs	P1	An erect herb with long spreading hairs on to leaves. It grows up to 0.70 m in height and its spikes up to 0.30 m in height.	No information available.	Occurs along creeklines.	Potential
Isotropis parviflora	P2	A perennial herb.	It produces white/pink- flowers in March.	Occurs on valley slopes of ironstone plateau.	Previously recorded
Gymnanthera cunninghamii	P3	An erect shrub that grows between 1 and 2 m in height.	It produces cream-yellow-green flowers from January to December.	Occurs on sandy soils.	Potential
Josephinia sp. Marandoo	P1	A small, upright shrub with round, woolly, soft spined fruit. It grows up to 0.30 m in height.	It produces pink flowers in August.	Occurs on plains in mixed shrubland of Senna and Acacia in gritty soil and granite.	Potential
Calotis latiuscula	P3	An erect herb that grows up to 0.50 m in height.	It produces yellow flowers from June to October.	Occurs on rocky hillsides, floodplains, rocky creeks and river beds.	Potential

Species	Rank	Life form	Flowering time	Habitat	Potential occurrence in survey area*
Eremophila magnifica subsp. *velutina*	P3	A shrub that grows 0.50 to 1.50 m in height.	It produces blue-purple flowers from August to September.	Occurs on summits and in skeletal soils over ironstone.	Potential
Gymnanthera cunninghamii	P3	An erect shrub that grows 1.00 to 2.00 m in height.	It produces cream-yellow-green flowers from January to December.	Occurs in sandy soils.	Previously recorded
Goodenia nuda	P4	An erect to ascending herb that grows up to 0.50 m in height.	It produces yellow flowers from April to August.	No information available.	Potential

**Note: Potential to occur – preferable habitat identified in the survey area and previous records known to occur within the survey area or in the vicinity of the survey area*
Not likely to occur – no preferable habitat identified within the survey area
Previously recorded – has been identified from previous reports as occurring within the survey area

3.2 Vegetation and Flora Survey

3.2.1 Vegetation

Twenty-three vegetation associations from the following eleven broad floristic formations were mapped within the survey area:

1. *Acacia* Low Open Woodland to Low Woodland: two vegetation associations (1a and 1b)
2. *Acacia* Tall Shrubland: one vegetation association (2a)
3. *Triodia* Hummock Grassland: three vegetation associations (3a, 3b and 3c)
4. **Cenchrus* Open Tussock Grassland: three vegetation associations (4a, 4b and 4c)
5. *Acacia* Shrubland: one vegetation association (5a)
6. *Eucalyptus* Open Forest: one vegetation association (6a)
7. *Triodia* Open Hummock Grassland: Four vegetation associations (7a, 7b, 7c and 7d)
8. *Grevillea* Tall Shrubland: two vegetation associations (8a and 8b)
9. *Amphipogon* Open Tussock Grassland: one vegetation association (9a)
10. *Themeda* Tussock Grassland: two vegetation associations (10a and 10b)
11. *Acacia* Tall Open Scrub: three vegetation associations (11a, 11b and 11c)

These 23 vegetation associations and 11 broad floristic formations are summarised in Table 8.

Locations of quadrats in the survey area are shown in Appendix H. Quadrat and relevé data and photographs are provided in Appendix I, as per BHP Billiton Iron Ore's (2010) *Guidance for flora and Vegetation Surveys*. A site by species matrix is presented in Appendix J. A detailed summary of each vegetation association mapped in the survey area is provided below (according to broad floristic formation), and is illustrated on vegetation association mapping in Appendix K, Figures K.1 to K.12.

Two of the vegetation associations described, 11b and 8b, represent a mosaic of two separate vegetation associations which, due to the spatial patterns on the ground, are too complex to be mapped separately. These associations are formed between vegetation associations on the foothills and the drainage tracts dispersing from the ranges, to the north and south of the ranges within the survey area. Where possible, the vegetation associations which make up the mosaics were mapped separately, but where this was not possible, they were mapped as the mosaic community.

Approximately 212 ha of the survey area has been mapped as disturbed vegetation. These areas have been cleared of vegetation for the Warrawandu village and associated infrastructure.

Table 8: Broad floristic formations or the Ninga survey area.

<table>
<tr><td colspan="4">Broad Floristic Formation: 1. Acacia Low Open Woodland to Low Woodland</td></tr>
<tr><td colspan="2">Vegetation Association: 1a
Low Open Woodland to Low Woodland of Acacia catenulata subsp. occidentalis, A. aptaneura, A. citrinoviridis, A. pruinocarpa and A. coriacea subsp. pendens over Tall Open Shrubland of A. aptaneura and Eremophila fraseri over Scattered Low Shrubs of Maireana tomentosa over Very Open to Open Tussock Grassland of Aristida latifolia, A. contorta, Eragrostis eriopoda and Eriachne pulchella and Very Open Hummock grasses of Triodia basedowii.</td><td colspan="2">  </td></tr>
<tr><td colspan="2">Area: 86.26 ha</td><td colspan="2">Quadrats: NFV26, NFV17</td></tr>
<tr><td colspan="4">Landform Description</td></tr>
<tr><td>Location and Landform:</td><td colspan="3">This vegetation association occurs on flood plains located in the southern section of the survey area. These plains direct surface flow to the Warrawandu Creek.</td></tr>
<tr><td>Geology:</td><td colspan="3">Ironstone rocks and gravels.</td></tr>
<tr><td>Soil Attributes:</td><td colspan="3">Red-brown silty clay.</td></tr>
<tr><td>Litter Cover:</td><td>1.5%</td><td>Bare Ground:</td><td>45%</td></tr>
<tr><td colspan="4">Vegetation Structure and Floristics
Low Open Woodland to Low Woodland of Acacia catenulata subsp. occidentalis, A. aptaneura, A. citrinoviridis, A. pruinocarpa and A. coriacea subsp. pendens over Tall Open Shrubland of A. aptaneura and Eremophila fraseri over Scattered Low Shrubs of Maireana tomentosa over Very Open to Open Tussock Grassland of Aristida latifolia, A. contorta, Eragrostis eriopoda and Eriachne pulchella and Very Open Hummock grasses of Triodia basedowii.</td></tr>
<tr><td colspan="4">Vegetation Condition</td></tr>
<tr><td>Condition Rating:</td><td colspan="3">Excellent.</td></tr>
<tr><td>Disturbances:</td><td colspan="3">Grazing, vehicular and flooding.</td></tr>
<tr><td>Average Fire Age:</td><td colspan="3">> 10 years.</td></tr>
<tr><td>Stratum</td><td colspan="3">Key Characteristics</td></tr>
<tr><td colspan="4">Overstorey</td></tr>
<tr><td colspan="4">Low Open Woodland to Low Woodland of Acacia catenulata subsp. occidentalis, A. aptaneura, A. citrinoviridis, A. pruinocarpa and A. coriacea subsp. pendens.</td></tr>
<tr><td colspan="4">Midstorey</td></tr>
<tr><td>Middle shrub layer</td><td colspan="3">Tall Open Shrubland of A. aptaneura and Eremophila fraseri over Scattered Low Shrubs of Maireana tomentosa.</td></tr>
<tr><td colspan="4">Understorey</td></tr>
<tr><td>Hummock Grasses</td><td colspan="3">Very Open Hummock grasses of Triodia basedowii.</td></tr>
<tr><td>Tussock Grasses</td><td colspan="3">Very Open to Open Tussock Grassland of Aristida latifolia, A. contorta, Eragrostis eriopoda and Eriachne pulchella.</td></tr>
<tr><td colspan="4">Regional Representation of Vegetation Associations</td></tr>
<tr><td colspan="4">This vegetation association occurs within the Boolgeeda, Newman and Washplain land systems. The</td></tr>
</table>

Boolgeeda and Newman land systems are considered common throughout the Pilbara region, and the Washplain land system occurs in the Eastern Pilbara, near Newman. The majority (92%) of this vegetation association occurs within the Pre-European (Beard) vegetation association 29 and 216; both of which had over 99% of the Pre-European extent remaining in 2001. The total area of this vegetation association within the survey area is 2.21%.

<table>
<tr><td colspan="4">Broad Floristic Formation: 1. Acacia Low Open Woodland to Low Woodland</td></tr>
<tr><td colspan="2">Vegetation Association: 1b
Low Woodland of Acacia aptaneura over Tall Open Shrubland of A. sclerosperma subsp. sclerosperma over Very Open Hummock Grassland of Triodia epactia and Very Open Tussock Grassland of Aristida latifolia.</td><td colspan="2">  </td></tr>
<tr><td colspan="2">Area: 13.19 ha</td><td colspan="2">Quadrats: NFVr04.</td></tr>
<tr><td colspan="4">Landform Description</td></tr>
<tr><td>Location and Landform:</td><td colspan="3">This vegetation association occurs on flood plains in the south west of the survey area, adjacent to the Warrawandu Creek.</td></tr>
<tr><td>Geology:</td><td colspan="3">None recorded.</td></tr>
<tr><td>Soil Attributes:</td><td colspan="3">Red-brown silty loam.</td></tr>
<tr><td>Litter Cover:</td><td>1%</td><td>Bare Ground:</td><td>50%</td></tr>
<tr><td colspan="4">Vegetation Structure and Floristics
Low Woodland of Acacia aptaneura over Tall Open Shrubland of A. sclerosperma subsp. sclerosperma over Very Open Hummock Grassland of Triodia epactia and Very Open Tussock Grassland of Aristida latifolia.</td></tr>
<tr><td colspan="4">Vegetation Condition</td></tr>
<tr><td>Condition Rating:</td><td colspan="3">Excellent.</td></tr>
<tr><td>Disturbances:</td><td colspan="3">Grazing and flooding.</td></tr>
<tr><td>Average Fire Age:</td><td colspan="3">5-10 years.</td></tr>
<tr><td>Stratum</td><td colspan="3">Key Characteristics</td></tr>
<tr><td colspan="4">Overstorey</td></tr>
<tr><td colspan="4">Low Woodland of Acacia aptaneura.</td></tr>
<tr><td colspan="4">Midstorey</td></tr>
<tr><td>Middle shrub layer</td><td colspan="3">Tall Open Shrubland of A. sclerosperma subsp. sclerosperma.</td></tr>
<tr><td colspan="4">Understorey</td></tr>
<tr><td>Hummock Grasses</td><td colspan="3">Very Open Hummock Grassland of Triodia epactia.</td></tr>
<tr><td>Tussock Grasses</td><td colspan="3">Very Open Tussock Grassland of Aristida latifolia.</td></tr>
<tr><td colspan="4">Regional Representation of Vegetation Associations</td></tr>
<tr><td colspan="4">This vegetation association occurs entirely within the Washplain land system, which is well represented within the Eastern Pilbara. It is also entirely within the Pre-European (Beard) vegetation association 29; of which most of the 790,399,1 ha was still extant in 2001 and 5% is within conservation reserves. The total area of this vegetation association within the survey area is less than one per cent.</td></tr>
</table>

Broad Floristic Formation: 2. *Acacia* Tall Shrubland			
Vegetation Association: 2a Tall Open Shrubland to Tall Shrubland of *Acacia pruinocarpa, A. aptaneura* and *A. catenulata* subsp. *occidentalis* over Shrubland of A. *aptaneura, A. aneura, A. bivenosa* and *Eremophila forrestii* subsp. *forrestii* over Scattered Low Shrubs of *Scaevola parvifolia* subsp. *pilbarae* over Open Hummock Grassland of *Triodia basedowii* and Very Open Tussock Grasses of *Aristida contorta, Paraneurachne muelleri* and *Cymbopogon procerus.*			
Area: 73.70 ha		Quadrats: NFV29	
Landform Description			
Location and Landform:	This vegetation association occurs on valley plains located in the eastern section of the survey area south of the exploration track. These plains are below the foothills of the ranges (to the north).		
Geology:	Banded iron formation, small pebbles.		
Soil Attributes:	Red-brown sandy clay loam.		
Litter Cover:	5%	Bare Ground:	30%
Vegetation Structure and Floristics Tall Open Shrubland to Tall Shrubland of *Acacia pruinocarpa*, *A. aptaneura* and *A. catenulata* subsp. *occidentalis* over Shrubland of *A. aptaneura, A. aneura, A. bivenosa* and *Eremophila forrestii* subsp. *forrestii* over Scattered Low Shrubs of *Scaevola parvifolia* subsp. *pilbarae* over Open Hummock Grassland of *Triodia basedowii* and Very Open Tussock Grasses of *Aristida contorta*, *Paraneurachne muelleri* and *Cymbopogon procerus.*			
Vegetation Condition			
Condition Rating:	Excellent.		
Disturbances:	Vehicular, machinery, clearing and flooding.		
Average Fire Age:	5-10 years		
Stratum	Key Characteristics		
Overstorey			
Tall Open Shrubland to Tall Shrubland of *Acacia pruinocarpa, A. aptaneura* and *A. catenulata* subsp. *occidentalis.*			
Midstorey			
Middle shrub layer	Shrubland of *A. aptaneura, A. aneura, A. bivenosa* and *Eremophila forrestii* subsp. *forrestii* over Scattered Low Shrubs of *Scaevola parvifolia* subsp. *pilbarae.*		
Understorey			
Hummock Grasses	Open Hummock Grassland of *Triodia basedowii*.		
Tussock Grasses	Very Open Tussock Grasses of *Aristida contorta, Paraneurachne muelleri* and *Cymbopogon procerus.*		
Regional Representation of Vegetation Associations			
This vegetation association occurs within the Boolgeeda and Newman land systems, which are well represented within the Pilbara region. It is also within the Pre-European (Beard) vegetation association 82			

and 216; both of which had over 99% of the Pre-European extent remaining in 2001. The total area of this vegetation association within the survey area is 1.89%.

<table>
<tr><td colspan="4">Broad Floristic Formation: 3. Triodia Hummock Grassland</td></tr>
<tr><td colspan="2">Vegetation Association: 3a
Low Open Woodland of Hakea lorea subsp. lorea and Corymbia aspera over Scattered Tall Shrubs of Acacia pruinocarpa over Hummock Grassland of Triodia schinzii and Scattered herbs of Bonamia erecta and Duperreya commixta.</td><td colspan="2">  </td></tr>
<tr><td colspan="2">Area: 51.22 ha</td><td colspan="2">Quadrats: NFV14</td></tr>
<tr><td colspan="4">Landform Description</td></tr>
<tr><td>Location and Landform:</td><td colspan="3">This vegetation association occurs on a flood plains located in the south-eastern section of the survey area. These plains direct surface flow from the ranges to the north to the Warrawandu Creek to the south.</td></tr>
<tr><td>Geology:</td><td colspan="3">None recorded.</td></tr>
<tr><td>Soil Attributes:</td><td colspan="3">Red-brown sandy clay loam.</td></tr>
<tr><td>Litter Cover:</td><td>2%</td><td>Bare Ground:</td><td>15%</td></tr>
<tr><td colspan="4">Vegetation Structure and Floristics
Low Open Woodland of Hakea lorea subsp. lorea and Corymbia aspera over Scattered Tall Shrubs of Acacia pruinocarpa over Hummock Grassland of Triodia schinzii and Scattered herbs of Bonamia erecta and Duperreya commixta.</td></tr>
<tr><td colspan="4">Vegetation Condition</td></tr>
<tr><td>Condition Rating:</td><td colspan="3">Excellent.</td></tr>
<tr><td>Disturbances:</td><td colspan="3">Not present.</td></tr>
<tr><td>Average Fire Age:</td><td colspan="3">> 10 years.</td></tr>
<tr><td>Stratum</td><td colspan="3">Key Characteristics</td></tr>
<tr><td colspan="4">Overstorey</td></tr>
<tr><td colspan="4">Low Open Woodland of Hakea lorea subsp. lorea and Corymbia aspera.</td></tr>
<tr><td colspan="4">Midstorey</td></tr>
<tr><td>Middle shrub layer</td><td colspan="3">Scattered Tall Shrubs of Acacia pruinocarpa.</td></tr>
<tr><td colspan="4">Understorey</td></tr>
<tr><td>Hummock Grasses</td><td colspan="3">Hummock Grassland of Triodia schinzii.</td></tr>
<tr><td>Tussock Grasses</td><td colspan="3">Not present.</td></tr>
<tr><td colspan="4">Regional Representation of Vegetation Associations</td></tr>
<tr><td colspan="4">This vegetation association occurs within the Boolgeeda and Newman land systems, which are well represented within the Pilbara region. It is also within the Pre-European (Beard) vegetation association 82 and 216; both of which had over 99% of the Pre-European extent remaining in 2001. The total area of this vegetation association within the survey area is 1.31%.</td></tr>
</table>

Broad Floristic Formation: 3. *Triodia* Hummock Grassland			
Vegetation Association: 3b Tall Open Shrubland of *Acacia ancistrocarpa* and *Hakea chordophylla* over Hummock Grassland of *Triodia epactia* and *T. schinzii* over Scattered Herbs of *Bonamia erecta.*			
Area: 46.07 ha		Quadrats: NFV11	
Landform Description			
Location and Landform:	This vegetation association occurs on flood plains directing surface flow from the ranges to the north, to the Fortescue River to the West. This vegetation association has been mapped in the west of the survey area.		
Geology:	Banded ironstone formation gravels.		
Soil Attributes:	Red-brown clay loam.		
Litter Cover:	1%	Bare Ground:	25%
Vegetation Structure and Floristics Tall Open Shrubland of *Acacia ancistrocarpa* and *Hakea chordophylla* over Hummock Grassland of *Triodia epactia* and *T. schinzii* over Scattered Herbs of *Bonamia erecta.*			
Vegetation Condition			
Condition Rating:	Excellent.		
Disturbances:	Grazing.		
Average Fire Age:	> 10 years.		
Stratum	Key Characteristics		
Overstorey			
Not present.			
Midstorey			
Middle shrub layer	Tall Open Shrubland of *Acacia ancistrocarpa* and *Hakea chordophylla*.		
Understorey			
Hummock Grasses	Hummock Grassland of *Triodia epactia* and *T. schinzii.*		
Tussock Grasses	Not present.		
Regional Representation of Vegetation Associations			
This vegetation association occurs entirely within the Newman land system, which is well represented within the Pilbara region. It is also within the Pre-European (Beard) vegetation association 82 and 216; both of which had over 99% of the Pre-European extent remaining in 2001. The total area of this vegetation association within the survey area is 1.18%.			

<table>
<tr><td colspan="4">Broad Floristic Formation: 3. Triodia Hummock Grassland</td></tr>
<tr><td colspan="2">Vegetation Association: 3c
Scattered Low Trees of Eucalyptus leucophloia subsp. leucophloia over Scattered Tall Shrubs of Acacia pruinocarpa and A. aptaneura over Low Open Shrubland of A. hilliana and A. adoxa var. adoxa over Open Hummock Grassland of Triodia basedowii.</td><td colspan="2">  </td></tr>
<tr><td colspan="2">Area: 326.75 ha</td><td colspan="2">Quadrats: NFVr03, NFVr08, NFV13 and NFV15.</td></tr>
<tr><td colspan="4">Landform Description</td></tr>
<tr><td>Location and Landform:</td><td colspan="3">This vegetation association occurs on low rolling hills to the south of the rail line in the southern section of the survey area. The hills run in a westerly line through the survey area with the ranges and foothills to the north and floodplains to the south.</td></tr>
<tr><td>Geology:</td><td colspan="3">Banded ironstone formation rocks and gravels.</td></tr>
<tr><td>Soil Attributes:</td><td colspan="3">Red-brown clay loam.</td></tr>
<tr><td>Litter Cover:</td><td>1</td><td>Bare Ground:</td><td>25%</td></tr>
<tr><td colspan="4">Vegetation Structure and Floristics
Scattered Low Trees of Eucalyptus leucophloia subsp. leucophloia over Scattered Tall Shrubs of Acacia pruinocarpa and A. aptaneura over Low Open Shrubland of A. hilliana and A. adoxa var. adoxa over Open Hummock Grassland of Triodia basedowii.</td></tr>
<tr><td colspan="4">Vegetation Condition</td></tr>
<tr><td>Condition Rating:</td><td colspan="3">Excellent.</td></tr>
<tr><td>Disturbances:</td><td colspan="3">Vehicular, machinery, clearing and power lines.</td></tr>
<tr><td>Average Fire Age:</td><td colspan="3">> 10 years.</td></tr>
<tr><td>Stratum</td><td colspan="3">Key Characteristics</td></tr>
<tr><td colspan="4">Overstorey</td></tr>
<tr><td colspan="4">Scattered Low Trees of Eucalyptus leucophloia subsp. leucophloia.</td></tr>
<tr><td colspan="4">Midstorey</td></tr>
<tr><td>Middle shrub layer</td><td colspan="3">Scattered Tall Shrubs of Acacia pruinocarpa and A. aptaneura over Low Open Shrubland of A. hilliana and A. adoxa var. adoxa.</td></tr>
<tr><td colspan="4">Understorey</td></tr>
<tr><td>Hummock Grasses</td><td colspan="3">Open Hummock Grassland of Triodia basedowii.</td></tr>
<tr><td>Tussock Grasses</td><td colspan="3">Not present.</td></tr>
<tr><td colspan="4">Regional Representation of Vegetation Associations</td></tr>
<tr><td colspan="4">The majority (87%) of this vegetation association occurs within the Newman land system, which is well represented within the Pilbara region. The remainder occurs within the Boolgeeda (11.27%), Rocklea (<1%) and River (<1%) land systems, which are all considered common within the Pilbara region. It is also within the Pre-European (Beard) vegetation association 82 and 216; both of which had over 99% of the Pre-European extent remaining in 2001. The total area of this vegetation association within the survey area is 8.38%.</td></tr>
</table>

Broad Floristic Formation: 4. **Cenchrus* Open Tussock Grassland			
Vegetation Association: 4a Tall Shrubland of *Acacia sclerosperma* subsp. *sclerosperma* and *A. synchronicia* over Scattered Low Shrubs of *Sida* aff. *echinocarpa* (MET 15,350) over Open Tussock Grassland of **Cenchrus ciliaris* and *Eragrostis eriopoda* and Open Hummock Grassland of *Triodia epactia.*			
Area: 64.07 ha	Quadrats: NFV10.		
Landform Description			
Location and Landform:	This vegetation association occurs on flood plains directly alongside the Fortescue River. These plains occur in the north-west section of the survey area directing surface flow from the ranges to the north, to the Fortescue River to the West.		
Geology:	Scattered ironstone and quarts stones, alluvially deposited.		
Soil Attributes:	Red-brown sandy loam.		
Litter Cover:	2%	Bare Ground:	60%
Vegetation Structure and Floristics Tall Shrubland of *Acacia sclerosperma* subsp. *sclerosperma* and *A. synchronicia* over Scattered Low Shrubs of *Sida* aff. *echinocarpa* (MET 15,350) over Open Tussock Grassland of **Cenchrus ciliaris* and *Eragrostis eriopoda* and Open Hummock Grassland of *Triodia epactia*.			
Vegetation Condition			
Condition Rating:	Degraded.		
Disturbances:	Grazing.		
Average Fire Age:	> 10 years.		
Stratum	Key Characteristics		
Overstorey			
Tall Shrubland of *Acacia sclerosperma* subsp. *sclerosperma* and *A. synchronicia*.			
Midstorey			
Middle shrub layer	Scattered Low Shrubs of *Sida* aff. *echinocarpa* (MET 15,350).		
Understorey			
Hummock Grasses	Open Hummock Grassland of *Triodia epactia.*		
Tussock Grasses	Open Tussock Grassland of **Cenchrus ciliaris* and *Eragrostis eriopoda.*		
Regional Representation of Vegetation Associations			
This vegetation association occurs within the Newman and River land systems, which are well represented within the Pilbara region. It is also occurs entirely within the Pre-European (Beard) vegetation association 82; of which had over 99% of the Pre-European extent remaining in 2001. The total area of this vegetation association within the survey area is 1.64%.			

<table>
<tr><td colspan="4">Broad Floristic Formation: 4. *Cenchrus Open Tussock Grassland</td></tr>
<tr><td colspan="2">Vegetation Association: 4b
Open Woodland of Eucalyptus victrix over Tall Shrubland of Petalostylis labicheoides, Androcalva luteiflora, Acacia bivenosa, A. pyrifolia and A. citrinoviridis over Tussock Grassland of *Cenchrus ciliaris, Themeda triandra and Eriachne mucronata.</td><td colspan="2">  </td></tr>
<tr><td colspan="2">Area: 20.11 ha</td><td colspan="2">Quadrats: NFV18.</td></tr>
<tr><td colspan="4">Landform Description</td></tr>
<tr><td>Location and Landform:</td><td colspan="3">This vegetation association describes the vegetation located in a minor, incised creekline that flows between the ranges in the eastern section of the survey area.</td></tr>
<tr><td>Geology:</td><td colspan="3">Alluvial stones and pebbles.</td></tr>
<tr><td>Soil Attributes:</td><td colspan="3">Red-brown river sand.</td></tr>
<tr><td>Litter Cover:</td><td>3%</td><td>Bare Ground:</td><td>30%</td></tr>
<tr><td colspan="4">Vegetation Structure and Floristics
Open Woodland of Eucalyptus victrix over Tall Shrubland of Petalostylis labicheoides, Androcalva luteiflora, Acacia bivenosa, A. pyrifolia and A. citrinoviridis over Tussock Grassland of *Cenchrus ciliaris, Themeda triandra and Eriachne mucronata.</td></tr>
<tr><td colspan="4">Vegetation Condition</td></tr>
<tr><td>Condition Rating:</td><td colspan="3">Degraded.</td></tr>
<tr><td>Disturbances:</td><td colspan="3">Flooding.</td></tr>
<tr><td>Average Fire Age:</td><td colspan="3">> 10 years.</td></tr>
<tr><td>Stratum</td><td colspan="3">Key Characteristics</td></tr>
<tr><td colspan="4">Overstorey</td></tr>
<tr><td colspan="4">Open Woodland of Eucalyptus victrix.</td></tr>
<tr><td colspan="4">Midstorey</td></tr>
<tr><td>Middle shrub layer</td><td colspan="3">Tall Shrubland of Petalostylis labicheoides, Androcalva luteiflora, Acacia bivenosa, A. pyrifolia and A. citrinoviridis</td></tr>
<tr><td colspan="4">Understorey</td></tr>
<tr><td>Hummock Grasses</td><td colspan="3">Not present.</td></tr>
<tr><td>Tussock Grasses</td><td colspan="3">Tussock Grassland of *Cenchrus ciliaris, Themeda triandra and Eriachne mucronata.</td></tr>
<tr><td colspan="4">Regional Representation of Vegetation Associations</td></tr>
<tr><td colspan="4">This vegetation association occurs entirely within the Newman land system, which is well represented within the Pilbara region. It is also occurs entirely within the Pre-European (Beard) vegetation association 82; of which had over 99% of the Pre-European extent remaining in 2001. The total area of this vegetation association within the survey area is less than one per cent.</td></tr>
</table>

<table>
<tr><td colspan="4">Broad Floristic Formation: 4. *Cenchrus Open Tussock Grassland</td></tr>
<tr><td colspan="2">Vegetation Association: 4c
Low Open Woodland of Corymbia hamersleyana and Acacia citrinoviridis over Tall Open Shrubland of Petalostylis labicheoides, Santalum lanceolatum and Grevillea wickhamii over Tussock Grassland of *Cenchrus ciliaris, Enneapogon robustissimus and Eriachne mucronata and Open Hummock Grassland of Triodia epactia.</td><td colspan="2">  </td></tr>
<tr><td colspan="2">Area: 73.48 ha</td><td colspan="2">Quadrats: NFV25.</td></tr>
<tr><td colspan="4">Landform Description</td></tr>
<tr><td>Location and Landform:</td><td colspan="3">This vegetation association describes the vegetation located in a wide and incised creekline. This system runs from the ranges to the north to the low hills in the south in the central-eastern section of the survey area.</td></tr>
<tr><td>Geology:</td><td colspan="3">Banded ironstone formation gravels.</td></tr>
<tr><td>Soil Attributes:</td><td colspan="3">Red-brown sand.</td></tr>
<tr><td>Litter Cover:</td><td>2%</td><td>Bare Ground:</td><td>45%</td></tr>
<tr><td colspan="4">Vegetation Structure and Floristics
Low Open Woodland of Corymbia hamersleyana and Acacia citrinoviridis over Tall Open Shrubland of Petalostylis labicheoides, Santalum lanceolatum and Grevillea wickhamii over Tussock Grassland of *Cenchrus ciliaris, Enneapogon robustissimus and Eriachne mucronata and Open Hummock Grassland of Triodia epactia.</td></tr>
<tr><td colspan="4">Vegetation Condition</td></tr>
<tr><td>Condition Rating:</td><td colspan="3">Excellent.</td></tr>
<tr><td>Disturbances:</td><td colspan="3">Flooding.</td></tr>
<tr><td>Average Fire Age:</td><td colspan="3">> 10 years.</td></tr>
<tr><td>Stratum</td><td colspan="3">Key Characteristics</td></tr>
<tr><td colspan="4">Overstorey</td></tr>
<tr><td colspan="4">Low Open Woodland of Corymbia hamersleyana and Acacia citrinoviridis.</td></tr>
<tr><td colspan="4">Midstorey</td></tr>
<tr><td>Middle shrub layer</td><td colspan="3">Tall Open Shrubland of Petalostylis labicheoides, Santalum lanceolatum and Grevillea wickhamii.</td></tr>
<tr><td colspan="4">Understorey</td></tr>
<tr><td>Hummock Grasses</td><td colspan="3">Open Hummock Grassland of Triodia epactia.</td></tr>
<tr><td>Tussock Grasses</td><td colspan="3">Tussock Grassland of *Cenchrus ciliaris, Enneapogon robustissimus and Eriachne mucronata.</td></tr>
<tr><td colspan="4">Regional Representation of Vegetation Associations</td></tr>
<tr><td colspan="4">This vegetation association occurs within the Boolgeeda and Newman land systems, which are well represented within the Pilbara region. It is also within the Pre-European (Beard) vegetation association 82 and 216; both of which had over 99% of the Pre-European extent remaining in 2001. The total area of this vegetation association within the survey area is 1.88%.</td></tr>
</table>

Broad Floristic Formation: 5. *Acacia* Shrubland			
Vegetation Association: 5a Open Woodland of *Corymbia hamersleyana* and *Eucalyptus gamophylla* over Tall Shrubland of *Acacia monticola, Petalostylis labicheoides* and *Santalum lanceolatum* and *A. bivenosa* over Hummock Grassland of *Triodia epactia* and *T. basedowii* and Open Tussock Grassland of *Themeda triandra* which occurs as a mosaic with vegetation association 11a in some places and thus cannot be mapped separately.			
Area: 25.36 ha	Quadrats: NFV30		
Landform Description			
Location and Landform:	This vegetation association occurs in slightly incised drainage lines on the foothills, originating from the ranges to the north.		
Geology:	Banded ironstone formation rocks, stones and pebbles.		
Soil Attributes:	Red-brown sandy clay loam.		
Litter Cover:	4%	Bare Ground:	12.5%
Vegetation Structure and Floristics Open Woodland of *Corymbia hamersleyana* and *Eucalyptus gamophylla* over Tall Shrubland of *Acacia monticola, Petalostylis labicheoides* and *Santalum lanceolatum* and *A. bivenosa* over Hummock Grassland of *Triodia epactia and T. basedowii* and Open Tussock Grassland of *Themeda triandra*.			
Vegetation Condition			
Condition Rating:	Excellent.		
Disturbances:	Flooding.		
Average Fire Age:	> 10 years.		
Stratum	Key Characteristics		
Overstorey			
Open Woodland of Corymbia hamersleyana and Eucalyptus gamophylla.			
Midstorey			
Middle shrub layer	Tall Shrubland of *Acacia monticola, Petalostylis labicheoides* and *Santalum lanceolatum* and *A. bivenosa*.		
Understorey			
Hummock Grasses	Hummock Grassland of *Triodia epactia* and *T. basedowii.*		
Tussock Grasses	Open Tussock Grassland of *Themeda triandra.*		
Regional Representation of Vegetation Associations			
This majority (925) of this vegetation association occurs within the Boolgeeda land system, which is well represented within the Pilbara region. The remainder occurs within the Newman land system, which is also well represented within the Pilbara region. The majority (99%) of this vegetation association is within the Pre-European (Beard) vegetation association 216 and the remainder in 82; both of which had over 99% of the Pre-European extent remaining in 2001. The total area of this vegetation association within the survey area is less than one per cent.			

<table>
<tr><td colspan="4">Broad Floristic Formation: 6. Eucalyptus Open Forest</td></tr>
<tr><td colspan="2">Vegetation Association: 6a
Open Forest of Eucalyptus camaldulensis subsp. obtusa and E. victrix over Low Woodland of Acacia citrinoviridis, Melaleuca glomerata and A. coriacea subsp. pendens over Tussock Grassland of *Cenchrus ciliaris, *Cynodon dactylon, Leptochloa digitata, Eulalia aurea and Themeda triandra and Very Open Sedges of Cyperus vaginatus and Very Open Hummock Grassland Triodia longiceps.</td><td colspan="2">  </td></tr>
<tr><td colspan="2">Area: 146.30 ha</td><td colspan="2">Quadrats: NFVr02 and NFV12</td></tr>
<tr><td colspan="4">Landform Description</td></tr>
<tr><td>Location and Landform:</td><td colspan="3">This vegetation association is located in the western section of the survey area, at the Fortescue River and where the Warrawandu Creek flows into the Fortescue River.</td></tr>
<tr><td>Geology:</td><td colspan="3">Alluvial stones and pebbles.</td></tr>
<tr><td>Soil Attributes:</td><td colspan="3">Orange-brown sand.</td></tr>
<tr><td>Litter Cover:</td><td>1.5%</td><td>Bare Ground:</td><td>45%</td></tr>
<tr><td colspan="4">Vegetation Structure and Floristics
Open Forest of Eucalyptus camaldulensis subsp. obtusa and E. victrix over Low Woodland of Acacia citrinoviridis, Melaleuca glomerata and A. coriacea subsp. pendens over Tussock Grassland of *Cenchrus ciliaris, *Cynodon dactylon, Leptochloa digitata, Eulalia aurea and Themeda triandra and Very Open Sedges of Cyperus vaginatus and Very Open Hummock Grassland Triodia longiceps.</td></tr>
<tr><td colspan="4">Vegetation Condition</td></tr>
<tr><td>Condition Rating:</td><td colspan="3">Degraded.</td></tr>
<tr><td>Disturbances:</td><td colspan="3">Grazing, vehicular and flooding.</td></tr>
<tr><td>Average Fire Age:</td><td colspan="3">> 10 years.</td></tr>
<tr><td>Stratum</td><td colspan="3">Key Characteristics</td></tr>
<tr><td colspan="4">Overstorey</td></tr>
<tr><td colspan="4">Open Forest of Eucalyptus camaldulensis subsp. obtusa and E. victrix.</td></tr>
<tr><td colspan="4">Midstorey</td></tr>
<tr><td>Middle shrub layer</td><td colspan="3">Low Woodland of Acacia citrinoviridis, Melaleuca glomerata and A. coriacea subsp. pendens.</td></tr>
<tr><td colspan="4">Understorey</td></tr>
<tr><td>Hummock Grasses</td><td colspan="3">Very Open Hummock Grassland Triodia longiceps.</td></tr>
<tr><td>Tussock Grasses</td><td colspan="3">Tussock Grassland of *Cenchrus ciliaris, *Cynodon dactylon, Leptochloa digitata, Eulalia aurea and Themeda triandra.</td></tr>
<tr><td colspan="4">Regional Representation of Vegetation Associations</td></tr>
<tr><td colspan="4">The majority (95%) of this vegetation association occurs within the River land system, which is well represented within the Pilbara region. The remainder occurs within the Newman (2.62%), Boolgeeda (1.52%) and Rocklea (<1%) land systems, which are all considered common within the Pilbara region. It is also within the Pre-European (Beard) vegetation association 82 and 216; both of which had over 99% of the Pre-European extent remaining in 2001. The total area of this vegetation association within the survey area is</td></tr>
</table>

3.75%.

Broad Floristic Formation: 7. *Triodia* Open Hummock Grassland			
Vegetation Association: 7a Low Shrubland of *Acacia hilliana, Mirbelia viminale* and *A. adoxa* var. *adoxa* over Open Hummock Grassland of *Triodia basedowii* and *T.* sp. Shovelanna Hill (S. van Leeuwen 3835) and Very Open Tussock Grassland of *Eriachne mucronata* and *Eragrostis setifolia.*			
Area: 129.01 ha		Quadrats: NFV23	
Landform Description			
Location and Landform:	This vegetation association is located in the north-eastern section of the survey area, immediately north of the ranges on high rolling hills that appear to have been recently burnt.		
Geology:	Banded Ironstone formation rocks and gravels.		
Soil Attributes:	Red-brown clay loam.		
Litter Cover:	1%	Bare Ground:	30%
Vegetation Structure and Floristics Low Shrubland of *Acacia hilliana*, *Mirbelia viminale* and *A. adoxa* var. *adoxa* over Open Hummock Grassland of *Triodia basedowii* and *T.* sp. Shovelanna Hill (S. van Leeuwen 3835) and Very Open Tussock Grassland of *Eriachne mucronata* and *Eragrostis setifolia.*			
Vegetation Condition			
Condition Rating:	Excellent.		
Disturbances:	Not present.		
Average Fire Age:	2-5 years.		
Stratum	Key Characteristics		
Overstorey			
Not present.			
Midstorey			
Middle shrub layer	Low Shrubland of *Acacia hilliana*, *Mirbelia viminale* and A*. adoxa* var. *adoxa*.		
Understorey			
Hummock Grasses	Open Hummock Grassland of *Triodia basedowii* and *T.* sp. Shovelanna Hill (S. van Leeuwen 3835).		
Tussock Grasses	Very Open Tussock Grassland of *Eriachne mucronata* and *Eragrostis setifolia*.		
Regional Representation of Vegetation Associations			
This vegetation association occurs entirely within the Newman land system, which is well represented within the Pilbara region. It is also within the Pre-European (Beard) vegetation association 82; of which had over 99% of the Pre-European extent remaining in 2001. The total area of this vegetation association within the survey area is 3.31%.			

Broad Floristic Formation: 7. *Triodia* Open Hummock Grassland			
Vegetation Association: 7b Tall Open Shrubland of *Acacia inaequilatera* over Scattered Shrubs of *Senna glutinosa* subsp. *pruinosa* over Open Hummock Grassland of *Triodia epactia.*			
Area: 599.10 ha	Quadrats: NFVr01 and NFV19		
Landform Description			
Location and Landform:	This vegetation association occurs on the upper and lower slopes on the northern side of the ranges, in the north of the survey area.		
Geology:	Banded ironstone formation rocks and gravels.		
Soil Attributes:	Red-brown clay loam.		
Litter Cover:	1%	Bare Ground:	21%
Vegetation Structure and Floristics Tall Open Shrubland of *Acacia inaequilatera* over Scattered Shrubs of *Senna glutinosa* subsp. *pruinosa* over Open Hummock Grassland of *Triodia epactia*.			
Vegetation Condition			
Condition Rating:	Excellent.		
Disturbances:	Not present.		
Average Fire Age:	5-10 years.		
Stratum	Key Characteristics		
Overstorey			
Not present.			
Midstorey			
Middle shrub layer	Tall Open Shrubland of *Acacia inaequilatera* over Scattered Shrubs of *Senna glutinosa* subsp. *pruinosa*.		
Understorey			
Hummock Grasses	Open Hummock Grassland of *Triodia epactia*.		
Tussock Grasses	Not present.		
Regional Representation of Vegetation Associations			
This vegetation association occurs entirely within the Newman land system, which is well represented within the Pilbara region. It is also within the Pre-European (Beard) vegetation association 82; of which had over 99% of the Pre-European extent remaining in 2001. The total area of this vegetation association within the survey area is 15.37%.			

Broad Floristic Formation: 7. *Triodia* Open Hummock Grassland			
Vegetation Association: 7c Low Open Woodland of *Eucalyptus leucophloia* subsp. *leucophloia* over Tall Open Shrubland of *Hakea chordophylla* and *Acacia pruinocarpa* over Low Shrubland of *A. hilliana, A. adoxa* var. *adoxa*, *Calytrix carinata* and *Keraudrenia velutina* subsp. *elliptica* over Open Hummock Grassland of *Triodia basedowii, T.* sp. Shovelanna Hill (S. van Leeuwen 3835) and *T. epactia* and Very Open Tussock Grasses of *Eriachne lanata.*			
Area: 962.48 ha		Quadrats: NFV05, NFV27, NFVr07, NFV24, NFV20, NFV02, NFV07, NFV09, NFV01 and NFV28.	
Landform Description			
Location and Landform:	This vegetation association occurs on the tops and upper slopes of the ranges, which dissects the centre of the survey area. The steeper slopes occur on the north-facing slopes. This landform has been impacted by fire to some degree across the survey area.		
Geology:	Banded ironstone formation rocks and gravels with some surface sheeting.		
Soil Attributes:	Red-brown clay loam.		
Litter Cover:	2%	Bare Ground:	29%
Vegetation Structure and Floristics Low Open Woodland of *Eucalyptus leucophloia* subsp. *leucophloia* over Tall Open Shrubland of *Hakea chordophylla* and *Acacia pruinocarpa* over Low Shrubland of *A. hilliana, A. adoxa* var. *adoxa*, *Calytrix carinata* and *Keraudrenia velutina* subsp. *elliptica* over Open Hummock Grassland of *Triodia basedowii, T.* sp. Shovelanna Hill (S. van Leeuwen 3835), and *T. epactia* and Very Open Tussock Grasses of *Eriachne lanata*.			
Vegetation Condition			
Condition Rating:	Excellent.		
Disturbances:	Vehicular and machinery.		
Average Fire Age:	5-10 years.		
Stratum	Key Characteristics		
Overstorey			
Low Open Woodland of Eucalyptus leucophloia subsp. leucophloia.			
Midstorey			
Middle shrub layer	Tall Open Shrubland of *Hakea chordophylla* and *Acacia pruinocarpa* over Low Shrubland of *A. hilliana, A. adoxa* var. *adoxa*, *Calytrix carinata* and *Keraudrenia velutina* subsp. *elliptica*.		
Understorey			
Hummock Grasses	Open Hummock Grassland of *Triodia basedowii*, *T.* sp. Shovelanna Hill (S. van Leeuwen 3835) and *T. epactia.*		
Tussock Grasses	Very Open Tussock Grasses of *Eriachne lanata.*		
Regional Representation of Vegetation Associations			
This majority (99%) of this vegetation association occurs within the Newman land system, which is well represented within the Pilbara region. The remainder occurs in the Boolgeeda (<1%) and River (<1%) land			

systems; both of which are well represented within the Pilbara region. It is also within the Pre-European (Beard) vegetation associations 82 (70%) and 216 (30%); of which had over 99% of the Pre-European extent remaining in 2001. The total area of this vegetation association within the survey area is 24.69%.

<table>
<tr><td colspan="4">Broad Floristic Formation: 7. Triodia Open Hummock Grassland</td></tr>
<tr><td colspan="2">Vegetation Association: 7d
Tall Open Shrubland of Acacia ancistrocarpa, A. bivenosa and A. inaequilatera over Low Open Shrubland of Ptilotus astrolasius over Open Hummock Grassland of Triodia epactia, and Open Tussock Grassland of Eragrostis setifolia and Paraneurachne muelleri which occurs as a mosaic with vegetation association 7d</td><td colspan="2">  </td></tr>
<tr><td colspan="2">Area: Not mapped separately, mapped as a mosaic as 8b (107.44 ha)</td><td colspan="2">Quadrats: NFV32</td></tr>
<tr><td colspan="4">Landform Description</td></tr>
<tr><td>Location and Landform:</td><td colspan="3">This vegetation association is located in the northern section of the survey area, below the ranges on a plain located just below the foothill.</td></tr>
<tr><td>Geology:</td><td colspan="3">Banded ironstone formations rocks and gravels.</td></tr>
<tr><td>Soil Attributes:</td><td colspan="3">Red-brown sandy clay loam.</td></tr>
<tr><td>Litter Cover:</td><td>1%</td><td>Bare Ground:</td><td>30%</td></tr>
<tr><td colspan="4">Vegetation Structure and Floristics
Tall Open Shrubland of Acacia ancistrocarpa, A. bivenosa and A. inaequilatera over Low Open Shrubland of Ptilotus astrolasius over Open Hummock Grassland of Triodia epactia and Open Tussock Grassland of Eragrostis setifolia and Paraneurachne muelleri which occurs as a mosaic with vegetation association 7d</td></tr>
<tr><td colspan="4">Vegetation Condition</td></tr>
<tr><td>Condition Rating:</td><td colspan="3">Excellent.</td></tr>
<tr><td>Disturbances:</td><td colspan="3">Not present.</td></tr>
<tr><td>Average Fire Age:</td><td colspan="3">> 10 years.</td></tr>
<tr><td>Stratum</td><td colspan="3">Key Characteristics</td></tr>
<tr><td colspan="4">Overstorey</td></tr>
<tr><td colspan="4">Tall Open Shrubland of Acacia ancistrocarpa, A. bivenosa and A. inaequilatera.</td></tr>
<tr><td colspan="4">Midstorey</td></tr>
<tr><td>Middle shrub layer</td><td colspan="3">Low Open Shrubland of Ptilotus astrolasius.</td></tr>
<tr><td colspan="4">Understorey</td></tr>
<tr><td>Hummock Grasses</td><td colspan="3">Open Hummock Grassland of Triodia epactia.</td></tr>
<tr><td>Tussock Grasses</td><td colspan="3">Open Tussock Grassland of Eragrostis setifolia and Paraneurachne muelleri.</td></tr>
<tr><td colspan="4">Regional Representation of Vegetation Associations</td></tr>
<tr><td colspan="4">This vegetation association occurs entirely within the Newman land system, which is well represented within the Pilbara region. It is also within the Pre-European (Beard) vegetation association 82; of which had over 99% of the Pre-European extent remaining in 2001. The total area of this vegetation association (mapped as a mosaic as 8b) within the survey area is 2.75%.</td></tr>
</table>

<table>
<tr><td colspan="4">Broad Floristic Formation: 8. Grevillea Tall Shrubland</td></tr>
<tr><td colspan="2">Vegetation Association: 8a
Tall Shrubland of Grevillea wickhamii, Acacia inaequilatera and A. monticola over Scattered Shrubs of Acacia pachyacra over Hummock Grassland of Triodia basedowii and T. epactia and Open Tussock Grassland of Amphipogon sericeus which occurs as a mosaic with vegetation association 8a.</td><td colspan="2">  </td></tr>
<tr><td colspan="2">Area: 27.85 ha. However, this vegetation association forms a mosaic with 7d and was mapped separately only where possible. Otherwise mapped as a mosaic as 8b (107.44 ha)</td><td colspan="2">Quadrats: NFV06</td></tr>
<tr><td colspan="4">Landform Description</td></tr>
<tr><td>Location and Landform:</td><td colspan="3">This vegetation association is located in the northern section of the survey area, below the ranges on undulating plains immediately below the foothills.</td></tr>
<tr><td>Geology:</td><td colspan="3">Banded ironstone formation rocks and gravels.</td></tr>
<tr><td>Soil Attributes:</td><td colspan="3">Red-brown sandy clay loam.</td></tr>
<tr><td>Litter Cover:</td><td>4%</td><td>Bare Ground:</td><td>40%</td></tr>
<tr><td colspan="4">Vegetation Structure and Floristics
Tall Shrubland of Grevillea wickhamii, Acacia inaequilatera and A. monticola over Scattered Shrubs of Acacia pachyacra over Hummock Grassland of Triodia basedowii and T. epactia and Open Tussock Grassland of Amphipogon sericeus.</td></tr>
<tr><td colspan="4">Vegetation Condition</td></tr>
<tr><td>Condition Rating:</td><td colspan="3">Excellent.</td></tr>
<tr><td>Disturbances:</td><td colspan="3">Not present.</td></tr>
<tr><td>Average Fire Age:</td><td colspan="3">2-5 years.</td></tr>
<tr><td>Stratum</td><td colspan="3">Key Characteristics</td></tr>
<tr><td colspan="4">Overstorey</td></tr>
<tr><td colspan="4">Tall Shrubland of Grevillea wickhamii, Acacia inaequilatera and A. monticola.</td></tr>
<tr><td colspan="4">Midstorey</td></tr>
<tr><td>Middle shrub layer</td><td colspan="3">Scattered Shrubs of Acacia pachyacra.</td></tr>
<tr><td colspan="4">Understorey</td></tr>
<tr><td>Hummock Grasses</td><td colspan="3">Hummock Grassland of Triodia basedowii and T. epactia.</td></tr>
<tr><td>Tussock Grasses</td><td colspan="3">Open Tussock Grassland of Amphipogon sericeus.</td></tr>
<tr><td colspan="4">Regional Representation of Vegetation Associations</td></tr>
<tr><td colspan="4">This vegetation association occurs entirely within the Newman land system, which is well represented within the Pilbara region. It is also within the Pre-European (Beard) vegetation association 82; of which had over 99% of the Pre-European extent remaining in 2001. The total area of this vegetation association (mapped as a mosaic as 8b) within the survey area is 2.75%.</td></tr>
</table>

Broad Floristic Formation: 8. Grevillea Tall Shrubland			
Vegetation Association: 8b This is a mosaic of two vegetation associations which could not always be mapped separately: 8a: Tall Shrubland of *Grevillea wickhamii*, *Acacia inaequilatera* and *A. monticola* over Scattered Shrubs of *Acacia pachyacra* over Hummock Grassland of *Triodia basedowii* and *T. epactia* and Open Tussock Grassland of *Amphipogon sericeus*. 7d: Tall Open Shrubland of *Acacia ancistrocarpa, A. bivenosa* and *A. inaequilatera* over Low Open Shrubland of *Ptilotus astrolasius* over Open Hummock Grassland of *Triodia epactia* and Open Tussock Grassland of *Eragrostis setifolia* and *Paraneurachne muelleri*.			
Area: 107.44	Quadrats: NFV06 and NFV32		
Landform Description			
Location and Landform:	This vegetation association is located in the northern section of the survey area, below the ranges on undulating plains immediately below the foothills.		
Geology:	Banded ironstone formation rocks and gravels.		
Soil Attributes:	Red-brown sandy clay loam.		
Litter Cover:	2.5%	Bare Ground:	35%
Vegetation Structure and Floristics This is a mosaic of two vegetation associations (7d and 8a) which could not always be mapped separately:			
Vegetation Condition			
Condition Rating:	Excellent.		
Disturbances:	Not present.		
Average Fire Age:	2-10 years.		
Stratum	Key Characteristics		
Overstorey			
Tall Shrubland of *Grevillea wickhamii*, *Acacia inaequilatera* and *A. monticola* or Tall Open Shrubland of *Acacia ancistrocarpa, A. bivenosa* and *A. inaequilatera*.			
Midstorey			
Middle shrub layer	Scattered Shrubs of *Acacia pachyacra* or Low Open Shrubland of *Ptilotus astrolasius.*		
Understorey			
Hummock Grasses	Hummock Grassland of *Triodia basedowii* and *T. epactia* or Open Hummock Grassland of *Triodia epactia*.		
Tussock Grasses	Open Tussock Grassland of *Amphipogon sericeus* or Open Tussock Grassland of *Eragrostis setifolia* and *Paraneurachne muelleri*.		
Regional Representation of Vegetation Associations			
This vegetation association occurs entirely within the Newman land system, which is well represented within the Pilbara region. It is also within the Pre-European (Beard) vegetation association 29; of which had over 99% of the Pre-European extent remaining in 2001. The total area of this vegetation association within the survey area is 2.75%.			

Broad Floristic Formation: 9. Amphipogon Open Tussock Grassland			
Vegetation Association: 9a Scattered Low Trees of *Corymbia deserticola* over Open Tussock Grassland of *Amphipogon sericeus*, and *Paraneurachne muelleri* and Very Open Hummock Grassland of *Triodia basedowii*.			
Area: 196.70	Quadrats: NFVr06 and NFV21.		
Landform Description			
Location and Landform:	This vegetation association is located on the foothills on the southern side of the ranges, which dissect the survey area.		
Geology:	Banded ironstone formation rocks and gravels.		
Soil Attributes:	Red-brown sandy clay loam.		
Litter Cover:	1%	Bare Ground:	32.5%
Vegetation Structure and Floristics Scattered Low Trees of *Corymbia deserticola* over Open Tussock Grassland of *Amphipogon sericeus* and *Paraneurachne muelleri* and Very Open Hummock Grassland of *Triodia basedowii*.			
Vegetation Condition			
Condition Rating:	Excellent.		
Disturbances:	Vehicular.		
Average Fire Age:	5-10 years.		
Stratum	Key Characteristics		
Overstorey			
Scattered Low Trees of Corymbia deserticola.			
Midstorey			
Middle shrub layer	No present.		
Understorey			
Hummock Grasses	Very Open Hummock Grassland of *Triodia basedowii*.		
Tussock Grasses	Open Tussock Grassland of *Amphipogon sericeus and Paraneurachne muelleri.*		
Regional Representation of Vegetation Associations			
This vegetation association occurs within the Boolgeeda and Newman land systems, which are well represented within the Pilbara region. It is also within the Pre-European (Beard) vegetation associations 82 and 216; both of which had over 99% of the Pre-European extent remaining in 2001. The total area of this vegetation association within the survey area is 5.05%.			

<table>
<tr><td colspan="4">Broad Floristic Formation: 10. Themeda Tussock Grassland</td></tr>
<tr><td colspan="2">Vegetation Association: 10a
Tall Open Shrubland of Acacia monticola and A. bivenosa over Tussock Grassland of Themeda triandra and *Cenchrus ciliaris.</td><td colspan="2">  </td></tr>
<tr><td colspan="2">Area: 14.57 ha</td><td colspan="2">Quadrats: NFVr05</td></tr>
<tr><td colspan="4">Landform Description</td></tr>
<tr><td>Location and Landform:</td><td colspan="3">This vegetation association occurs within a minor, incised creekline on the northern side of the ranges in the survey area. This creek flows into a major creekline to the east.</td></tr>
<tr><td>Geology:</td><td colspan="3">Not present.</td></tr>
<tr><td>Soil Attributes:</td><td colspan="3">Red-brown sandy clay.</td></tr>
<tr><td>Litter Cover:</td><td>2%</td><td>Bare Ground:</td><td>2%</td></tr>
<tr><td colspan="4">Vegetation Structure and Floristics
Tall Open Shrubland of Acacia monticola and A. bivenosa over Tussock Grassland of Themeda triandra and *Cenchrus ciliaris.</td></tr>
<tr><td colspan="4">Vegetation Condition</td></tr>
<tr><td>Condition Rating:</td><td colspan="3">Excellent.</td></tr>
<tr><td>Disturbances:</td><td colspan="3">Flooding.</td></tr>
<tr><td>Average Fire Age:</td><td colspan="3">>10 years.</td></tr>
<tr><td>Stratum</td><td colspan="3">Key Characteristics</td></tr>
<tr><td colspan="4">Overstorey</td></tr>
<tr><td colspan="4">Tall Open Shrubland of Acacia monticola and A. bivenosa.</td></tr>
<tr><td colspan="4">Midstorey</td></tr>
<tr><td>Middle shrub layer</td><td colspan="3">Not present.</td></tr>
<tr><td colspan="4">Understorey</td></tr>
<tr><td>Hummock Grasses</td><td colspan="3">Not present.</td></tr>
<tr><td>Tussock Grasses</td><td colspan="3">Tussock Grassland of Themeda triandra and *Cenchrus ciliaris.</td></tr>
<tr><td colspan="4">Regional Representation of Vegetation Associations</td></tr>
<tr><td colspan="4">This vegetation association occurs entirely within the Newman land system, which is well represented within the Pilbara region. It is also within the Pre-European (Beard) vegetation association 82; of which had over 99% of the Pre-European extent remaining in 2001. The total area of this vegetation association within the survey area is less than one per cent.</td></tr>
</table>

<table>
<tr><td colspan="4">Broad Floristic Formation: 10. Themeda Tussock Grassland</td></tr>
<tr><td colspan="2">Vegetation Association: 10b
Open Woodland of Eucalyptus kingsmillii subsp. kingsmillii and Eucalyptus leucophloia subsp. leucophloia over Tall Open Scrub of Acacia monticola, Santalum lanceolatum and Androcalva luteiflora over Tussock Grassland of Themeda triandra and Eulalia aurea and Open Hummock Grassland of Triodia epactia.</td><td colspan="2">  </td></tr>
<tr><td colspan="2">Area: 18.03 ha</td><td colspan="2">Quadrats: NFV22</td></tr>
<tr><td colspan="4">Landform Description</td></tr>
<tr><td>Location and Landform:</td><td colspan="3">This vegetation association occurs within a minor, incised creekline that flows between the ranges in the far eastern section of the survey area.</td></tr>
<tr><td>Geology:</td><td colspan="3">Banded ironstone formation rocks, alluvially deposited.</td></tr>
<tr><td>Soil Attributes:</td><td colspan="3">Red-brown river sand.</td></tr>
<tr><td>Litter Cover:</td><td>2%</td><td>Bare Ground:</td><td>10%</td></tr>
<tr><td colspan="4">Vegetation Structure and Floristics
Open Woodland of Eucalyptus kingsmillii subsp. kingsmillii and Eucalyptus leucophloia subsp. leucophloia over Tall Open Scrub of Acacia monticola, Santalum lanceolatum and Androcalva luteiflora over Tussock Grassland of Themeda triandra and Eulalia aurea and Open Hummock Grassland of Triodia epactia.</td></tr>
<tr><td colspan="4">Vegetation Condition</td></tr>
<tr><td>Condition Rating:</td><td colspan="3">Excellent.</td></tr>
<tr><td>Disturbances:</td><td colspan="3">Not present.</td></tr>
<tr><td>Average Fire Age:</td><td colspan="3">>10 years.</td></tr>
<tr><td>Stratum</td><td colspan="3">Key Characteristics</td></tr>
<tr><td colspan="4">Overstorey</td></tr>
<tr><td colspan="4">Open Woodland of Eucalyptus kingsmillii subsp. kingsmillii and Eucalyptus leucophloia subsp. leucophloia.</td></tr>
<tr><td colspan="4">Midstorey</td></tr>
<tr><td>Middle shrub layer</td><td colspan="3">Tall Open Scrub of Acacia monticola, Santalum lanceolatum and Androcalva luteiflora.</td></tr>
<tr><td colspan="4">Understorey</td></tr>
<tr><td>Hummock Grasses</td><td colspan="3">Open Hummock Grassland of Triodia epactia.</td></tr>
<tr><td>Tussock Grasses</td><td colspan="3">Tussock Grassland of Themeda triandra and Eulalia aurea.</td></tr>
<tr><td colspan="4">Regional Representation of Vegetation Associations</td></tr>
<tr><td colspan="4">This vegetation association occurs within the Newman and Boolgeeda land systems, which are well represented within the Pilbara region. It is also within the Pre-European (Beard) vegetation associations 82 and 216; both of which had over 99% of the Pre-European extent remaining in 2001. The total area of this vegetation association within the survey area is less than one per cent.</td></tr>
</table>

Broad Floristic Formation: 11. *Acacia Tall Open Scrub*			
Vegetation Association: 11a Tall scrub of *Acacia ancistrocarpa, A. dictyophleba, Grevillea wickhamii* and *A. inaequilatera* over Open Hummock Grassland of *Triodia basedowii*, and *T.* sp. Shovellana Hill (S. van Leeuwen 3835) and Very Open Tussock Grassland of *Paraneurachne muelleri* which occurs as a mosaic with vegetation association 5a			
Area: Not mapped separately, incorporated as a mosaic with 5a as vegetation association 11b (661.17 ha)	Quadrats: NFV31 and NFV08.		
Landform Description			
Location and Landform:	This vegetation association occurs on the foothills on the southern side of the ranges, which dissects the survey area.		
Geology:	Banded ironstone formation rocks and gravels.		
Soil Attributes:	Red-brown clay loam.		
Litter Cover:	3%	Bare Ground:	30%
Vegetation Structure and Floristics Tall scrub of *Acacia ancistrocarpa, A. dictyophleba, Grevillea wickhamii* and *A. inaequilatera* over Open Hummock Grassland of *Triodia basedowii*, and *T.* sp. Shovellana Hill (S. van Leeuwen 3835) and Very Open Tussock Grassland of *Paraneurachne muelleri*.			
Vegetation Condition			
Condition Rating:	Excellent.		
Disturbances:	Vehicular and machinery.		
Average Fire Age:	>10 years.		
Stratum	Key Characteristics		
Overstorey			
Tall scrub of *Acacia ancistrocarpa, A. dictyophleba, Grevillea wickhamii* and *A. inaequilatera*.			
Midstorey			
Middle shrub layer	Not present.		
Understorey			
Hummock Grasses	Open Hummock Grassland of *Triodia basedowii*, and *T.* sp. Shovellana Hill (S. van Leeuwen 3835)		
Tussock Grasses	Very Open Tussock Grassland of *Paraneurachne muelleri*.		
Regional Representation of Vegetation Associations			
This vegetation association occurs within the Newman and Boolgeeda land systems, which are well represented within the Pilbara region. It is also within the Pre-European (Beard) vegetation associations 82 and 216; both of which had over 99% of the Pre-European extent remaining in 2001. The total area of this vegetation association (mapped as a mosaic as 5a) within the survey area is 16.96%.			

Broad Floristic Formation: 11. *Acacia Tall Open Scrub*			
Vegetation Association: 11b This is a mosaic of two vegetation associations: 11a :Tall scrub of *Acacia ancistrocarpa*, *A. dictyophleba, Grevillea wickhamii* and A. *inaequilatera* over Open Hummock Grassland of *Triodia basedowii*, and *T.* sp. Shovelanna Hill (S. van Leeuwen 3835) and Very Open Tussock Grassland of *Paraneurachne muelleri* which occurs as a mosaic with vegetation association 5a. 5a: Open Woodland of *Corymbia hamersleyana* and *Eucalyptus gamophylla* over Tall Shrubland of *Acacia monticola, Petalostylis labicheoides, Santalum lanceolatum* and A. bivenosa over Hummock Grassland of *Triodia epactia* and *T. basedowii* and Open Tussock Grassland of *Themeda triandra*.			
Area: 661.17 ha		Quadrats: NF21, NFV30, NFV04 and NFV03.	
Landform Description			
Location and Landform:	This vegetation association occurs on the foothills on the southern side of the ranges, which dissects the survey area.		
Geology:	Banded ironstone formation rocks and gravels.		
Soil Attributes:	Red-brown clay loam.		
Litter Cover:	3%	Bare Ground:	30%
Vegetation Structure and Floristics Tall scrub of *Acacia ancistrocarpa*, *A. dictyophleba*, *Grevillea wickhamii* and *A. inaequilatera* over Open Hummock Grassland of *Triodia basedowii*, and *T.* sp. Shovelanna Hill (S. van Leeuwen 3835) and Very Open Tussock Grassland of *Paraneurachne muelleri*.			
Vegetation Condition			
Condition Rating:	Excellent.		
Disturbances:	Vehicular and machinery.		
Average Fire Age:	>10 years.		
Stratum	Key Characteristics		
Overstorey			
Tall scrub of *Acacia ancistrocarpa, A. dictyophleba, Grevillea wickhamii* and *A. inaequilatera* or Open Woodland of *Corymbia hamersleyana* and *Eucalyptus gamophylla*.			
Midstorey			
Middle shrub layer	Not present or Shrubland of *Acacia monticola*, *Petalostylis labicheoides* and *Santalum lanceolatum* and *A. bivenosa.*		
Understorey			
Hummock Grasses	Open Hummock Grassland of *Triodia basedowii*, and *T.* sp. Shovellana Hill (S. van Leeuwen 3835) or Hummock Grassland of *Triodia epactia* and T. *basedowii.*		
Tussock Grasses	Very Open Tussock Grassland of *Paraneurachne muelleri* or Open Tussock Grassland of *Themeda triandra*.		
Regional Representation of Vegetation Associations			
This vegetation association occurs within the Newman and Boolgeeda land systems, which are well represented within the Pilbara region. It is also within the Pre-European (Beard) vegetation associations 82			

and 216; both of which had over 99% of the Pre-European extent remaining in 2001. The total area of this vegetation association within the survey area is 16.96%.

Broad Floristic Formation: 11. *Acacia Tall Open Scrub*			
Vegetation Association: 11c Tall Open Scrub of *Acacia aptaneura* and *A. catenulata* subsp. *occidentalis* over Very Open Hummock Grassland of *Triodia* sp. Shovelanna Hill (S. van Leeuwen 3835).			
Area: 43.18 ha	Quadrats: NFV16		
Landform Description			
Location and Landform:	This vegetation association occurs on flood plains located in the southern section of the survey area. These plains direct surface flow to the Warrawandu Creek.		
Geology:	Not present.		
Soil Attributes:	Red-brown sandy clay loam.		
Litter Cover:	4%	Bare Ground:	35%
Vegetation Structure and Floristics Tall Open Scrub of *Acacia aptaneura* and *A. catenulata* subsp. *occidentalis* over Very Open Hummock Grassland of *Triodia* sp. Shovellana Hill (S. van Leeuwen 3835).			
Vegetation Condition			
Condition Rating:	Excellent.		
Disturbances:	Vehicular.		
Average Fire Age:	2-5 years.		
Stratum	Key Characteristics		
Overstorey			
Tall Open Scrub of *Acacia aptaneura* and *A. catenulata* subsp. *occidentalis*.			
Midstorey			
Middle shrub layer	Not present.		
Understorey			
Hummock Grasses	Very Open Hummock Grassland of *Triodia* sp. Shovellana Hill (S. van Leeuwen 3835).		
Tussock Grasses	Not present.		
Regional Representation of Vegetation Associations			
This vegetation association occurs within the Boolgeeda and Washplain land systems. The Boolgeeda land system is well represented within the Pilbara region and the Washplain land system is well represented within the Eastern Pilbara. It is also within the Pre-European (Beard) vegetation association 29; of which had over 99% of the Pre-European extent remaining in 2001. The total area of this vegetation association within the survey area is 1.11%.			

3.2.2 Vegetation Condition

The survey area occurs on a mining lease, is in close proximity to mining operations and is adjacent to the Marble Bar Road. As such, the survey area has been impacted by historical drilling, clearing for infrastructure, construction camps, weed species introductions and grazing. Vegetation condition ranged from 'excellent' to 'degraded" (Keighery 1994) condition, with the majority of sites (90%) in 'excellent' condition.

Four of the sites sampled were considered to be in 'degraded' condition (NFVr02, NFV10, NFV12 and NFV18). These sites were all associated with minor drainage systems, river systems or floodplains. Introduced species (hereafter referred to as weed species) in high abundances were recorded at these 'degraded' sites and disturbances including grazing, flooding, vehicular and machinery egress were observed. The vegetation immediately alongside the rail line, roads and tracks which dissect the survey area were also generally in 'degraded' condition. The weed species recorded in the survey area were only a dominant component of the vegetation at these sites discussed above.

Approximately 212 ha, or 5.5% of the survey area, has been cleared for infrastructure (power line tracks and laydown areas) and the Warrawandu village (BHPBIO facility).

Eleven weed species were recorded within the survey area, which is relatively high, however these were generally restricted to the disturbed areas described above. The rainfall received in the six months prior to the field survey is likely to have resulted in the better than average emergence of weed species and thus the condition ratings applied to the native vegetation are likely to be accurate.

The vegetation condition classification (Keighery 1994) is presented in Appendix F and vegetation condition mapping of the survey area is presented in Appendix L.

3.2.3 Vegetation of Conservation Significance

Threatened Ecological Communities and Priority Ecological Communities

No TECs listed under the EPBC Act or endorsed by the State Minister for Environment or PECs as listed by the DEC (DEC 2013c) were recorded within the survey area.

Ecosystems 'at risk' and of Reservation Priority

Of the 15 ecosystems listed by Kendrick (2001) as being 'at risk' in the Hamersley subregion, the survey area supports two (Table 9). Both are considered to be vulnerable (VU) in status (Kendrick 2001) (Table 9).

Table 9: Summary of ecosystems listed as 'at risk' in the survey area.

Ecosystem (Kendrick 2001)	Vegetation association(s)	Extent in the survey area (ha)
Valley floor mulga (VU)	1a and 11c	129.44 ha (3.32% of the survey area)
All major ephemeral water courses (VU)	6a	146.29 ha (3.75% of the survey area)

Of the 39 pre-European vegetation associations/ecosystems (Beard 1975) listed as having medium or high reservation priority in the Hamersley subregion (Kendrick 2001), three are considered to be analogous with vegetation associations recorded in the survey area. One is considered to be of high

reservation priority (H) and two are considered to be of medium reservation priority (M) (Kendrick 2001) (Table 10).

Table 10: Summary of Beard vegetation associations of medium and high reservation priority in the survey area.

Beard vegetation association and ecosystem description (1975)	Vegetation association(s)	Extent in the survey area (ha)	Reservation priority
18: Low woodland; mulga (*Acacia aneura*) (M)	1a and 11c	599.10 ha (15.36% of the survey area)	Medium
93: Hummock grasslands, shrub steppe; kanji over soft spinifex (M)	7b	129.44 ha (3.31% of the survey area)	Medium
641: Medium woodland; coolibah and river gum (H)	6a	146.29 ha (3.75% of the survey area)	High

3.2.4 Flora

A total of 227 vascular flora species representing 110 genera and 38 families were recorded from the survey area. The total number of taxa recorded in the survey area is comparable to the total number of flora species recorded in previous surveys (Table 6, Section 3.1.1). A complete species list is presented in Appendix M and the information recorded from each quadrat and relevé site is presented in Appendix I. The Fabaceae (legumes) family had the highest number of species recorded (Table 11), with 50 species from 13 genera represented. The *Acacia* (wattle) genus had the greatest number of species represented, with 27 taxa recorded (Table 11).

Table 11: Families and genera with the highest number of taxa represented in the survey area.

Family	Number of taxa
Fabaceae	50
Poaceae	40
Malvaceae	29
Amaranthaceae	12
Myrtaceae	10
Chenopodiaceae	10
Scrophulariaceae	8
Genus	**Number of taxa**
Acacia	27
Senna	10
Eremophila	8
Ptilotus	7
Corchorus	6
Sida	6

The most frequently recorded species were the grasses: *Aristida holathera* var. *holathera* (28 sites), *Cymbopogon procerus* (27 sites), *Eriachne mucronata* (27 sites); and *Solanum lasiophyllum* (25 sites) (Table 12). Species richness per quadrat and relevé ranged from 13 to 63 taxa and averaged 31 taxa. The location of each vascular flora species recorded during the vegetation and flora assessment are presented in a site by species matrix in Appendix J.

Table 12: Most recorded species in the quadrats and relevés sampled within the survey area.

Family	Species name	Total recorded in quadrats	Total recorded in relevés	Total overall
Amaranthaceae	*Ptilotus calostachyus*	19	2	21
Amaranthaceae	*Ptilotus nobilis*	14	1	15
Amaranthaceae	*Gomphrena kanisii*	15	1	16
Convolvulaceae	*Duperreya commixta*	16	2	18
Fabaceae	*Acacia bivenosa*	18	3	21
Fabaceae	*Acacia aptaneura*	17	3	20
Fabaceae	*Acacia hilliana*	12	4	16
Fabaceae	*Acacia pruinocarpa*	16	1	17
Fabaceae	*Senna artemisioides* subsp. *oligophylla*	21	1	22
Fabaceae	*Senna glutinosa* subsp. *luerssenii*	17	2	19
Fabaceae	*Senna glutinosa* subsp. *glutinosa*	15	2	17
Fabaceae	*Senna glutinosa* subsp. *pruinosa*	15	2	17
Poaceae	*Aristida holathera* var. *holathera*	25	3	28
Poaceae	*Aristida latifolia*	16	1	17
Poaceae	*Cymbopogon procerus*	23	4	27
Poaceae	*Eriachne lanata*	15	3	18
Poaceae	*Eriachne mucronata*	22	5	27
Poaceae	*Paraneurachne muelleri*	22	2	24
Poaceae	*Triodia basedowii*	16	3	19
Poaceae	*Triodia epactia*	18	1	19
Poaceae	*Triodia* sp. Shovelanna Hill (S. van Leeuwen 3835)	18	4	22
Proteaceae	*Grevillea wickhamii*	19	3	22
Proteaceae	*Hakea chordophylla*	12	3	15
Solanaceae	*Solanum lasiophyllum*	23	2	25

Flora of Conservation Significance

EPBC Act Listed Flora

No flora listed as threatened under the EPBC Act were recorded in the survey area.

Threatened Flora and Priority Flora

No DRF, pursuant to the *Wildlife Conservation Act 1950*, was recorded in the survey area. Three priority species have been recorded within the survey area during previous surveys: *Aristida jerichoensis* var. *subspinulifera* (P1) (Outback Ecology Services 2009a), *Gymnanthera cunninghamii* (P3) (ENV Australia 2006) and *Isotropis parviflora* (P2) (Ecologia Environment 2004). Location details and mapping of these species within the survey area is presented in Appendix N.

Range Extensions

All of the species recorded in the survey area have previously been recorded in the broader area (Section 2.1.2). None of the species recorded is considered to be a range extension in the survey area.

Three species are considered to be at the edge of their normal distribution in the survey area (Table 13). These species tended to be at the southern extent of their known range (Western Australia Herbarium 2013).

Table 13: Flora species at the edge of their normal distribution in the survey area (Western Australia Herbarium 2013).

Species	Distribution	Sites recorded from in the survey area
Bonamia media	Southern extent	NFV19
Triumfetta appendiculata	Southern extent	NFV18, NFV22 and NFV25
**Chloris barbata*	Southern extent	NFVr02 and NFVr04

Weeds

Ten weed species were recorded within the survey area, **Bidens bipinnata*, **Cenchrus ciliaris*, **C. setiger*, **Chloris barbata*, **Cynodon dactylon*, **Echinochloa colona*, **Malvastrum americanum*, **Portulaca oleracea, *Setaria verticillata, *Sonchus oleraceus* and **Vachellia farnesiana*. None of these weed species are a WONS (Australian Weeds Committee 2012) or a declared pest under the *Biosecurity and Agriculture Management Act 2007* (DAFWA 2013). **Portulaca oleracea* occurs across Australia in both native and introduced forms and is widely considered naturalised. The weeds recorded during the current survey are listed in Table 14, and location details, further information about each species, including other ratings applied by the IPPP, and mapping of these species in the survey area is presented in Appendix O.

Table 14: Introduced flora species, number of site recordings, and previous recordings within the survey area.

Species	Common name	Family	No. of sites	Estimated no. of individuals
**Bidens bipinnata*	Bipinnate beggartick	Asteraceae	3	~20
**Cenchrus ciliaris*	Buffel grass	Poaceae	11^	~5600
**Cenchrus setiger*	Birdwood grass	Poaceae	1^	30
**Chloris barbata*	Purpletop Chloris	Poaceae	2	~25
**Cynodon dactylon*	Couch	Poaceae	2^	~400
**Echinochloa colona*	Awnless barnyard grass	Poaceae	1	~15
**Malvastrum americanum*	Spiked malvastrum	Malvaceae	1^	155
**Portulaca oleracea*	Purslane	Portulacaceae	6	~15
**Setaria verticillata*	Whorled pigeon grass	Poaceae	2^	~10
**Sonchus oleraceus*	Common sowthistle	Asteraceae	1	1
**Vachellia farnesiana*	Mimosa bush	Fabaceae	1	2

^ Includes opportunistic records

There are 49 records of weed species previously recorded within the survey area (Ecologia Environment 2004; ENV Australia 2008; Outback Ecology Services 2009a; ENV Australia 2007a).

These records represent eight weed species, **Aerva javanica,*Bidens bipinnata, *Cenchrus ciliaris, *Citrullus lanata, *Cynodon dactylon, *Setaria verticillata, *Tribulus terrestris* and **Vachellia farnesiana* and. These records were located within the Fortescue River and its floodplain and along the railway line. These weed species are mapped alongside the records obtained from this survey in Appendix O.

The following sections provide information about the 11 weed species recorded by Astron within the survey area. In the absence of diagnostic photos of these weeds taken *in situ* during the survey, these species are illustrated with images from previous Astron surveys conducted within the vicinity of the survey area. Photos of representative habitats in the survey area for these species are included where possible.

**Bidens bipinnata* (bipinnate beggartick) is an erect annual herb up to 1.5 m in height, which produces yellow daisy-like flowers between March and September. It grows on alluvial soils, clays, and loam over sandstone and is found along rivers and creeks, in coastal areas and on rocky hillsides (Western Australian Herbarium 2013) (Plate 1). Most of the weed records in this survey come from drainage systems and at all three locations is was recorded from, this species had a percentage cover of less than 1% (Plate 2).

Plate 1: *_Bidens bipinnata_ (bipinnate beggartick) (Astron).

Plate 2: *_Bidens bipinnata_ habitat at site NFV25 (Astron).

*C*enchrus ciliaris* (buffel grass) is a tufted or sometimes stoloniferous perennial grass between 0.2 m to 1.5 m in height with purple, ciliate flowers between February and October. It favours sandy, loamy and clayey soils, where it displaces native species (Western Australian Herbarium 2013) (Plate 3). Buffel grass is widespread throughout the Pilbara region and is considered naturalised through the rangelands. In the survey area it was mainly associated with degraded areas (cattle) and drainage areas including creeklines and the river (Plate 4). **C. ciliaris* was recorded from 11 quadrat and relevé sites, with an average of 9% foliar cover.

Plate 3: ****Cenchrus ciliaris* **(buffel grass) (Astron).

Plate 4: ****Cenchrus ciliaris* **habitat at site NFV (Astron).

**Cenchrus setiger* (birdwood grass) is an erect, tussocky, stoloniferous perennial grass, growing to 0.5 m in height. It produces cream to purple flowers during April and May. It prefers brown sands, red loams and pindan soils. It occupies a variety of habitats including sand dunes, plains, rangelands, stony hillsides and floodplains (Western Australian Herbarium 2013) (Plate 5). In the survey area it was found in the river and the banks with orange-brown sand and opportunistically in creeklines. This species had a percentage foliar cover that ranged from less than 1% to 10% Plate 6).

Plate 5: ****Cenchrus setiger* **(birdwood grass) (Astron).

Plate 6: ****Cenchrus setiger* **habitat at site NFV12 (Astron).

**Chloris barbata* (purpletop chloris) is annual or short-lived perennial grass-like or herb, which grows 0.4 m to 0.9 m in height. It produces purple flowers during February and April to October. It occurs on sand dunes and river levees in white or red sand, loam and black clay (Western Australian Herbarium 2013) (Plate 7). In the survey area it was recorded in the river and banks with orange-brown sand (1% foliar cover) and a floodplain adjacent to drainage with red-brown silty loam and (4% foliar cover) (Plate 8).

Plate 7:*_Chloris barbata_ (purpletop Chloris) (Astron).

Plate 8: *_Chloris barbata_ habitat at site NFVr04 (Astron).

*_Cynodon dactylon_* (couch) is a rhizomatous, prostrate perennial grass-like or herb that grows 0.05 m to 0.3 m in height. It produces green-purple flowers during February and July to October to November (Western Australian Herbarium 2013) (Plate 9). It occurs in sand, loamy and clay. In the survey area it was found in creeklines and the river and the banks with orange-brown sand. This species was recorded from two quadrats at less than 1% foliar cover and 65 % foliar cover, at at two opportunistic locatiosn at 30% and 100% foliar cover (in a 5m x 5m area) (Plate 10).

Plate 9: *_Cynodon dactylon_ (couch) (Astron).

Plate 10: *_Cynodon dactylon_ habitat at site NFVr02 (Astron).

*_Echinochloa colona_* is a tufted annual, grass-like or herb that grows 0.2 m to 0.6 m in height. It produces green-purple flowers during February to July. It occurs near watercourses and swamps in black sand and black clay (Western Australian Herbarium 2013) (Plate 11). In the survey area it occurred in the river and on the banks with orange-brown sand at 1% total foliar cover (Plate 12).

Plate 11: ****Echinochloa colona* **(awnless barnyard grass) (Astron).**

Plate 12: ****Echinochloa colona* **habitat at site NFVr02 (Astron).**

**Malvastrum americanum* (spiked malvastrum) is an erect herbaceous perennial or short-lived shrub, reaching up to 1.3 m in height. It produces yellow to orange flowers from April to July, prefers sandy and clayey soils, and is also found on limestone and calcrete (Western Australian Herbarium 2013) (Plate 13). It colonises predominantly floodplains and drainage lines, but also stony ridges and hillsides. In the survey area it was mainly associated with mulga communities in the alluvial plains and along drainage lines This species was recorded from one quadrat at less than 1% foliar cover, and from four opportunistic records averaging 17% foliar cover (in a 5 m x 5m area) (Plate 14).

Plate 13: ****Malvastrum americanum* **(spiked Malvastrum) (Astron).**

Plate 14: ****Malvastrum americanum* **habitat at site NFVr04 (Astron).**

**Portulaca oleracea* (purslane) is a succulent, prostrate to decumbent annual herb, reaching up to 0.2 m in height. It produces yellow flowers from April to May and prefers clayey and loam soils (Western Australian Herbarium 2013) (Plate 15). It favours clayey, loam areas, but appears widespread in most low lying habitats. In the survey area it was mainly associated with mulga communities in the alluvial flats with red-brown (sandy) loam soils. This species was recorded at less than 1% foliar cover from six quadrats and relevés in the survey area (Plate 16).

Plate 15: ****Portulaca oleracea* **(purslane) (Astron).**

Plate 16: ****Portulaca oleracea* **habitat at site NFV10 (Astron).**

*Setaria verticillata (whorled pigeon grass) is a loosely tufted annual, herbaceous grass, growing up to 1.3 m high. Typically flowering in December or January to June it prefers sand, clay and loam habitats (Western Australia Herbarium 2013) (Plate 17). In the survey area it was recorded from two sites; a floodplain containing mulga species, and an incised creekline to the north of the ranges. This species was recorded at less than 1% foliar cover from two quadrat/relevé locations and two opportunistic locations (Plate 18).

Plate 17: ****Setaria verticillata* **(whorled pigeon grass) (Astron).**

Plate 18: ****Setaria verticillata* **habitat at site NFV18 (Astron).**

**Sonchus oleraceus* (common sowthistle) is an erect annual herb, reaching up to 1.5 m in height. It produces yellow flowers from January to December and occurs in a variety of soils, particularly in disturbed areas (Western Australian Herbarium 2013) (Plate 19). In the survey area it was found on a river bank covered with **Cynodon dactylon* tussock grassland with orange-brown sands. This species was recorded at less than 1% foliar cover from one relevé site within the survey area (Plate 20).

Plate 19: ****Sonchus oleraceus* **(common sowthistle) (Astron).

Plate 20: ****Sonchus oleraceus* **habitat at site NFVr02 (Astron).

**Vachellia farnesiana* (mimosa bush) is an erect, spreading, thicket-forming, thorny tree or shrub reaching up to 4 m in height. It produces yellow flowers during June to August. It is found in low-lying area, river and creek banks and disturbed sites. It occurs in stony sandy, clay or loam soils and gravel (Western Australian Herbarium 2013) (Plate 21). In the survey area it was found in the river and the banks with orange-brown sand and opportunistically in creeklines. This species was recorded at less than 1% foliar cover from one quadrat site within the survey area (Plate 22).

Plate 21: ****Vachellia farnesiana* **(mimosa bush) (Astron).

Plate 22: ****Vachellia farnesiana* **habitat at site NFV12 (Astron).

4 Discussion

The eastern end of the Ophthalmia Ranges runs through the center of the survey area, in a rough west-east tract. The ranges consist of long strike ridges rising above 300 m above the valley floor with skeletal soils and areas of exposed rock. The survey area is also characterised by numerous and narrow drainage tracts which disperse from the base of the range.

Twenty-three vegetation associations from 11 broad floristic formations were mapped within the survey area. No TECs or PECs were recorded in the survey area. There is only one terrestrial TEC listed for the Hamersley subregion (PIL3): *Themeda grasslands on cracking clays* (Hamersley Station, Pilbara) *grassland plains dominated by the perennial Themeda (kangaroo grass) and many annual herbs and grasses* (DEC 2013d). This priority 3 TEC is located 240 km north-west of the survey area and no cracking clay habitat was recorded in the survey area.

The vegetation described and mapped in the survey area is considered to be representative of what would be expected in the survey area and is reasonably widespread in the local area. Five pre-European vegetation associations have been broadly mapped over the survey area (Beard 1975), all of which are well represented within the Hamersley subregion.

Floristic diversity in the survey area (227 taxa) is comparable to the total number of flora species recorded in previous surveys. Species richness per quadrat and relevé ranged from 13 to 63 taxa and averaged 31 taxa. The annual rainfall in the year preceding the slightly below the long term average, however as the survey followed on from a four month period of above average rainfall conditions were generally good.

No threatened or priority flora species were recorded in the survey area. Previous surveys in 2004, 2006 and 2009 which overlapped the survey area to some extent, recorded three priority species, *Isotropis parviflora* (P2), *Aristida jerichoensis* var. *subspinulifera* (P1) and *Gymnanthera cunninghamii* (P3). Given below average rainfall it is possible that these species still occur in the survey area but were not recorded due to seasonal conditions.

Approximately 5% of the survey area has been cleared for infrastructure (power line tracks and laydown areas) and the Warrawandu village. Vegetation condition was assessed according to the vegetation condition scale with the survey area ranging from ‘excellent’ to ‘degraded’ vegetation condition with the majority of sites sampled considered to be in ‘excellent’ condition. Eleven weed species were recorded within the survey area, which is relatively high in comparison to the reports reviewed, however these were generally restricted to disturbed areas and minor and major drainage areas. Two additional weed species *(*Citrullus lanatus and *Tribulus terrestris*) have previously been recorded within the survey area. None of the weed species are a WONS (Australian Weeds Committee 2012) or a declared pest under the *Biosecurity and Agriculture Management Act 2007* (DAFWA 2013). Eight recorded introduced species are listed as having a high ecological impact and rapid rate of invasiveness within the Pilbara region (DEC 2011).

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Appendix A: Land Systems Mapping

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792000 794000 796000 798000 800000 802000 804000

7422000 7420000 7418000 7416000 7414000

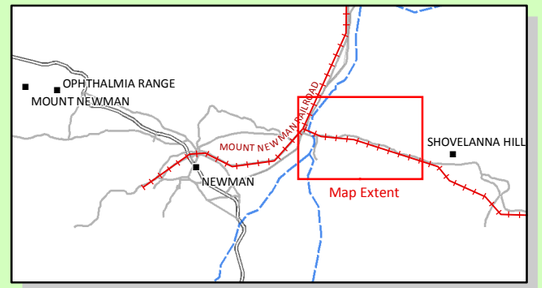
NEW BGD ROC NEW ROC NEW NEW ELI RIV NEW NEW BGD NEW MCK WSP DIV DIV MCK WSP MCK

MARBLE BAR RD

FORTESCUE RIVER

MOUNT NEWMAN RAILROAD

DAM ACCESS RD



Legend

- Road
- Rail
- River
- Survey Area
- Warrawandu Village
- Tenement ID: ML 244SA

Land Systems - Rangelands

Land System Type

- Boolgeeda Land System
- Divide Land System
- Elimunna Land System
- McKay Land System
- Newman Land System
- River Land System
- Rocklea Land System
- Washplain Land System

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Ninga Vegetation and Flora Survey

Figure A.1: Land Systems in the Survey Area

Datum: GDA 1994 - Projection: MGA Zone 50 - Scale: 1:35,000 (A3)

0 500 1,000 1,500 2,000 2,500 Metres

N

astron environmental services

Author: A. Bott | Drawn: C. Dyde | Date: 09-07-2013 | Figure Ref: 2438-13-GDR-1RevA_20130709_FigA1_LandSys

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Appendix B: Pre-European Vegetation Mapping

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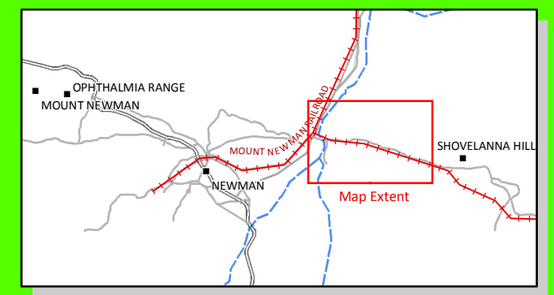
792000 794000 796000 798000 800000 802000 804000

7422000 7420000 7418000 7416000 7414000

HAMMERSLEY_82
FORTESCUE RIVER
MOUNT NEWMAN RAILROAD
MARBLE BAR RD
FORTESCUE VALLEY_29
FORTESCUE VALLEY_82
HAMMERSLEY_82
FORTESCUE VALLEY_82
FORTESCUE VALLEY_82
FORTESCUE VALLEY_82
FORTESCUE VALLEY_216
FORTESCUE VALLEY_82
FORTESCUE VALLEY_82
DAM ACCESS
KUMARINA HILLS_29



Legend

- Road
- Rail
- River
- Survey Area
- Accommodation Area
- Tenement ID: ML 244SA

Pre-European Vegetation

System Association

- FORTESCUE VALLEY - 29
- FORTESCUE VALLEY - 82
- FORTESCUE VALLEY - 216
- HAMMERSLEY - 82
- KUMARINA HILLS - 29

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Ninga Vegetation and Flora Survey

Figure B.1: Pre-European Vegetation Mapping in the Survey Area

Datum: GDA 1994 - Projection: MGA Zone 50 - Scale: 1:35,000 (A3)

0 500 1,000 1,500 2,000 2,500 Metres

N

astron environmental services

Author: A. Bott | Drawn: C. Dyde | Date: 09-07-2013 | Figure Ref: 2438-13-GDR-1RevA_20130709_FigB1_PEV

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Appendix C: Definitions, Categories and Criteria for Threatened and Priority Ecological Communities

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Table C.1: Categories of threatened ecological communities (DEC 2010).

PD: Presumed Destroyed
An ecological community that has been adequately searched for but for which no representative occurrences have been located. The community has been found to be totally destroyed or so extensively modified throughout its range that no occurrence of it is likely to recover its species composition and/or structure in the foreseeable future. An ecological community will be listed as presumed totally destroyed if there are no recent records of the community being extant **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.
CR : Critically Endangered
An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or that was originally of limited distribution and is facing severe modification or destruction throughout its range in the immediate future, or is already severely degraded throughout its range but capable of being substantially restored or rehabilitated. An ecological community will be listed as **Critically Endangered** when it has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future. 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).

En: Endangered
An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or was originally of limited distribution and is in danger of significant modification throughout its range or severe modification or destruction over most of its range in the near future. An ecological community will be listed as **Endangered** when it has been adequately surveyed and is not Critically Endangered but is facing a very high risk of total destruction in the near future. 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).
VU: Vulnerable
An ecological community that has been adequately surveyed and is found to be declining and/or has declined in distribution and/or condition and whose ultimate security has not yet been assured and/or a community that is still widespread but is believed likely to move into a category of higher threat in the near future if threatening processes continue or begin operating throughout its range. An ecological community will be listed as **Vulnerable** when it has been adequately surveyed and is not Critically Endangered or Endangered but is facing a high risk of total destruction or significant modification in the medium to long-term future. 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.

Table C.2: Definitions and criteria for priority ecological communities: priority ecological communities (DEC 2010).

Possible threatened ecological communities that do not meet survey criteria or that are not adequately defined are added to the Priority Ecological Community Lists under Priorities 1, 2 and 3. Ecological Communities that are adequately known, and are rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list, are placed in Priority 4. These ecological communities require regular monitoring. Conservation Dependent ecological communities are placed in Priority 5.

P1: 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.
P2: 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.
P3: 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 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.
P4: Priority Four
Ecological communities that are adequately known, rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list. These communities require regular monitoring. (a) Rare. Ecological communities known from few occurrences that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These communities are usually represented on conservation lands. (b) Near Threatened. Ecological communities that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. (c) Ecological communities that have been removed from the list of threatened communities during the past five years.
P5: 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 C.3: Definitions and criteria for threatened ecological communities (DEC 2010).

Three categories exist for listing threatened ecological communities under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). An ecological community may be categorised:

Categories of ecological communities	
Critically endangered	If, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future.
Endangered	If, at that time, it is not critically endangered and is facing a very high risk of extinction in the wild in the near future.
Vulnerable	If, at that time, it is not critically endangered or endangered, and is facing a high risk of extinction in the wild in the medium-term future.

Appendix D: Categories of Conservation Significant Flora Species

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Table D.1: Categories of conservation significant flora species (Wildlife Conservation Act 1950) (Western Australian Herbarium 2013).

T: Threatened - (Declared Rare Flora - Extant)
Taxa which have been adequately searched for, and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such, following approval by the Minister for the Environment, after recommendation by the State's Endangered Flora Consultative Committee.
P1: Priority One - Poorly Known
Taxa which are known from one or a few (generally <5) populations which are under threat, either due to small population size, or being on lands under immediate threat, e.g. road verges, urban areas, farmland, active mineral leases, etc., or the plants are under threat, e.g. from disease, grazing by feral animals, etc. May include taxa with threatened populations on protected lands. Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.
P2: Priority Two - Poorly Known
Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.
P3: Priority Three - Poorly Known
Taxa which are known from several populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but are in need of further survey.
P4: Priority Four - Rare
Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5–10 years.
P5: Priority 5 - Conservation Dependent Taxa
Taxa that are not threatened but are subject to a specific conservation program, the cessation of which would result in the taxon becoming threatened within five years.

Table D.2: Categories of threatened species (DEC 2010).

Threatened flora may be listed in any one of the following categories as defined in Section 179 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act):

Section 179 Categories of threatened species	
(1) 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.	
(2) 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.
(3) 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.	
(4) 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.
(5) 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.
(6) 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. (7) In subsection (6): fish includes all species of bony fish, sharks, rays, crustaceans, molluscs and other marine organisms, but does not include marine mammals or marine reptiles.	

Appendix E: Categories of Introduced Flora Species and the IPP Process Rating System

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Table E.1: Declared pests in Western Australia categories under the Biosecurity and Agriculture Management (BAM) Act 2007 (DAFWA 2013).

A declared pest can be further categorised under the BAM Regulations 2013 as:	
C1 excluded	i.e. introducing it should be prevented. This applies to organisms which may be present in the State or parts of the state, but that would be prohibited entry at the border as an additional control.
C2 eradicated	i.e. eradicating it is feasible. This applies to organisms that are present in the State, but that have been identified as eradicable. This requires destruction of the organism, whether it is pre or post border for the entire State or parts of the State; and
C3 managed	i.e. eradication is not feasible, but it should be managed to alleviate harmful impacts, reduce its number or distribution, or prevent or contain its spread.
A declared pest may also be assigned to keeping categories defined under the BAM Regulations 2013, which are:	
Prohibited keeping	If in the opinion of the Minister keeping the Declared Pest in an area or part of an area for which it is declared should be prohibited except under the authority of a of a permit to keep at a zoological park, at a scientific organisation approved by the Minister, or for scientific, education or government operational purposes.
Restricted keeping	If in the opinion of the Minister keeping the Declared Pest in an area or part of an area for which it is declared should be restricted to keeping under the authority of a of a permit.
Exempt keeping	If in the opinion of the Minister keeping the Declared Pest in an area or part of an area for which it is declared should be exempt from any requirement under the Act in relation to keeping.

Table E.2: Invasive Plant Prioritisation (IPP) process rating system (DEC 2011).

Field	**Description**	**Code**	**Code description**
Potential Distribution	Area of potential habitat in the Region that could be occupied of the area at risk of invasion by the weed.	L	Limited (localised)
		M	Moderate
		H	High
		E	Extensive (widespread)
		U	Unknown
Current Distribution	Area of habitat in the Region currently occupied by the weed.	L	Limited (localised)
		M	Moderate
		H	High
		E	Extensive (widespread)
		U	Unknown
Survey Effort	Survey effort of IBRA.	Nil	0%
		Some	0 - 25%
		Patchy	25 – 50%
		Extensive	50 – 75%
		Complete	75 – 100%
Abundance	Density class across one or more IBRA regions in the DEC region.	Occasional	Light – scattered individual plants (< 10 populations or 1 – 10% of IBRA region)

Field	Description	Code	Code description
		Common	Medium to scattered patches with isolated plants interspersed (>10 populations or 11 – 50% of IBRA region)
		Abundant	Heavy to large infestations (>100 populations or 51 – 100% of IBRA region)
Ecological Impact	Impact of species with the Region, from low impact (causes minimal disruption to ecological processes or loss of biodiversity) to high (causes acute disruptions of ecological processes, dominates and/or significantly alters the vegetation structure, composition and function of ecosystems).	L	Low impact species
		M	Medium impact species
		H	High impact species
		U	Unknown
Impact attributes	List of known ecological impact attribute, based on Platt et al (2005).	1	Changed fire regime
		2	Changed nutrient conditions
		3	Changed hydrological patterns
		4	Changed soil erosion patterns
		5	Changed geomorphological processes
		6	Changed biomass distribution
		7	Changed light distribution
		8	Loss of biodiversity
		9	Substantially reduces regeneration opportunities of native plants
		10	Allelopathic effects
Invasiveness	Rate of spread of a weed in native vegetation, encompassing factors of establishment, reproductions (time to seeding, seed production, vegetative reproductions) and dispersal (wind, water, flying animals, ground animals, deliberate human spread, vehicles, produce contaminant).	S	Slow
		M	Moderate
		R	Rapid
		U	Unknown
Feasibility of Control	The longer a coordinated control program takes to achieve its desired goal, the more expensive and less feasible it becomes. Key factors to consider include	L	Low feasibility infestation
		M	Moderate feasibility infestation
		H	High feasibility infestation
		U	Unknown

Field	Description	Code	Code description
	how widespread a weed is, ease of finding infestations, difficulty of limiting the weeds dispersal, willingness of landholders and governments to control the weed, and commercial use of the plant.		
General Trend	General trend in distribution and abundance across the region.	Decreasing	
		Increasing	
		Stable	
		Unknown	
Status	Define whether the species is outside the region, considered emerging (density class of occasional), established (density class of common or abundant) or unknown.	Outside	Occurs outside the region but known from WA
		Emerging	Density class of occasional
		Established	Density class of common or abundant
		Unknown	Current status in doubt or unknown

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Appendix F: Vegetation Classification and Condition Scales

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Table F.1: Vegetation Classification System Specht (1970) as modified by Aplin (1979).

Stratum	70-100% cover	30-70% cover	10-30% cover	2-10% cover	<2% cover
Trees > 30 m	Tall closed forest	Tall open Forest	Tall woodland	Tall open woodland	Scattered tall trees
Trees 10-30 m	Closed forest	Open forest	Woodland	Open woodland	Scattered trees
Trees < 10 m	Low closed forest	Low open forest	Low woodland	Low open woodland	Scattered low trees
Shrubs > 2 m	Tall closed scrub	Tall open scrub	Tall shrubland	Tall open shrubland	Scattered tall shrubs
Shrubs 1-2 m	Closed heath	Open heath	Shrubland	Open shrubland	Scattered shrubs
Shrubs < 1 m	Low closed heath	Low open heath	Low shrubland	Low open shrubland	Scattered low shrubs
Hummock grasses	Closed hummock grassland	Hummock grassland	Open hummock grassland	Very open hummock grassland	Scattered hummock grasses
Grasses, sedges, herbs	Closed tussock grassland/ sedgeland/ herbland	Tussock grassland/ sedgeland/ herbland	Open tussock grassland/ sedgeland/ herbland	Very open tussock grassland/ sedgeland/ herbland	Scattered tussock grasses / sedges / herbs

Table F.2: Summary of adapted Vegetation Condition Scale as developed by Keighery (1994)

Rating	Condition	Descriptive features
1	Pristine	Pristine or nearly so, no obvious signs of disturbance
2	Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species
3	Very Good	Vegetation structure altered, obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing
4	Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic structure or ability to regenerate to it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.
5	Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
6	Completely Degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native trees or shrubs.

Appendix G: Chain of Custody Form

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Table G.1: Chain of Custody – Submission of flora specimens to BHPBIO funded botanist by Astron Environmental Services.

BHP Billiton Chain of Custody

bhpbilliton
resourcing the future

Company Astron Environmental Services

Date Submitted Friday 17th May 2013

Project Code Ninga

Project Location Newman

Collectors	Specimen code	Habit (including height & form)	Plant description (including flower/fruit colour)	Locality	GPS location	Landform/Habitat description	Plant associations	Soil description	Astron ID	BHP sponsored botanist ID
Alice Bott and Natalie Krawczyk	NFV05-02	0.2 m, tussock-forming perennial, grass-like or herb.	No information available.	20 km east of Newman	797162mE 7419427mN	Steep upperslope of large hill.	*Triodia* Open Hummock Grassland.	Red-brown clay loam.	*Triodia* sp. Shovelanna Hill	*Triodia* sp. Shovelanna Hill (S. van Leeuwen 3835)
Alice Bott and Natalie Krawczyk	NFV26-04	0.2 m, tussock-forming perennial, grass-like or herb.	It produces green-purple flowers during January to December. Its lemma are bi-textured, deeply lobed and panicle are linear, usually short and dense.	20 km east of Newman	797444mE 7418095mN	Floodplain, ranges trail to the north.	*Acacia* Low Open Woodland.	Red-brown silty clay.	*Triodia basedowii*	*Triodia basedowii*
Alice Bott and Natalie Krawczyk	NFV07-03	0.25 m, tussock-forming perennial, grass-like or herb.	It produces green-purple flowers during January to December. Lemmas are bi-textured, deeply lobed and panicles are linear, usually short and dense.	20 km east of Newman	797781mE 7419521mN	Very top of high hills.	*Triodia* Open Hummock Grassland.	Red-brown clay loam.	*Triodia basedowii*	*Triodia basedowii*
Alice Bott and Natalie Krawczyk	NFV10-08	1.6 m, rounded straggly shrub.	It produces cream-green flowers during February, May or July.	20 km east of Newman	793614mE 7420054mN	Floodplain, Fortescue River to the west and hills to the east.	**Cenchrus* Open Tussock Grassland.	Red-brown sandy loam.	*Rhagodia eremaea*	*Rhagodia eremaea*
Alice Bott and Natalie Krawczyk	NFVr04-01	2 m, small tree.	No information available.	20 km east of Newman	797835mE 7416059mN	Floodplain adjacent to drainage, south of ranges.	*Acacia* Low Open Woodland.	Red-brown silty loam.	*Acacia macraneura*	*Acacia pteraneura*
Alice Bott and	NFV05-03	1.5 m, small tree.	No information available.	20 km east of	797162mE	Steep upperslope of	*Triodia* Open Hummock	Red-brown clay	*Acacia macraneura*	*Acacia macraneura*

Collectors	Specimen code	Habit (including height & form)	Plant description (including flower/fruit colour)	Locality	GPS location	Landform/Habitat description	Plant associations	Soil description	Astron ID	BHP sponsored botanist ID
Natalie Krawczyk				Newman	7419427mN	large hill.	Grassland.	loam.		
Alice Bott and Natalie Krawczyk	NFV26-01	6.5 m, tree.	No information available.	20 km east of Newman	797444mE 7418095mN	Floodplain, ranges trail to the north.	*Acacia* Low Open Woodland.	Red-brown silty clay.	*Acacia ?catenulata* subsp. *occidentalis*	*Acacia catenulata* subsp. *occidentalis*
Alice Bott and Natalie Krawczyk	NFV29-02	2 m, bushy shrub or tree.	It produces yellow flowers during February to July or October.	20 km east of Newman	802510mE 7416955mN	Floodplain in between drainage lines, from the ranges in the north.	*Acacia* Tall Shrubland.	Red-brown sandy clay loam.	*Acacia caesaneura*	*Acacia aneura*
Alice Bott and Natalie Krawczyk	NFV04-06	2 m, small tree.	No information available.	20 km east of Newman	797398mE 7418570mN	Floodplain, to the north of the hills and ranges.	*Triodia* Open Hummock Grassland.	Red-brown clay loam.	*Acacia ?orthocarpa*	*Acacia pteraneura*
Alice Bott and Natalie Krawczyk	NFV13-03	1.8 m, small tree.	No information available.	20 km east of Newman	802488mE 7416180mN	Top and upperslope of foothills, ranges to the north.	*Triodia* Hummock Grassland.	Red-brown silty clay.	*Acacia aptaneura*	*Acacia aptaneura*
Alice Bott and Natalie Krawczyk	NFV13-04	4.5 m, tree.	No information available.	20 km east of Newman	802488mE 7416180mN	Top and upperslope of foothills, ranges to the north.	*Triodia* Hummock Grassland.	Red-brown silty clay.	*Acacia aptaneura*	*Acacia aptaneura*
Alice Bott and Natalie Krawczyk	NFV10-12	2.5 m, tree.	No information available.	20 km east of Newman	793614mE 7420054mN	Floodplain, Fortescue River to the west and hills to the east.	**Cenchrus* Open Tussock Grassland.	Red-brown sandy loam.	*Acacia aptaneura*	*Acacia aptaneura*
Alice Bott and Natalie Krawczyk	NFV11-02	2.5 m, tree.	No information available.	20 km east of Newman	794352mE 7419750mN	Floodplain, in between hills and ranges to the north and south.	*Triodia* Hummock Grassland.	Red-brown clay loam.	*Acacia aptaneura*	*Acacia aptaneura*

Appendix H: Locations of Quadrats and Relevés in the Survey Area

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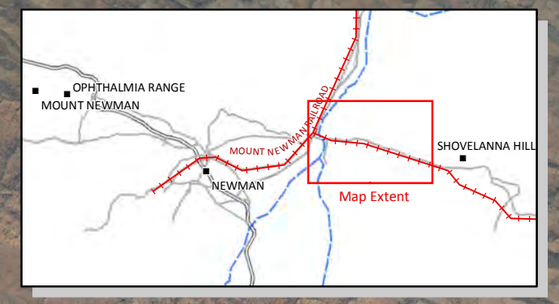
792000 794000 796000 798000 800000 802000 804000

7422000 7420000 7418000 7416000 7414000

MOUNT NEWMAN RAILROAD
MARBLE BAR RD
FORTESCUE RIVER
DAM ACCESS RD

NFV12 NFV32 NFV06 NFV10 NFV09 NFV02 NFV11 NFV07 NFV05 NFV01 NFV27 NFVr02 NFV04 NFV03 NFV26 NFVr08 NFV21 NFVr05 NFV18 NFV19 NFV23 NFV20 NFVr01 NFV24 NFV22 NFV28 NFVr06 NFVr07 NFV30 NFV25 NFV29 NFV31 NFV15 NFV08 NFV16 NFV17 NFV13 NFVr04 NFVr03 NFV14



Legend

- Road
- Rail
- River
- Survey Area
- Warrawandu Village
- Tenement ID: ML 244SA

Quadrat/Releve Locations

- Quadrat
- Relevé

BHP Billiton Iron Ore Pty Ltd
Ninga Vegetation and Flora Survey

Figure H.1: Quadrat Locations in the Survey Area

Datum: GDA 1994 - Projection: MGA Zone 50 - Scale: 1:35,000 (A3)

0 500 1,000 1,500 2,000 2,500 Metres

N

astron environmental services

Author: A. Bott | Drawn: C. Dyde | Date: 09-07-2013 | Figure Ref: 2438-13-GDR-1RevA_20130709_FigH1_Quadrats

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Appendix I: Quadrat andRelevé Data and Photographs

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BHP Ninga **Site NFV01**

Date: 15/04/2013 **Described by:** AB/NK **Type:** Quadrat 50 x 50 m

Seasonal Conditions: Excellent

MGA Zone: 50 **Easting:** 794863 mE **Northing:** 7419288 mN

Habitat: Top of hills, south facing.
Soil: Red-brown clay loam.
Rock Type: Banded Ironstone Formation (BIF).
Broad Floristic Formation: *Triodia* Hummock Grassland.

Vegetation Association: Low Open Woodland of *Eucalyptus leucophloia* subsp. *leucophloia, Hakea chordophylla* and *Grevillea berryana* over Open Shrubland of *Calytrix carinata* and *Senna artemisioides* subsp. *helmsii* over Hummock Grassland of *Triodia* sp. Shovelanna Hill (S. van Leeuwen 3835), *T. epactia* and *Eriachne lanata*.

Vegetation Sub-Association: Low Open Woodland of *Eucalyptus leucophloia* subsp. *leucophloia, Hakea chordophylla* and *Grevillea berryana* over Open Shrubland of *Calytrix carinata* and *Senna artemisioides* subsp. *helmsii* over Low Open Shrubland of *Acacia hilliana* over Hummock Grassland of *Triodia* sp. Shovelanna Hill (S. van Leeuwen 3835) and *T. epactia* over Very Open Tussock Grassland of *Eriachne lanata* and *Amphipogon caricinus*.

Veg Condition: Excellent
Fire Age: 5-10 years
Notes: Disturbance: Vehicular.

Leaf Litter: 2%; Bare Ground: 35%.

Species List

Name	Cover (%)	Height (m)
Acacia adoxa var. *adoxa*	+	0.20
Acacia bivenosa	+	1.20
Acacia hilliana	2.00	0.20
Acacia pruinocarpa	+	2.50
Amphipogon caricinus	1.00	0.20
Aristida holathera var. *holathera*	+	0.40

Aristida latifolia	+	0.50
Calytrix carinata	1.00	1.00
Corchorus lasiocarpus ?subsp.	+	0.30
Corchorus sp.	+	0.30
Cymbopogon procerus	+	0.50
Dampiera candicans	+	0.40
Duperreya commixta	+	climber
Eragrostis setifolia	+	0.25
Eremophila latrobei subsp. *latrobei*	+	1.20
Eriachne lanata	2.00	0.30
Eriachne mucronata	+	0.30
Eriachne pulchella subsp. *pulchella*	+	0.10
Eucalyptus leucophloia subsp. *leucophloia*	2.00	5.50
Fimbristylis simulans	+	0.20
Goodenia stobbsiana	+	0.20
Grevillea berryana	1.00	4.00
Grevillea wickhamii	+	1.50
Hakea chordophylla	2.00	4.50
Heliotropium ovalifolium	+	0.15
Indigofera monophylla	+	0.25
Ptilotus astrolasius	+	0.20
Ptilotus calostachyus	+	0.40
Ptilotus rotundifolius	+	0.80
Schizachyrium fragile	+	0.05
Senna artemisioides subsp. *helmsii*	1.00	1.20
Senna artemisioides subsp. *oligophylla*	+	1.50
Senna glutinosa subsp. *luerssenii*	+	2.00
Senna glutinosa subsp. *pruinosa*	+	1.60
Senna sp. Meekatharra (E. Bailey 1-26)	+	0.80
Sida arenicola	+	0.30
Solanum lasiophyllum	+	0.40
Tribulus suberosus	+	1.20
Triodia epactia	2.00	0.20
Triodia sp. Shovelanna Hill (S. van Leeuwen 3835)	28.00	0.30

BHP Ninga **Site NFV02**

Date: 15/04/2013 **Described by:** AB/NK **Type:** Quadrat 50 x 50 m

Seasonal Conditions: Excellent

MGA Zone: 50 **Easting:** 796041 mE **Northing:** 7419897 mN

Habitat: Upperslope and top of Hill, north facing.
Soil: Red-brown clay loam.
Rock Type: BIF.
Broad Floristic Formation: *Triodia* Open Hummock Grassland.

Vegetation Association: Low Open Woodland of *Eucalyptus leucophloia* subsp. *leucophloia* and *Acacia pruinocarpa* over Low Open Shrubland of *Calytrix carinata, Acacia hilliana* and *Senna glutinosa* subsp. *glutinosa* over Open Hummock Grassland of *Triodia* sp. Shovelanna Hill (S. van Leeuwen 3835), *Eriachne lanata* and *Cymbopogon procerus*.

Vegetation Sub-Association: Low Open Woodland of *Eucalyptus leucophloia* subsp. *leucophloia* and *Acacia pruinocarpa* over Scattered Tall Shrubs of *Senna glutinosa* subsp. *glutinosa* over Low Open Shrubland of *Calytrix carinata* and *Acacia hilliana* over Open Hummock Grassland of *Triodia* sp. Shovellana Hill (S. van Leeuwen 3835) over Very Open Tussock Grassland of *Eriachne lanata* and *Cymbopogon procerus*.

Veg Condition: Excellent
Fire Age: 2-5 years
Notes: Disturbance: Vehicular.

Leaf Litter: 5; Bare Ground: 35%.

Species List

Name	Cover (%)	Height (m)
Acacia ancistrocarpa	+	1.15
Acacia pruinocarpa	1.00	3.20
Amphipogon sericeus	+	0.20
Aristida holathera var. *holathera*	+	0.35
Aristida latifolia	+	0.40
Calytrix carinata	2.00	0.60

Corchorus lasiocarpus ?subsp.	+	0.50
Cymbopogon procerus	1.00	0.30
Eragrostis setifolia	+	0.25
Eriachne lanata	3.00	0.35
Eucalyptus leucophloia subsp. *leucophloia*	1.00	4.00
Goodenia stobbsiana	1.00	0.10
Grevillea berryana	+	3.00
Grevillea wickhamii	+	2.50
Hakea chordophylla	+	2.20
Hibiscus aff. *coatesii*	+	0.45
Paraneurachne muelleri	+	0.60
Petalostylis labicheoides	+	1.30
**Portulaca oleracea*	+	0.08
Ptilotus calostachyus	+	0.70
Senna artemisioides subsp. *oligophylla*	+	0.60
Senna glutinosa subsp. *glutinosa*	1.00	2.20
Senna glutinosa subsp. *luerssenii*	2.00	0.50
Senna glutinosa subsp. *pruinosa*	+	0.10
Sida arenicola	+	0.45
Solanum lasiophyllum	+	0.20
Tribulus hirsutus	+	0.25
Trichodesma zeylanicum	+	0.30
Triodia epactia	+	0.40
Triodia sp. Shovelanna Hill (S. van Leeuwen 3835)	28.00	0.20

BHP Ninga

Site **NFV03**

Date:15/04/2013 **Described by:** AB/NK **Type:** Quadrat 25 x 100 m

Seasonal Conditions: Excellent

MGA Zone: 50 **Easting:** 798652 mE **Northing:** 7418581 mN

Habitat: Very narrow creekline (drainage depression).
Soil: Red-brown sandy clay loam.
Rock Type: BIF, rocks, stones and pebbles.
Broad Floristic Formation: *Acacia* Shrubland.

Vegetation Association: Open Woodland of *Corymbia hamersleyana* and *Eucalyptus gamophylla* over Tall Shrubland of *Acacia monticola, Petalostylis labicheoides* and *Santalum lanceolatum* over Open Tussock Grassland of *Themeda triandra, Triodia epactia* and *Abutilon* aff. *fraseri.*

Vegetation Sub-Association: Open Woodland of *Corymbia hamersleyana* over Scattered Low Trees of *Eucalyptus gamophylla* over Tall Shrubland of *Acacia monticola, Petalostylis labicheoides* and *Santalum lanceolatum* over Scattered Low Shrubs of *Abutilon* aff. *fraseri* over Very Open Hummock Grassland of *Triodia epactia* over Open Tussock Grassland of *Themeda triandra* over Scattered Climbers of *Duperreya commixta*.

Veg Condition: Excellent
Fire Age: >10 years
Notes: Disturbance: Nil.

Leaf Litter: 5%; Bare Ground: 5%.

Species List

Name	Cover (%)	Height (m)
Abutilon aff. *fraseri*	1.00	0.40
Abutilon aff. *lepidum*	+	0.40
Acacia bivenosa	+	2.00
Acacia caesaneura	+	2.00
Acacia monticola	25.00	3.20
Acacia pruinocarpa	+	2.00
Aristida holathera var. *holathera*	+	0.30

**Cenchrus ciliaris*	+	0.50
Santalum lanceolatum	2.00	2.50
Corchorus lasiocarpus subsp. *lasiocarpus*	+	0.30
Corchorus sidoides subsp. *vermicularis*	+	0.25
Corymbia hamersleyana	5.00	10.00
Cymbopogon procerus	+	0.40
Duperreya commixta	1.00	climber
Eragrostis eriopoda	+	0.25
Eucalyptus gamophylla	1.00	4.00
Evolvulus alsinoides var. *villosicalyx*	+	0.20
Gomphrena kanisii	+	0.15
Gossypium robinsonii	+	2.50
Hibiscus sp.	+	0.20
Indigofera monophylla	+	0.25
Jasminum didymum	+	2.50
Paraneurachne muelleri	+	0.30
Petalostylis labicheoides	2.00	2.20
Rhynchosia minima	+	0.20
Scaevola parvifolia subsp. *pilbarae*	+	0.20
Senna artemisioides subsp. *oligophylla*	+	0.40
Senna glutinosa subsp. *glutinosa*	+	1.40
Solanum cleistogamum	+	0.20
Themeda triandra	2.00	0.50
Trichodesma zeylanicum	+	0.20
Triodia epactia	4.00	0.50

BHP Ninga **Site NFV04**

Date: 15/04/2013 **Described by:** AB/NK **Type:** Quadrat 50 x 50 m

Seasonal Conditions: Excellent

MGA Zone: 50 **Easting:** 797398 mE **Northing:** 7418570 mN

Habitat: Floodplain, to the north of the hills and ranges.
Soil: Red-brown clay loam.
Rock Type: BIF and Quartz.
Broad Floristic Formation: *Triodia* Open Hummock Grassland.

Vegetation Association: Scattered Low Trees of *Eucalyptus gamophylla* over Tall Open Shrubland of *Acacia sclerosperma* subsp. *sclerosperma* and *A. pteraneura* over Open Hummock Grassland of *Triodia epactia, T. basedowii* and **Cenchrus ciliaris*.

Vegetation Sub-Association: Scattered Low Trees of *Eucalyptus gamophylla* over Tall Open Shrubland of *Acacia sclerosperma* subsp. *sclerosperma* and *A. pteraneura* over Open Hummock Grassland of *Triodia epactia* and *T. basedowii* over Scattered Tussock Grasses of **Cenchrus ciliaris*.

Veg Condition: Excellent
Fire Age: 2-5 years
Notes: Disturbance: Vehicular and machinery.

Leaf Litter: 2%; Bare Ground: 30%.

Species List

Name	Cover (%)	Height (m)
Acacia bivenosa	+	2.20
Acacia caesaneura	+	2.50
Acacia dictyophleba	+	1.50
Acacia pruinocarpa	+	1.80
Acacia pteraneura	1.00	2.00
Acacia sclerosperma subsp. *sclerosperma*	4.00	2.20
Acacia synchronicia	1.00	0.50
Aristida latifolia	+	0.30
**Cenchrus ciliaris*	1.00	0.35

Corchorus lasiocarpus ?subsp.	+	0.30
Cymbopogon procerus	+	0.40
Enneapogon caerulescens	+	0.15
Eragrostis setifolia	+	0.30
Eremophila forrestii subsp. *forrestii*	+	0.60
Eucalyptus gamophylla	1.00	3.50
Evolvulus alsinoides var. *villosicalyx*	+	0.10
Paraneurachne muelleri	+	0.40
Petalostylis labicheoides	+	1.20
Ptilotus astrolasius	+	0.35
Ptilotus calostachyus	+	0.80
Sarcostemma viminale	+	0.30
Scaevola parvifolia subsp. *pilbarae*	+	0.15
Senna artemisioides subsp. *oligophylla*	+	0.40
Sida ? echinocarpa	+	0.35
Solanum lasiophyllum	+	0.40
Stylobasium spathulatum	+	1.00
Trichodesma zeylanicum	+	0.40
Triodia basedowii	8.00	0.20
Triodia epactia	20.00	0.35
Triodia sp. Shovelanna Hill (S. van Leeuwen 3835)	+	0.20

BHP Ninga **Site NFV05**

Date: 16/04/2013 **Described by:** AB/NK **Type:** Quadrat 50 x 50 m

Seasonal Conditions: Excellent

MGA Zone: 50 **Easting:** 797162 mE **Northing:** 7419427 mN

Habitat: Steep upperslope of a large hill.
Soil: Red-brown clay loam.
Rock Type: BIF, some sheet outcropping.
Broad Floristic Formation: *Triodia* Open Hummock Grassland.

Vegetation Association: Open Woodland of *Eucalyptus leucophloia* subsp. *leucophloia* over Open Shrubland of *Acacia synchronicia* over Open Hummock Grassland of *Triodia epactia* and *T.* sp. Shovelanna Hill (S. van Leeuwen 3835).

Vegetation Sub-Association: Open Woodland of *Eucalyptus leucophloia* subsp. *leucophloia* over Open Shrubland of *Acacia synchronicia* over Open Hummock Grassland of *Triodia epactia* and *T.* sp. Shovelanna Hill (S. van Leeuwen 3835).

Veg Condition: Excellent
Fire Age: 5-10 years
Notes: Disturbance: Nil.

Leaf Litter: 2%; Bare Ground: 35%.

Species List

Name	Cover (%)	Height (m)
Acacia macraneura	+	1.50
Acacia synchronicia	2.00	1.20
Acacia tetragonophylla	+	0.40
Clerodendrum tomentosum var. *lanceolatum*	+	0.15
Enneapogon polyphyllus	+	0.10
Eriachne mucronata	+	0.30
Eucalyptus leucophloia	4.00	10.00
Salsola australis	+	0.30
Sclerolaena eriacantha	+	0.20

Senna glutinosa subsp. *glutinosa*	+	0.50
Solanum lasiophyllum	+	0.20
Triodia epactia	25.00	0.25
Triodia sp. Shovelanna Hill (S. van Leeuwen 3835)	2.00	0.20

BHP Ninga **Site NFV06**

Date: 16/04/2013 **Described by:** AB/NK **Type:** Quadrat 50 x 50 m

Seasonal Conditions: Excellent

MGA Zone: 50 **Easting:** 797322 mE **Northing:** 7420214 mN

Habitat: Plain, north of hills and ranges. Foothill
Soil: Red-brown sandy clay loam.
Rock Type: BIF.
Broad Floristic Formation: *Grevillea* Tall Shrubland.

Vegetation Association: Tall Shrubland of *Grevillea wickhamii, Acacia inaequilatera* and *A. monticola* over Scattered Shrubs of *Acacia pachyachra* over Open Tussock Grassland of *Amphipogon sericeus, Triodia basedowii* and *T. epactia.*

Vegetation Sub-Association: Tall Shrubland of *Grevillea wickhamii, Acacia inaequilatera* and *A. monticola* over Scattered Shrubs of *Acacia pachyachra* over Very Open Hummock Grassland of *Triodia basedowii* and *T. epactia* over Open Tussock Grassland of *Amphipogon sericeus*.

Veg Condition: Excellent
Fire Age: 2-5 years
Notes: Disturbance: Nil.

Leaf Litter: 4%; Bare Ground: 40%.

Species List

Name	Cover (%)	Height (m)
Acacia bivenosa	+	1.80
Acacia hilliana	+	0.40
Acacia inaequilatera	1.00	3.00
Acacia monticola	2.00	2.50
Acacia pachyacra	1.50	1.70
Amphipogon sericeus	15.00	0.35
Aristida holathera var. *holathera*	+	0.25
Corchorus lasiocarpus ?subsp.	+	0.15
Corchorus lasiocarpus subsp. *lasiocarpus*	+	0.30

Cymbopogon procerus	+	0.80
Dampiera candicans	+	0.40
Dodonaea coriacea	+	0.40
Enneapogon polyphyllus	+	0.30
Eragrostis eriopoda	+	0.25
Eremophila longifolia	+	1.70
Eriachne lanata	+	0.30
Eriachne mucronata	+	0.35
Fimbristylis simulans	+	0.15
Gomphrena kanisii	+	0.15
Goodenia stobbsiana	+	0.20
Gossypium robinsonii	+	1.00
Grevillea wickhamii	20.00	4.00
Hakea chordophylla	+	2.50
Hakea lorea subsp. *lorea*	+	2.20
Hibiscus aff. *coatesii*	+	0.25
Paraneurachne muelleri	+	0.40
**Portulaca oleracea*	+	0.08
Ptilotus astrolasius	1.00	0.25
Ptilotus calostachyus	1.00	0.40
Ptilotus nobilis	+	0.15
Ptilotus rotundifolius	+	1.00
Sarcostemma viminale	+	0.30
Senna artemisioides subsp. *helmsii*	+	1.00
Senna glutinosa subsp. *glutinosa*	+	2.00
Senna glutinosa subsp. *luerssenii*	+	1.10
Senna glutinosa subsp. *pruinosa*	+	1.20
Sida arenicola	+	1.00
Solanum lasiophyllum	+	1.00
Tribulus hirsutus	+	0.30
Tribulus suberosus	+	0.15
Triodia basedowii	5.00	0.25
Triodia epactia	1.00	0.40

BHP Ninga **Site NFV07**

Date: 16/04/2013 **Described by:** AB/NK **Type:** Quadrat 50 x 50 m

Seasonal Conditions: Excellent

MGA Zone: 50 **Easting:** 797781 mE **Northing:** 7419521 mN

Habitat: Very top of high hills.
Soil: Red-brown clay loam.
Rock Type: BIF, some sheet surface and outcrops.
Broad Floristic Formation: *Triodia* Open Hummock Grassland.

Vegetation Association: Scattered Low Trees of *Eucalyptus leucophloia* subsp. *leucophloia* over Open Shrubland of *Hakea chordophylla, Acacia pruinocarpa* and *A. hilliana* over Open Hummock Grassland of *T.* sp. Shovelanna Hill (S. van Leeuwen 3835), *Eriachne lanata* and *Amphipogon sericeus*.

Vegetation Sub-Association: Scattered Low Trees of *Eucalyptus leucophloia* subsp. *leucophloia* over Open Shrubland of *Hakea chordophylla* and *Acacia pruinocarpa* over Low Open Shrubland of *Acacia hilliana* over Open Hummock Grassland of *T.* sp. Shovelanna Hill (S. van Leeuwen 3835) over Very Open Tussock Grassland of *Eriachne lanata* and *Amphipogon sericeus*.

Veg Condition: Excellent
Fire Age: 5-10 years
Notes: Disturbance: Vehicular and machinery, very old track dissects southern half of quadrat.

Leaf Litter: 2%; Bare Ground: 40%.

Species List

Name	Cover (%)	Height (m)
Acacia hilliana	2.00	0.50
Acacia pruinocarpa	1.00	2.20
Amphipogon sericeus	1.00	0.20
Aristida holathera var. *holathera*	+	0.30
Calytrix carinata	+	0.50
Cymbopogon procerus	+	0.40
Eriachne lanata	1.50	0.20

Eriachne mucronata	+	0.25
Eucalyptus leucophloia	1.00	5.00
Goodenia stobbsiana	+	0.20
Grevillea berryana	+	2.00
Grevillea wickhamii	+	1.80
Hakea lorea subsp. *lorea*	1.00	2.50
Indigofera monophylla	+	0.40
Petalostylis labicheoides	+	1.60
**Portulaca oleracea*	+	0.04
Ptilotus calostachyus	+	0.80
Senna artemisioides subsp. *oligophylla*	+	0.20
Senna glutinosa subsp. *glutinosa*	+	1.20
Senna glutinosa subsp. *pruinosa*	+	1.50
Senna stricta	+	1.00
Triodia basedowii	+	0.25
Triodia sp. Shovelanna Hill (S. van Leeuwen 3835)	20.00	0.20

BHP Ninga

Site **NFV08**

Date: 16/04/2013 **Described by:** AB/NK **Type:** Quadrat 50 x 50 m

Seasonal Conditions: Excellent

MGA Zone: 50 **Easting:** 804311 mE **Northing:** 7416491 mN

Habitat: Plain; floodplain, hills to the north and drainage surrounding the area. Valley Plain.

Soil: Red-brown clay loam.

Rock Type: BIF rocks and stones.

Broad Floristic Formation: *Acacia* Shrubland.

Vegetation Association: Tall Open Shrubland of *Acacia inaequilatera* and *Grevillea wickhamii* over Shrubland of *Acacia dictyophleba* over Open Hummock Grassland of *Triodia* sp. Shovelanna Hill (S. van Leeuwen 3835), *Amphipogon sericeus* and *Paraneurachne muelleri*.

Vegetation Sub-Association: Tall Open Shrubland of *Acacia inaequilatera* and *Grevillea wickhamii* over Shrubland of *Acacia dictyophleba* over Open Hummock Grassland of *Triodia* sp. Shovelanna Hill (S. van Leeuwen 3835) over Very Open Tussock Grassland of *Amphipogon sericeus* and *Paraneurachne muelleri*.

Veg Condition: Excellent

Fire Age: >10 years

Notes: Disturbance: Vehicular and machinery.

Leaf Litter: 2%; Bare Ground: 30%.

Species List

Name	Cover (%)	Height (m)
Acacia caesaneura	+	0.20
Acacia dictyophleba	22.00	1.60
Acacia inaequilatera	1.00	2.20
Acacia maitlandii	+	1.00
Acacia tenuissima	+	1.70
Amphipogon sericeus	1.00	0.30
Aristida holathera var. *holathera*	+	0.25
Aristida latifolia	+	1.20

Bonamia erecta	+	0.25
Chrysocephalum pterochaetum	+	0.40
Cymbopogon procerus	+	0.50
Dicrastylis cordifolia	+	0.25
Dodonaea coriacea	+	1.00
Eragrostis setifolia	+	0.30
Eriachne mucronata	+	0.30
Grevillea wickhamii	1.00	2.20
Hakea chordophylla	+	1.60
Halgania gustafsenii	+	0.30
Indigofera monophylla	+	0.40
Paraneurachne muelleri	1.00	0.30
Ptilotus calostachyus	+	0.40
Scaevola parvifolia subsp. *pilbarae*	+	2.00
Senna artemisioides subsp. *helmsii*	+	1.20
Senna artemisioides subsp. *oligophylla*	+	0.60
Senna glutinosa subsp. *glutinosa*	+	1.30
Sida arenicola	+	0.20
Solanum lasiophyllum	+	0.40
Tribulus hirsutus	+	0.90
Triodia sp. Shovelanna Hill (S. van Leeuwen 3835)	20.00	0.15

BHP Ninga **Site NFV09**

Date: 17/04/2013 **Described by:** AB/NK **Type:** Quadrat 50 x 50 m

Seasonal Conditions: Excellent

MGA Zone: 50 **Easting:** 794818 mE **Northing:** 7420005 mN

Habitat: Upperslopes and top of the hill, south facing.
Soil: Red-brown clay loam.
Rock Type: BIF, massive sheet outcropping and a few ledges.
Broad Floristic Formation: *Triodia* Open Hummock Grassland.

Vegetation Association: Low Open Woodland of *Eucalyptus leucophloia* subsp. *leucophloia, E. gamophylla* and *Hakea chordophylla* over Low Shrubland of *Acacia hilliana* and *Calytrix carinata* over Open Hummock Grassland of *Triodia* sp. Shovelanna Hill (S. van Leeuwen 3835), *T. epactia* and *Eriachne lanata*.

Vegetation Sub-Association: Low Open Woodland of *Eucalyptus leucophloia* subsp. *leucophloia* and *E. gamophylla* over Scattered Tall Shrubs of *Hakea chordophylla* over Low Shrubland of *Acacia hilliana* and *Calytrix carinata* over Open Hummock Grassland of *Triodia* sp. Shovelanna Hill (S. van Leeuwen 3835) and *T. epactia* over Very Open Tussock Grassland of *Eriachne lanata*.

Veg Condition: Excellent
Fire Age: 2-5 years
Notes: Disturbance: Vehicular.

Leaf Litter: 1%; Bare Ground: 50%.

Species List

Name	Cover (%)	Height (m)
Acacia bivenosa	+	1.20
Acacia hilliana	20.00	0.50
Acacia pruinocarpa	+	3.00
Aristida holathera var. *holathera*	+	0.20
Calytrix carinata	1.00	0.50
Corchorus lasiocarpus ?subsp.	4.00	6.00
Dodonaea coriacea	+	0.60

Dodonaea pachyneura	+	1.10
Duperreya commixta	+	climber
Eriachne lanata	4.00	0.30
Eriachne mucronata	+	0.30
Eucalyptus gamophylla	1.00	2.50
Goodenia stobbsiana	+	0.25
Grevillea wickhamii	+	3.00
Hakea chordophylla	1.00	2.50
Halgania gustafsenii	+	0.35
Paraneurachne muelleri	+	0.40
Petalostylis labicheoides	+	0.50
**Portulaca oleracea*	+	0.08
Ptilotus calostachyus	+	0.40
Senna glutinosa subsp. *glutinosa*	+	1.50
Senna glutinosa subsp. *luerssenii*	+	1.80
Solanum lasiophyllum	+	0.40
Tribulus suberosus	+	0.40
Trichodesma zeylanicum	+	0.50
Triodia epactia	3.00	0.40
Triodia sp. Shovelanna Hill (S. van Leeuwen 3835)	20.00	0.25

BHP Ninga **Site NFV10**

Date: 17/04/2013 **Described by:** AB/NK **Type:** Quadrat 50 x 50 m

Seasonal Conditions: Excellent

MGA Zone: 50 **Easting:** 793614 mE **Northing:** 7420054 mN

Habitat: Floodplain, Fortescue river to the west and hills to the east.
Soil: Red-brown sandy loam.
Rock Type: Scattered ironstone and quartz, alluvially deposited.
Broad Floristic Formation: *Cenchrus* Open Tussock Grassland.

Vegetation Association: Tall Shrubland of *Acacia sclerosperma* subsp. *sclerosperma* and *A. synchronicia* over Scattered Low Shrubs of *Sida* aff. *echinocarpa* (MET 15,350) over Open Tussock Grassland of **Cenchrus ciliaris*, *Triodia epactia* and *Eragrostis eriopoda*.

Vegetation Sub-Association: Tall Shrubland of *Acacia sclerosperma* subsp. *sclerosperma* and *A. synchronicia* over Scattered Low Shrubs of *Sida* aff. *echinocarpa* (MET 15,350) over Very Open Hummock Grassland of *Triodia epactia* over Open Tussock Grassland of **Cenchrus ciliaris, Eragrostis eriopoda* and *Aristida contorta*.

Veg Condition: Degraded
Fire Age: >10 years
Notes: Disturbance: Grazing.

Leaf Litter: 2%; Bare Ground: 60%.

Species List

Name	Cover (%)	Height (m)
Acacia aptaneura	+	2.50
Acacia bivenosa	+	0.80
Acacia sclerosperma subsp. *sclerosperma*	15.00	3.00
Acacia synchronicia	1.00	3.00
Aristida contorta	1.00	0.20
**Cenchrus ciliaris*	15.00	0.35
Cleome viscosa	+	0.35

Dactyloctenium radulans	+	0.04
Enneapogon caerulescens	+	0.08
Enneapogon polyphyllus	+	0.15
Eragrostis eriopoda	2.00	0.40
Evolvulus alsinoides var. *villosicalyx*	+	0.15
Gomphrena kanisii	+	0.20
Paraneurachne muelleri	+	0.40
**Portulaca oleracea*	+	0.08
Ptilotus aervoides	+	0.04
Ptilotus astrolasius	+	0.45
Ptilotus nobilis	+	0.08
Rhagodia eremaea	+	1.60
Salsola australis	+	0.10
Sclerolaena cornishiana	+	0.15
Sclerolaena costata	+	0.08
Sclerolaena densiflora	+	0.08
Senna artemisioides subsp. *oligophylla*	+	0.30
Senna glutinosa subsp. *luerssenii*	+	0.40
Senna sp. Meekatharra (E. Bailey 1-26)	+	0.40
Sida ?aff. *echinocarpa* (MET 15,350)	1.00	0.50
Sida aff. *fibulifera*	+	0.15
Solanum lasiophyllum	+	0.35
Sporobolus australasicus	+	0.15
Stylobasium spathulatum	+	1.50
Trianthema triquetra	+	0.06
Triodia epactia	5.00	0.40

BHP Ninga

Site **NFV11**

Date: 17/04/2013 **Described by:** AB/NK **Type:** Quadrat 50 x 50 m

Seasonal Conditions: Excellent

MGA Zone: 50 **Easting:** 794352 mE **Northing:** 7419750 mN

Habitat: Floodplain, in between hills and ranges to the north and south.

Soil: Red-brown clay loam.

Rock Type: BIF.

Broad Floristic Formation: *Triodia* Hummock Grassland.

Vegetation Association: Tall Open Shrubland of *Acacia ancistrocarpa* and *Hakea chordophylla* over Hummock Grassland of *Triodia epactia, T. schinzii* and *Bonamia erecta.*

Vegetation Sub-Association: Tall Open Shrubland of *Acacia ancistrocarpa* and *Hakea chordophylla* over Low Open Shrubland of *Bonamia erecta* over Hummock Grassland of *Triodia epactia* and *T. schinzii* over Scattered Tussock Grasses of *Eragrostis eriopoda* over Scattered Herbs of *Scaevola parvifolia* subsp. *pilbarae.*

Veg Condition: Excellent

Fire Age: >10 years

Notes: Disturbance: Grazing.

Leaf Litter; 1%; Bare Ground: 25%.

Species List

Name	Cover (%)	Height (m)
Acacia adoxa var. *adoxa*	+	0.40
Acacia ancistrocarpa	4.00	3.50
Acacia aptaneura	+	2.50
Acacia bivenosa	+	1.70
Acacia elachantha	+	1.80
Acacia pruinocarpa	+	0.80
Aristida holathera var. *holathera*	+	0.30
Bonamia erecta	2.00	0.30
**Cenchrus ciliaris*	+	0.35

Cymbopogon procerus	+	1.00
Duperreya commixta	+	climber
Eragrostis eriopoda	1.00	0.40
Eremophila latrobei subsp. *filiformis*	+	1.60
Eriachne mucronata	+	0.30
Evolvulus alsinoides var. *villosicalyx*	+	0.10
Grevillea wickhamii	+	2.50
Hakea chordophylla	1.00	3.30
Halgania gustafsenii	+	0.60
Hibiscus sturtii var. *platychlamys*	+	0.20
Indigofera monophylla	+	0.40
Paraneurachne muelleri	+	0.35
Perotis rara	+	0.10
Ptilotus astrolasius	+	0.20
Ptilotus nobilis	+	0.15
Scaevola parvifolia subsp. *pilbarae*	1.00	0.30
Solanum cleistogamum	+	0.25
Solanum lasiophyllum	+	0.60
Trichodesma zeylanicum	+	1.00
Triodia epactia	15.00	0.35
Triodia schinzii	25.00	0.35

BHP Ninga

Site **NFV12**

Date: 17/04/2013 **Described by:** AB/NK **Type:** Quadrat 50 x 50 m

Seasonal Conditions: Excellent

MGA Zone: 50 **Easting:** 793201 mE **Northing:** 7420489 mN

Habitat: River and approximately 5 m of the bank on both sides.
Soil: Orange-brown sand.
Rock Type: Alluvial stones and pebbles.
Broad Floristic Formation: *Eucalyptus* Open Forest.

Vegetation Association: Open Forest of *Eucalyptus camaldulensis* subsp. *obtusa* and *E. victrix* over Low Woodland of *Acacia citrinoviridis, Melaleuca glomerata* and *A. coriacea* subsp. *pendens* over Tussock Grassland of **Cenchrus ciliaris, Cyperus vaginatus, Leptochloa digitata, Eulalia aurea*, *Themeda triandra* and *Triodia longiceps*.

Vegetation Sub-Association: Open Forest of *Eucalyptus camaldulensis* subsp. *obtusa* and *E. victrix* over Low Woodland of *Acacia citrinoviridis, Melaleuca glomerata* and *A. coriacea* subsp. *pendens* over Very Open Hummock Grassland of *Triodia longiceps* over Tussock Grassland of **Cenchrus ciliaris, Themeda triandra, Leptochloa digitata* and *Eulalia aurea* over Very Open Sedgeland of *Cyperus vaginatus*.

Veg Condition: Degraded
Fire Age: >10 years
Notes: Disturbance: Grazing, flooding and vehicular.

Leaf Litter: 10%; Bare Ground: 70%.

Species List

Name	Cover (%)	Height (m)
Acacia citrinoviridis	15.00	8.00
Acacia coriacea subsp. *pendens*	3.00	10.00
Acacia sclerosperma var. *sclerosperma*	+	2.20
Aristida contorta	+	0.15
Aristida holathera var. *holathera*	+	0.30
**Cenchrus ciliaris*	32.00	0.40

**Cenchrus setiger*	+	0.35
Cleome viscosa	+	0.40
Cullen leucanthum	+	0.20
Cymbopogon procerus	+	0.80
Cynodon dactylon	+	0.20
Cyperus vaginatus	4.00	1.00
Duperreya commixta	+	climber
Eriachne pulchella	+	0.10
Eucalyptus camaldulensis subsp. *obtusa*	20.00	20.00
Eucalyptus victrix	15.00	20.00
Eulalia aurea	1.00	1.00
Euphorbia australis	+	0.02
Gomphrena kanisii	+	0.15
Gossypium australe	+	1.20
Heliotropium ovalifolium	+	0.20
Leptochloa digitata	2.00	1.00
Melaleuca glomerata	10.00	7.00
Panicum decompositum	+	0.70
Paraneurachne muelleri	+	0.35
Petalostylis labicheoides	+	4.00
Phyllanthus maderaspatensis	+	0.20
Pluchea rubelliflora	+	0.20
Rhynchosia minima	+	0.20
Stemodia grossa	+	0.20
Tephrosia clementii	+	0.40
Themeda triandra	1.00	0.60
Triodia longiceps	2.00	0.40
**Vachellia farnesiana*	+	2.50

BHP Ninga **Site NFV13**

Date: 18/04/2013 **Described by:** AB/NK **Type:** Quadrat 50 x 50 m

Seasonal Conditions: Excellent

MGA Zone: 50 **Easting:** 802488 mE **Northing:** 7416180 mN

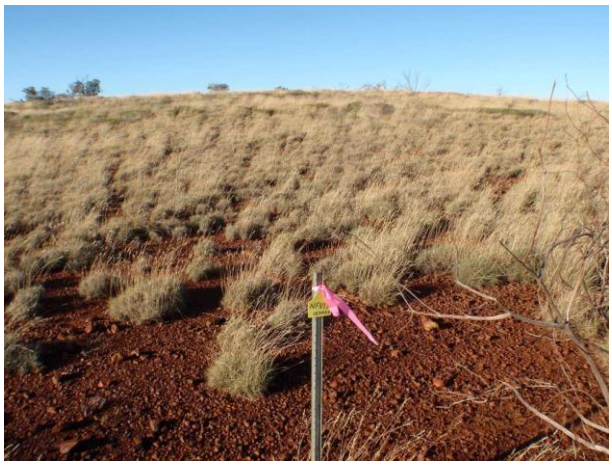
Habitat: Top and upperslope of foothills, ranges to the north.
Soil: Red-brown silty clay.
Rock Type: BIF surface outcrops and ledges, rocks and gravel.
Broad Floristic Formation: *Triodia* Hummock Grassland.

Vegetation Association: Scattered Tall Shrubs of *Acacia pruinocarpa* over Low Open Shrubland of *Acacia hilliana*, *A. adoxa* var. *adoxa* and *Halgania gustafsenii* over Hummock Grassland of *Triodia* sp. Shovelanna Hill (S. van Leeuwen 3835).

Vegetation Sub-Association: Scattered Tall Shrubs of *Acacia pruinocarpa* over Low Open Shrubland of *Acacia hilliana, A. adoxa* var. *adoxa* and *Halgania gustafsenii* over Hummock Grassland of *Triodia* sp. Shovelanna Hill (S. van Leeuwen 3835).

Veg Condition: Excellent
Fire Age: 5-10 years
Notes: Disturbance: Nil.

Leaf Litter: 1%; Bare Ground: 20%.



Species List

Name	Cover (%)	Height (m)
Acacia adoxa var. *adoxa*	2.00	0.50
Acacia aneura	+	1.00
Acacia aptaneura	+	4.50
Acacia bivenosa	+	2.20
Acacia hilliana	5.00	0.50
Acacia maitlandii	+	0.60
Acacia pruinocarpa	1.00	3.00
Calytrix carinata	+	0.40
Eremophila latrobei subsp. *latrobei*	+	1.10

Eriachne lanata	+	0.30
Eriachne mucronata	+	0.35
Grevillea wickhamii	+	2.20
Halgania gustafsenii	1.00	0.20
Indigofera monophylla	+	0.20
Ptilotus calostachyus	+	0.80
Senna artemisioides subsp. *oligophylla*	+	0.90
Senna glutinosa subsp. *glutinosa*	+	1.40
Senna glutinosa subsp. *luerssenii*	+	1.60
Senna glutinosa subsp. *pruinosa*	+	0.80
Solanum lasiophyllum	+	0.50
Triodia sp. Shovelanna Hill (S. van Leeuwen 3835)	35.00	0.20

BHP Ninga

Site **NFV14**

Date: 18/04/2013 **Described by:** AB/NK **Type:** Quadrat 50 x 50 m

Seasonal Conditions: Excellent

MGA Zone: 50 **Easting:** 804138 mE **Northing:** 7415862 mN

Habitat: Floodplain, ranges to the north.
Soil: Red-brown sandy clay loam.
Rock Type: N/A.
Broad Floristic Formation: *Triodia* Hummock Grassland.

Vegetation Association: Low Open Woodland of *Hakea lorea* subsp. *lorea* and *Corymbia aspera* over Scattered Tall Shrubs of *Acacia pruinocarpa* over Hummock Grassland of *Triodia schinzii, Bonamia erecta* and *Duperreya commixta.*

Vegetation Sub-Association: Low Open Woodland of *Hakea lorea* subsp. *lorea* and *Corymbia aspera* over Scattered Tall Shrubs of *Acacia pruinocarpa* over Scattered Low Shrubs of *Bonamia erecta* over Hummock Grassland of *Triodia schinzii* over Scattered Climbers of *Duperreya commixta*.

Veg Condition: Excellent
Fire Age: >10 years
Notes: Disturbance: Nil.

Leaf Litter: 2%; Bare Ground: 15%.

Species List

Name	Cover (%)	Height (m)
Acacia ancistrocarpa	+	2.20
Acacia aptaneura	+	3.20
Acacia bivenosa	+	3.20
Acacia coriacea subsp. *pendens*	+	2.10
Acacia dictyophleba	+	1.50
Acacia pruinocarpa	1.00	3.50
Anthobolus leptomerioides	+	1.60
Aristida holathera var. *holathera*	+	0.40
Bonamia erecta	1.00	0.35

Chrysocephalum pterochaetum	+	0.20
Corymbia aspera	1.00	7.00
Cymbopogon procerus	+	0.60
Dicrastylis cordifolia	+	0.20
Duperreya commixta	1.00	climber
Enneapogon polyphyllus	+	0.35
Eragrostis setifolia	+	0.25
Eremophila longifolia	+	1.50
Evolvulus alsinoides var. *villosicalyx*	+	0.10
Gomphrena kanisii	+	0.15
Hakea lorea subsp. *lorea*	4.00	4.00
Halgania gustafsenii	+	0.30
Indigofera boviperda	+	1.10
Paraneurachne muelleri	+	0.35
Ptilotus astrolasius	+	0.15
Ptilotus nobilis	+	0.20
Scaevola parvifolia subsp. *pilbarae*	+	0.15
Senna artemisioides subsp. *oligophylla*	+	0.40
Sida arenicola	+	0.30
Solanum cleistogamum	+	0.20
Solanum sturtianum	+	1.20
Triodia schinzii	45.00	0.60
Triodia sp. Shovelanna Hill (S. van Leeuwen 3835)	+	0.30

BHP Ninga

Site **NFV15**

Date: 18/04/2013 **Described by:** AB/NK **Type:** Quadrat 50 x 50 m

Seasonal Conditions: Excellent

MGA Zone: 50 **Easting:** 800975 mE **Northing:** 7416652 mN

Habitat: Plain, ranges to the north.
Soil: Red-brown sandy clay loam.
Rock Type: BIF, small pebbles.
Broad Floristic Formation: *Acacia* Tall Open Shrubland.

Vegetation Association: Tall Open Shrubland of *Acacia aptaneura, A. dictylophleba, A. pruinocarpa* and *A. tenuissima* over Scattered Low Shrubs of *Scaevola parvifolia* subsp. *pilbarae* over Open Hummock Grassland of *Triodia* sp. Shovelanna Hill (S. van Leeuwen 3835), *Paraneurachne muelleri* and *Cymbopogon procerus*.

Vegetation Sub-Association: Tall Open Shrubland of *Acacia aptaneura, A. dictylophleba, A. pruinocarpa* and *A. tenuissima* over Scattered Low Shrubs of *Scaevola parvifolia* subsp. *pilbarae* over Open Hummock Grassland of *Triodia* sp. Shovelanna Hill (S. van Leeuwen 3835) over Very Open Tussock Grassland of *Paraneurachne muelleri, Cymbopogon procerus* and *Eulalia aurea*.

Veg Condition: Excellent
Fire Age: 2-5 years
Notes: Disturbance: Clearing, vehicular and machinery.

Leaf Litter: 5%; Bare Ground: 25%.

Species List

Name	Cover (%)	Height (m)
Acacia aptaneura	25.00	2.30
Acacia bivenosa	+	2.40
Acacia coriacea	+	1.20
Acacia dictyophleba	2.00	2.30
Acacia pruinocarpa	3.00	2.50
Acacia tenuissima	1.00	2.00
Acacia tetragonophylla	+	2.00

Aristida holathera var. *holathera*	+	0.30
Aristida latifolia	+	0.60
Bonamia erecta	+	0.35
**Cenchrus ciliaris*	+	0.30
Cymbopogon procerus	1.00	0.80
Duperreya commixta	+	climber
Enchylaena tomentosa var. *tomentosa*	+	0.45
Eragrostis setifolia	+	0.30
Eulalia aurea	1.00	0.50
Evolvulus alsinoides var. *villosicalyx*	+	0.15
Gomphrena kanisii	+	0.20
Hakea lorea subsp. *lorea*	+	2.50
Panicum decompositum	+	0.35
Paraneurachne muelleri	1.00	0.35
Ptilotus calostachyus	+	0.60
Ptilotus nobilis	+	0.20
Salsola australis	+	0.30
Scaevola parvifolia subsp. *pilbarae*	1.00	0.20
Senna artemisioides subsp. *oligophylla*	+	1.60
Sida cardiophylla	+	1.00
Solanum lasiophyllum	+	0.60
Triodia sp. Shovelanna Hill (S. van Leeuwen 3835)	25.00	0.30

BHP Ninga **Site NFV16**

Date: 18/04/2013 **Described by:** AB/NK **Type:** Quadrat 50 x 50 m

Seasonal Conditions: Excellent

MGA Zone: 50 **Easting:** 797942 mE **Northing:** 7416278 mN

Habitat: Floodplain.
Soil: Red-brown sandy clay loam.
Rock Type: N/A.
Broad Floristic Formation: *Acacia* Tall Open Scrub.

Vegetation Association: Tall Open Scrub of *Acacia aptaneura* and *A. catenulata* subsp. *occidentalis* over Very Open Hummock Grassland of *Triodia* sp. Shovelanna Hill (S. van Leeuwen 3835).

Vegetation Sub-Association: Tall Open Scrub of *Acacia aptaneura* and *A. catenulata* subsp. *occidentalis* over Very Open Hummock Grassland of *Triodia* sp. Shovelanna Hill (S. van Leeuwen 3835).

Veg Condition: Excellent
Fire Age: 2-5 years
Notes: Disturbance: Vehicular.

Leaf Litter: 4%; Bare Ground: 35%.

Species List

Name	Cover (%)	Height (m)
Acacia aneura	+	2.20
Acacia aptaneura	45.00	2.00
Acacia catenulata subsp. *occidentalis*	1.00	2.40
Acacia pruinocarpa	+	1.60
Acacia synchronicia	+	1.40
Acacia tenuissima	+	1.40
Acacia tumida var. *pilbarensis*	+	2.20
Aristida contorta	+	0.20
Aristida holathera var. *holathera*	+	0.15

Aristida latifolia	+	0.40
Enneapogon polyphyllus	+	0.30
Eragrostis setifolia	+	0.25
Eremophila forrestii subsp. *forrestii*	+	0.30
Gomphrena kanisii	+	0.15
Panicum decompositum	+	0.20
Petalostylis labicheoides	+	2.50
Psydrax latifolia	+	1.50
Psydrax suaveolens	+	1.00
Senna artemisioides subsp. *oligophylla x helmsii*	+	1.10
Sporobolus australasicus	+	0.25
Triodia sp. Shovelanna Hill (S. van Leeuwen 3835)	5.00	0.30

BHP Ninga

Site **NFV17**

Date: 18/04/2013 **Described by:** AB/NK **Type:** Quadrat 50 x 50 m

Seasonal Conditions: Excellent

MGA Zone: 50 **Easting:** 798518 mE **Northing:** 7416127 mN

Habitat: Plain, ?floodplain.
Soil: Red-brown clay loam.
Rock Type: Ironstone rocks and gravel.
Broad Floristic Formation: *Acacia* Low Woodland.

Vegetation Association: Low Woodland of *Acacia aptaneura, A. citrinoviridis, A. pruinocarpa* and *A. coriacea* subsp. *pendens* over Tall Open Shrubland of *Eremophila fraseri, Acacia catenulata* subsp. *occidentalis* and *Eremophila forrestii* subsp. *forrestii* over Open Tussock Grassland of *Aristida latifolia, A. contorta, Eragrostis eriopoda* and *Triodia* sp. Shovelanna Hill (S. van Leeuwen 3835).

Vegetation Sub-Association: Low Woodland of *Acacia aptaneura, A. citrinoviridis, A. pruinocarpa* and *A. coriacea* subsp. *pendens* over Tall Open Shrubland of *Eremophila fraseri* over Open Shrubland of *Acacia catenulata* subsp. *occidentalis* and *Eremophila forrestii* subsp. *forrestii* over Very Open Hummock Grassland of *Triodia* sp. Shovelanna Hill (S. van Leeuwen 3835) over Open Tussock Grassland of *Aristida latifolia, A. contorta* and *Eragrostis eriopoda*.

Veg Condition: Excellent
Fire Age: 5-10 years
Notes: Disturbance: Grazing and flooding.

Leaf Litter: 2%; Bare Ground: 25%.

Species List

Name	Cover (%)	Height (m)
Acacia aptaneura	15.00	10.00
Acacia catenulata subsp. *occidentalis*	2.00	1.70
Acacia citrinoviridis	2.00	10.00
Acacia coriacea	1.00	12.00
Acacia pruinocarpa	1.00	10.00
Acacia rhodophloia	+	2.00

Acacia tetragonophylla	+	0.35
Anthobolus leptomerioides	+	1.00
Aristida contorta	3.00	0.15
Aristida latifolia	6.00	0.80
Cheilanthes sp.	+	0.20
Corchorus lasiocarpus subsp. *lasiocarpus*	+	0.30
Cymbopogon procerus	+	0.90
Enneapogon polyphyllus	+	0.20
Eragrostis eriopoda	3.00	0.25
Eremophila forrestii subsp. *forrestii*	1.00	1.40
Eremophila fraseri	4.00	6.00
Eremophila latrobei subsp. *filiformis*	+	2.20
Eriachne mucronata	+	0.35
Eulalia aurea	+	0.90
Evolvulus alsinoides var. *villosicalyx*	+	0.10
Gomphrena kanisii	+	0.15
Hibiscus aff. *coatesii*	+	1.20
Hibiscus sturtii ?var.	+	0.20
Keraudrenia nephrosperma	+	1.50
Panicum decompositum	+	0.25
Perotis rara	+	0.10
Ptilotus nobilis	+	0.15
Ptilotus schwartzii	+	0.20
Schizachyrium fragile	+	0.15
Senna artemisioides subsp. *helmsii*	+	0.20
Senna glaucifolia	+	1.60
Senna glutinosa subsp. *luerssenii*	+	1.20
Sida arenicola	+	1.00
Solanum lasiophyllum	+	0.70
Tribulus suberosus	+	1.00
Triodia sp. Shovelanna Hill (S. van Leeuwen 3835)	2.00	0.20
Yakirra australiensis var. *australiensis*	+	0.10

BHP Ninga — Site NFV18

Date:19/04/2013 **Described by:** AB/NK **Type:** Quadrat 25 x 100 m

Seasonal Conditions: Excellent

MGA Zone: 50 **Easting:** 802632 mE **Northing:** 7419005 mN

Habitat: River, between ranges to the north and south.
Soil: Red-brown river sand.
Rock Type: Alluvial stones and pebbles.
Broad Floristic Formation: *Cenchrus* Tussock Grassland.

Vegetation Association: Open Woodland of *Eucalyptus victrix* over Tall Shrubland of *Petalostylis labicheoides*, *Androcalva luteiflora, Acacia bivenosa, A. pyrifolia* and *A. citrinoviridis* over Tussock Grassland of **Cenchrus ciliaris, Themeda triandra* and *Eriachne mucronata*.

Vegetation Sub-Association: Open Woodland of *Eucalyptus victrix* over Tall Shrubland of *Petalostylis labicheoides, Androcalva luteiflora, Acacia bivenosa, A. pyrifolia* and *A. citrinoviridis* over Tussock Grassland of **Cenchrus ciliaris, Themeda triandra* and *Eriachne mucronata*.

Veg Condition: Degraded
Fire Age: >10 years
Notes: Disturbance: Flooding.

Leaf Litter: 3%; Bare Ground: 30%.

Species List

Name	Cover (%)	Height (m)
Abutilon aff. *fraseri*	+	0.80
Acacia aneura	+	2.20
Acacia aptaneura	+	2.00
Acacia bivenosa	6.00	5.00
Acacia citrinoviridis	1.00	5.00
Acacia maitlandii	1.00	3.00
Acacia monticola	+	3.50
Acacia pyrifolia	1.00	2.20

Amaranthus undulatus	+	0.20
Aristida holathera var. *holathera*	+	0.25
Aristida latifolia	+	0.80
**Bidens bipinnata*	+	0.35
Boerhavia coccinea	+	0.15
Bulbostylis barbata	+	0.10
**Cenchrus ciliaris*	40.00	0.80
Cleome viscosa	+	0.35
Santalum lanceolatum	1.00	2.00
Corchorus lasiocarpus subsp. *lasiocarpus*	+	0.60
Corchorus tridens	+	0.15
Crotalaria medicaginea	+	0.45
Cucumis maderaspatanus	+	climber
Cymbopogon procerus	+	0.80
Dissocarpus paradoxus	+	0.90
Duperreya commixta	+	climber
Enneapogon polyphyllus	+	0.25
Eragrostis cumingii	+	0.15
Eragrostis eriopoda	+	0.30
Eriachne mucronata	3.00	0.35
Eucalyptus victrix	8.00	10.00
Eulalia aurea	+	0.90
Euphorbia biconvexa	+	0.30
Evolvulus alsinoides var. *villosicalyx*	+	0.20
Glycine canescens	+	climber
Gomphrena cunninghamii	+	0.20
Gomphrena kanisii	+	0.08
Goodenia lamprosperma	+	0.30
Gossypium robinsonii	+	1.20
Grevillea wickhamii	+	1.00
Hybanthus aurantiacus	+	0.20
Indigofera monophylla	+	0.45
Jasminum didymum	+	0.35
Melaleuca glomerata	+	1.30
Paraneurachne muelleri	+	0.40
Perotis rara	+	0.10
Petalostylis labicheoides	8.00	3.50
Pluchea dentex	1.00	0.35

Polycarpaea longiflora	+	0.25
Rhynchosia minima	+	climber
Androcalva luteiflora	6.00	2.50
Salsola australis	+	0.40
Senna artemisioides subsp. *helmsii*	+	0.30
Senna glaucifolia	+	0.30
Senna oligophylla	+	0.90
Setaria verticillata	+	0.15
Sida aff. *fibulifera*	+	0.15
Solanum lasiophyllum	+	0.40
Sporobolus australasicus	+	0.20
Themeda triandra	3.00	0.80
Trichodesma zeylanicum	+	0.70
Triodia epactia	+	0.60
Triumfetta appendiculata	+	0.20

BHP Ninga

Site **NFV19**

Date: 19/04/2013 **Described by:** AB/NK **Type:** Quadrat 50 x 50 m

Seasonal Conditions: Excellent

MGA Zone: 50 **Easting:** 801995 mE **Northing:** 7418879 mN

Habitat: Upper and lowerslopes, facing north.
Soil: Red-brown clay loam.
Rock Type: BIF.
Broad Floristic Formation: *Triodia* Open Hummock Grassland.

Vegetation Association: Tall Open Shrubland of *Acacia inaequilatera* over Scattered Shrubs of *Senna glutinosa* subsp. *pruinosa* over Open Hummock Grassland of *Triodia epactia*.

Vegetation Sub-Association: Tall Open Shrubland of *Acacia inaequilatera* over Scattered Shrubs of *Senna glutinosa* subsp. *pruinosa* over Open Hummock Grassland of *Triodia epactia*.

Veg Condition: Excellent
Fire Age: 5-10 years
Notes: Disturbance: Nil.

Leaf Litter: 1%; Bare Ground: 20%.

Species List

Name	Cover (%)	Height (m)
Acacia hilliana	+	0.40
Acacia inaequilatera	2.00	5.00
Acacia maitlandii	+	1.40
Aristida contorta	+	0.15
Aristida holathera var. *holathera*	28.00	0.25
Aristida latifolia	+	0.25
Bonamia media	+	0.03
Corchorus lasiocarpus ?subsp.	+	0.35
Cymbopogon procerus	+	0.40

Enneapogon polyphyllus	+	0.15
Eriachne lanata	+	0.15
Eriachne mucronata	+	0.40
Hakea lorea subsp. *lorea*	+	1.00
Indigofera monophylla	+	0.30
Ptilotus calostachyus	+	0.90
Senna artemisioides subsp. *helmsii*	+	0.15
Senna artemisioides subsp. *oligophylla*	+	1.00
Senna glutinosa subsp. *pruinosa*	1.00	1.50
Tribulus suberosus	+	0.35
Triodia basedowii	+	0.20
Triodia epactia	28	0.25

BHP Ninga

Site **NFV20**

Date: 19/04/2013 **Described by:** AB/NK **Type:** Quadrat 50 x 50 m

Seasonal Conditions: Excellent

MGA Zone: 50 **Easting:** 800843 mE **Northing:** 7418683 mN

Habitat: Top of the range.
Soil: Red-brown clay loam.
Rock Type: BIF, sheet outcropping, rocks and gravel.
Broad Floristic Formation: *Acacia* Low Shrubland.

Vegetation Association: Low Open Woodland of *Eucalyptus kingsmillii* subsp. *kingsmillii* and *Grevillea berryana* over Low Shrubland of *Acacia hilliana*, *Keraudrenia velutina* subsp. *elliptica* and *Calytrix carinata* over Very Open Hummock Grassland of *Triodia* sp. Shovelanna Hill (S. van Leeuwen 3835) and *Eriachne lanata*.

Vegetation Sub-Association: Low Open Woodland of *Eucalyptus kingsmillii* subsp. *kingsmillii* over Scattered Shrubs of *Grevillea berryana* over Low Shrubland of *Acacia hilliana*, *Keraudrenia velutina* subsp. *elliptica, Calytrix carinata* and *Halgania gustafsenii* over Very Open Hummock Grassland of *Triodia* sp. Shovelanna Hill (S. van Leeuwen 3835) over Scattered Tussock Grasses of *Eriachne lanata.*

Veg Condition: Excellent
Fire Age: 2-5 years
Notes: Disturbance: Vehicular and machinery, very old track dissects quadrat.

Leaf Litter: 1%; Bare Ground: 20%.

Species List

Name	Cover (%)	Height (m)
Acacia adoxa var. *adoxa*	+	0.30
Acacia hamersleyensis	+	2.50
Acacia hilliana	12.00	0.25
Amphipogon sericeus	+	0.25
Anthobolus leptomerioides	+	1.10
Aristida holathera var. *holathera*	+	0.25

Calytrix carinata	5.00	0.35
Chrysocephalum pterochaetum	+	0.25
Codonocarpus cotinifolius	+	1.40
Dicrastylis cordifolia	+	0.20
Duperreya commixta	+	climber
Enneapogon polyphyllus	+	0.15
Eragrostis setifolia	+	0.20
Eremophila latrobei	+	1.50
Eriachne lanata	1.00	0.30
Eriachne mucronata	+	0.20
Eucalyptus kingsmillii subsp. *kingsmillii*	3.00	3.00
Grevillea berryana	1.00	1.60
Grevillea wickhamii	+	2.00
Hakea chordophylla	+	2.50
Halgania gustafsenii	2.00	0.30
Heliotropium ovalifolium	+	0.25
Hybanthus aurantiacus	+	0.20
Keraudrenia velutina subsp. *elliptica*	10.00	0.40
Lamarchea sulcata	+	0.90
Petalostylis labicheoides	+	1.60
Ptilotus nobilis	+	0.40
Schizachyrium fragile	+	0.10
Senna artemisioides subsp. *helmsii*	+	1.00
Senna glutinosa subsp. *glutinosa*	+	1.20
Solanum cleistogamum	+	0.10
Solanum lasiophyllum	+	0.30
Stackhousia intermedia	+	0.20
Triodia sp. Shovelanna Hill (S. van Leeuwen 3835)	10.00	0.25
Waltheria virgata	+	0.60

BHP Ninga

Site **NFV21**

Date: 19/04/2013 **Described by:** AB/NK **Type:** Quadrat 50 x 50 m

Seasonal Conditions: Excellent

MGA Zone: 50 **Easting:** 799646 mE **Northing:** 7418253 mN

Habitat: Foothill, south of the ranges and in between drainage.
Soil: Red-brown sandy clay loam.
Rock Type: BIF.
Broad Floristic Formation: *Amphipogon* Open Tussock Grassland.

Vegetation Association: Open Tussock Grassland of *Amphipogon sericeus, Paraneurachne muelleri* and *Triodia basedowii.*

Vegetation Sub-Association: Scattered Hummock Grasses of *Triodia basedowii* over Open Tussock Grassland of *Amphipogon sericeus* and *Paraneurachne muelleri*.

Veg Condition: Excellent
Fire Age: 2-5 years
Notes: Disturbance: Nil.

Leaf Litter: 1%; Bare Ground: 35%.

Species List

Name	Cover (%)	Height (m)
Acacia ancistrocarpa	+	2.20
Acacia bivenosa	+	2.00
Amphipogon sericeus	18.00	0.20
Aristida contorta	+	0.15
Calytrix carinata	+	0.80
Corchorus lasiocarpus ?subsp.	+	0.20
Corymbia aspera	+	5.00
Cymbopogon procerus	+	0.30
Duperreya commixta	+	climber
Eragrostis setifolia	+	0.20
Eriachne lanata	+	0.15

Eriachne mucronata	+	0.30
Fimbristylis simulans	+	0.10
Gomphrena kanisii	+	0.15
Goodenia sp.	+	0.05
Goodenia stobbsiana	+	0.15
Paraneurachne muelleri	1.00	0.30
Ptilotus astrolasius	+	0.15
Ptilotus calostachyus	+	0.60
Ptilotus nobilis	+	0.15
Senna artemisioides subsp. *oligophylla x helmsii*	+	0.30
Senna glutinosa subsp. *luerssenii*	+	1.40
Senna glutinosa subsp. *pruinosa*	+	1.60
Solanum lasiophyllum	+	0.30
Tribulus suberosus	+	0.20
Triodia basedowii	1.00	0.20
Triodia sp. Shovelanna Hill (S. van Leeuwen 3835)	+	0.15

BHP Ninga

Site **NFV22**

Date: 20/04/2013 **Described by:** AB/NK **Type:** Quadrat 25 x 100 m

Seasonal Conditions: Excellent

MGA Zone: 50 **Easting:** 804369 mE **Northing:** 7418280 mN

Habitat: Incised minor creekline, ranges to the south and hills to the north.

Soil: Red-brown river sand.

Rock Type: BIF rocks, alluvially deposited.

Broad Floristic Formation: *Themeda* Tussock Grassland.

Vegetation Association: Open Woodland of *Eucalyptus kingsmillii* subsp. *kingsmillii* and *E. leucophloia* subsp. *leucophloia* over Tall Open Scrub of *Acacia monticola, Santalum lanceolatum* and *Androcalva luteiflora* over Tussock Grassland of *Themeda triandra, Triodia epactia* and *Eulalia aurea.*

Vegetation Sub-Association: Open Woodland of *Eucalyptus kingsmillii* subsp. *kingsmillii* and *E. leucophloia* subsp. *leucophloia* over Tall Open Scrub of *Acacia monticola, Santalum lanceolatum* and *A. bivenosa* over Open Shrubland of *Androcalva luteiflora* over Very Open Hummock Grassland of *Triodia epactia* over Tussock Grassland of *Themeda triandra* and *Eulalia aurea* over Scattered Climbers of *Duperreya commixta.*

Veg Condition: Excellent

Fire Age: >10 years

Notes: Disturbance: Nil.

Leaf Litter: 2%; Bare Ground: 10%.

Notes: Some of the species have come from the low hill to the east that graduates into the drainage line.

Species List

Name	Cover (%)	Height (m)
Abutilon aff. *fraseri*	+	0.70
Abutilon aff. *lepidum*	+	0.30
Abutilon leucopetalum	+	0.50
Acacia ancistrocarpa	+	2.10

Acacia aneura	+	1.80
Acacia aptaneura	+	1.50
Acacia bivenosa	4.00	3.50
Acacia citrinoviridis	+	1.20
Acacia hilliana	+	0.30
Acacia maitlandii	+	1.40
Acacia monticola	35.00	3.50
Acacia tetragonophylla	+	1.50
Aristida holathera var. *holathera*	+	0.35
**Bidens bipinnata*	+	0.25
Santalum lanceolatum	8.00	2.10
Corchorus lasiocarpus subsp. *lasiocarpus*	+	0.30
Cymbopogon procerus	+	0.70
Duperreya commixta	1.00	climber
Eragrostis cumingii	+	0.20
Eragrostis eriopoda	+	0.25
Eriachne mucronata	1.00	0.25
Eucalyptus kingsmillii subsp. *kingsmillii*	2.00	6.00
Eucalyptus leucophloia subsp. *leucophloia*	1.00	20.00
Eulalia aurea	3.00	0.90
Euphorbia biconvexa	+	0.30
Evolvulus alsinoides var. *villosicalyx*	+	0.20
Glycine canescens	+	climber
Gomphrena kanisii	+	0.30
Gossypium robinsonii	+	3.00
Grevillea wickhamii	+	2.10
Hybanthus aurantiacus	+	0.30
Jasminum didymum	+	1.60
Paraneurachne muelleri	+	0.30
Perotis rara	+	0.10
Phyllanthus maderaspatensis	+	0.35
Ptilotus astrolasius	+	0.20
Ptilotus nobilis	+	0.40
Rhynchosia minima	+	climber
Androcalva luteiflora	5.00	1.60
Senna artemisioides subsp. *helmsii*	+	0.50
Senna artemisioides subsp. *oligophylla*	+	1.10
Senna glaucifolia	+	0.80

Senna glutinosa subsp. *luerssenii*	+	1.10
Senna glutinosa subsp. *pruinosa*	+	1.80
Setaria surgens	+	0.15
Sida aff. *fibulifera*	+	0.15
Sida arenicola	+	1.20
Solanum lasiophyllum	+	0.20
Themeda triandra	40.00	0.80
Trichodesma zeylanicum	+	0.20
Triodia epactia	10.00	0.40
Triumfetta appendiculata	+	0.20

BHP Ninga

Site **NFV23**

Date: 20/04/2013 **Described by:** AB/NK **Type:** Quadrat 50 x 50 m

Seasonal Conditions: Excellent

MGA Zone: 50 **Easting:** 804296 mE **Northing:** 7418991 mN

Habitat: Top of the ranges.
Soil: Red-brown clay loam.
Rock Type: BIF.
Broad Floristic Formation: *Triodia* Open Hummock Grassland.

Vegetation Association: Low Shrubland of *Acacia hilliana, Mirbelia viminale* and *A. adoxa* var. *adoxa* over Open Hummock Grassland of *Triodia basedowii, T.* sp. Shovelanna Hill (S. van Leeuwen 3835), *Eriachne mucronata* and *Eragrostis setifolia*.

Vegetation Sub-Association: Low Shrubland of *Acacia hilliana, Mirbelia viminale* and *A. adoxa* var.*adoxa* over Open Hummock Grassland of *Triodia basedowii* and *T.* sp. Shovelanna Hill (S. van Leeuwen 3835) over Very Open Tussock Grassland of *Eriachne mucronata* and *Eragrostis setifolia*.

Veg Condition: Excellent
Fire Age: 2-5 years
Notes: Disturbance: Nil.

Leaf Litter: 1%; Bare Ground: 30%.

Notes: There are *Eucalytpus leucophloia* hills that have been recently burnt.

Species List

Name	Cover (%)	Height (m)
Acacia adoxa var. *adoxa*	1.00	0.25
Acacia hilliana	10.00	0.30
Acacia maitlandii	+	1.40
Acacia tetragonophylla	+	1.20
Amphipogon sericeus	+	0.20
Aristida holathera var. *holathera*	+	0.20
Calytrix carinata	+	0.25

Corymbia hamersleyana	+	2.50
Cymbopogon procerus	+	0.50
Dicrastylis cordifolia	+	0.20
Eragrostis setifolia	1.00	0.25
Eremophila latrobei subsp. *latrobei*	+	1.20
Eriachne lanata	+	0.20
Eriachne mucronata	1.00	0.25
Eucalyptus leucophloia subsp. *leucophloia*	+	3.50
Goodenia stobbsiana	+	0.15
Grevillea berryana	+	1.30
Grevillea wickhamii	+	1.20
Hakea chordophylla	+	3.50
Hibiscus sturtii var. *truncatus*	+	0.15
Hybanthus aurantiacus	+	0.25
Mirbelia viminalis	3.00	1.00
Petalostylis labicheoides	+	1.80
Ptilotus calostachyus	+	0.60
Ptilotus nobilis	+	0.15
Schizachyrium fragile	+	0.10
Senna glutinosa subsp. *glutinosa*	+	1.10
Senna glutinosa subsp. *luerssenii*	+	1.20
Senna glutinosa subsp. *pruinosa*	+	1.00
Sida sp. Excedentifolia (J.L. Egan 1925)	+	0.15
Solanum lasiophyllum	+	0.20
Triodia basedowii	20.00	0.25
Triodia epactia	+	0.15
Triodia sp. Shovelanna Hill (S. van Leeuwen 3835)	2.00	0.25
Waltheria virgata	+	0.30

BHP Ninga **Site NFV24**

Date: 20/04/2013 **Described by:** AB/NK **Type:** Quadrat 50 x 50 m

Seasonal Conditions: Excellent

MGA Zone: 50 **Easting:** 802977 mE **Northing:** 7418204 mN

Habitat: Top of the ranges and upperslopes.
Soil: Red-brown clay loam.
Rock Type: BIF, some small sheet outcrops, rocks and gravel.
Broad Floristic Formation: *Triodia* Open Hummock Grassland.

Vegetation Association: Low Open Woodland of *Eucalyptus leucophloia* subsp. *leucophloia* over Shrubland of *Acacia hilliana* and *Grevillea wickhamii* over Open Hummock Grassland of *Triodia* sp. Shovelanna Hill (S. van Leeuwen 3835) and *T. basedowii*.

Vegetation Sub-Association: Low Open Woodland of *Eucalyptus leucophloia* subsp. *leucophloia* over Scattered Shrubs of *Grevillea wickhamii* over Low Shrubland of *Acacia hilliana* over Open Hummock Grassland of *Triodia* sp. Shovelanna Hill (S. van Leeuwen 3835) and *T. basedowii*.

Veg Condition: Excellent
Fire Age: >10 years
Notes: Disturbance: Nil.

Leaf Litter: 2%; Bare Ground: 25%.

Species List

Name	Cover (%)	Height (m)
Acacia adoxa var. *adoxa*	+	0.25
Acacia hilliana	18.00	0.25
Aristida contorta	+	0.10
Aristida holathera var. *holathera*	+	0.35
Aristida latifolia	+	0.50
Calytrix carinata	+	0.35
Corchorus lasiocarpus subsp. *lasiocarpus*	+	0.25
Cymbopogon procerus	+	0.70

Eremophila latrobei subsp. *filiformis*	+	1.70
Eriachne lanata	+	0.15
Eriachne mucronata	+	0.20
Eucalyptus leucophloia subsp. *leucophloia*	2.00	5.50
Grevillea berryana	+	1.60
Grevillea wickhamii	1.00	2.00
Hakea chordophylla	+	2.20
Halgania gustafsenii	+	0.30
Hybanthus aurantiacus	+	0.15
Keraudrenia velutina subsp. *elliptica*	+	0.50
Paraneurachne muelleri	+	0.40
Ptilotus calostachyus	+	0.70
Schizachyrium fragile	+	0.15
Senna artemisioides subsp. *oligophylla*	+	0.40
Senna glutinosa subsp. *glutinosa*	+	1.70
Senna glutinosa subsp. *luerssenii*	+	1.00
Senna glutinosa subsp. *pruinosa*	+	1.50
Senna sp. Meekatharra (E. Bailey 1-26)	+	1.10
Solanum lasiophyllum	+	0.30
Triodia basedowii	2.00	0.20
Triodia sp. Shovelanna Hill (S. van Leeuwen 3835)	25.00	0.25
Waltheria virgata	+	0.20

BHP Ninga **Site NFV25**

Date:20/04/2013 **Described by:** AB/NK **Type:** Quadrat 25 x 100 m

Seasonal Conditions: Excellent

MGA Zone: 50 **Easting:** 801543 mE **Northing:** 7417492 mN

Habitat: Wide drainage, flowing down south from the ranges.

Soil: Red-brown sand.

Rock Type: BIF.

Broad Floristic Formation: *Cenchrus* Tussock Grassland.

Vegetation Association: Low Open Woodland of *Corymbia hamersleyana* and *Acacia citrinoviridis* over Tall Open Shrubland of *Petalostylis labicheoides, Santalum lanceolatum* and *Grevillea wickhamii* over Tussock Grassland of **Cenchrus ciliaris, Enneapogon robustissimus, Triodia epactia* and *Eriachne mucronata.*

Vegetation Sub-Association: Low Open Woodland of *Corymbia hamersleyana* and *Acacia citrinoviridis* over Tall Open Shrubland of *Petalostylis labicheoides* and *Grevillea wickhamii* over Open Shrubland of *Santalum lanceolatum* over Very Open Hummock Grassland of *Triodia epactia* over Tussock Grassland of **Cenchrus ciliaris, Enneapogon robustissimus, Themeda triandra*, *Cymbopogon procerus* and *Eriachne mucronata*.

Veg Condition: Excellent

Fire Age: 5-10 years

Notes: Disturbance: Flooding.

Leaf Litter: 2%; Bare Ground: 45%.

Species List

Name	Cover (%)	Height (m)
Abutilon aff. *fraseri*	+	0.35
Abutilon leucopetalum	+	0.15
Acacia aptaneura	+	2.50
Acacia citrinoviridis	10.00	10.00
Acacia inaequilatera	+	1.80
Acacia maitlandii	+	3.20
Acacia pyrifolia	+	0.90
Acacia tenuissima	+	1.90
Amaranthus mitchellii	+	0.25
Aristida holathera var. *holathera*	+	0.35
Aristida latifolia	+	0.40
**Bidens bipinnata*	+	0.20
Boerhavia coccinea	+	climber
**Cenchrus ciliaris*	35.00	0.60
Cleome viscosa	+	0.50
Santalum lanceolatum	2.00	1.50
Corchorus lasiocarpus subsp. *lasiocarpus*	+	0.40
Corymbia hamersleyana	3.00	6.00
Cymbopogon procerus	1.00	0.90
Dissocarpus paradoxus	+	1.20
Dodonaea pachyneura	+	1.80
Duperreya commixta	+	climber
Enneapogon polyphyllus	+	0.25
Enneapogon robustissimus	3.00	0.90
Enteropogon ramosus	+	0.35
Eragrostis cumingii	+	0.25

Eragrostis eriopoda	+	0.35
Eriachne mucronata	2.00	0.30
Eulalia aurea	+	0.80
Euphorbia biconvexa	+	0.25
Evolvulus alsinoides var. *villosicalyx*	+	0.10
Glycine canescens	+	climber
Gomphrena cunninghamii	+	0.15
Gomphrena kanisii	+	0.20
Goodenia sp.	+	0.10
Gossypium robinsonii	+	2.50
Grevillea wickhamii	1.00	3.50
Hybanthus aurantiacus	+	0.40
Indigofera boviperda	+	1.00
Isotropis forrestii	+	0.80
Paraneurachne muelleri	+	0.30
Petalostylis labicheoides	3.00	2.20
Polycarpaea longiflora	+	0.20
Ptilotus nobilis	+	0.30
Ptilotus obovatus	+	0.70
Ptilotus rotundifolius	+	1.00
Rhagodia eremaea	+	1.20
Rhynchosia minima	+	climber
Androcalva luteiflora	+	1.10
Rutidosis helichrysoides	+	0.25
Senna artemisioides subsp. *helmsii*	+	0.15
Senna artemisioides subsp. *oligophylla*	+	1.00
Senna artemisioides subsp. *oligophylla x helmsii*	+	0.25
Senna glutinosa subsp. *glutinosa*	+	0.30
Senna oligophylla	+	1.70
Setaria surgens	+	0.30
Sida aff. *fibulifera*	+	0.15
Solanum lasiophyllum	+	0.40
Tephrosia rosea var. *clementii*	1.00	0.60
Themeda triandra	1.00	0.60
Trichodesma zeylanicum	+	0.60
Triodia epactia	2.00	0.30
Triumfetta appendiculata	+	0.40

BHP Ninga **Site NFV26**

Date: 20/04/2013 **Described by:** AB/NK **Type:** Quadrat 50 x 50 m

Seasonal Conditions: Excellent

MGA Zone: 50 **Easting:** 797444 mE **Northing:** 7418095 mN

Habitat: Floodplain, ranges trail to the north.
Soil: Red-brown silty clay.
Rock Type: ?Gilgai gravel, crust.
Broad Floristic Formation: *Acacia* Low Open Woodland.

Vegetation Association: Low Open Woodland of *Acacia catenulata* subsp. *occidentalis* and *A. aptaneura* over Very Open Tussock Grassland of *Aristida contorta, Triodia basedowii, Eriachne pulchella* and *Maireana tomentosa*.

Vegetation Sub-Association: Low Open Woodland of *Acacia catenulata* subsp. *occidentalis* and *A. aptaneura* over Very Open Hummock Grassland of *Triodia basedowii* over Very Open Tussock Grassland of *Aristida contorta* and *Eriachne pulchella* over Scattered Herbs of *Maireana tomentosa*.

Veg Condition: Excellent
Fire Age: >10 years
Notes: Disturbance: Grazing and vehicular.

Leaf Litter: 1%; Bare Ground: 65%.

Species List

Name	Cover (%)	Height (m)
Acacia aptaneura	3.00	4.50
Acacia catenulata subsp. *occidentalis*	4.00	6.50
Acacia synchronicia	+	2.50
Aristida contorta	2.00	0.25
Aristida latifolia	+	0.50
Cucumis maderaspatanus	+	climber
Eragrostis eriopoda	+	0.40
Eremophila forrestii	+	0.15
Eriachne mucronata	+	0.20

Eriachne pulchella	1.00	0.10
Eulalia aurea	+	0.15
Maireana tomentosa	1.00	0.20
Paraneurachne muelleri	+	0.30
Perotis rara	+	0.10
Psydrax suaveolens	+	1.40
Rhagodia eremaea	+	0.80
Salsola australis	+	0.20
Sclerolaena cornishiana	+	0.15
Senna artemisioides subsp. *oligophylla*	+	1.20
Triodia basedowii	2.00	0.20

BHP Ninga

Site **NFV27**

Date: 21/04/2013 **Described by:** AB/NK **Type:** Quadrat 50 x 50 m

Seasonal Conditions: Excellent

MGA Zone: 50 **Easting:** 795844 mE **Northing:** 7418909 mN

Habitat: Upperslope of hills and ranges, south facing.
Soil: Red-brown clay loam.
Rock Type: BIF.
Broad Floristic Formation: *Triodia* Open Hummock Grassland.

Vegetation Association: Low Open Woodland of *Eucalyptus leucophloia* subsp. *leucophloia* over Low Shrubland of *Acacia hilliana, A. adoxa* var. *adoxa* and *Keraudrenia velutina* subsp. *elliptica* over Open Hummock Grassland of *Triodia basedowii*, *T.* sp. Shovelanna Hill (S. van Leeuwen 3835), *T. epactia* and *Eriachne lanata*.

Vegetation Sub-Association: Low Open Woodland of *Eucalyptus leucophloia* subsp. *leucophloia* over Low Shrubland of *Acacia hilliana, A. adoxa* var. *adoxa* and *Keraudrenia velutina* subsp. *elliptica* over Open Hummock Grassland of *Triodia basedowii, T.* sp. Shovelanna Hill (S. van Leeuwen 3835) and *T. epactia* over Scattered Tussock Grasses of *Eriachne lanata*.

Veg Condition: Excellent
Fire Age: >10 years
Notes: Disturbance: Vehicular.

Leaf Litter: 1%; Bare Ground: 20%.

Species List

Name	Cover (%)	Height (m)
Acacia adoxa var. *adoxa*	3.00	0.25
Acacia aneura	+	0.90
Acacia bivenosa	+	1.50
Acacia hilliana	15.00	0.50
Acacia pruinocarpa	+	1.00
Aristida holathera var. *holathera*	+	0.15
Aristida latifolia	+	0.35

Calytrix carinata	+	0.15
Chrysocephalum pterochaetum	+	0.20
Codonocarpus cotinifolius	+	2.20
Duperreya commixta	+	climber
Enneapogon robustissimus	+	0.20
Eriachne lanata	1.00	0.35
Eucalyptus leucophloia subsp. *leucophloia*	2.00	5.00
Goodenia stobbsiana	+	0.15
Grevillea berryana	+	0.90
Hakea chordophylla	+	1.80
Hybanthus aurantiacus	+	0.25
Keraudrenia velutina subsp. *elliptica*	1.00	0.50
Lamarchea sulcata	+	1.30
Mirbelia viminalis	+	0.60
Paraneurachne muelleri	+	0.25
Petalostylis labicheoides	+	0.60
Ptilotus astrolasius	+	0.20
Ptilotus calostachyus	+	0.40
Ptilotus obovatus	+	1.00
Senna glutinosa subsp. *luerssenii*	+	1.00
Senna glutinosa subsp. *pruinosa*	+	1.70
Senna sp. Meekatharra (E. Bailey 1-26)	+	1.70
Solanum lasiophyllum	+	0.40
Triodia basedowii	10.00	0.25
Triodia epactia	4.00	0.40
Triodia sp. Shovelanna Hill (S. van Leeuwen 3835)	10.00	0.20

BHP Ninga

Site **NFV28**

Date: 21/04/2013 **Described by:** AB/NK **Type:** Quadrat 50 x 50 m

Seasonal Conditions: Excellent

MGA Zone: 50 **Easting:** 801786 mE **Northing:** 7418028 mN

Habitat: Upperslopes of a range.
Soil: Red-brown clay loam.
Rock Type: BIF, sheet outcrops and rocks.
Broad Floristic Formation: *Triodia* Hummock Grassland.

Vegetation Association: Low Open Woodland of *Eucalytpus leucophloia* subsp. *leucophloia* over Tall Open Shrubland of *Acacia pruinocarpa* and *A. hilliana* over Hummock Grassland of *Triodia epactia, T. basedowii* and *T*. sp. Shovelanna Hill (S. van Leeuwen 3835).

Vegetation Sub-Association: Low Open Woodland of *Eucalytpus leucophloia* subsp. *leucophloia* over Tall Open Shrubland of *Acacia pruinocarpa* over Scattered Low Shrubs of *Acacia hilliana* over Hummock Grassland of *Triodia epactia, T. basedowii* and *T*. sp. Shovelanna Hill (S. van Leeuwen 3835).

Veg Condition: Excellent
Fire Age: >10 years
Notes: Disturbance: Nil.

Leaf Litter: 2%; Bare Ground: 15%.

Species List

Name	Cover (%)	Height (m)
Acacia aptaneura	+	2.00
Acacia bivenosa	+	1.80
Acacia hamersleyensis	+	2.20
Acacia hilliana	1.00	0.60
Acacia maitlandii	+	1.20
Acacia pruinocarpa	1.00	2.50
Acacia pteraneura	+	1.00
Eremophila latrobei subsp. *filiformis*	+	1.30

Eremophila latrobei subsp. *latrobei*	+	1.30
Eriachne lanata	+	0.30
Eriachne pulchella	+	0.10
Eucalyptus leucophloia	2.00	6.00
Goodenia stobbsiana	+	0.35
Grevillea berryana	+	1.80
Grevillea wickhamii	+	2.20
Hakea chordophylla	+	2.00
Ptilotus calostachyus	+	0.35
Senna artemisioides subsp. *oligophylla x helmsii*	+	0.60
Senna glutinosa subsp. *glutinosa*	+	2.00
Senna glutinosa subsp. *luerssenii*	+	1.40
Senna glutinosa subsp. *pruinosa*	+	0.35
Solanum lasiophyllum	+	0.35
Tribulus suberosus	+	1.00
Triodia basedowii	4.00	0.25
Triodia epactia	25.00	0.50
Triodia sp. Shovelanna Hill (S. van Leeuwen 3835)	1.00	0.20

BHP Ninga **Site NFV29**

Date: 21/04/2013 **Described by:** AB/NK **Type:** Quadrat 50 x 50 m

Seasonal Conditions: Excellent

MGA Zone: 50 **Easting:** 802510 mE **Northing:** 7416955 mN

Habitat: Floodplain in between drainage lines, from the ranges in the north. Below foothills

Soil: Red-brown sandy clay loam.

Rock Type: BIF and quartz.

Broad Floristic Formation: *Acacia* Tall Shrubland.

Vegetation Association: Tall Shrubland of *Acacia pruinocarpa, A. catenulata* subsp. *occidentalis* and *A. aptaneura* over Shrubland of *Acacia aneura, A. bivenosa* and *Eremophila forrestii* subsp. *forrestii* over Very Open Hummock Grassland of *Triodia basedowii, Aristida contorta* and *Maireana tomentosa*.

Vegetation Sub-Association: Tall Shrubland of *Acacia pruinocarpa, A. catenulata* subsp. *occidentalis* and *A. aptaneura* over Shrubland of *Acacia aneura, A. bivenosa* and *Eremophila forrestii* subsp. *forrestii* over Scattered Hummock Grasses of *Triodia basedowii* over Scattered Tussock Grasses of *Aristida contorta* over Scattered Herbs of *Maireana tomentosa*.

Veg Condition: Excellent

Fire Age: 5-10 years

Notes: Disturbance: Flooding and vehicular.

Leaf Litter: 5%; Bare Ground: 35%.

Species List

Name	Cover (%)	Height (m)
Acacia aneura	1.00	2.00
Acacia aptaneura	10.00	2.50
Acacia bivenosa	1.00	2.00
Acacia catenulata subsp. *occidentalis*	4.00	5.50
Acacia dictyophleba	+	1.50
Acacia pachyacra	+	1.60
Acacia pruinocarpa	20.00	3.00

Acacia tetragonophylla	+	1.00
Anthobolus leptomerioides	+	1.90
Aristida contorta	1.00	0.15
Aristida holathera var. *holathera*	+	0.25
Aristida latifolia	+	0.35
Cenchrus ciliaris	+	0.50
Corymbia hamersleyana	+	5.00
Cymbopogon procerus	+	0.60
Duperreya commixta	+	climber
Enneapogon polyphyllus	+	0.15
Eragrostis setifolia	+	0.35
Eremophila forrestii subsp. *forrestii*	2.00	1.50
Eremophila latrobei subsp. *latrobei*	+	1.70
Eriachne mucronata	+	0.20
Eriachne pulchella	+	0.10
Eucalyptus gamophylla	+	4.00
Eucalyptus leucophloia subsp. *leucophloia*	1.00	2.50
Eulalia aurea	+	0.50
Evolvulus alsinoides var. *villosicalyx*	+	0.10
Gomphrena kanisii	+	0.20
Goodenia microptera	+	0.20
Grevillea wickhamii	+	1.40
Hibiscus sturtii var. *truncatus*	+	0.15
Hybanthus aurantiacus	+	0.25
Maireana tomentosa	1.00	0.35
Paraneurachne muelleri	+	0.30
Psydrax latifolia	+	1.50
Ptilotus astrolasius	+	0.20
Ptilotus calostachyus	+	0.35
Ptilotus nobilis	+	0.10
Salsola australis	+	0.15
Senna artemisioides subsp. *helmsii*	+	0.50
Senna artemisioides subsp. *oligophylla*	+	0.50
Senna glutinosa subsp. *luerssenii*	+	1.40
Sida aff. *fibulifera*	+	0.15
Solanum lasiophyllum	+	0.35
Triodia basedowii	1.00	0.25

BHP Ninga **Site NFV30**

Date:21/04/2013 **Described by:** AB/NK **Type:** Quadrat 25 x 100 m

Seasonal Conditions: Excellent

MGA Zone: 50 **Easting:** 800574 mE **Northing:** 7417680 mN

Habitat: Minor drainage line, narrowly incised.

Soil: Red-brown sandy clay loam.

Rock Type: BIF, gravel and alluvially deposited rocks.

Broad Floristic Formation: *Acacia* Tall Open Scrub.

Vegetation Association: Low Open Woodland of *Eucalytpus leucophloia* subsp. *leucophloia* and *E. gamophylla* over Tall Open Scrub of *Petalostylis labicheoides, Santalum lanceolatum, Acacia monticola* and *A. bivenosa* over Very Open Hummock Grassland of *Triodia epactia, T. basedowii* and *Themeda triandra.*

Vegetation Sub-Association: Low Open Woodland of *Eucalytpus leucophloia* subsp. *leucophloia* and *E. gamophylla* over Tall Open Scrub of *Petalostylis labicheoides, Santalum lanceolatum, Acacia monticola* and *A. bivenosa* over Very Open Hummock Grassland of *Triodia basedowii* and *T. wiseana* over Very Open Tussock Grassland of *Themeda triandra*.

Veg Condition: Excellent

Fire Age: >10 years

Notes: Disturbance: Flooding.

Leaf Litter: 3%; Bare Ground: 20%.

Notes: This creek was narrow and not too straight, as such there are a number of species that are from adjacent landforms.

Species List

Name	Cover (%)	Height (m)
Acacia adoxa	+	0.20
Acacia ancistrocarpa	+	1.50
Acacia bivenosa	6.00	3.00
Acacia monticola	10.00	4.00
Acacia pruinocarpa	+	1.40
Amphipogon sericeus	+	0.35
Aristida holathera var. *holathera*	+	0.30
Clerodendrum floribundum var. *angustifolium*	1.00	2.20
Santalum lanceolatum	10.00	1.80
Corchorus lasiocarpus subsp. *lasiocarpus*	+	0.30
Corchorus sidoides	+	0.35
Cymbopogon procerus	+	0.60
Duperreya commixta	+	climber
Enneapogon polyphyllus	+	0.30
Eragrostis eriopoda	+	0.30
Eriachne lanata	+	0.25
Eriachne mucronata	+	0.25
Eucalyptus gamophylla	1.00	3.00
Eucalyptus leucophloia	1.00	6.00
Eulalia aurea	+	0.40
Evolvulus alsinoides var. *villosicalyx*	+	0.10
Gossypium robinsonii	1.00	2.50
Grevillea wickhamii	2.00	4.00
Hybanthus aurantiacus	+	0.40
Indigofera monophylla	+	0.25
Jasminum didymum	+	climber

Paraneurachne muelleri	+	0.30
Petalostylis labicheoides	15.00	1.40
Ptilotus astrolasius	+	0.30
Ptilotus calostachyus	+	0.50
Ptilotus nobilis	+	0.08
Scaevola parvifolia subsp. *pilbarae*	+	0.20
Scaevola spinescens	+	0.80
Schizachyrium fragile	+	0.15
Senna artemisioides subsp. *helmsii*	+	0.80
Senna artemisioides subsp. *oligophylla*	+	0.40
Senna glutinosa subsp. *glutinosa*	+	2.00
Senna glutinosa subsp. *luerssenii*	+	0.60
Senna glutinosa subsp. *pruinosa*	+	1.10
Solanum cleistogamum	+	0.30
Themeda triandra	8.00	0.40
Tribulus hirsutus	+	0.40
Tribulus suberosus	+	0.35
Triodia basedowii	1.00	0.20
Triodia epactia	8.00	0.40

BHP Ninga **Site NFV31**

Date: 21/04/2013 **Described by:** AB/NK **Type:** Quadrat 50 x 50 m

Seasonal Conditions: Excellent

MGA Zone: 50 **Easting:** 803834 mE **Northing:** 7416955 mN

Habitat: Slight rise in between drainage lines, ranges to the north. Foothills
Soil: Red-brown sandy clay loam.
Rock Type: BIF.
Broad Floristic Formation: *Acacia* Tall Closed Scrub.

Vegetation Association: Tall Closed Scrub of *Acacia ancistrocarpa, A. dictyophleba, Grevillea wickhamii* and *A. inaequilatera* over Open Hummock Grassland of *Triodia basedowii, Paraneurachne muelleri* and *T.* sp. Shovelanna Hill (S. van Leeuwen 3835).

Vegetation Sub-Association: Tall Closed Scrub of *Acacia ancistrocarpa, A. dictyophleba, Grevillea wickhamii* and *A. inaequilatera* over Open Hummock Grassland of *Triodia basedowii* and *T.* sp. Shovelanna Hill (S. van Leeuwen 3835) over Very Open Tussock Grassland of *Paraneurachne muelleri*.

Veg Condition: Excellent
Fire Age: >10 years
Notes: Disturbance: Nil.

Leaf Litter: 4%; Bare Ground: 30%.

Species List

Name	Cover (%)	Height (m)
Acacia adoxa var. *adoxa*	+	0.35
Acacia ancistrocarpa	45.00	2.20
Acacia dictyophleba	20.00	2.00
Acacia inaequilatera	1.00	2.20
Acacia monticola	+	4.50
Amphipogon sericeus	2.00	0.20
Aristida holathera var. *holathera*	+	0.30
Aristida latifolia	+	0.50

Santalum lanceolatum	+	0.40
Corchorus sidoides	+	0.30
Corymbia hamersleyana	+	5.00
Cymbopogon procerus	+	0.60
Dactyloctenium radulans	+	0.15
Dicrastylis cordifolia	+	0.40
Dodonaea coriacea	+	0.50
Eragrostis eriopoda	+	0.35
Eriachne mucronata	+	0.35
Eucalyptus gamophylla	+	0.20
Eucalyptus gamophylla	+	4.50
Gomphrena kanisii	+	0.20
Grevillea wickhamii	5.00	3.00
Hakea lorea subsp. *lorea*	+	2.40
Halgania gustafsenii	+	0.20
Indigofera monophylla	+	0.30
Paraneurachne muelleri	3.00	0.40
Ptilotus calostachyus	+	0.40
Senna artemisioides subsp. *oligophylla*	+	1.00
Senna glutinosa subsp. *luerssenii*	+	0.70
Senna glutinosa subsp. *pruinosa*	+	2.00
Triodia basedowii	20.00	0.20
Triodia sp. Shovelanna Hill (S. van Leeuwen 3835)	2.00	0.20

BHP Ninga

Site **NFV32**

Date: 22/04/2013 **Described by:** AB/NK **Type:** Quadrat 50 x 50 m

Seasonal Conditions: Excellent

MGA Zone: 50 **Easting:** 794986 mE **Northing:** 7420571 mN

Habitat: Slight rise amongst drainage, ranges to the south.

Soil: Red-brown sandy clay loam.

Rock Type: BIF.

Broad Floristic Formation: *Triodia* Open Hummock Grassland.

Vegetation Association: Tall Open Shrubland of *Acacia ancistrocarpa, A. bivenosa* and *A. inaequilatera* over Low Open Shrubland of *Ptilotus astrolasius* over Open Hummock Grassland of *Triodia epactia, Eragrostis setifolia* and *Paraneurachne muelleri*.

Vegetation Sub-Association: Tall Open Shrubland of *Acacia ancistrocarpa, A. bivenosa* and *A. inaequilatera* over Low Open Shrubland of *Ptilotus astrolasius* over Open Hummock Grassland of *Triodia epactia, T. basedowii* and *T.* sp. Shovelanna Hill (S. van Leeuwen 3835) over Open Tussock Grassland of *Eragrostis setifolia, Paraneurachne muelleri, Amphipogon sericeus* and *Aristida holathera* subsp. *holathera*.

Veg Condition: Excellent

Fire Age: >10 years

Notes: Disturbance: Nil.

Leaf Litter: 1%; Bare Ground: 30%.

Species List

Name	Cover (%)	Height (m)
Abutilon aff. *fraseri*	+	0.50
Acacia ancistrocarpa	5.00	3.20
Acacia bivenosa	3.00	3.20
Acacia inaequilatera	2.00	4.00
Acacia monticola	+	2.50
Acacia tenuissima	1.00	3.50
Amphipogon sericeus	2.00	0.25

Aristida holathera var. *holathera*	1.00	0.20
Aristida latifolia	+	0.70
Bonamia erecta	+	1.20
Calytrix carinata	+	0.35
Corchorus lasiocarpus subsp. *lasiocarpus*	+	0.50
Cymbopogon procerus	+	0.70
Dodonaea coriacea	+	1.20
Duperreya commixta	+	climber
Enneapogon polyphyllus	+	0.30
Eragrostis setifolia	4.00	0.25
Eriachne lanata	+	0.25
Eriachne mucronata	+	0.35
Evolvulus alsinoides var. *villosicalyx*	+	0.10
Gomphrena kanisii	+	0.20
Goodenia stobbsiana	+	0.20
Gossypium robinsonii	+	3.00
Grevillea wickhamii	+	2.50
Hakea chordophylla	+	3.50
Hakea lorea subsp. *lorea*	+	4.00
Hybanthus aurantiacus	+	0.50
Indigofera monophylla	+	0.40
Mollugo molluginea	+	0.15
Paraneurachne muelleri	4.00	0.40
Ptilotus astrolasius	5.00	0.40
Ptilotus calostachyus	+	0.50
Ptilotus nobilis	+	0.30
Senna glutinosa subsp. *glutinosa*	+	1.80
Senna glutinosa subsp. *luerssenii*	+	0.80
Senna glutinosa subsp. *pruinosa*	+	1.20
Sida arenicola	+	0.60
Solanum cleistogamum	+	0.15
Solanum lasiophyllum	+	0.60
Tribulus suberosus	+	1.50
Triodia basedowii	2.00	0.25
Triodia epactia	10.00	0.30
Triodia sp. Shovelanna Hill (S. van Leeuwen 3835)	1.00	0.20

BHP Ninga **Site NFVr01**

Date: 2004/2013 **Described by:** AB/NK **Type:** Relevé

Seasonal Conditions: Excellent

MGA Zone: 50 **Easting:** 804421 mE **Northing:** 7418643 mN

Habitat: Upper and lower slopes, north-facing.
Soil: Red-brown clay loam.
Rock Type: BIF.
Broad Floristic Formation: *Triodia* Open Hummock Grassland.

Vegetation Association: Tall Open Shrubland of *Acacia inaequilatera* over Scattered Shrubs of *Senna glutinosa* subsp. *pruinosa* over Open Hummock Grassland of *Triodia epactia*.

Vegetation Sub-Association: Tall Open Shrubland of *Acacia inaequilatera* over Scattered Shrubs of *Senna glutinosa* subsp. *pruinosa* over Open Hummock Grassland of *Triodia epactia.*

Veg Condition: Excellent
Fire Age: >10 years
Notes: Disturbance: Nil.

Leaf Litter: 1%; Bare Ground: 22%.

Species List

Name	Cover (%)	Height (m)
Acacia hilliana	+	*0.50*
Acacia inaequilatera	2.00	4.50
Aristida holathera var. holathera	+	0.25
Eriachne lanata	+	*0.20*
Eriachne mucronata (arid form) (MET 12 736)	+	0.15
Hakea lorea	+	1.80
Indigofera monophylla	+	0.20
Senna artemisioides subsp. *oligophylla*	+	0.90
Senna glutinosa subsp. *pruinosa*	1.00	1.60

Tribulus suberosus	+	0.40
Triodia basedowii	*+*	*0.25*
Triodia epactia	25	0.30

BHP Ninga **Site NFVr02**

Date: 17/04/2013 **Described by:** AB/NK **Type:** Relevé

Seasonal Conditions: Excellent

MGA Zone: 50 **Easting:** 793883 mE **Northing:** 7418850 mN

Habitat: River and approximately 5 m of the bank on either side.
Soil: Orange-brown sand.
Rock Type: Alluvial stones and pebbles.
Broad Floristic Formation: *Cynodon* Tussock Grassland.

Vegetation Association: Woodland of *Eucalyptus victrix* and *E. camaldulensis* over Tall Open Shrubland of *Acacia coriacea, A. citrinoviridis* and *Melaleuca glomerata* over Tussock Grassland of **Cynodon dactylon, *Chloris barbata* and *Cyperus vaginatus*.

Vegetation Sub-Association: Woodland of *Eucalyptus victrix* and *E. camaldulensis* over Tall Open Shrubland of *Acacia coriacea, A. citrinoviridis* and *Melaleuca glomerata* over Tussock Grassland of **Cynodon dactylon* and **Chloris barbata* over Very Open Sedgeland of *Cyperus vaginatus*.

Veg Condition: Degraded
Fire Age: >10 years
Notes: Disturbance: Grazing, flooding and vehicular.

Leaf Litter: 2%; Bare Ground: 20%.

Species List

Name	Cover (%)	Height (m)
Acacia citrinoviridis	2.00	8.00
Acacia coriacea	2.00	8.00
Alternanthera nodiflora	+	0.20
Calandrinia ptychosperma	+	0.08
**Chloris barbata*	4.00	0.50
**Cynodon dactylon*	65.00	0.10
Cyperus difformis	+	0.25
Cyperus vaginatus	4.00	1.00

**Echinochloa colona*	1.00	0.60
Eragrostis cumingii	+	0.35
Eragrostis tenellula	+	0.15
Eucalyptus camaldulensis subsp. obtusa	5.00	20.00
Eucalyptus victrix	20.00	18.00
Melaleuca glomerata	1.00	5.00
Panicum decompositum	+	0.40
Pluchea rubelliflora	+	0.15
**Sonchus oleraceus*	+	0.40

BHP Ninga

Site **NFVr03**

Date: 18/04/2013 **Described by:** AB/NK **Type:** Relevé

Seasonal Conditions: Excellent

MGA Zone: 50 **Easting:** 803657 mE **Northing:** 7415889 mN

Habitat: Small hill, south facing.
Soil: Red-brown silty loam.
Rock Type: BIF.
Broad Floristic Formation: *Triodia* Hummock Grassland.

Vegetation Association: Tall Open Shrubland of *Acacia pruinocarpa* and *A. aptaneura* over Low Open Shrubland of *Acacia hilliana* over Hummock Grassland of *Triodia basedowii*.

Vegetation Sub-Association: Tall Open Shrubland of *Acacia pruinocarpa* and *A. aptaneura* over Low Open Shrubland of *Acacia hilliana* over Hummock Grassland of *Triodia basedowii*.

Veg Condition: Excellent
Fire Age: >10 years
Notes: Disturbance: Clearing, vehicular and powerlines.

Leaf Litter: 1%; Bare Ground: 20%.

Species List

Name	Cover (%)	Height (m)
Acacia adoxa var. *adoxa*	+	0.60
Acacia aptaneura	1.00	3.50
Acacia hilliana	3.00	0.50
Acacia pruinocarpa	1.50	4.50
Calytrix carinata	+	1.00
Eremophila cuneifolia	+	1.00
Eriachne lanata	+	0.35
Eriachne mucronata	+	0.30
Halgania gustafsenii	+	0.30

Indigofera monophylla	+	0.25
Senna glutinosa subsp. *glutinosa*	+	1.00
Senna glutinosa subsp. *luerssenii*	+	0.90
Triodia sp. Shovelanna Hill (S. van Leeuwen 3835)	35.00	0.20

BHP Ninga

Site **NFVr04**

Date: 18/04/2013 **Described by:** AB/NK **Type:** Relevé

Seasonal Conditions: Excellent

MGA Zone: 50 **Easting:** 797835 mE **Northing:** 7416059 mN

Habitat: Floodplain adjacent to drainage, south of ranges.

Soil: Red-brown silty loam.

Rock Type: N/A.

Broad Floristic Formation: *Acacia* Low Woodland.

Vegetation Association: Low Woodland of *Acacia aptaneura* over Tall Open Shrubland of *Acacia sclerosperma* var. *sclerosperma* over Very Open Hummock Grassland of *Triodia epactia* and *Aristida latifolia*.

Vegetation Sub-Association: Low Woodland of *Acacia aptaneura* over Tall Open Shrubland of *Acacia sclerosperma* var. *sclerosperma* over Very Open Hummock Grassland of *Triodia epactia* over Scattered Tussock Grasses of *Aristida latifolia*.

Veg Condition: Excellent

Fire Age: 5-10 years

Notes: Disturbance: Grazing and flooding.

Leaf Litter: 1%; Bare Ground: 50%.

Species List

Name	Cover (%)	Height (m)
Acacia aptaneura	15.00	10.00
Acacia pteraneura	+	2.00
Acacia sclerosperma var. *sclerosperma*	8.00	4.00
Aristida contorta	+	0.30
Aristida latifolia	1.00	0.50
**Cenchrus ciliaris*	+	0.40
**Chloris barbata*	+	0.40
Cucumis maderaspatanus	+	climber
Duperreya commixta	+	climber

Enneapogon polyphyllus	+	0.35
Hakea chordophylla	+	2.50
**Malvastrum americanum*	+	0.30
Senna artemisioides subsp. *helmsii*	+	1.00
**Setaria verticillata*	+	0.25
Triodia basedowii	+	0.25
Triodia epactia	4.00	0.35

BHP Ninga **Site NFVr05**

Date: 19/04/2013 **Described by:** AB/NK **Type:** Relevé

Seasonal Conditions: Excellent

MGA Zone: 50 **Easting:** 802088 mE **Northing:** 7419048 mN

Habitat: Narrowly incised drainage, ranges to the south, hills to the north and a creek to the east.

Soil: Red-brown sandy clay.

Rock Type: N/A.

Broad Floristic Formation: *Themeda* Tussock Grassland.

Vegetation Association: Tall Open Shrubland of *Acacia monticola* and *A. bivenosa* over Tussock Grassland of *Themeda triandra* and **Cenchrus ciliaris*.

Vegetation Sub-Association: Tall Open Shrubland of *Acacia monticola* and *A. bivenosa* over Tussock Grassland of *Themeda triandra* and **Cenchrus ciliaris.*

Veg Condition: Excellent

Fire Age: >10 years

Notes: Disturbance: Flooding.

Leaf Litter: 2%; Bare Ground: 2%.

Species List

Name	Cover (%)	Height (m)
Acacia bivenosa	1.00	3.00
Acacia citrinoviridis	+	5.00
Acacia colei	+	1.20
Acacia monticola	8.00	4.00
**Cenchrus ciliaris*	3.00	0.60
Corymbia hamersleyana	+	8.00
Cymbopogon procerus	+	0.80
Eriachne mucronata	+	0.40
Eulalia aurea	+	0.60
Gossypium robinsonii	+	2.20
Jasminum didymum	+	climber

Rhynchosia minima	+	climber
Androcalva luteiflora	+	1.00
Sida aff. *fibulifera*	+	0.20
Sida arenicola	+	1.20
Themeda triandra	45.00	0.70

BHP Ninga

Site **NFVr06**

Date: 19/04/2013 **Described by:** AB/NK **Type:** Relevé

Seasonal Conditions: Excellent

MGA Zone: 50 **Easting:** 801054 mE **Northing:** 7417826 mN

Habitat: Foothill of ranges, minor drainage to the east and west.
Soil: Red-brown sandy clay loam.
Rock Type: BIF rocks and gravel.
Broad Floristic Formation: *Amphipogon* Open Tussock Grassland.

Vegetation Association: Scattered Low Trees of *Corymbia aspera* over Open Tussock Grassland of *Amphipogon sericeus* and *Triodia basedowii*.

Vegetation Sub-Association: Scattered Low Trees of *Corymbia aspera* over Scattered Hummock Grasses of *Triodia basedowii* over Open Tussock Grassland of *Amphipogon sericeus*.

Veg Condition: Excellent
Fire Age: >10 years
Notes: Disturbance: Vehicular.

Leaf Litter: <1%; Bare Ground: 30%.

Species List

Name	Cover (%)	Height (m)
Acacia ancistrocarpa	+	1.60
Acacia bivenosa	+	2.00
Acacia hilliana	+	0.25
Acacia maitlandii	+	1.60
Amphipogon sericeus	15.00	0.30
Aristida contorta	+	0.15
Aristida holathera var. *holathera*	+	0.10
Corymbia aspera	1.00	5.00
Cymbopogon procerus	+	1.00
Duperreya commixta	+	climber
Eragrostis setifolia	+	0.20

Eriachne lanata	+	0.20
Fimbristylis simulans	+	0.15
Gomphrena kanisii	+	0.30
Goodenia sp.	+	0.20
Grevillea wickhamii	+	3.00
Keraudrenia velutina subsp. *elliptica*	+	0.10
Paraneurachne muelleri	+	0.25
Petalostylis labicheoides	+	1.50
Ptilotus calostachyus	+	0.30
Senna artemisioides subsp. *oligophylla x helmsii*	+	0.20
Senna glutinosa subsp. *pruinosa*	+	0.80
Solanum lasiophyllum	+	0.40
Triodia basedowii	1.00	0.25
Triodia sp. Shovelanna Hill (S. van Leeuwen 3835)	+	0.20

BHP Ninga

Site **NFVr07**

Date: 20/04/2013 **Described by:** AB/NK **Type:** Relevé

Seasonal Conditions: Excellent

MGA Zone: 50 **Easting:** 804426 mE **Northing:** 7417835 mN

Habitat: Top of the ranges.
Soil: Red-brown clay loam.
Rock Type: BIF.
Broad Floristic Formation: *Triodia* Open Hummock Grassland.

Vegetation Association: Low Open Woodland of *Eucalyptus leucophloia* subsp. *leucophloia* and *Hakea chordophylla* over Low Shrubland of *Acacia hilliana, Keraudrenia velutina* subsp. *elliptica* and *Calytrix carinata* over Open Hummock Grassland of *Triodia* sp. Shovelanna Hill (S. van Leeuwen 3835), *T. basedowii* and *Eriachne lanata.*

Vegetation Sub-Association: Low Open Woodland of *Eucalyptus leucophloia* subsp. *leucophloia* and Hakea chordophylla over Low Shrubland of *Acacia hilliana*, *Keraudrenia velutina* subsp. *elliptica* and *Calytrix carinata* over Open Hummock Grassland of *Triodia* sp. Shovelanna Hill (S. van Leeuwen 3835) and *T. basedowii* over Scattered Tussock Grasses of *Eriachne lanata*.

Veg Condition: Excellent
Fire Age: >10 years
Notes: Disturbance: Nil.

Leaf Litter: 1%; Bare Ground: 15%.

Species List

Name	Cover (%)	Height (m)
Acacia adoxa var. *adoxa*	+	0.30
Acacia hilliana	10.00	0.40
Amphipogon sericeus	+	0.20
Aristida holathera var. *holathera*	+	0.30
Calytrix carinata	1.00	0.35
Cymbopogon procerus	+	0.60
Dodonaea coriacea	+	0.40

Eriachne lanata	1.00	0.25
Eriachne mucronata	+	0.30
Eucalyptus leucophloia subsp. *leucophloia*	1.00	5.50
Grevillea berryana	+	2.00
Grevillea wickhamii	1.00	3.00
Hakea chordophylla	1.00	3.20
Keraudrenia velutina subsp. *elliptica*	2.00	0.20
Ptilotus nobilis	+	0.30
Schizachyrium fragile	+	0.10
Senna artemisioides subsp. *oligophylla*	+	0.30
Senna glutinosa subsp. *glutinosa*	+	1.10
Senna glutinosa subsp. *pruinosa*	+	1.00
Solanum lasiophyllum	+	0.50
Triodia basedowii	5.00	0.25
Triodia sp. Shovelanna Hill (S. van Leeuwen 3835)	15.00	0.25
Waltheria virgata	+	0.30

BHP Ninga

Site **NFVr08**

Date: 21/04/2013 **Described by:** AB/NK **Type:** Relevé

Seasonal Conditions: Excellent

MGA Zone: 50 **Easting:** 798701 mE **Northing:** 7417806 mN

Habitat: Top and slopes of low hills, rail and ranges to the north.

Soil: Red-brown clay loam.

Rock Type: BIF, some sheet outcropping.

Broad Floristic Formation: *Triodia* Open Hummock Grassland.

Vegetation Association: Scattered Low Trees of *Eucalytpus leucophloia* over Open Shrubland of *Acacia bivenosa* and *A. hilliana* over Open Hummock Grassland of *Triodia basedowii* and *Paraneurachne muelleri.*

Vegetation Sub-Association: Scattered Low Trees of *Eucalytpus leucophloia* over Scattered Shrubs of *Acacia bivenosa* over Low Open Shrubland of *A. hilliana* over Open Hummock Grassland of *Triodia basedowii* over Scattered Tussock Grasses of *Paraneurachne muelleri*.

Veg Condition: Excellent

Fire Age: >10 years

Notes: Disturbance: Clearing, vehicular and machinery.

Leaf Litter: <1%; Bare Ground: 25%.

Species List

Name	Cover (%)	Height (m)
Acacia ancistrocarpa	+	1.40
Acacia bivenosa	1.00	2.00
Acacia hilliana	2.00	0.40
Amphipogon sericeus	+	0.25
Aristida holathera var. *holathera*	+	0.15
Cymbopogon procerus	+	0.30
Dodonaea coriacea	+	0.50
Eragrostis setifolia	+	0.25
Eriachne mucronata	+	0.30

Eriachne mucronata	+	0.30
Eucalyptus leucophloia	1.00	5.00
Grevillea wickhamii	+	2.00
Hakea chordophylla	+	3.00
Hakea lorea subsp*. lorea*	+	1.90
Halgania gustafsenii	+	0.20
Paraneurachne muelleri	1.00	0.30
**Portulaca oleracea*	+	0.05
Ptilotus astrolasius	+	0.20
Ptilotus calostachyus	+	0.60
Ptilotus rotundifolius	+	1.20
Sclerolaena densiflora	+	0.15
Senna glutinosa subsp*. luerssenii*	+	1.50
Triodia sp. Shovelanna Hill (S. van Leeuwen 3835)	15.00	0.25

BHP Ninga **Site** **NFVOPP**

Date:14/04/2013 **Described by:** AB/NK **Type:** Opportunistic Observations

Seasonal Conditions: Excellent

Species List

Name	Cover (%)	Height (m)
**Cenchrus setiger*		
Corchorus sidoides subsp. sidoides	+	0.40
**Cynodon dactylon*		
Enneapogon caerulescens	+	0.15
Eremophila cuneifolia	+	1.20
Gomphrena kanisii	+	0.20
Hibiscus sturtii var. *truncatus*	+	0.90
**Malvastrum americanum*		
Perotis rara	+	0.08
Ptilotus nobilis	+	0.30
Sclerolaena cuneata		
Senna notabilis	+	0.40
**Setaria verticillata*		
Sporobolus australasicus	+	0.10
Stackhousia intermedia	+	0.25
Typha domingensis		

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Appendix J: Site x Species Matrix

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Table J.1: Site by species matrix.

Family	Species name	NFV01	NFV02	NFV03	NFV04	NFV05	NFV06	NFV07	NFV08	NFV09	NFV10	NFV11	NFV12	NFV13	NFV14	NFV15	NFV16	NFV17	NFV18	NFV19	NFV20	NFV21	NFV22	NFV23	NFV24	NFV25	NFV26	NFV27	NFV28	NFV29	NFV30	NFV31	NFV32	NFVr02	NFVr03	NFVr04	NFVr05	NFVr06	NFVr07	NFVr08	NFVOPP
Malvaceae	*Abutilon* aff. *fraseri*			1															+				+			+							+							
Malvaceae	*Abutilon* aff. *lepidum*			+																			+																	
Malvaceae	*Abutilon leucopetalum*																						+			+														
Malvaceae	*Abutilon otocarpum*																																							
Fabaceae	*Acacia adoxa* var. *adoxa*	+										+		2							+			1	+			3			+	+			+				+		
Fabaceae	*Acacia ancistrocarpa*		+									4			+							+	+									4 5	5					+		+	
Fabaceae	*Acacia aneura*			+	+									+			+		+				+					+		+										
Fabaceae	*Acacia aptaneura*										+	+		+	+	2 5	4 5	1 5	+				+			+	1		+	8					1	1 5					
Fabaceae	*Acacia bivenosa*	+		+	+		+			+	+	+		+	+	+			6			+	4					+	+	1	6		3				1	+		1	
Fabaceae	*Acacia catenulata* subsp. *occidentalis*																1	2									4			+											
Fabaceae	*Acacia citrinoviridis*												1 5					2	1				+			1 0							2			+				
Fabaceae	*Acacia colei*																																			+				
Fabaceae	*Acacia coriacea* subsp. *coriacea*															+		1															2							
Fabaceae	*Acacia coriacea* subsp. *pendens*												3		+																									
Fabaceae	*Acacia dictyophleba*				+				2 2						+	2														+		2 0								
Fabaceae	*Acacia elachantha*											+																												
Fabaceae	*Acacia hamersleyensis*																				+								+											
Fabaceae	*Acacia hilliana*	2					+	2		2 0				5						+	8		+	1 0	1 8			1 5	1					3			+	1 0	2	
Fabaceae	*Acacia inaequilatera*						1		1											2						+					1	2								
Fabaceae	*Acacia macraneura*					+																																		
Fabaceae	*Acacia maitlandii*								+					+					1	+			+	+		+			+							+				
Fabaceae	*Acacia monticola*			2 5			2												+				3 5								1 0	+	+			8				
Fabaceae	*Acacia pachyacra*						1. 5																							+										
Fabaceae	*Acacia pruinocarpa*	+	1	+	+			1		+		+		1	1	3	+	1										+	1	2 0	+			1. 5						
Fabaceae	*Acacia pteraneura*				1																								+						+				
Fabaceae	*Acacia pyrifolia*																		1							+														
Fabaceae	*Acacia rhodophloia*																	+																						
Fabaceae	*Acacia sclerosperma* subsp. *sclerosperma*				4						1 5		+																						8					
Fabaceae	*Acacia synchronicia*				1	2					1						+										+													
Fabaceae	*Acacia tenuissima*								+							1	+									+						1								
Fabaceae	*Acacia tetragonophylla*					+										+		+					+	+					+											
Fabaceae	*Acacia tumida* var. *pilbarensis*																+																							
Amaranthaceae	*Alternanthera nodiflora*																																+							
Amaranthaceae	*Amaranthus mitchellii*																									+														
Amaranthaceae	*Amaranthus undulatus*																		+																					
Poaceae	*Amphipogon caricinus*	1																																						
Poaceae	*Amphipogon sericeus*		+				1 5	1	1												+	1 8		+						+	2	2					1 5	+	+	

Family	Species name	NFV01	NFV02	NFV03	NFV04	NFV05	NFV06	NFV07	NFV08	NFV09	NFV10	NFV11	NFV12	NFV13	NFV14	NFV15	NFV16	NFV17	NFV18	NFV19	NFV20	NFV21	NFV22	NFV23	NFV24	NFV25	NFV26	NFV27	NFV28	NFV29	NFV30	NFV31	NFV32	NFVr02	NFVr03	NFVr04	NFVr05	NFVr06	NFVr07	NFVr08	NFVOPP
Santalaceae	*Anthobolus leptomerioides*														+			+			+								+												
Poaceae	*Aristida contorta*										1		+				+	3		+		+			+		2		1						+		+				
Poaceae	*Aristida holathera* var. *holathera*	+	+	+			+	+	+	+		+	+		+	+	+		+	28	+		+	+	+	+		+		+	+	+	1				+	+	+	
Poaceae	*Aristida latifolia*	+	+		+				+							+	+	6	+	+					+	+	+	+		+		+			1					
Araliaceae	*Astrotricha hamptonii*																																								
Asteraceae	**Bidens bipinnata*																		+				+			+															
Nyctaginaceae	*Boerhavia coccinea*																		+							+															
Convolvulaceae	*Bonamia media*																			+																				
Convolvulaceae	*Bonamia rosea*								+			2			1	+																	+								
Cyperaceae	*Bulbostylis barbata*																		+																					
Portulacaceae	*Calandrinia ptychosperma*																																	+							
Myrtaceae	*Calytrix carinata*	1	2					+		1				+							5	+		+	+			+					+		+				1		
Poaceae	**Cenchrus ciliaris*			+	4						15	+	32			+			40						35				+				+			+	3				
Poaceae	**Cenchrus setiger*												+																											
Adiantaceae	*Cheilanthes* sp.																	+																						
Poaceae	**Chloris barbata*																																	4		+					
Asteraceae	*Chrysocephalum pterochaetum*								+						+						+							+													
Capparaceae	*Cleome viscosa*										+		+						+							+														
Verbenaceae	*Clerodendrum floribundum* var. *angustifolium*																														1										
Verbenaceae	*Clerodendrum tomentosum* var. *lanceolatum*					+																																		
Gyrostemonaceae	*Codonocarpus cotinifolius*			2															1		+		8			2		+			10	+								
Malvaceae	*Corchorus lasiocarpus* ?subsp.	+	+		+		+			4										+		+																		
Malvaceae	*Corchorus lasiocarpus* subsp. *lasiocarpus*			+			+											+	+				+		+	+				+		+								
Malvaceae	*Corchorus sidoides* subsp. *sidoides*																														+	+								+
Malvaceae	*Corchorus sidoides* subsp. *vermicularis*			+																																				
Malvaceae	*Corchorus* sp.	+																																						
Malvaceae	*Corchorus tridens*																		+																					
Myrtaceae	*Corymbia aspera*														1							+														1				
Myrtaceae	*Corymbia hamersleyana*			5																				+		3				+		+				+				
Fabaceae	*Crotalaria medicaginea*																		+																					
Cucurbitaceae	*Cucumis maderaspatanus*																		+								+									+				
Fabaceae	*Cullen leucanthum*												+																											
Fabaceae	*Cullen leucochaites*																																							
Poaceae	*Cymbopogon procerus*	+	1	+	+		+	+	+			+	+		+	1		+	+	+		+	+	+	+	1				+	+	+	+				+	+	+	+	
Poaceae	**Cynodon dactylon*												+																					65							
Cyperaceae	*Cyperus difformis*																																	+							
Cyperaceae	*Cyperus vaginatus*												4																					4							
Poaceae	*Dactyloctenium radulans*										+																					+								
Goodeniaceae	*Dampiera candicans*	+					+																																		
Lamiaceae	*Dicrastylis cordifolia*								+						+						+			+							+									
Chenopodiaceae	*Dissocarpus paradoxus*																		+							+															

Family	Species name	NFV01	NFV02	NFV03	NFV04	NFV05	NFV06	NFV07	NFV08	NFV09	NFV10	NFV11	NFV12	NFV13	NFV14	NFV15	NFV16	NFV17	NFV18	NFV19	NFV20	NFV21	NFV22	NFV23	NFV24	NFV25	NFV26	NFV27	NFV28	NFV29	NFV30	NFV31	NFV32	NFVr02	NFVr03	NFVr04	NFVr05	NFVr06	NFVr07	NFVr08	NFVOPP
Sapindaceae	*Dodonaea coriacea*						+		+	+																					+	+							+	+	
Sapindaceae	*Dodonaea pachyneura*									+																+															
Convolvulaceae	*Duperreya commixta*	+		1						+		+	+		1	+			+		+	+	1			+		+		+	+		+			+		+			
Poaceae	**Echinochloa colona*																																	1							
Chenopodiaceae	*Enchylaena tomentosa* var. *tomentosa*															+																									
Poaceae	*Enneapogon caerulescens*				+						+																														+
Poaceae	*Enneapogon polyphyllus*					+	+				+				+		+	+	+	+	+					+				+	+		+			+					
Poaceae	*Enneapogon robustissimus*																									3		+													
Poaceae	*Enteropogon ramosus*																									+															
Poaceae	*Eragrostis cumingii*																		+				+			+								+							
Poaceae	*Eragrostis eriopoda*			+			+				2	1						3	+				+			+	+				+	+									
Poaceae	*Eragrostis setifolia*	+	+		+				+						+	+	+				+	+		1					+			4					+		+	
Poaceae	*Eragrostis tenellula*																																	+							
Scrophulariaceae	*Eremophila cuneifolia*																																		+						+
Scrophulariaceae	*Eremophila forrestii*																										+														
Scrophulariaceae	*Eremophila forrestii* subsp. *forrestii*				+												+	1												2											
Scrophulariaceae	*Eremophila fraseri*																	4																							
Scrophulariaceae	*Eremophila latrobei*																				+																			
Scrophulariaceae	*Eremophila latrobei* subsp. *filiformis*											+						+							+				+											
Scrophulariaceae	*Eremophila latrobei* subsp. *latrobei*	+												+										+					+	+										
Scrophulariaceae	*Eremophila longifolia*						+								+																									
Poaceae	*Eriachne lanata*	2	3				+	1.5		4				+						+	1	+		+	+			1	+		+		+		+			1		
Poaceae	*Eriachne mucronata*	+				+	+	+	+	+		+		+				+	3	+	+	+	1	1	+	2	+			+	+	+	+		+		+		+	+	
Poaceae	*Eriachne pulchella* subsp. *pulchella*	+											+														1		+	+										
Myrtaceae	*Eucalyptus camaldulensis* var. *obtusa*												20																					5							
Myrtaceae	*Eucalyptus gamophylla*			1	1					1																				+	1	+								
Myrtaceae	*Eucalyptus kingsmillii* subsp. *kingsmillii*																				3		2																		
Myrtaceae	*Eucalyptus leucophloia*																																							1	
Myrtaceae	*Eucalyptus leucophloia* subsp. *leucophloia*	2	1			4		1															1	+	2			2	2	1	1							1		
Myrtaceae	*Eucalyptus victrix*												15						8															20							
Poaceae	*Eulalia aurea*												1			1		+	+				3			+	+			+	+						+				
Euphorbiaceae	*Euphorbia australis*												+																												
Euphorbiaceae	*Euphorbia biconvexa*																		+				+			+															
Convolvulaceae	*Evolvulus alsinoides* var. *decumbens*																																								
Convolvulaceae	*Evolvulus alsinoides* var. *villosicalyx*			+	+						+	+			+	+		+	+				+			+				+	+		+							
Cyperaceae	*Fimbristylis simulans*	+					+															+																+			
Fabaceae	*Glycine canescens*																		+				+			+															
Amaranthaceae	*Gomphrena cunninghamii*																		+							+															

Family	Species name	NFV01	NFV02	NFV03	NFV04	NFV05	NFV06	NFV07	NFV08	NFV09	NFV10	NFV11	NFV12	NFV13	NFV14	NFV15	NFV16	NFV17	NFV18	NFV19	NFV20	NFV21	NFV22	NFV23	NFV24	NFV25	NFV26	NFV27	NFV28	NFV29	NFV30	NFV31	NFV32	NFVr02	NFVr03	NFVr04	NFVr05	NFVr06	NFVr07	NFVr08	NFVOPP
Amaranthaceae	*Gomphrena kanisii*			+			+				+		+		+	+	+	+	+			+	+			+				+		+	+					+			+
Goodeniaceae	*Goodenia lamprosperma*																		+																							
Goodeniaceae	*Goodenia microptera*																													+											
Goodeniaceae	*Goodenia* sp.																					+				+												+			
Goodeniaceae	*Goodenia stobbsiana*	+	1				+	+		+												+		+				+	+				+							
Malvaceae	*Gossypium australe*												+																												
Malvaceae	*Gossypium robinsonii*			+			+												+				+			+					1		+				+			
Proteaceae	*Grevillea berryana*	1	+					+													1			+	+			+	+										+		
Proteaceae	*Grevillea wickhamii*	+	+				20	+	1	+		+		+					+		+		+	+	1	1			+	+	2	5	+				+	1	+	
Proteaceae	*Hakea chordophylla*	2	+				+		+	1		1									+			+	+			+	+					+			1	+	
Proteaceae	*Hakea lorea* subsp. *lorea*						+	1							4	+				+											+	+						+	
Boraginaceae	*Halgania gustafsenii*								+	+		+		1	+						2				+						+			+					+	
Boraginaceae	*Heliotropium ovalifolium*	+											+								+																			
Malvaceae	*Hibiscus* aff. *coatesii*		+				+											+																						
Malvaceae	*Hibiscus* sp.			+																																				
Fabaceae	*Hibiscus sturtii* ?var.																	+																						
Malvaceae	*Hibiscus sturtii* var. *platychlamys*											+																												
Malvaceae	*Hibiscus sturtii* var. *truncatus*																							+						+										+
Violaceae	*Hybanthus aurantiacus*																		+		+		+	+	+	+		+		+	+		+							
Fabaceae	*Indigofera boviperda*														+											+															
Fabaceae	*Indigofera monophylla*	+		+				+	+			+		+					+	+											+	+	+		+					
Fabaceae	*Indigofera rugosa*																		+																		+			
Fabaceae	*Isotropis forrestii*																									+														
Oleaceae	*Jasminum didymum*			+															+				+							+						+			
Malvaceae	*Keraudrenia nephrosperma*																	+																						
Malvaceae	*Keraudrenia velutina* subsp. *elliptica*																				10				+			1									+	2		
Myrtaceae	*Lamarchea sulcata*																				+							+												
Poaceae	*Leptochloa digitata*												2																												
Chenopodiaceae	*Maireana tomentosa*																										1			1										
Malvaceae	**Malvastrum americanum*																																			+				
Myrtaceae	*Melaleuca glomerata*												10						+															1						
Fabaceae	*Mirbelia viminalis*																							3				1												
Molluginaceae	*Mollugo molluginea*																																+							
Rubiaceae	*Oldenlandia crouchiana*																																							
Poaceae	*Panicum decompositum*												+			+	+	+															+							
Poaceae	*Paraneurachne muelleri*		+	+	+		+		1	+	+	+	+		+	1			+			1	+		+	+	+	+		+	+	3	4					+		1	
Poaceae	*Perotis rara*											+						+	+				+				+													+
Fabaceae	*Petalostylis labicheoides*		+	2	+			+		+			+				+		8		+			+		3		+			15						+			
Euphorbiaceae	*Phyllanthus maderaspatensis*												+										+																	
Asteraceae	*Pluchea dentex*																		1																						
Asteraceae	*Pluchea rubelliflora*												+																												
Caryophyllaceae	*Polycarpaea corymbosa*																																								
Caryophyllaceae	*Polycarpaea longiflora*																		+							+															
Portulacaceae	**Portulaca oleracea*		+				+	+		+	+																													+	

Family	Species name	NFV01	NFV02	NFV03	NFV04	NFV05	NFV06	NFV07	NFV08	NFV09	NFV10	NFV11	NFV12	NFV13	NFV14	NFV15	NFV16	NFV17	NFV18	NFV19	NFV20	NFV21	NFV22	NFV23	NFV24	NFV25	NFV26	NFV27	NFV28	NFV29	NFV30	NFV31	NFV32	NFVr02	NFVr03	NFVr04	NFVr05	NFVr06	NFVr07	NFVr08	NFVOPP
Rubiaceae	*Psydrax latifolia*																+												+												
Rubiaceae	*Psydrax suaveolens*																+										+														
Amaranthaceae	*Ptilotus aervoides*										+																														
Amaranthaceae	*Ptilotus astrolasius*	+			+		1				+	+			+							+	+					+		+	+		5						+	
Amaranthaceae	*Ptilotus calostachyus*	+	+		+		1	+	+	+				+		+				+		+		+	+			+	+	+	+	+	+					+		+	
Amaranthaceae	*Ptilotus nobilis*						+				+	+			+	+		+			+	+	+	+		+				+	+		+						+		+
Amaranthaceae	*Ptilotus obovatus*																									+		+													
Amaranthaceae	*Ptilotus rotundifolius*	+					+																			+														+	
Amaranthaceae	*Ptilotus schwartzii*																	+																							
Chenopodiaceae	*Rhagodia eremaea*										+															+	+														
Asteraceae	*Rhodanthe margarethae*																																								
Fabaceae	*Rhynchosia minima*			+									+						+				+			+											+				
Malvaceae	*Rulingia luteiflora*																		6				5			+											+				
Asteraceae	*Rutidosis helichrysoides*																									+															
Chenopodiaceae	*Salsola australis*					+					+					+			+								+			+											
Asclepiadaceae	*Sarcostemma viminale*				+		+																																		
Goodeniaceae	*Scaevola browniana*																																								
Goodeniaceae	*Scaevola parvifolia* subsp. *pilbarae*			+	+				+			1			+	1															+										
Goodeniaceae	*Scaevola spinescens*																														+										
Poaceae	*Schizachyrium fragile*	+																+			+			+	+						+							+			
Chenopodiaceae	*Sclerolaena cornishiana*										+																+														
Chenopodiaceae	*Sclerolaena costata*										+																														
Chenopodiaceae	*Sclerolaena cuneata*																																								
Chenopodiaceae	*Sclerolaena densiflora*										+																													+	
Chenopodiaceae	*Sclerolaena eriacantha*					+																																		
Fabaceae	*Senna artemisioides* subsp. *helmsii*	1					+		+									+	+	+	+		+			+				+	+				+					
Fabaceae	*Senna artemisioides* subsp. *oligophylla*	+	+	+	+			+	+		+			+	+	+			+	+			+		+	+	+			+	+	+						+		
Fabaceae	*Senna artemisioides* subsp. *oligophylla x helmsii*																+					+				+			+								+			
Fabaceae	*Senna glaucifolia*																	+	+				+																	
Fabaceae	*Senna glutinosa* subsp. *glutinosa*		1	+		+	+	+	+	+				+							+			+	+	+			+		+		+		+			+		
Fabaceae	*Senna glutinosa* subsp. *luerssenii*	+	2				+			+	+			+				+				+	+	+	+			+	+	+	+	+	+		+				+	
Fabaceae	*Senna glutinosa* subsp. *pruinosa*	+	+				+	+						+						1		+	+	+	+			+	+		+	+	+					+	+		
Fabaceae	*Senna notabilis*																																								+
Fabaceae	*Senna* sp. Meekatharra (E. Bailey 1-26)	+									+														+			+												
Fabaceae	*Senna stricta*							+															+			+														
Poaceae	*Setaria surgens*																						+			+														
Poaceae	**Setaria verticillata*																		+																		+				
Malvaceae	*Sida ? echinocarpa*				+																																			
Malvaceae	*Sida* aff. *fibulifera*										+								+				+			+				+							+			
Malvaceae	*Sida arenicola*	+	+		+		+		+						+			+	+				+														+			
Malvaceae	*Sida cardiophylla*															+																									

Family	Species name	NFV01	NFV02	NFV03	NFV04	NFV05	NFV06	NFV07	NFV08	NFV09	NFV10	NFV11	NFV12	NFV13	NFV14	NFV15	NFV16	NFV17	NFV18	NFV19	NFV20	NFV21	NFV22	NFV23	NFV24	NFV25	NFV26	NFV27	NFV28	NFV29	NFV30	NFV31	NFV32	NFVr02	NFVr03	NFVr04	NFVr05	NFVr06	NFVr07	NFVr08	NFVOPP
Malvaceae	*Sida* sp. Excedentifolia (J.L. Egan 1925)																							+																	
Solanaceae	*Solanum cleistogamum*			+								+			+						+										+		+							
Solanaceae	*Solanum lasiophyllum*	+	+		+	+	+		+	+	+	+		+		+		+	+		+	+	+	+	+	+		+	+	+			+				+	+		
Solanaceae	*Solanum sturtianum*														+																										
Asteraceae	**Sonchus oleraceus*																																	+							
Poaceae	*Sporobolus australasicus*										+						+		+																						+
Stackhousiaceae	*Stackhousia intermedia*																				+																				+
Plantaginaceae	*Stemodia grossa*												+																												
Surianaceae	*Stylobasium spathulatum*				+						+																														
Fabaceae	*Tephrosia rosea* var. *clementii*												+													1															
Poaceae	*Themeda triandra*			2									1						3				40			1					8						45				
Aizoaceae	*Trianthema triquetra*										+																														
Zygophyllaceae	*Tribulus hirsutus*		+				+		+																						+									
Zygophyllaceae	*Tribulus suberosus*	+					+			+								+		+		+							+		+		+							
Boraginaceae	*Trichodesma zeylanicum*		+	+	+					+		+							+				+		+															
Poaceae	*Triodia basedowii*				8		5	+								25		2		+		1		20	2		2	10	4	1	1	20	2			+		1	5		
Poaceae	*Triodia epactia*	2	+	4	20	25	1			3	5	15							+	28			10	+		2		4	25		8		10			4				
Poaceae	*Triodia longiceps*												2																												
Poaceae	*Triodia schinzii*											25			45																										
Poaceae	*Triodia* sp. Shovelanna Hill (S. van Leeuwen 3835)	28	28		+	2		20	20	20				35	+		5				10	+		2	25			10	1			2	1		35			+	15	15	
Malvaceae	*Triumfetta appendiculata*																		+				+			+														
Typhaceae	*Typha domingensis*																									+														
Fabaceae	**Vachellia farnesiana*												+																											
Malvaceae	*Waltheria virgata*																				+			+	+															+	
Poaceae	*Yakirra australiensis* var. *australiensis*																	+																						

Appendix K: Vegetation Association Mapping

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Figure K.1: Legend to Figures K.2 - K.7

Vegetation Association

Acacia Low Open Woodland to Low Woodland

1a Low Open Woodland to Low Woodland of *Acacia catenulata* subsp. *occidentalis, A. aptaneura, A. citrinoviridis, A. pruinocarpa* and *A. coriacea* subsp. *pendens* over Tall Open Shrubland of *A. aptaneura* and *Eremophila fraseri* over Scattered Low Shrubs of *Maireana tomentosa* over Very Open to Open Tussock Grassland of *Aristida latifolia, A. contorta, Eragrostis eriopoda* and *Eriachne pulchella* and Very Open Hummock grasses of *Triodia basedowii.*

1b Low Woodland of *Acacia aptaneura* over Tall Open Shrubland of *A. sclerosperma* subsp. *sclerosperma* over Very Open Hummock Grassland of *Triodia epactia* and Very Open Tussock Grassland of *Aristida latifolia.*

Acacia Tall Shrubland

2a Tall Open Shrubland to Tall Shrubland of *Acacia pruinocarpa, A. aptaneura* and *A. catenulata* subsp. *occidentalis* over Shrubland of *A. aptaneura, A. aneura, A. bivenosa* and *Eremophila forrestii* subsp. *forrestii* over Scattered Low Shrubs of *Scaevola parvifolia* subsp. *pilbarae* over Open Hummock Grassland of *Triodia basedowii* and Very Open Tussock Grasses of *Aristida contorta*, *Paraneurachne muelleri* and *Cymbopogon procerus.*

Triodia Hummock Grassland

3a Low Open Woodland of *Hakea lorea* subsp. *lorea* and *Corymbia aspera* over Scattered Tall Shrubs of *Acacia pruinocarpa* over Hummock Grassland of *Triodia schinzii* and Scattered herbs of *Bonamia rosea* and *Duperreya commixta.*

3b Tall Open Shrubland of *Acacia ancistrocarpa* and *Hakea chordophylla* over Hummock Grassland of *Triodia epactia* and *T. schinzii* over Scattered Herbs of *Bonamia rosea.*

3c Scattered Low Trees of *Eucalyptus leucophloia* subsp. *leucophloia* over Scattered Tall Shrubs of *Acacia pruinocarpa* and *A. aptaneura* over Low Open Shrubland of *A. hilliana* and *A. adoxa* var. *adoxa* over Open Hummock Grassland of *Triodia basedowii.*

**Cenchrus* Open Tussock Grassland

4a Tall Shrubland of *Acacia sclerosperma* subsp. *sclerosperma* and *A. synchronicia* over Scattered Low Shrubs of *Sida* aff. *echinocarpa* (MET 15,350) over Open Tussock Grassland of **Cenchrus ciliaris* and *Eragrostis eriopoda* and Open Hummock Grassland of *Triodia epactia.*

4b Open Woodland of *Eucalyptus victrix* over Tall Shrubland of *Petalostylis labicheoides, Androcalva luteiflora, Acacia bivenosa, A. pyrifolia* and *A. citrinoviridis* over Tussock Grassland of **Cenchrus ciliaris, Themeda triandra* and *Eriachne mucronata.*

4c Low Open Woodland of *Corymbia hamersleyana* and *Acacia citrinoviridis* over Tall Open Shrubland of *Petalostylis labicheoides, Santalum lanceolatum* and *Grevillea wickhamii* over Tussock Grassland of **Cenchrus ciliaris, Enneapogon robustissimus* and *Eriachne mucronata* and Open Hummock Grassland of *Triodia epactia.*

Acacia Shrubland

5a Open Woodland of *Corymbia hamersleyana* and *Eucalyptus gamophylla* over Tall Shrubland of *Acacia monticola, Petalostylis labicheoides* and *Santalum lanceolatum* and *A. bivenosa* over Hummock Grassland of *Triodia epactia* and *T. basedowii* and Open Tussock Grassland of *Themeda triandra* which occurs as a mosaic with vegetation association 11a

Eucalyptus Open Forest

6a Open Forest of *Eucalyptus camaldulensis* subsp. *obtusa* and *E. victrix* over Low Woodland of *Acacia citrinoviridis, Melaleuca glomerata* and *A. coriacea* subsp. *pendens* over Tussock Grassland of **Cenchrus ciliaris, *Cynodon dactylon, Leptochloa digitata, Eulalia aurea* and *Themeda triandra* and Very Open Sedges of *Cyperus vaginatus* and Very Open Hummock Grassland *Triodia longiceps.*

Triodia Open Hummock Grassland

7a Low Shrubland of *Acacia hilliana, Mirbelia viminale* and *A. adoxa* var. *adoxa* over Open Hummock Grassland of *Triodia basedowii, T.* sp. *Shovellana Hill* (S. van Leeuwen 3835) and Very Open Tussock Grassland of *Eriachne mucronata* and *Eragrostis setifolia.*

7b Tall Open Shrubland of *Acacia inaequilatera* over Scattered Shrubs of *Senna glutinosa* subsp. *pruinosa* over Open Hummock Grassland of *Triodia epactia.*

7c Scattered Low Trees of *Grevillea wickhamii* subsp. *hispidula* and *G. pyramidalis* subsp. *leucadendron* over Closed Hummock Grassland of *Triodia wiseana* and *T. epactia*.

Grevillea Tall Shrubland

8a Tall Open Shrubland of *Acacia ancistrocarpa, A. bivenosa* and *A. inaequilatera* over Low Open Shrubland of *Ptilotus astrolasius* over Open Hummock Grassland of *Triodia epactia*, and Open Tussock Grassland of *Eragrostis setifolia* and *Paraneurachne muelleri* which occurs as a mosaic with vegetation association 7d

8b This is a mosaic of two vegetation associations which cannot be mapped separately:
8a: Tall Open Shrubland of *Acacia ancistrocarpa, A. bivenosa* and *A. inaequilatera* over Low Open Shrubland of *Ptilotus astrolasius* over Open Hummock Grassland of *Triodia epactia*, and Open Tussock Grassland of *Eragrostis setifolia* and *Paraneurachne muelleri* which occurs as a mosaic with vegetation association 7d
7d: Tall Shrubland of *Grevillea wickhamii, Acacia inaequilatera* and *A. monticola* over Scattered Shrubs of *Acacia pachyachra* over Hummock Grassland of *Triodia basedowii* and *T. epactia* and Open Tussock Grassland of *Amphipogon sericeus* which occurs as a mosaic with vegetation association 8a.

Amphipogon Open Tussock Grassland

9a Scattered Low Trees of *Corymbia deserticola* over Open Tussock Grassland of *Amphipogon sericeus, Paraneurachne muelleri* and Very Open Hummock Grassland of *Triodia basedowii.*

Themeda Tussock Grassland

10a Tall Open Shrubland of *Acacia monticola* and *A. bivenosa* over Tussock Grassland of *Themeda triandra* and **Cenchrus ciliaris.*

10b Open Woodland of *Eucalyptus kingsmillii* subsp. *kingsmillii* and *Eucalyptus leucophloia* subsp. *leucophloia* over Tall Open Scrub of *Acacia monticola, Santalum lanceolatum* and *Androcalva luteiflora* over Tussock Grassland of *Themeda triandra* and *Eulalia aurea* and Open Hummock Grassland of *Triodia epactia.*

Acacia Tall Open Scrub

11b This is a mosaic of two vegegation associations:
11a:Tall scrub of *Acacia ancistrocarpa, A. disctylophleba, Grevillea wickhamii* and *A. inaequilatera* over Open Hummock Grassland of *Triodia basedowii*, and *T.* sp. *Shovellana Hill* (S. van Leeuwen 3835) and Very Open Tussock Grassland of *Paraneurachne muelleri* which occurs as a mosaic with vegetation association 5a.
5a: Open Woodland of *Corymbia hamersleyana* and *Eucalyptus gamophylla* over Tall Shrubland of *Acacia monticola, Petalostylis labicheoides* and *Santalum lanceolatum* and *A. bivenosa* over Hummock Grassland of *Triodia epactia* and *T. basedowii* and Open Tussock Grassland of *Themeda triandra.*

11c Tall Open Scrub of *Acacia aptaneura* and *A. catenulata* subsp. *occidentalis* over Very Open Hummock Grassland of *Triodia* sp. *Shovellana Hill* (S. van Leeuwen 3835).

Disturbed

Dist. Disturbed, cleared areas.

Mapping Layers

- Roads
- Rail
- River
- Survey Area
- Warrawandu Village
- Tenement ID: ML 244SA

Quadrat/Releve Locations

- Quadrat
- Relevé

793000 793500 794000 794500 795000

7421000 7420500 7420000 7419500 7419000 7418500 7418000

MOUNT NEWMAN RAILROAD
FORTESCUE RIVER
MARBLE BAR RD
DAM ACCESS RD

3c
6a
4a
7c
3b
11b
7b
8b
Disturbed

NFV12
NFV10
NFV11
NFV09
NFV32
NFV01
NFVr02

K.2 K.3 K.4 K.5 K.6 K.7
Map Extent

BHP Billiton Iron Ore Pty Ltd
Ninga Vegetation and Flora Survey

Figure K.2: Vegetation Mapping

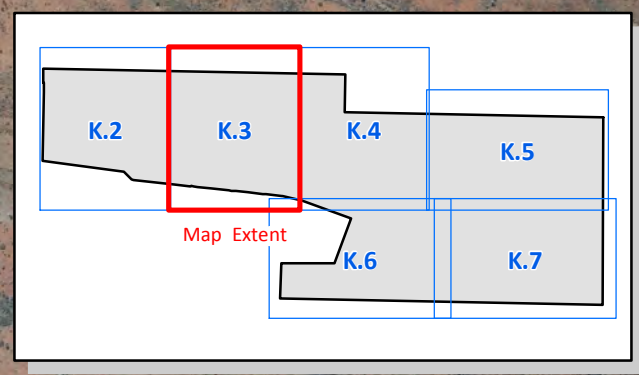
astron environmental services

Author: A. Bott	Date: 09-07-2013	Datum: GDA 1994 - Projection: MGA Zone 50 - Scale: 1:10,000 (A3)
Drawn: C. Dyde	Figure Ref: 2438-13-GDR-1RevA_20130709_K02_VegMap	Metres 0 100 200 300 400 500

N

795500 796000 796500 797000 797500 798000

7421000 7420500 7420000 7419500 7419000 7418500 7418000



8b 8b 7b 8a 7b 7b 3b 7c NFV07 NFV05 NFV02 NFV06 NFV27 11b NFV04 Disturbed 1a NFV26 3c 11b

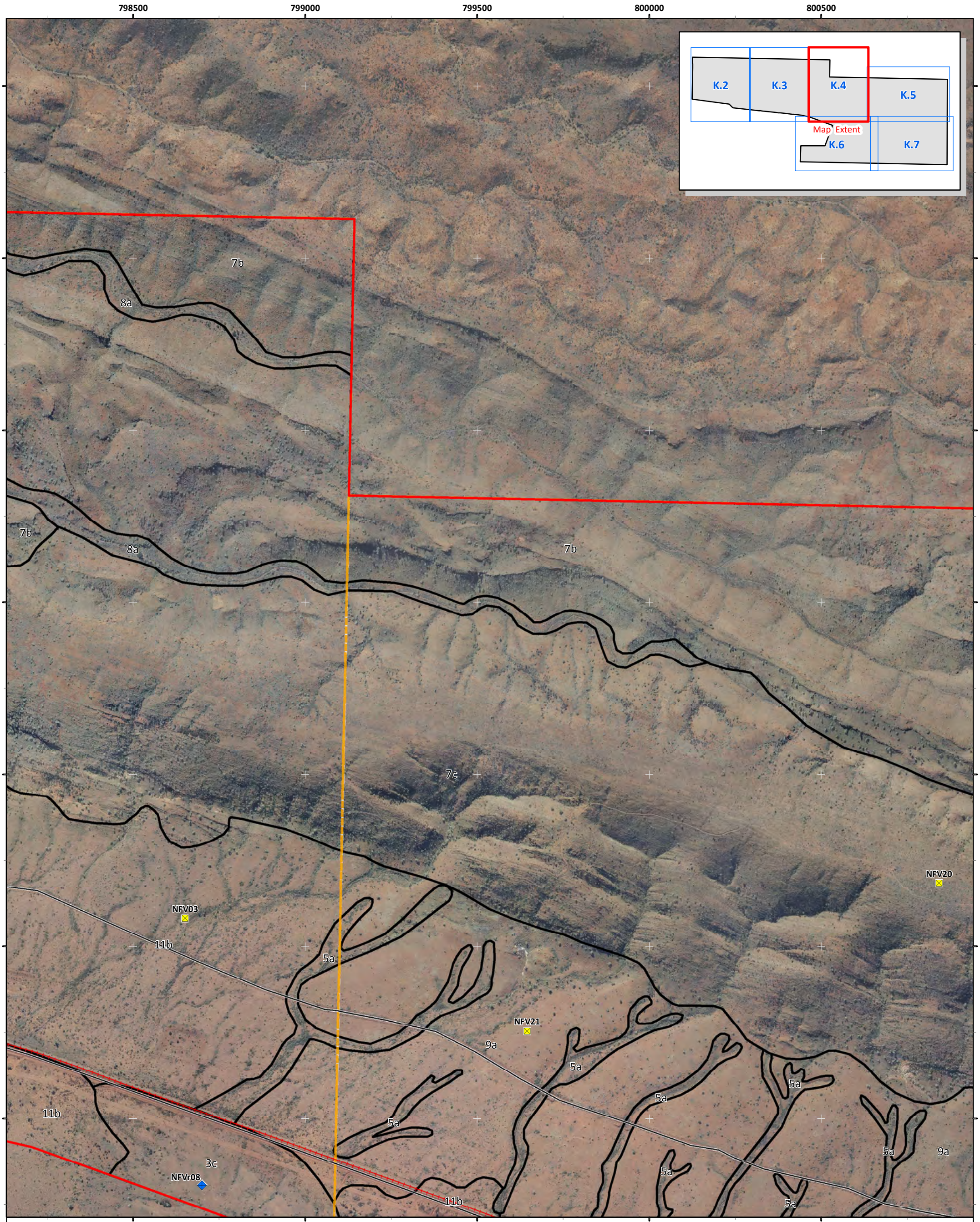
BHP Billiton Iron Ore Pty Ltd
Ninga Vegetation and Flora Survey

Figure K.3: Vegetation Mapping

astron environmental services

Author: A. Bott	Date: 09-07-2013	Datum: GDA 1994 - Projection: MGA Zone 50 - Scale: 1:10,000 (A3)
Drawn: C. Dyde	Figure Ref: 2438-13-GDR-1RevA_20130709_K03_VegMap	Metres 0 100 200 300 400 500

N



BHP Billiton Iron Ore Pty Ltd
Ninga Vegetation and Flora Survey

Figure K.4: Vegetation Mapping

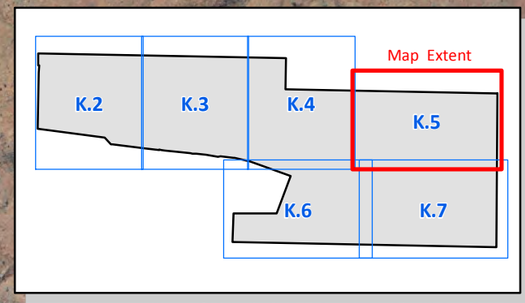
astron environmental services

Author: A. Bott	Date: 09-07-2013	Datum: GDA 1994 - Projection: MGA Zone 50 - Scale: 1:10,000 (A3)
Drawn: C. Dyde	Figure Ref: 2438-13-GDR-1RevA_20130709_K04_VegMap	Metres 0 100 200 300 400 500

N

801000 801500 802000 802500 803000 803500 804000 804500

7420000 7419500 7419000 7418500 7418000



7a 7b 7a 10a 4b NFVr05 NFV18 NFV19 NFV23 7b NFVr01 7c NFV24 NFV22 10b 7b NFV28 9a 4c 4c NFVr06 9a 4c 11b 7c NFVr07

BHP Billiton Iron Ore Pty Ltd
Ninga Vegetation and Flora Survey

Figure K.5: Vegetation Mapping

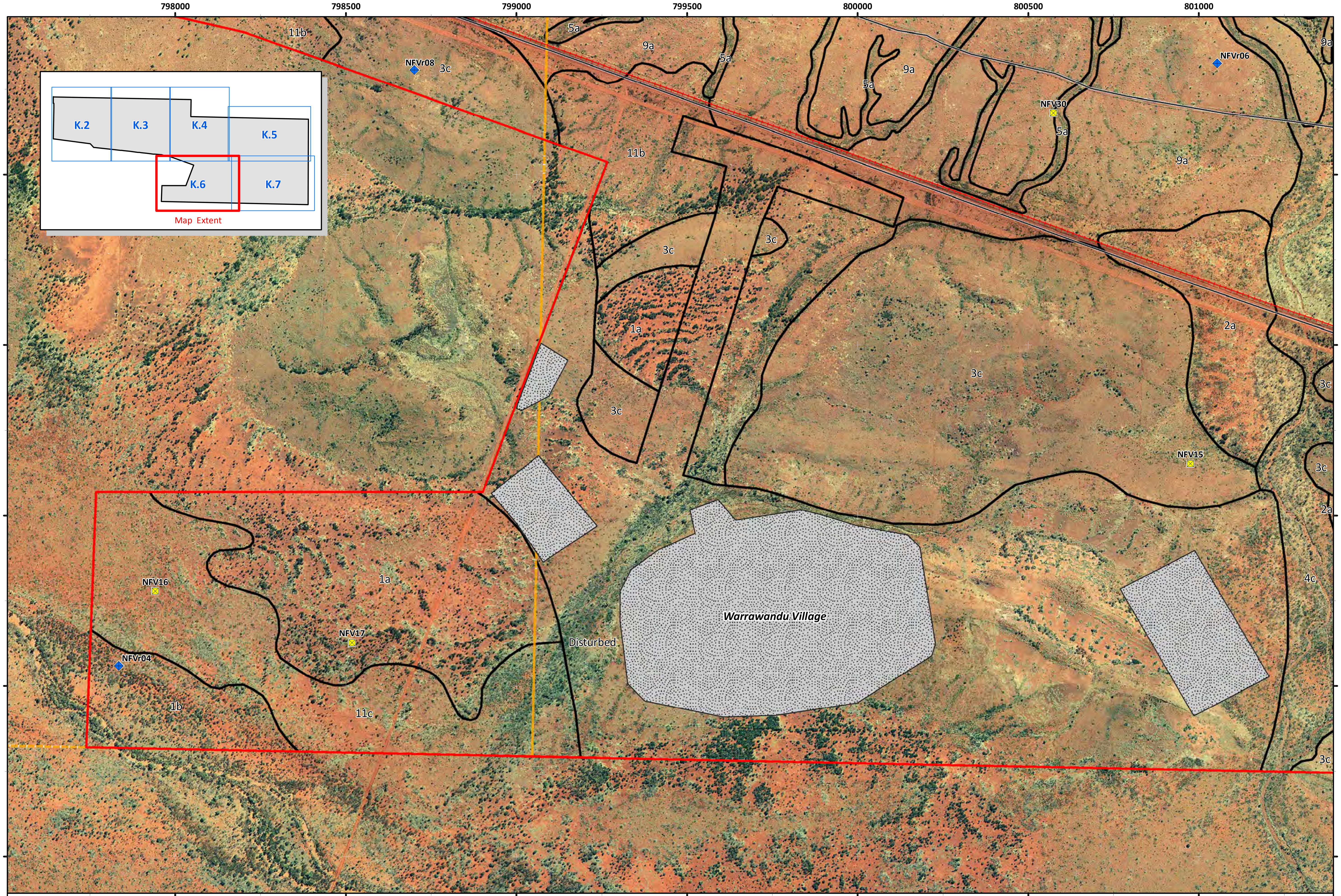
Datum: GDA 1994 - Projection: MGA Zone 50 - Scale 1:10,000 (A3)

0 200 400 600 800 1,000 Metres

N

astron environmental services

Author: A. Bott | Drawn: C. Dyde | Date: 09-07-2013 | Figure Ref: 2438-13-GDR-1RevA_20130709_K05_VegMap



BHP Billiton Iron Ore Pty Ltd
Ninga Vegetation and Flora Survey

Figure K.6: Vegetation Mapping

Datum: GDA 1994 - Projection: MGA Zone 50 - Scale 1:10,000 (A3)

0 200 400 600 800 1,000 Metres

N

astron environmental services

Author: A. Bott | Drawn: C. Dyde | Date: 09-07-2013 | Figure Ref: 2438-13-GDR-1RevA_20130709_K06_VegMap

801500 802000 802500 803000 803500 804000 804500

7417500 7417000 7416500 7416000 7415500

NFVr06 NFVr07 NFV25 NFV29 NFV31 NFV08 NFV13 NFV03 NFV14

9a 9a 9a 7c 7c 7b 11b 10b 4c 2a 2a 11b 3c 3c Disturbed 2a 3c 3a

K.2 K.3 K.4 K.5 K.6 K.7 Map Extent

BHP Billiton Iron Ore Pty Ltd
Ninga Vegetation and Flora Survey

Figure K.7: Vegetation Mapping

Datum: GDA 1994 - Projection: MGA Zone 50 - Scale 1:10,000 (A3)

0 200 400 600 800 1,000 Metres

N

astron environmental services

Author: A. Bott | Drawn: C. Dyde | Date: 09-07-2013 | Figure Ref: 2438-13-GDR-1RevA_20130709_K07_VegMap

Figure K.8: Legend to Figures K.9 - K.14

Vegetation Association

Acacia Low Open Woodland to Low Woodland

1a Low Open Woodland to Low Woodland of *Acacia catenulata* subsp. *occidentalis, A. aptaneura, A. citrinoviridis, A. pruinocarpa* and *A. coriacea* subsp. *pendens* over Tall Open Shrubland of *A. aptaneura* and *Eremophila fraseri* over Scattered Low Shrubs of *Maireana tomentosa* over Very Open to Open Tussock Grassland of *Aristida latifolia, A. contorta, Eragrostis eriopoda* and *Eriachne pulchella* and Very Open Hummock grasses of *Triodia basedowii.*

1b Low Woodland of *Acacia aptaneura* over Tall Open Shrubland of *A. sclerosperma* subsp. *sclerosperma* over Very Open Hummock Grassland of *Triodia epactia* and Very Open Tussock Grassland of *Aristida latifolia.*

Acacia Tall Shrubland

2a Tall Open Shrubland to Tall Shrubland of *Acacia pruinocarpa, A. aptaneura* and *A. catenulata* subsp. *occidentalis* over Shrubland of *A. aptaneura, A. aneura, A. bivenosa* and *Eremophila forrestii* subsp. *forrestii* over Scattered Low Shrubs of *Scaevola parvifolia* subsp. *pilbarae* over Open Hummock Grassland of *Triodia basedowii* and Very Open Tussock Grasses of *Aristida contorta*, *Paraneurachne muelleri* and *Cymbopogon procerus.*

Triodia Hummock Grassland

3a Low Open Woodland of *Hakea lorea* subsp. *lorea* and *Corymbia aspera* over Scattered Tall Shrubs of *Acacia pruinocarpa* over Hummock Grassland of *Triodia schinzii* and Scattered herbs of *Bonamia rosea* and *Duperreya commixta.*

3b Tall Open Shrubland of *Acacia ancistrocarpa* and *Hakea chordophylla* over Hummock Grassland of *Triodia epactia* and *T. schinzii* over Scattered Herbs of *Bonamia rosea.*

3c Scattered Low Trees of *Eucalyptus leucophloia* subsp. *leucophloia* over Scattered Tall Shrubs of *Acacia pruinocarpa* and *A. aptaneura* over Low Open Shrubland of *A. hilliana* and *A. adoxa* var. *adoxa* over Open Hummock Grassland of *Triodia basedowii.*

**Cenchrus* Open Tussock Grassland

4a Tall Shrubland of *Acacia sclerosperma* subsp. *sclerosperma* and *A. synchronicia* over Scattered Low Shrubs of *Sida* aff. *echinocarpa* (MET 15,350) over Open Tussock Grassland of **Cenchrus ciliaris* and *Eragrostis eriopoda* and Open Hummock Grassland of *Triodia epactia.*

4b Open Woodland of *Eucalyptus victrix* over Tall Shrubland of *Petalostylis labicheoides, Androcalva luteiflora, Acacia bivenosa, A. pyrifolia* and *A. citrinoviridis* over Tussock Grassland of **Cenchrus ciliaris, Themeda triandra* and *Eriachne mucronata.*

4c Low Open Woodland of *Corymbia hamersleyana* and *Acacia citrinoviridis* over Tall Open Shrubland of *Petalostylis labicheoides, Santalum lanceolatum* and *Grevillea wickhamii* over Tussock Grassland of **Cenchrus ciliaris, Enneapogon robustissimus* and *Eriachne mucronata* and Open Hummock Grassland of *Triodia epactia.*

Acacia Shrubland

5a Open Woodland of *Corymbia hamersleyana* and *Eucalyptus gamophylla* over Tall Shrubland of *Acacia monticola, Petalostylis labicheoides* and *Santalum lanceolatum* and *A. bivenosa* over Hummock Grassland of *Triodia epactia* and *T. basedowii* and Open Tussock Grassland of *Themeda triandra* which occurs as a mosaic with vegetation association 11a

Eucalyptus Open Forest

6a Open Forest of *Eucalyptus camaldulensis* subsp. *obtusa* and *E. victrix* over Low Woodland of *Acacia citrinoviridis, Melaleuca glomerata* and *A. coriacea* subsp. *pendens* over Tussock Grassland of **Cenchrus ciliaris, *Cynodon dactylon, Leptochloa digitata, Eulalia aurea* and *Themeda triandra* and Very Open Sedges of *Cyperus vaginatus* and Very Open Hummock Grassland *Triodia longiceps.*

Triodia Open Hummock Grassland

7a Low Shrubland of *Acacia hilliana, Mirbelia viminale* and *A. adoxa* var. *adoxa* over Open Hummock Grassland of *Triodia basedowii, T.* sp. *Shovellana Hill* (S. van Leeuwen 3835) and Very Open Tussock Grassland of *Eriachne mucronata* and *Eragrostis setifolia.*

7b Tall Open Shrubland of *Acacia inaequilatera* over Scattered Shrubs of *Senna glutinosa* subsp. *pruinosa* over Open Hummock Grassland of *Triodia epactia.*

7c Scattered Low Trees of *Grevillea wickhamii* subsp. *hispidula* and *G. pyramidalis* subsp. *leucadendron* over Closed Hummock Grassland of *Triodia wiseana* and *T. epactia*.

Grevillea Tall Shrubland

8a Tall Open Shrubland of *Acacia ancistrocarpa, A. bivenosa* and *A. inaequilatera* over Low Open Shrubland of *Ptilotus astrolasius* over Open Hummock Grassland of *Triodia epactia*, and Open Tussock Grassland of *Eragrostis setifolia* and *Paraneurachne muelleri* which occurs as a mosaic with vegetation association 7d

8b This is a mosaic of two vegetation associations which cannot be mapped separately:
8a: Tall Open Shrubland of *Acacia ancistrocarpa, A. bivenosa* and *A. inaequilatera*over Low Open Shrubland of *Ptilotus astrolasius* over Open Hummock Grassland of *Triodia epactia*, and Open Tussock Grassland of *Eragrostis setifolia* and *Paraneurachne muelleri* which occurs as a mosaic with vegetation association 7d
7d: Tall Shrubland of *Grevillea wickhamii, Acacia inaequilatera* and *A. monticola* over Scattered Shrubs of *Acacia pachyachra* over Hummock Grassland of *Triodia basedowii* and *T. epactia* and Open Tussock Grassland of *Amphipogon sericeus* which occurs as a mosaic with vegetation association 8a.

Amphipogon Open Tussock Grassland

9a Scattered Low Trees of *Corymbia deserticola* over Open Tussock Grassland of *Amphipogon sericeus, Paraneurachne muelleri* and Very Open Hummock Grassland of *Triodia basedowii.*

Themeda Tussock Grassland

10a Tall Open Shrubland of *Acacia monticola* and *A. bivenosa* over Tussock Grassland of *Themeda triandra* and **Cenchrus ciliaris.*

10b Open Woodland of *Eucalyptus kingsmillii* subsp. *kingsmillii* and *Eucalyptus leucophloia* subsp. *leucophloia* over Tall Open Scrub of *Acacia monticola, Santalum lanceolatum* and *Androcalva luteiflora* over Tussock Grassland of *Themeda triandra* and *Eulalia aurea* and Open Hummock Grassland of *Triodia epactia.*

Acacia Tall Open Scrub

11b This is a mosaic of two vegegation associations:
11a:Tall scrub of *Acacia ancistrocarpa, A. disctylophleba, Grevillea wickhamii* and *A. inaequilatera* over Open Hummock Grassland of *Triodia basedowii*, and *T.* sp. *Shovellana Hill* (S. van Leeuwen 3835) and Very Open Tussock Grassland of *Paraneurachne muelleri* which occurs as a mosaic with vegetation association 5a.
5a: Open Woodland of *Corymbia hamersleyana* and *Eucalyptus gamophylla* over Tall Shrubland of *Acacia monticola, Petalostylis labicheoides* and *Santalum lanceolatum* and *A. bivenosa* over Hummock Grassland of *Triodia epactia* and *T. basedowii* and Open Tussock Grassland of *Themeda triandra.*

11c Tall Open Scrub of *Acacia aptaneura* and *A. catenulata* subsp. *occidentalis* over Very Open Hummock Grassland of *Triodia* sp. *Shovellana Hill* (S. van Leeuwen 3835).

Disturbed

Dist. Disturbed, cleared areas.

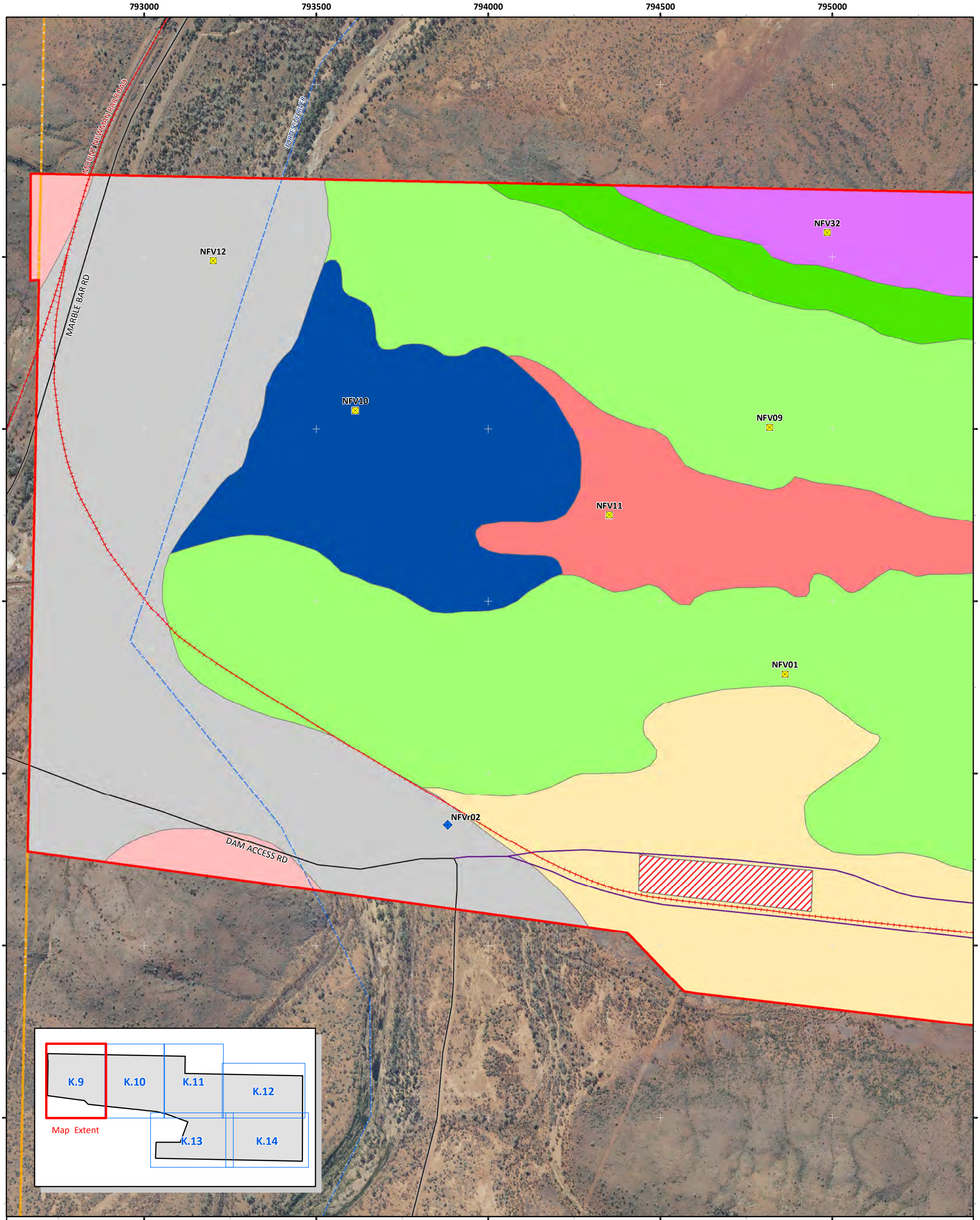
Mapping Layers

- Roads
- Rail
- River
- Survey Area
- Warrawandu Village
- Tenement ID: ML 244SA

Quadrat/Releve Locations

- Quadrat
- Relevé

Figure Ref: 2438-13-GDR-1RevA_20130709_K08_VegMap_Legend



BHP Billiton Iron Ore Pty Ltd
Ninga Vegetation and Flora Survey

Figure K.9: Vegetation Mapping

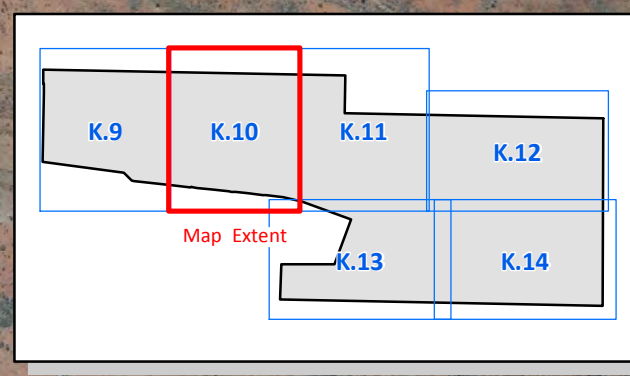
astron environmental services

Author: A. Bott	Date: 09-07-2013	Datum: GDA 1994 - Projection: MGA Zone 50 - Scale: 1:10,000 (A3)
Drawn: C. Dyde	Figure Ref: 2438-13-GDR-1RevA_20130709_K09_VegMap	Metres 0 100 200 300 400 500

N

795500 796000 796500 797000 797500 798000

7421000 7420500 7420000 7419500 7419000 7418500 7418000



NFV06

NFV02

NFV07

NFV05

NFV27

NFV04

NFV26

BHP Billiton Iron Ore Pty Ltd
Ninga Vegetation and Flora Survey

Figure K.10: Vegetation Mapping

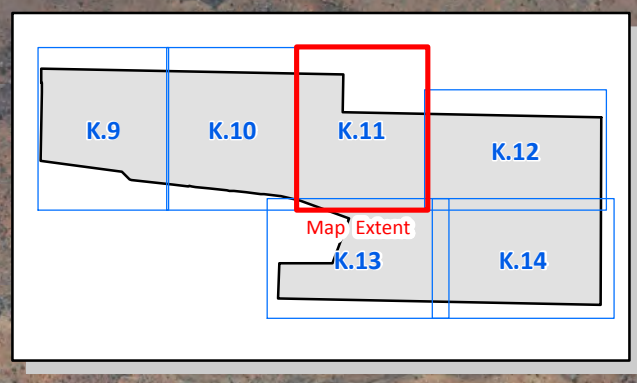
astron environmental services

Author: A. Bott	Date: 09-07-2013	Datum: GDA 1994 - Projection: MGA Zone 50 - Scale: 1:10,000 (A3)
Drawn: C. Dyde	Figure Ref: 2438-13-GDR-1RevA_20130709_K10_VegMap	Metres 0 100 200 300 400 500

N

798500 799000 799500 800000 800500

7421000 7420500 7420000 7419500 7419000 7418500 7418000



NFV20

NFV03

NFV21

NFVr08

BHP Billiton Iron Ore Pty Ltd
Ninga Vegetation and Flora Survey

Figure K.11: Vegetation Mapping

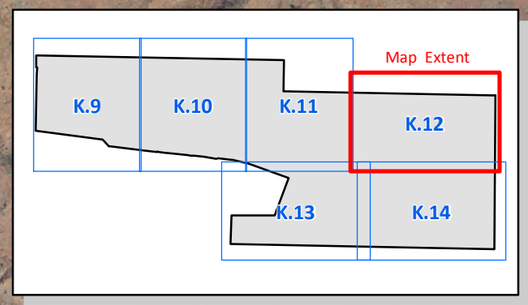
astron environmental services

Author: A. Bott	Date: 09-07-2013	Datum: GDA 1994 - Projection: MGA Zone 50 - Scale: 1:10,000 (A3)
Drawn: C. Dyde	Figure Ref: 2438-13-GDR-1RevA_20130709_K11_VegMap	0 100 200 300 400 500 Metres

N

801000 801500 802000 802500 803000 803500 804000 804500

7420000 7419500 7419000 7418500 7418000



NFVr05
NFV18
NFV19
NFV23
NFVr01
NFV22
NFV24
NFV28
NFVr06
NFVr07

BHP Billiton Iron Ore Pty Ltd
Ninga Vegetation and Flora Survey

Figure K.12: Vegetation Mapping

Datum: GDA 1994 - Projection: MGA Zone 50 - Scale 1:10,000 (A3)

0 200 400 600 800 1,000 Metres

N

astron environmental services

Author: A. Bott | Drawn: C. Dyde | Date: 09-07-2013 | Figure Ref: 2438-13-GDR-1RevA_20130709_K12_VegMap

798000 798500 799000 799500 800000 800500 801000

7417500 7417000 7416500 7416000 7415500

K.9 K.10 K.11 K.12 K.13 K.14

Map Extent

NFVr08 NFVr06 NFV30 NFV15 NFV16 NFV17 NFVr04

Warrawandu Village

BHP Billiton Iron Ore Pty Ltd
Ninga Vegetation and Flora Survey

Figure K.13: Vegetation Mapping

Datum: GDA 1994 - Projection: MGA Zone 50 - Scale 1:10,000 (A3)

0 200 400 600 800 1,000 Metres

N

astron environmental services

Author: A. Bott | Drawn: C. Dyde | Date: 09-07-2013 | Figure Ref: 2438-13-GDR-1RevA_20130709_K13_VegMap

801500 802000 802500 803000 803500 804000 804500

7417500
7417000
7416500
7416000
7415500

NFVr06
NFVr07
NFV25
NFV29
NFV31
NFV08
NFV13
NFVr03
NFV14

K.9 K.10 K.11 K.12 K.13 K.14
Map Extent

BHP Billiton Iron Ore Pty Ltd
Ninga Vegetation and Flora Survey

Figure K.14: Vegetation Mapping

Datum: GDA 1994 - Projection: MGA Zone 50 - Scale 1:10,000 (A3)

0 200 400 600 800 1,000 Metres

N

astron environmental services

Author: A. Bott | Drawn: C. Dyde | Date: 09-07-2013 | Figure Ref: 2438-13-GDR-1RevA_20130709_K14_VegMap

Appendix L: Vegetation Condition Mapping

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792000 794000 796000 798000 800000 802000 804000

7422000 7420000 7418000 7416000 7414000

MOUNT NEWMAN RAILROAD
MARBLE BAR RD
FORTESCUE RIVER
DAM ACCESS

NFV12 NFV32 NFV06 NFV10 NFV09 NFV02 NFV11 NFV07 NFV05 NFV01 NFV27 NFVr02 NFV04 NFV03 NFV26 NFVr08 NFV30 NFV25 NFV15 NFV16 NFV17 NFVr04

NFVr05 NFV18 NFV19 NFV23 NFV20 NFVr01 NFV21 NFV24 NFV22 NFV28 NFVr06 NFVr07 NFV29 NFV31 NFV08 NFV13 NFVr03 NFV14

OPHTHALMIA RANGE
MOUNT NEWMAN
MOUNT NEWMAN ROAD
NEWMAN
SHOVELANNA HILL
Map Extent

Legend

- Road
- Rail
- River
- Survey Area
- Warrawandu Village
- Tenement ID: ML 244SA

Quadrat/Releve Locations

- Quadrat
- Relevé

Vegetation Condition

- Excellent
- Degraded
- Disturbed

BHP Billiton Iron Ore Pty Ltd
Ninga Vegetation and Flora Survey

Figure L.1: Vegetation Condition

Datum: GDA 1994 - Projection: MGA Zone 50 - Scale: 1:35,000 (A3)

0 500 1,000 1,500 2,000 2,500 Metres

N

astron environmental services

Author: A. Bott | Drawn: C. Dyde | Date: 09-07-2013 | Figure Ref: 2438-13-GDR-1RevA_20130709_FigL1_VegCond

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Appendix M: Vascular Flora Species List

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Table M.1: Vascular flora species list.

Family	Species name	Weed species
Aizoaceae	*Trianthema triquetra*	
Amaranthaceae	*Alternanthera nodiflora*	
	Amaranthus mitchellii	
	Amaranthus undulatus	
	Gomphrena cunninghamii	
	Gomphrena kanisii	
	Ptilotus aervoides	
	Ptilotus astrolasius	
	Ptilotus calostachyus	
	Ptilotus nobilis	
	Ptilotus obovatus	
	Ptilotus rotundifolius	
	Ptilotus schwartzii	
Apocynaceae	*Sarcostemma viminale*	
Araliaceae	*Astrotricha hamptonii*	
Asteraceae	*Bidens bipinnata*	*
	Chrysocephalum pterochaetum	
	Pluchea dentex	
	Pluchea rubelliflora	
	Rhodanthe margarethae	
	Rutidosis helichrysoides	
	Sonchus oleraceus	*
Boraginaceae	*Halgania gustafsenii*	
	Heliotropium ovalifolium	
	Trichodesma zeylanicum	
Caryophyllaceae	*Polycarpaea corymbosa*	
	Polycarpaea longiflora	
Celastraceae	*Stackhousia intermedia*	
Chenopodiaceae	*Dissocarpus paradoxus*	
	Enchylaena tomentosa var. *tomentosa*	
	Maireana tomentosa	
	Rhagodia eremaea	
	Salsola australis	
	Sclerolaena cornishiana	
	Sclerolaena costata	
	Sclerolaena cuneata	
	Sclerolaena densiflora	
	Sclerolaena eriacantha	
Cleomaceae	*Cleome viscosa*	

Family	Species name	Weed species
Convolvulaceae	*Bonamia erecta*	
	Bonamia media	
	Duperreya commixta	
	Evolvulus alsinoides var. *decumbens*	
	Evolvulus alsinoides var. *villosicalyx*	
Cucurbitaceae	*Cucumis maderaspatanus*	
Cyperaceae	*Bulbostylis barbata*	
	Cyperus difformis	
	Cyperus vaginatus	
	Fimbristylis simulans	
Euphorbiaceae	*Euphorbia australis*	
	Euphorbia biconvexa	
Fabaceae	*Acacia adoxa* var. *adoxa*	
	Acacia ancistrocarpa	
	Acacia aneura	
	Acacia aptaneura	
	Acacia bivenosa	
	Acacia catenulata subsp. *occidentalis*	
	Acacia citrinoviridis	
	Acacia colei	
	Acacia coriacea subsp. *pendens*	
	Acacia dictyophleba	
	Acacia elachantha	
	Acacia hamersleyensis	
	Acacia hilliana	
	Acacia inaequilatera	
	Acacia macraneura	
	Acacia maitlandii	
	Acacia monticola	
	Acacia pachyacra	
	Acacia pruinocarpa	
	Acacia pteraneura	
	Acacia pyrifolia	
	Acacia rhodophloia	
	Acacia sclerosperma subsp. *sclerosperma*	
	Acacia synchronicia	
	Acacia tenuissima	
	Acacia tetragonophylla	
	Acacia tumida var. *pilbarensis*	
	Crotalaria medicaginea	

Family	Species name	Weed species
Fabaceae	*Cullen leucanthum*	
	Cullen leucochaites	
	Glycine canescens	
	Indigofera boviperda	
	Indigofera monophylla	
	Indigofera rugosa	
	Isotropis forrestii	
	Mirbelia viminalis	
	Petalostylis labicheoides	
	Rhynchosia minima	
	Senna artemisioides subsp. *helmsii*	
	Senna artemisioides subsp. *oligophylla*	
	Senna artemisioides subsp. *oligophylla x helmsii*	
	Senna glaucifolia	
	Senna glutinosa subsp. *glutinosa*	
	Senna glutinosa subsp. *pruinosa*	
	Senna glutinosa subsp. *x luerssenii*	
	Senna notabilis	
	Senna sp. Meekatharra (E. Bailey 1-26)	
	Senna stricta	
	Tephrosia rosea var. *clementii*	
	Vachellia farnesiana	*
Goodeniaceae	*Dampiera candicans*	
	Goodenia lamprosperma	
	Goodenia microptera	
	Goodenia sp.	
	Goodenia stobbsiana	
	Scaevola browniana	
	Scaevola parvifolia subsp. *pilbarae*	
	Scaevola spinescens	
Gyrostemonaceae	*Codonocarpus cotinifolius*	
Lamiaceae	*Clerodendrum floribundum* var. *angustifolium*	
	Clerodendrum tomentosum var. *lanceolatum*	
	Dicrastylis cordifolia	
Malvaceae	*Abutilon* aff. *fraseri*	
	Abutilon aff. *lepidum*	
	Abutilon leucopetalum	
	Abutilon otocarpum	
	Corchorus lasiocarpus ?subsp.	
	Corchorus lasiocarpus subsp. *lasiocarpus*	

Family	Species name	Weed species
Malvaceae	*Corchorus sidoides* subsp. *sidoides*	
	Corchorus sidoides subsp. *vermicularis*	
	Corchorus sp.	
	Corchorus tridens	
	Gossypium australe	
	Gossypium robinsonii	
	Hibiscus aff. *coatesii*	
	Hibiscus sp.	
	Hibiscus sturtii ?var.	
	Hibiscus sturtii var. *platychlamys*	
	Hibiscus sturtii var. *truncatus*	
	Keraudrenia nephrosperma	
	Keraudrenia velutina subsp. *elliptica*	
	Malvastrum americanum	*
	Androcalva luteiflora	
	Sida ? echinocarpa	
	*Sida ?*aff. *echinocarpa* (MET 15,350)	
	Sida aff. *fibulifera*	
	Sida arenicola	
	Sida cardiophylla	
	Sida sp. Excedentifolia (J.L. Egan 1925)	
	Triumfetta appendiculata	
	Waltheria virgata	
Molluginaceae	*Mollugo molluginea*	
Myrtaceae	*Calytrix carinata*	
	Corymbia aspera	
	Corymbia hamersleyana	
	Eucalyptus camaldulensis var. *obtusa*	
	Eucalyptus gamophylla	
	Eucalyptus kingsmillii subsp. *kingsmillii*	
	Eucalyptus leucophloia subsp. *leucophloia*	
	Eucalyptus victrix	
	Lamarchea sulcata	
	Melaleuca glomerata	
Nyctaginaceae	*Boerhavia coccinea*	
Oleaceae	*Jasminum didymum*	
Phyllanthaceae	*Phyllanthus maderaspatensis*	
Plantaginaceae	*Stemodia grossa*	
Poaceae	*Amphipogon caricinus*	
	Amphipogon sericeus	

Family	Species name	Weed species
Poaceae	*Aristida contorta*	
	Aristida holathera var. *holathera*	
	Aristida latifolia	
	Cenchrus ciliaris	*
	Cenchrus setiger	*
	Chloris barbata	*
	Cymbopogon procerus	
	Cynodon dactylon	*
	Dactyloctenium radulans	
	Echinochloa colona	*
	Enneapogon caerulescens	
	Enneapogon polyphyllus	
	Enneapogon robustissimus	
	Enteropogon ramosus	
	Eragrostis cumingii	
	Eragrostis eriopoda	
	Eragrostis setifolia	
	Eragrostis tenellula	
	Eriachne lanata	
	Eriachne mucronata	
	Eriachne mucronata (arid form) (MET 12 736)	
	Eriachne pulchella subsp. *pulchella*	
	Eulalia aurea	
	Leptochloa digitata	
	Panicum decompositum	
	Paraneurachne muelleri	
	Perotis rara	
	Schizachyrium fragile	
	Setaria surgens	
	Setaria verticillata	*
	Sporobolus australasicus	
	Themeda triandra	
	Triodia basedowii	
	Triodia epactia	
	Triodia longiceps	
	Triodia schinzii	
	Triodia sp. Shovelanna Hill (S. van Leeuwen 3835)	
	Yakirra australiensis var. *australiensis*	
Portulacaceae	*Calandrinia ptychosperma*	
	Portulaca oleracea	* (naturalised)

Family	Species name	Weed species
Proteaceae	*Grevillea berryana*	
	Grevillea wickhamii	
	Hakea chordophylla	
	Hakea lorea subsp. *lorea*	
Pteridaceae	*Cheilanthes* sp. Indeterminate	
Rubiaceae	*Oldenlandia crouchiana*	
	Psydrax latifolia	
	Psydrax suaveolens	
Santalaceae	*Anthobolus leptomerioides*	
	Santalum lanceolatum	
Sapindaceae	*Dodonaea coriacea*	
	Dodonaea pachyneura	
Scrophulariaceae	*Eremophila cuneifolia*	
	Eremophila forrestii	
	Eremophila forrestii subsp. *forrestii*	
	Eremophila fraseri	
	Eremophila latrobei	
	Eremophila latrobei subsp. *filiformis*	
	Eremophila latrobei subsp. *latrobei*	
	Eremophila longifolia	
Solanaceae	*Solanum cleistogamum*	
	Solanum lasiophyllum	
	Solanum sturtianum	
Surianaceae	*Stylobasium spathulatum*	
Typhaceae	*Typha domingensis*	
Violaceae	*Hybanthus aurantiacus*	
Zygophyllaceae	*Tribulus hirsutus*	
	Tribulus suberosus	

Appendix N: Priority Flora Locations and Mapping

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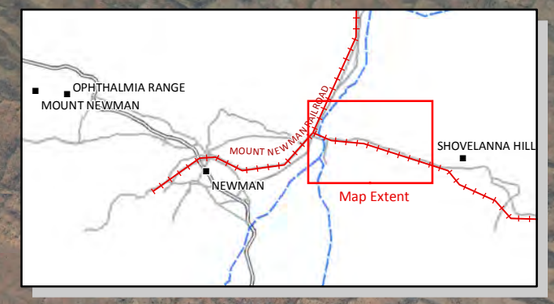
Table N.1: Locations of priority flora within the survey area during previous surveys.

Survey	Species	Easting	Northing
Ecologia Environment 2004	*Isotropis winneckei* (P1)	800741	7418485
Outback Ecology 2009a	*Aristida jerichoensis* var. *subspinulifera* (P1)	799171	7417937
		802446	7416837
		803201	7416649
ENV Australia 2006	*Gymnanthera cunninghamii* (P3)	792693	7419398

792000 794000 796000 798000 800000 802000 804000

7422000 7420000 7418000 7416000 7414000

MOUNT NEWMAN RAILROAD
MARBLE BAR RD
FORTESCUE RIVER
DAM ACCESS RD



Legend

- Road
- Rail
- River
- Survey Area
- Warrawandu Village
- Tenement ID: ML 244SA

Priority Flora

Species

- *Aristida jerichoensis* var. *subspinulifera*
- *Gymnanthera cunninghamii* (P3)
- *Isotropis winneckei* (P1)

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Ninga Vegetation and Flora Survey

Figure N.1: Priority Flora Locations

Datum: GDA 1994 - Projection: MGA Zone 50 - Scale: 1:35,000 (A3)

0 500 1,000 1,500 2,000 2,500 Metres

N

astron environmental services

Author: A. Bott | Drawn: C. Dyde | Date: 09-07-2013 | Figure Ref: 2438-13-GDR-1RevA_20130709_FigN1_PriFlora

Appendix O: Map, Locations and Assessment of Introduced Flora

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Table O.1: Locations of weeds recorded in the survey area during the current survey.

Species name	Site number	Easting	Northing	% Cover
**Cenchrus ciliaris*	NFV03	798652	7418581	+ (= <0.5%)
**Cenchrus ciliaris*	NFV04	797398	7418570	4%
**Cenchrus ciliaris*	NFV10	793614	7420054	15%
**Cenchrus ciliaris*	NFV11	794352	7419750	+ (= <0.5%)
**Cenchrus ciliaris*	NFV12	793201	7420489	32%
**Cenchrus ciliaris*	NFV15	800975	7416652	+ (= <0.5%)
**Cenchrus ciliaris*	NFV18	802632	7419005	4%
**Cenchrus ciliaris*	NFV25	801543	7417492	35%
**Cenchrus ciliaris*	NFV29	802510	7416995	+ (= <0.5%)
**Cenchrus ciliaris*	NFVr04	797835	7416059	+ (= <0.5%)
**Cenchrus ciliaris*	NFVr05	802088	7419048	3%
**Cenchrus ciliaris*	Opportunistic	793123	7420464	80%
**Cenchrus ciliaris*	Opportunistic	798744	7418602	<1%
**Cenchrus ciliaris*	Opportunistic	798711	7418591	<1%
**Cenchrus ciliaris*	Opportunistic	798697	7418602	<1%
**Cenchrus ciliaris*	Opportunistic	798682	7418588	10%
**Cenchrus ciliaris*	Opportunistic	798667	7418458	60%
**Cenchrus ciliaris*	Opportunistic	798692	7418450	20%
**Cenchrus ciliaris*	Opportunistic	798722	7418437	10%
**Cenchrus ciliaris*	Opportunistic	797410	7418544	10%
**Cenchrus ciliaris*	Opportunistic	797414	7418538	<1%
**Cenchrus ciliaris*	Opportunistic	797414	7418542	80%
**Cenchrus ciliaris*	Opportunistic	797423	7418532	10%
**Cenchrus ciliaris*	Opportunistic	797269	7418769	10%
**Cenchrus ciliaris*	Opportunistic	797248	7418774	<1%
**Cenchrus ciliaris*	Opportunistic	797124	7418774	<1%
**Cenchrus ciliaris*	Opportunistic	797078	7418773	90%
**Cenchrus ciliaris*	Opportunistic	796677	7418764	10%
**Cenchrus ciliaris*	Opportunistic	797192	7418794	10%
**Cenchrus ciliaris*	Opportunistic	797415	7418787	<1%
**Cenchrus ciliaris*	Opportunistic	797560	7418760	<1%
**Cenchrus ciliaris*	Opportunistic	800619	7417772	<1%
**Cenchrus ciliaris*	Opportunistic	802375	7417110	70%
**Cenchrus ciliaris*	Opportunistic	802340	7417115	90%
**Cenchrus ciliaris*	Opportunistic	802395	7417034	100%
**Cenchrus ciliaris*	Opportunistic	793126	7420510	90%
**Cenchrus ciliaris*	Opportunistic	793137	7420516	90%
**Cenchrus ciliaris*	Opportunistic	793148	7420518	90%

Species name	Site number	Easting	Northing	% Cover
*Cenchrus ciliaris	Opportunistic	793158	7420516	90%
*Cenchrus ciliaris	Opportunistic	793172	7420524	80%
*Cenchrus ciliaris	Opportunistic	793194	7420524	70%
*Cenchrus ciliaris	Opportunistic	793218	7420523	80%
*Cenchrus ciliaris	Opportunistic	793246	7420513	90%
*Cenchrus ciliaris	Opportunistic	793267	7420491	20%
*Cenchrus ciliaris	Opportunistic	793306	7420456	90%
*Cenchrus ciliaris	Opportunistic	793322	7420455	90%
*Cenchrus ciliaris	Opportunistic	793434	7420452	70%
*Cenchrus ciliaris	Opportunistic	793444	7420459	90%
*Cenchrus ciliaris	Opportunistic	793495	7420546	90%
*Cenchrus ciliaris	Opportunistic	793502	7420535	90%
*Cenchrus ciliaris	Opportunistic	793504	7420521	90%
*Cenchrus ciliaris	Opportunistic	793496	7420502	70%
*Cenchrus ciliaris	Opportunistic	793490	7420480	70%
*Cenchrus ciliaris	Opportunistic	793502	7420456	40%
*Cenchrus ciliaris	Opportunistic	793529	7420462	30%
*Cenchrus ciliaris	Opportunistic	793553	7420474	20%
*Cenchrus ciliaris	Opportunistic	793576	7420466	90%
*Cenchrus ciliaris	Opportunistic	793597	7420463	90%
*Cenchrus ciliaris	Opportunistic	793695	7420466	20%
*Cenchrus ciliaris	Opportunistic	793924	7420383	30%
*Cenchrus ciliaris	Opportunistic	794017	7420266	30%
*Cenchrus ciliaris	Opportunistic	794081	7420204	50%
*Cenchrus ciliaris	Opportunistic	794096	7420194	30%
*Cenchrus ciliaris	Opportunistic	794133	7420167	<1%
*Cenchrus ciliaris	Opportunistic	794156	7420148	10%
*Cenchrus ciliaris	Opportunistic	794179	7420119	10%
*Cenchrus ciliaris	Opportunistic	794188	7420109	90%
*Cenchrus ciliaris	Opportunistic	794216	7420083	10%
*Cenchrus ciliaris	Opportunistic	794244	7420061	10%
*Cenchrus ciliaris	Opportunistic	794273	7420038	20%
*Cenchrus ciliaris	Opportunistic	794305	7420015	10%
*Cenchrus ciliaris	Opportunistic	794019	7420247	80%
*Cenchrus ciliaris	Opportunistic	794009	7420235	20%
*Cenchrus ciliaris	Opportunistic	793998	7420218	60%
*Cenchrus ciliaris	Opportunistic	793986	7420190	10%
*Cenchrus ciliaris	Opportunistic	793969	7420179	70%
*Cenchrus ciliaris	Opportunistic	793949	7420132	40%

Species name	Site number	Easting	Northing	% Cover
**Cenchrus ciliaris*	Opportunistic	793888	7420075	80%
**Cenchrus ciliaris*	Opportunistic	793867	7420072	90%
**Cenchrus ciliaris*	Opportunistic	793856	7420062	60%
**Cenchrus ciliaris*	Opportunistic	793837	7420053	40%
**Cenchrus ciliaris*	Opportunistic	793809	7420035	70%
**Cenchrus ciliaris*	Opportunistic	793792	7419995	70%
**Cenchrus ciliaris*	Opportunistic	793807	7419983	50%
**Cenchrus ciliaris*	Opportunistic	793867	7419945	40%
**Cenchrus ciliaris*	Opportunistic	793893	7419931	40%
**Cenchrus ciliaris*	Opportunistic	793926	7419908	40%
**Cenchrus ciliaris*	Opportunistic	794269	7419853	10%
**Cenchrus ciliaris*	Opportunistic	794290	7419936	<1%
**Cenchrus ciliaris*	Opportunistic	793037	7420444	70%
**Cenchrus ciliaris*	Opportunistic	792882	7420466	60%
**Cenchrus ciliaris*	Opportunistic	794127	7418692	<1%
**Cenchrus ciliaris*	Opportunistic	793986	7418766	10%
**Cenchrus ciliaris*	Opportunistic	801045	7416840	10%
**Cenchrus ciliaris*	Opportunistic	797831	7416077	50%
**Cenchrus ciliaris*	Opportunistic	797858	7416028	<1%
**Cenchrus ciliaris*	Opportunistic	802436	7418379	80%
**Cenchrus ciliaris*	Opportunistic	802434	7418396	90%
**Cenchrus ciliaris*	Opportunistic	802438	7418406	100%
**Cenchrus ciliaris*	Opportunistic	802449	7418431	80%
**Cenchrus ciliaris*	Opportunistic	802426	7418576	90%
**Cenchrus ciliaris*	Opportunistic	802430	7418601	90%
**Cenchrus ciliaris*	Opportunistic	802428	7418630	90%
**Cenchrus ciliaris*	Opportunistic	802452	7418770	90%
**Cenchrus ciliaris*	Opportunistic	802460	7418787	90%
**Cenchrus ciliaris*	Opportunistic	802480	7418811	90%
**Cenchrus ciliaris*	Opportunistic	802510	7418845	90%
**Cenchrus ciliaris*	Opportunistic	802516	7418924	90%
**Cenchrus ciliaris*	Opportunistic	802368	7418988	90%
**Cenchrus ciliaris*	Opportunistic	802172	7419025	<1%
**Cenchrus ciliaris*	Opportunistic	801565	7417545	20%
**Cenchrus ciliaris*	Opportunistic	794403	7418611	40%
**Cenchrus ciliaris*	Opportunistic	795377	7420542	80%
**Cenchrus ciliaris*	Opportunistic	796363	7420513	90%
**Cenchrus setiger*	NFV12	793201	7420489	+ (= <0.5%)
**Cenchrus setiger*	Opportunistic	794143	7418680	10%

Species name	Site number	Easting	Northing	% Cover
**Cenchrus setiger*	Opportunistic	793986	7418766	<1%
**Chloris barbata*	NFVr02	793883	7418850	+ (= <0.5%)
**Chloris barbata*	NFVr04	797835	7416059	4%
**Cynodon dactylon*	NFV12	793201	7420489	+ (= <0.5%)
**Cynodon dactylon*	NFVr02	793883	7418850	65%
**Cynodon dactylon*	Opportunistic	794076	7418728	30%
**Cynodon dactylon*	Opportunistic	794055	7418746	100%
**Cynodon dactylon*	Opportunistic	793986	7418766	80%
**Echinochloa colona*	NFVr02	793883	7418850	1%
**Malvastrum americanum*	NFVr04	797835	7416059	+ (= <0.5%)
**Malvastrum americanum*	Opportunistic	794146	7418676	30%
**Malvastrum americanum*	Opportunistic	794118	7418701	30%
**Malvastrum americanum*	Opportunistic	794108	7418710	10%
**Malvastrum americanum*	Opportunistic	797859	7416027	<1%
**Portulaca oleracea*	NFV02	796041	7419897	+ (= <0.5%)
**Portulaca oleracea*	NFV06	797322	7420214	+ (= <0.5%)
**Portulaca oleracea*	NFV07	797781	7419521	+ (= <0.5%)
**Portulaca oleracea*	NFV09	794818	7420005	+ (= <0.5%)
**Portulaca oleracea*	NFV10	793614	7420054	+ (= <0.5%)
**Portulaca oleracea*	NFVr08	798701	7417806	+ (= <0.5%)
**Setaria verticillata*	NFV18	802632	7419005	+ (= <0.5%)
**Setaria verticillata*	NFVr04	797835	7416059	+ (= <0.5%)
**Setaria verticillata*	Opportunistic	797829	7416078	<1%
**Setaria verticillata*	Opportunistic	797859	7416027	<1%
**Sonchus oleraceus*	NFVr02	793883	7418850	+ (= <0.5%)
**Vachellia farnesiana*	NFV12	793201	7420489	+ (= <0.5%)

Table O.2: Locations of weeds recorded in the survey area during previous surveys.

Survey	Species	Easting	Northing
Ecologia Environment 2004	**Bidens bipinnata*	801912	7417813
	**Cenchrus ciliaris*	795300	7419290
	**Cenchrus ciliaris*	793760	7419660
	**Cenchrus ciliaris*	796266	7419520
	**Cenchrus ciliaris*	798161	7418780
	**Cenchrus ciliaris*	801912	7417813
ENV Australia 2007a	**Cynodon dactylon*	796963	7418684
	**Cynodon dactylon*	794224	7418629
	**Cenchrus ciliaris*	794407	7418790
	**Cenchrus ciliaris*	794579	7418704
	**Cenchrus ciliaris*	796284	7418483
	**Cenchrus ciliaris*	798874	7418402
	**Cenchrus ciliaris*	795513	7418545
	**Cenchrus ciliaris*	795078	7418697
	**Cenchrus ciliaris*	796997	7418413
	**Vachellia farnesiana*	793620	7419009
ENV Australia 2008	**Aerva javanica*	801347	7417066
	**Cenchrus ciliaris*	797724	7418192
	**Cenchrus ciliaris*	801923	7417012
	**Cenchrus ciliaris*	802256	7417264
	**Cenchrus ciliaris*	799550	7418086
	**Cenchrus ciliaris*	803769	7416333
	**Cenchrus ciliaris*	795506	7418502
	**Cenchrus ciliaris*	796151	7418409
	**Cenchrus ciliaris*	800092	7417450
	**Cenchrus ciliaris*	804315	7416140
	**Cenchrus ciliaris*	798981	7417898
	**Cenchrus ciliaris*	794552	7418502
	**Cenchrus ciliaris*	801992	7416835
Outback Ecology 2009a	**Bidens bipinnata*	798189	7418010
	**Cenchrus ciliaris*	792844	7419981
	**Cenchrus ciliaris*	792803	7419092
	**Cenchrus ciliaris*	793740	7419038
	**Cenchrus ciliaris*	793956	7418902
	**Cenchrus ciliaris*	794912	7418460
	**Cenchrus ciliaris*	795335	7418329
	**Cenchrus ciliaris*	795450	7418561
	**Cenchrus ciliaris*	798189	7418010
	**Cenchrus ciliaris*	800476	7417462

Survey	Species	Easting	Northing
	**Cenchrus ciliaris*	800775	7417373
	**Cenchrus ciliaris*	801051	7417051
	**Cenchrus ciliaris*	801356	7417154
	**Cenchrus ciliaris*	801845	7416990
	**Cenchrus ciliaris*	802155	7416912
	**Cenchrus ciliaris*	802446	7416837
	**Setaria verticillata*	800476	7417462
	**Tribulus terrestris*	792803	7419092

Table O.3: Summary assessment of weeds recorded in the survey area during the current survey (DEC 2011).

Species	Ecological impact (Low, Moderate, High, Unknown)	Current distribution (Low, Moderate, High, Unknown)	Potential distribution (Low, Moderate, High, Unknown)	Invasiveness (Rapid, Moderate, Slow)	General trend (Increasing, Stable, Decreasing, Unknown)	Status (Outside, Emerging, Established, Unknown)	Feasibility for control (Low, Moderate, High, Unknown)
**Bidens bipinnata* (bipinnate beggartick)	Unknown	High	High	Rapid	-	-	Low
**Cenchrus ciliaris* (buffel grass)	High	High	High	Rapid	Increasing	Established	Low
**Cenchrus setiger* (birdwood grass)	High	High	High	Rapid	Increasing	Established	Low
**Chloris barbata* (purpletop chloris)	High	Medium	Medium	Rapid	Increasing	Established	Unknown
**Cynodon dactylon* (couch)	High	High	High	Rapid	Increasing	Established	Low
**Echinochloa colona* (awnless barnyard grass)	High	High	Low	Rapid	Increasing	Established	Low
**Malvastrum americanum* (spiked malvastrum)	High	High	Low	Rapid	Increasing	Established	Low
**Portulaca oleracea* (purslane)	Low	Unknown	Unknown	Unknown	Unknown	Unknown	-
**Setaria verticillata* (whorled pigeon grass)	High	Medium	Low	Rapid	Increasing	Established	Low
**Sonchus oleraceus* (common sowthistle)	Low	High	Low	Rapid	-	-	Low
**Vachellia farnesiana* (mimosa bush)	High	High	Low	Rapid	Stable	Established	Low

794000 796000 798000 800000 802000 804000

7420000 7418000 7416000 7414000

MOUNT NEWMAN RAILROAD
MARBLE BAR RD
FORTESCUE R
DAM ACCESS RD

OPHTHALMIA RANGE
MOUNT NEWMAN
MOUNT NEWMAN ROAD
NEWMAN
SHOVELANNA HILL
Map Extent

Legend

Road
Rail
River
Survey Area
Warrawandu Village
Tenement ID: ML 244SA

Current (Astron 2013)

Species

- **Bidens bippinata*
- **Cenchrus ciliaris*
- **Cenchrus setiger*
- **Cynodon dactylon*
- **Malvastrum americanum*
- **Portulaca oleracea*
- **Setaria verticillata*
- **Sonchus oleraceus*
- **Vachellia farnesiana*

Previous Surveys

Species

- **Aerva javanica*
- **Bidens bipinnata*
- **Cenchrus ciliaris*
- **Citrullus lanatus*
- **Cynodon dactylon*
- **Setaria verticillata*
- **Tribulus terrestris*
- **Vachellia farnesiana*

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Ninga Vegetation and Flora Survey

Figure O.1: Introduced Flora Locations

Datum: GDA 1994 - Projection: MGA Zone 50 - Scale: 1:35,000 (A3)

0 500 1,000 1,500 2,000 2,500 Metres

N

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Author: A. Bott | Drawn: C. Dyde | Date: 09-07-2013 | Figure Ref: 2438-13-GDR-1RevA_20130709_FigO1_IntroFlora