14th July 2008



BHPBIO
Newman Water Pipeline Enhancement Project:
Vegetation and Flora Survey

Providing sustainable environmental strategies, management and monitoring solutions to industry and government.

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ENVIRONMENT

Version 3

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EXECUTIVE SUMMARY

BHP Billiton Iron Ore (BHPBIO) proposes to construct a new water supply pipeline linking the existing pipeline systems surrounding the town of Newman in Western Australia to meet the future process water demands for the Newman Hub projects. BHPBIO also intends to replace selected sections of the existing pipelines.

ecologia Environment (*ecologia*) was contracted by BHPBIO to undertake a Level 1 survey of the flora and vegetation of the existing and proposed pipeline corridors likely to be impacted by the proposed activities.

The study was to be conducted to assist with the assessment of the potential impacts of the proposed pipline works on the flora and vegetation of the area.

To this end a survey of the Newman water pipeline corridor was carried out between the 18th and 23rd of April, 2008. The survey methods used were developed to meet the Environmental Protection Authority's Guidance Statement 51 and Position Statement Number 3.

Survey sites were chosen on the basis of topography, interpretation and ground truthing of aerial photographs and field observations of vegetation structure, floristics and condition. Sixty nine quadrats were surveyed and an additional 12 transects were walked along the pipeline corridors to allow a more comprehensive species list to be produced and to more accurately define vegetation community boundaries.

The project area is in the Pilbara Biogeographic Region of the Interim Biogeographic Regionalisation for Australia (IBRA). The Pilbara IBRA region is subdivided into the Hamersley, Fortescue Plains, Chichester and Roebourne Subregions, and the project area occurs in the Hamersley Subregion. This subregion is described as a mountainous area of sedimentary ranges dissected by gorges, with *Acacia aneura* (mulga) low woodlands over tussock grasses on valley floors and *Eucalyptus leucophloia* over *Triodia brizoides* on skeletal soils of the ranges.

The vegetation has been mapped and classified on the basis of field observation and data classification including species presence / absence, densities and the associated landform type. It has been classified broadly into eight units (subdivided into 14 vegetation associations) occurring on eight landform types; a river / creek bank, hill crest, hill midslope, hill footslope, flood plain, gully base and a minor drainage channel.

Three hundred and seventy five flora taxa were recorded during the Newman pipeline survey, including subspecies, varieties, forms and affinities (Appendix B). The taxa comprised 47 families, 137 genera and 353 confirmed species. The most species rich plant families were Poaceae (65 confirmed taxa) and Mimosaceae (28 confirmed taxa), while the most species rich genera were *Acacia* (35 confirmed taxa) and *Senna* (21 confirmed taxa): 15 families were represented by a single taxon and five taxa were identified to genus level only.

Records indicate that one Declared Rare and 12 Priority Flora taxa have been collected from an area including and surrounding the project area.

No Declared Rare Flora taxa were recorded during the survey; however, one Priority Flora taxon was recorded at two sites during the survey – *Themeda* sp. Hamersley Station – a Priority 3 species.

No threatened or priority ecological communities were identified in the corridors surveyed.

Fourteen weed species were collected during the survey: **Aerva javanica* (Kapok Bush), **Bidens bipinnata* (Bipinnate Beggartick), **Cenchrus cilliaris* (Buffel Grass), **Centaurium erythraea* (Common Centaury)**,** **Chloris virgata* (Feathertop Rhodes Grass, Windmill Grass), **Citrullus colocynthis* **(**Colocynth**)**, **Citrullus lanatus* **(**Afghan Melon, Pie Melon, Wild Melon**)**, **Conyza bonariensis* **(**Flaxleaf Fleabane), **Cynodon dactylon* (Couch Grass), **Datura leichhardtii*, **Echinochloa colona* (Awnless Barnyard Grass), **Malvastrum americanum* (Spiked Malvastrum), **Portulaca oleracea* (Purslane) and **Vachellia farnesiana* (Mimosa Bush). **D. leichhardtii* is a declared weed in some parts of Western Australia but not in the Pilbara.

The conservation significance of the vegetation and flora of the project area, and an assessment of potential impacts, are discussed in the body of the report. Significant threats to biodiversity, ecological function, vegetation and flora of conservation significance identified by a risk analysis include vegetation clearing, fire, dust and off-road driving. Possible management options are included in a risk analysis for consideration.

1.0 INTRODUCTION

1.1 Project Background

BHP Billiton Iron Ore (BHPBIO) proposes to construct a new water supply pipeline linking the existing pipeline systems surrounding the town of Newman in Western Australia to meet the future process water demands for the Newman Hub projects. BHPBIO also intends to replace selected sections of the existing pipelines.

ecologia Environment (*ecologia*) was contracted by BHPBIO to undertake a Level 1 survey of the flora and vegetation of the existing and proposed pipeline corridors likely to be impacted by the proposed activities (Figure 1-1).

1.2 Objectives

BHPBIO commissioned *ecologia* Environment (*ecologia*) to undertake a Level 1 survey of the flora and vegetation of the existing and proposed pipeline corridors.

The study was conducted to assist with the assessment of the potential impacts of the proposed pipline works on the flora and vegetation of the area. This report provides:

(a) An inventory and discussion of:

- the vascular flora species occurring in the study area;
- any biologically significant species occurring in the study area;
- the vegetation associations occurring in the study area; and
- the habitats and vegetation associations in the study area that are poorly represented, or that are essential to the survival of rare flora.

(b) A review of:

- the regional and local conservation value of flora present, or likely to be present, in the study area;
- the flora species of particular conservation value, such as Priority species, likely to occur in the study area;
- current impact of the land-use on vegetation associations; and
- other potential impacts on the existing environment.

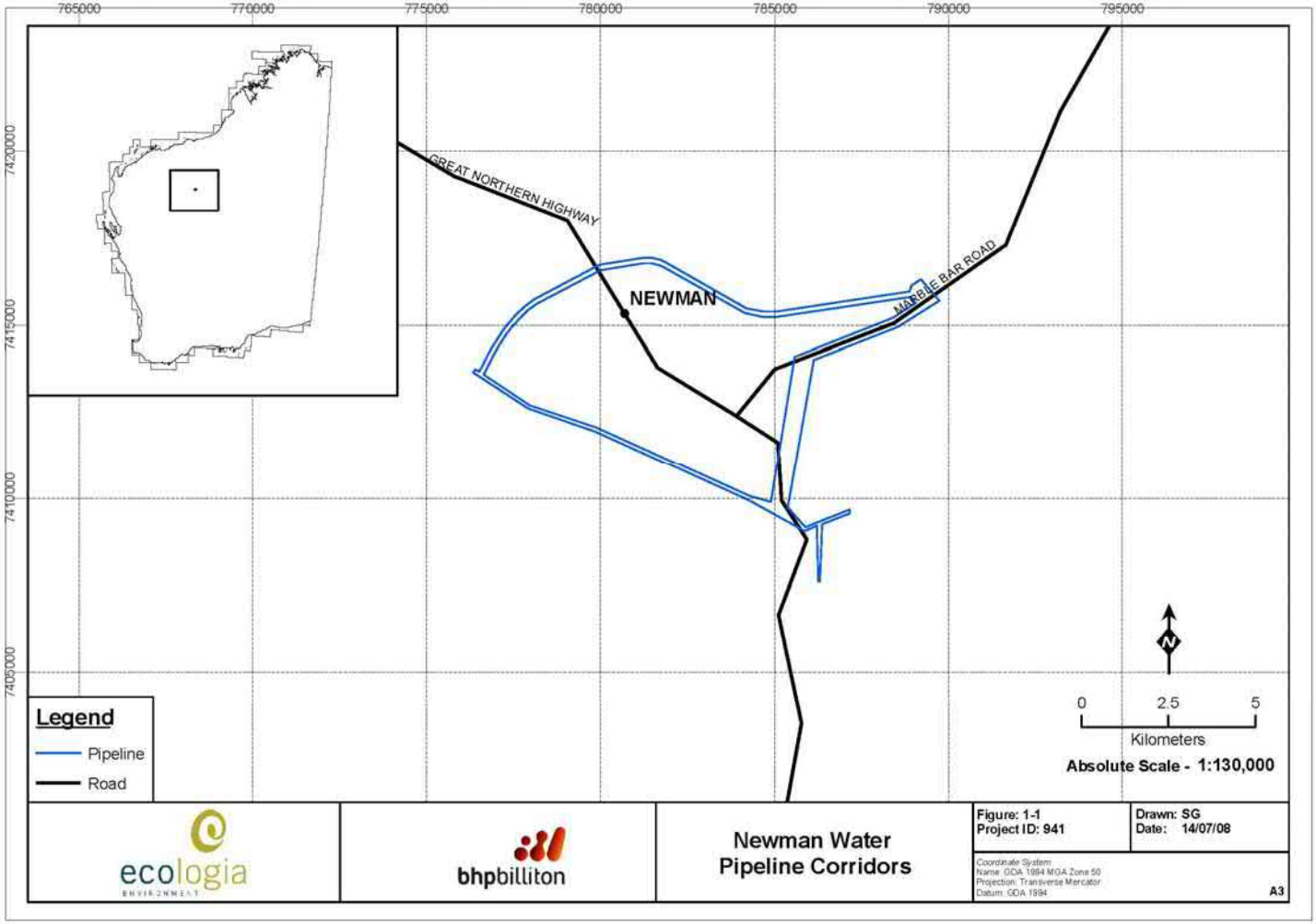

Figure 1-1: Location of Newman

2.0 EXISTING ENVIRONMENT

2.1 Climate

The existing and proposed water pipeline surrounds the town of Newman in the East Pilbara.

The tropical-arid climate experienced in the survey area is characterised by two distinct seasons; a hot summer from October to April and a mild winter from May to September.

Annual evaporation exceeds rainfall by as much as 500 mm per year and the rainfall is seasonally low and unpredictable. A bimodal rainfall distribution pattern results in two distinct rainfall periods. Sporadic rainfall is produced from January to March due to tropical cyclones moving south from northern Australian waters, and from May to June extensive cold fronts move easterly across the state and occasionally reach the northern Gascoyne (Beard, 1975).

The climate experienced throughout the year is usually very dry, as both high temperatures and humidity seldom occur simultaneously. The temperature range is large and maxima are high. Summer temperatures may reach as high as 46°C (average maximum ranging from 22.2 – 38.8°C) and winter temperatures may drop to -2°C (average minimum ranging from 8.0 - 25.3°C) (Bureau of Meteorology, 2008.)

The closest current Bureau of Meteorology (BoM) weather station is at Newman. The station is approximately 5 km west of the water pipeline survey area and thus provides a good indication of climatic conditions experienced within the project area (Figure 2-1).

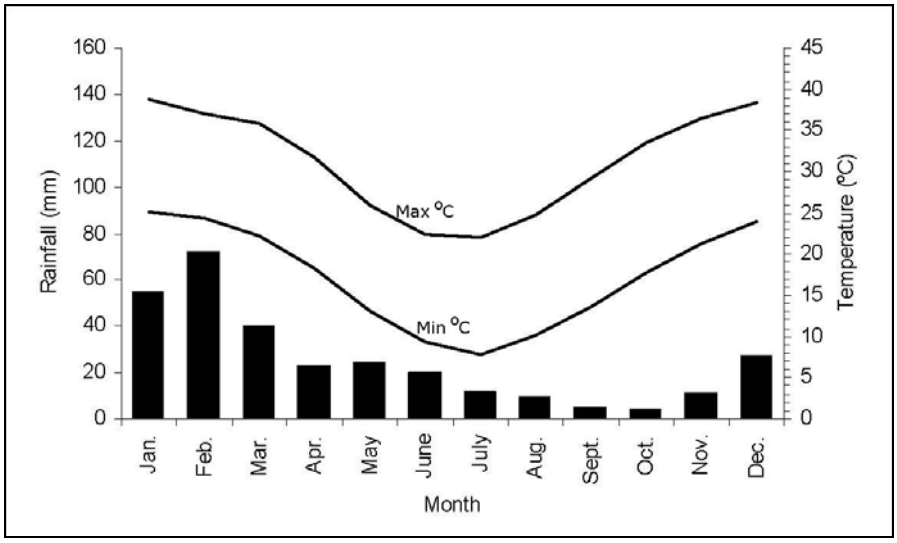

Figure 2-1: Summary of climatic data from Newman (Bureau of Meteorology, 2008).

The data represented in Figure 2-1 represents mean temperature from 1965 – 1997 and mean annual rainfall from 1965 – 2003.

The calculated average annual rainfall is 303 mm, occurring over 44 rain days. It loosely follows the typical Pilbara bimodal distribution pattern, with a peak between December and

March and a smaller peak in May and June (Figure 2-1, Table 2-1). Most of the rainfall occurs in the summer period, with over 55% of total annual precipitation occurring between December and March.

Rainfall in the summer of 06/07 and the summer of 05/06 in Newman and the greater Pilbara area was average, with only a few significant tropical cyclone associated low pressure systems penetrating that far south over this period. The monthly rainfall data for 06/07 and the first three months of 2008 compared with the long-term monthly means are presented in Table 2-2.

Table 2-1: Summary of Climatic Data for Newman.

	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Temp (°C)												
Daily max. (mean)	39.0	37.2	35.8	31.6	26.0	22.4	22.3	24.8	29.2	33.6	36.6	38.3
Daily min. (mean)	25.3	24.4	22.4	18.4	13.0	9.6	8.1	10.1	13.7	17.9	21.4	23.9
Rainfall (mm) (mean)	51.4	80.1	38.6	25.3	23.2	25.0	12.6	10.5	4.1	3.9	9.8	27.0
Mean # rain days	4.5	5.0	3.3	2.6	2.6	2.3	1.7	1.4	0.6	0.8	1.5	3.2

Newman station: elevation 554 m, location 23°22'S 119°44'E.

Table 2-2: Newman monthly rainfalls compared with the long-term mean

Elevation: 554m Location: 23°22'S 119°44'E

Rainfall (mm)	Dec	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov
06/07	41.6	41.0	6.6	64.6	66.0	0.0	0.0	7.2	0.0	0.0	2.8	2.2
07/08	28.8	15.6	124.6	35.4	1.2	0.0	0.0					
Mean	27.0	51.4	80.1	38.6	25.3	23.2	25.0	12.6	10.5	4.1	3.9	9.8

2.2 Geology

The geology of the proposed pipeline corridor has been mapped and described in detail by Tyler (1994). Ten geological substrates were identified and are detailed in Table 2-3, below.

Table 2-3: Geology of the Newman water pipeline project area.

Group	#	Description
QUATERNARY	1	Alluvium - unconsolidated silt, sand and gravel
	2	Colluvium - unconsolidated quartz and rock fragments in soil
	3	Alluvium and colluvium; red-brown sandy and clayey soil
CAINOZOIC	4	Calcrete - sheet carbonate usually formed in major drainage channels
	5	Laterite including surficial hematite-goethite deposits over banded iron-formation - forms the Hamersley Surface
HAMERSLEY	6	Marra Mamba Iron Formation - chert, ferruginous chert and banded iron-formation with minor shale
FORTESCUE	7	Jeerinah Formation - interbedded mudstone, siltstone and chert with minor felsic tuff, dolomite and sandstone
	8	Metabasalt - pillows locally well developed
	9	Upper mafic volcanic unit - metabasalt and minor mafic metatuff intruded by metadolerite sills
	10	Metadolorite sills intruded into Fortescue Group, medium- to coarse-grained, massive grey-green rock usually foliated

The Marra Mamba Formation features in the project area and is composed of chert, iron formation and shale. It is a basal member of the Hamersley Group, and is host to many high grade iron ore deposits in the surrounding area, including deposits in and around Newman.

2.3 Land System Classification

An inventory of the land systems occurring in the Pilbara was completed by Van Vreeswyk *et al.* (2004). The survey aimed to provide a comprehensive description and mapping of the biophysical resources of the region, together with an evaluation of the condition of soils and vegetation throughout. The new section of the water pipeline is proposed to be constructed on the floodplain east and south-east of Newman townsite, and are in the Elimunna, Newman, McKay, Spearhole and River Land Systems (Van Vreeswyk *et al.,* 2004). The older sections of the pipeline proposed for upgrade or replacement occur on the rocky country north, south and west of the town of Newman on the Newman, Elimunna, Spearhole, Rocklea, River and Washplain Land Systems (Van Vreeswyk *et al.,* 2004). A map of the Land Systems of the Newman area with the pipeline survey areas overlaid is included as Figure 2-2 and descriptions of these land systems follow (Van Vreeswyk *et al.,* 2004).

- The River Land System comprises 4088 km^2, or 2.3% of the Pilbara region, and is characterised by river plains with grassy woodlands and shrublands, and tussock grasslands (Land Type 17). The geology is Quaternary alluvium.

- The Newman Land System comprises 14580 km^2, or 8.0% of the Pilbara region, and is characterised by mountains, ridges, and gorges with relief up to 450 m with *Triodia* grasslands (Land Type 1). The geology is Lower Proterozoic jaspilite, chert, siltstone, shale, dolomite and minor acid volcanics.

- The Rocklea Land System comprises 22993 km^2, or 12.7% of the Pilbara region, and is characterised by Basalt hills, plateaux, lower slopes and minor stony plains supporting spinifex grasslands (Land Type 1). The geology is Archaean basalt, Lower Proterozoic basalt, dolerite, tuff and agglomerate, minor shale and jaspilite.

- The Spearhole Land System comprises 2170 km^2, or 0.7% of the Pilbara region, and is characterised by gently undulating hardpan plains supporting groved mulga shrublands and hard spinifex (Land Type 12). The geology is partially cemented Quaternary alluvium and colluvium.

- The Elimunna Land System comprises 617 km^2, or 0.3% of the Pilbara region, and is characterised by stony plains on basalt supporting sparse acacia and cassia shrublands and patchy tussock grasslands (Land Type 10). The geology is Quaternary colluvium, elumium and alluvium, Archaean basalt and dolerite.

- The McKay Land System comprises 4202 km^2, or 2.3% of the Pilbara region, and is characterised by hills, ridges, plateaux remnants and breakaways of meta sedimentary and sedimentary rocks supporting hard Spinifex grasslands (Land Type 1). The geology is Lower Proterozoic shale, chert, mudstone, sandstone and dolomite.

- The Washplain Land System comprises 917 km^2, or 0.5% of the Pilbara region, and is characterised by hardpan plains supporting groved mulga shrublands (Land Type 12). The geology is Quaternary partly cemented alluvium.

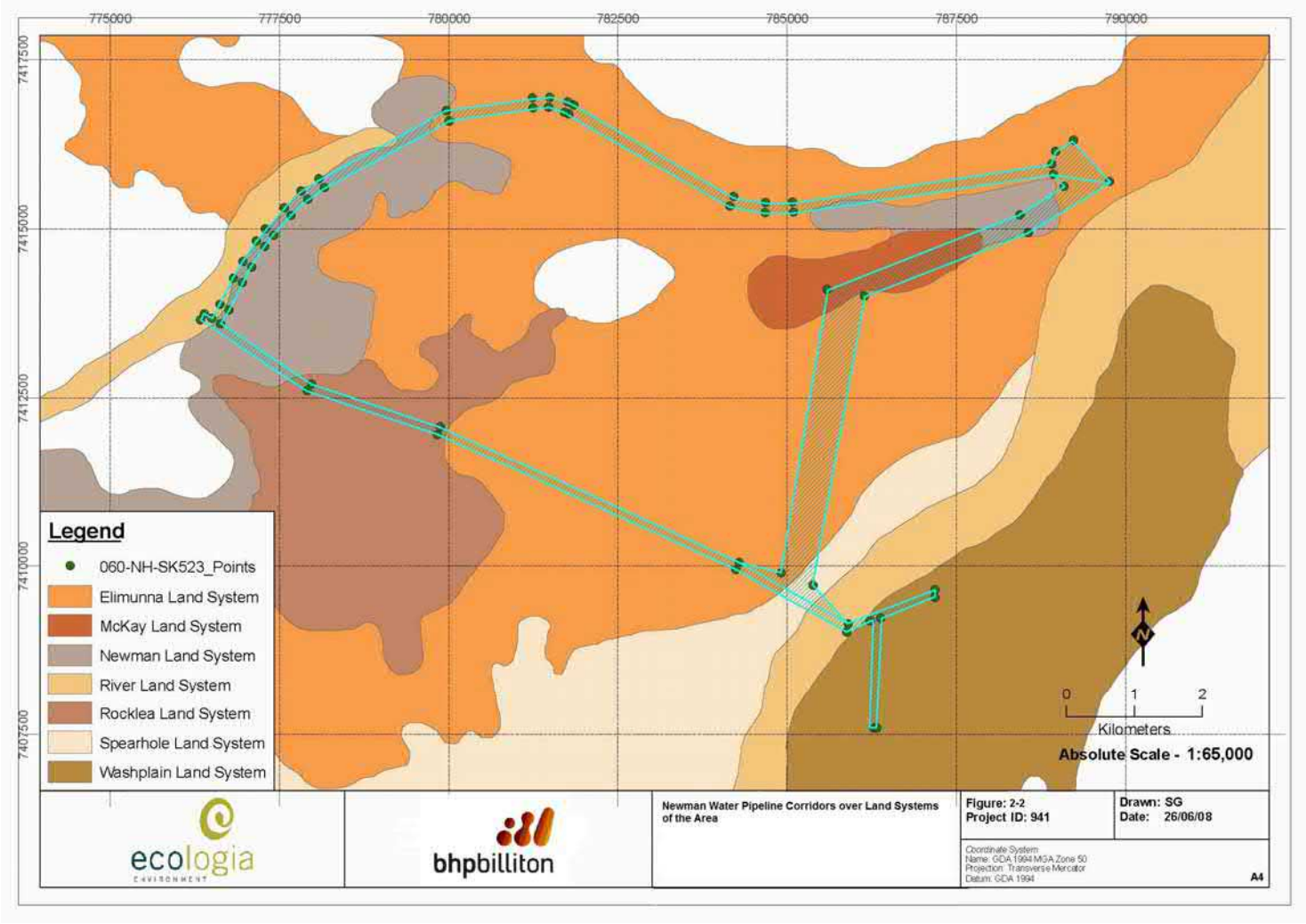

Figure 2-2: The land systems of the project area.

2.4 Soils

The soils of the Newman water pipeline have been determined as part of the Land System Classification, detailed by Van Vreeswyk *et al.* (2004); they are described in Table 2-4.

This soil information should be interpreted only as the range of possible soil types that could occur in the area, rather than those that are known to. Because Van Vreeswyk *et al.*'s (2004) Pilbara Land System classification was carried out at a relatively broad scale, and the proposed project is limited to a small area, it is not possible to determine exact soil types for the water pipeline corridor from the available data. Instead, the major soil types belonging to the main Van Vreeswyck *et al*. (2004) Land Systems included in the project area (Section 2.3) are shown.

Table 2-4: Soils of the Newman water pipeline corridor.

Soil Group	Description	Landscape location
Calcareous shallow loams	Shallow (25-50 cm) uniform textured, fine sandy loams to sandy clay loams or clay loams overlying calcrete, weathered basalt or occasionally dolerite. Colour varies from dark reddish brown to brown or yellowish red. Highly alkaline and calcareous throughout, mostly with an abundant stony mantle, or with cryptogam crusts, with stones through much of the profile.	Stony plains
Deep red/brown non-cracking clays	Mostly deep (>100 cm) with thin to medium (10-30 cm) topsoil textures of mainly dark reddish brown to yellowish brown clay loam to light or medium clay. The thick subsoils (30-80 cm) have light to heavy clay textures, are mostly well structured and overlain by massive topsoils	Flood plains and lower terraces
Red loamy earths	Thin to medium (10-30 cm) loam to clay loam topsoils overlying thick (30-60 cm) clay loam to light clay subsoils, dark reddish brown in colour, non-calcareous, non-saline with neutral to slightly alkaline soil reaction trends.	Flood plains and lower terraces
Red sandy earths	Thin to medium (10-30 cm) topsoils of clayey sand to sandy loam graduating to medium to thick (30-60 cm) subsoils of sandy clay loam or clay loam. Deep versions over 1 m deep with moderately deep to shallow versions (80-100 cm) overlying ironstone, quartz or decomposing granite. Usually contain very few coarse fragments, are non-saline and show a weakly acidic to neutral soil reaction trend. Dark reddish brown to red.	Sandy levees and sand sheets
River bed soils	Poorly developed soils of juvenile or recent alluvial deposits with sediment layers of coarse loose sand, clayey sand, silty sand and silty clay.	Minor and major channels
Stony soils	Mostly occur within the extensive areas of hills, ranges and upper stony plains and are very shallow to shallow (<25-50 cm) and skeletal or poorly developed. Vary depending on the nature of the parent rock, which is mostly basalt, granite or sedimentary rocks such as sandstone and shale and, less frequently, metamorphic rocks.	Stony plains

Halpern Glick Maunsell Pty Ltd (HGM) carried out a survey of the soils of Mt Whaleback and Ore Body 29 for BHP (1997). The area surveyed was to the west of Newman townsite and included some of the proposed water pipeline corridor. While this study did not cover the entire area of the water pipeline corridor, it does provide information at a much finer scale than Van Vreeswyk et al. (2004) so has been included here. According to HGM (1997), the pipeline occurs on soil types Um 1.23, Um 5.52, Um 6.43, and Gn 1.14 (Table 2-5).

Table 2-5: Soil types of the Newman water pipeline corridor as defined by HGM.

Soil type	Description
Um 1.23	Dusky red, fine textured silt-loam with slight to moderate coarse fraction, on tops and sides of ridges. A_1 horizon: (5-10 cm) unmottled red/brown silt loam (pH 5.5-7.2, EC 2-4 mS/m). Minimal organic with slight coarse fraction. Material below A_1 horizon is not calcareous and only weakly coherent in a moderately moist state.
Um 5.52	Dusky red/brown silt-loam, on flats, adjacent to drainage lines and along valley floors. Uniform and porous with low coarse fraction and A_1 horizon to 30 cm with a gravely substrate (pH 6.7-7.5, EC 2-5 mS/m). Surface often covered by quartz, alluvial material, basalt, or ironstone.
Um 6.43	Dusky red silt-loam to clay-loam, on flats surrounding drainage lines. A_1 horizon to 80 cm, slight to moderate coarse fraction, distinct boundary with underlying material. pH 7.1-8.6, ECO 2 mS/m, minimal organic material.
Gn 1.14	On creeklines. A_1 horizon: coarse red sandy silt-loam to 15 cm (pH 3.5, EC 19-29 mS/m). A_2 horizon unbleached, overlying Quaternary alluvium. Halpern Glick Maunsell (1997) note that the low pH could be due to the recent construction of a nearby acid rock drainage dam.

2.5 Biogeographic Regions

The project area lies in the Pilbara Biogeographic Region of the Interim Biogeographic Regionalisation for Australia (IBRA, Version 6.1) (Thackway and Cresswell 1995). This is a system of some 80 biogeographic regions covering the whole of Australia, and is the result of collaboration between all state conservation agencies with co-ordination by the Australian Nature Conservation Agency (ANCA).

Bioregions are defined on the basis of climate, geology, landforms, vegetation and fauna. The Pilbara Biogeographic Region is similar to that commonly recognised as Beard's Pilbara Region, and includes four major components; Hamersley, Fortescue Plains, Chichester and Roebourne (Figure 2-3). Hamersley, the component relevant to this biological assessment, is summarised by Thackway and Cresswell (1995) as: "Mountainous areas of Proterozoic sedimentary ranges and plateaus with mulga low woodland over bunch grasses on fine textured soils and snappy gum over *Triodia* on skeletal sandy soils of the ranges.".

With an area of 179, 287 km^2, the Pilbara Bioregion is one of the largest bioregions. Others vary from 2,372 to 423,751 km^2 (Thackway and Cresswell, 1995), most being between 14,000 and 200,000 km^2. However, the size of the Pilbara Bioregion is fairly typical of bioregions situated in remote arid and semi-arid areas. The reservation status of the Pilbara Bioregion is 7.75% (Kendrick 2001), which is relatively low as the reservation status of some bioregions is more than 10% (Thackway and Cresswell 1995), while the Hamersley sub-region has 14.1% of its area reserved (Kendrick 2001).

Shepherd *et al*. (2002) indicate that of the 17 944 694 ha in the Pilbara Bioregion very little of the vegetation has been cleared and the authors state that 10.1 to 30% of the Pilbara 3 (Hamersley) subregion is reserved in the conservation estate.

Figure 2-3: Map of Western Australia showing IBRA 6.1 subregions and the location of the PIL3/Hamersley subregion.

2.5.1 Vegetation described by Beard (1975)

Beard (1975) places the project area at the boundary of the Fortescue Botanical District of the Pilbara Region and the Ashburton Botanical District of the Gascoyne Region (Figure 2-4). Beard describes the vegetation as:

- Mulga (*Acacia aneura*) in groved patterns;
- Mulga low woodland; and
- Snappy gum (*Eucalyptus leucophloia* subsp. *leucophloia*) tree steppe over *Triodia wiseana* hummock grassland.

These vegetation classes are widespread in the region as indicated on the section of Beard's map covering the Newman area. (Note the corridor does not plot exactly, due to minor discrepancies between old and new coordinates.)

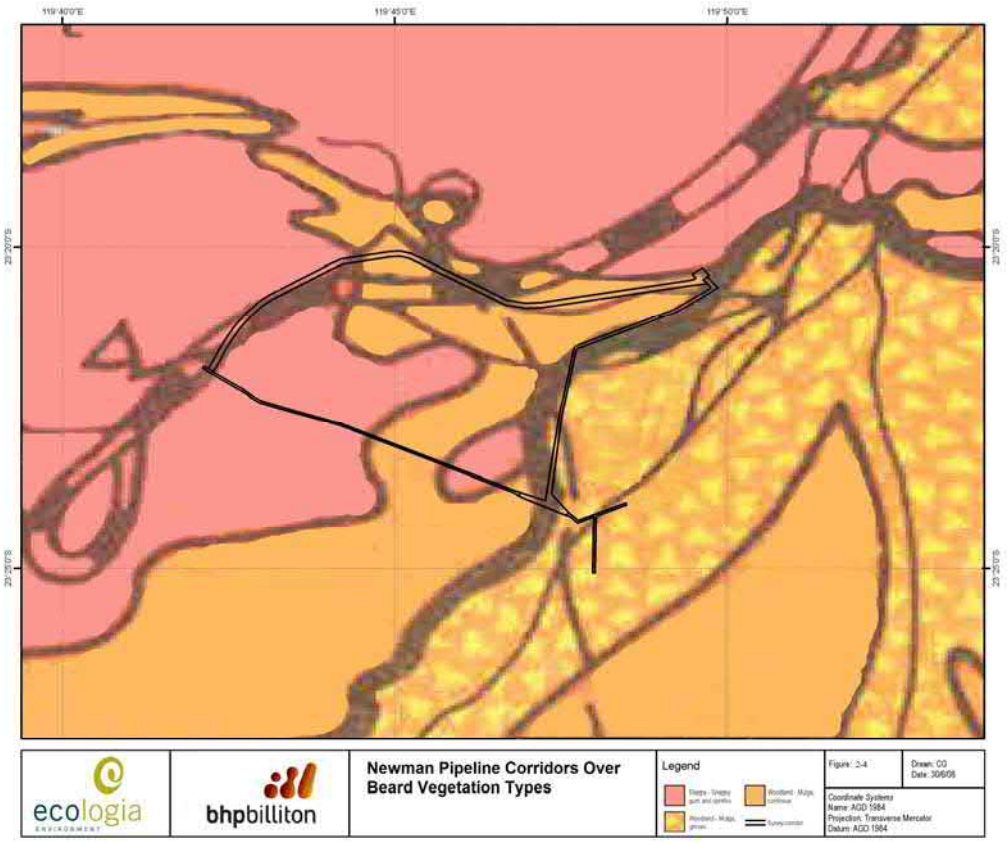

Figure 2-4: Vegetation of the Newman area (extracted from Beard, 1975).

2.6 Previous Biological Surveys

Early flora survey work was carried out by Royce (1948) and Burbidge (1959) while broad scale vegetation mapping was first carried out by Burbidge (1945) and later refined by Beard (1975).

Site-specific detailed flora and fauna surveys have only been conducted in the Pilbara region during the last 20 years concurrent with the increased development of mineral resources in

the region. Over this time, numerous surveys by private consultants and government organisations have been conducted, with particular emphasis on the mineral-rich ranges.

HGM carried out a survey of the soils and vegetation of Mt Whaleback and Ore Body 29 for BHPIO (1997). This area lies immediately west of Newman townsite and includes some of the corridor of the section of old pipeline that is proposed to be replaced. This study classified the vegetation types in the area to be developed as:

- Open *Acacia aneura* woodland/tall shrubland;
- Dense *Acacia citrinoviridis* woodland;
- Dense *Acacia aneura* woodland;
- Shrub steppe of *Acacia bivenosa* over *Triodia pungens;*
- Tree steppe of *Eucalyptus leucophloia* over *Triodia basedowii;*
- Tree steppe of *Eucalyptus* species over *Triodia basedowii.*

HGM (1997) state that the vegetation of this area is representative of associations that are broadly distributed in the Pilbara and in the local area.

ecologia has undertaken several biological surveys at areas in the wider Pilbara region and these include surveys at Orebody 24 (2004b), Hashimoto (2007), Jimblebar (1996; 1999; 2004d; 2005c), Orebody 18 (1995a; 2004c; 2005c), East Jimblebar (2005b), Wheelarra Hill (2004d; 2005a), Orebody 23 (1998a; 1998b; 2004c), Orebody 25 (1995b; 2004c), Eastern Ophthalmia Range (2004a) and Newman to Jimblebar (2008). While ENV carried out phase 2 of a survey and produced a report on a two phase assessment of the flora and fauna of Orebody 24 (2006).

More extensive biological surveys have also been undertaken, such as that at Karijini National Park (Muir, 1983). Research projects conducted by the Department of Environment and Conservation (DEC) and opportunistic collecting by amateur naturalists have further supplemented information on the area. The DEC in association with the Western Australian Musuem (WAM) is currently undertaking a five year regional Pilbara Biological Survey to provide comprehensive, long-term baseline data for future management.

2.7 Land Use History

Mineral exploration in the Pilbara began in 1888 when gold was found in the Pilbara Creek, and although this did not prove productive, more consistent deposits were subsequently discovered at Marble Bar. Tin was discovered in 1899 and manganese and asbestos have since been mined in the Pilbara. Massive iron ore deposits were discovered with exploitation expanding immensely in the 1960s when the Commonwealth embargo on exporting iron ore was relaxed. Subsequently, the construction of several mining towns, including Newman, was undertaken. Newman was developed in the early 1970s to provide accommodation for workers at the Mt. Whaleback iron-ore mine. Ports, such as Port Hedland and Dampier, and standard gauge railways from Mt. Tom Price and Paraburdoo to Dampier, Pannawonica to Cape Lambert, and Mt. Goldsworthy and Mt. Newman to Port Hedland, also were constructed. The development of the iron ore industry has resulted in activity within the Pilbara increasing from cattle and sheep stations and small coastal ports to a large mining economic base with a commensurate increase in population.

The wider Newman area currently supports a moderate level of mining activity. The nearest active mines to the project area are at Mt Whaleback and Orebodies 29 and Orebodies 23, 24 and 25 (Australian Mines Atlas, 2008).

3.0 VEGETATION AND FLORA

3.1 Methods

The vegetation and flora of the Newman water pipeline corridor (Figure 3-1) was surveyed between the 18th and 23rd of April, 2008. The survey methods used were developed to meet the Environmental Protection Authority's Guidance Statement 51 (Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia; EPA, 2004) and Position Statement Number 3 (Terrestrial Biological Surveys as an element of Biodiversity Protection; EPA, 2002).

Based on the location and the scale and nature of the development, Guidance Statement No. 51 indicates that a Level 1 survey be undertaken (Reconnaissance Field Survey). The purpose of a Reconnaissance Field Survey is to verify the accuracy of the background/desktop study, and to further delineate and characterise the flora and the range of vegetation units present in the target area, and to identify potential impacts. This involves:

"a target area visit by suitably qualified personnel to undertake selective, low intensity sampling of the flora and vegetation, and to produce maps of vegetation units and vegetation condition at an appropriate scale."

The objectives of the survey therefore were to provide:

- An inventory of vascular plant species;
- A description and mapping of vegetation associations;
- An inventory of plant species considered to be rare and endangered, or geographically restricted ;
- An inventory of exotic plants, including declared weeds; and
- A description of the condition of the vegetation in the survey area.

The survey combined the following methods:

(i) Detailed site/association assessments; and
(ii) Broad-scale vegetation mapping.

In addition, opportunistic collections were made while traversing from site to site to provide a more comprehensive species list for the project area.

3.1.1 Floristic survey sites

The flora was sampled in quadrats approximately 50 m by 50 m, or of an equivalent area (2,500 m^2) at sites less than 50 m wide (e.g. along creeks). These quadrats contribute to the accurate mapping of small-scale vegetation units and produce a comprehensive floristic inventory of the survey area.

Quadrat sites were chosen on the basis of topography, interpretation and ground truthing of aerial photographs and field observations of vegetation structure, floristics and condition. Sixty nine quadrats were surveyed and in addition 12 transects walked along the pipeline corridors to provide a more comprehensive species list and to more accurately define

vegetation community boundaries. Quadrats and transects are shown in Figure 3-1 and quadrat locations are listed in Table A-1 of Appendix A.

775000 778000 781000 784000 787000 790000

7418000 7416000 7414000 7412000 7410000 7408000 7406000

T1a T2a T3a T4a T5a T6a T7a T8a T9a T10a T11a T25

Newman Water Pipeline Corridors:
Locations of Quadrats and Transects

Quadrat
Transect Start Location
Transect
Option A Corridor
Existing E and K Line Corridors

bhpbilliton
ecologia ENVIRONMENT

Figure: 3-1
Drawn: SH
Date: 29/06/08

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

Absolute Scale: 1:19,820
A3

3.2 Vegetation Units

The vegetation communities recorded in the survey area are described below. They are typical of vegetation communities found in the Pilbara region as described by Kendrick (2001) and Beard (1975). The vegetation has been classified on the basis of field observation and data classification including; species presence / absence, densities and the associated landform type. As a result it has been separated broadly into eight main units occurring on eight landform types; a river / creek bank, hill crest, hill midslope, hill footslope, flood plain, gully base and a minor drainage channel. These eight main units were subdivided into 14 vegetation associations and these are described further in Table 3-2 and illustrated in Plates 3-1 to 3-14. The vegetation units have been mapped and are shown in Figures 3-2 to 3-5. A separate legend indicating the vegetation units mapped (numbered as in Table 3-2) is included as Table 3-3.

3.2.1 Vegetation Condition of the Newman Pipeline Survey Area

Vegetation condition in the survey area was noted in the field using the levels indicated below (Table 3-1). Factors considered when determining these levels were the presence of weeds, tracks and litter and evidence of grazing and ground disturbance.

Table 3-1: Vegetation condition.

Vegetation condition	Level	Percent of area surveyed
Pristine	No disturbance	5.8
Excellent	Minimal disturbance	4.3
Good	Moderate disturbance	56.5
Poor	Significant disturbance	27.6
Degraded	Very high disturbance	5.8

Vegetation along the corridors surveyed was generally degraded and disturbed, especially on the northern extent of the existing E-line corridor adjacent to the rail line. In this area the vegetation is heavily grazed by cattle, weed species are abundant and there are areas where the ground is disturbed and also where large quantities of rubbish have been dumped. Because of this it is difficult to provide an accurate representation of the vegetation of those areas, as it is largely dominated by exotics and species that proliferate in disturbed areas.

Vegetation condition recorded at each quadrat is indicated in Appendix A.

Table 3-2: Vegetation units of the existing and proposed water pipeline corridors.

Landform type	Veg Unit #	Quadrat	Vegetation description
River / creek bank (Plate 3-1)	**1**	**10, 22, 26, 33, 34 and 45**	Moderately dense *Eucalyptus camaldulensis* var. *obtusa* and *E. victrix* moderately tall trees, over sparse to open *Acacia citrinoviridis*, low trees, over **Vachellia farnesiana* medium shrubs sometimes over open *Dodonaea Lanceolata* low shrubs, over open *Centipeda minima* subsp. *macrocephala* and *Alternanthera nodiflora* and occasionally **Bidens bipinnata* herbs, over sparse sedges consisting of *Cyperus cunninghamii* subsp. *cunninghamii* and *Fimbristylis oxystachya* and moderately dense *Leptochloa digitata, *Cenchrus ciliaris* and *Eragrostis tenax* soft grasses.
Hill crest (Plate 3-2)	**2**	**48**	Sparse *Eucalyptus leucophloia* subsp. *leucophloia* and *Acacia pruinocarpa* low trees, over sparse *Acacia aneura* var. *aneura* tall shrubs over sparse *Senna glutinosa* subsp. *glutinosa* and *Eremophila latrobei* subsp. *latrobei* medium shrubs, over sparse *Eriachne mucronata* and *Cymbopogon obtectus* soft grasses and open *Triodia basedowii* and *Triodia epactia* hummock grasses.
Hill midslope (Plate 3-3)	**3**	**6, 7, 18, 41, 43, 46, 47**	Scattered *Eucalyptus leucophloia* subsp. *leucophloia* low trees, over sparse *Acacia bivenosa* occasionally with *A. arida* medium shrubs, over sparse *Senna glutinosa* medium shrubs, over sparse *Tribulus suberosus*, *Ptilotus rotundifolius* and *Acacia hilliana* low shrubs, over sparse *Paraneurachne muelleri* and *Triodia basedowii*, *Triodia epactia* and *Triodia wiseana* hummock grasses.
Hill footslope (Plate 3-4)	**4**	**39**	Sparse *Acacia inaequliatera* and *A. pruinocarpa* low trees over sparse *Acacia aneura* tall shrubs, over sparse *Eremophila fraseri* subsp. *fraseri* medium shrubs, over sparse *Tribulus suberosus* low shrubs, over sparse *Cymbopogon ambiguus* soft grass and moderately dense *Triodia wiseana* and *Triodia epactia* hummock grass.
Flat / Plain (Plates 3-5 to 3-10)	**5**	**4, 5, 14, 15, 16,17, 23, 27, 28, 29, 31, 35, 61, 63, 65**	Scattered to sparse *Corymbia candida* subsp. *dipsodes* occasionally with *Corymia hamersleyana*, *Eucalyptus leucophloia* subsp. *leucophloia* and *E. xerothermica* tall trees, over moderately dense low trees dominated by *Acacia aneura*, *Hakea lorea* subsp. *lorea*, *A. synchronicia*, over sparse *Rhagodia eremaea* occasionally with **Vachellia farnesiana* medium shrubs, over open low shrubs including **Malvastrum americanum*, *Sclerolaena eriacantha*, *S. cornishiana, S. deserticola, Sida fibulifera* and *Euphorbia coghlanii* small shrubs over moderately dense **Bidens bipinnata*, *Goodenia muelleriana*, *Heliotropium cunninghamii* and *Evolvulus alsinoides* var. *villosicalyx* herbs with open *Chrysopogon fallax* and **Cenchrus ciliarus* soft grasses and sparse *Triodia epactia* hummock grass.
	6	**3, 8, 9, 11, 12, 19, 20, 21, 24, 25, 30, 32, 37, 38, 51, 52, 53, 55, 57, 59**	Sparse to open mixed *Acacia aneura* low trees and tall shrubs occasionally with *A. paraneura* tall trees, over sparse *Eremophila forrestii* subsp. *forrestii* and *E. latrobei* subsp. *filiformis* with mixed *Senna* spp. including *Senna glutinosa*, *S. artemisioides* subsp. *helmsii* and *S. glaucifolia* medium shrubs over sparse Maireana planifolia low shrubs over sparse **Bidens bipinnata* and *Portulaca pilosa* herbs over open soft grasses consisting of *Aristida latifolia*, *Aristida holathera* var. *holathera* and **Cenchrus ciliaris*, occasionally with *Triodia epactia* and *T. wiseana* hummock grasses.
	7	**56 and 58**	Sparse *Senna ferraria* x and *S. hamersleyensis* dwarf shrubs over open mixed herbs, over moderately dense *Aristida latifolia* / *Eragrostis setifolia*, *Astrebla pectinata* and **Cenchrus ciliaris* soft grasses.

Landform type	Veg Unit #	Quadrat	Vegetation description
	8	**60**	Sparse *Acacia pruinocarpa* low trees, over sparse *Acacia bivenosa* and *Petalostylis labicheoides* moderate shrubs, over sparse *Ptilotus obovatus* var. *obovatus* low shrubs, over open *Triodia basedowii* and *Triodia wiseana* hummock grass.
	9	**50, 62**	Isolated *Corymbia aspera* / *Hakea lorea* subsp. *lorea* low trees, over sparse *Eucalyptus gamophylla* mallee, over sparse *Acacia synchronicia* tall shrubs, over isolated *Senna artemisioides* subsp. *oligophylla* x helmsii low shrubs, with open **Cenchrus ciliaris* tussock and sparse *Triodia pungens* hummock grasses.
	10	**64**	Moderately dense *Acacia citrinoviridis*, sometimes with *Acacia aneura* var. ?*aneura* medium trees, over scattered mixed *Corymbia aspera* and *Corymbia* ?*candida* subsp. *dipsodes* low trees, over scattered *Rhagodia eremaea* medium shrubs, over moderately dense **Cenchrus ciliaris* tussock grass.
Floodplain (Plate 3-11)	**11**	**1, 2 and 13**	Moderately dense *Corymbia candida* subsp. *dipsodes* moderately tall trees, over open *Acacia citrinoviridis* low trees, over open *A. aneura* and *A. synchronicia*, occasionally with *Hakea lorea* subsp. *lorea* tall to moderate shrubs over sparse *A. sclerosperma* var.*sclerosperma* moderate shrubs, over open mixed small shrubs including **Malvastrum americanum* over sparse *Rhynchosia minima* and *Citrullus colocynthis* over mixed open herbs and isolated clumps of sedges and ferns which include *Cyperus iria* and *Marsilea hirsuta* and open mixed soft grasses as well as isolated clumps of *Triodia epactia* hummock grass.
Gully base (Rehabilitated) (Plate 3-12)	**12**	**44, 49, 54**	Scattered *Eucalyptus camaldulensis* var. *obtusa* and *E. leucophloia* subsp.*leucophloia* medium trees over sparse *Corymbia hamersleyana* low trees, over sparse *Acacia dictyophleba* tall shrubs, over open *A. bivenosa* moderate shrubs, with scattered *Duperraya commixta* climber over sparse *Themeda triandra*, *Aristida holathera* var. *holathera* and *paraneurachne muelleri* soft grasses and open *Triodia wiseana* and *T. epactia* hummock grasses.
Minor drainage channel (Plate 3-13 & 3-14)	**13**	**40 and 42**	Scattered *Hakea chordophylla* low trees over, open *Eucalyptus gamophylla* mallee, over open *Acacia maitlandii* and *A. bivenosa* moderate shrubs, over sparse *Sida arsiniata* and *Abutilon ?malvifolium* dwarf shrubs, over sparse *Cymbopogon* species and other soft grasses over open *Triodia epactia* and *T. angusta* hummock grass.
	14	**36**	Moderately dense **Vachellia farnesiana* and *Acacia synchronicia* over moderately dense **Cenchrus ciliaris* soft grass.

Plate 3-1: Vegetation typical of a creek bank

Plate 3-2: Vegetation typical of a hill crest

Plate 3-3: Vegetation typical of a mislope

Plate 3-4: Vegetation typical of a footslope

Plate 3-5: Vegetation typical of a flat / plain (*Corymbia* sp)

Plate 3-6: Vegetation typical of a flat / plain (mulga.)

Plate 3-7: Vegetation typical of a flat / plain (grassland)

Plate 3-8: Vegetation typical of a flat / plain (*Acacia* spp. shrubland)

Plate 3-9: Vegetation typical of a flat / plain (mallee)

Plate 3-10: Vegetation typical of a flat / plain (mixed)

Plate 3-11: Vegetation typical of a floodplain

Plate 3-12; Vegetation typical of a gully base

Plate 3-13: Vegetation typical of a minor drainage channel

Plate 3-14: Vegetation typical of a minor drainage channel (degraded)

Table 3-3: Legend for vegetation units mapped in Figures 3-2 to 3-5.

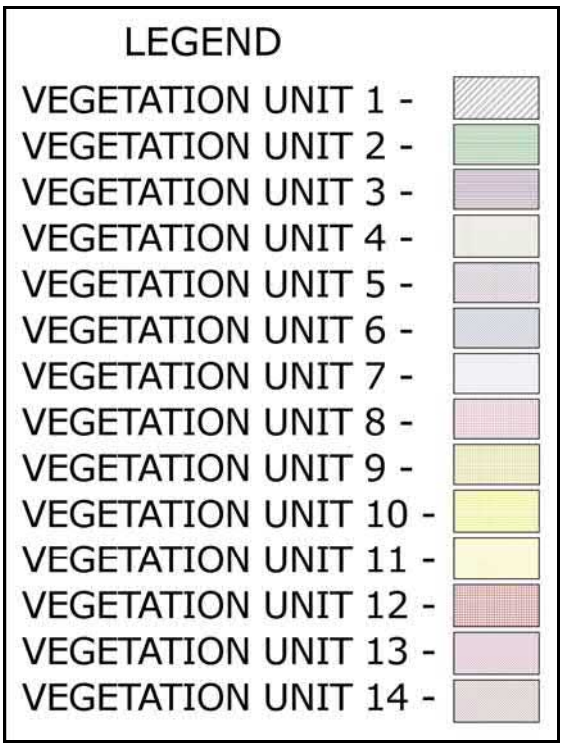

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Figure: 3-2 Vegetation units of the pipeline corridors (nw corner)

Drawn: SH
Date: 29/06/09

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

Absolute Scale: 1:19,820
A3

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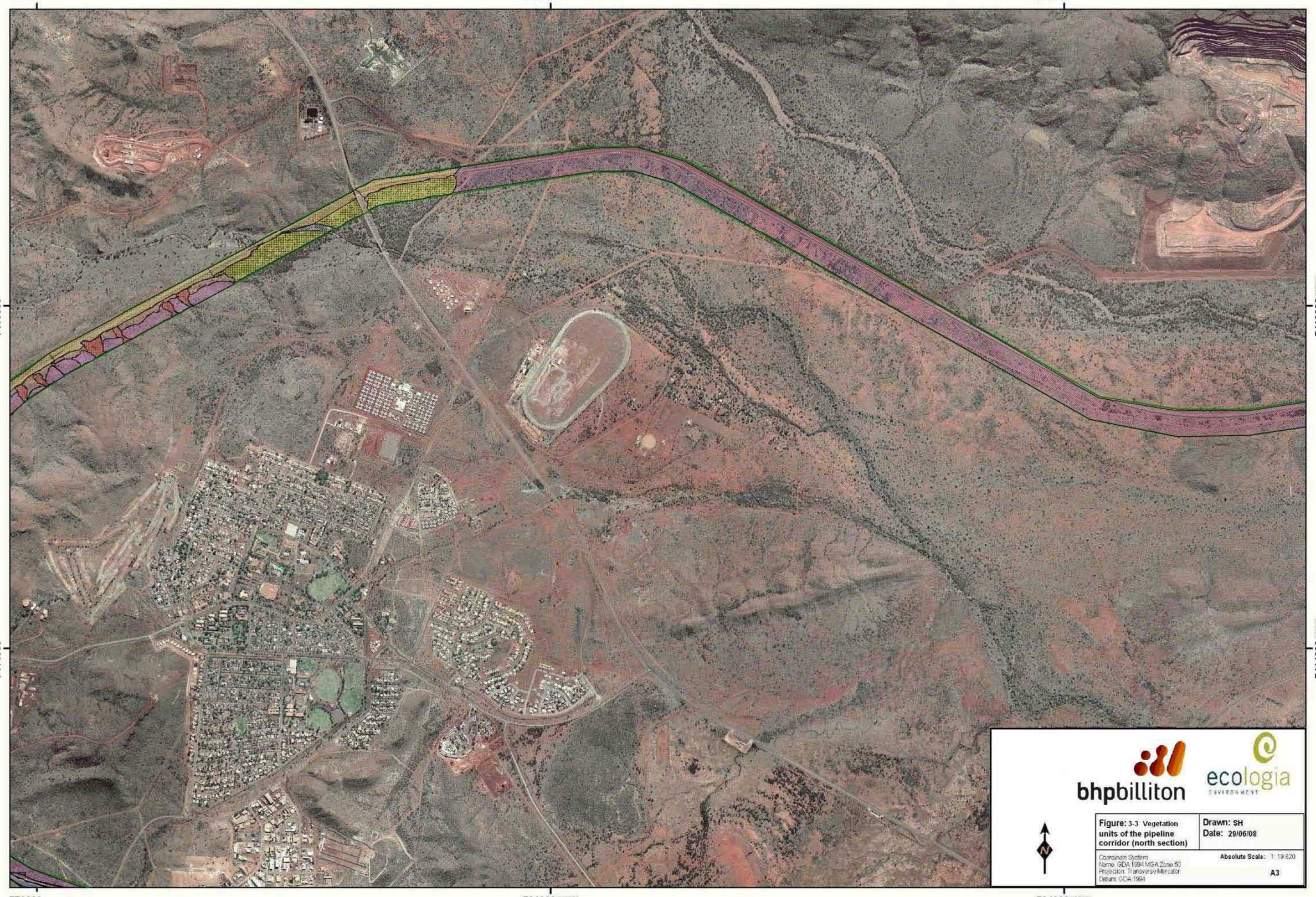

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Figure: 3-3 Vegetation units of the pipeline corridor (north section)

Drawn: SH
Date: 29/06/08

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

Absolute Scale: 1: 19,820

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Figure: 3–4 Vegetation units of the pipeline corridor (ne corner)

Drawn: SH
Date: 29/06/08

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

Absolute Scale: 1:19,820
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Figure: 3-5 Vegetation units of the pipeline corridor (se corner)

Drawn: SH
Date: 29/06/08

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

Absolute Scale: 1: 19,820

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3.3 Flora

3.3.1 Flora of the Newman pipeline corridor

Three hundred and seventy five flora taxa were recorded during the Newman pipeline survey, including subspecies, varieties, forms and affinities (Table B-1, Appendix B). They comprised 47 families, 137 genera and 353 confirmed species. The most species rich plant families were Poaceae (65 confirmed taxa) and Mimosaceae (38 confirmed taxa), while the most species rich genera were *Acacia* (35 confirmed taxa) and *Senna* (21 confirmed taxa): 15 families were represented by a single taxon, one specimen was identified to family level only and five genus level only.

3.3.2 Flora of conservation significance

Environment Protection and Biodiversity Conservation Act 1999

Flora species are protected at a National level under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The Act contains a list of species that are considered Critically Endangered, Endangered, Vulnerable, Conservation Dependent, Extinct or Extinct in the Wild (Appendix D).

A search was carried out using the EPBC Act Protected Matters search tool (coordinates 23° 16' - 23° 27' S and 119° 39' - 119° 51' E; GDA94). This search produced a report showing that *Lepidium catapycnon* (Vulnerable) occurs in the vicinity of the survey area.

Wildlife Conservation Act 1950

Conservation significance is determined under the *Wildlife Conservation Act 1950*; under this Act, flora taxa of conservation significance are protected. Declared Rare Flora taxa (DRF) are protected under the *Western Australian Wildlife Conservation (Rare Flora) Notice 2008* of the above Act. This notice lists flora taxa that are extant and considered likely to become extinct or rare. They are defined as "taxa which have been adequately searched for and deemed to be either rare, in danger of extinction, or otherwise in need of special protection in the wild". These taxa are legally protected and removal or impact to their surroundings cannot be conducted without ministerial approval obtained specifically on each occasion for each population. Currently two DRF are recorded in the Pilbara; *Lepidium catapycnon* and *Thryptomene wittweri*.

The Department of Environment and Conservation (DEC) also maintains a list of Priority Flora taxa, which are considered poorly known, uncommon, or under threat, but for which there is insufficient justification based on known distribution and population sizes for inclusion on the DRF schedule. Priority Flora taxa are assigned to one of four Priority categories (Atkins, 2008) (for a full definition of categories see Appendix D). Currently, 96 Priority Flora taxa are listed on FloraBase as occurring in the Pilbara bioregion (Western Australian Herbarium, 2008).

3.3.3 Database searches and Declared Rare and Priority Flora records for the area

A search was undertaken of the Department of Environment and Conservation's (DEC's) Threatened (Declared Rare) Flora database, the Western Australian Herbarium Specimen

database for Priority Flora species opportunistically collected in the area of interest and the DEC's Declared Rare and Priority Flora List before carrying out the survey. The search area encompassed the town of Newman, the proposed pipeline corridor, and the surrounding area - approximately 400 km^2 (search coordinates: 23° 16' - 23° 27' S and 119° 39' - 119° 51' E (GDA94)). The results of these searches are included as Appendix C.

The database searches indicate that one DRF and 12 Priority Flora species have been recorded previously in the vicinity of the study area. These species, their distribution, conservation status and number of records on FloraBase are summarised in Table 3-4.

Table 3-4: Results from searches of the WA Herbarium database and the Declared Rare Flora and Priority Species list.

Species	Nearest named locations	Status	Records
Lepidium catapycnon	Wittenoom Gorge, Hamersley Range, Weeli Wolli, Newman	R	3
Amaranthus sp. Todd River (G. Chippendale 482)	Newman	P1	1
Brachyscome sp. Wanna Munna Flats (S. van Leeuwen 4662)	Tom Price, Newman	P1	3
Brunonia sp. Long hairs (D.E. Symon 2440)	Schwerin Mural Crescent, Newman	P1	3
Goodenia lyrata	Laverton, Newman	P1	6
Goodenia sp. East Pilbara (AA Mitchell PRP 727)	Weeli Wolli, Mulga Downs, Nullagine, NW	P1	1
Goodenia sp. Pilbara calcrete (A.A. Mitchell PRP 1436)	Newman, Nullagine	P1	1
Gonocarpus ephemerus	East of Wiluna, Mt Augustus, Ruddall River, Jiggalong, Newman	P2	22
Olearia fluvialis	Hamersley Range, Karijini N.P., West Angelas, Newman	P2	5
Eremophila magnifica subsp. *velutina*	Hamersley Ranges, Newman, Marandoo	P3	8
Tephrosia sp. Cathedral Gorge (F.H. Mollemans 2420)	Newman, Hamersley Range, Fortescue	P3	7
Triumfetta leptacantha F. Muell.	Yandicoogina, Ministers North, Yandicoogina Creek, Packsaddle Range, Northeast of Newman	P3	8
***Prostanthera ferricola*	Wiluna, Meekatharra, Newman	P3	13 none from the Pilbara

Note: Status codes 1, 2, and 3 denote Priority levels and R signifies Declared Rare Flora taxon. **It is probable that this record is incorrect in the database, as there are no records indicated on FloraBase for *P. ferricola* in the Pilbara.

Except for *Prostanthera ferricola*, each of the species listed above could possibly occur in the survey area.

3.3.4 Rare and Priority Flora recorded during the current survey

No Declared Rare Flora taxa were collected during the Newman pipeline survey. One Priority Three Flora taxon, *Themeda* sp. Hamersley Station, was recorded at two sites - 16 and 33 – during the survey. A brief description of the plant follows, its locations are listed in Table 3-5 and the voucher forms to be lodged with the specimens collected are included as Appendix E.

Table 3-5: Location of *T.* sp. Hamersley Station recorded in the survey area.

Priority species	Site	Cover (%)	Zone	Easting (mE)*	Northing (mN)*
Themeda sp. Hamersley Station (M.E. Trudgen 11431) – Priority 3	16	Isolated clumps	50 K	785345	7415391
	33	<10%	50 K	785028	7410507

*Coordinates in WGS84

Themeda sp. Hamersley Station (M.E. Trudgen 11431) (Priority 3)

T. sp. Hamersley Station (Plate 3-15) occurs either as a tussocky perennial grass or as a herb, growing from 0.9 m to 1.8 m in height. The plants generally produce flowers in August and they tend to grow on red clay in clay pan and grass plain habitats.

Plate 3-15: *Themeda* sp. Hamersley Station

The sites where *T.* sp. Hamersley Station was located are in a minor creekline and on a flat plain. Weeds were present at both sites and one of the sites was lightly grazed while the other was heavily grazed, trampled and rubbish strewn.

Eleven records for *T.* sp. Hamersley Station are listed on FloraBase (Western Australian Herbarium, 2008) and collections have been from Karratha, Millstream, Hamersley Station, West Angelas and Coondewanna Flats. Population sizes recorded at these locations ranged from one to 200 plants.

3.3.5 Introduced flora

Weeds that are, or have the potential to become, pests to agriculture can formally be declared under the *Agriculture and Related Resources Protection Act, 1976*. Declared plants listed under the Act are listed with a coded definition of the requirements for their control. Five Priority groupings are used, and more than one Priority may be placed on a weed species (Appendix D).

A search was conducted of the list of Declared Plants under the ARRP Act, 1976 for any declared weed species that potentially could be found within the survey area. Eighty-two declared weed species are currently known to occur in the East Pilbara Region (Department of Agriculture and Food, 2008) and a search of FloraBase records for weeds occurring in the Pilbara indicated that 90 alien species are recorded for the area.

Fourteen environmental weeds were found during the Newman pipeline survey. One of the weed species is **Datura leichhardtii*, which is a declared weed in most of Western Australia but not in the Pilbara Shires.

Descriptions and photographs of the weeds recorded during the survey are included below and their locations are listed in Table F-1, Appendix F.

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

**A. javanica* is an erect, many-branched perennial herb, growing to 1.6 m in height. It is densely covered in short, branched hairs, giving it a greyish appearance. Its flowers are white, and are produced for most of the year. **A. javanica* is native to northern Africa and south west Asia, and was originally introduced to Western Australia to assist with the revegetation of degraded rangelands. It is now widespread in many types of vegetation from Carnarvon to the Kimberley (Hussey *et al.*, 1997).

**Aerva javanica* (from Hussey *et al.*, 1997)

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

**B. bipinnata* is an erect annual, herb, growing from 0.1 to 0.9 m in height (Western Australian Herbarium, 2008). Its flowers are yellow and are produced from March to September. It is commonly found in alluvium, clay, loam over sandstone, limestone and along rivers, creeks, coastal areas and rocky hillsides. It is deeply lobed and has bipinnate leaves with two to three awns. **B. bipinnata* is found throughout the northern end of Western Australia, including Kalbarri, Newman and the Kimberley (Hussey *et al.*, 1997).

Bidens bipinnata (S. Hitchcock, *ecologia*)

***Cenchrus cilliaris* (Buffel Grass), Poaceae**

**C. ciliaris* is a tufted, perennial grass growing to 1 m in height (Western Australian Herbarium, 2008). It was widely planted in pastoral regions as a pasture grass, and has since become a widespread weed of roadsides, creeklines, river edges and most vegetation types from Shark Bay to the Pilbara and adjacent desert. **C. ciliaris* is native to Africa and India and continues to spread throughout the state both naturally and through deliberate establishment (Hussey *et al.*, 1997).

****Cenchrus ciliaris*** (from Hussey *et al.*, 1997)

***Centaurium erythraea* (Common Centaury), Gentianaceae**

**C. erythraea* is an erect, more or less branched, hairless herb, with opposite leaves and pink flowers. This species has been recorded from south-west of Meekatharra to Balladonia in damp habitats and it flowers from October to April (Hussey *et al*, 1997).

****Centaurium erythraea*** (FloraBase, 2008)

Photography by C. Hortin & L. Fontanini. Image used with the permission of the Western Australian Herbarium, Department of Environment and Conservation (http://florabase.dec.wa.gov.au/help/copyright). Accessed on Saturday, 28 June 2008.

******Chloris virgata* (Feathertop Rhodes Grass, Windmill Grass), Poaceae**

**C. virgata* is a tufted perennial, grass-like herb, usually growing to 0.5 m in height. The flowers are green – purple colour and are produced between April–May or September (Western Australian Herbarium, 2008). Native to Africa, **C. virgata* is now scattered on roadsides and other disturbed sites throughout southern Western Australia, the Goldfields, edges of the desert and the Ord River (Source: Hussey *et al*, 1997).

****Chloris virgata*** (from Hussey *et al.*, 1997)

******Citrullus colocynthis* (Colocynth), Cucurbitaceae**

**C. colocynthis* is a trailing perennial herb or climber that produces yellow flowers from January to October (Western Australian Herbarium, 2008). This species is a native of northern Africa and western Asia and is found in disturbance areas as well as in wetlands

and creeks of the Pilbara and Kimberley regions. It is more sticky and hairy than **C. lanatus* and its fruits are green with yellow markings (Hussey *et al*, 1997).

***Citrullus lanatus* (Afghan Melon, Pie Melon, Wild Melon), Cucurbitaceae**

**C. lanatus*, a native of tropical and southern Africa, is a trailing, perennial herb or climber that produces 3-4 cm yellow flowers from January to December (Western Australian Herbarium, 2008). It is a familiar sight in late summer in paddocks in agricultural regions, along roadsides and disturbed water courses. The mature spherical fruit is up to 15 cm across, hairy, with mottled green stripes at first, but becoming yellow and hairless with age. The dense, fleshy fruit is usually bitter and unpalatable (Hussey *et al.*, 1997).

**Citrullus lanatus* (from Hussey *et al.*, 1997)

***Conyza bonariensis* (Flaxleaf Fleabane), Asteraceae**

**C. bonariensis* is a grey-hairy plant that grows from 0.5 m to 1.5 m high and is best distinguished by its stem which branches below each pyramid of inflorescences, resulting in a candelabra shape. This is a weed resulting from cultivation; it is found in waste places and along roadsides and grows in a variety of soil types. It produces white flowers from January to December (Western Australian Herbarium, 2008).

(FloraBase, 2008)

Photography by R. Randall. Image used with the permission of the Western Australian Herbarium, Department of Environment and Conservation (http://florabase.dec.wa.gov.au/help/copyright). Accessed on Saturday, 28 June 2008.

***Cynodon dactylon* (Couch Grass), Poaceae**

**C. dactylon* is a rhizomatous (or stoloniferous), prostrate perennial grass that roots at the nodes. It grows from 0.05–0.3 m high, its leaves are bluish-green (Hussey *et al.*, 1997) and it produces green and purple flowers from June to November and February (Western Australian Herbarium, 2008). It favours sand, loam or clay soils and is distributed widely in Western Australia. It is widely planted as a lawn grass and it invades wetlands and river edges in southern Western Australia. **C. dactylon* is native to the Kimberley and the tropics worldwide (Hussey *et al.*, 1997).

**Cynodon dactylon* (from Hussey *et al.*, 1997)

***Datura leichhardtii* (Native Thornapple), Solanaceae**

**D. leichhardtii* is a declared weed in most of Western Australia and was formerly considered native to Australia but is actually of Mexican origin. It is an erect herb growing to 1 m with ovate, lobed leaves (Hussey *et al.*, 1997) and white flowers that are produced from June to October (Western Australian Herbarium, 2008). The fruits are a spiny capsule about 3 cm wide and contain alkaloids making them very poisonous. It grows along creeklines in the Pilbara and Gascoyne (Hussey *et al.*, 1997).

***Echinochloa colona* (Awnless Barnyard Grass), Poaceae**

**E. colona* is a tufted annual grass, growing from 0.2 m to 0.9 m in height (Western Australian Herbarium, 2008). The flowers are a green to purple colour and are produced from February to July (Florabase, 2008). This species is generally found growing on black sand and black clay (Florabase, 2008). It is a widespread weed of creeks, swamps and irrigated crops in the Kimberley and Pilbara and is native to Africa and Asia (Hussey *et al.*, 1997).

****Echinochloa colona*** (Florabase, 2008)

Photography by S.M. Armstrong and J. English. Image used with the permission of the Western Australian Herbarium, Department of Environment and Conservation (http://florabase.dec.wa.gov.au/help/copyright). Accessed on Saturday, 28 June 2008.

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

**M. americanum* is an erect, hairy, perennial herb or shrub growing to between 0.5 and 1.3 m in height (Hussey *et a.l*, 1997). The flowers are yellow to orange in a dense terminal spike (Western Australian Herbarium, 2008). Native to America, **M. americanum* is a weed of river and creek margins, wastelands, and many arid zone habitats from the Nullabor to the Pilbara and Kimberley Regions of Western Australia (Hussey *et al*, 1997).

****Malvastrum americanum*** (Source: Hussey *et al*, 1997)

****Portaluca oleraceae*** (Purslane/Pigweed), Portulacaceae

**P. oleraceae* is a succulent, prostrate to decumbent annual herb growing to 0.2 m high. Its shiny leaves are spoon-shaped and the yellow flowers occur in their axils from April to May. Under water stress the whole plant becomes reddish. The species favours clay loams and sands, is often found on disturbed sites and is widely distributed in Western Australia. Pigweed is a common and widespread weed of horticulture, paddocks and gardens. It is considered a native in most of the State but is probably introduced to the south-west (Hussey *et al.*, 1997).

Portulaca oleracea (Source: Florabase, 2008)

Photography by C.P. Campbell and L. Fontanini. Image used with the permission of the Western Australian Herbarium, Department of Environment and Conservation (http://florabase.dec.wa.gov.au/help/copyright). Accessed on Saturday, 28 June 2008.

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

**V. farnesiana* is an erect, spreading, thicket-forming, thorny tree or shrub growing to 4 m in height. Its bark is dark grey and rough. Its leaves are pinnate while its flowers are yellow and are produced from June to August. Mimosa bush is common in low-lying areas, river and creek banks and disturbed sites. It is widely distributed in Western Australia, particularly west of a line linking between Perth and Halls Creek (Hussey *et al.*, 1997).

Vachellia farnesiana (*ecologia*)

Descriptions by the Western Australian Herbarium, Department of Environment and Conservation. Text used with permission (http://florabase.dec.wa.gov.au/help/copyright). Accessed on Sunday, 29 June 2008.

3.4 Ecological Communities

3.4.1 State and nationally recognised threatened and priority ecological communities

Ecological communities are naturally occurring biological assemblages associated with a particular type of habitat. At a national level, flora and Threatened Ecological Communities (TECs) are protected under the EPBC Act 1999. TECs are listed as Critically Endangered, Endangered or Vulnerable (Table D.1 Appendix D).

The Western Australian Department of Environment and Conservation (DEC) maintains a list of TECs that are Presumed Totally Destroyed, Critically Endangered, Endangered or Vulnerable.

Potential TECs that do not meet survey criteria, or that are not adequately defined, are added by the DEC to a list of Priority Ecological Communities (PECs). Communities are placed in this category while consideration can be given to their declaration as TECs (Table D.1 Appendix D. No TECs or PECs were recorded in the project area.

3.5 Survey Limitations and Constraints

According to the Environmental Protection Authority (EPA) Guidance Statement for Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia (EPA, 2004), flora and vegetation surveys may be limited by the following:

- Scope (i.e. the influence in terms of reference, such as what life forms etc. were sampled);
- Proportion of flora collected and identified (based on sampling, timing and intensity);
- Sources of information (i.e. pre-existing background versus new material);
- The proportion of the task achieved and further work which might be needed;
- Timing/weather/season/cycle;
- Disturbances (e.g. fire, flood, accidental human intervention etc.);
- Intensity (in retrospect, was the intensity adequate?);
- Completeness (e.g. was the relevant area fully surveyed?);
- Resources (e.g. degree of expertise available in plant identification to taxon level);
- Access problems;
- Availability of contextual information; and
- Experience levels.

These potential constraints and their relevance to this survey are presented in Table 3-6.

Table 3-6: Flora survey constraints and their relevance to this project.

Aspect	Constraint	Comment
Sources of information and availability of contextual information *(i.e.* pre-existing background versus new material)	No	HGM carried out a survey of the soils and vegetation of Mt Whaleback and Ore Body 29 for BHPIO (1997). This area lies immediately west of Newman townsite and includes some of the corridor of the section of old pipeline that is proposed to be replaced. *ecologia* has undertaken several biological surveys at areas in the wider Pilbara region and these include surveys at Orebody 24 (2004b), Hashimoto (2007a), Jimblebar (1996a; 1999; 2004d; 2005c), Orebody 18 (1995a; 2004c; 2005c), East Jimblebar (2005b), Wheelarra Hill (2004d; 2005a), Orebody 23 (1998a; 1998b; 2004c), Orebody 25 (1995b; 2004c), Eastern Ophthalmia Range (2004a) and Newman to Jimblebar (2008). While ENV carried out phase 2 of a survey and produced a report on a two phase assessment of the flora and fauna of Orebody 24 (2006) .
The scope *(i.e*. what life forms were sampled)	No	The vascular flora of the project area was sampled during a single phase assessment. The survey scope was prepared in consultation with the relevant government agencies (via BHPBIO), and was designed to comply with EPA requirements.
Proportion of flora collected and identified (based on sampling, timing and intensity)	No	Approximately 900 voucher specimens were collected during the this survey and the following identifications were made from these specimens. Taxa identified: 375 Identified to species, subspecies, variety, affinity: 353 taxa. Identified to family only: 1 specimen. Identified to genus only: 5 taxa. Annuals and weak perennials were well represented in the species list (105 species) indicating that adequate rains had fallen before the survey.
Completeness and further work which might be needed *(e.g.* was the relevant area fully surveyed)	No	Aerial photography was used to determine different areas to be sampled during the survey. This ensured that all areas displaying potentially different or unique vegetation were visited during the survey. In addition, the botanists carrying out the survey ground-truthed the vegetation associations occurring in the sites chosen from the aerial photography and added or removed sites depending on the vegetation encountered while traversing the survey areas. The area was fully surveyed.
Mapping reliability	No	Mapping reliability is high as good aerial imagery was used to select sites to be sampled during the survey and to produce a digitized map of the vegetation associations occurring in the study area.
Timing/weather/season/cycle	Yes - negligible	Rainfall in the three months preceeding the second phase of the survey was average at 169.00 mm. A fairly large fall of 56 mm was recorded on January 23rd and 23 mm on January 31st. Further rains followed in February and March. Therefore, approximately seven weeks of good growing time occurred between the start of significant rains and the survey.
Disturbances *(e.g*. fire, flood, accidental human intervention)	No	Many areas of the corridor surveyed had been impacted by cattle grazing and trampling, as well as by humans dumping rubbish. A number of areas within the corridor to the south of Newman townsite are used by recreational off road vehicles. Many of these locations showed significant signs of erosion and damage to vegetation.

Aspect	Constraint	Comment
Intensity (in retrospect, was the intensity adequate?)	No	The intensity of these surveys was adequate and will add to already existing knowledge on the vegetation and flora of the Newman project area. Twelve person days were spent on the survey and all vegetation types occurring along the corridors were sampled more than once. Sixty-nine quadrats were assessed during the survey.
Resources	No	Resources were adequate for the botanical survey as 12 person days were invested in the field survey. An experienced taxonomist / botanist, was responsible for plant specimen determination/taxonomy.
Access problems	No	All sections of the survey area were accessible, as it surrounds the town of Newman and many tracks exist in the area.
Experience levels (*e.g.* degree of expertise in plant identification to taxon level)	No	One of the field botanists carrying out the survey has 4 years of field experience and 3 years of taxonomic experience while the second has 3 years field experience and 1 of taxonomic. Both botanists have carried out many surveys in the Pilbara Biogeographic Region. The taxonomist who identified the voucher specimens collected during the survey has more than 7 years' experience of taxonomic work on the flora of the Pilbara.

4.0 CONSERVATION SIGNIFICANCE

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

4.1 International / National Significance

Vegetation and Flora

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

No flora species or TECs of national significance were recorded during the vegetation and flora survey of the Newman pipeline.

4.2 State Significance

State significance refers to those features of the environment that are recognised under State legislation as being of importance to the Western Australian community; in particular, species scheduled/listed under the *Wildlife Conservation Act 1950*.

Vegetation and Flora

No TECs or DRFs of state significance were recorded in the Newman pipeline project area.

4.3 Regional Significance

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

Vegetation and Flora

One Priority Flora taxon of regional significance was recorded at the Newman pipeline project area – *Themeda* sp. Hamersley Station, a Priority 3 species. Eleven records for this species are listed on FloraBase and populations recorded number from 1 to 200 plants or are described as common or abundant. During the Newman pipeline survey the plants occurred as isolated clumps or at a cover of less than 10%.

The corridors surveyed contain vegetation of the Elimunna, McKay, Newman, River, Rocklea, Spearhole and Washplain Land Systems. The area of each of these Land Systems in the Pilbara Bioregion and in the pipeline corridor is shown in Table 4-1 below along with the estimated impact to each Land System if the whole corridor were to be cleared. These impact estimates are greater than the actual impact would be, as much of the project involves upgrading an existing stretch of pipeline and the proposed new section is much shorter. Additionally, a narrow corridor is to be impacted and not the wider corridor surveyed.

Table 4-1: Land systems of the survey area: areas and potential impact.

Land System	Land Type	Total area in WA (km^2)	Approx. total in survey area (km^2)	Potential impact (%)
Newman	Hills and ranges with spinifex grasslands	14580	1.0	0.007
River	River plains with grassy woodlands and shrublands, and tussock grasslands	4088	0.2	0.024
Rocklea	Basalt hills, plateaux, lower slopes and minor stony plains supporting spinifex grasslands	22993	0.9	0.004
Spearhole	Gently undulating hardpan plains supporting groved mulga shrublands and hard spinifex	1270	0.1	0.008
Elimunna	Stony plains on basalt supporting sparse acacia and cassia shrublands and patchy tussock grasslands	617	4.7	0.762
McKay	Hills, ridges and plateaux remnants and breakaways of meta sedimentary and sedimentary rocks supporting hard spinifex grasslands	4202	0.7	0.017
Washplain	Hardpan plains supporting groved mulga shrublands	917	0.2	0.022

The McKay, Newman, River and Rocklea Land Systems are extensive in the Pilbara Bioregion and are of lower conservation value than the Elimunna, Spearhole and Washplain Land Systems that are not as extensive. Of these land systems the Elimunna would be impacted most by the pipeline works; however, the bulk of the Elimunna Land System occurs in the longer stretch of the existing pipeline corridor than in the newly proposed corridor. A small area of the Spearhole Land System occurs in the southeast section of the corridor and while this land system is not as extensive as others about 50% of its occurrence in the project area is along the existing pipeline corridor. The Washplain Land System occurring in the Newman pipeline project area is not as extensive as the majority of the others, and is its western-most extent. Again, this land system occurs along a section of the existing pipeline and impact to it would not be as great as if it were along the proposed new pipeline corridor.

The vegetation occurring in the project area, as mapped by Beard (1975), is:

- Woodland: Low woodland; mulga, trees in groves or patches
- Woodland: Low woodland; mulga low woodland, continuous
- Steppe (hummock grassland): Tree steppe; snappy gum and spinifex.

According to Shepherd *et al.* (2002) 99.9% of the mulga woodland estimated to have been present in Western Australia in pre-European times still remains. As a small area of this vegetation association is proposed for clearing (along the new pipeline corridor) and the rest is along the existing pipeline corridor, this vegetation type should not be significantly impacted by this project. Shepherd *et al.* (2002) estimate that 100% of the tree steppe of snappy gum and spinifex still remains. This vegetation occurs along the existing pipeline corridor.

4.4 Local Significance

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

Vegetation and Flora

The habitat type in which *Themeda* sp. Hamersley Station is typically found is not specialised as small creeks and low plains are common in the survey area. It is probable that more plants of this species exist in the area outside of the quadrats surveyed and that the proposed upgrade of the pipeline or construction of a new section of pipeline would not lead to the local extinction of *Themeda* sp. Hamersley Station. If the boundaries of the recorded populations were clearly marked before pipeline works commenced, any potential impacts to the Priority species could be removed or reduced.

4.1 Biodiversity

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

One of the major issues from a biodiversity perspective is whether individual species would be restricted to the particular habitat of the project area. Only one Priority Flora taxon was recorded during the survey in two of the 69 quadrats assessed along the pipeline. The habitats in which the plants were found (on a plain and minor creekline) are generally well represented in the immediate area and within the region, therefore, loss or modification of habitat within the project area is unlikely to significantly reduce regional biodiversity; particularly as the project involves the upgrade of an already existing pipeline as well as the construction of a new one.

5.0 ENVIRONMENTAL IMPACTS

The vegetation associations, habitats and landforms found in the project area (and within the proposed disturbance footprint) are not considered to be of national, state, regional or local conservation significance and are well represented across the Pilbara biogeographic region, as indicated by the mapping of Van Vreeswyk *et al.* (2004) and Beard (1975). This implies that at a regional scale, loss of vegetation associations, habitat types and landforms found in the project area will not constitute a significant loss of biodiversity.

Potential impacts on flora and fauna of the pipeline corridor include:

- Loss of natural vegetation and flora through clearing; and
- Indirect loss of vegetation and flora from ongoing practices.

Clearing: Direct loss of vegetation and flora

The most substantial environmental impact arising from the proposed project would be the clearing of native vegetation, and the consequent loss of flora and habitat.

Within the proposed disturbance footprint flora species are expected to be lost; however, the areas proposed to be newly disturbed are relatively small and generally well represented in the surrounding area.

Indirect loss of vegetation and flora

Flora habitats can be impacted indirectly by increased activity in an area leading to increased dust, fire and weeds.

No 'declared' weeds listed under the *Agriculture and Related Resources Protection Act*, 1976 were recorded in the project area. Fourteen weed species were collected during the survey: **Aerva javanica* (Kapok Bush), **Bidens bipinnata* (Bipinnate Beggartick), **Cenchrus cilliaris* (Buffel Grass),**Centaurium erythraea* (Common Centaury)**,** **Chloris virgata* (Feathertop Rhodes Grass, Windmill Grass),**Citrullus colocynthis* **(**Colocynth**)**, **Citrullus lanatus* **(**Afghan Melon, Pie Melon, Wild Melon**)**, **Conyza bonariensis* **(**Flaxleaf Fleabane), **Cynodon dactylon* (Couch Grass), **Datura leichhardtii*, **Echinochloa colona* (*Awnless Barnyard Grass*), **Malvastrum americanum* (Spiked Malvastrum), **Portulaca oleracea* (Purslane) and **Vachellia farnesiana* (Mimosa Bush) and their spread should be minimised. Many environmental weeds are highly invasive and lead to the displacement of native vegetation.

An environmental impacts risk assessment analysis has been carried out and is presented in Appendix G. The analysis considers the main activities that could impact on the vegetation and flora as a result of the proposed works. Using a risk matrix and risk assessment ratings, the inherent risk level (the product of the scores for the likelihood of an event occurring and its consequence) is calculated. The significance of this risk level is then rated as either low, moderate or high. Controls are suggested and the residual risk associated with the activities

is then calculated in the same way. The analysis indicates that by employing various management actions the impact risks associated with key activities could be reduced from high and moderate to moderate and low.

6.0 CLEARING PRINCIPLES AND THE EPA ACT, 1986

Under regulations gazetted in 2004 as an amendment to Part V of the *Environmental Protection Act 1986*, clearing not classified as exempt will require a Clearing Permit. However, Item 25 of Regulation 5 of the Native Vegetation Clearing Regulations allows clearing for prospecting or exploration activities approved under the mining act. As of 30th March 2007 clearing of native vegetation for mineral and petroleum exploration (items 24 and 25 of Regulation 5 of the Clearing Regulations) outside of Environmentally Sensitive Areas is permanently exempt from the need for a Clearing Permit.

An exemption for other mineral or petroleum activities is defined in Clause 2(2) of Schedule 1, and allows clearing of up to 10 hectares per financial year for clearing authorised under the *Mining Act 1978* in an authority area.

Schedule 5 of the Act provides the following set of principles on which to evaluate whether clearing should or should not be permitted; the vegetation surveyed has been assessed within this context.

Table 6-1: Clearing permit requirements and the Newman water pipeline survey area.

Principle	Requirements	Assessment based on current survey:
a)	It comprises a high level of biological diversity.	The area is of moderate diversity for the Pilbara and 375 taxa were recorded during the survey. Fourteen of these taxa were weed species i.e. 3.7%.
b)	It comprises the whole, or a part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous to Western Australia.	The vegetation assemblages recorded during the survey of the pipeline corridors are common and widespread locally and regionally in the Pilbara.
c)	It includes, or is necessary for the continued existence of, rare flora.	No Declared Rare Flora taxa were recorded during the survey. One Priority three taxon, *Themeda* sp. Hamersley Station, was recorded at two sites during the survey; however populations of this species are known from 11 records in the Pilbara region. One of the sites where *T.* sp. Hamersley was located was at the boundary of the corridor and the second was towards the centre of the corridor, BHPBIO will attempt to minimise impact in these areas.
d)	It comprises the whole or a part of, or is necessary for the maintenance of, a threatened ecological community.	No threatened ecological communities are present in the area.
e)	It is significant as a remnant of native vegetation in an area that has been extensively cleared.	Not significant at present, as the vegetation of the Pilbara region is largely uncleared. The vegetation of the pipeline corridors is: low woodland of mulga trees in groves or patches; continuous low woodland of mulga; and tree steppe of snappy gum and spinifex. In 2002 (Shepherd *et al*.) it was estimated that 99.9% of pre-European mulga woodland still existed and 100% of snappy gum and spinifex tree steppe. The pipeline corridor traverses seven land systems. If the whole of the pipeline corridors were

Principle	Requirements	Assessment based on current survey:
e) continued	It is significant as a remnant of native vegetation in an area that has been extensively cleared.	to be cleared for the proposed works 0.007% of the Newman Land System would be cleared and 0.024%, 0.004%, 0.008%, 0.762%, 0.017% and 0.022% of the River, Rocklea, Spearhole, Elimunna, McKay and Washplain Land Systems respectively (see Table 4.1). However, the work involves the upgrade of an existing pipeline along with the construction of a new stretch of pipeline, and the potential impact will be lower than indicated above. Of these land systems the Elimunna would be impacted most by the pipeline works; however, the bulk of the Elimunna Land System occurs in the longer stretch of the existing pipeline corridor rather than in the newly proposed corridor (see Figure 2-2).
f)	It is growing in, or in association with, an environment associated with a watercourse or wetland.	The eastern proposed water pipeline corridor is adjacent to and west of an approximately 7 km section of the Fortescue River south of Ophthalmia dam wall. Smaller creeks feeding into the Fortescue flow through this corridor. Two minor creeklines will be crossed by the new pipeline corridor and these crossings will require an Application for a 11/17/21A Permit to Interfere Bed and Banks. The vegetation proposed to be cleared is described as Vegetation unit 1 in Table 3-2.. This vegetation unit is widely distributed in both the project area and region along creeklines. The proposed clearing corridor at creek crossings will be limited to 3.5 m wide.
g)	The clearing of the land is likely to cause appreciable land degradation.	Considered unlikely – especially as some of the land in the northern stretch of the corridor is already degraded.
h)	The clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area.	Unlikely, as the eastern edge of the nearest conservation area, Karajini National Park, is approximately 120 km from the project area.
i)	The clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water.	Vegetation clearing could possibly affect the quality of surface water by increasing siltation where the new pipeline is to be constructed.. Management measures could be implemented to reduce the likelihood of this happening. Soil conservation techniques could be employed where surface water flow is managed to reduce its velocity in drainage areas where vegetation has been cleared. Pipeline works could be undertaken in the drier months of the year or, if this is not possible, in areas of high risk suitable geotextiles could be used. The impact of clearing on underground water was beyond the scope of this botanical assessment.
j)	The clearing of the vegetation is likely to cause, or exacerbate, the incidence or intensity of flooding.	These are areas of intense rainfall and flooding during the summer months when cyclones can be common. However, at other times of the year the drainage lines are dry. While clearing of vegetation will increase run-off, the incidence and intensity of flooding is unlikely to be affected markedly, especially as Ophthalmia dam is not far from some sections of the pipeline.

7.0 RECOMMENDATIONS

Detailed recommendations are listed in two categories where appropriate; design level and management level. Recommendations at the design level present strategies which will mitigate impacts to the environment inherent in the design of proposed developments. Management level recommendations aim to reduce the ongoing impacts to the biological environment following pipeline works and to preserve existing conservation values. In order to reduce impacts to vegetation and flora from the Newman pipeline works BHPBIO should implement the following:

DESIGN LEVEL

RECOMMENDATION 1

Limit vegetation clearing to within the areas documented by this report. This will ensure that any significant species potentially occurring outside the study area will not be impacted.

RECOMMENDATION 2

Minimise vegetation clearing to that which is absolutely necessary within the design parameters of the project. Clearing should not extend beyond 10 m (wide) where practicable. Where not practicable the minimum level of clearing should be undertaken. Where possible, existing tracks and cleared envelopes should be used in preference to constructing new ones.

RECOMMENDATION 3

Where permanent structures are not developed remove the minimum amount of topsoil possible. Minimal topsoil disturbance will encourage natural regeneration due to retention of the seed store and microbiological activity, which is largely confined to the topsoil. Achieving minimum disturbance of temporary disturbance areas will also discourage weeds and other species which proliferate following disturbance.

MANAGEMENT LEVEL

The following management items are recommended to mitigate impacts of the development on native flora:

RECOMMENDATION 5

Implement existing environmental procedures. BHPBIO should implement environmental procedures for staff and contractors. These include managing the risk of fire, the spread of environmentally significant weeds and encouraging general environmental impact awareness.

The following management items are recommended to mitigate impacts of the development on native flora:

- Vegetation clearing boundaries should be clearly defined and marked in the field.

- Areas no longer required to be cleared should be rehabilitated as soon as practicable. Rehabilitation should include placing cleared vegetation and logs within the area, as these provide fauna refugia. Following rehabilitation, areas should be monitored and treated for weed invasion.
- Existing tracks should be used in preference to constructing new ones.
- Vehicles should be prohibited from driving off-road. This will prevent damage to vegetation and reduce the possibility of grass/spinifex fires.
- All vehicles should be fitted with fire extinguishers.
- Weed hygiene measures should be implemented.
- Speed limits should be enforced on dirt roads to prevent excess dust clouds.

Site personnel should be familiarised with species of conservation significance recorded in the area and report any sightings to environmental personnel

8.0 STUDY TEAM

The proposed Newman water pipeline vegetation and flora survey described in this document was planned, coordinated and executed by:

ecologia Environment
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WEST PERTH
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Project Staff		
Christina Cox	PhD	Project Manager, Manager Botany
Scott Hitchcock	BSc.	Botanist
Conrad Slee	BSc. (Honours)	Botanist
Rochelle Haycock	BSc.	Botanist
Sharnya Thomson	BSc. (Honours)	Plant Taxonomist
Chris Hancock	PhD	Plant Taxonomist

Licences - "Licence to take flora for scientific purposes"		
The Newman Water Pipeline vegetation and flora survey was conducted under the authorisation of the following licences issued by Department of Environment and Conservation to:		
	Permit Number	**Valid Until**
"Licence to take flora for scientific purposes"		
Scott Hitchcock	SL007816	30th April 2008
Conrad Slee	SL008038	30th April 2008

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APPENDIX A: LOCATIONS OF SURVEY SITES AND VEGETATION CONDITION

Table A-1: Sites surveyed and vegetation condition at each

Site	Zone	Easting mE	Northing mN	Vegetation condition
1	50 K	789089	7415548	Good
2	50 K	789095	7415769	Poor
3	50 K	789021	7416045	Good
4	50 K	786113	7415495	Poor
5	50 K	785976	7415408	Poor
6	50 K	788587	7415272	Pristine
7	50 K	786994	7414630	Pristine
8	50 K	786500	7414215	Excellent
9	50 K	785480	7412277	Good
10	50 K	785446	7411425	Good
11	50 K	789086	7415308	Good
12	50 K	789345	7415489	Poor
13	50 K	789355	7415968	Good
14	50 K	788049	7415708	Good
15	50 K	786814	7415608	Good
16	50 K	785345	7415391	Degraded
17	50 K	788236	7414876	Good
18	50 K	787506	7414800	Good
19	50 K	785760	7414104	Good
20	50 K	785696	7413794	Good
21	50 K	785442	7411991	Poor
22	50 K	785979	7413275	Good
23	50 K	785802	7412863	Good
24	50 K	785391	7411117	Good
25	50 K	785315	7409934	Good
26	50 K	785660	7409393	Degraded
27	50 K	784700	7409802	Good
28	50 K	783991	7410152	Poor
29	50 K	783710	7410316	Poor
30	50 K	781461	7411168	Good
31	50 K	785458	7411457	Good
32	50 K	785478	7410969	Good
33	50 K	785028	7410507	Good
34	50 K	785601	7409208	Good
35	50 K	782769	7410698	Good
36	50 K	782447	7410811	Poor
37	50 K	783226	7410568	Good
38	50 K	780502	7411690	Good
39	50 K	780103	7411868	Good
40	50 K	779573	7412087	Poor
41	50 K	779387	7412113	Pristine
42	50 K	779244	7412242	Excellent
43	50 K	777232	7414684	Pristine
44	50 K	777777	7415358	Poor
45	50 K	779314	7416322	Good
46	50 K	777144	7413136	Good
47	50 K	777591	7412932	Good
48	50 K	778127	7415658	Good
49	50 K	778755	7415996	Good
50	50 K	788220	7415854	Poor

Site	Zone	Easting mE	Northing mN	Vegetation condition
51	50 K	781316	7411305	Good
52	50 K	780810	7411523	Good
53	50 K	780866	7416798	Poor
54	50 K	780001	7416628	Good
55	50 K	786944	7409562	Good
56	50 K	782197	7410992	Good
57	50 K	786303	7408892	Good
58	50 K	781872	7411051	Good
59	50 K	776736	7413448	Excellent
60	50 K	776692	7413600	Good
61	50 K	782662	7416240	Poor
62	50 K	782022	7416626	Poor
63	50 K	778028	7415593	Poor
64	50 K	779156	7416260	Poor
65	50 K	777203	7414780	Poor
66	50 K	776948	7414494	Poor
67	50 K	776976	7414350	Degraded
68	50 K	781274	7416804	Poor
69	50 K	789286	7415686	Degraded

APPENDIX B: FLORA SPECIES RECORDED DURING THE NEWMAN WATER PIPELINE SURVEY

Table B-1: Flora taxa recorded during survey.

Family	Name
Acanthaceae	*Dicladanthera forrestii*
	Dipteracanthus australasicus subsp. *australasicus*
	Rostellularia adscendens var *pogonanthera*
Adiantaceae	*Cheilanthes sieberi* subsp. *sieberi*
Aizoaceae	*Trianthema pilosa*
	Trianthema triquetra
	Trianthema turgidifolia
Amaranthaceae	***Aerva javanica*
	Alternanthera nana
	Alternanthera nodiflora
	Amaranthus mitchellii
	Gomphrena cunninghamii
	Gomphrena kanisii
	Ptilotus aervoides
	Ptilotus astrolasius var. *astrolasius*
	Ptilotus auriculifolius
	Ptilotus calostachyus var. *calostachyus*
	Ptilotus carinatus
	Ptilotus exaltatus var. *exaltatus*
	Ptilotus gaudichaudii var. *gaudichaudii*
	Ptilotus gomphrenoides
	Ptilotus helipteroides var. *helipteroides*
	Ptilotus macrocephalus
	Ptilotus obovatus var. *obovatus*
	Ptilotus rotundifolius
	Ptilotus schwartzii
	Ptilotus schwartzii var. *schwartzii*
Apiaceae	*Trachymene oleracea*
Asclepiadaceae	*Marsdenia australis*
Asteraceae	Asteraceae sp.
	**Bidens bipinnata*
	Blumea tenella
	Centipeda ?minima subsp. *macrocephala*
	Centipeda minima subsp. *macrocephala*
	Chrysocephalum pterochaetum
	**Conyza bonariensis*
	Helichrysum ?gilesii
	Pluchea dentex
	Pluchea rubelliflora
	Pterocaulon sphaeranthoides
	Streptoglossa adscendens
	Streptoglossa decurrens
	Streptoglossa liatroides
	Streptoglossa tenuiflora
Boraginaceae	*Heliotropium ?moorei*

Family	Name
	Heliotropium cunninghamii
	Heliotropium heteranthum
	Trichodesma zeylanicum var. *zeylanicum*
Brassicaceae	*Lepidium pedicellosum*
	Stenopetalum velutinum
Caesalpiniaceae	*Petalostylis cassioides*
	Petalostylis labicheoides
	Senna artemisioides subsp. x *artemisioides*
	Senna artemisioides subsp. *artemisioides*
	Senna artemisioides subsp. *filifolia*
	Senna artemisioides subsp. *helmsii*
	Senna artemisioides subsp. *oligophylla*
	Senna artemisioides subsp. *oligophylla* x *helmsii*
	Senna artemisioides subsp. *petiolaris*
	Senna artemisioides subsp. x *artemisioides*
	Senna artemisioides x *sericea*
	Senna ferraria
	Senna glaucifolia
	Senna glutinosa subsp. ?*pruinosa*
	Senna glutinosa subsp. *charlesiana*
	Senna glutinosa subsp. *glutinosa*
	Senna glutinosa subsp. *luerssenii*
	Senna glutinosa subsp. *pruinosa*
	Senna glutinosa subsp. x *luerssenii*
	Senna hamersleyensis
	Senna notabilis
	Senna sericea
	Senna sp. Meekatharra (E. Bailey 1-26)
	Senna stricta
Capparaceae	*Capparis lasiantha*
	Cleome oxalidea
	Cleome viscosa
Caryophyllaceae	*Polycarpaea corymbosa* var. *corymbosa*
Chenopodiaceae	*Chenopodium melanocarpum* forma *leucocarpum*
	Dysphania rhadinostachya subsp. *inflata*
	Enchylaena tomentosa var. *tomentosa*
	Eremophea spinosa
	Maireana georgei
	Maireana melanocoma
	Maireana planifolia
	Maireana sp.
	Maireana triptera
	Maireana villosa
	Rhagodia eremaea
	Salsola australis
	Salsola tragus subsp. *tragus*

Family	Name
	Sclerolaena bicornis var. *bicornis*
	Sclerolaena convexula
	Sclerolaena cornishiana
	Sclerolaena cuneata
	Sclerolaena deserticola
	Sclerolaena eriacantha
Chloanthaceae	*Dicrastylis georgei*
Commelinaceae	*Commelina ensifolia*
Convolvulaceae	*Bonamia rosea*
	Convolvulus angustissimus subsp. *angustissimus*
	Convolvulus remotus
	Duperraya commixta
	Evolvulus alsinoides var. *villosicalyx*
	Ipomoea calobra
	Ipomoea coptica
	Ipomoea costata
	Ipomoea muelleri
	Ipomoea plebeia
	Ipomoea polymorpha
Cucurbitaceae	**Citrullus colocynthis*
	**Citrullus lanatus*
	Cucumis maderaspatanus
Cyperaceae	*Bulbostylis barbata*
	Cyperus cunninghamii subsp. *cunninghamii*
	Cyperus iria
	Cyperus vaginatus
	Fimbristylis depauperata
	Fimbristylis elegans
	Fimbristylis oxystachya
	Fimbristylis rara
Euphorbiaceae	*Euphorbia australis*
	Euphorbia biconvexa
	Euphorbia coghlanii
	Euphorbia drummondii subsp. *drummondii*
	Euphorbia schultzii
	Euphorbia tannensis subsp. *eremophila*
	Phyllanthus erwinii
	Phyllanthus maderaspatensis
Gentianaceae	**Centaurium erythraea*
Goodeniaceae	*Dampiera candicans*
	Goodenia cusackiana
	Goodenia lamprosperma
	Goodenia microptera
	Goodenia muelleriana
	Goodenia prostrata
	Goodenia stobbsiana

Family	Name
	Scaevola amblyanthera var. *centralis*
	Scaevola parvifolia subsp. *pilbarae*
	Scaevola spinescens
Gyrostemonaceae	*Codonocarpus cotinifolius*
Loranthaceae	*Amyema ?miquelii*
	Amyema bifurcata
	Amyema fitzgeraldii
	Amyema hilliana
	Lysiana casuarinae
Malvaceae	*Abutilon ?cunninghamii*
	Abutilon amplum
	Abutilon dioicum
	Abutilon fraseri
	Abutilon macrum
	Abutilon malvifolium
	Abutilon otocarpum
	Abutilon sp.
	Gossypium robinsonii
	Hibiscus burtonii
	Hibiscus coatesii
	Hibiscus gardneri
	Hibiscus sturtii var. *campylochlamys*
	Hibiscus sturtii var. *platychlamys*
	**Malvastrum americanum*
	Sida aff. *fibulifera* (FMG 125-20)
	Sida arenicola
	Sida arsiniata
	Sida echinocarpa
	Sida fibulifera
	Sida petrophila
	Sida platycalyx
	Sida sp. *excedentifolia* (J.L. Egan 1925)
Marsileaceae	*Marsilea exarata*
	Marsilea hirsuta
Mimosaceae	*Acacia adoxa* var. *adoxa*
	Acacia adsurgens
	Acacia aff. *aneura* (narrow fine veined; site 1259)
	Acacia ancistrocarpa
	Acacia aneura
	Acacia aneura var ? *microcarpa*
	Acacia aneura var. ? *conifera*
	Acacia aneura var. ? *macrocarpa*
	Acacia aneura var. *?aneura*
	Acacia aneura var. *?pilbarana*
	Acacia aneura var. *aneura*
	Acacia aneura var. *longicarpa*

Family	Name
	Acacia aneura var. *macrocarpa*
	Acacia aneura var. *pilbarana*
	Acacia aneura var. *tenuis*
	Acacia arida
	Acacia bivenosa
	Acacia catenulata subsp. *occidentalis* Maslin ms
	Acacia citrinoviridis
	Acacia coriacea subsp. *pendens*
	Acacia dictyophleba
	Acacia hilliana
	Acacia inaequilatera
	Acacia kempeana
	Acacia ligulata
	Acacia maitlandii
	Acacia marramamba
	Acacia pachyacra
	Acacia paraneura
	Acacia pruinocarpa
	Acacia pyrifolia
	Acacia pyrifolia var. *morrisonii*
	Acacia pyrifolia var. *pyrifolia*
	Acacia rhodophloia
	Acacia sclerophylla var. *sclerophylla*
	Acacia sibirica
	Acacia spondylophylla
	Acacia synchronicia
	Acacia tenuissima
	Acacia tetragonophylla
	Neptunia dimorphantha
	Neptunia monosperma
	**Vachellia farnesiana*
Myoporaceae	*Eremophila ?jucunda* subsp. *pulcherrima*
	Eremophila ?latrobei subsp. *glabra*
	Eremophila aff. *jucunda*
	Eremophila canaliculata
	Eremophila clarkei
	Eremophila cuneifolia
	Eremophila exilifolia
	Eremophila forrestii
	Eremophila forrestii subsp. *forrestii*
	Eremophila fraseri subsp. *fraseri*
	Eremophila jucunda
	Eremophila lanceolata
	Eremophila latrobei
	Eremophila latrobei subsp. *filiformis*
	Eremophila latrobei subsp. *glabra*

Family	Name
	Eremophila latrobei subsp. *latrobei*
	Eremophila longifolia
	Eremophila maculata subsp. *brevifolia*
	Eremophila margarethae
	Eremophila platycalyx subsp. *pardalota*
	Eremophila tietkensii (sens lat.)
Myrtaceae	*Calytrix carinata*
	Corymbia aff. *hamersleyana*
	Corymbia aspera
	Corymbia candida subsp. *dipsodes*
	Corymbia hamersleyana
	Corymbia opaca
	Eucalyptus camaldulensis var. *obtusa*
	Eucalyptus gamophylla
	Eucalyptus leucophloia subsp. *leucophloia*
	Eucalyptus socialis subsp. *eucentrica*
	Eucalyptus sp.
	Eucalyptus victrix
	Eucalyptus xerothermica
	Melaleuca glomerata
Nyctaginaceae	*Boerhavia coccinea*
	Boerhavia gardneri
	Boerhavia paludosa
Oleaceae	*Jasminum didymum* subsp. *lineare*
Papilionaceae	*Aeschynomene indica*
	Crotalaria medicaginea var. *neglecta*
	Glycine canescens
	Glycine tomentella
	Gompholobium karijini
	Indigofera linifolia
	Indigofera monophylla
	Isotropis forrestii
	Rhynchosia minima
	Rhynchosia minima var. *australis*
	Tephrosia aff. *clementii*
	Tephrosia clementii
	Tephrosia rosea var. *glabrior*
	Vigna sp. central (M.E. Trudgen 1626)
Poaceae	*Amphipogon sericeus*
	Aristida contorta
	Aristida holathera var. *holathera*
	Aristida inaequiglumis
	Aristida latifolia
	Aristida obscura
	Astrebla pectinata
	Bothriochloa ewartiana

Family	Name
	**Cenchrus ciliaris*
	Cenchrus setiger
	Chloris pectinata
	**Chloris virgata*
	Chrysopogon fallax
	Cymbopogon ambiguus
	Cymbopogon obtectus
	**Cynodon dactylon*
	Dactyloctenium radulans
	Dichanthium sericeum subsp. *humilius*
	Digitaria ammophila
	Digitaria ctenantha
	**Echinochloa colona*
	Enneapogon caerulescens
	Enneapogon caerulescens var. *caerulescens*
	Enneapogon intermedius
	Enneapogon lindleyanus
	Enneapogon polyphyllus
	Enneapogon purpurascens
	Enteropogon ramosus
	Eragrostis cumingii
	Eragrostis elongata
	Eragrostis eriopoda
	Eragrostis leptocarpa
	Eragrostis pergracilis
	Eragrostis setifolia
	Eragrostis tenellula
	Eragrostis xerophila
	Eriachne aristidea
	Eriachne lanata
	Eriachne mucronata
	Eriachne obtusa
	Eriachne ovata
	Eriachne pulchella subsp. *dominii*
	Iseilema eremaeum
	Iseilema membranaceum
	Leptochloa digitata
	Panicum decompositum
	Paraneurachne muelleri
	Paspalidium basicladum
	Paspalidium constrictum
	Paspalidium rarum
	Perotis rara
	Setaria dielsii
	Sporobolus australasicus
	⚐***Themeda* sp. Hamersley Station (M.E. Trudgen 11431) (P3)**

Family	Name
	Themeda sp. Mt Barricade (M.E. Trudgen 2471)
	Themeda triandra
	Tragus australianus
	Triodia ? pungens
	Triodia angusta
	Triodia basedowii
	Triodia epactia
	Triodia longiceps
	Triodia pungens
	Triodia sp. Shovelanna Hill (S. van Leeuwen 3835)
	Triodia wiseana
	Xerochloa laniflora
Polygalaceae	*Polygala* aff. *isingii*
Portulacaceae	*Calandrinia* sp.
	**Portulaca oleracea*
	Portulaca pilosa
Potamogetonaceae	*Ruppia ?polycarpa*
Proteaceae	*Grevillea berryana*
	Grevillea striata
	Hakea chordophylla
	Hakea lorea subsp. *lorea*
	Hakea preissii
Rubiaceae	*Oldenlandia crouchiana*
	Psydrax latifolia
	Psydrax suaveolens
Santalaceae	*Anthobolus leptomerioides*
	Santalum ?lanceolatum
	Santalum lanceolatum
	Santalum sp.
	Santalum spicatum
Sapindaceae	*Dodonaea coriacea*
	Dodonaea lanceolata
Scrophulariaceae	*Stemodia grossa*
	Stemodia viscosa
Solanaceae	**Datura leichhardtii*
	Nicotiana occidentalis
	Nicotiana occidentalis subsp. *obliqua*
	Solanum ellipticum
	Solanum lasiophyllum
Sterculiaceae	*Keraudrenia nephrosperma*
	Melhania oblongifolia
	Rulingia luteiflora
Surianaceae	*Stylobasium spathulatum*
Tiliaceae	*Corchorus crozophorifolius*
	Corchorus lasiocarpus subsp. *parvus*
	Corchorus sidoides subsp. *sidoides*

Family	Name
	Corchorus tridens
Typhaceae	*Typha domingensis*
Violaceae	*Hybanthus aurantiacus*
Zygophyllaceae	*Tribulus astrocarpus*
	Tribulus macrocarpus
	Tribulus occidentalis
	Tribulus platypterus
	Tribulus suberosus

Key: ⚐ indicates a species of interest, P3 = indicates Priority three listed taxon. * indicates an alien / weed species.

Classification and nomenclature according to FloraBase (Western Australian Herbarium, 2008).

APPENDIX C: RESULTS OF DATABASE SEARCHES

13/02/2008

DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT
DECLARED RARE AND PRIORITY FLORA LIST
21 December 2006

SPECIES / TAXON	CONS CODE	CALM REGION	DISTRIBUTION	FLOWER PERIOD
Amaranthus sp. Todd River (G. Chippendale 482)	1	P	Newman	
Brachyscome sp. Wanna Munna Flats (S. van Leeuwen 4662)	1	P	Tom Price, Newman	July, Sep
Brunonia sp. Long hairs (D.E. Symon 2440)	1	GLD, P	Schwerin Mural Crescent, Newman	Jul
Eremophila magnifica subsp. velutina	3	P	Hamersley Ranges, Newman, Marandoo	
Gonocarpus ephemerus	2	GLD,MW, P	East of Wiluna, Mt Augustus, Rudall River, Jiggalong, Newman	Apr-May
Goodenia lyrata	1	GLD,P	Laverton, Newman	
Goodenia sp. East Pilbara (AA Mitchell PRP 727)	1	P	Weeli Wolli, Mulga Downs, Nullagine, NW of Newman	Aug,Sep
Goodenia sp. Pilbara calcrete (A.A. Mitchell PRP 1436)	1	P	Newman, Nullagine	Aug
Lepidium catapycnon	R	P	Wittenoom Gorge, Hamersley Range, Weeli Wolli, Newman	Oct-Jan?
Olearia fluvialis	2	P	Hamersley Range, Karijini N.P., West Angelas, Newman	Apr
Prostanthera ferricola	3	MW	Wiluna, Meekathara, Newman	Jul-Sep
Tephrosia sp. Cathedral Gorge (FH Mollemans 2420)	3	P	Newman, Hamersley Range Fortescue Valley	

WAHERB SPECIMEN DATABASE
GENERAL ENQUIRY

Tephrosia sp. Cathedral Gorge (F.H. Mollemans 2420) PN (Papilionaceae)
CONSERVATION STATUS:P3
Coll.: F.H. Mollemans 2420 Date: 02 03 1987 (PERTH 02942739)
LOCALITY Pilbara Region, 3.5 km ESE of Cathedral Gorge and 10.5 km Along Newman-Packsaddle road turnoff NNE of Railway Crossing WA
Erect low shrub to 25 cm tall. Gentle drainage depression. Lower part of a gentle slope. Substrate comprised of a continuous pebble and cobble scatter over a brown clay-sand also containing pebbles and cobbles.
Spinifex Triodia basedowii low (to 25 cm) hummock grassland.
Previous det.: Tephrosia sp.

Coll.: B. Vincent s.n. Date: 09 08 2004 (PERTH 07682972)
LOCALITY ca 8 km NE of the Newman (WP 33) WA
Burnt between 1999 - 2003. Eucalyptus leucophloia subsp. leucophloia with scattered Corymbia hamersleyana over Dampiera candicans, Gompholobium polyzygum, Acacia hilliana and Solanum lasiophyllum low shrubs over Eriachne lanata with scattered Triodia pungens.

Triumfetta leptacantha F.Muell. (Tiliaceae)
CONSERVATION STATUS:P3
Coll.: B. Vincent s.n. Date: 07 08 2004 (PERTH 07682891)
LOCALITY ca 8 km NE of Newman (WP007) WA
Burnt between 1999-2003. Dense Eucalyptus leucophloia subsp. leucophloia interspersed with occasional Corymbia ferriticola and Corymbia hamersleyana over mixed shrubs with a Triodia pungens dominated ground layer.

Results of Threatened Flora Database Search February 13, 2008

There were no results from the Threatened (Declared Rare) Flora Database for this search.

APPENDIX D: DEFINITIONS OF CONSERVATION AND DECLARED WEED CODES

Table D-1 Explanation of codes for Threatened Ecological Communities (TEC) and Priority Ecological Communities (PEC)

Code	Definition
TECs	
PD: Presumed Totally Destroyed	An ecological community that has been adequately searched for but for which no representative occurrences have been located. The community has been found to be totally destroyed or so extensively modified throughout its range that no occurrence of it is likely to recover its species composition and/or structure in the foreseeable future. An ecological community will be listed as presumed totally destroyed if there are no recent records of the community being extant
CR: Critically Endangered	An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or that was originally of limited distribution and is facing severe modification or destruction throughout its range in the immediate future, or is already severely degraded throughout its range but capable of being substantially restored or rehabilitated. An ecological community will be listed as *Critically Endangered* when it has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future.
EN: Endangered	An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or was originally of limited distribution and is in danger of significant modification throughout its range or severe modification or destruction over most of its range in the near future. An ecological community will be listed as *Endangered* when it has been adequately surveyed and is not Critically Endangered but is facing a very high risk of total destruction in the near future.
VU: Vulnerable	An ecological community that has been adequately surveyed and is found to be declining and/or has declined in distribution and/or condition and whose ultimate security has not yet been assured and/or a community that is still widespread but is believed likely to move into a category of higher threat in the near future if threatening processes continue or begin operating throughout its range. An ecological community will be listed as *Vulnerable* when it has been adequately surveyed and is not Critically Endangered or Endangered but is facing a high risk of total destruction or significant modification in the medium to long-term future.
PECs	
P1: Priority One	Ecological communities with apparently few, small occurrences, all or most not actively managed for conservation (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) and for which current threats exist. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.
P2: Priority Two	Communities that are known from few small occurrences, all or most of which are actively managed for conservation (e.g. within national parks, conservation parks, nature reserves, State forest, unallocated Crown land, water reserves, etc.) and not under imminent threat of destruction or degradation. Communities may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under threat from known threatening processes.
P3: Priority Three	(i) Communities that are known from several to many occurrences, a 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

Code	Definition
	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	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 D-2 Definition of categories described under the EPBC Act.

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

Table D-3 Definition of Declared Rare and Priority categories.

Code	Definition
DRF	Declared Rare Flora-Extant Taxa. Taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such.
P1: Priority One	Poorly Known Taxa. Taxa which are known from one or a few (generally

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

(From Atkins, K.J., Declared Rare and Priority Flora List Dec. 2008, DEC)

Table D-4: Explanation of codes for Declared Weeds in Western Australia**.**

Priority	Requirements
P1 Prohibits movement	The movement of plants or their seeds is prohibited within the State. This prohibits the movement of contaminated machinery and produce, including livestock and fodder.
P2 Aim is to eradicate infestation	Treat all plants to destroy and prevent propagation each year until no plants remain. The infested area must be managed in such a way that prevents the spread of seed or plant parts on or in livestock, fodder, grain, vehicles and/or machinery.
P3 Aims to control infestation by reducing area and/or density of infestation	The infested area must be managed in such a way that prevents the spread of seed or plant parts within and from the property, on or in livestock, fodder, grain, vehicles and/or machinery. Treat to destroy and prevent seed set for all plants: • within 100 metres inside of the boundaries of the infestation. • within 50 metres of roads and high-water marks on waterways. • within 50 metres of sheds, stock yards and houses. Treatment must be done prior to seed set each year. Of the remaining infested area: • Where plant density is 1-10 per hectare, treat 100% of infestation. • Where plant density is 11-100 per hectare, treat 50% of infestation. • Where plant density is 101-1000 per hectare, treat 10% of infestation. Properties with less than two hectares of infestation must treat the entire infestation. Additional areas may be ordered to be treated.

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

APPENDIX E: HERBARIUM VOUCHER FORMS

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Department of Environment and Conservation

RARE FLORA REPORT FORM

TAXON: ***Themeda* sp. Hamersley Station (M.E. Trudgen 11431)** **DEFL POPULATION No.:** _____
DRF ❒ Priority Species: P3___ Partial Survey ❒ Full Survey ☒ New Population ❒

FROM: *ecologia* (SH-941-01) **TITLE**: _____ **SURVEY DATE:** 19/04/08

REGION: Pilbara **DISTRICT:** Hamersley **SHIRE:** East Pilbara

LOCATION: ENE of Newman townsite adjacent to Railway corridor. **Reserve No**: _____

EASTING (mE**): 785345 NORTHING (**mN**): 7415391 (MGA 50) Map Used:** _____

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

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

LANDFORM: Hilltop ❒ Cliff ❒ Slope ❒ Valley ❒ Swamp ❒
Outcrop ❒ Breakaway ❒ Low Plain ❒ Gully ❒ Riverbank ❒
Ridge ❒ Sand Dune ❒ Flat ☒ Drainageline ❒ Lake Edge ❒
Firebreak ❒ Other ❒ Specify: _____

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

VEGETATION CLASSIFICATION (Muir's): Isolated clumps of moderate trees of Corymbia candida subsp. dipsodes over moderately dense small trees dominated by Acacia aneura, over sparse Rhagodia eremaea shrubs and sparse Sida fibulifera and Euphorbia coghlanii small shrubs over moderately dense Bidens bipinnata and Evolvulus alsinoides var. villosicalyx herbs, open Chrysopogon fallax soft grasses and sparse Triodia epactia hummock grass.

ASSOCIATED SPECIES:_____

No. of PLANTS: Mature: _____ Seedlings: _____ Dead**:** _____ Actual ❒ Estimate ❒ Area Occupied: _____
(Leave blank if unable to observe, or no attempt made to count plants)
REPRODUCTIVE STATE: Clonal ❒ Flower bud ❒ Flower ❒ Immat. fruit ❒ Fruit ❒ Old Fruit ❒ Vegetative ❒
POLLINATORS: Native bees ❒ Honey bees ❒ Other insects ❒ Birds ❒ Mammals ❒
Other observations: _____
CONDITION OF POPULATION: Healthy ❒ Moderate ☒ Poor ❒ Disturbed ❒ Comment:

POTENTIAL THREATS: Firebreaks ❒ Mining ❒ Recreation ☒ Roadworks ❒ Grazing ❒ Weeds ☒
Salinity ❒ Disease ❒ Prescribed Burning ❒ Other ❒ Comment:_____
FIRE HISTORY: Not known ☒ Burnt in 19____ Summer ❒ Autumn ❒ Winter ❒ Spring ❒
FENCING: Not Required ☒ Fenced ❒ Required ❒ Replace/Repair ❒
ROADSIDE MARKERS: Not Required ☒ Present ❒ Required ❒ Replace ❒ Reposition ❒

OTHER COMMENTS (include action taken/required):_____

VOUCHER SPECIMEN: Regional Herb. ❒ District Herb. ❒ WA Herb. ☒ Other ❒
_____
ATTACHED: Map ❒ Mudmap ❒ Illustration ❒ Photo ❒ Field Notes ❒
COPY SENT TO: Regional Office ❒ District Office ❒ Other ❒ Specify: _____

Signed: _____ Date: 30/06/2008

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

ecologia ENVIRONMENT

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Department of Environment and Conservation

RARE FLORA REPORT FORM

TAXON: ***Themeda* sp. Hamersley Station (M.E. Trudgen 11431)** **DEFL POPULATION No.:** _____
DRF ❒ Priority Species: P3___ Partial Survey ❒ Full Survey ☒ New Population ❒

FROM: *ecologia* (CCS-941-01) **TITLE**: _____ **SURVEY DATE:** 19/04/08

REGION: Pilbara **DISTRICT:** Hamersley **SHIRE:** East Pilbara

LOCATION: ENE of Newman townsite adjacent to Railway corridor. **Reserve No**: _____

EASTING (mE**): 785029 NORTHING (**mN**): 7410507 (MGA 50) Map Used:** _____

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

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

LANDFORM:
Hilltop ❒ Cliff ❒ Slope ❒ Valley ❒ Swamp ❒
Outcrop ❒ Breakaway ❒ Low Plain ❒ Gully ❒ Riverbank ❒
Ridge ❒ Sand Dune ❒ Flat ❑ Drainageline ☒ Lake Edge ❒
Firebreak ❒ Other ❒ Specify: _____

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

VEGETATION CLASSIFICATION (Muir's): Dense 8m trees consisting of Eucalyptus victrix/Corymbia hamersleyana/Corymbia candida subsp. dipsodes/Acacia aneura/Hakea lorea subsp. lorea/Acacia coriacea subsp. pendens/Acacia?citrinoviridis over sparse tall shrubs of Acacia synchronicia over open Bidens bipinnata weed over sparse mixed soft grasses and sparse Triodia angusta.

ASSOCIATED SPECIES:_____

No. of PLANTS: Mature: _____ Seedlings: _____ Dead**:** _____ Actual ❒ Estimate ❒ Area Occupied: _____
(Leave blank if unable to observe, or no attempt made to count plants)
REPRODUCTIVE STATE: Clonal ❒ Flower bud ❒ Flower ❒ Immat. fruit ❒ Fruit ❒ Old Fruit ❒ Vegetative ❒
POLLINATORS: Native bees ❒ Honey bees ❒ Other insects ❒ Birds ❒ Mammals ❒
Other observations: _____
CONDITION OF POPULATION: Healthy ❒ Moderate ☒ Poor ❒ Disturbed ❒ Comment:

POTENTIAL THREATS: Firebreaks ❒ Mining ❒ Recreation ☒ Roadworks ❒ Grazing ❒ Weeds ☒
Salinity ❒ Disease ❒ Prescribed Burning ❒ Other ❒ Comment:_____
FIRE HISTORY: Not known ☒ Burnt in 19____ Summer ❒ Autumn ❒ Winter ❒ Spring ❒
FENCING: Not Required ☒ Fenced ❒ Required ❒ Replace/Repair ❒
ROADSIDE MARKERS: Not Required ☒ Present ❒ Required ❒ Replace ❒ Reposition ❒

OTHER COMMENTS (include action taken/required):_____

VOUCHER SPECIMEN: Regional Herb. ❒ District Herb. ❒ WA Herb. ☒ Other ❒
_____

ATTACHED: Map ❒ Mudmap ❒ Illustration ❒ Photo ❒ Field Notes ❒
COPY SENT TO: Regional Office ❒ District Office ❒ Other ❒ Specify: _____

Signed: _____ Date: 30/06/2008

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

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APPENDIX F: INTRODUCED FLORA

Table F-1: Locations of introduced flora recorded during the Newman Pipeline survey.

Weed	Status	Site	% Cover or No. of plants	Zone	Easting (mE)	Northing (mN)
**Aerva javanica*		29	<10 plants	50 K	783710	7410316
		Opp coll	<10%	50 K	785525	7412307
**Bidens bipinnata*		Opp coll	<10%	50 K	786068	7415481
		Opp coll	<10%	50 K	789086	7415308
		4	Isolated clumps	50 K	786113	7415495
		11	Isolated clumps	50 K	789086	7415308
		26	<10%	50 K	785660	7409393
		27	<10 plants	50 K	784700	7409802
		60	Isolated clumps	50 K	776692	7413600
		34	<10%	50 K	785601	7409208
		29	Isolated clumps	50 K	783710	7410316
		45	10%-30%	50 K	779314	7416322
		54	Isolated clumps	50 K	780001	7416628
		33	1000+	50 K	785028	7410507
		5	50 plants	50 K	785976	7415408
		20	Isolated clumps	50 K	785696	7413794
		12	Isolated clumps	50 K	789345	7415489
		15	Isolated clumps	50 K	786813	7415608
		16	30%-70%	50 K	785435	7415406
		21	30%-70%	50 K	785813	7413639
		22	10%-30%	50 K	785979	7413275
		28	<10%	50 K	783991	7410152
		34	<10%	50 K	785601	7409208
		51	<10%	50 K	781316	7411305
		52	10%-30%	50 K	780810	7411523
**Cenchrus ciliaris*		1	<10%	50 K	789089	7415548
		2	10%-30%	50 K	789095	7415769
		4	30%-70%	50 K	786113	7415495
		5	10%-30%	50 K	785976	7415408
		9	<10%	50 K	785480	7412277
		11	10%-30%	50 K	789086	7415308
		26	10%-30%	50 K	785660	7409393
		34	30%-70%	50 K	785601	7409208
		44	<10%	50 K	777777	7415358
		45	30%-70%	50 K	779314	7416322
		48	<10 plants	50 K	778127	7415658
		57	Isolated clumps	50 K	786303	7408892
		60	Isolated clumps	50 K	776692	7413600
		56	Isolated clumps	50 K	785813	7413639
		55	Isolated clumps	50 K	786944	7409562
		52	Isolated clumps	50 K	780810	7411523
		49	<10 plants	50 K	778755	7415996
		28	<10%	50 K	783991	7410152
		19	Isolated clumps	50 K	785760	7414104
		35	<10%	50 K	782769	7410698

Weed	Status	Site	% Cover or No. of plants	Zone		Easting (mE)	Northing (mN)
		37	Isolated clumps	50	K	783226	7410568
		8	<10%	50	K	786500	7414215
		32	Isolated clumps	50	K	785477	7410969
		33	Isolated clumps	50	K	785028	7410507
		31	<10%	50	K	785458	7411457
		13	<10%	50	K	789355	7415968
		25	Isolated clumps	50	K	785315	7409934
		16	<10%	50	K	785345	7415391
		36	30%-70%	50	K	782447	7410811
		14	10%-30%	50	K	788049	7415708
		15	10%-30%	50	K	786813	7415608
		20	10%-30%	50	K	785696	7413794
		21	10%-30%	50	K	785813	7413639
		22	30%-70%	50	K	785979	7413275
		23	10%-30%	50	K	785801	7412863
		27	10%-30%	50	K	784700	7409802
		29	10%-30%	50	K	783710	7410316
		30	30%-70%	50	K	781461	7411168
		31	<10%	50	K	785458	7411457
		35	<10%	50	K	782769	7410698
		54	30%-70%	50	K	780001	7416628
*Centaurium erythraea		34	<10%	50	K	785601	7409208
*Chloris virgata		4	<10%	50	K	786113	7415495
*Citrullus colocynthis		21	Isolated clumps	50	K	785813	7413639
		26	<10 plants	50	K	785660	7409393
		57	Isolated clumps	50	K	786303	7408892
		31	Isolated clumps	50	K	785458	7411457
		1	<10%	50	K	789089	7415548
*Citrullus lanatus		15	<10 plants	50	K	786813	7415608
*Conyza bonariensis		28	N/A	50	K	783991	7410152
*Cynodon dactylon		1	Isolated clumps	50	K	789089	7415548
		10	Isolated clumps	50	K	785446	7411425
		28	30%-70%	50	K	783991	7410152
*Datura leichhardtii		26	<10 plants	50	K	785661	7409394
*Echinochloa colona		1	Isolated clumps	50	K	789089	7415548
		10	Isolated clumps	50	K	785446	7411425
		36	<10%	50	K	782447	7410811
*Malvastrum americanum		1	10%-30%	50	K	789089	7415548
		4	<10%	50	K	786113	7415495
		11	<10 plants	50	K	789086	7415308
		51	<10%	50	K	786236	7414222

Weed	Status	Site	% Cover or No. of plants	Zone		Easting (mE)	Northing (mN)
		56	Isolated clumps	50	K	785813	7413639
		26	Isolated clumps	50	K	785660	7409393
*Malvastrum americanum		27	<10 plants	50	K	784700	7409802
		29	<10%	50	K	783710	7410316
		33	<10%	50	K	785028	7410507
		34	<10%	50	K	785601	7409208
		45	<10%	50	K	779314	7416322
		25	<10 plants	50	K	785315	7409934
		20	Isolated clumps	50	K	785696	7413794
		15	<10%	50	K	786813	7415608
		16	10%-30%	50	K	785345	7415391
		21	10%-30%	50	K	785813	7413639
		22	10%-30%	50	K	785979	7413275
		28	10%-30%	50	K	783991	7410152
*Portulaca oleracea		1	Isolated clumps	50	K	789089	7415548
		2	<10%	50	K	789095	7415769
		4	Isolated clumps	50	K	786113	7415495
		5	Isolated clumps	50	K	785976	7415408
		12	Isolated clumps	50	K	789345	7415489
		30	Isolated clumps	50	K	781461	7411168
		56	10%-30%	50	K	782197	7410992
		58	<10%	50	K	781872	7411051
		20	<10%	50	K	785696	7413794
		16	Isolated clumps	50	K	785345	7415391
		24	Isolated clumps	50	K	785391	7411117
		15	Isolated clumps	50	K	786813	7415608
		27	Isolated clumps	50	K	784700	7409802
		28	Isolated clumps	50	K	783991	7410152
		29	Isolated clumps	50	K	783710	7410316
		30	<10%	50	K	781461	7411168
		14	<10%	50	K	788049	7415708
*Vachellia farnesiana		1	<10%	50	K	789089	7415548
		22	<10 plants	50	K	785979	7413275
		36	10%-30%	50	K	782447	7410811
		56	<10 plants	50	K	785813	7413639
		26	<10 plants	50	K	785660	7409393
		45	Isolated clumps	50	K	779314	7416322
		10	<10%	50	K	785446	7411425
		opp coll	Isolated clumps	50	K	785774	7412855
		opp coll	<10 plants	50	K	785446	7411425
		28	10%-30%	50	K	783991	7410152

Note: Coordinates in WGS84

APPENDIX G: RISK ASSESSMENT

Appendix G: Vegetation and Flora Environmental Impact Risk Assessment											
Newman water pipeline survey		*Location: Pilbara*					*Date: 29 June 2008*				
			Inherent Risk					Residual Risk			
Process/Activity	**Event**	**Impact**	**Likelihood**	**Consequence**	**Risk Level**	**Significance**	**Controls**	**Likelihood**	**Consequence**	**Risk Level**	**Significance**
Vegetation Clearing	Removal of vegetation and flora	Loss of biodiversity	5	3	15	**High**	Clearing should be restricted to that which is necessary. Cleared areas not in use should be rehabilitated as soon as possible.	4	2	8	**Mod**
Vegetation Clearing	Removal of vegetation and flora	Adverse impact to ecological function	3	3	9	**Mod**	Clearing should be restricted to that which is necessary. Cleared areas not in use should be rehabilitated to reduce long term ecological impact.	3	3	9	**Mod**
Vegetation Clearing	Removal of vegetation and flora	Loss of conservation significant flora in the project area	4	4	16	**High**	One conservation significant flora taxon and no conservation significant ecosystems were recorded in the areas surveyed. However, as not all of the area was surveyed other conservation significant taxa may be present. Before clearing vegetation a Rare and Priority Flora survey could be undertaken to ensure that no conservation significant taxa will be impacted.	1	4	4	**Low**
Human Presence	Increased weed species	Increased competition pressure on native flora	3	3	9	**Mod**	Weed hygiene measures should be employed to prevent the movement of weeds to and from areas of infestation. A weed eradication programme could be implemented.	2	3	6	**Mod**

Appendix G: Vegetation and Flora Environmental Impact Risk Assessment											
Newman water pipeline survey		*Location: Pilbara*					*Date: 29 June 2008*				
			Inherent Risk					Residual Risk			
Process/Activity	**Event**	**Impact**	**Likelihood**	**Consequence**	**Risk Level**	**Significance**	**Controls**	**Likelihood**	**Consequence**	**Risk Level**	**Significance**
Construction	Fire	Destruction of vegetation	2	3	6	**Mod**	Ensure that fire extinguishers are available to work personnel, and that they are trained in their use. Fire prevention to be an integral part of contractor HSE planning. Smoking near vegetated areas, particularly highly flammable grasses and spinifex, should be prohibited.	1	4	4	**Low**
Construction	Fire	Destruction of flora of conservation significance	2	4	8	**Mod**	One conservation significant flora taxon was recorded in the areas surveyed. However, others might exist in areas not surveyed. Ensure that fire extinguishers are available to work personnel, and that personnel are trained in their use. Fire prevention to be an integral part of contractor HSE planning. Smoking near vegetated areas, particularly highly flammable grasses and spinifex, should be prohibited.	1	4	4	**Low**
Construction and clearing	Dust degradation of native vegetation	Loss of vegetation	3	3	9	**Mod**	Dust suppression measures should be utilised during construction and clearing	3	3	9	**Mod**
Construction and clearing	Vegetation destruction from off-track driving	Direct loss of vegetation	3	3	9	**Mod**	Off track driving is to be prohibited or restricted.	2	2	6	**Mod**

Risk Matrix						
Risk Assessment Rating		LIKELIHOOD				
		5	4	3	2	1
		ALMOST CERTAIN	LIKELY	POSSIBLE	UNLIKELY	RARE
		Is expected to occur in most circumstance	Will probably occur in most circumstance	Could occur	Could occur but not expected	Occurs in exceptional circumstances
CONSEQUENCES	5 - CATASTROPHIC Significant impact to flora species of conservation significance or regional biodiversity	25	20	15	10	5
	4 - MAJOR Impact to flora species of conservation significance in project area.	20	16	12	8	4
	3 - MODERATE Loss of flora biodiversity in project area.	15	12	9	6	3
	2 - MINOR Short term or localised impact to flora biodiversity.	10	8	6	4	2
	1 - INSIGNIFICANT No impact to flora of conservation significance or biodiversity.	5	4	3	2	1
11-25	High risk, site/issue specific management programmes required, advice/approval from regulators required.					
6 – 10	Medium risk, specific management and procedures must be specified.					
1 – 5	Low risk, managed by routine procedures.					