



21 August 2012

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(via email)

Dear Peter

## **Brockman 4 Camps Vegetation and Flora Survey**

Biota Environmental Sciences (Biota) was commissioned by Rio Tinto Pty Ltd (Rio Tinto) to conduct a vegetation and flora survey for the Brockman Camps area (hereafter referred to as the "study area"), located east of the operational BS4 mine and immediately adjacent to the existing accommodation village. This brief report presents the results obtained during that field work.

### Scope and Objectives

The potential development site (defined by the boundaries of the study area) around the Brockman Camps extends over an area of 180 ha, of which 53 ha has been cleared or is deemed as extensively disturbed. Prior to this clearing, a survey conducted by Biota in early December 2006 and late January 2007 recorded no flora of conservation significance in this area (Biota 2007). Vegetation over about 30 ha of the remaining area was previously mapped as part of the Brockman Syncline 4 (BS4) project (Biota 2006).

The botanical field survey was therefore conducted over the remaining 97 ha of the study area (adjoining the previously surveyed BS4 study area). This survey was undertaken in accordance with the Guidance Statement No. 51 "Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia" (EPA 2004).

The scope and objectives of the study were to:

- document the suite of flora species occurring in the study area;
- identify any plant species of conservation significance in the study area, including Threatened flora species listed under the Commonwealth Environment Protection and Biodiversity Conservation (EPBC) Act 1999 and Western Australian (WA) Wildlife Conservation Act 1950, and species classified as Priority flora by the Department of Environment and Conservation (DEC);
- describe and map the vegetation communities occurring within the study area; and
- record the presence of introduced plant species (weeds) within the study area.

## Approach and Methods

The survey was undertaken from 5 July to 7 July 2012. Two botanists from Biota (Rachel Butler and Dr Shadila Venkatasamy) undertook the field work. A total of six person days were spent on the field component of the study.

During the survey, vegetation types were described and mapped at sub-association level (as per Level VI of the National Vegetation Information System framework<sup>1</sup>). Vegetation descriptions were based on the height and estimated cover of dominant species using Aplin's (1979) modification of the vegetation classification of Specht (1970). Descriptions were made and vegetation unit boundaries were recorded during foot traverses through representative areas.

In addition, vegetation was described in six quadrats (permanently marked flora sampling sites with an area equivalent to 50x50 m) and one relevé (unbounded flora sampling site). The quadrats were 50 m by 50 m in size (or an equivalent area), which is the recognised standard for the Pilbara bioregion. The quadrats were permanently marked using steel fence droppers at all four corners. Optical squares and measuring tapes were used to correctly position the quadrat sides. A photograph representing the vegetation at each quadrat was taken. These descriptions were integrated with those obtained from foot traverses in order to provide accurate information on the vegetation assemblages of the study area.

No systematic targeted rare flora searches were performed as part of this survey. However, searches for conservation significant flora were conducted while sampling the quadrats and relevé, and during foot-traverses through the area. All locations of conservation significant flora were recorded using a GPS (WGS84 datum).

The resulting data were then overlain on aerial photography in Quantum GIS Version 1.6.0 and unit boundaries were digitised. A final map was created and consolidated using MapInfo Version 11.

### Limitations

Some limitations of the field survey are discussed below. These are factors that must be considered when reviewing and applying the results of this study. Despite these limitations, the survey is believed to give a reasonable representation of the flora and vegetation of the study area.

- While foot traverses and quadrat sampling were conducted throughout the study area, no systematic searches were conducted for Threatened and Priority flora or introduced flora. The final species list should therefore be taken as indicative rather than exhaustive.
- Even though conditions during the survey were adequate for the collection of ephemeral flora and cryptic perennial species, some species may not have been present or identifiable at the time of survey.
- Fungi and nonvascular flora (e.g. algae, mosses and liverworts) were not specifically sampled, as is typical for surveys of this nature.

## Results

### Overview of Vegetation Units

Six vegetation units were identified in the study area. The vegetation units are described and representative photographs presented in Attachment 1. Each vegetation unit has been assigned a code, where species are ordered from highest to lowest strata, and identified using a unique combination of upper-case letters for genus and lower-case letters for species. The map showing the distribution of the vegetation units is given in Attachment 2.

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<sup>1</sup> <http://www.environment.gov.au/erin/nvis/publications/avam/section-2-1.html#hierarchy>

### Vegetation Units of Conservation Significance

None of the vegetation units identified in the Brockman Camps study area represent Threatened Ecological Communities (TECs) listed under the Commonwealth EPBC Act 1999, or TECs listed by DEC (2012a). Similarly, none of the units represent Priority Ecological Communities defined by DEC (2012b).

The vegetation units identified are considered to be widely distributed and well represented in this section of the Pilbara bioregion. All intact native vegetation has inherent conservation value, however none of the vegetation types in the study area are considered to be of any elevated conservation significance.

### Overview of Flora

A total of 140 native vascular flora taxa from 68 genera and 29 families was recorded from the study area. This included one Priority 3 flora species, *Indigofera* sp. Bungaroo Creek (S. van Leeuwen 4301). Two additional introduced flora species, *Cenchrus ciliaris* and *Flaveria trinervia*, were recorded. The distributions of the above three plant taxa (*Indigofera* sp. Bungaroo Creek, *Cenchrus ciliaris* and *Flaveria trinervia*) are illustrated in Attachment 2, while their locations are given in Appendix 3. A list of all the plant species encountered in this survey is provided in Attachment 4.

### Flora Species of Conservation Significance

The species recorded did not include any Threatened flora species listed under the Commonwealth EPBC Act 1999 or WA Wildlife Conservation Act 1950.

The undescribed pea species *Indigofera* sp. Bungaroo Creek (S. van Leeuwen 4301) was identified during the course of this survey and is listed as a Priority 3 species (DEC 2012c). Approximately 100 plants of *Indigofera* sp. Bungaroo Creek were recorded in the broad drainage line habitat located in the far northeastern corner of the study area.

A number of other undescribed taxa were recorded. These included three undescribed taxa in the genus *Euphorbia*, namely *Euphorbia* aff. *australis* var. 1 (MET 12 337), *Euphorbia australis* (mid green form) and *Euphorbia* sp. (PAN5-15). None of these species are believed to be uncommon or restricted in distribution. *Euphorbia australis* (mid green form) and *Euphorbia* aff. *australis* var. 1 (MET 12 337) are both widespread and common in the Pilbara. *Euphorbia* sp. (PAN5-15) has been recorded from areas ranging from the Bungaroo Valley (near Pannawonica) to the Koodaideri area (situated approximately 70 km northeast of the current study area; Biota internal database). A further undescribed taxon, *Sida* aff. *echinocarpa* (MET 15,350), was sampled during this survey. The distribution of this species does not appear to be limited to any particular habitat and several collections have been made near Newman, roughly 183 km to the east of the current study area (Biota internal database).

It should be noted that the identification of some of the specimens collected has not yet been resolved. In particular, the recognised species complex *Acacia* "aneura" (Mulga) contains numerous undescribed taxa in the Pilbara, some of which have only recently been described. A key to these taxa is not yet available, consequently all variants of this species have been temporarily assigned to the *Acacia aneura* complex. The specimens of *Acacia aneura* will be sent for specialist identification as soon as possible and the results will be forwarded to you. It is considered unlikely that these specimens represent any taxa of conservation significance.

Yours sincerely,



**Biota Environmental Sciences Pty Ltd**



Dr Shadila Venkatasamy  
Senior Botanist

## References



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- DEC (2012a). List of Threatened Ecological Communities endorsed by the Western Australian Minister for the Environment. List prepared by the Species and Communities Branch, WA Department of Environment and Conservation, correct to April 2012.
- DEC (2012b). Priority Ecological Communities for Western Australia, Version 17. List prepared by the Species and Communities Branch, WA Department of Environment and Conservation, 13 April 2012.
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- EPA (2004). EPA Guidance Statement 51: *Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia*. Environmental Protection Authority, Western Australia.
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## Attachment 1: Vegetation Descriptions

Vegetation Code	Vegetation Unit Description	Indicative Photographs
Drainage Lines		
ChGOrAaAbApyTeTw	<p><i>Corymbia hamersleyana</i> scattered low trees over <i>Gossypium robinsonii</i> scattered tall shrubs over <i>Acacia ancistrocarpa</i>, <i>A. bivenosa</i>, <i>A. pyrifolia</i> var. <i>pyrifolia</i> open shrubland over <i>Triodia epactia</i>, <i>T. wiseana</i> very open hummock grassland</p> <p>This unit occurred in a broad drainage line at the north-eastern edge of the study area. A single population of approximately 100 plants of the Priority 3 species <i>Indigofera</i> sp. Bungaroo Creek (S. van Leeuwen 4301) was recorded from this vegetation type.</p>	
Stony Plains		
P3 (described by Biota 2006)	<p><i>Eucalyptus leucophloia</i> scattered low trees over <i>Acacia aneura</i> (various forms), <i>Acacia ayersiana</i> tall open shrubland over <i>Triodia epactia</i>, <i>T. wiseana</i> hummock grassland</p> <p>This unit was mapped by Biota (2006) as occurring in patches over the broad stony plain to the north of the BS4 range.</p>	

Vegetation Code	Vegetation Unit Description	Indicative Photographs
AanAkAexTwTe	<p>Acacia aneura open woodland over A. kempeana, A. exilis open shrubland over Triodia wiseana, T. epactia very open hummock grassland</p> <p>This open Mulga vegetation was similar to unit P3, but differed in the presence of Acacia kempeana in the understorey.</p>	
CdAkAaTwTe	<p>Corymbia deserticola scattered low trees over Acacia kempeana, A. ancistrocarpa open shrubland over Triodia wiseana, T. epactia very open hummock grassland</p> <p>This unit, along with the two following units, occurred over the broad stony plains; the units differed in the proportions of the dominant eucalypt, wattle and spinifex species. Unit P6 described by Biota (2006) would broadly encompass all three units, although Acacia kempeana was found to be more common in the Brockman Camps study area than A. atkinsiana, which was characteristic of unit P6 as described by Biota (2006).</p>	

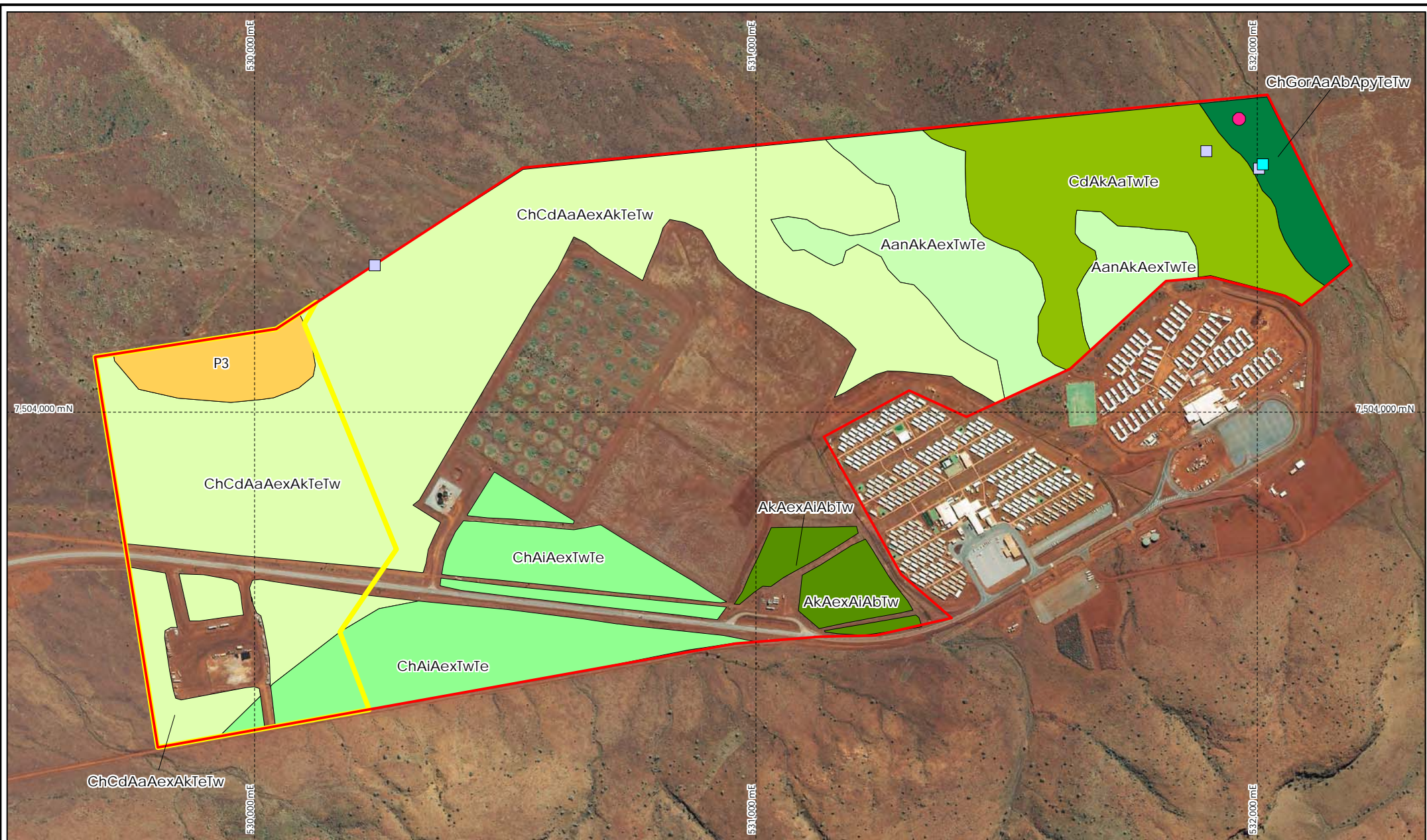


Vegetation Code	Vegetation Unit Description	Indicative Photographs
ChCdAaAexAkTeTw	<p><i>Corymbia hamersleyana</i>, <i>C. deserticola</i> scattered low trees over <i>Acacia ancistrocarpa</i>, <i>A. exilis</i>, <i>A. kempeana</i> open shrubland over <i>Triodia epactia</i>, <i>T. wiseana</i> open hummock grassland</p>	
AkAexAiAbTw	<p><i>Acacia kempeana</i>, <i>A. exilis</i>, <i>A. inaequilatera</i>, <i>A. bivenosa</i> tall open shrubland over <i>Triodia wiseana</i> hummock grassland</p>	

Vegetation Code	Vegetation Unit Description	Indicative Photographs
Low Stony Rises		
ChAiAexTwTe	<p><i>Corymbia hamersleyana</i> scattered low trees over <i>Acacia inaequilatera</i> tall open shrubland over <i>A. exilis</i> scattered shrubs over <i>Triodia wiseana</i>, <i>T. epactia</i> open hummock grassland</p> <p>This unit extended over the lower slopes of a hill in the southwestern section of the study area.</p>	



## Attachment 2: Vegetation Map and Legend



- Study Area
- Area Previously Surveyed

**Vegetation Types**

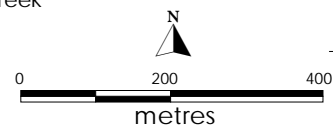
- |   |  |
|---|--|
| <span style="display: inline-block; width: 15px; height: 10px; background-color: #d9ead3; border: 1px solid black; margin-right: 5px;"></span> AanAkAexTwTe | <span style="display: inline-block; width: 15px; height: 10px; background-color: #d9ead3; border: 1px solid black; margin-right: 5px;"></span> ChCdAaAexAKTeTw                         |
| <span style="display: inline-block; width: 15px; height: 10px; background-color: #55a868; border: 1px solid black; margin-right: 5px;"></span> AkAexAiAbTw  | <span style="display: inline-block; width: 15px; height: 10px; background-color: #2e8b57; border: 1px solid black; margin-right: 5px;"></span> ChGorAaAbApyTeTw                        |
| <span style="display: inline-block; width: 15px; height: 10px; background-color: #70ad47; border: 1px solid black; margin-right: 5px;"></span> CdAkAaTwTe   | <span style="display: inline-block; width: 15px; height: 10px; background-color: #f4b084; border: 1px solid black; margin-right: 5px;"></span> P3 (Brockman Syncline 4 Project - 2006) |
| <span style="display: inline-block; width: 15px; height: 10px; background-color: #90ee90; border: 1px solid black; margin-right: 5px;"></span> ChAiAexTwTe  |  |

**Priority Species**

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

**Introduced Species**





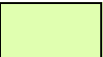

- Cenchrus ciliaris*
- Flaveria trinervia*




**Brockman Camps  
Vegetation Map**



## Vegetation of Brockman Camp

	<b>AanAkAexTwTe</b>	<i>Acacia aneura</i> open woodland over <i>Acacia kempeana</i> , <i>Acacia exilis</i> open shrubland over <i>Triodia wiseana</i> , <i>Triodia epactia</i> very open hummock grassland
	<b>AkAexAiAbTw</b>	<i>Acacia kempeana</i> , <i>Acacia exilis</i> , <i>Acacia inaequilatera</i> , <i>Acacia bivenosa</i> tall open shrubland over <i>Triodia wiseana</i> hummock grassland
	<b>CdAkAaTwTe</b>	<i>Corymbia deserticola</i> scattered low trees over <i>Acacia kempeana</i> , <i>Acacia ancistrocarpa</i> open shrubland over <i>Triodia wiseana</i> , <i>Triodia epactia</i> very open hummock grassland
	<b>ChAiAexTwTe</b>	<i>Corymbia hamersleyana</i> scattered low trees over <i>Acacia inaequilatera</i> tall open shrubland over <i>Acacia exilis</i> scattered shrubs over <i>Triodia wiseana</i> , <i>Triodia epactia</i> open hummock grassland
	<b>ChCdAaAexAkTeTw</b>	<i>Corymbia hamersleyana</i> , <i>Corymbia deserticola</i> scattered low trees over <i>Acacia ancistrocarpa</i> , <i>Acacia exilis</i> , <i>Acacia kempeana</i> open shrubland over <i>Triodia epactia</i> , <i>Triodia wiseana</i> open hummock grassland
	<b>ChGOrAaAbApyTeTw</b>	<i>Corymbia hamersleyana</i> scattered low trees over <i>Gossypium robinsonii</i> scattered tall shrubs over <i>Acacia ancistrocarpa</i> , <i>Acacia bivenosa</i> , <i>Acacia pyrifolia</i> var <i>pyrifolia</i> open shrubland over <i>Triodia epactia</i> , <i>Triodia wiseana</i> very open hummock grassland

## Vegetation from Previous Survey

	<b>P3</b>	<i>Eucalyptus leucophloia</i> scattered low trees over <i>Acacia aneura</i> (various forms), <i>Acacia ayersiana</i> tall open shrubland over <i>Triodia epactia</i> , <i>Triodia wiseana</i> hummock grassland
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## Attachment 3: Locations of Priority and Introduced Plant Species

Species	Easting	Northing	Site	No of individuals
Priority 3 Plant Species				
<i>Indigofera</i> sp. Bungaroo Creek (S. van Leeuwen 4301)	531963	7504585	BCK02	Approx. 100
Introduced Species				
<i>Cenchrus ciliaris</i>	532003	7504486	BCK02	11
	530240	7504293	BCK05	1
	531898	7504521	BCK-RSVA	2
<i>Flaveria trinervia</i>	532011	7504495	BCK02	1

## Attachment 4: List of Species Recorded from the Study Area

NB: An asterisk (\*) prior to a species name denotes an introduced taxon (weed)

The genus *Cassia* has been retained in preference to *Senna* for this study, however equivalent names under the two genera are provided in the list below.

## Amaranthaceae

*Amaranthus cuspidifolius*  
*Gomphrena canescens* subsp. *canescens*  
*Gomphrena cunninghamii*  
*Ptilotus astrolasius*  
*Ptilotus calostachyus*  
*Ptilotus fusiformis*  
*Ptilotus helipteroides*  
*Ptilotus nobilis* subsp. *nobilis*  
*Ptilotus obovatus*  
*Ptilotus rotundifolius*

## Apocynaceae

*Cynanchum floribundum*  
*Rhyncharrhena linearis*

## Araliaceae

*Trachymene oleracea* subsp. *oleracea*

## Asteraceae

\**Flaveria trinervia* (Speedy Weed)  
*Peripleura obovata*  
*Pterocaulon sphacelatum*  
*Streptoglossa bubakii*  
*Streptoglossa decurrens*

## Boraginaceae

*Trichodesma zeylanicum* var. *zeylanicum*

## Caryophyllaceae

*Polycarpaea corymbosa* var. *corymbosa*  
*Polycarpaea holtzei*  
*Polycarpaea longiflora*

## Chenopodiaceae

*Dysphania rhadinostachya* (sterile; subsp. not determined)  
*Dysphania rhadinostachya* subsp. *rhadinostachya*  
*Maireana villosa*  
*Salsola australis*

## Cleomaceae

*Cleome viscosa*

## Convolvulaceae

*Bonamia rosea*  
*Duperreya commixta*  
*Evolvulus alsinoides* var. *villosicalyx*

## Cucurbitaceae

*Cucumis variabilis*

## Cyperaceae

*Bulbostylis barbata*  
*Fimbristylis simulans*



## Euphorbiaceae

*Euphorbia australis* (mid-green form)  
*Euphorbia* aff. *australis* var. 1 (MET 12 337)  
*Euphorbia biconvexa*  
*Euphorbia biconvexa/alsiniflora* (sterile; inadequate material for further determination)  
*Euphorbia* sp. (PAN5-15)

## Fabaceae

*Acacia ancistrocarpa*  
*Acacia aneura* (species complex; pending further identification)  
*Acacia atkinsiana*  
*Acacia ayersiana*  
*Acacia bivenosa*  
*Acacia cowleana*  
*Acacia elachantha*  
*Acacia eriopoda*  
*Acacia exilis*  
*Acacia inaequilatera*  
*Acacia kempeana*  
*Acacia monticola*  
*Acacia pruinocarpa*  
*Acacia pyrifolia* var. *pyrifolia*  
*Acacia sibirica*  
*Acacia sibirica* (crowded smaller phyllodes)  
*Cassia 'glaucifolia'* (= *Senna glaucifolia*)  
*Cassia ferraria* (= *Senna ferraria*)  
*Cassia glutinosa* (= *Senna glutinosa* subsp. *glutinosa*)  
*Cassia glutinosa* x '*stricta*' (= *Senna glutinosa* subsp. *glutinosa* x *Senna stricta*)  
*Cassia helmsii* (= *Senna artemisioides* subsp. *helmsii*)  
*Cassia helmsii* x (= *Senna artemisioides* subsp. *helmsii* hybrid)  
*Cassia luerssenii* (= *Senna glutinosa* subsp. x *luerssenii*)  
*Cassia luerssenii* x '*stricta*' (= *Senna glutinosa* subsp. x *luerssenii* x *Senna stricta*)  
*Cassia notabilis* (= *Senna notabilis*)  
*Cassia oligophylla* (= *Senna artemisioides* subsp. *oligophylla*)  
*Cassia oligophylla* x *helmsii* (= *Senna artemisioides* subsp. *oligophylla* x subsp. *helmsii*)  
*Cassia* aff. *oligophylla* (thinly sericeous) (a taxon with affinities to *Senna artemisioides* subsp. *oligophylla*, but with a thin appressed indumentum on the leaflets)  
*Cassia pruinosa* (= *Senna glutinosa* subsp. *pruinosa*)  
*Crotalaria medicaginea* var. *neglecta*  
*Gompholobium oreophilum*  
*Indigofera monophylla*  
*Indigofera* sp. Bungaroo Creek (S. van Leeuwen 4301) (Priority 3)  
*Rhynchosia minima*  
*Tephrosia rosea* var. *glabrior*

## Goodeniaceae

*Dampiera candicans*  
*Goodenia forrestii*  
*Goodenia microptera*  
*Goodenia stobbsiana*  
*Scaevola spinescens*

## Gyrostemonaceae

*Codonocarpus cotinifolius*

Lamiaceae	<i>Clerodendrum floribundum</i> var. <i>angustifolium</i>
Malvaceae	<i>Abutilon dioicum</i> <i>Abutilon otocarpum</i> <i>Abutilon trudgenii</i> <i>Corchorus crozophorifolius</i> <i>Corchorus lasiocarpus</i> subsp. <i>parvus</i> <i>Gossypium australe</i> (Burrup Peninsula form) <i>Gossypium australe</i> (Whim Creek form) <i>Gossypium robinsonii</i> <i>Hibiscus burtonii</i> <i>Hibiscus coatesii</i> <i>Hibiscus goldsworthii</i> <i>Hibiscus sturtii</i> var. <i>campylochlamys</i> <i>Hibiscus sturtii</i> var. <i>platychlamys</i> <i>Keraudrenia nephrosperma</i> <i>Melhania oblongifolia</i> <i>Sida arenicola</i> <i>Sida arsiniata</i> <i>Sida cardiophylla</i> <i>Sida</i> aff. <i>echinocarpa</i> (MET 15,350) <i>Sida</i> sp. spiciform panicles (E. Leyland s.n. 14/8/1990)
Molluginaceae	<i>Mollugo molluginea</i>
Myrtaceae	<i>Corymbia deserticola</i> subsp. <i>deserticola</i> <i>Corymbia hamersleyana</i> <i>Eucalyptus gamophylla</i> <i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i>
Oleaceae	<i>Jasminum didymum</i> subsp. <i>lineare</i>
Phyllanthaceae	<i>Phyllanthus maderaspatensis</i>
Plantaginaceae	<i>Stemodia grossa</i>
Poaceae	<i>Amphipogon</i> sp. (sterile; inadequate material for further determination) <i>Aristida contorta</i> <i>Aristida holathera</i> var. <i>holathera</i> * <i>Cenchrus ciliaris</i> (Buffel Grass) <i>Cymbopogon ambiguus</i> <i>Cymbopogon obtectus</i> <i>Digitaria brownii</i> <i>Enneapogon caeruleus</i> <i>Enneapogon lindleyanus</i> <i>Enneapogon polyphyllus</i> <i>Eriachne aristidea</i> <i>Eriachne mucronata</i> (typical form) <i>Eriachne pulchella</i> <i>Eriachne tenuiculmis</i> <i>Eulalia aurea</i> <i>Panicum effusum</i> <i>Paraneurachne muelleri</i> <i>Paspalidium clementii</i> <i>Schizachyrium fragile</i>

## Poaceae (continued)

*Themeda triandra*  
*Triodia epactia*  
*Triodia wiseana*  
*Triraphis mollis*  
*Yakirra australiensis* var. *australiensis*

## Proteaceae

*Hakea lorea* subsp. *lorea*

## Rubiaceae

*Psydrax suaveolens*

## Scrophulariaceae

*Eremophila forrestii* subsp. *forrestii*  
*Eremophila longifolia*

## Solanaceae

*Solanum diversiflorum*  
*Solanum horridum*  
*Solanum lasiophyllum*  
*Solanum sturtianum*

## Violaceae

*Hybanthus aurantiacus*

## Zygophyllaceae

*Tribulus suberosus*