FLORA AND VEGETATION

OF BARRAMBIE SURVEY AREA, BORE FIELDS

AND WATER PIPELINE CORRIDOR

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and
Reed Resources Ltd

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1. SUMMARY

Mattiske Consulting Pty Ltd was commissioned by Aquaterra, on behalf of Reed Resources Limited, to define the flora and vegetation values of a water pipeline corridor, the Bore Fields area and undertake additional flora and vegetation surveys of proposed infrastructure facilities at the Barrambie tenement. Six botanists completed the survey during four trips, between 8th - 12th October 2007, 24th – 26th July 2008, 6th – 8th April and 31st August – 2nd September 2009.

Flora

A total of 33 families, 76 genera, 172 species and 192 taxa have been recorded within the survey area (Appendix B). Species representation was greatest amongst the Chenopodiaceae (38 taxa), Myoporaceae (24 taxa), Asteraceae (24 taxa) and Mimosaceae (21 taxa) families.

Forty-two of the 193 recorded taxa are considered annual or biennial species (Appendix B). Of these Forty-two species, twenty five were recorded in September 2009.

Five of these taxa were introduced (weed) species, however none are declared pursuant to Section 37 of the *Agriculture and Related Resources Act, 1976* (WA).

Rare, Priority and Threatened Flora

No Declared Rare Flora species, pursuant to the *Wildlife Conservation Act, 1950* or listed by the Department of Environment and Conservation were located during the survey. No Priority species were recorded during the survey.

Vegetation

Twenty Four plant communities were defined within the survey area covering the mining operations and the water pipeline (Figure 1). The communities differed in their structure, dominance and range of associated species and geographic factors.

No Threatened Ecological Communities (TEC's) as defined by the EPBC Act (1999) or the Department of Environment and Conservation (2009c) were observed in the survey area

No Priority Ecological Communities (PEC's) as defined by the Department of Environment and Conservation (2009b) were observed in the survey area.

None of the Vegetation Communities recorded are considered locally or regionally significant.

The plant communities varied in condition from Good-Degraded in areas that have been subject to grazing and where current infrastructure is in place, to Excellent in less disturbed areas of native vegetation.

Groundwater Dependent Ecosystems

A few of defined communities; A12, M1, M2 and E1 have been identified as potentially being impacted by the placement of the bore field. These communities contain a range of tree and tall shrub species that may be dependent on groundwater; such as *Acacia aneura*, *Melaleuca stereophloia*, *Melaleuca xerophila* and *Eucalyptus victrix*. These communities occur on the waterways and floodplains that are infrequently subjected to recent rainfall events. In other periods the communities are subjected to periods of extended below average rainfall levels and consequently the list above is considered to be a conservative list of potential communities that may be influenced by water extraction. As the floodplain is dominated by clay and clay loams soils the potential impacts of the ground water may be minimized as the communities may be more dependent on the rainfall events as compared to the groundwater levels. Therefore water extraction impacts should have limited impacts. Nevertheless monitoring is recommended as a conservative approach to monitoring trends in the area.

2. INTRODUCTION

Mattiske Consulting Pty Ltd was commissioned by Aquaterra, on behalf of Reed Resources Limited, to define the flora and vegetation values of a water pipeline corridor and undertake additional flora and vegetation surveys of proposed infrastructure facilities at the Barrambie tenement. Six botanists completed the survey during four trips, between 8th - 12th October 2007, 24th – 26th July 2008, 6th – 8th April and 31st August – 2nd September 2009.

2.1 Location

The tenement area is located at Barrambie, approximately 75kms north of Sandstone in the Murchison region of Western Australia in the Austin Botanical District of the Eremaean Province, as defined by Beard (1990).

2.2 Flora and Vegetation

The Eremaean Botanical Province is typified by plants from the families Mimosaceae (*Acacia* spp.), Myrtaceae (*Eucalyptus* spp.), Myoporaceae (*Eremophila* spp.), Chenopodiaceae (Samphires, Bluebushes, Saltbushes), Asteraceae (Daisies) and Poaceae (grasses).

Arid shrublands make up the vast majority of vegetation types encountered in the Murchison region. Most landscapes are dominated by mixed shrubland/scrubland, with few or no trees or perennial grasses, with shrubs apparently randomly scattered or loosely aggregated, and with large amounts of bare ground and shallow red soils exposed between the shrubs (Curry *et al.* 1994).

The region is well known for the dominance of the Mulga (*Acacia aneura*) woodlands (Beard 1976, 1990). Optimum conditions for the Mulga occur on the extensive flats and plains. The communities defined by Beard (1976) have recently been updated and refined by Hopkins *et al.* (2001). The dominant vegetation types as defined by Hopkins *et al.* (2001) within the Murchison area are the mulga woodlands.

The Austin Botanical District is essentially Mulga (*Acacia aneura*) woodlands associated with red loams over siliceous hardpans on the plains (van Vreeswyk, 1994) reducing to scrub on the rises and hills (Beard, 1990). Mulga and *Eremophila* shrublands dominate on stony plains, whilst chenopod communities are more often associated with duplex soils (Pringle, 1994).

2.3 Groundwater Dependant Ecosystems

Groundwater Dependent Ecosystems (GDEs) are ecosystems that depend on groundwater, which include:

- Aquifer and cave ecosystems where stygofauna reside;
- Ecosystems dependent on the surface expression of groundwater (such as baseflow rivers and streams, wetlands and some floodplains); and
- Ecosystems dependent on the subsurface presence of groundwater (Eamus *et al.* 2006).

Within a GDE, water use is likely to vary according to vegetation structure (ie tree water use versus shrub water use). The dependence of an ecosystem on groundwater may also be variable: infrequently utilised such as during plant establishment or in periods of drought; or continual dependence but facultative (ie species will utilise groundwater if present, but are not groundwater dependent for survival) (Eamus *et al.* 2006).

Key indicator species, such as *Melaleuca argentea* in the Daly River catchment in the Northern Territory (O'Grady *et al*. 2006) or *Banksia* sp. on the Swan Coastal Plain (Eamus *et al.* 2006), can be used to identify GDEs. However it has been shown that groundwater use varies according to the position in the landscape and trees at lower elevations closer to rivers are highly dependent compared to opportunistic groundwater use by trees at higher elevations (O'Grady *et al*. 2006).

The groundwater dependence of ecosystems is rated according to the depth to the water table:

0 – 10 m	Groundwater dependent
>10 m	Reduced dependence on groundwater
10 – 20 m	Possible groundwater dependence, although negligible
> 20 m	Groundwater dependence low (Eamus *et al.* 2006).

Due to the variability of groundwater use as mentioned above, the response of a GDE to groundwater drawdown will not be uniform. Hence determining the ecological water requirements (EWRs) and the subsequent statutory ecological water provisions (EWPs) according to the *Environmental Protection Act 1986* [WA] and the *Rights in Water and Irrigation Act 1914* [WA], necessary for the maintenance of the structure and function of GDEs is complex (Water and Rivers Commission 2000; Sinclair Knight Merz Pty Ltd 2001; Eamus and Froend 2006; Eamus *et al.* 2006).

Monitoring ecosystems over long-term periods are necessary to determine the impacts of lowering groundwater availability, prior to and during pumping. Monitoring can indicate if GDEs are more resilient than predicted or determine if the ecosystem condition falls below acceptable levels, and then EWPs can be adjusted where required. However, ecosystems may respond proportionally or show a threshold response to declining water availability. Often ecosystems do not respond immediately and the "lag" effects on ecosystem health may result in exponentially declining condition. Changes in understorey species and an increase in introduced (exotic) species may indicate disturbances in the short-term within GDEs. Whilst overstorey species tend to be more resilient to changes in groundwater levels and are good long-term indicators of GDEs.

To assess the impacts of altered groundwater levels as a result of EWPs set in Water Allocation Plans; monitoring should include an assessment of:

- species diversity;
- species cover and abundance;
- "weediness";
- density of indicator species;
- community distribution (change in aerial extent);
- canopy health;
- water quality; and
- soil moisture (Eamus *et al*. 2006; Loomes *et al*. 2006; Water and Rivers Commission 2000).

2.4 Climate

The Murchison region is characterised by an arid climate with cool winters and hot, dry summers. Rain falls in both the warm and cool seasons (Beard, 1990). Sandstone, located approximately 75kms to the south of Barrambie, has a mean annual precipitation of 247.9mm. Mean summer maximum temperatures are 35.5^{o}C dropping to 18.4^{o}C in winter. Mean minima are 20.7^{o}C and 5.9^{o}C for summer and winter, respectively (BOM, 2009).

2.5 Clearing of Native Vegetation

The *Environmental Protection (Clearing of Native Vegetation) Regulations* 2004 dictate that any clearing of native vegetation in Western Australia requires a permit to do so from the Department of Environment and Conservation. Native vegetation includes aquatic and terrestrial vegetation indigenous to Western Australia, and intentionally planted vegetation declared by regulation to be native vegetation, but not vegetation planted in a plantation or planted with commercial intent (*Environmental Protection Act, 1986*). The *Environmental Protection Act 1986* Section 51A, defines clearing as: "the killing or destruction of; the removal of; the severing or ringbarking of trunks or stems of; or the doing of substantial damage to some or all of the native vegetation in an area, including the

flooding of land, the burning of vegetation, the grazing of stock or an act or activity that results in the above"

Under the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004 - Regulation 6 – Environmentally sensitive areas* are "the area covered by vegetation within 50 m of Rare Flora, to the extent to which the vegetation is continuous with the vegetation in which the Rare Flora is located". Ministerial approval must be granted prior to any clearing of Declared Rare Flora, including a minimum of 50 m surrounding all populations of Rare Flora. The area covered by a threatened ecological community is also considered an environmentally sensitive area and therefore non-permitted, unless Ministerial approval is granted.

2.6 Rare and Priority Flora

Species of flora and fauna are defined as Rare or Priority conservation status where their populations are restricted geographically or threatened by local processes. The Department of Environment and Conservation recognises these threats of extinction and consequently applies regulations towards population and species protection.

Rare Flora species are gazetted under subsection 2 of section 23F of the *Wildlife Conservation Act 1950* [WA] and therefore it is an offence to "take" or damage rare flora without Ministerial approval. Section 23F of the *Wildlife Conservation Act 1950* [WA] defines "to take" as "… to gather, pick, cut, pull up, destroy, dig up, remove or injure the flora to cause or permit the same to be done by any means."

Priority Flora are under consideration for declaration as 'Rare Flora', but are in urgent need of further survey (Priority One to Three) or require monitoring every 5-10 years (Priority Four). Appendix A1 presents the definitions of Declared Rare and the four Priority ratings under the *Wildlife Conservation Act 1950* [WA], defined by the Department of Environment and Conservation (2009a).

The *Environment Protection and Biodiversity Conservation Act 1999* [Commonwealth] lists Threatened Flora species which are considered of national environmental significance (Department of Environment, Water, Heritage and the Arts 2009a). A person must not take an action that has, will have, or is likely to have a significant impact on a listed threatened species or an ecological community, without approval from the Commonwealth Minister for the Environment, Water, Heritage and the Arts. Appendix A2 presents the definitions of the categories of Threatened Flora Species, defined by the *Environment Protection and Biodiversity Conservation Act 1999* [Commonwealth].

2.7 Threatened Ecological Communities

Communities in Western Australia can be listed as 'Threatened Ecological Communities' (TEC's) (Department of Environment and Conservation 2009c) once they have been defined by the Western Australian Threatened Ecological Communities Scientific Advisory Committee. TEC's are listed under four categories; Presumed Totally Destroyed (PD), Critically Endangered (CR), Endangered (EN) or Vulnerable (VU) (Department of Environment and Conservation 2009d). Appendix A3 presents a summary of the definitions of Threatened Ecological Communities as extracted from the Department of Environment and Conservation (2009d). Some Western Australian TEC's are also listed under the *Environment Protection and Biodiversity Conservation Act 1999* [Commonwealth] (Department of the Environment, Water, Heritage and the Arts 2009b).

Possible Threatened Ecological Communities can be listed as Priority Ecological Communities (PEC's) by the Department of Environment and Conservation (2009e). PEC's are listed under five categories based on survey criteria and current knowledge, Priority 1, 2, 3, 4 and 5 Department of Environment and Conservation (2009b). Appendix A4 presents a summary of the definitions of Priority Ecological Communities as extracted from the Department of Environment and Conservation (2009d).

2.8 Local and Regional Significance

Flora or vegetation may be locally or regionally significant in addition to statutory listings by the State or Federal Government.

In regards to flora; species, subspecies, varieties, hybrids and ecotypes may be significant other than as Declared Rare Flora or Priority Flora, for a variety of reasons, including:

". a keystone role in a particular habitat for threatened species, or supporting large populations representing a significant proportion of the local regional population of a species;
. relic status;
. anomalous features that indicate a potential new discovery;
. being representative of the range of a species (particularly, at the extremes of range, recently discovered range extensions, or isolated outliers of the main range);
. the presence of restricted subspecies, varieties, or naturally occurring hybrids;
. local endemism/a restricted distribution;
. being poorly reserved" (Environmental Protection Authority 2004).

The Environmental Protection Authority (2004) in Guidance Statement 51 states that Vegetation may be significant because the extent is below a threshold level and a range of other reasons, including:

". scarcity;
. unusual species;
. novel combinations of species;
. a role as a refuge;
. a role as a key habitat for threatened species or large populations representing a significant proportion of the local to regional total population of a species;
. being representative of the range of a unit (particularly, a good local and/or regional example of a unit in "prime" habitat, at the extremes of range, recently discovered range extensions, or isolated outliers of the main range);
. a restricted distribution" (Environmental Protection Authority 2004).

Vegetation communities are locally significant if they contain Priority Flora species or contain a range extension of a particular taxon outside of the normal distribution. They may also be locally significant if they are very restricted to one or two locations or occur as small isolated communities. In addition, vegetation communities that exhibit unusually high structural and species diversity are also locally significant.

Vegetation communities are regionally significant where they are limited to specific landform types, are uncommon or restricted plant community types within the regional context, or support populations of Declared Rare Flora.

Determining the significance of flora and vegetation may be applied at various scales, for example, a vegetation community may be nationally significant and governed by statutory protection as well as being locally and regionally significant.

3. OBJECTIVES

The general objective was to define the flora and vegetation values of the following areas:

- Water pipeline from Barrambie north along Meekatharra – Sandstone Road to Limestone Well (approximately 25kms)
- Barrambie mining and infrastructure areas (as additional work from survey in 2005)
- Identify ground water dependant vegetation communities likely to be affected by de-watering within the bore fields area

The specific objectives were to:

- review the literature for the area.
- search the survey area for rare and priority flora.
- collect and identify all vascular plant species within the survey area.
- define the vegetation values in the survey area.
- review the significance of the values as defined on the survey area.
- define any management issues related to flora and vegetation values

4. METHODS

The assessment of the flora and vegetation of the proposed corridor and Bore Fields was undertaken by six botanists completed the survey during four trips, between 8th – 12th October 2007, 24th – 26th July 2008, 6th – 8th April and 31st August – 2nd September 2009. Prior to undertaking survey work, a desktop search for Rare and Priority flora that may occur within the proposed impact was undertaken. Aerial photographs of the project area were supplied by Reed Resources Limited. Sampling sites were selected to sample representative vegetation types within the project area.

The flora and vegetation was described and sampled systematically at each survey site (50x50m, Appendix D) in accordance with Environmental Protection Authority (2004) Guidance Statement 51. Opportunistic collecting was undertaken wherever previously unrecorded plants were observed. At each site the following floristic and environmental parameters were noted:

- GPS location,
- Topography,
- Percentage litter cover,
- Soil type and colour,
- Percentage of bare ground,
- Outcropping rocks and their type,
- Gravel type and size,
- Time since fire, and
- Percentage cover and average height of each vegetation stratum.

For each vascular plant species, the average height and percent cover (both live and dead material) were recorded.

All plant specimens collected during the field surveys were dried and fumigated in accordance with the requirements of the Western Australian Herbarium. The plant species were identified through comparisons with pressed specimens housed at the Western Australian Herbarium. Where appropriate, plant taxonomists with specialist skills were consulted. Nomenclature of the species recorded is in accordance with the Department of Environment and Conservation (2009a; 2009b).

5. RESULTS

5.1 Desktop Survey for Potential Rare and Priority Flora Species in the Survey Area

The results of a desktop search for rare and priority flora, which may occur within the survey area, are listed in Table 1 (DEC, 2009a).

Table 1: Rare or Priority Flora with potential to occur in Survey Area

Species	Family	Conservation Status
Acacia burrowsiana (ms)	Mimosaceae	P1
Anacampseros sp. Eremaean	Portulacaceae	P1
Baeckea sp. Sandstone	Myrtaceae	P1
Dampiera plumosa	Goodeniaceae	P1
Euryomyrtus inflata	Myrtaceae	P1
Labichea eremaea	Caesalpiniaceae	P1
Pityrodia canaliculata	Lamiaceae	P1
Ptilotus procumbens	Amaranthaceae	P1
Beyeria lapidicola	Euphorbiaceae	P2
Baeckea sp. London Bridge	Myrtaceae	P3
Calytrix erosipetala	Myrtaceae	P3
Calytrix uncinata	Myrtaceae	P3
Drummondita miniata	Rutaceae	P3
Eremophila arachnoides subsp. *arachnoides*	Myoporaceae	P3
Euryomyrtus patrickiae	Myrtaceae	P3
Homalocalyx echinulatus	Myrtaceae	P3
Mirbelia stipitata	Papilionaceae	P3
Philotheca coateana	Rutaceae	P3
Acacia balsamea	Mimosaceae	P4
Baeckea sp. Melita Station	Myrtaceae	P4
Grevillea inconspicua	Proteaceae	P4

5.2 Flora

A total of 33 families, 76 genera, 172 species and 192 taxa were recorded within the survey area (Appendix B). Species representation was greatest amongst the Chenopodiaceae (38 taxa), Myoporaceae (24 taxa), Asteraceae (24 taxa) and Mimosaceae (21 taxa) families.

No Declared Rare Flora species, pursuant to subsection (2) of section 23F of the *Wildlife Conservation Act, 1950* (WA) and as listed by the Department of Environment and Conservation (2009a, 2009d) were located during the survey.

No plant taxa pursuant to section 179 of the *Environment Protection Biodiversity Conservation Act, 1999* (Commonwealth) were located within the survey area.

No Priority flora species as defined by the Department of Environment and Conservation (2009a, 2009d) were located within the survey area.

The species *Tecticornia fimbriata*, initially recorded in 2007 as *Halosarcia fimbriata*, has been revised since the previous report due to taxonomic revision. It has been listed in this report as *Tecticornia indica*.

Five introduced (weed) species were recorded within the survey area:

- **Centaurium erythraea* was recorded within an area disturbed by cattle grazing;
- **Erodium aureum* was recorded within a disturbed area,
- **Malva parviflora* was recorded within a disturbed area,
- **Malvastrum americanum* was recorded from a drainage water hole,
- **Rostraria pumila* was recorded within a disturbed area.

None of these weeds are defined as Declared Weeds pursuant to Section 37 of the *Agriculture and Related Resources Act, 1976* (WA).

Forty-two of the 193 recorded taxa are considered annual or biennial species (Appendix B). Of these Forty-two species, twenty five were recorded in September 2009.

Twenty Four plant communities were defined within the survey area. The communities differed in their structure, dominance and range of associated species and geographic factors.

Acacia Woodland – Shrublands

A1 – Low Woodland of *Acacia aneura* var *aneura* with occasional *Eucalyptus lucasii, Psydrax latifolia* and *Acacia ramulosa* var. *linophylla* on lower slopes and adjacent to drainage lines.

A2 – Low Woodland of *Acacia aneura* var *aneura*, *Acacia ayersiana* and *Acacia aneura* var. *microcarpa* over *Eremophila forrestii*, *Eremophila latrobei* subsp. *latrobei*, *Acacia ramulosa* var. *linophylla* and *Ptilotus obovatus* on slopes and flats.

A3 – Low Open Woodland of *Acacia aneura* var. *microcarpa*, *Acacia aneura* var. *aneura*, *Hakea preissii* and *Acacia tetragonophylla* over *Senna artemisioides* subsp. x *sturtii*, *Sclerolaena eriacantha*, *Eremophila galeata* and *Maireana triptera* on lower slopes and well drained plains.

A4 – Low Open Woodland to Tall Shrubland of *Acacia burkittii*, *Acacia ramulosa* var. *linophylla*, *Acacia craspedocarpa* over *Ptilotus obovatus*, *Maireana pyramidata*, *Maireana triptera*, *Maireana glomerifolia*, *Senna artemisioides* subsp. *filifolia* and *Senna artemisioides* subsp. x *sturtii* on drainage channels.

A5 – Low Open Woodland to Tall Shrubland of *Acacia aneura* var. *microcarpa*, *Acacia aneura* var. *aneura* and *Acacia ayersiana* over *Acacia ramulosa* var. *linophylla* over *Eremophila forrestii* with occasional emergent *Acacia pruinocarpa* on orange sandy loams with a dense covering of ironstone pebbles on flats and slopes.

A8 – Tall Shrubland to Tall Open Shrubland of *Acacia aneura var. intermedia*, *Acacia aneura* var. *microcarpa* with *Acacia ayersiana* over *Acacia ramulosa* var. *linophylla* over *Eremophila forrestii* and *Eremophila spectabilis* subsp. *spectabilis* on flat, red, sandy-loam soils with a covering of coarse grain sand.

A9 – Tall Shrubland of *Acacia aneura* var. *intermedia* with *Acacia pruinocarpa*, *Acacia aneura* var. *microcarpa*, *Acacia craspedocarpa* and *Acacia tetragonophylla* over mixed low shrubs on flat, red sandy loam with a covering of coarse grain sand.

A10 – Tall Shrubland of *Acacia aneura* var. *microcarpa*, *Acacia aneura* var. *intermedia, Acacia craspedocarpa*, *Acacia tetragonophylla*, *Acacia ayersiana* and *Grevillea striata* over a dense covering of *Eragrostis* ?*pergracilis* on sandy-clay soils.

A11 – Tall Open Shrubland of *Acacia aneura* var. *microcarpa* with *Acacia tetragonophylla* and mixed *Acacia* spp. over *Ptilotus obovatus* and mixed low open shrubs and Chenopods on orange sandy loams with a dense covering of quartz rock on flats.

A12- Tall Shrubland of *Acacia tetragonophylla, Acacia aneura* var. *aneura* and *Hakea preissii* over *Rhagodia eremaea, Atriplex vesicaria* and other Chenopods on orange sand.

Shrublands

S1 – Open Scrub of *Hakea preissii* over *Maireana pyramidata, Senna artemisioides* subsp. x *sturtii* and *Sclerolaena cuneata* on sheet wash areas.

S2 – Tall Shrubland of *Hakea preissii* with *Acacia tetragonophylla* over mixed low shrubs over *Ptilotus obovatus, Maireana triptera* and *Eragrostis eriopoda* with occasional emergent *Pittosporum angustifolium* and *Eremophila longifolia* on red sandy-clay soils in depressions.

S3 – Open Shrubland of *Eremophila galeata* with *Acacia tetragonophylla* and *Senna artemisioides* subsp. *helmsii* over *Salsola tragus*, *Maireana triptera* and mixed low shrubs on flat red clay soils with a thick cover ironstone pebbles.

S4 – Open Shrubland of *Eremophila youngii* subsp. *youngii* with mixed low open shrubs and Chenopods with occasional emergent *Acacia aneura* var. *aneura* on low hills.

S5- Scrub of *Acacia sclerosperma* subsp. *sclerosperma* and *Acacia burkittii* with other mixed Acacias over Chenopods on calcrete.

Melaleuca Shrublands

M1- Scrub of *Melaleuca xerophila* over Chenopods on Clay.

M2- Open scrub of *Melaleuca stereophloia* over *Maireana tomentosa* subsp. *tomentosa* with *Scaevola spinescens* on red clay loam with coarse sand.

Chenopod Shrublands

C1 – Chenopod Shrubland of *Maireana triptera*, *Maireana pyramidata* and *Sclerolaena cuneata* with mixed low shrubs and Chenopods with occasional emergent *Hakea preissii* on flat red clays with patches of ironstone covering.

C2 – Chenopod Shrubland of *Tecticornia* spp. and *Maireana pyramidata* with mixed low shrubs and Chenopods on flat orange clays with a thick cover of quartz and ironstone.

C3 – Chenopod Shrubland of *Tecticornia indica subsp. bidens, Maireana glomerifolia, Sclerolaena cuneata, Atriplex codonocarpa* and *Maireana pyramidata* with occasional emergent *Hakea preissii* and *Eremophila pantonii* on flat orange clay-sand saline flats with some quartz rock cover.

C4 – Chenopod Shrubland of *Sclerolaena cuneata, Maireana triptera, Frankenia setosa, Frankenia pauciflora, Atriplex codonocarpa* and *Solanum lasiophyllum* with occasional *Acacia aneura* var. *microcarpa* on fine black gravel.

C5 – Chenopod Shrubland of *Maireana pyramidata* and *Maireana triptera* with *Sclerolaena patenticuspis* and *Ptilotus obovatus* with occasional emergent *Acacia aneura* var. *microcarpa* and *Hakea preissii* on flat orange sandy-clays with quartz rock cover.

C6- Chenopod shrubland of *Tecticornia indica* subsp. *bidens* and other mixed Chenopods with occasional emergent *Melaleuca xerophila* on orange clay-loam.

Eucalypt Woodland

E1- Low open woodland of *Eucalyptus victrix* over *Eremophila glabra* subsp. *glabra, Acacia aneura* var. *aneura, Acacia burkittii* and *Melaleuca xerophila* on orange clay and sand loam.

The plant communities varied in condition from Good –Degraded, in areas that have been subject to grazing and where current infrastructure is in place, to Excellent in less disturbed areas of native vegetation (based on the criteria as developed by Keighery 1994a).

No Threatened Ecological Communities (TEC's) as defined by the EPBC Act (1999) or the Department of Environment and Conservation (2009c) were observed within the survey area.

No Priority Ecological Communities (PEC's) as defined by the Department of Environment and Conservation (2009e) were observed within the survey area.

5.3 Ground Water Dependant Ecosystems

Groundwater Dependent Ecosystems (GDEs) are ecosystems that depend on groundwater, which include:

- Ecosystems dependent on the surface expression of groundwater (such as baseflow rivers and streams, wetlands and some floodplains); and
- Ecosystems dependent on the subsurface presence of groundwater (Eamus *et al.* 2006).

Seven of the defined communities; A12, M1, M2 and E1 have been identified as potentially being impacted by the placement of the bore field. These communities contain a range of tree and tall shrub species that may be dependent on groundwater; such as *Acacia aneura, Melaleuca stereophloia, Melaleuca xerophila* and *Eucalyptus victrix*. These communities occur on the waterways and floodplains that are infrequently subjected to recent rainfall events. In other periods the communities are subjected to periods of extended below average rainfall levels and consequently the list above is considered to be a conservative list of potential communities that may be influenced by water extraction. As the floodplain is dominated by clay and clay loams soils the potential impacts of the ground water may be minimized as the communities may be more dependent on the rainfall events as compared to the groundwater levels. Therefore water extraction impacts should have limited impacts. Nevertheless monitoring is recommended as a conservative approach to monitoring trends in the area.

6. DISCUSSION

As indicated below coverage of the area appeared to be more than adequate (Figure 2) and as such meets the requirement of the EPA process.

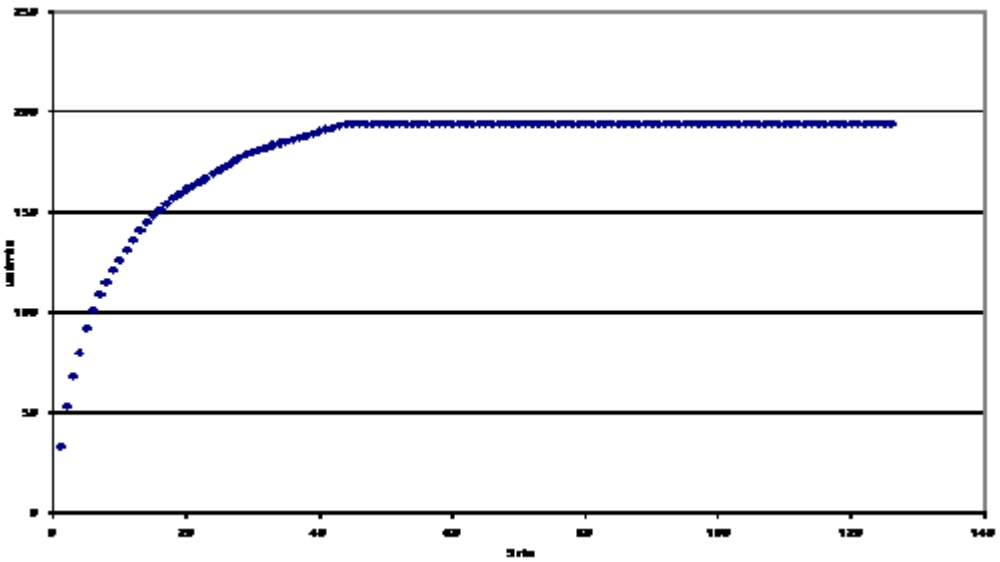

Figure 2: Species Area Curve

A total of 33 families, 76 genera, 172 species and 192 taxa were recorded within the survey area. Species representation was greatest amongst the Chenopodiaceae (38 taxa), Myoporaceae (24 taxa), Asteraceae (24 taxa) and Mimosaceae (21 taxa) families. Forty-two of the 193 recorded taxa are considered annual or biennial species. Of these Forty-two species, twenty five were recorded in September 2009 in the borefield area.

None of the flora species recorded are Declared Rare or Priority Flora species, as defined by the Department of Environment and Conservation or by the EPBC Act (1999). All species are well represented in the area, although *Olearia muelleri* was previously considered to be a potential range extension, recent collections in the region indicate that this is no longer the case.

Twenty Four plant communities were defined within the survey area covering the mining operations and the water pipeline (Figure 1). The communities differed in their structure, dominance and range of associated species and geographic factors.

No Threatened Ecological Communities (TEC's) as defined by the EPBC Act (1999) or the Department of Environment and Conservation (2009c) were observed in the survey area

No Priority Ecological Communities (PEC's) as defined by the Department of Environment and Conservation (2009b) were observed in the survey area.

Eight of the twenty four described communities from the survey area are *Acacia aneura* (Mulga) Woodlands - Shrublands. Beard (1976, 1990) reported that Mulga typically covers lower plains within the region. Mulga communities are likely to be well represented within the Lake Mason and Black Range reserves.

Communities A12 and S1 were both recorded from salty flats within the survey area. Beard (1990) reported that scrub of *Acacia sclerosperma, A. tetragonophylla, A. victoriae* and *Hakea preissii* is found in patches near salt lakes, and are likely to be well represented outside of the survey adjacent to salt lakes.

Community S2 is similar to the community described by Keighery *el al.* (1994b) as scattered groves of mixed trees and tall shrubs that included *Eremophila longifolia* and *Pittosporum phylliraeoides* (likely to be *Pittosporum angustifolium* in the Murchison region) found on non-saline poorly drained soils.

Community S3 is similar to the vegetation unit SS20 described by Keighery *el al.* (1994b) from the Sandstone-Sir Samuel Study Area as *Eremophila fraseri* (now *Eremophila galeata*) Tall Shrubland, which occurs stony plains.

Community S5 is similar to the vegetation unit SS12 described by Keighery *el al.* (1994b) from the Sandstone-Sir Samuel Study Area as *Acacia sclerosperma* Tall Shrubland, which occurs on calcrete.

Community M1 is similar to the vegetation unit LL13 described by Keighery *el al.* (1994b) from the Sandstone-Sir Samuel Study Area as *Melaleuca lanceolata* (likely to be referring to *M. xerophila*, *M. lanceolata* is a coastal species) Tall Shrubland, which occurs on calcareous soils, marginal to salt lakes.

Chenopod Shrublands C1 - C5 are likely to be well represented outside of the survey area. Community C1 has been recorded to the south, outside of the survey area, and is similar to the community *Maireana pyramidata* and *Maireana triptera* described by Beard (1990) which is found in open areas in saline areas. Communities C2-C5 are likely to be found in saline areas outside of the survey area, particularly to the west of the proposed Barrambie mine site.

Community S4, comprised of scattered shrubs, chenopods and Mulga on small low hills has not been recorded from outside of the survey area and may be considered locally significant. None of the species recorded from S4 are restricted to this community.

Community E1 and M2, recorded from draw down area, were not well replicated within the survey area., and may be considered locally significant These areas could be indirectly impacted by water draw down. These impacts are discussed later on.

The plant communities varied in condition from Good-Degraded in areas that have been subject to grazing and where current infrastructure is in place, to Excellent in less disturbed areas of native vegetation.

Four of defined communities; A12, M1, M2 and E1 have been identified as potentially being impacted by the placement of the bore field. These communities contain water table dependant species such as *Acacia aneura, Melaleuca stereophloia, Melaleuca xerophila* and *Eucalyptus victrix.*

These communities occur on the waterways and floodplains that are infrequently subjected to recent rainfall events. As the floodplain is dominated by clay and clay loams soils the potential impacts of the ground water may be minimized as the communities may be more dependent on the rainfall events as compared to the groundwater levels. Therefore water extraction impacts should have limited impacts. Monitoring of the bore field impact area should continue, to ensure that the ground water dependant species are not being adversely affected.

7. RECOMMENDATIONS

On the basis of these findings, it is recommended that:

- Minimise disturbances by keeping any clearing of native vegetation to an absolute minimum by laying the pipeline in existing disturbed areas, such as adjacent to established roads and tracks;
- Remove and stockpile topsoil, log debris and leaf litter where possible for use in future rehabilitation programs. If possible, stockpiled topsoil should be directly replaced on disturbed areas;
- Minimise soil disturbance during clearing and practice standard vehicle hygiene to limit the potential spread of invasive weed species;
- Continued monitoring of bore field impact area to ensure that the ground water dependant species are not being adversely affected.

8. LIST OF PERSONNEL

The following personnel of Mattiske Consulting Pty Ltd were involved in this project:

Principle Ecologist:	Dr E.M. Mattiske
Senior Botanist:	Mrs B. Koch
Botanists:	Mr S. Reiffer Mr T. Phillips Mr A. Robinson Ms S. Robinson Ms F. Smith Ms M. van Wees Mr T. Sleigh

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LEGEND

Acacia Woodland Shrublands

A1 Low Woodland of *Acacia aneura* var *aneura* with occasional *Eucalyptus lucasii, Psydrax latifolia* and *Acacia ramulosa* var. *linophylla* on lower slopes and adjacent to drainage lines.

A2 Low Woodland of *Acacia aneura* var *aneura*, *Acacia ayersiana* and *Acacia aneura* var. *microcarpa* over *Eremophila forrestii*, *Eremophila latrobei* subsp. *latrobei*, *Acacia ramulosa* var. *linophylla* and *Ptilotus obovatus* on slopes and flats.

A3 Low Open Woodland of *Acacia aneura* var. *microcarpa, Acacia aneura* var. *aneura, Hakea preissii* and *Acacia tetragonophylla* over *Senna artemisioides* subsp. x *sturtii, Sclerolaena eriacantha, Eremophila galeata* and *Maireana triptera* on lower slopes and well drained plains.

A4 Low Open Woodland to Tall Shrubland of *Acacia burkittii, Acacia ramulosa* var. *linophylla, Acacia craspedocarpa* over *Ptilotus obovatus*, *Maireana pyramidata, Maireana triptera, Maireana glomerifolia, Senna artemisioides* subsp. *filifolia* and *Senna artemisioides* subsp. x *sturtii* on drainage channels.

A5 Low Open Woodland to Tall Shrubland of *Acacia aneura* var. *microcarpa*, *Acacia aneura* var. *aneura* and *Acacia ayersiana* over *Acacia ramulosa* var. *linophylla* over *Eremophila forrestii* with occasional emergent *Acacia pruinocarpa* on orange sandy loams with a dense covering of ironstone pebbles on flats and slopes.

A8 Tall Shrubland to Tall Open Shrubland of *Acacia aneura var. aneura*, *Acacia aneura* var. *microcarpa* with *Acacia ayersiana* over *Acacia ramulosa* var. *linophylla* over *Eremophila forrestii* and *Eremophila spectabilis* subsp. *spectabilis* on flat, red, sandy-loam soils with a covering of coarse grain sand.

A9 Tall Shrubland of *Acacia aneura* var. *intermedia* with *Acacia pruinocarpa*, *Acacia aneura* var. *microcarpa*, *Acacia craspedocarpa* and *Acacia tetragonophylla* over mixed low shrubs on flat, red sandy loam with a covering of coarse grain sand.

A10 Tall Shrubland of *Acacia aneura* var. *microcarpa*, *Acacia aneura* var. *intermedia, Acacia craspedocarpa*, *Acacia tetragonophylla*, *Acacia ayersiana* and *Grevillea striata* over a dense covering of *Eragrostis ?pergracilis* on sandy-clay soils.

A11 Tall Open Shrubland of *Acacia aneura* var. *microcarpa* with *Acacia tetragonophylla* and mixed *Acacia* spp. over *Ptilotus obovatus* and mixed low open shrubs and Chenopods on orange sandy loams with a dense covering of quartz rock on flats.

A12 Tall Shrubland of *Acacia tetragonophylla, Acacia aneura* var. *aneura* and *Hakea preissii* over *Rhagodia eremaea, Atriplex vesicaria* and other Chenopods on orange sand.

Shrublands

S1 Open Scrub of *Hakea preissii* over *Maireana pyramidata, Senna artemisioides* subsp. x *sturtii* and *Sclerolaena cuneata* on sheet wash areas.

S2 Tall Shrubland of *Hakea preissii* with *Acacia tetragonophylla* over mixed low shrubs over *Ptilotus obovatus, Maireana triptera* and *Eragrostis eriopoda* with occasional emergent *Pittosporum angustifolium* and *Eremophila longifolia* on red sandy-clay soils in depressions.

S3 Open Shrubland of *Eremophila galeata* with *Acacia tetragonophylla* and *Senna artemisioides* subsp. *helmsii* over *Salsola tragus*, *Maireana triptera* and mixed low shrubs on flat red clay soils with a thick cover ironstone pebbles.

S4 Open Shrubland of *Eremophila youngii* subsp. *youngii* with mixed low open shrubs and Chenopods with occasional emergent *Acacia aneura* var. *aneura* on low hills.

S5 Scrub of *Acacia sclerosperma* subsp. *sclerosperma* and *Acacia burkittii* with other mixed Acacias over Chenopods on calcrete.

Melaleuca Shrublands

M1 Scrub of *Melaleuca xerophila* over Chenopods on Clay.

M2 Open scrub of *Melaleuca stereophloia* over *Maireana tomentosa* subsp. *tomentosa* with *Scaevola spinescens* on red clay loam with coarse sand.

Chenopod Shrublands

C1 Chenopod Shrubland of *Maireana triptera*, *Maireana pyramidata* and *Sclerolaena cuneata* with mixed low shrubs and Chenopods with occasional emergent *Hakea preissii* on flat red clays with patches of ironstone covering.

C2 Chenopod Shrubland of *Tecticornia* spp. and *Maireana pyramidata* with mixed low shrubs and Chenopods on flat orange clays with a thick cover of quartz and ironstone.

C3 Chenopod Shrubland of *Tecticornia indica* subsp. *bidens*, *Maireana glomerifolia, Sclerolaena cuneata, Atriplex codonocarpa* and *Maireana pyramidata* with occasional emergent *Hakea preissii* and *Eremophila pantonii* on flat orange clay-sand saline flats with some quartz rock cover.

C4 Chenopod Shrubland of *Sclerolaena cuneata, Maireana triptera, Frankenia setosa, Frankenia pauciflora, Atriplex codonocarpa* and *Solanum lasiophyllum* with occasional *Acacia aneura* var. *microcarpa* on fine black gravel.

C5 Chenopod Shrubland of *Maireana pyramidata* and *Maireana triptera* with *Sclerolaena patenticuspis* and *Ptilotus obovatus* with occasional emergent *Acacia aneura* var. *microcarpa* and *Hakea preissii* on flat orange sandy-clays with quartz rock cover.

C6 Chenopod shrubland of *Tecticornia indica* subsp. *bidens* and other mixed Chenopods with occasional emergent *Melaleuca xerophila* on orange clay-loam.

Eucalypt Woodland

E1 Low open woodland of *Eucalyptus victrix* over *Eremophila glabra* subsp. *glabra, Acacia aneura* var. *aneura, Acacia burkittii* and *Melaleuca xerophila* on orange clay and sand loam.

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Scale
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Reed Resources Ltd

BARRAMBIE MINE

VEGETATION

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APPENDIX A1: DEFINITION OF RARE AND PRIORITY FLORA SPECIES (Department of Environment and Conservation 2009a)

Conservation Code	Category
R	**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 <5) populations which are under threat, either due to small population size, or being on lands under immediate threat. 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 urgently need 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 need 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."

APPENDIX A2: CATEGORIES OF THREATENED FLORA SPECIES (Department of the Environment, Water, Heritage and the Arts. 2009a)

Category Code	Category
Ex	**Extinct** Taxa which at a particular time if, at that time, there is no reasonable doubt that the last member of the species has died.
ExW	**Extinct in the Wild** Taxa which is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or it has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
CE	**Critically Endangered** Taxa which at a particular time if, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
E	**Endangered** Taxa which is not critically endangered and it is facing a very high risk of extinction in the wild in the immediate or near future, as determined in accordance with the prescribed criteria.
V	**Vulnerable** Taxa which is not critically endangered or endangered and is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
CD	**Conservation Dependent** Taxa which at a particular time if, at that time, the species is the focus of a specific conservation program, the cessation of which would result in the species becoming vulnerable, endangered or critically endangered within a period of 5 years.

APPENDIX A3: SUMMARY OF THREATENED ECOLOGICAL COMMUNITIES (Department of Environment and Conservation 2009b)

Category Code	Category
PTD	**Presumed Totally Destroyed** An ecological community will be listed as Presumed Totally Destroyed if there are no recent records of the community being extant and either of the following applies: (i) records within the last 50 years have not been confirmed despite thorough searches or known likely habitats or; (ii) all occurrences recorded within the last 50 years have since been destroyed.
CE	**Critically Endangered** 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, meeting any one of the following criteria: (i) The estimated geographic range and distribution has been reduced by at least 90% and is either continuing to decline with total destruction imminent, or is unlikely to be substantially rehabilitated in the immediate future due to modification; (ii) The current distribution is limited ie. highly restricted, having very few small or isolated occurrences, or covering a small area; (iii) The ecological community is highly modified with potential of being rehabilitated in the immediate future.
E	**Endangered** 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. The ecological community must meet any one of the following criteria: (i) The estimated geographic range and distribution has been reduced by at least 70% and is either continuing to decline with total destruction imminent in the short term future, or is unlikely to be substantially rehabilitated in the short term future due to modification; (ii) The current distribution is limited ie. highly restricted, having very few small or isolated occurrences, or covering a small area; (iii) The ecological community is highly modified with potential of being rehabilitated in the short term future.
V	**Vulnerable** An ecological community will be listed as Vulnerable when it has been adequately surveyed and is not Critically Endangered or Endangered but is facing high risk of total destruction in the medium to long term future. The ecological community must meet any one of the following criteria: (i) The ecological community exists largely as modified occurrences that are likely to be able to be substantially restored or rehabilitated; (ii) The ecological community may already be modified and would be vulnerable to threatening process, and restricted in range or distribution; (iii) The ecological community may be widespread but has potential to move to a higher threat category due to existing or impending threatening processes.

APPENDIX A4: SUMMARY OF PRIORITY ECOLOGICAL COMMUNITIES (Department of Environment and Conservation 2009b)

Category Code	Category
P1	**Poorly-known ecological communities** Ecological communities with apparently few, small occurrences, all or most not actively managed for conservation (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) and for which current threats exist.
P2	**Poorly-known ecological communities** Communities that are known from few small occurrences, all or most of which are actively managed for conservation (e.g. within national parks, conservation parks, nature reserves, State forest, un-allocated Crown land, water reserves, etc.) and not under imminent threat of destruction or degradation.
P3	**Poorly known ecological communities** (i) Communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation or: (ii) Communities known from a few widespread occurrences, which are either large or within significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat, or; (iii) Communities made up of large, and/or widespread occurrences, that may or not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing and inappropriate fire regimes.
P4	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.
P5	**Conservation Dependent ecological communities** Ecological communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.

APPENDIX A5: CATEGORIES OF STANDARD CONTROL CODES FOR DECLARED PLANT SPECIES IN WESTERN AUSTRALIA (Department of Agriculture and Food 2009)

CONTROL CODE REQUIREMENTS	CONDITIONS
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 all plants:- • within 100 metres inside of the boundaries of the infestation • within 50 metres of roads and highwater mark 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 2 hectares of infestation must treat the entire infestation. Additional areas may be ordered to be treated.
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 all plants:- • within 100 metres inside of the boundaries of the infested property • within 50 metres of roads and highwater mark 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 2 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.

APPENDIX B: VASCULAR PLANT SPECIES RECORDED BARRAMBIE SURVEY AREA WATER PIPELINE CORRIDOR, 2005-2009

Note: * denotes introduced species, a denotes annual species, b denotes biennial species

FAMILY	SPECIES
POACEAE	*Aristida contorta*
	Austrostipa elegantissima
	Austrostipa nitida
	Austrostipa scabra
	Enneapogon caerulescens
	Eragrostis ?*pergracilis*
	Eragrostis eriopoda
	* *Rostraria pumila*
	Poaceae sp.
HEMEROCALLIDACEAE	*Dianella revoluta*
CASUARINACEAE	*Casuarina pauper*
PROTEACEAE	*Grevillea berryana*
	Grevillea nematophylla subsp. *supraplana*
	Grevillea striata
	Hakea leucoptera
	Hakea lorea
	Hakea preissii
SANTALACEAE	*Exocarpos aphyllus*
	Santalum spicatum
LORANTHACEAE	*Amyema fitzgeraldii*
	Amyema gibberula var. *gibberula*
	Amyema preissii
POLYGONACEAE	*Muehlenbeckia florulenta*
CHENOPODIACEAE	*Atriplex codonocarpa*
	Atriplex semilunaris
	Atriplex vesicaria
	Dissocarpus paradoxus
	Dysphania kalpari
	Enchylaena tomentosa
	Enchylaena tomentosa var. *tomentosa*
	Enchylaena x Maireana tomentosa x georgei
	Maireana amoena
	Maireana carnosa
	Maireana convexa
	Maireana georgei
	Maireana glomerifolia
	Maireana planifolia
	Maireana pyramidata

APPENDIX B: VASCULAR PLANT SPECIES RECORDED BARRAMBIE SURVEY AREA WATER PIPELINE CORRIDOR, 2005-2009

Note: * denotes introduced species, a denotes annual species, b denotes biennial species

FAMILY	SPECIES
CHENOPODIACEAE (continued)	*Maireana tomentosa* subsp. *tomentosa*
	Maireana trichoptera
	Maireana triptera
	Maireana villosa
	Rhagodia drummondii
	Rhagodia eremaea
	Salsola tragus
	Sclerolaena cornishiana
	Sclerolaena ? *convexula*
	Sclerolaena cuneata
	Sclerolaena densiflora
	Sclerolaena diacantha
	Sclerolaena eriacantha
	Sclerolaena ? *eriacantha*
	Sclerolaena eurotioides
	Sclerolaena fusiformis
	Sclerolaena patenticuspis
	Tecticornia ?*pruinosa*
	Tecticornia calyptrata
	Tecticornia disarticulata
	Tecticornia indica
	Tecticornia indica subsp. *bidens*
AMARANTHACEAE	*Alternanthera nodiflora*
	Ptilotus aervoides
	Ptilotus divaricatus
	Ptilotus exaltatus var. *exaltatus*
	Ptilotus obovatus
	Ptilotus roei
	Ptilotus schwartzii var. *georgei*
	Ptilotus schwartzii var. *schwartzii*
GYROSTEMONACEAE	*Codonocarpus cotinifolius*
PORTULACACEAE	*Calandrinia polyandra*
	Calandrinia ?*polyandra*
BRASSICACEAE	*Lepidium oxytrichum*
	Lepidium platypetalum
PITTOSPORACEAE	*Billardiera* sp.
	Pittosporum angustifolium

APPENDIX B: VASCULAR PLANT SPECIES RECORDED BARRAMBIE SURVEY AREA WATER PIPELINE CORRIDOR, 2005-2009

Note: * denotes introduced species, a denotes annual species, b denotes biennial species

FAMILY		SPECIES
MIMOSACEAE		*Acacia aneura* var. *aneura*
		Acacia aneura var. *argentea*
		Acacia aneura var. *conifera*
		Acacia aneura var. *fuliginea*
		Acacia aneura var. *intermedia*
		Acacia aneura var. *microcarpa*
		Acacia aneura var. *tenuis*
		Acacia ayersiana
		Acacia burkittii
		Acacia craspedocarpa
		Acacia donaldsonii
		Acacia oswaldii
		Acacia pruinocarpa
		Acacia quadrimarginea
		Acacia ramulosa var. *linophylla*
		Acacia ramulosa var. *ramulosa*
		Acacia rhodophloia
		Acacia aff. wanyu
		Acacia sclerosperma subsp. *sclerosperma*
		Acacia sp.
		Acacia tetragonophylla
		Acacia victoriae
CAESALPINIACEAE		*Senna artemisioides* subsp. *filifolia*
		Senna artemisioides subsp. *helmsii*
		Senna artemisioides subsp. *x artemisioides*
		Senna artemisioides subsp. *x sturtii*
		Senna glaucifolia
		Senna glutinosa subsp. *chatelainiana*
GERANIACEAE	*	*Erodium aureum*
		Erodium cygnorum
ZYGOPHYLLACEAE		*Zygophyllum iodocarpum*
EUPHORBIACEAE		*Euphorbia australis*
		Euphorbia boophthona
SAPINDACEAE		*Dodonaea microzyga* var. *acrolobata*
		Dodonaea petiolaris
		Dodonaea rigida

APPENDIX B: VASCULAR PLANT SPECIES RECORDED BARRAMBIE SURVEY AREA WATER PIPELINE CORRIDOR, 2005-2009

Note: * denotes introduced species, a denotes annual species, b denotes biennial species

FAMILY		SPECIES
MALVACEAE		*Abutilon oxycarpum*
		Hibiscus burtonii
	*	*Malva parviflora*
		Malvastrum americanum
		Sida calyxhymenia
		Sida ? sp. Excedentifolia
		Sida fibulifera
		Sida sp. dark green fruits
FRANKENIACEAE		*Frankenia pauciflora*
		Frankenia setosa
MYRTACEAE		*Calytrix* ?*desolata*
		Eucalyptus kingsmillii subsp. *kingsmillii*
		Eucalyptus lucasii
		Eucalyptus victrix
		Melaleuca stereophloia
		Melaleuca xerophila
APIACEAE		*Trachymene bialata*
GENTIANACEAE	*	*Centaurium erythraea*
ASCLEPIADACEAE		*Marsdenia australis*
CONVOLVULACEAE		*Convolvulus remotus*
		Duperreya sericea
LAMIACEAE		*Hemigenia tomentosa*
		Spartothamnella teucriiflora
SOLANACEAE		*Lycium australe*
		Solanum lasiophyllum
		Solanum nummularium
SCROPHULARIACEAE		*Peplidium muelleri*
MYOPORACEAE		*Eremophila clarkei*
		Eremophila eriocalyx
		Eremophila flabellata
		Eremophila forrestii
		Eremophila forrestii subsp. *forrestii*
		Eremophila forrestii subsp. *hastieana*
		Eremophila galeata

APPENDIX B: VASCULAR PLANT SPECIES RECORDED BARRAMBIE SURVEY AREA WATER PIPELINE CORRIDOR, 2005-2009

Note: * denotes introduced species, a denotes annual species, b denotes biennial species

FAMILY	SPECIES
MYOPORACEAE (continued)	*Eremophila glabra* subsp. *glabra*
	Eremophila granitica
	Eremophila jucunda subsp. *jucunda*
	Eremophila lachnocalyx
	Eremophila latrobei
	Eremophila latrobei subsp. *latrobei*
	Eremophila longifolia
	Eremophila maculata subsp. *brevifolia*
	Eremophila oldfieldii subsp. *angustifolia*
	Eremophila oppositifolia subsp. *angustifolia*
	Eremophila pantonii
	Eremophila punctata
	Eremophila punicea
	Eremophila serrulata
	Eremophila spectabilis subsp. *spectabilis*
	Eremophila spuria
	Eremophila youngii subsp. *youngii*
RUBIACEAE	*Psydrax latifolia*
	Psydrax rigidula
	Psydrax suaveolens
GOODENIACEAE	*Brunonia australis*
	?*Goodenia occidentalis*
	Goodenia tenuiloba
	Scaevola spinescens
ASTERACEAE	*Actinobole oldfieldianum*
	Actinobole uliginosum
	Angianthus tomentosus
	Brachyscome ciliaris
	Brachyscome ciliaris var. *ciliaris*
	Brachyscome ciliaris var. ? *lanuginosa*
	Centipeda thespidioides
	Cephalipterum drummondii
	Chthonocephalus viscosus
	Cratystylis subspinescens
	Dielitzia tysonii
	Erymophyllum ramosum subsp. *ramosum*
	Gnephosis angianthoides
	Gnephosis brevifolia
	Gnephosis tenuissima
	Lemooria burkittii
	Myriocephalus guerinae

APPENDIX B: VASCULAR PLANT SPECIES RECORDED BARRAMBIE SURVEY AREA WATER PIPELINE CORRIDOR, 2005-2009

Note: * denotes introduced species, a denotes annual species, b denotes biennial species

FAMILY	SPECIES
ASTERACEAE (continued)	*Olearia muelleri*
	Podolepis capillaris
	Pogonolepis stricta
	Rhodanthe battii
	Rhodanthe charsleyae
	Rhodanthe floribunda
	Vittadinia sulcata

APPENDIX C: VASCULAR PLANT SPECIES BY COMMUNITY RECORDED BARRAMBIE SURVEY AREA AND WATER PIPELINE CORRIDOR, 2005-2009

Note: * denotes introduced species

SPECIES	COMMUNITY																						
	A1	A2	A3	A4	A5	A8	A9	A10	A11	A12	S1	S2	S3	S4	S5	C1	C2	C3	C4	C5	C6	E1	M1	M2
Abutilon oxycarpum			+							+														
Acacia aneura var. *aneura*	+	+	+	+	+	+	+	+	+	+		+	+	+	+	+				+		+		
Acacia aneura var. *intermedia*	+	+	+	+	+	+	+	+	+	+		+				+								
Acacia aneura var. *argentea*		+																						
Acacia aneura var. *conifera*							+	+				+			+									
Acacia aneura var. *fuliginea*		+	+	+							+													
Acacia aneura var. *microcarpa*	+	+	+	+	+	+	+	+	+		+	+	+			+	+		+	+				
Acacia aneura var. *tenuis*																+		+						
Acacia ayersiana		+		+	+	+	+	+	+						+									
Acacia burkittii		+	+	+					+		+		+		+	+			+			+		
Acacia craspedocarpa				+	+		+	+		+	+	+			+									
Acacia donaldsonii		+							+							+	+							
Acacia oswaldii															+				+					
Acacia pruinocarpa	+	+		+	+	+	+	+	+		+		+			+	+							
Acacia quadrimarginea		+	+		+				+															
Acacia ramulosa var. *linophylla*	+	+	+	+	+	+	+	+	+															
Acacia ramulosa var. *ramulosa*																	+							
Acacia rhodophloia					+																			
Acacia sclerosperma subsp. *sclerosperma*							+			+					+									
Acacia tetragonophylla	+	+	+	+		+	+	+	+	+	+	+	+	+	+	+	+			+		+		+
Acacia victoriae										+	+				+							+		
Acacia aff. *wanyu*				+																				
Acacia sp.						+	+						+			+								
Actinobole oldfieldianum		+						+																
Actinobole uliginosum								+		+														
Alternanthera nodiflora													+											
Amyema fitzgeraldii					+																			
Amyema gibberula var. *gibberula*			+					+				+												
Amyema preissii												+												
Angianthus tomentosus								+		+					+						+	+	+	
Aristida contorta							+		+	+	+					+	+							+
Atriplex codonocarpa		+	+								+			+		+	+	+	+	+				
Atriplex semilunaris							+			+											+			+
Atriplex vesicaria							+		+	+						+		+		+	+	+	+	
Austrostipa elegantissima								+			+				+									
Austrostipa nitida			+						+															
Austrostipa scabra		+																						
Billardiera sp.											+													
Brachyscome ciliaris										+														
Brachyscome ciliaris var. *ciliaris*																		+						

APPENDIX C: VASCULAR PLANT SPECIES BY COMMUNITY RECORDED BARRAMBIE SURVEY AREA AND WATER PIPELINE CORRIDOR, 2005-2009

Note: * denotes introduced species

SPECIES	COMMUNITY																							
	A1	A2	A3	A4	A5	A8	A9	A10	A11	A12	S1	S2	S3	S4	S5	C1	C2	C3	C4	C5	C6	E1	M1	M2
Brachyscome ciliaris var. ?lanuginosa							+	+		+		+									+			
Brunonia australis			+																					
Calandrinia polyandra							+			+		+									+			
Calandrinia ?polyandra								+																
Calytrix ?desolata		+																						
Casuarina pauper									+							+								
* *Centaurium erythraea*												+												
Centipeda thespidioides			+	+					+			+	+			+								
Cephalipterum drummondii		+		+			+	+		+												+	+	
Chthonocephalus viscosus			+																					
Codonocarpus cotinifolius															+									
Convolvulus remotus																+								
Cratystylis subspinescens		+						+		+		+				+	+	+						
Dianella revoluta									+															
Dielitzia tysonii		+																						
Dissocarpus paradoxus																		+	+					
Dodonaea microzyga var. *acrolobata*									+		+													
Dodonaea petiolaris			+																					
Dodonaea rigida					+								+											
Duperreya sericea			+										+											
Dysphania kalpari										+														
Enchylaena tomentosa	+		+			+	+	+	+		+	+	+		+									
Enchylaena tomentosa var. *tomentosa*	+			+																				
Enchylaena x *Maireana tomentosa* x *georgei*		+																						
Enneapogon caerulescens									+						+	+								
Eragrostis ?pergracilis			+					+																
Eragrostis eriopoda	+		+	+	+	+		+				+			+	+		+						
Eremophila clarkei	+																							
Eremophila eriocalyx								+																
Eremophila flabellata	+	+	+	+																				
Eremophila forrestii	+	+		+	+	+			+				+			+	+			+				
Eremophila forrestii subsp. *forrestii*							+																	
Eremophila forrestii subsp. *hastieana*		+	+			+	+	+																
Eremophila galeata	+	+	+		+	+	+		+		+		+											
Eremophila glabra subsp. *glabra*								+							+						+	+		
Eremophila granitica						+																		
Eremophila jucunda subsp. *jucunda*	+	+																						
Eremophila lachnocalyx				+							+					+	+	+	+					
Eremophila latrobei	+						+	+																
Eremophila latrobei subsp. *latrobei*	+	+	+	+	+				+															

APPENDIX C: VASCULAR PLANT SPECIES BY COMMUNITY RECORDED BARRAMBIE SURVEY AREA AND WATER PIPELINE CORRIDOR, 2005-2009

Note: * denotes introduced species

SPECIES	COMMUNITY																						
	A1	A2	A3	A4	A5	A8	A9	A10	A11	A12	S1	S2	S3	S4	S5	C1	C2	C3	C4	C5	C6	E1	M1	M2
Eremophila longifolia			+				+	+			+	+				+	+							
Eremophila maculata subsp. *brevifolia*																	+							
Eremophila oldfieldii subsp. *angustifolia*	+		+						+			+				+		+						
Eremophila oppositifolia subsp. *angustifolia*									+		+		+			+								
Eremophila pantonii			+			+			+		+	+	+			+	+	+	+					
Eremophila punctata		+			+																			
Eremophila punicea		+			+				+		+						+							
Eremophila serrulata					+																			
Eremophila spectabilis subsp. *spectabilis*	+			+	+	+																		
Eremophila spuria			+																					
Eremophila youngii subsp. *youngii*					+		+		+				+	+		+		+						
* *Erodium aureum*												+												
Erodium cygnorum							+	+				+			+						+			
Erymophyllum ramosum subsp. *ramosum*																		+						
Eucalyptus kingsmillii subsp. *kingsmillii*						+																		
Eucalyptus lucasii	+				+	+																		
Eucalyptus victrix																						+		
Euphorbia australis																	+							
Euphorbia boophthona																+								
Exocarpos aphyllus				+				+		+					+			+						
Frankenia pauciflora									+						+	+		+	+		+			
Frankenia setosa											+								+					
Gnephosis angianthoides							+	+		+		+												
Gnephosis brevifolia		+					+			+											+			
Gnephosis tenuissima				+			_+																	
? Goodenia occidentalis							+	+		+											+			
Goodenia tenuiloba	+							+																
Grevillea berryana		+			+		+	+							+									
Grevillea nematophylla subsp. *supraplana*															+									
Grevillea striata								+							+							+		
Hakea leucoptera													+			+	+							
Hakea lorea				+																				
Hakea preissii		+	+						+	+	+	+		+		+	+	+		+				
Hemigenia tomentosa					+																			
Hibiscus burtonii			+																					
Lemooria burkittii								+																+
Lepidium oxytrichum							+			+					+									
Lepidium platypetalum		+																						
Lycium australe									+		+				+	+	+						+	+
Maireana amoena																					+			

APPENDIX C: VASCULAR PLANT SPECIES BY COMMUNITY RECORDED BARRAMBIE SURVEY AREA AND WATER PIPELINE CORRIDOR, 2005-2009

Note: * denotes introduced species

SPECIES	COMMUNITY																						
	A1	A2	A3	A4	A5	A8	A9	A10	A11	A12	S1	S2	S3	S4	S5	C1	C2	C3	C4	C5	C6	E1	M1	M2
Maireana carnosa							+			+														
Maireana convexa		+														+								
Maireana georgei							+								+									+
Maireana glomerifolia				+					+		+						+	+						
Maireana planifolia							+											+						
Maireana pyramidata			+	+					+		+	+	+			+	+	+		+				
Maireana tomentosa subsp. *tomentosa*								+	+	+	+	+			+	+	+	+				+	+	+
Maireana trichoptera			+								+		+			+								
Maireana triptera	+	+	+	+					+		+	+	+	+		+	+	+	+	+				
Maireana villosa									+							+								
* *Malva parviflora*										+														
* *Malvastrum americanum*												+				+								
Marsdenia australis							+				+								+					
Melaleuca stereophloia																						+		+
Melaleuca xerophila															+						+	+	+	
Muehlenbeckia florulenta															+							+		
Myriocephalus guerinae			+																					
Olearia muelleri			+						+															
Peplidium muelleri								+							+									
Pittosporum angustifolium				+				+		+		+			+	+								
Poaceae sp.								+							+									
Podolepis capillaris								+			+				+	+								
Pogonolepis stricta										+														
Psydrax latifolia	+		+	+	+								+											
Psydrax rigidula			+		+																			
Psydrax suaveolens			+		+	+																		
Ptilotus aervoides		+																						
Ptilotus divaricatus								+					+											
Ptilotus exaltatus var. *exaltatus*		+					+	+								+								
Ptilotus obovatus	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+		
Ptilotus roei													+											
Ptilotus schwartzii var. *georgei*		+	+																					
Ptilotus schwartzii var. *schwartzii*		+			+																			
Rhagodia drummondii			+	+		+			+		+			+		+	+	+						
Rhagodia eremaea						+	+	+		+	+	+	+		+									
Rhodanthe battii	+																							
Rhodanthe charsleyae								+		+		+			+							+		+
Rhodanthe floribunda								+							+									
* *Rostraria pumila*										+														
Salsola tragus							+				+		+		+	+								

APPENDIX C: VASCULAR PLANT SPECIES BY COMMUNITY RECORDED BARRAMBIE SURVEY AREA AND WATER PIPELINE CORRIDOR, 2005-2009

Note: * denotes introduced species

SPECIES	COMMUNITY																						
	A1	A2	A3	A4	A5	A8	A9	A10	A11	A12	S1	S2	S3	S4	S5	C1	C2	C3	C4	C5	C6	E1	M1	M2
Santalum spicatum								+			+		+											
Scaevola spinescens	+	+	+	+	+			+	+	+	+	+	+		+	+	+	+	+	+				+
Sclerolaena ?convexula										+					+								+	
Sclerolaena cornishiana													+			+								
Sclerolaena cuneata		+	+			+			+		+	+	+	+		+	+	+	+	+			+	
Sclerolaena densiflora						+	+						+			+	+	+						+
Sclerolaena diacantha											+													
Sclerolaena eriacantha		+	+																+					
Sclerolaena ?eriacantha							+								+									+
Sclerolaena eurotioides		+	+																+					
Sclerolaena fusiformis					+					+											+			
Sclerolaena patenticuspis																				+				
Senna artemisioides subsp. *filifolia*				+		+	+	+			+													
Senna artemisioides subsp. *helmsii*	+	+	+					+	+			+	+			+	+							
Senna artemisioides subsp. *x artemisioides*							+		+							+								
Senna artemisioides subsp. *x sturtii*		+	+	+					+		+					+	+							
Senna glaucifolia		+																						
Senna glutinosa subsp. *chatelainiana*			+																					
Sida calyxhymenia	+	+	+	+	+				+				+	+		+								
Sida ? sp. Excedentifolia (J.L. Egan 1925)			+												+									
Sida fibulifera												+	+											
Sida sp. dark green fruits (S. van Leeuwen 2260)	+		+										+											
Solanum lasiophyllum		+	+			+	+		+		+	+	+		+	+	+	+	+					
Solanum nummularium						+			+			+	+			+								
Spartothamnella teucriiflora		+		+	+																			
Tecticornia ?pruinosa											+						+		+					
Tecticornia calyptrata											+						+	+						
Tecticornia disarticulata																					+			
Tecticornia indica											+						+	+		+				
Tecticornia indica subsp. *bidens*									+		+				+	+	+	+	+		+			
Trachymene bialata								+				+			+									
Vittadinia sulcata												+												
Zygophyllum iodocarpum							+			+					+	+					+			

APPENDIX D: SUMMARY OF SITE RECORDING LOCATIONS, BARRAMBIE SURVEY AREA AND WATER PIPELINE CORRIDOR, 2005-2009

Easting mE GDA94	Northing mN GDA94
690513	6988312
691014	6987444
691618	6986421
691797	6986236
692017	6985865
692931	6984323
693540	6983356
694657	6982321
696608	6980623
696553	6980580
699778	6978304
700883	6977626
701644	6977307
702363	6976762
702575	6976500
702945	6975828
704305	6973172
704540	6972320
704717	6971356
707026	6970638
706700	6970620
706738	6970380
706696	6970280
706150	6970248
708007	6969997
705517	6969823
705785	6969815
705472	6969801
706841	6969500
706694	6969477
707200	6969422
706179	6969226
706500	6969009
707342	6968959
707944	6968481
707843	6968424
707756	6968370
709292	6968297
707850	6968272
708147	6968268
707470	6968119
709002	6968014
707960	6967710
708083	6967614
707938	6967518

Easting mE GDA94	Northing mN GDA94
708596	6967150
709090	6967100
708612	6967068
707378	6966430
707200	6966000
708125	6965822
707500	6965800
708510	6965758
708181	6965703
708194	6965553
708274	6965481
707876	6965418
706649	6965404
708228	6965400
707734	6965160
707612	6965131
706940	6964900
709685	6964765
706223	6964707
708960	6964667
706566	6964652
706410	6964629
707900	6964600
707400	6964600
705866	6964552
709161	6964465
705314	6964424
709265	6964398
705228	6964324
708500	6964200
705603	6964120
705692	6964074
705770	6964061
708487	6963691
709503	6963616
709404	6963580
708116	6963342
709792	6963283
708400	6963280
708084	6963231
709903	6963211
708320	6962840
709000	6962580
710177	6962475
708986	6962296

APPENDIX D: SUMMARY OF SITE RECORDING LOCATIONS, BARRAMBIE SURVEY AREA AND WATER PIPELINE CORRIDOR, 2005-2009

Easting mE GDA94	Northing mN GDA94
710150	6962091
711458	6962029
711347	6962029
711515	6961990
711569	6961970
710620	6961545
707800	6961400
706900	6961140
708800	6961000
710652	6960900
706000	6960800
709512	6960758
709751	6960747
708300	6960700
710812	6960665
705500	6960600
705033	6960554
707100	6960450
705040	6960340
706000	6960300
705500	6960200
706699	6960140
705120	6959760
709964	6959040
685873	6986933
691111	6988423
689930	6986962
689761	6985818
688800	6990363
683630	6994214
684321	6994594
685108	6994230
686520	6993576
686764	6993622
686950	6993521
685748	6986850
687511	6993304
688444	6994378
688693	6994294
683365	6997808
682060	6995444
685395	6993971
688323	6993116
687218	6990781
686523	6987133

Easting mE GDA94	Northing mN GDA94
686105	6991097
684517	6991397
686950	6985021
687365	6984961
689742	6987978
684932	6989417
684253	6990882
684984	6990632
686900	6989822
690000	6988874
691973	6988337