

A Vegetation and Flora Survey of the Mesa K Mine Site, near Pannawonica



Prepared for
Robe River Mining Pty Ltd

Prepared by
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1.0 Summary

1.1 Background to this Study

Robe River Mining Pty Ltd is preparing to re-mine the Mesa K deposit, located ~10 km south-west of the town of Pannawonica. This deposit has been previously mined to varying depths, ranging from relatively shallow to 20 m or greater depth. Much of the ground surface is therefore already disturbed.

Biota Environmental Sciences was commissioned to conduct a botanical survey of the Mesa K study area to provide baseline vegetation and flora data for the environmental impact assessment and management of the project.

1.2 Methodology

A total of 13 person days were spent surveying the study area during September 2005 and November 2006. The survey comprised:

- systematic searches for rare flora across the entire area (during which locations of weed species were also recorded).
- mapping of vegetation types; and
- assessment of two detailed 50 m x 50 m flora recording quadrats.

1.3 Vegetation

The Mesa K biological study area was approximately 465 ha in size, comprising:

- the Mesa K mesa formation (substantially disturbed) hosting the orebody, and immediately adjacent stony hills;
- an adjacent portion of the Robe River system surrounding the existing causeway; and
- a portion of the river floodplain adjacent to the mesa and river system.

Almost 50% of the study area was classed as "disturbed", being either entirely cleared or comprising regenerating vegetation. Most of the disturbed areas were in the Mesa K mesa formation.

Seven vegetation types were described for the intact remnants within the Mesa K study area, all of which had been either identified previously within the area or within nearby areas during recent studies.

Broadly, these vegetation types comprised:

- tall open shrublands of *Acacia atkinsiana* and *A. arida*, often with scattered *Acacia inaequilatera* and *Eucalyptus leucophloia*, over *Triodia wiseana* hummock grasslands on mesa crests and low stony hills;
- riverine forest of *Melaleuca argentea* and *Eucalyptus camaldulensis* var. *obtusa* in the Robe River itself; and
- low open woodlands of *Corymbia candida* or tall open shrublands of *Acacia synchronicia* and *A. bivenosa* over hummock grasslands of *Triodia epactia* or *T. longiceps* on the floodplain of the Robe River.

The vegetation types identified within the study area are typical of the locality, and the only unit of particular conservation significance is the riverine vegetation in the Robe River (EcMaAtrPISg), which is considered to be of High conservation value.

1.4 Flora

A total of 164 native vascular flora taxa from 91 genera and 42 families was recorded from the Mesa K study area. In addition, 14 weed species were recorded.

1.4.1 Flora of Conservation Significance

No Declared Rare Flora were recorded within the Mesa K study area, despite systematic targeted searches for rare species through the entire study area.

Three Priority 3 flora (*Abutilon trudgenii* ms., *Rhynchosia bungarensis* and *Sida* sp. Wittenoom (W.R. Barker 1962)) have been identified at Mesa K: all are relatively common in the Pannawonica area. In addition, an undescribed spinifex species (*Triodia* sp. nov.) occurs in rocky habitats at Mesa K, and more broadly in the Pannawonica locality.

Family	Number of Records (Estimate of No. of Plants)	Distribution within the study area
Species		
Malvaceae		
<i>Abutilon trudgenii</i> ms.	44 (80+ plants)	Widespread, mainly on the Robe River floodplain adjacent to disturbed areas
<i>Sida</i> sp. Wittenoom (W.R. Barker 1962)	55 (630+ plants)	Widespread, mainly on the Robe River floodplain adjacent to disturbed areas
Papilionaceae		
<i>Rhynchosia bungarensis</i>	3 (25+ plants)	Scattered through the Robe River

1.4.2 Introduced Flora (Weeds)

Fourteen species of introduced flora were recorded from the Mesa K area. Kapok, Ruby Dock, Buffel Grass and Birdwood Grass are all considered to be serious environmental weeds.

Species	No. of Records	Broad Distribution within the Mesa K Survey Area
* <i>Acetosa vesicaria</i> (Ruby Dock)	1	Single record adjacent to the Mesa J access road
* <i>Aerva javanica</i> (Kapok Bush)	5	Adjacent to access tracks at Mesa K and along the Mesa J access road
* <i>Argemone ochroleuca</i> subsp. <i>ochroleuca</i> (Mexican Poppy)	42	Mainly in the Robe River
* <i>Cenchrus ciliaris</i> (Buffel Grass)	97	Widespread through the Robe River floodplain east of Mesa K; also present in the Robe River itself
* <i>Cenchrus setiger</i> (Birdwood Grass)	39	Widespread through the Robe River floodplain east of Mesa K; also present in the Robe River itself
* <i>Chloris barbata</i> (Purpletop Chloris)	1	In the Robe River
* <i>Citrullus colocynthis</i> (Wild Melon)	13	Mainly in disturbed areas; also in the Robe River
* <i>Euphorbia hirta</i> (Asthma Bush)	2	In the Robe River
* <i>Lactuca serriola</i> (Prickly Lettuce)	1	In the Robe River
* <i>Malvastrum americanum</i> (Spiked Malvastrum)	13	Mainly on the Robe River floodplain; also in the river itself
* <i>Passiflora foetida</i> var. <i>hispida</i> (Stinking Passion Flower)	1	In the Robe River
* <i>Setaria verticillata</i> (Whorled Pigeon Grass)	3	In the Robe River
* <i>Solanum nigrum</i> (Black Berry Nightshade)	2	In the Robe River
* <i>Sonchus oleraceus</i> (Prickly Sowthistle)	2	Along the Mesa J access road on the northern edge of the Robe River

1.5 Management Recommendations

The riverine vegetation (EcMaAtrPISg) is considered to be of High conservation significance, as it supports habitat-restricted species (including Priority flora) and occurs in the major drainage feature for the locality. The remainder of the vegetation types within the study area are not considered to require any particular management beyond the standard measures implemented for best practice environmental management.

The Priority 3 flora *Abutilon trudgenii* ms. and *Sida* sp. Wittenoom (WR. Barker 1962) are widespread in the Pilbara and are considered to warrant removal from the Department of Environment and Conservation Priority flora listing. *Rhynchosia bungarensis*, also a Priority 3 species, is recorded less frequently and is more restricted in habitat. Disturbance to this species should be largely avoided by minimising clearing of the riverine vegetation which supports it.

The following management measures are recommended to minimise disturbance to the vegetation and flora of the Mesa K study area.

- Clearing of vegetation type EcMaAtrPISg, found within the Robe River system, should be avoided wherever possible, and otherwise minimised, particularly during upgrade of the causeway across the Robe River.
- All other clearing of intact vegetation should be minimised: mine planning should preferentially site infrastructure within historically disturbed areas. All vehicles should be required to keep to designated roads and tracks.
- Weed control measures should be developed and implemented to prevent the introduction or spread of weeds in the Mesa K project area. Weed hygiene and management controls should be developed and implemented prior to construction commencing.
- A Topsoil Management and Rehabilitation Plan should be prepared for all non-permanent cleared areas prior to the commencement of construction activities. This plan should include use of provenance collected native seed, characterisation and management of topsoil, and the respreading of cleared vegetative material. Recovery monitoring and appropriate remedial measures should also be carried out.
- Appropriate dust suppression measures should be implemented across the Mesa K project area during construction and operation to minimise effects on surrounding vegetation and flora.
- The appearance and significance of the Priority flora species in the area (particularly *Rhynchosia bungarensis*), and the need to avoid disturbance to such species wherever possible, should be communicated to all staff on site.

2.0 Introduction

2.1 Background to the Mesa K Project

Robe River Mining Pty Ltd is preparing to re-mine the Mesa K deposit, located approximately 10 km south-west of the town of Pannawonica (Figure 2.1). This deposit has been previously mined to varying depths, ranging from relatively shallow to 20 m or greater depth. The site has also been disturbed by the location of the rail, cutting through part of the mesa; the development of waste dumps; the siting of mining infrastructure; access roads and tracks; and exploration activities. Much of the ground surface is therefore already disturbed and some areas are partially rehabilitated. A small proportion of the proposed mining activity may be undertaken in areas which are currently undisturbed.

The Mesa K project will involve:

- remnant mining of up to five open-cut pits, largely within areas which have been previously disturbed;
- establishment of minimal associated mine infrastructure (waste dumps, laydown areas, haul roads etc); and
- upgrading of the existing causeway across the Robe River to improve access between Mesa K and Mesa J (see Figure 2.2).

Biota Environmental Sciences (Biota) was commissioned to undertake a vegetation and flora survey of the Mesa K study area to provide baseline data for the Mesa K Remnant Mining Project environmental assessment process and environmental management measures.

2.2 Scope of the Mesa K Botanical Survey

2.2.1 The Mesa K Study Area

The Mesa K biological study area was approximately 465 ha in size, comprising:

- the Mesa K mesa formation (substantially disturbed) hosting the orebody, and immediately adjacent stony hills;
- an adjacent portion of the Robe River system surrounding the existing causeway; and
- a portion of the river floodplain adjacent to the mesa and river system (see Figure 2.2).

The remnant mining activity will be confined to the mesa formation itself.

2.2.2 Scope and Objectives of the Survey

The vegetation and flora survey of the Mesa K study area was planned and implemented as far as practicable according to the Environmental Protection Authority (EPA) Position Statement No. 3 "Terrestrial Biological Surveys as an element of Biodiversity Protection" (EPA 2002) and Guidance Statement No. 51 "Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia " (EPA 2004).

As such, the survey aimed to:

- provide baseline information regarding vegetation and flora values of the study area. This incorporated a desktop review of available information, together with a field study (utilising techniques generally accepted as standard for the region) which addressed: description and mapping of vegetation types occurring in the study area; identification of any vegetation types of particular conservation significance and; collation of information regarding any rare flora or other flora of conservation interest;

- place the information from the study area in regional context by comparison with available data from other localities; and
- provide management recommendations to minimise impact to vegetation types and flora species of conservation significance within the study area.

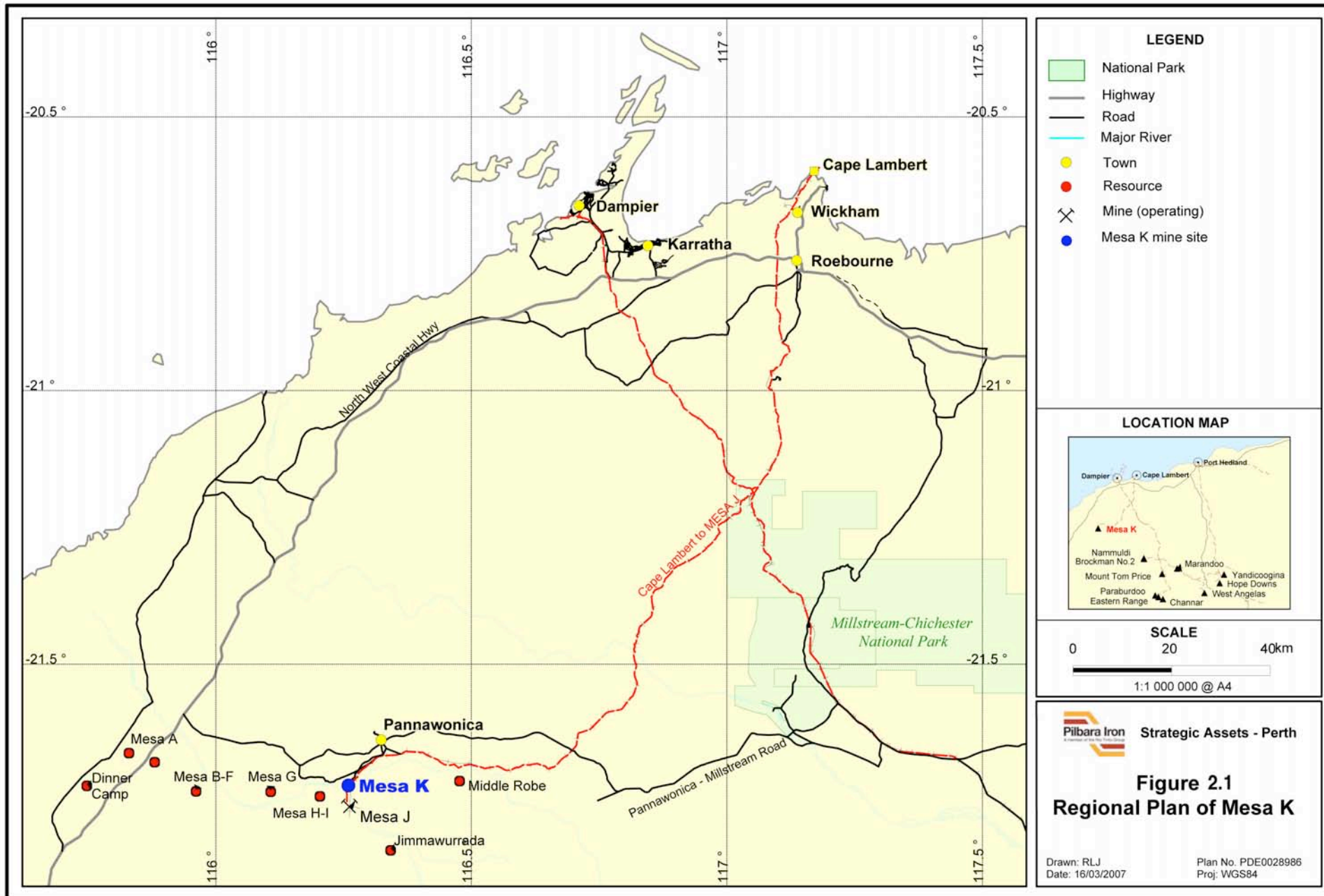


Figure 2.1: Regional plan showing the location of Mesa K.

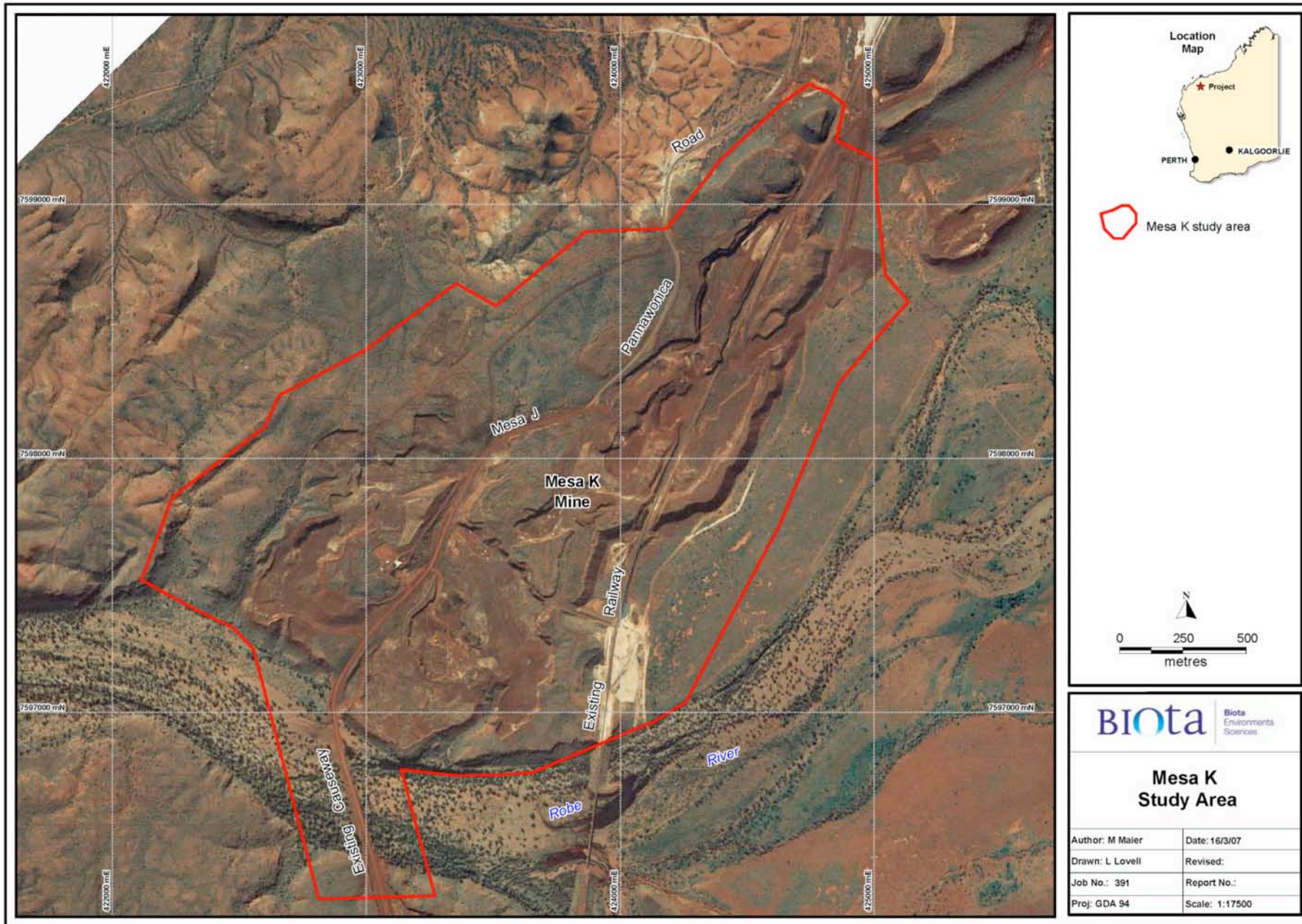


Figure 2.2: Mesa K biological study area.

2.3 Purpose of this Report

This report describes the methodology employed for the vegetation and flora survey of the Mesa K study area, documents the findings of the survey, and presents management recommendations to minimise impacts of the Mesa K project. It is intended for use as a supporting document providing baseline vegetation and flora data for the environmental impact assessment and subsequent environmental management of the Mesa K project.

2.4 Geological and Physiographic Context of the Study Area

2.4.1 Major Physiographic units

Beard (1975) identified four major physiographic units within the Fortescue Botanical District:

- Abydos Plain – extending from Cape Preston east to Pardoo Creek and south to the Chichester Range; it includes alluvial plains, low stony hills and granite outcrops, comprising largely granitic soils with alluvial soils on the coastal regions;
- Chichester Plateau – a predominantly basaltic plateau of siltstones, mudstones, shales, dolomite and jaspilite; it forms a watershed between drainage lines flowing north through the Abydos Plain and the Fortescue drainage to the south;
- Fortescue Valley – occupies a trough between the Chichester and Hamersley Plateaux, with the eastern portion draining into the Fortescue Marshes; and
- Hamersley Plateau – rounded hills and ranges comprised largely of dolomite and jaspilite, with some shale, siltstone and volcanics.

The study area lies towards the western end of the Hamersley Plateau.

2.4.2 Land Systems

Land System mapping covering the study area has been prepared by the Western Australian Department of Agriculture (van Vreeswyk et al. 2004) (see Figure 2.3). These are broad units that each consist of a series of "land units" that occur on characteristic physiographic types within the Land System.

One hundred and seven (107) Land Systems occur in the Pilbara bioregion (see Section 2.5.1). [This information was obtained by merging the Ashburton Land System mapping (Payne et al. 1988) and Pilbara Land System mapping (van Vreeswyk et al. 2004) and intersecting this with the Pilbara bioregion (Environment Australia 2000) in ArcView 3.2.]

A brief description of the four Land Systems intersected by the study area is given in Table 2.1. Less than 0.5% of the total mapped area for the Pilbara bioregion for each Land System lies within the study area (Table 2.2). All of the Land systems are widespread through the Pilbara bioregion.

Table 2.1: Land Systems mapped within the Mesa K study area (descriptions from van Vreeswyk et al. 2004).

Land System	Description
McKay (RGEMCK)	Hills, ridges, plateaux remnants and breakaways of metasedimentary and sedimentary rocks supporting hard spinifex grasslands; a small area occurring at the northern boundary of the Mesa K study area.
Newman (RGENEW)	Rugged jaspilite plateaux, ridges and mountains supporting hard spinifex grasslands; a small area occurring at the western boundary of the Mesa K study area
River (RGERIV)	Active flood plains and major rivers supporting grassy eucalypt woodlands, tussock grasslands and soft spinifex grasslands; occurring within the Robe River and on the adjacent floodplain.
Robe (RGEROB)	Low limonite mesas and buttes supporting soft spinifex (and occasionally hard spinifex) grasslands; this was the main land system intersected by the survey area, occurring broadly over the stony hills of the Mesa K deposit.

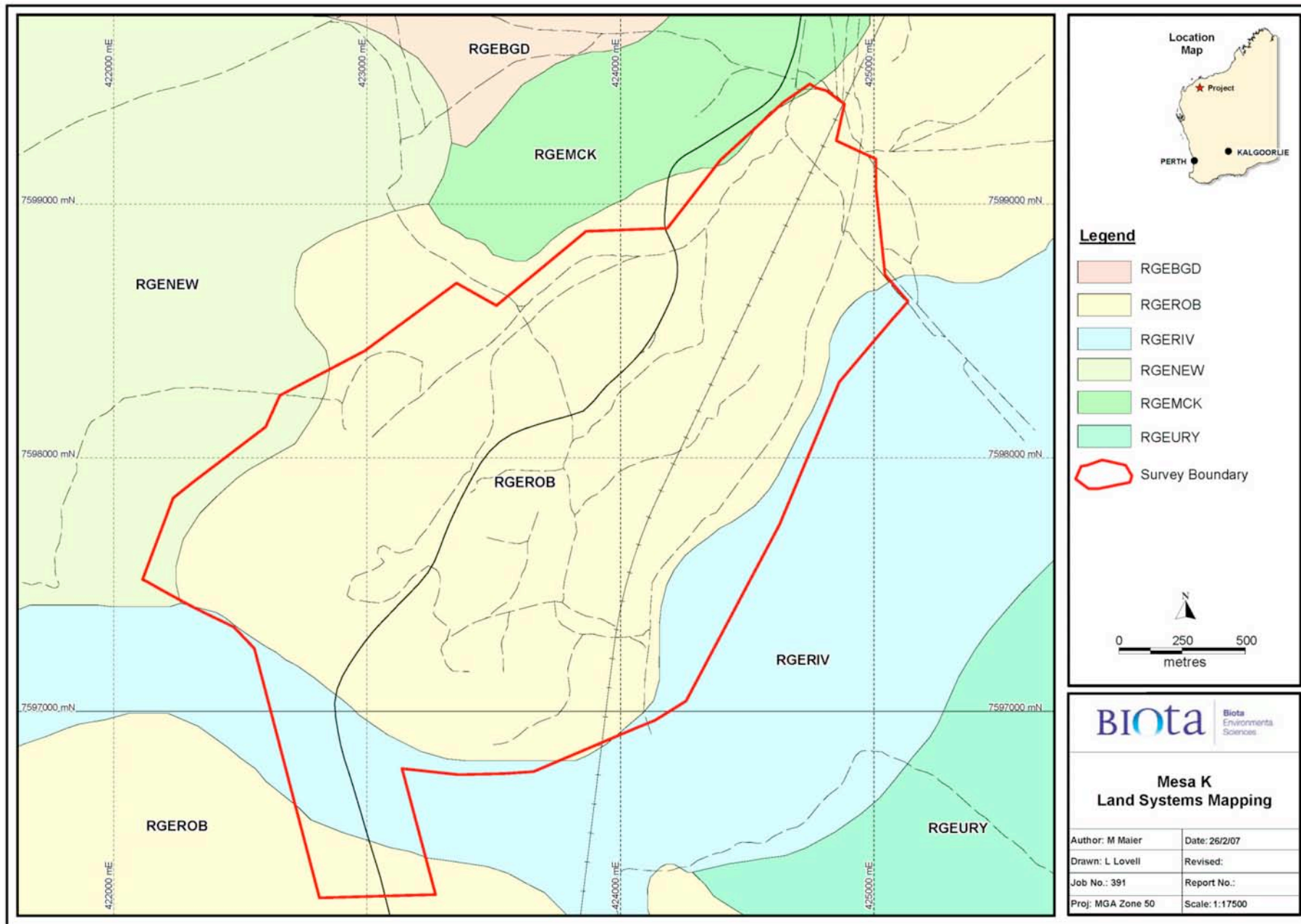


Figure 2.3: Land Systems mapping for the region encompassing the Mesa K study area (data from van Vreeswyk et al. 2004).

Table 2.2: Distribution of Land Systems within the Mesa K study area and wider Pilbara bioregion (data from Payne et al. 1988 and van Vreeswyk et al. 2004).

Land System	Total Area in the Pilbara Bioregion (Rank†)	Number of Mapping Polygons in the Pilbara Bioregion	General Distribution through the Pilbara Bioregion	Amount of Land System within the Current Study Area	
				Hectares	% of total in Pilbara Bioregion
McKay	426,141 ha (99 th)	129	Widespread through the Pilbara	0.6	<0.01
Newman	1,993,741 ha (106 th)	321	Widespread through the Hamersley Range, also occurring as a band along the Chichester Range to the north of the Fortescue Marsh; numerous occurrences; study area is at the western edge of distribution of this Land System	12.2	<0.01
River	482,175 ha (101 st)	126	Widespread in major river systems through the Pilbara	60.3	0.01
Robe	128,859 ha (76 th)	251	Occurs throughout the Hamersley subregion, with a few occurrences in the Chichester subregion; study area is at the western edge of distribution of this Land System	391.5	0.30
Pilbara Total	303,0916 ha	827		464.6	

† Ranking of Land System in terms of area out of the 107 Land Systems in the Pilbara bioregion; ranked from the least abundant in terms of area (1) to most abundant (107).

2.4.3 Geology

The Geological Survey of Western Australia 1:500, 000 scale mapsheet (Thorne and Trendall 2001) shows four geological types in the vicinity of the Mesa K study area. These comprise:

- **Czp** (Robe Pisolite: pisolite limonite deposits; developed palaeodrainage lines) occurring broadly over the hills of Mesa K;
- **Qa** (Alluvium: unconsolidated silt, sand, and gravel; in river channels) occurring in the Robe River and on the floodplain at the eastern edge of the survey area; and
- **Afj** (Jeerinah Formation: mudstone, siltstone, sandstone, chert, massive basaltic flows, basaltic pillow lava, basaltic breccia, and minor felsic volcanoclastic rock; intruded by numerous dolerite sills; metamorphosed) and **Ahm** (Marra Mamba Formation: chert, banded iron formation, mudstone and siltstone; metamorphosed) occurring in small areas along the western edge of the survey area.

2.5 Botanical Context of the Study Area

2.5.1 Pilbara IBRA Bioregion

The Interim Biogeographic Regionalisation for Australia (IBRA) recognises 85 bioregions (Environment Australia 2000). The study area lies within the Pilbara bioregion, at the northwestern end of the Hamersley subregion.

With increasing survey work in the Pilbara, it is becoming more apparent that the Pilbara bioregion is one of the centres of biodiversity in Western Australia. This appears to be related to the diversity of geological, altitudinal and climatic elements in the region, as well as a function of its location. The Pilbara is located in a transitional zone between the floras of the Eyrean (central desert) and southern Torresian (tropical) bioclimatic regions, and contains elements of both floras (see for example van Leeuwen and Bromilow 2002) for a detailed discussion of the significance of the Hamersley Range). In recognition of this high species diversity and the high levels of endemism in the region, the Pilbara has been nominated as one of 15 national biodiversity "hotspots" by the Minister for the Environment and Heritage (go to www.deh.gov.au/minister/env/2003/mr03oct03.html).

The Pilbara bioregion is listed as a medium priority for funding for land purchase under the National Reserves System Co-operative Program due to the limited representation of the area in conservation reserves. Portions of various pastoral leases in the region have been nominated for exclusion for public purposes in 2015, when the leases come up for renewal. Many of the submissions are from the Department of Environment and Conservation (DEC), with the intention of adding these areas to the existing conservation estate in order to provide a comprehensive, adequate and representative reserve system. None of these proposed exclusions are located in the vicinity of the study area.

2.5.2 Beard's Vegetation Mapping

Beard (1975) mapped the vegetation of the Pilbara at a scale of 1:1,000,000. The study area lies entirely within the Fortescue Botanical District of the Eremaean Botanical Province as defined by Beard. The vegetation of this province is typically open, and frequently dominated by Spinifex, wattles and occasional Eucalypts.

Beard's mapping units intersected by the study area include:

- *Acacia pyrifolia* and/or *A. bivenosa* sparse shrubs over *Triodia basedowii* and/or *T. wiseana* hummock grasslands; and
- Riverine woodland dominated by eucalypts in the Robe River (Beard 1975).

Given the broad nature of Beard's mapping, these units are only broadly applicable to the vegetation occurring in the study area (see Section 4.2).

2.5.3 More Detailed Botanical Studies in the Area

Various other areas around Pannawonica have been surveyed as part of baseline vegetation and flora surveys for Robe River Iron Associates, including work associated with Mesa A (see Trudgen 2003a, 2003b; Biota 2005a, 2006, Biota in prep.), Mesa G (Biota 2005a), at or near Mesa J (Trudgen 2002; Biota 2003, 2005b), Mesa L and Mesa L Minor (Biota 2005c), and Bungaroo Creek (Trudgen 2003c, Biota 2007a).

As previously mentioned, the Department of Agriculture (van Vreeswyk et al. 2004) has carried out a broadscale survey of parts of the Pilbara, which provides broad vegetation descriptions for the component land units within each Land System (see Section 2.4.2). The DEC is also in the process of undertaking the Pilbara Biological Survey, which is expected to finish in 2007: data from this study is not yet available.

2.5.4 Threatened Ecological Communities Known from the Locality

No Threatened Ecological Communities have been identified in the Pannawonica locality to date. However, in the Western Australian Biodiversity Audit prepared by the DEC, "all major ephemeral water courses" (which would include the Robe River) are identified as "ecosystems at risk" due to pressures from weed invasion and grazing by introduced herbivores (see Kendrick 2001).

2.5.5 Flora of Conservation Significance Known from the Locality

There are no records of Declared Rare Flora in the Pannawonica locality to date, despite intensive and systematic searches of a number of areas (see Section 2.5.3). Other flora of conservation significance known to exist in the locality include:

- *Abutilon trudgenii* ms. (Priority 3 species);
- *Hibiscus brachysiphonius* (Priority 3 species);
- *Rhynchosia bungarensis* (Priority 3 species);
- *Sida* sp. *Wittenoom* (W.R Barker 1962) (Priority 3 species); and
- *Triodia* sp. nov. (an undescribed species of spinifex) (see Section 5.2).

3.0 Methodology

3.1 Botanical Survey Team and Timing of Survey

Approximately 172 ha (some 37%) of the Mesa K study area was surveyed in September 2005, as part of the broader study of the Mesa A transport corridor (Figure 4.1; see Biota 2006). The survey was conducted by Michi Maier, Myles Menz (both of Biota) and Brian Morgan (private consultant), and comprised:

- Rare flora searches (and recording of weed locations) and vegetation mapping; and
- Establishment of one 50 m x 50 m floristic survey quadrat (MATR19) (see Section 3.3).

In addition, a rare flora survey was conducted in September 2005 by the same botanists listed above within a narrow corridor encompassing the existing Robe River causeway on the access road to Mesa J (Biota 2005d).

Further survey work was conducted by Paul Hoffman and Rachel Warner (both of Biota) from the 7th to 11th of November 2006 to ground-truth the remainder of the study area (Figure 4.1). This work included:

- Rare flora searches of the remaining sections of the project area (during which weed locations were also noted);
- Extension of the existing vegetation mapping to cover the entire project area; and
- Establishment of an additional 50m x 50m floristic survey quadrat (MEK01).

3.1.1 Seasonal Conditions

The initial survey work followed six months of substantial and repeated rainfall (a total of 210 mm) for the Pannawonica locality, and conditions at this time were thus optimal for the collection of annual flora (Figure 3.1). Prior to the November 2006 survey, there was only 7.4 mm of rainfall over a six month period (Figure 3.1): conditions at this time were dry, and not optimal for the collection of ephemeral and cryptic species.

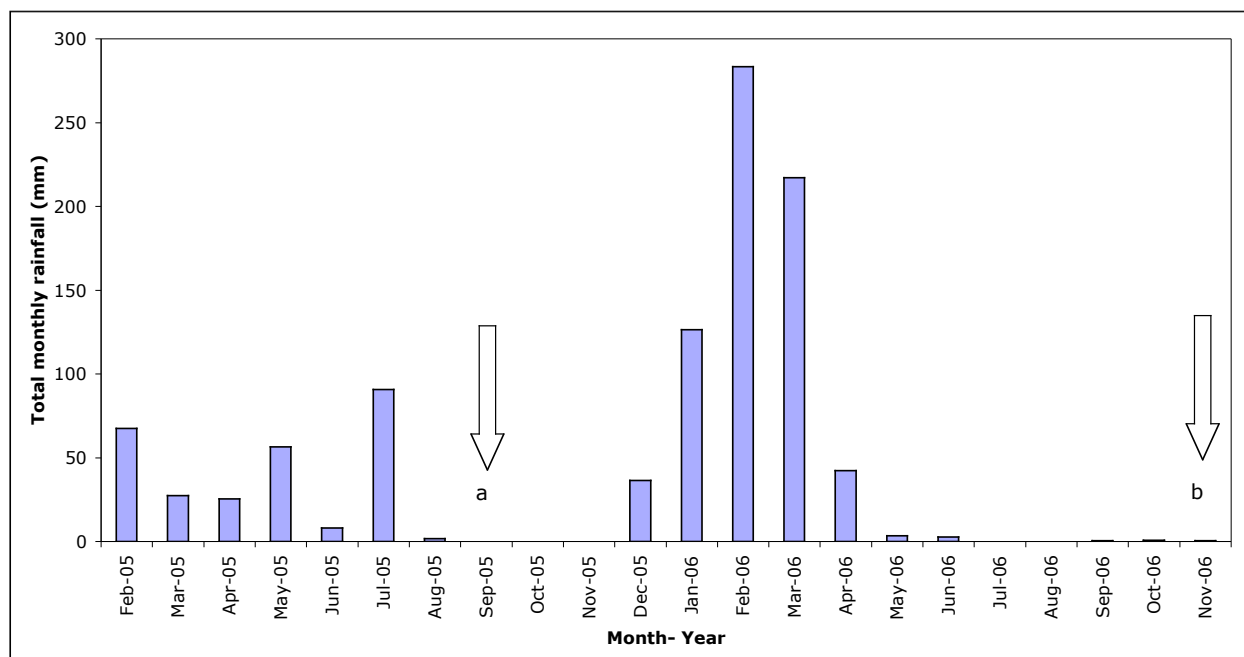


Figure 3.1: Monthly rainfall for Pannawonica from February 2005 to November 2006 (data supplied by Bureau of Meteorology) and timing of botanical surveys in the study area: a= initial survey by M. Maier, M. Menz and B. Morgan; b= survey of remaining area at Mesa K by P. Hoffman and R. Warner.

3.2 Vegetation Description and Mapping

In the current study, 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) to include a hummock grassland category (see Appendix 1). Descriptions were made at the two floristic survey quadrats (see Section 3.3) and at various other points in the study area. Vegetation boundaries were ground-truthed during the systematic foot traverses required for the rare flora searches (see Section 3.4).

The vegetation descriptions were then grouped to arrive at vegetation units that were defined on the basis of a shared suite of perennial species with a similar range of cover values. These have been listed under the main landform/habitat types in which they were found to occur. Alternative approaches could utilise another framework, such as Land System (Rangelands) mapping or geology.

The coding system for the vegetation types incorporated the dominant flora species for the type, organised from tallest strata to lowest strata. Species names were abbreviated to capital letter/s for genus, followed by lower case letter/s for species, with multiple letters used where necessary to avoid confusion (eg. EcMaAtrPISg = dominant species *Eucalyptus camaldulensis*, *Melaleuca argentea*, *Acacia trachycarpa*, *Petalostylis labicheoides* and *Stemodia grossa*). Although this can result in some large and unwieldy codes, this system at least allows for continual expansion of vegetation types while retaining original coding, allowing easier rationalisation of vegetation mapping between different studies.

The mapping notes gathered in the field were used to prepare a draft map of vegetation, utilising rectified 1:20,000 scale colour digital photography as the background. The vegetation boundaries were subsequently digitised on-screen using the ArcView 3.2 package. The resulting shapefiles were "tagged" to provide each polygon with the vegetation unit code. Other point source datasets, such as locations of quadrats, weeds and priority flora, were generated into spatial data using MapInfo. These datasets were subsequently saved as separate MapInfo shapefiles.

These datasets, in conjunction with other data supplied from other organisations, were used in the production of the vegetation maps contained in this report. All maps were produced using the MapInfo package.

3.3 Assessment of Floristic Survey Quadrats

Given the small size of the study area and the amount of sampling already conducted in the Pannawonica area in similar habitats (see for example Biota 2006), only two quadrats were established: these were uniquely numbered (MATR19 and MEK01).

Quadrats were typically 50 m x 50 m, as this size gives a good sample of flora presence in the Pilbara. It also gives a good indication of the shrub and grass layer vegetation structure for most vegetation types in the Pilbara that occur in 'uniform' habitats (eg. plains and hillslopes, where vegetation stands are typically greater than this quadrat size).

Each quadrat was permanently marked using a steel fence dropper at one corner of the quadrat. An optical square and measuring tapes were used to ensure that the quadrat sides were correctly positioned.

The following parameters were recorded for each quadrat:

1. Location: Location coordinates recorded in WGS84 datum (within 1-2 m of GDA94) using a hand-held Global Positioning System (GPS), to an accuracy usually within 5 m; readings taken for all four corners of the quadrat;

2. Vegetation Description: Broad description based on the height and estimated cover of dominant species after Aplin's (1979) modification of the vegetation classification system of Specht (1970) (see Appendix 1);
3. Habitat: Description of landform and habitat;
4. Soil: Broad description of soil type and stony surface mantle;
5. Disturbance Details: Evidence of grazing, mining exploration activities, weed invasion, frequent fires etc. Note that fire effects are only considered as a negative impact if they are caused by repeated burning (such as that done for pastoral purposes). Fire is a natural and frequent process in the Pilbara to which the vegetation has adapted, and to class areas as being in poor condition simply because they have been recently burnt is misleading; and
6. Percentage Foliar Cover: Cover was estimated visually for each species. Estimates were made to the nearest percent where possible, or a range (eg. 5-10%) was used. '+' was used where only occasional individuals were present, with a cover of less than 1%.

Colour photographs of the vegetation at each site were taken using a digital camera.

3.4 Rare Flora Searches

Pilbara Iron's internal environmental management practices require all new development areas to be systematically searched for rare flora. The rare flora searches were conducted in 50-60 m wide transects throughout the entire survey area. The field botanists were each equipped with a Magellan™ hand-held GPS unit with a polygon overlay of the survey area up-loaded onto the device to ensure the team surveyed the correct area.

Location coordinates in WGS84 datum (zone 50) were recorded using a hand-held GPS for all rare flora and weed species noted. Numbers of individuals were counted or estimated for each location, and other details such as habitat and associated species were also recorded. Voucher specimens were also collected for lodgement with the Western Australian Herbarium. Rare Flora Report Forms have subsequently been completed and lodged with DEC.

All records of flora of conservation significance and weed species are presented in Appendix 3.

3.5 Specimen Identification and Nomenclature

Common species that were well known to the survey botanists were identified in the field. Voucher specimens of all other species were collected and assigned a unique number to facilitate tracking of data. These were pressed in the field, and dried in a drying oven.

These vouchers were then identified by keying out, reference to appropriate publications, use of a reference collection held by ME Trudgen and Associates, and comparison to the collections held at the Western Australian Herbarium. Paul Hoffman and Rachel Warner of Biota identified most specimens, with assistance from Michi Maier and Malcolm Trudgen (ME Trudgen & Associates) for various problematic groups. Specimens will be lodged with the Western Australian Herbarium for all taxa for which suitable material is available.

Nomenclature was checked against the current listing of scientific names recognised by the Western Australian Herbarium and updated as necessary. The main outdated nomenclature retained was that relating to *Cassia*. This genus is currently recognised as *Senna* (see Randell 1989), however the older *Cassia* classification (Symon 1966) was perceived to be a more realistic level of separation of the taxa (eg. with taxa such as '*glutinosa*' and '*pruinosa*' recognised at specific rather than subspecific level). A more detailed discussion is contained in Trudgen and Casson (1998), while a comparison of the nomenclature under the two classifications is presented in Appendix 2.

3.6 Data Management

All raw site data was entered into an Access database structure developed by Malcolm Trudgen and Ted Griffin (private consultant) held at Biota, with species names entered following identification of the specimens.

3.7 Limitations of this Study

A number of limitations of the field survey and subsequent conservation assessments are discussed in the following section. These are factors that must be considered when reviewing and applying the results of this study. Despite these limitations, the field study and the subsequent analyses are believed to give a reasonable representation of the flora and vegetation values of the Mesa K study area.

The main limitations of this study are as follows:

- Fungi and nonvascular flora (eg. algae, mosses and liverworts) were not specifically sampled, as is typical for surveys of this nature.
- Conditions at the time of the 2006 survey were dry and not optimal for the collection of annual species. It should be noted that the species of conservation significance that were considered likely to occur in the area (based on extensive work previously completed in the vicinity; see Biota 2006) are perennial flora that would have been evident despite the poor conditions.
- In addition, some species (eg. annual daisies that would germinate mostly after late winter rains) would not have been present or identifiable at the time of the field surveys, and the floristic survey quadrats were only sampled once. The species lists should therefore be taken as indicative rather than exhaustive.

4.0 Vegetation

4.1 Overview of Vegetation Types

Almost 50% of the study area was classed as "disturbed", being either entirely cleared of vegetation (Plate 4.1 and Plate 4.2) or comprising regenerating vegetation (mainly tall shrublands of wattle species) in rehabilitation areas (Plate 4.3 and Plate 4.4).

Seven vegetation types were described for the intact remnants within the Mesa K study area, all of which had been either identified previously within the area or within nearby areas of the broader Mesa A transport corridor (see Biota 2006).

Broadly, these vegetation types comprised:

- tall open shrublands of *Acacia atkinsiana* and *A. arida*, often with scattered *Acacia inaequilatera* and *Eucalyptus leucophloia*, over *Triodia wiseana* hummock grasslands on mesa crests and low stony hills;
- riverine forest of *Melaleuca argentea* and *Eucalyptus camaldulensis* var. *obtusa* in the Robe River itself; and
- low open woodlands of *Corymbia candida* or tall open shrublands of *Acacia synchronicia* and *A. bivenosa* over hummock grasslands of *Triodia epactia* or *T. longiceps* on the floodplain of the Robe River.

Individual vegetation types are described in Section 4.2 and are considered to be at or somewhat below the association level, although they are not strictly defined as such.



Plate 4.1: Cleared area adjacent to rail line.



Plate 4.2: Existing laydown area.



Plate 4.3: Regenerating vegetation in rehabilitation area.



Plate 4.4: Regenerating vegetation in rehabilitation area.

4.2 Descriptions of Vegetation Types

The distribution of the following vegetation types is shown in Figure 4.1.

4.2.1 Vegetation of Stony Hills

EIAatAarTw *Eucalyptus leucophloia* scattered low trees over *Acacia atkinsiana* (*A. arida*) open shrubland to tall shrubland over *Triodia wiseana* hummock grassland

This vegetation type occurred broadly over the crest of Mesa K, comprising some 36% of the study area, and was also recorded from Mesa A and Warramboos (Biota 2006). It was associated mainly with the Robe Land System, and to a lesser extent with the Newman and Peedamulla Land Systems. The shrub overstorey was dominated by *Acacia atkinsiana*, with a variable amount of *A. arida*. Other associated species: *Acacia ancistrocarpa*, *A. inaequilatera*, *Cassia notabilis*, *Corchorus sidoides* subsp. *sidoides*, *Ptilotus calostachyus* var. *calostachyus*, *Triumfetta clementii*. [No sites from the Mesa K study area; sites MEA01, MEA02, MEA07, MEA09, MEA12, MEA13, MEA16, MEA18, MEA20, MEA22 of the Mesa A / Mesa G study (Biota 2005a); sites WAR01, WAR07 and relevé MATMG of the Mesa A transport corridor study (Biota 2006).]

AiAarTw *Acacia inaequilatera* scattered tall shrubs over *A. arida* open shrubland to open heath over *Triodia wiseana* hummock grassland

This vegetation type occurred on the low stony hills south of the Robe River, associated with the Robe Land System, and has also been mapped at Warramboos and in the northern option of the Mesa A transport corridor surrounding Mesas B and C (Biota 2006). Other associated species: *Cassia oligophylla*, *Corchorus sidoides* subsp. *sidoides*, *Dysphania rhadinostachya* subsp. *rhadinostachya*, *Gomphrena cunninghamii*, *Ptilotus incanus*, *Trachymene oleracea* subsp. *oleracea*, *Triumfetta chaetocarpa*, *T. clementii*. [No sites from the Mesa K study area; site MATH11 of the Mesa A transport corridor study (Biota 2006).]

EIAiAbTw *Eucalyptus leucophloia* scattered low trees over *Acacia inaequilatera* scattered tall shrubs over *Acacia bivenosa* scattered shrubs to open shrubland over *Triodia wiseana* hummock grassland

This vegetation type occurred on low stony hills at the northern extent of the Mesa K study area, and was also recorded throughout the northern section and within the southern section of the Mesa A transport corridor (Biota 2006). It was most strongly associated with the Robe, Newman and Boolgeeda Land Systems, although it was also recorded on the McKay LS. The sparse to sometimes open shrub cover was typically dominated by *Acacia bivenosa*. Other associated species: *Cassia luerssenii*, *Corchorus sidoides* subsp. *sidoides*, *Dysphania rhadinostachya* subsp. *rhadinostachya*, *Gomphrena cunninghamii*, *Hakea chordophylla*, *Ptilotus calostachyus* var. *calostachyus*, *Trichodesma zeylanicum* var. *zeylanicum*. [No sites from the Mesa K study area.]

4.2.2 Vegetation of Major Creeklines and Floodplains

EcMaAtrPISg *Eucalyptus camaldulensis*, *Melaleuca argentea* open forest over *Acacia trachycarpa*, *Petalostylis labicheoides* tall open scrub over *Stemodia grossa* low shrubland

This vegetation type occurred in the Robe River itself, south of the Mesa K deposit, and has also been recorded in the northern option of the Mesa A transport corridor and along the Bungaroo Road (see Biota 2006). It is associated with the River Land System. Other associated species: *Acacia pyrifolia*, *Amaranthus undulatus*, *Chenopodium melanocarpum*, *Cleome viscosa*, *Corchorus sidoides* subsp. *sidoides*, *Cyperus vaginatus*, *Euphorbia* spp., *Goodenia lamprosperma*, *Gossypium robinsonii*, *Hybanthus aurantiacus*, *Mukia maderaspatana*, *Phyllanthus erwinii*, *P. maderaspatensis*, *Pluchea rubelliflora*, *Rhynchosia bungarensis*, *Sesbania cannabina*, *S. formosa*, *Trachymene oleracea* subsp. *oleracea*, *Trichodesma zeylanicum* var. *zeylanicum*, *Typha domingensis*. [Site MEK01 from the Mesa K study area; sites MATH12, MATH14, relevés MATC and MATMD of the Mesa A transport corridor study (Biota 2006).]

CcTe *Corymbia candida* scattered low trees to low woodland over *Triodia epactia* hummock grassland

This vegetation type occurred broadly on the Robe River floodplain within the Mesa K study area, and has also been recorded from the Yarraloola borefield and from west of Mesa G (see Biota 2006). The associated Land System is the River LS. Scattered tall shrubs of *Acacia inaequilatera*, *A. synchronica*, *A. trachycarpa*, *Hakea chordophylla* and *Petalostylis labicheoides* were typically present. Other associated species: *Abutilon otocarpum* (acute leaf form), *Acacia sclerosperma* subsp. *sclerosperma*, *Alternanthera nana*, *Boerhavia coccinea*, *Calotis hispidula*, *Dysphania rhadinostachya* subsp. *rhadinostachya*, *Euphorbia* spp., *Goodenia forrestii*, *Gossypium australe* (Burrup form), *Indigofera colutea*, *Mukia maderaspatana*, *Rhynchosia minima* var. *australis*, *Sida rohlenae* subsp. *rohlenae*, *Solanum horridum*, *Themeda triandra*, *Triodia wiseana*. [Site MATR19 from the Mesa K study area.]

AsyAbAaTe *Acacia synchronica*, *A. bivenosa*, *A. ancistrocarpa* open shrubland to shrubland over *Triodia epactia* open hummock grassland

This vegetation type occurred in a small patch on the Robe River floodplain, associated with the River Land System. It has also been mapped on stony plains in the Yarraloola borefield and pipeline corridor, and through the northern option of the Mesa A transport corridor, where it was recorded mainly from the Cane Land System (Biota 2006). Other associated species: *Alternanthera nana*, *Cassia notabilis*, *Cleome viscosa*, *Dysphania rhadinostachya* subsp. *rhadinostachya*, *Euphorbia boophthona* (large seed form), *Evolvulus alsinoides* var. *villosicalyx*, *Flaveria australasica*, *Goodenia forrestii*, *Indigofera linifolia*, *Ipomoea muelleri*, *Rhynchosia minima* var. *australis*, *Sida* aff. *fibulifera* (various forms), *Sida* sp. Wittenoom (W.R. Barker 1962), *Solanum horridum*, *Sporobolus australasicus*, *Streptoglossa bubakii*, *Tribulus macrocarpus*, *Trichodesma zeylanicum* var. *zeylanicum*, *Triumfetta clementii*. [No sites from the Mesa K study area; sites MATH13, MATR24 and relevé MATMF of the Mesa A transport corridor study (Biota 2006).]

AsyAbTlo *Acacia synchronica*, *A. bivenosa* open shrubland over *Triodia longiceps* hummock grassland

This vegetation type occurred on a small area of calcareous soil on the Robe River floodplain, associated with the River Land System. It was also noted as uncommon within the Mesa A transport corridor, being recorded from small areas of stony plain south of Mesa A and west of Mesa G (Biota 2006). Other associated species: *Dysphania rhadinostachya* subsp. *rhadinostachya*, *Euphorbia boophthona* (large seed form), *Streptoglossa bubakii*, *Trichodesma zeylanicum* var. *zeylanicum*. [No sites from the Mesa K study area.]

4.3 Conservation Significance of the Vegetation Types

4.3.1 Vegetation Condition

As mentioned in Section 4.1, almost 50% of the ground surface within the Mesa K study area has been previously disturbed: these areas were considered to be in Poor condition.

With respect to the relatively intact vegetation in the remainder of the study area:

- the vegetation types associated with the stony hills habitats supported no or only few weeds, and were considered to be in Excellent to Very Good condition; and
- the vegetation types associated with the Robe River itself and the adjacent floodplain supported a variety of weed species, though generally only as scattered individuals: these areas were considered to be in Very Good to Good condition.

4.3.2 Distribution of the Mesa K Vegetation Types in the Pannawonica Locality

All of the vegetation types recorded from the Mesa K study area have been mapped elsewhere in nearby study areas, including within the Mesa A transport corridor (see Biota 2006) and on Mesa A itself (see Biota 2005a). None are expected to be particularly restricted in the

Pannawonica locality, given the landforms and dominant species, however vegetation type EcMaAtrPISg would be restricted to the Robe River itself.

4.3.3 Conservation Significance of the Vegetation Types Found in the Mesa K Survey Area

The areas classed as "disturbed" are considered to have no particular conservation value for flora and vegetation.

With respect to the intact vegetation types:

- EcMaAtrPISg of the Robe River is considered to be of High conservation significance; this habitat supports Priority flora and other restricted taxa, and comprises the major local drainage feature;
- the remainder of the vegetation types are considered to have Moderate conservation significance, comprising areas of native vegetation in relatively good condition.

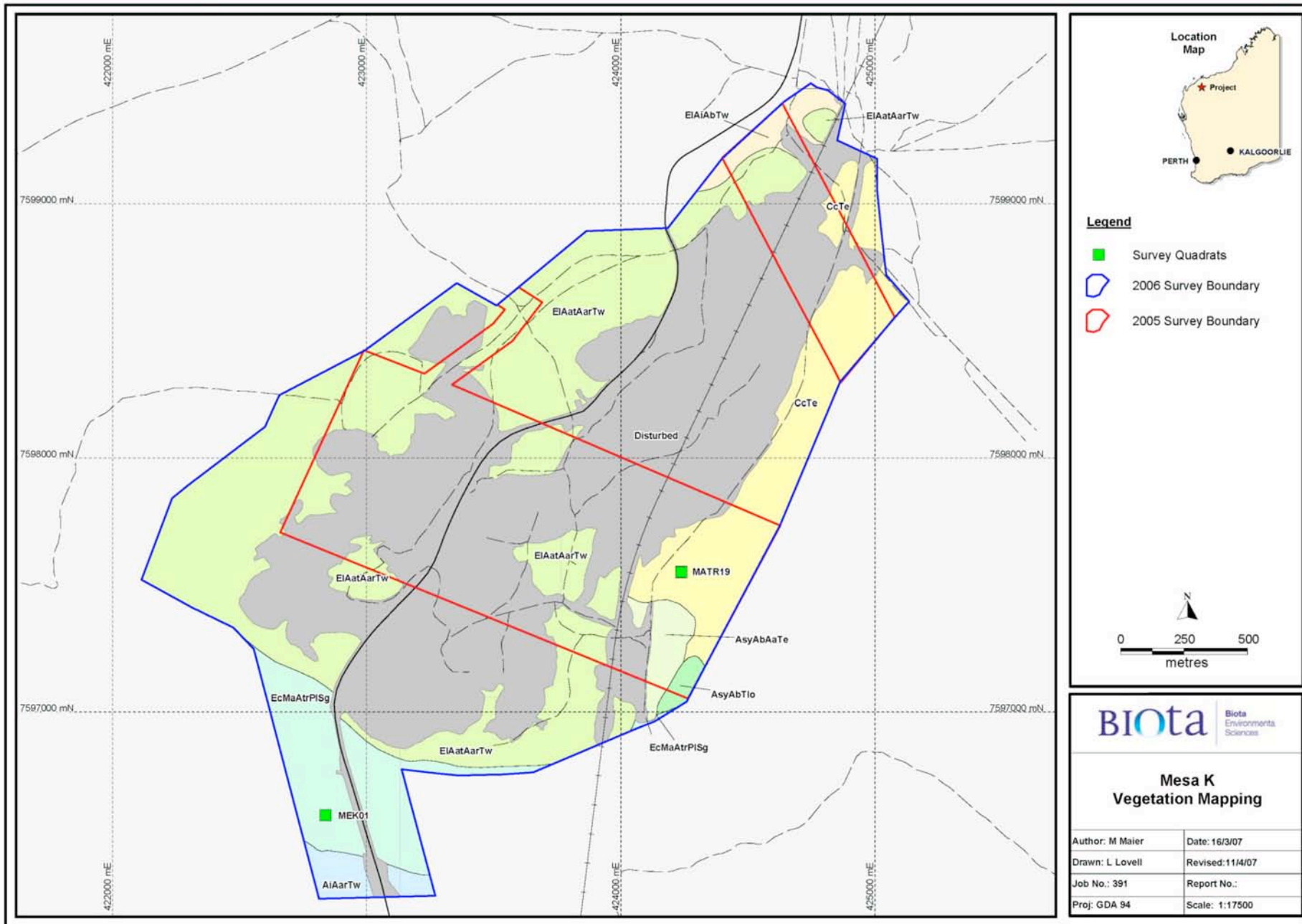


Figure 4.1: Vegetation of the Mesa K study area.

Vegetation mapping for Mesa K

	CcTe	<i>Corymbia candida</i> scattered low trees to low woodland over <i>Triodia epactia</i> hummock grassland
	EcMaAtrPISg	<i>Eucalyptus camaldulensis</i> , <i>Melaleuca argentea</i> open forest over <i>Acacia trachycarpa</i> , <i>Petalostylis labicheoides</i> tall open scrub over <i>Stemodia grossa</i> low shrubland
	AiAarTw	<i>Acacia inaequilatera</i> scattered tall shrubs over <i>A. arida</i> open shrubland to open heath over <i>Triodia wiseana</i> hummock grassland
	EIAatAarTw	<i>Eucalyptus leucophloia</i> scattered low trees over <i>Acacia atkinsiana</i> (<i>A. arida</i>) open shrubland to tall shrubland over <i>Triodia wiseana</i> hummock grassland
	AsyAbAaTe	<i>Acacia synchronicia</i> , <i>A. bivenosa</i> , <i>A. ancistrocarpa</i> open shrubland to shrubland over <i>Triodia epactia</i> open hummock grassland
	AsyAbTlo	<i>Acacia synchronicia</i> , <i>A. bivenosa</i> open shrubland over <i>Triodia longiceps</i> hummock grassland
	EIAiAbTw	<i>Eucalyptus leucophloia</i> scattered low trees over <i>Acacia inaequilatera</i> scattered tall shrubs over <i>Acacia bivenosa</i> scattered shrubs to open shrubland over <i>Triodia wiseana</i> hummock grassland
 <u>Other</u>		
	Disturbed	

5.0 Flora

5.1 Overview of Flora

A total of 164 taxa of native vascular flora from 91 genera belonging to 42 families was recorded from the study area (see Appendix 2). In addition, 14 species of introduced flora were recorded (see Section 5.3).

The families and genera with the greatest number of native taxa within the study area are shown in Table 5.1 and Table 5.2. These are all typical dominant plant groups for study sites in the locality.

Table 5.1: Most species rich families within the Mesa K study area.

Family	No. of Native taxa (No. of Introduced Taxa)
Malvaceae (hibiscus family)	18 (1)
Mimosaceae (wattle family)	18
Poaceae (grass family)	17 (4)
Asteraceae (daisy family)	12 (2)
Amaranthaceae (mulla-mulla family)	12 (1)
Euphorbiaceae (spurge family)	9 (1)
Papilionaceae (pea family)	9

Table 5.2: Most species rich genera within the Mesa K study area.

Genus	No of Native taxa (No. of Introduced Taxa)
<i>Acacia</i> (wattle family)	18
<i>Sida</i> (hibiscus family)	8
<i>Ptilotus</i> (mulla-mulla family)	7
<i>Euphorbia</i> (spurge family)	5 (1)
<i>Abutilon</i> (hibiscus family)	5
<i>Cassia</i> (cassia family)	4

5.2 Flora of Conservation Significance

5.2.1 Legislative and Administrative Levels of Conservation Protection

While all native flora are protected under the *Wildlife Conservation Act 1950-1979*, a number of plant species are assigned an additional level of conservation significance based on the limited number of known populations and the perceived threats to these populations (Table 5.3). Species of the highest conservation significance are designated Declared Rare Flora (DRF), either extant or presumed extinct. Species that appear to be rare or threatened, but for which there is insufficient information to properly evaluate their conservation significance, are assigned to one of four Priority flora categories.

In addition, the presence of some flora species means that it may be necessary to refer proposals to the Federal Minister for the Environment under the *Environment Protection and Biodiversity Conservation Act 1999*. In the Pilbara, only the two Declared Rare Flora species (*Lepidium catapycnon* and *Thryptomene wittweri*) are currently listed under the *EPBC Act*.

Table 5.3: Categories of conservation significance for flora species (Atkins 2006).

Declared Rare Flora - Extant Taxa. Taxa that 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.
Declared Rare Flora - Presumed Extinct. Taxa which have not been collected, or otherwise verified, over the past 50 years despite thorough searching, or of which all known wild populations have been destroyed more recently.
Priority 1 - Poorly Known Taxa. Taxa which are known from one or a few (generally <5) populations which are under threat.
Priority 2 - 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.
Priority 3 - Poorly Known Taxa. Taxa which are known from several populations, at least some of which are not believed to be under immediate threat.
Priority 4 - Rare Taxa. Taxa which are considered to have been adequately surveyed and which whilst being rare, are not currently threatened by any identifiable factors.

5.2.2 Probability of Declared Rare Flora Occurring in the Mesa K Survey Area

There are currently only two Declared Rare Flora (DRF) in the Pilbara; Mountain Thryptomene *Thryptomene wittweri* and Hamersley Lepidium *Lepidium catapycnon*. Neither species has been recorded to date from the Mesa K study area, nor from the vicinity of Pannawonica.

T. wittweri is much less common than *L. catapycnon*. Within the Pilbara bioregion, it occurs only on high-altitude hilltops further east in the Hamersley subregion. There are also records from the Gascoyne and Great Victoria Desert bioregions. As there is no suitable habitat for *T. wittweri* in the Mesa K Project area, this species would not be expected to occur.

L. catapycnon occurs in hummock grasslands on low stony hills and occasionally stony plains in the Hamersley subregion. This relatively short-lived low shrub species is often recorded from areas that have recently been disturbed, apparently persisting for only a few years. While suitable habitat for *L. catapycnon* is present throughout the Mesa K study area, intensive searches of the study area (and of extensive similar habitat in the Pannawonica area) by botanists with familiarity of this species have not located any populations.

There are thus no DRF or listed Threatened Flora Species under the *EPBC Act 1999* within the Mesa K survey area.

5.2.3 Priority Flora Occurring Within the Mesa K Survey Area

Three species listed as Priority 3 taxa by DEC were found within the Mesa K survey area. The broad distribution of these species within the study area is shown in Table 5.4, and each is discussed individually below.

Table 5.4: Priority species found in the Mesa K study area.

Species	No. of Records* (No. of Individuals)*	Broad Location
<i>Abutilon trudgenii</i> ms.	44 (80+ plants)	Widespread, mainly on the Robe River floodplain adjacent to disturbed areas
<i>Rhynchosia bungarensis</i>	3 (25+ plants)	Scattered through the Robe River
<i>Sida</i> sp. Wittenoom (W.R. Barker 1962)	55 (630+ plants)	Widespread, mainly on the Robe River floodplain adjacent to disturbed areas

* Based on the current survey (November 2006) and previous survey work (see Biota 2005d, Biota 2006).

- ***Abutilon trudgenii* ms.**

Priority 3

This low shrub species has a relatively straggly habit (see Plate 5.1) and tends to occur in recently burnt or otherwise disturbed areas. Both factors probably contribute to the fact that it was poorly collected in the past, however it is now recorded routinely on surveys in the Hamersley Range.



Plate 5.1: *Abutilon trudgenii* ms.: young plant, leaf, and fruit (note pendant pedicels).

Specimens of *A. trudgenii* are lodged at the WA Herbarium from Cane River, Hillside Station, Goldsworthy, Pannawonica and Tom Price. However, according to the Priority Species List this species is known from other locations including Warralong, Woodstock, Point Sampson and Karratha (Atkins 2006). It has also been recorded from Yanrey Station on the eastern side of the Exmouth Gulf (M. Maier, pers. obs.), west of Dampier (Halpern Glick Maunsell 2000), and south-southeast of Port Hedland (Trudgen et al. 2002). Further inland in the vicinity of Newman, *A. trudgenii* was recorded 23 times by Trudgen and Casson (1998) during the West Angelas surveys, seven times during the initial survey of the Hope Downs rail corridor (Biota and Trudgen 2002), once during the Hamersley Range Extension to the Hope Downs rail corridor (Biota 2004a), three times during the survey of the FMG Stage A rail corridor between Port Hedland and Mindy Mindy (Biota 2004b), and four times from the FMG Stage B rail corridor and tenements (Biota 2004c). This species has also been recorded recently from areas around Pannawonica, including the Mesa J area (1 record; Biota 2005b), Mesa L Minor (7 records; Biota 2005c), Mesa A and Mesa G study areas (46 records; see Biota 2005a), the Bungaroo Valley (over 100 records; Biota 2007a), and within the Mesa A transport corridor study area (over 1,800 records from the combined area of the transport corridors, Warrambo deposit and Yarraloola borefield; Biota 2006, in prep.). Given the broad distribution of this species and the frequency with which it is recorded, it should be removed from the Priority flora listing (see Biota 2007b).

A. trudgenii was recorded 44 times within the Mesa K study area, mainly from vegetation type CcTe (see Section 4.2.2) on the broad floodplain bordering the Robe River, particularly in areas adjacent to waste dumps and roads (see Appendix 3). These records were mainly of single plants, and the total population is estimated at over 80 individuals.

- ***Rhynchosia bungarensis***

Priority 3

This pea is a perennial creeper, sometimes forming a dense shrub, with sticky trifoliate leaves and yellow flowers (see Plate 5.3). Bungaroo is the type locality for *R. bungarensis*; this species was recorded numerous times from gullies and floodplains in the Bungaroo Valley and has been recorded from a number of additional locations in the locality (mainly along the Robe River) (see Biota 2007a). It would appear to be common in the Pannawonica area but not abundant. *R. bungarensis* has also been recorded from Koodaideri in the eastern Pilbara, ~120km northwest of Newman (Biota unpublished data).

Rhynchosia bungarensis was recorded three times from the Mesa K study area: twice in the riverine forest of the Robe River (vegetation type EcMaAtrPISg; see Section 4.2.2), and once on the lower slopes and at the base of an adjacent rocky mesa (Appendix 3). These three records comprised at least 25 individuals, however this species should be considered to be scattered throughout the Robe River.



Plate 5.2: *Rhynchosia bungarensis*: an individual with the dense shrub-form habitat, and a close-up of a flowering stem.

• ***Sida* sp. Wittenoom (W.R. Barker 1962)**

Priority 3

This low to medium-height shrub is similar in appearance to the more common *Sida echinocarpa*, but differs in some key features, including having fewer carpels to its spiny fruit, and calyx lobes that are depressed or concave in the centres (Plate 5.3).



Plate 5.3: *Sida* sp. Wittenoom (W.R. Barker 1962): habit and fruit (note spiny carpels and concave calyx lobes).

Similar to *Abutilon trudgenii*, *Sida* sp. Wittenoom has been poorly collected in the past but is now recorded frequently during surveys in the Hamersley Range. This species is widespread through the Pilbara bioregion, occurring in both the Hamersley and Chichester subregions. Specific records include two locations in the Hope Downs rail corridor (Biota 2004a), nine locations in the FMG Stage A rail corridor (Biota 2004b), two locations in the FMG Stage B rail corridor (Biota 2004c), 5 locations in the Mesa J area (Biota 2005b), 1 location at Mesa L Minor (Biota 2005c), 24 locations at Mesa A and Mesa G (Biota 2005a), over 100 locations in the Bungaroo Valley (Biota 2007a), and over 2,500 locations within the combined area of the Mesa A transport corridor, Warrambo deposit and Yarraloola borefield (Biota 2006, in prep.). As for *Abutilon trudgenii*, given the relatively common nature and broad distribution of this species, it should be removed from the Priority flora listing (see Biota 2007b).

Sida sp. Wittenoom (W.R. Barker 1962) was recorded 55 times within the Mesa K study area, from similar areas to those in which *Abutilon trudgenii* ms. was recorded (ie. mainly near disturbed areas in vegetation type CcTe; see Section 4.2.2, Appendix 3). The total population of this species in the study area is estimated at over 600 individuals.

5.2.4 Other Flora of Conservation Significance

- ***Triodia* sp. nov.**

Trudgen (2002) recorded an undescribed spinifex (*Triodia*) species from mesas in the Robe Valley, mainly along the rocky upper edges of the mesas but also occasionally on the rocky crests. Specimens could not be matched with any of the species currently distinguished by the WA Herbarium, hence this taxon appeared to be a new entity. Trudgen (2002) describes this *Triodia* as quite common on mesas in the Robe Valley, but moderately geographically restricted and also habitat restricted. This spinifex has subsequently been recorded in the Mesa J area (Biota 2003; Biota 2005b), at Mesa L Minor (Biota 2005c), at Mesa G (Biota 2005a) and on the hills bordering the Bungaroo Valley (Biota 2007a), typically occurring in rocky habitats.

Scattered to dense populations of *Triodia* sp. nov. were recorded from 90 locations in the Mesa K study area, occurring mainly on rocky edges and crests of the main mesa and surrounding hills (vegetation types ElAatAarTw and AiAarTw). The total population in the study area is estimated at close to 2,300 individuals (see Appendix 3). This spinifex has a very different appearance to the other species that inhabit similar areas, such as *T. wiseana* and *T. epactia*: the Inflorescence is long and feathery and the leaves are less rigid (see Plate 5.4 and Plate 5.5).



Plate 5.4: Growth form of *Triodia* sp. nov.



Plate 5.5: Florets of *Triodia* sp. nov.

- ***Centaurium* sp.**

Two specimens of *Centaurium* collected from site MEK01 in the Robe River could not be positively identified). These were submitted to Mr Laurie Adams of the Australian National Herbarium for further consideration. He advised that there are significant taxonomic issues within this genus, and that until these are resolved, a conservative approach would retain all taxa other than *Centaurium clementii* in *C. spicatum* (L. Adams, Australian National Herbarium, pers. comm. 17/01/07). We have opted to maintain this taxa as "*Centaurium* sp." for the current report in order to highlight its apparent distinctness from the more typical *C. spicatum* collected from the study area.

- **Malvaceae family**

The Malvaceae family contains a large number of taxa in the Pilbara, many of which are poorly collected. The genera *Abutilon*, *Hibiscus* and *Sida* are particularly speciose, and apparently new taxa are frequently recorded, however the specimens collected from the Mesa K study area all appear to represent taxa collected previously from other locations in the Pilbara.

5.3 Introduced Flora (Weed Species)

Fourteen species of introduced flora were recorded in the Mesa K survey area (Table 5.5). Most records were associated with the Robe River, or with the adjacent floodplain (see Appendix 3).

According to Dr Stephen van Leeuwen (DEC Karratha), Mexican Poppy **Argemone ochroleuca* subsp. *ochroleuca* is a Declared Plant for the Pilbara under the *Agriculture and Related Resources Protection Act 1976*, however control is only required when the species occurs beyond the limits of creeklines. With the exception of Purpletop Chloris **Chloris barbata*, Asthma Plant **Euphorbia hirta*, Prickly Sowthistle **Sonchus ?asper* and Black Berry Nightshade **Solanum nigrum*, which are infrequently recorded in the Pilbara, all of the introduced species recorded are common and widespread weeds of the region (and most have been previously recorded in the Pannawonica locality; see Biota 2006). Kapok, Ruby Dock, Buffel Grass and Birdwood Grass are all considered to be serious environmental weeds by DEC.

Table 5.5: Weed species identified in the Mesa K survey area.

Species	No. of Records	Broad Distribution within the Mesa K Survey Area
<i>*Acetosa vesicaria</i> (Ruby Dock)	1	Single record adjacent to the Mesa J access road
<i>*Aerva javanica</i> (Kapok Bush)	5	Adjacent to access tracks at Mesa K and along the Mesa J access road
<i>*Argemone ochroleuca</i> subsp. <i>ochroleuca</i> (Mexican Poppy)	42	Mainly in the Robe River
<i>*Cenchrus ciliaris</i> (Buffel Grass)	97	Widespread through the Robe River floodplain east of Mesa K; also present in the Robe River itself
<i>*Cenchrus setiger</i> (Birdwood Grass)	39	Widespread through the Robe River floodplain east of Mesa K; also present in the Robe River itself
<i>*Chloris barbata</i> (Purpletop Chloris)	1	In the Robe River
<i>*Citrullus colocynthis</i> (Wild Melon)	13	Mainly in disturbed areas; also in the Robe River
<i>*Euphorbia hirta</i> (Asthma Bush)	2	In the Robe River
<i>*Lactuca serriola</i> (Prickly Lettuce)	1	In the Robe River
<i>*Malvastrum americanum</i> (Spiked Malvastrum)	13	Mainly on the Robe River floodplain; also in the river itself
<i>*Passiflora foetida</i> var. <i>hispida</i> (Stinking Passion Flower)	1	In the Robe River
<i>*Setaria verticillata</i> (Whorled Pigeon Grass)	3	In the Robe River
<i>*Solanum nigrum</i> (Black Berry Nightshade)	2	In the Robe River
<i>*Sonchus ?asper</i> (Prickly Sowthistle)	2	Along the Mesa J access road on the northern edge of the Robe River

A brief discussion of each species follows:

- Ruby Dock **Acetosa vesicaria* was initially introduced to the Pilbara for minesite rehabilitation, and has since spread to surrounding areas. It is an aggressive weed that spreads by vegetative material as well as seed. There was a single record of two plants adjacent to the Mesa J access road, on the north side of the Robe River causeway (Appendix 3). These plants should be removed to prevent their spread.
- Kapok **Aerva javanica* is a native of northern Africa and South West Asia, which was introduced to assist with rangeland revegetation (Hussey et al. 1997). This perennial shrub is now a widespread weed of arid regions and can be quite invasive in disturbed sandy substrates in the Pilbara. Kapok was recorded from three locations near access tracks around the Mesa K deposit, and from two locations adjacent to the Robe River causeway on the Mesa J access road (Appendix 3).
- Mexican Poppy **Argemone ochroleuca* subsp. *ochroleuca* is a relatively common weed of major creeks in the Hamersley Range, where it typically occurs in the open, gravelly creekbeds. This annual herb is difficult to control as it produces very large quantities of seed, and flooding of its preferred habitat can spread this seed for large distances. There were 42 records of Mexican Poppy from the Mesa K study area, virtually of which were from the Robe River, where it was often seen in large numbers (Appendix 3).

- Buffel Grass **Cenchrus ciliaris* and the less common Birdwood Grass **C. setiger* were introduced by pastoralists as fodder species in 1934 (Bisset 1964). Buffel Grass has demonstrated allelopathic capacities, whereby it releases chemicals that inhibit the growth of other plants, and both species are aggressive and effective competitors with native flora. These perennial grasses form dense tussock grasslands, particularly along creeklines, floodplains and in sandy coastal areas. Infestations of these species are common throughout the Hamersley Range, particularly in major creeklines. Within the Mesa K study area, Buffel Grass and Birdwood Grass were recorded from 97 locations and 39 locations respectively, mainly from the broad floodplain between the Robe River and Mesa K, and also scattered within the Robe River itself (Appendix 3).
- Purpletop Chloris **Chloris barbata* is an infrequent weed of the Pilbara region. Scattered individuals of this species were recorded at a single location in the section of the Robe River intersected by the Mesa K study area (Appendix 3).
- **Citrullus colocynthis*, native to Africa, is a member of the Cucurbitaceae family and is recognised by its deeply lobed leaves, creeping habit and grasping tendrils. Widespread throughout Western Australia, including the Pilbara, scattered individuals of this species were recorded at 13 locations in the Mesa K study area, mainly in disturbed areas but also in the Robe River (Appendix 3). This species is not considered to be a serious environmental weed.
- Asthma Plant **Euphorbia hirta* was recorded from two locations within the Robe River. Although no specimens from the Pilbara have been lodged with the WA Herbarium to date, this species was recorded near Mesa G (Biota 2005a), from four locations spread through the northern option of the Mesa A transport corridor (Biota 2006), from the Hope Downs rail alignment between Port Hedland and Newman (Biota and Trudgen 2002), and has also been seen at Karratha townsite (Michi Maier, Biota, pers. obs.).
- Prickly Lettuce **Lactuca serriola* is a spindly, erect annual daisy, which is encountered infrequently in the Pilbara. **L. serriola* has been recorded at West Angelas and Jimblebar, near Newman (Biota, unpubl. data) and from the vicinity of a permanent soak in the Bungaroo valley (Biota 2007a). This species was recorded once in the Mesa K study area, at the same site at which **Chloris barbata* was recorded (Appendix 3).
- Spiked Malvastrum **Malvastrum americanum* is a common weed of Mulga vegetation, clayey substrates and creeklines. Native to tropical America, **M. americanum* infests creeklines and rivers of the Pilbara, where it thrives largely because it is not grazed by stock. Nearly all major creeklines of the Pilbara carry this species, but within the Mesa K study area, Spiked Malvastrum was only an incidental species in the Robe River: most of the 13 records came from the adjacent floodplain (Appendix 3).
- Stinking Passion Flower **Passiflora foetida* var. *hispidula* is widespread in the Kimberley bioregion, and has been recorded from a number of major creeklines in the Pilbara. This species was recorded once from the Mesa K study area, from the same site in the Robe River at which **Chloris barbata* and **Lactuca serriola* were recorded (Appendix 3).
- Whorled Pigeon Grass **Setaria verticillata* is a widespread weed species of creeklines and Mulga vegetation in the Pilbara, but rarely occurs in large numbers. Within the Mesa K study area, this species was found in small numbers at three locations within the Robe River (Appendix 3).
- Black Berry Nightshade **Solanum nigrum* was recorded from two locations within the Robe River (Appendix 3). This species is widespread through Western Australia, but recorded infrequently in the Pilbara, mainly from coastal areas.
- There were two records of a species thought to be Prickly Sowthistle **Sonchus asper* from along the Mesa J access road at the northern edge of the Robe River (Appendix 3). This species has not been collected previously from the Pilbara and the records require confirmation.

6.0 Discussion and Recommendations

6.1 Probable Impacts of the Project

The potential impacts to vegetation and flora resulting from the proposed Mesa K project are primarily related to vegetation clearing. As the Mesa K ore deposit is located above the water table, there should be no impact on groundwater levels as a result of the project. Other potential impacts include weed introduction and/or spread, erosion and dust.

6.1.1 Clearing of Vegetation

Clearing of some vegetation will be required for remnant mining of the Mesa K pits and associated minor infrastructure. Much of the project area has already been historically disturbed (see Figure 2.2). The majority of activity associated with the Mesa K remnant mining project will be located within areas already disturbed by previous mining.

Of the intact vegetation types, EcMaAtrPlSg (the vegetation of the Robe River) is considered to be of high conservation significance: impact to this vegetation type should be avoided where possible, and otherwise minimised. Impact to this vegetation could result from construction of the causeway upgrade across the Robe River. This causeway upgrade should be designed and constructed to minimise clearing of vegetation through this area. If constructed at the natural ground surface level, there should be no alteration to surface drainage through this area.

6.1.2 Clearing of Rare Flora

No Declared Rare Flora have been found in the Mesa K study area, and none are expected to occur.

The study has identified additional populations of three Priority flora species, all of which are relatively common in the Pannawonica area. The section of the Mesa K survey area encompassing the Robe River contains the Priority 3 species *Rhynchosia bungarensis*. This area is also a sensitive habitat due to its function as the major drainage feature in the locality, and its potential function as a refugia for both flora and fauna species. *Rhynchosia bungarensis* has been recorded at a number of other locations along the Robe River and its tributaries during previous surveys (see Section 5.2.3) and is believed to be widespread within the upper Robe valley. No particular management is required for this species beyond minimising impact to the vegetation within the Robe River (see Section 6.1.1). The populations of *Abutilon trudgenii* ms. and *Sida* sp. Wittenoom (W.R. Barker 1962) are not considered significant from a conservation viewpoint, as there is general agreement that these two species warrant removal from the DEC Priority flora list (see Biota 2007b). In any case, the loss of a proportion of the individuals identified within the Mesa K study area would not be expected to impact on the conservation status of either species.

Additional populations of the undescribed species *Triodia* sp. nov. were also identified within the study area. On the basis of current information, this species has a geographically restricted range (the Pannawonica locality), but is well represented within this range.

6.1.3 Introduction and/or Spread of Weeds

The abundance of weeds in the Mesa K study area reflects the historical disturbance of the area, associated largely with pastoral use and with mining at both Mesa K and the nearby Mesa J mine (eg. construction of the railway and access road to Mesa J, and clearing of the historic pit areas and associated infrastructure areas at Mesa K (including numerous access roads, laydown areas and buildings)). Further development in the area has the potential to spread existing populations

within the study area and possibly introduce additional weed species: these issues should be managed through the implementation of appropriate weed management measures.

6.1.4 Dust and Erosion

The generation of dust through excavation of the mine pits, construction of roads and other infrastructure, and operation of the proposed mine has the potential to damage vegetation, however this is considered to be a minor impact provided standard dust suppression measures are implemented.

Erosion could likewise arise following disturbance of the soil profile and/or alteration of surface drainage patterns, however with the exception of the Robe River itself, there are no substrates particularly susceptible to erosion (eg. cracking clays) within the study area. The existing causeway across the Robe River does not appear to have caused any erosion in the vicinity, hence upgrade of this causeway should not be a significant factor.

6.2 Management Recommendations

The following management measures are proposed to minimise impact to the flora and vegetation of the Mesa K project area:

- Clearing of vegetation type EcMaAtrPISg, found within the Robe River system, should be avoided wherever possible, and otherwise minimised, particularly during upgrade of the causeway across the Robe River.
- All other clearing of intact vegetation should be minimised: mine planning should preferentially site infrastructure within historically disturbed areas. All vehicles should be required to keep to designated roads and tracks.
- Weed control measures should be developed and implemented to prevent the introduction or spread of weeds in the Mesa K project area. Weed hygiene and management controls should be developed and implemented prior to construction commencing.
- A Topsoil Management and Rehabilitation Plan should be prepared for all non-permanent cleared areas prior to the commencement of construction activities. This plan should include use of provenance collected native seed, characterisation and management of topsoil, and the respreading of cleared vegetative material. Recovery monitoring and appropriate remedial measures should also be carried out.
- Appropriate dust suppression measures should be implemented across the Mesa K project area during construction and operation to minimise effects on surrounding vegetation and flora.
- The appearance and significance of the Priority flora species in the area (particularly *Rhynchosia bungarensis*), and the need to avoid disturbance to such species wherever possible, should be communicated to all staff on site.
- Flora survey work undertaken in future for this and other projects should follow adequate rainfall (and even then, should preferably have a seasonal component to the study).

7.0 Acknowledgements

Apart from the botanical survey team mentioned in Section 3.1, the following persons are gratefully acknowledged for their assistance with this study:

- Mr Malcolm Trudgen (ME Trudgen & Associates) assisted with identification of some difficult plant groups.
- Mr Laurie Adams (Australian National Herbarium) accepted the *Centaurium* sp. for further consideration.

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Appendix 1

Site Data from Quadrats
Assessed within the Mesa K
Study Area

Vegetation Structural Classification and Condition Scale used for the current survey

Vegetation Structural Classes*

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

* Based on Aplin's (1979) modification of the vegetation classification system of Specht (1970): Aplin T.E.H. (1979). The Flora. Chapter 3 In O'Brien, B.J. (ed.) (1979). Environment and Science. University of Western Australia Press; Specht R.L. (1970). Vegetation. In The Australian Environment. 4th edn (Ed. G.W. Leeper). Melbourne.

Vegetation Condition Scale*

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

* Based on Trudgen M.E. (1988). A Report on the Flora and Vegetation of the Port Kennedy Area. Unpublished report prepared for Bowman Bishaw and Associates, West Perth.

Mesa A Transport	Site	MATR19				
Described	MyM	Date	16/09/2005	Type:	Q	50 x 50 m
MGA Zone	50	424238	mE	7597551	mN	
Habitat	Floodplain					
Soil	Red-brown sandy clay loam.					
Rock Type	Ironstone					
Vegetation	<i>Corymbia candida</i> subsp. <i>candida</i> low open shrubland over <i>Hakea chordophylla</i> scattered tall shrubs over <i>Triodia epactia</i> hummock grassland over <i>*Cenchrus ciliaris</i> very open tussock grassland					
Veg Condition	Good. Presence of <i>*Cenchrus</i> and signs of cattle					
Fire Age	>5 years since last fire					
Mesa K Biological	Site	MEK01				
Described	RW	Date	10/11/2006	Type:	Q	50 x 50 m
MGA Zone	50	422838	mE	7596593	mN	
Habitat	Bed of a major river (Robe River)					
Soil	Brown river sand with clay.					
Rock Type	Riverstone, ironstone					
Vegetation	<i>Melaleuca argentea</i> , (<i>Eucalyptus camaldulensis</i> var. <i>obtusa</i>) closed forest over <i>Petalostylis labicheoides</i> , <i>Sesbania formosa</i> open shrubland over <i>Stemodia grossa</i> low open shrubland over <i>Cyperus vaginatus</i> , (<i>Typha domingensis</i>) very open sedgeland					
Veg Condition	Very Good; signs of cattle and some weeds.					
Fire Age	>10 years since last fire					

Species	Quadrat MATR19	Quadrat MEK01	Opportunistic records from Mesa K	Opportunistic records from Robe River Causeway
<i>Abutilon dioicum</i>		+	nc	nc
<i>Abutilon lepidum</i>	+			
<i>Abutilon</i> aff. <i>lepidum</i> (1) (MET 15 352)			nc	
<i>Abutilon otocarpum</i> (acute leaf form)	+		nc	
<i>Abutilon trudgenii</i>	+		nc	
<i>Acacia ancistrocarpa</i>			nc	nc
<i>Acacia arida</i>			nc	nc
<i>Acacia atkinsiana</i>			nc	nc
<i>Acacia bivenosa</i>			nc	nc
<i>Acacia citrinoviridis</i>			nc	nc
<i>Acacia colei</i> var. <i>ileocarpa</i>	+		nc	
<i>Acacia coriacea</i>				nc
<i>Acacia elachantha</i>			nc	
<i>Acacia farnesiana</i>				nc
<i>Acacia inaequilatera</i>	+		nc	nc
<i>Acacia maitlandii</i>				nc
<i>Acacia orthocarpa</i>			nc	
<i>Acacia pyrifolia</i>			nc	nc
<i>Acacia sclerosperma</i> subsp. <i>sclerosperma</i>	+		nc	
<i>Acacia synchronicia</i>	+		nc	nc
<i>Acacia trachycarpa</i>	+	+	nc	nc
<i>Acacia tumida</i> var. <i>pilbarensis</i>			nc	
<i>Acacia xiphophylla</i>			nc	
* <i>Acetosa vesicaria</i>				nc
<i>Achyranthes aspera</i>			nc	
<i>Adriana urticoides</i> var. <i>urticoides</i>			nc	nc
* <i>Aerva javanica</i>			nc	nc
<i>Alternanthera nana</i>	+		nc	nc
<i>Alternanthera nodiflora</i>				nc
<i>Amaranthus undulatus</i>	+	+	nc	nc
<i>Ammannia baccifera</i>				nc
<i>Ammannia multiflora</i>		+		
<i>Amphipogon sericeus</i>			nc	
* <i>Argemone ochroleuca</i> subsp. <i>ochroleuca</i>		<1		nc
<i>Aristida holathera</i> var. <i>holathera</i>			nc	
<i>Aristida inaequiglumis</i>			nc	
<i>Basilicum polystachyon</i>				nc
<i>Boerhavia coccinea</i>	+		nc	
<i>Bonamia rosea</i>	+			
<i>Bulbostylis barbata</i>	+		nc	nc
<i>Calandrinia ptychosperma</i>	+			
<i>Calocephalus knappii</i>	+			
<i>Calotis hispidula</i>	+			
<i>Capparis spinosa</i> var. <i>nummularia</i>		+	nc	nc
<i>Cassia glutinosa</i>			nc	nc
<i>Cassia luerssenii</i>			nc	
<i>Cassia notabilis</i>	+		nc	
<i>Cassia oligophylla</i>			nc	
* <i>Cenchrus ciliaris</i>	5-10%	+		nc
* <i>Cenchrus setiger</i>	+	+		nc
<i>Centaurium spicatum</i>			nc	
<i>Centaurium</i> sp.		+		
<i>Centipeda minima</i> subsp. <i>macrocephala</i>		+		nc
<i>Chenopodium melanocarpum</i>	+			
* <i>Chloris barbata</i>		+		
* <i>Citrullus colocynthis</i>		+		nc

Species	Quadrat MATR19	Quadrat MEK01	Opportunistic records from Mesa K	Opportunistic records from Robe River Causeway
<i>Cleome viscosa</i>	+	+	nc	nc
<i>Corchorus sidoides</i> subsp. <i>sidoides</i>		+	nc	nc
<i>Corymbia candida</i> subsp. <i>candida</i>	2-5%		nc	
<i>Corymbia hamersleyana</i>				nc
<i>Crotalaria medicaginea</i> var. <i>neglecta</i>		+	nc	
<i>Cullen martinii</i>			nc	
<i>Cymbopogon ambiguus</i>			nc	nc
<i>Cynodon dactylon</i>				nc
<i>Cyperus vaginatus</i>		4		nc
<i>Dampiera candidans</i>			nc	
<i>Dodonaea coriacea</i>			nc	
<i>Dysphania kalpari</i>				nc
<i>Dysphania rhadinostachya</i> subsp. <i>rhadinostachya</i>	+		nc	nc
<i>Eleocharis atropurpurea</i>				nc
<i>Enneapogon caeruleus</i> var. <i>caeruleus</i>			nc	nc
<i>Eragrostis cumingii</i>	+		nc	
<i>Eragrostis dielsii</i>			nc	
<i>Eragrostis eriopoda</i>			nc	
<i>Eremophila forrestii</i> subsp. <i>forrestii</i>			nc	
<i>Eriachne aristidea</i>			nc	
<i>Eriachne pulchella</i> subsp. <i>dominii</i>				nc
<i>Eucalyptus camaldulensis</i> var. <i>obtusa</i>		15		
<i>Eucalyptus victrix</i>				nc
<i>Euphorbia australis</i>	+		nc	
<i>Euphorbia boophthona</i> (Large seed form)	+			
<i>Euphorbia careyi</i>		+		nc
<i>Euphorbia coghlanii</i>	+		nc	
* <i>Euphorbia hirta</i>		+		nc
<i>Euphorbia tannensis</i> subsp. <i>eremophila</i> (Hamersley form)				nc
<i>Evolvulus alsinoides</i> var. <i>decumbens</i>	+			
<i>Evolvulus alsinoides</i> var. <i>villosicalyx</i>	+		nc	
<i>Ficus opposita</i>				nc
<i>Flaveria australasica</i>		+	nc	nc
<i>Glinus lotoides</i>				nc
<i>Gomphrena cunninghamii</i>			nc	nc
<i>Goodenia forrestii</i>	+		nc	
<i>Goodenia lamprosperma</i>			nc	nc
<i>Goodenia microptera</i>			nc	
<i>Gossypium australe</i> (Burrup Peninsula form)	+		nc	
<i>Gossypium robinsonii</i>				nc
<i>Grevillea pyramidalis</i>				nc
<i>Hakea chordophylla</i>	+			
<i>Hakea lorea</i> subsp. <i>lorea</i>			nc	
<i>Helichrysum luteoalbum</i>		1		nc
<i>Hibiscus brachychlaenus</i>			nc	
<i>Hibiscus leptocladus</i>			nc	
<i>Hibiscus sturtii</i> var. aff. <i>grandiflorus</i>	+			
<i>Hybanthus aurantiacus</i>			nc	nc
<i>Indigofera colutea</i>	+		nc	
<i>Indigofera linifolia</i>			nc	
<i>Indigofera monophylla</i>				nc
<i>Ipomoea muelleri</i>		+	nc	nc
<i>Jasminum didymum</i> subsp. <i>lineare</i>	+	+	nc	nc
* <i>Lactuca serriola</i>		+		
<i>Lepidium muelleri-ferdinandii</i>				nc
<i>Lepidium pholidogynum</i>			nc	

Species	Quadrat MATR19	Quadrat MEK01	Opportunistic records from Mesa K	Opportunistic records from Robe River Causeway
<i>Leptopus decaisnei</i> var. <i>decaisnei</i>				nc
<i>Lobelia quadrangularis</i>		+		nc
* <i>Malvastrum americanum</i>	+		nc	
<i>Melaleuca argentea</i>		65		nc
<i>Mollugo molluginis</i>			nc	
<i>Mukia maderaspatana</i>	+	+	nc	nc
<i>Nicotiana occidentalis</i> subsp. <i>obliqua</i>		+		
<i>Nicotiana occidentalis</i> (insufficient material to determine subsp.)				nc
<i>Paspalidium clementii</i>			nc	nc
* <i>Passiflora foetida</i> var. <i>hispida</i>		+		nc
<i>Petalostylis labicheoides</i>		3	nc	nc
<i>Phyllanthus erwinii</i>	+		nc	nc
<i>Phyllanthus maderaspatensis</i>	+	+		nc
<i>Pluchea dentex</i>			nc	
<i>Pluchea rubelliflora</i>		+	nc	nc
<i>Polycarpaea corymbosa</i> var. <i>corymbosa</i>	+		nc	
<i>Pterocaulon sphaeranthoides</i>		+	nc	nc
<i>Pterocaulon sphaeranthoides</i> x <i>sphacelatum</i>	+			
<i>Ptilotus astrolasius</i> var. <i>astrolasius</i>			nc	nc
<i>Ptilotus auriculifolius</i>				nc
<i>Ptilotus axillaris</i>	+		nc	
<i>Ptilotus calostachyus</i> var. <i>calostachyus</i>			nc	nc
<i>Ptilotus exaltatus</i> var. <i>exaltatus</i>	+		nc	nc
<i>Ptilotus fusiformis</i> var. <i>fusiformis</i>				nc
<i>Ptilotus incanus</i> var. <i>incanus</i>			nc	nc
<i>Rhodanthe margarethae</i>				nc
<i>Rhyncharhena linearis</i>		+		
<i>Rhynchosia bungarensis</i>		+	nc	nc
<i>Rhynchosia minima</i> var. <i>australis</i>	+		nc	
<i>Salsola tragus</i> subsp. <i>tragus</i>	+		nc	nc
<i>Schoenoplectus subulatus</i>				nc
<i>Sclerolaena convexula</i>			nc	
<i>Sesbania cannabina</i>		+		nc
<i>Sesbania formosa</i>		1		nc
* <i>Setaria verticillata</i>		+		
<i>Sida clementii</i>			nc	
<i>Sida echinocarpa</i>			nc	nc
<i>Sida</i> aff. <i>fibulifera</i> (MET Site 1346)	+			
<i>Sida</i> aff. <i>fibulifera</i> (oblong; MET 15 220)			nc	
<i>Sida</i> aff. <i>fibulifera</i> (site 1394)	+		nc	
<i>Sida rohlena</i> subsp. <i>rohlena</i>	+		nc	
<i>Sida spinosa</i>				nc
<i>Sida</i> sp. Wittenoom (W.R. Barker 1962)			nc	
<i>Solanum ashbyae</i>			nc	nc
<i>Solanum diversiflorum</i>			nc	
<i>Solanum horridum</i>	+			nc
* <i>Solanum nigrum</i>		+		nc
* <i>Sonchus</i> ? <i>asper</i>				nc
<i>Sporobolus australasicus</i>				nc
<i>Stemodia grossa</i>		7		nc
<i>Streptoglossa bubakii</i>	+		nc	nc
<i>Streptoglossa decurrens</i>			nc	
<i>Stylobasium spathulatum</i>		+		nc
<i>Themeda triandra</i>	+		nc	
<i>Trachymene oleracea</i> subsp. <i>oleracea</i>		+		nc
<i>Trianthema triquetra</i>	+		nc	

Species	Quadrat MATR19	Quadrat MEK01	Opportunistic records from Mesa K	Opportunistic records from Robe River Causeway
<i>Tribulus macrocarpus</i>	+			
<i>Trichodesma zeylanicum</i> var. <i>zeylanicum</i>			nc	nc
<i>Triodia epactia</i>	50-60%		nc	nc
<i>Triodia wiseana</i>	+		nc	nc
<i>Triodia</i> sp. nov.			nc	
<i>Triumfetta chaetocarpa</i>				nc
<i>Triumfetta clementii</i>			nc	
<i>Typha domingensis</i>		1		nc
<i>Wahlenbergia tumidifructa</i>				nc
<i>Waltheria indica</i>			nc	

+ = minimal cover (<1%)

nc = present but no cover assigned.

Appendix 2

Vascular Flora Species List for the Mesa K Study Area

NB. * denotes introduced species

Comparison of *Cassia* versus *Senna* nomenclature:

<i>Cassia glutinosa</i>	–	<i>Senna glutinosa</i> subsp. <i>glutinosa</i>
<i>Cassia luerssenii</i>	–	<i>Senna glutinosa</i> subsp. <i>x luerssenii</i>
<i>Cassia notabilis</i>	–	<i>Senna notabilis</i>
<i>Cassia oligophylla</i>	–	<i>Senna artemisioides</i> subsp. <i>oligophylla</i>

Native Species

AIZOACEAE (110)
<i>Trianthema triquetra</i>
AMARANTHACEAE (106)
<i>Achyranthes aspera</i>
<i>Alternanthera nana</i>
<i>Alternanthera nodiflora</i>
<i>Amaranthus undulatus</i>
<i>Gomphrena cunninghamii</i>
<i>Ptilotus astrolasius</i> var. <i>astrolasius</i>
<i>Ptilotus auriculifolius</i>
<i>Ptilotus axillaris</i>
<i>Ptilotus calostachyus</i> var. <i>calostachyus</i>
<i>Ptilotus exaltatus</i> var. <i>exaltatus</i>
<i>Ptilotus fusiformis</i> var. <i>fusiformis</i>
<i>Ptilotus incanus</i> var. <i>incanus</i>
APIACEAE (281)
<i>Trachymene oleracea</i> subsp. <i>oleracea</i>
ASCLEPIADACEAE (305)
<i>Rhyncharhena linearis</i>
ASTERACEAE (345)
<i>Calocephalus knappii</i>
<i>Calotis hispidula</i>
<i>Centipeda minima</i> subsp. <i>macrocephala</i>
<i>Flaveria australasica</i>
<i>Helichrysum luteoalbum</i>
<i>Pluchea dentex</i>
<i>Pluchea rubelliflora</i>
<i>Pterocaulon sphaeranthoides</i>
<i>Pterocaulon sphaeranthoides</i> x <i>sphacelatum</i>
<i>Rhodanthe margarethae</i>
<i>Streptoglossa bubakii</i>
<i>Streptoglossa decurrens</i>
BORAGINACEAE (310)
<i>Trichodesma zeylanicum</i> var. <i>zeylanicum</i>
BRASSICACEAE (138)
<i>Lepidium muelleri-ferdinandii</i>
<i>Lepidium pholidogynum</i>
CAESALPINIACEAE (164)
<i>Cassia glutinosa</i>
<i>Cassia luerssenii</i>
<i>Cassia notabilis</i>
<i>Cassia oligophylla</i>
<i>Petalostylis labicheoides</i>
CAMPANULACEAE (339)
<i>Wahlenbergia tumidifruca</i>
CAPPARACEAE (137A)
<i>Capparis spinosa</i> var. <i>nummularia</i>
<i>Cleome viscosa</i>

CARYOPHYLLACEAE (113)
<i>Polycarpha corymbosa</i> var. <i>corymbosa</i>
CHENOPODIACEAE (105)
<i>Chenopodium melanocarpum</i>
<i>Dysphania kalpari</i>
<i>Dysphania rhadinostachya</i> subsp. <i>rhadinostachya</i>
<i>Salsola tragus</i> subsp. <i>tragus</i>
<i>Sclerolaena convexula</i>
CONVOLVULACEAE (307)
<i>Bonamia rosea</i>
<i>Evolvulus alsinoides</i> var. <i>decumbens</i>
<i>Evolvulus alsinoides</i> var. <i>villosicalyx</i>
<i>Ipomoea muelleri</i>
CUCURBITACEAE (337)
<i>Mukia maderaspatana</i>
CYPERACEAE (032)
<i>Bulbostylis barbata</i>
<i>Cyperus vaginatus</i>
<i>Eleocharis atropurpurea</i>
<i>Schoenoplectus subulatus</i>
EUPHORBIACEAE (185)
<i>Adriana urticoides</i> var. <i>urticoides</i>
<i>Euphorbia australis</i>
<i>Euphorbia boophthona</i> (large seed form)
<i>Euphorbia careyi</i>
<i>Euphorbia coghlanii</i>
<i>Euphorbia tannensis</i> subsp. <i>eremophila</i> (Hamersley form)
<i>Leptopus decaisnei</i> var. <i>decaisnei</i>
<i>Phyllanthus erwinii</i>
<i>Phyllanthus maderaspatensis</i>
GENTIANACEAE (303)
<i>Centaurium spicatum</i>
<i>Centaurium</i> sp. (pending further taxonomic research)
GOODENIACEAE (341)
<i>Dampiera candicans</i>
<i>Goodenia forrestii</i>
<i>Goodenia lamprosperma</i>
<i>Goodenia microptera</i>
LAMIACEAE (311)
<i>Basilicum polystachyon</i>
LOBELIACEAE (340)
<i>Lobelia quadrangularis</i>
LYTHRACEAE (265)
<i>Ammannia baccifera</i>
<i>Ammannia multiflora</i>
MALVACEAE (221)
<i>Abutilon dioicum</i>
<i>Abutilon lepidum</i>
<i>Abutilon</i> aff. <i>lepidum</i> (1) (MET 15 352)
<i>Abutilon otocarpum</i> (acute leaf form)
<i>Abutilon trudgenii</i>
<i>Gossypium australe</i> (Burrup Peninsula form)
<i>Gossypium robinsonii</i>
<i>Hibiscus brachychlaenus</i>
<i>Hibiscus leptocladus</i>
<i>Hibiscus sturtii</i> var. aff. <i>grandiflorus</i>
<i>Sida clementii</i>
<i>Sida echinocarpa</i>
<i>Sida</i> aff. <i>fibulifera</i> (MET Site 1346)

<i>Sida</i> aff. <i>fibulifera</i> (oblong; MET 15 220)
<i>Sida</i> aff. <i>fibulifera</i> (site 1394)
<i>Sida rohlenae</i> subsp. <i>rohlenae</i>
<i>Sida spinosa</i>
<i>Sida</i> sp. Wittenoom (W.R. Barker 1962)
MIMOSACEAE (163)
<i>Acacia ancistrocarpa</i>
<i>Acacia arida</i>
<i>Acacia atkinsiana</i>
<i>Acacia bivenosa</i>
<i>Acacia citrinoviridis</i>
<i>Acacia colei</i> var. <i>ileocarpa</i>
<i>Acacia coriacea</i>
<i>Acacia elachantha</i>
<i>Acacia farnesiana</i>
<i>Acacia inaequilatera</i>
<i>Acacia maitlandii</i>
<i>Acacia orthocarpa</i>
<i>Acacia pyrifolia</i>
<i>Acacia sclerosperma</i> subsp. <i>sclerosperma</i>
<i>Acacia synchronicia</i>
<i>Acacia trachycarpa</i>
<i>Acacia tumida</i> var. <i>pilbarensis</i>
<i>Acacia xiphophylla</i>
MOLLUGINACEAE (110A)
<i>Glinus lotoides</i>
<i>Mollugo molluginis</i>
MORACEAE (087)
<i>Ficus opposita</i>
MYOPORACEAE (326)
<i>Eremophila forrestii</i> subsp. <i>forrestii</i>
MYRTACEAE (273)
<i>Corymbia candida</i> subsp. <i>candida</i>
<i>Corymbia hamersleyana</i>
<i>Eucalyptus camaldulensis</i> var. <i>obtusata</i>
<i>Eucalyptus victrix</i>
<i>Melaleuca argentea</i>
NYCTAGINACEAE (107)
<i>Boerhavia coccinea</i>
OLEACEAE (301)
<i>Jasminum didymum</i> subsp. <i>lineare</i>
PAPILIONACEAE (165)
<i>Crotalaria medicaginea</i> var. <i>neglecta</i>
<i>Cullen martinii</i>
<i>Indigofera colutea</i>
<i>Indigofera linifolia</i>
<i>Indigofera monophylla</i>
<i>Rhynchosia bungarensis</i>
<i>Rhynchosia minima</i> var. <i>australis</i>
<i>Sesbania cannabina</i>
<i>Sesbania formosa</i>
POACEAE (031)
<i>Amphipogon sericeus</i>
<i>Aristida holathera</i> var. <i>holathera</i>
<i>Aristida inaequiglumis</i>
<i>Cymbopogon ambiguus</i>
<i>Cynodon dactylon</i>
<i>Enneapogon caeruleus</i> var. <i>caeruleus</i>
<i>Eragrostis cumingii</i>

<i>Eragrostis dielsii</i>
<i>Eragrostis eriopoda</i>
<i>Eriachne aristidea</i>
<i>Eriachne pulchella</i> subsp. <i>dominii</i>
<i>Paspalidium clementii</i>
<i>Sporobolus australasicus</i>
<i>Themeda triandra</i>
<i>Triodia epactia</i>
<i>Triodia wiseana</i>
<i>Triodia</i> sp. nov.
PORTULACACEAE (111)
<i>Calandrinia ptychosperma</i>
PROTEACEAE (090)
<i>Grevillea pyramidalis</i>
<i>Hakea chordophylla</i>
<i>Hakea lorea</i> subsp. <i>lorea</i>
SAPINDACEAE (207)
<i>Dodonaea coriacea</i>
SCROPHULARIACEAE (316)
<i>Stemodia grossa</i>
SOLANACEAE (315)
<i>Nicotiana occidentalis</i> (insufficient material for subsp. det.)
<i>Nicotiana occidentalis</i> subsp. <i>obliqua</i>
<i>Solanum ashbyae</i>
<i>Solanum diversiflorum</i>
<i>Solanum horridum</i>
STERCULIACEAE (223)
<i>Waltheria indica</i>
SURIANACEAE (160)
<i>Stylobasium spathulatum</i>
TILIACEAE (220)
<i>Corchorus sidoides</i> subsp. <i>sidoides</i>
<i>Triumfetta chaetocarpa</i>
<i>Triumfetta clementii</i>
TYPHACEAE (020)
<i>Typha domingensis</i>
VIOLACEAE (243)
<i>Hybanthus aurantiacus</i>
ZYGOPHYLLACEAE (173)
<i>Tribulus macrocarpus</i>

Weed Species

AMARANTHACEAE (106)
* <i>Aerva javanica</i>
ASTERACEAE (345)
* <i>Lactuca serriola</i>
* <i>Sonchus asper</i>
CUCURBITACEAE (337)
* <i>Citrullus colocynthis</i>
EUPHORBIACEAE (185)
* <i>Euphorbia hirta</i>
MALVACEAE (221)
* <i>Malvastrum americanum</i>
PAPAVERACEAE (135)
* <i>Argemone ochroleuca</i> subsp. <i>ochroleuca</i>
PASSIFLORACEAE (248)
* <i>Passiflora foetida</i> var. <i>hispida</i>
POACEAE (031)
* <i>Cenchrus ciliaris</i>

* <i>Cenchrus setiger</i>
* <i>Chloris barbata</i>
* <i>Setaria verticillata</i>
POLYGONACEAE (103)
* <i>Acetosa vesicaria</i>
SOLANACEAE (315)
* <i>Solanum nigrum</i>

Appendix 3

Locations of Rare Flora and
Weeds Within the Mesa K
Survey Area

Priority Flora Species

Records of *Abutilon trudgenii* ms. (Priority 3) from the Mesa K study area.

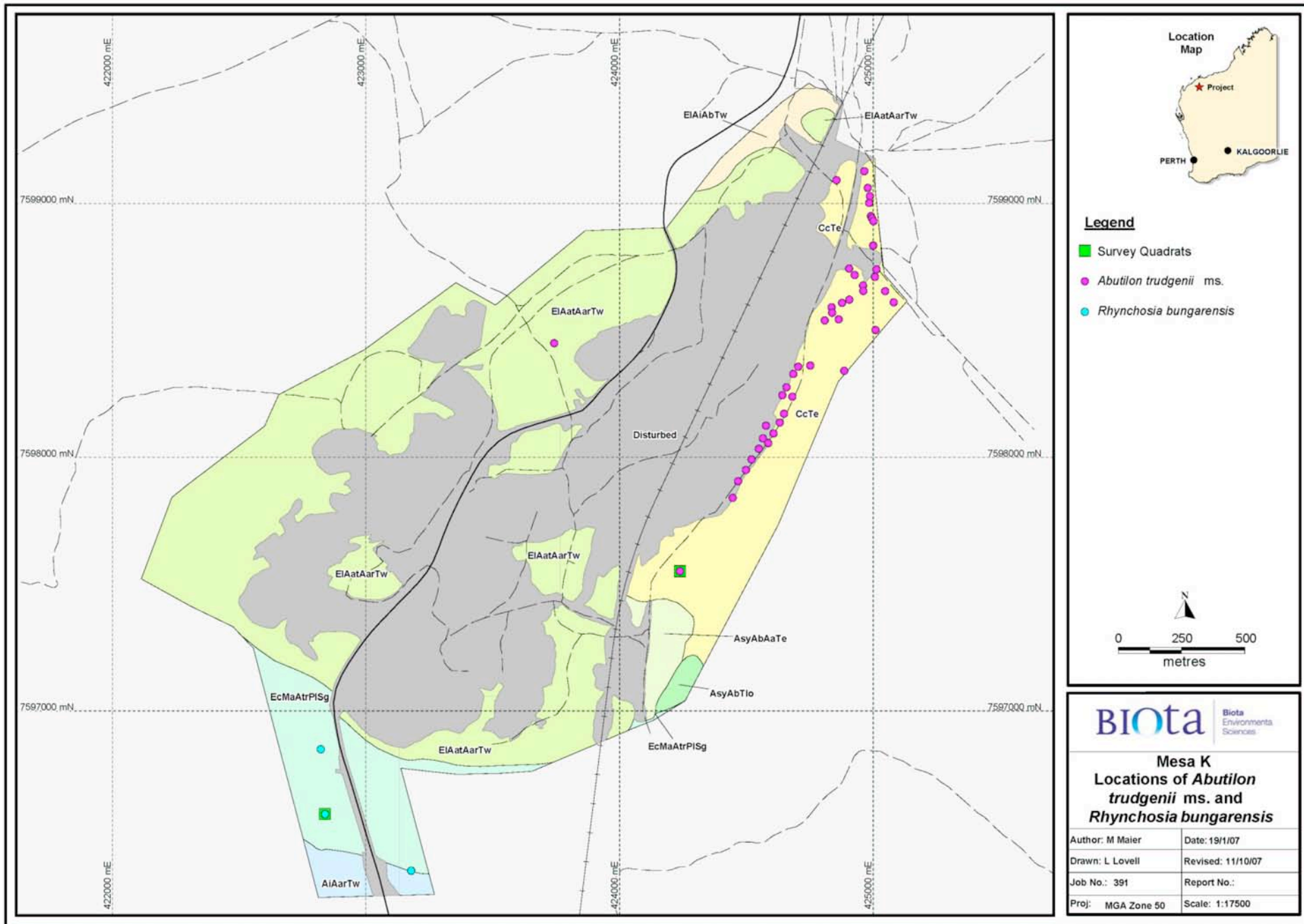
Easting (WGS84)	Northing (WGS84)	Recorder	Date	No. of Individuals
423742	7598450	PH	8/11/06	1
424238	7597551	MM	16/9/05	scattered
424446	7597840	MM	30/10/06	2
424467	7597906	MM	30/10/06	1
424498	7597950	MM	30/10/06	2
424520	7597992	MM	30/10/06	4
424549	7598034	MM	30/10/06	1
424565	7598075	MM	30/10/06	2
424577	7598125	MM	30/10/06	3
424586	7598056	MM	30/10/06	1
424607	7598094	MM	30/10/06	1
424632	7598137	MM	30/10/06	2
424642	7598245	MM	30/10/06	1
424648	7598172	MM	30/10/06	2
424658	7598276	MM	30/10/06	2
424681	7598239	MM	30/10/06	5
424685	7598329	MM	30/10/06	1
424704	7598357	MM	30/10/06	1
424752	7598362	MM	30/10/06	1
424809	7598540	MM	16/9/05	1
424836	7598592	MM	16/9/05	1
424838	7598570	MM	16/9/05	1
424855	7599093	MM	30/10/06	1
424864	7598544	MM	16/9/05	1
424877	7598609	MM	16/9/05	1
424886	7598341	MM	16/9/05	1
424905	7598744	MM	16/9/05	2
424906	7598622	MM	16/9/05	5
424927	7598719	MM	16/9/05	1
424960	7598677	MM	16/9/05	1
424961	7598656	MM	16/9/05	7
424965	7599128	MM	30/10/06	1
424979	7599062	MM	30/10/06	2
424984	7599003	MM	30/10/06	1
424987	7599030	MM	30/10/06	4
424991	7598951	MM	30/10/06	3
424995	7598943	MM	30/10/06	1
425000	7598835	MM	30/10/06	1
425001	7598931	MM	30/10/06	1
425007	7598711	MM	30/10/06	1
425009	7598502	MM	16/9/05	3
425013	7598741	MM	30/10/06	1
425047	7598655	MM	30/10/06	3
425081	7598611	MM	30/10/06	1

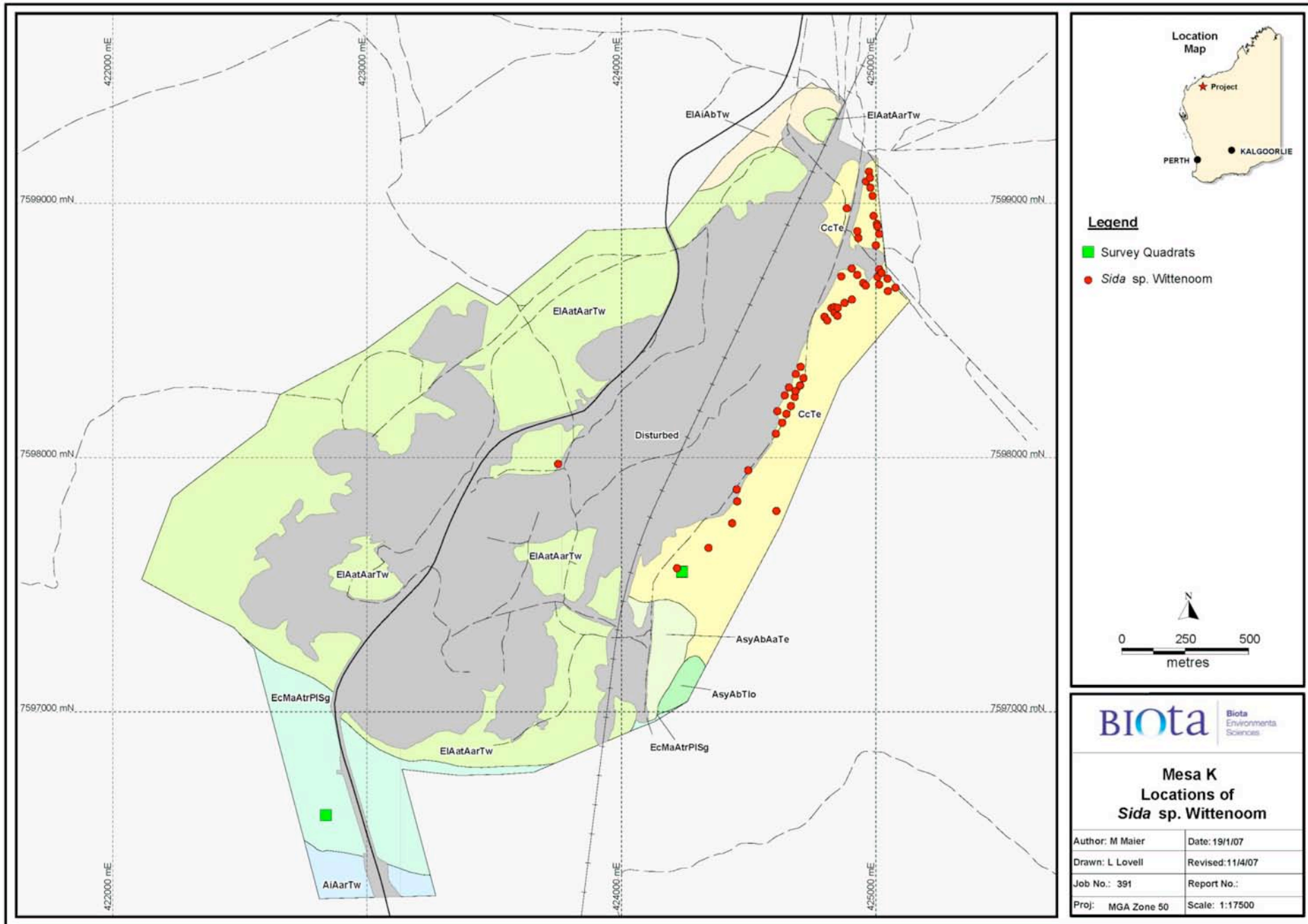
Records of *Rhynchosia bungarensis* (Priority 3) from the Mesa K study area.

Easting (WGS84)	Northing (WGS84)	Recorder	Date	No. of Individuals	Specimen	Comments
422822	7596849	MM	16/9/05	1		Robe River
422838	7596593	RW	9/11/06	scattered		Robe River
423178	7596370	RW	9/11/06	20	MEKRW-20	base of mesa, rocky outcrops immediately adjacent to Robe River

Records of *Sida* sp. Wittenoom (W.R. Barker 1962) (Priority 3) from the Mesa K study area.

Easting (WGS84)	Northing (WGS84)	Recorder	Date	No. of Individuals
423751	7597975	MyM	16/9/05	1
424218	7597565	MM	16/9/05	3
424342	7597645	MM	16/9/05	1
424435	7597742	MM	16/9/05	1
424453	7597875	MM	30/10/06	1
424455	7597828	MM	30/10/06	5
424498	7597950	MM	30/10/06	2
424607	7598094	MM	30/10/06	5
424609	7597790	MM	30/10/06	4
424613	7598183	MM	30/10/06	40
424632	7598137	MM	30/10/06	20
424642	7598245	MM	30/10/06	10
424648	7598172	MM	30/10/06	5
424658	7598276	MM	30/10/06	100
424666	7598203	MM	30/10/06	40
424681	7598239	MM	30/10/06	12
424684	7598262	MM	30/10/06	2
424685	7598329	MM	30/10/06	5
424702	7598284	MM	30/10/06	40
424704	7598357	MM	30/10/06	20
424715	7598313	MM	30/10/06	3
424798	7598554	MM	16/9/05	1
424809	7598540	MM	16/9/05	5
424825	7598588	MM	16/9/05	6
424836	7598592	MM	16/9/05	1
424838	7598570	MM	16/9/05	6
424849	7598558	MM	16/9/05	8
424850	7598590	MM	16/9/05	15
424864	7598713	MM	16/9/05	3
424877	7598609	MM	16/9/05	5
424886	7598981	MM	30/10/06	5
424905	7598744	MM	16/9/05	20
424906	7598622	MM	16/9/05	10
424927	7598891	MM	30/10/06	50
424927	7598719	MM	16/9/05	5
424931	7598864	MM	30/10/06	1
424950	7598687	MM	16/9/05	20
424960	7598677	MM	16/9/05	3
424961	7599087	MM	30/10/06	30
424973	7599125	MM	30/10/06	2
424977	7599101	MM	30/10/06	15
424979	7599062	MM	30/10/06	10
424987	7599030	MM	30/10/06	1
424991	7598951	MM	30/10/06	4
425000	7598835	MM	30/10/06	10
425004	7598920	MM	30/10/06	1
425006	7598910	MM	30/10/06	5
425007	7598711	MM	30/10/06	10
425013	7598880	MM	30/10/06	10
425013	7598741	MM	30/10/06	8
425013	7598681	MM	30/10/06	1
425022	7598727	MM	30/10/06	10
425046	7598704	MM	30/10/06	10
425047	7598655	MM	30/10/06	1
425077	7598669	MM	30/10/06	20



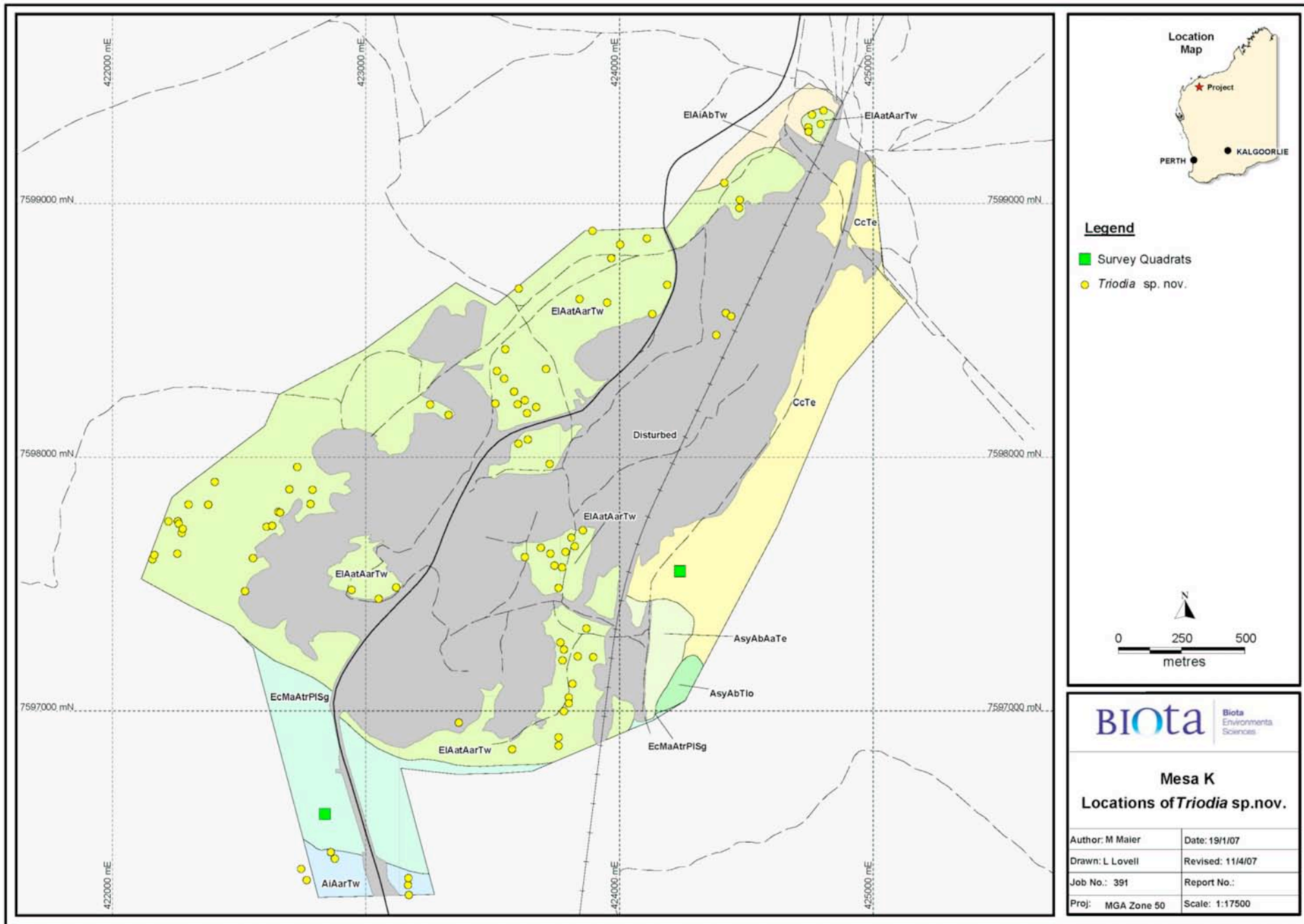


Other Flora of Conservation Significance

Records of *Triodia* sp. nov. from the Mesa K study area.

Eastings (WGS84)	Northing (WGS84)	Recorder	Date	No. of Individuals
422158	7597598	PH	8/11/06	55
422165	7597615	PH	8/11/06	30
422221	7597747	PH	8/11/06	20
422256	7597620	RW	8/11/06	30
422258	7597748	RW	8/11/06	10
422262	7597738	RW	8/11/06	30
422274	7597702	RW	8/11/06	50
422277	7597718	RW	8/11/06	25
422300	7597814	RW	8/11/06	5
422378	7597813	RW	8/11/06	25
422404	7597903	RW	8/11/06	10
422523	7597472	PH	8/11/06	2
422554	7597602	PH	8/11/06	1
422608	7597726	PH	8/11/06	20
422630	7597730	RW	8/11/06	10
422654	7597785	PH	8/11/06	20
422661	7597782	RW	8/11/06	2
422698	7597874	RW	8/11/06	50
422729	7597962	RW	8/11/06	100
422744	7596377	PH	8/11/06	1
422766	7596333	PH	8/11/06	30
422781	7597816	BM	16/9/05	scattered
422789	7597872	MyM	16/9/05	50+
422861	7596443	RW	9/11/06	20
422877	7596417	RW	9/11/06	20
422943	7597477	PH	8/11/06	50
423050	7597442	PH	8/11/06	25
423119	7597487	RW	9/11/06	50
423166	7596313	RW	9/11/06	50
423167	7596341	RW	9/11/06	150
423169	7596274	RW	9/11/06	50
423253	7598208	MyM	16/9/05	1
423326	7598167	MyM	16/9/05	50+
423366	7596954	RW	9/11/06	100
423510	7598212	PH	8/11/06	1
423516	7598340	PH	8/11/06	30
423545	7598310	PH	8/11/06	3
423549	7598426	PH	8/11/06	10
423576	7596849	RW	8/11/06	100
423584	7598259	RW	8/11/06	10
423598	7598209	RW	8/11/06	50
423601	7598054	MM	16/9/05	scattered
423602	7598665	PH	7/11/06	10
423626	7598225	RW	8/11/06	30
423626	7597607	BM	16/9/05	scattered
423635	7598174	RW	8/11/06	20
423638	7598070	MM	16/9/05	scattered
423671	7598198	RW	8/11/06	15
423689	7597643	MyM	16/9/05	20+; scattered
423710	7598348	RW	8/11/06	15
423724	7597974	MM	16/9/05	scattered
423727	7597620	MM	16/9/05	scattered
423743	7597573	BM	16/9/05	scattered
423759	7596863	RW	8/11/06	100
423759	7596896	RW	8/11/06	60
423759	7597485	MyM	16/9/05	10+
423767	7597270	MyM	16/9/05	5+

Easting (WGS84)	Northing (WGS84)	Recorder	Date	No. of Individuals
423773	7597566	MyM	16/9/05	20+; scattered
423775	7597199	PH	8/11/06	4
423780	7596999	PH	8/11/06	50
423780	7597242	MyM	16/9/05	10+
423787	7597627	MyM	16/9/05	20+; scattered
423800	7597053	PH	8/11/06	1
423800	7597030	PH	8/11/06	30
423810	7597683	MyM	16/9/05	10+
423814	7597107	PH	8/11/06	19
423823	7597649	MM	16/9/05	scattered
423835	7597215	MM	16/9/05	scattered
423842	7598624	PH	8/11/06	10
423855	7597712	MM	16/9/05	scattered
423869	7597325	MM	16/9/05	scattered
423893	7598893	PH	7/11/06	25
423896	7597212	MM	16/9/05	scattered
423951	7598610	PH	8/11/06	3
423967	7598785	RW	7/11/06	scattered
424002	7598839	PH	7/11/06	35
424108	7598863	PH	7/11/06	15
424129	7598565	RW	8/11/06	5
424188	7598680	RW	8/11/06	50
424381	7598482	RW	8/11/06	10
424413	7599082	RW	7/11/06	40
424419	7598569	RW	8/11/06	10
424440	7598556	RW	8/11/06	40
424472	7598983	RW	8/11/06	20
424474	7599015	RW	8/11/06	30
424744	7599301	PH	30/10/06	10
424745	7599284	PH	30/10/06	10
424759	7599351	PH	30/10/06	6
424793	7599314	PH	30/10/06	10
424804	7599367	PH	30/10/06	12



Weed Species**Records of *Acetosa vesicaria from the Mesa K study area.**

Easting (WGS84)	Northing (WGS84)	Recorder	Date	No. of Individuals
422887	7597027	MM	16/9/05	2

Records of *Aerva javanica from the Mesa K study area.

Easting (WGS84)	Northing (WGS84)	Recorder	Date	No. of Individuals
422861	7596783	MM	16/9/05	1
423041	7596432	MM	16/9/05	small patch
424549	7598034	MM	30/10/06	scattered
424609	7598442	MM	30/10/06	scattered
424732	7598340	MM	30/10/06	scattered

Records of *Argemone ochroleuca subsp. ochroleuca from the Mesa K study area.

Easting (WGS84)	Northing (WGS84)	Recorder	Date	No. of Individuals
422584	7597238	PH	8/11/06	50
422656	7596852	PH	8/11/06	15
422690	7596731	PH	8/11/06	1
422694	7597053	RW	9/11/06	20
422726	7596634	PH	8/11/06	25
422727	7597116	RW	9/11/06	5
422735	7596535	PH	8/11/06	30
422748	7597302	RW	9/11/06	5
422757	7597136	RW	9/11/06	50
422785	7597023	MM	16/9/05	200
422786	7596633	RW	9/11/06	30
422802	7596644	RW	9/11/06	10
422806	7597076	MM	16/9/05	50
422821	7597041	MM	16/9/05	scattered
422822	7596849	MM	16/9/05	50
422824	7596988	MM	16/9/05	scattered
422829	7597103	MM	16/9/05	20
422830	7596781	MM	16/9/05	40
422831	7597082	MM	16/9/05	scattered
422833	7596580	RW	9/11/06	5
422836	7596574	RW	9/11/06	30
422838	7596593	RW	10/11/06	scattered
422839	7596545	RW	9/11/06	200
422847	7597104	MM	16/9/05	3
422858	7596828	MM	16/9/05	10+
422861	7596783	MM	16/9/05	2
422887	7597027	MM	16/9/05	5
422890	7596997	MM	16/9/05	scattered
422890	7596983	MM	16/9/05	scattered
422899	7596962	MM	16/9/05	scattered
422918	7596833	MM	16/9/05	scattered
422977	7596909	RW	9/11/06	50
422986	7596736	MM	16/9/05	scattered
422987	7596693	MM	16/9/05	hundreds
422993	7596635	MM	16/9/05	scattered
423052	7596456	MM	16/9/05	scattered
423100	7596659	RW	9/11/06	100
423129	7596465	RW	9/11/06	60
423165	7596331	RW	9/11/06	50
423168	7596456	PH	8/11/06	5
423239	7596375	PH	8/11/06	1
424150	7596997	RW	30/10/06	

Records of *Cenchrus ciliaris from the Mesa K study area.

Easting (WGS84)	Northing (WGS84)	Recorder	Date	No. of Individuals
422245	7597497	PH	8/11/06	20
422785	7596448	PH	8/11/06	5
422829	7597103	MM	16/9/05	scattered

Easting (WGS84)	Northing (WGS84)	Recorder	Date	No. of Individuals
422831	7597082	MM	16/9/05	scattered
422838	7596593	RW	10/11/06	scattered
422847	7597104	MM	16/9/05	5
422849	7596480	RW	9/11/06	scattered
422890	7596983	MM	16/9/05	scattered
422910	7597065	MM	16/9/05	scattered
422977	7596909	RW	9/11/06	scattered
422993	7596635	MM	16/9/05	scattered
424087	7597400	MM	16/9/05	scattered
424088	7597451	MM	16/9/05	scattered
424102	7597125	RW	30/10/06	dense
424103	7597561	MM	16/9/05	scattered
424136	7597080	RW	30/10/06	dense
424136	7597397	MM	16/9/05	scattered
424138	7597106	RW	30/10/06	very dense
424161	7597621	MM	16/9/05	scattered
424203	7597436	MM	16/9/05	scattered
424210	7597398	MM	16/9/05	scattered
424221	7597576	MM	16/9/05	scattered
424238	7597551	MM	16/9/05	5-10%
424272	7597051	RW	30/10/06	dense
424354	7597716	MM	16/9/05	scattered
424453	7597875	MM	30/10/06	scattered
424455	7597828	MM	30/10/06	scattered
424467	7597906	MM	30/10/06	scattered
424473	7597635	MM	16/9/05	scattered
424490	7597773	MM	16/9/05	scattered
424494	7597840	MM	30/10/06	scattered
424498	7597950	MM	30/10/06	scattered
424506	7597659	MM	16/9/05	scattered
424511	7597875	MM	30/10/06	scattered
424520	7597992	MM	30/10/06	scattered
424531	7597748	MM	16/9/05	scattered
424538	7597808	RW	30/10/06	dense
424546	7597946	MM	30/10/06	scattered
424549	7598034	MM	30/10/06	scattered
424565	7598075	MM	30/10/06	scattered
424567	7598004	MM	30/10/06	scattered
424575	7597703	MM	16/9/05	scattered
424577	7598125	MM	30/10/06	scattered
424581	7597899	RW	30/10/06	scattered
424586	7598056	MM	30/10/06	scattered
424604	7597977	RW	30/10/06	scattered
424607	7598094	MM	30/10/06	scattered
424609	7597790	PH	30/10/06	~500
424613	7598183	MM	30/10/06	scattered
424632	7598137	MM	30/10/06	scattered
424635	7597849	PH	30/10/06	~100
424642	7598245	MM	30/10/06	scattered
424648	7598172	MM	30/10/06	scattered
424658	7598276	MM	30/10/06	scattered
424666	7598203	MM	30/10/06	scattered
424681	7598239	MM	30/10/06	scattered
424684	7598262	MM	30/10/06	scattered
424685	7598329	MM	30/10/06	scattered
424697	7598160	RW	30/10/06	scattered
424699	7598417	MM	30/10/06	scattered
424700	7597992	PH	30/10/06	~100
424702	7598284	MM	30/10/06	scattered
424704	7598357	MM	30/10/06	scattered
424715	7598313	MM	30/10/06	scattered
424727	7598469	MM	30/10/06	scattered
424732	7598340	MM	30/10/06	scattered

Easting (WGS84)	Northing (WGS84)	Recorder	Date	No. of Individuals
424735	7598063	PH	30/10/06	20
424751	7598292	RW	30/10/06	scattered
424752	7598362	MM	30/10/06	scattered
424772	7598563	MM	16/9/05	scattered
424776	7598145	PH	30/10/06	~50
424784	7598438	MM	30/10/06	scattered
424798	7598554	MM	16/9/05	scattered
424819	7598392	RW	30/10/06	dense
424820	7598442	MM	16/9/05	scattered
424821	7598498	MM	16/9/05	scattered
424824	7598529	MM	16/9/05	scattered
424836	7598312	PH	30/10/06	~50
424838	7598570	MM	16/9/05	scattered
424859	7598327	MM	16/9/05	scattered
424909	7598468	MM	16/9/05	scattered
424931	7598864	MM	30/10/06	scattered
424932	7598583	MM	16/9/05	scattered
424933	7598448	MM	16/9/05	scattered
424950	7598576	MM	16/9/05	scattered
424954	7598829	MM	30/10/06	scattered
424971	7598548	MM	16/9/05	scattered
424980	7598561	MM	16/9/05	scattered
424990	7598619	MM	16/9/05	scattered
425001	7598931	MM	30/10/06	scattered
425008	7598870	MM	30/10/06	scattered
425013	7598741	MM	30/10/06	scattered
425020	7598523	MM	16/9/05	scattered
425022	7598727	MM	30/10/06	scattered
425022	7598574	MM	16/9/05	scattered
425077	7598669	MM	30/10/06	scattered
425083	7598607	MM	30/10/06	scattered

Records of *Cenchrus setiger from the Mesa K study area.

Easting (WGS84)	Northing (WGS84)	Recorder	Date	No. of Individuals
422757	7597136	RW	9/11/06	dense
422760	7597127	RW	9/11/06	dense
422771	7597136	RW	9/11/06	dense
422801	7596608	RW	9/11/06	scattered
422821	7597041	MM	16/9/05	1
422836	7596574	RW	9/11/06	dense
422838	7596593	RW	10/11/06	scattered
422993	7596635	MM	16/9/05	scattered
424073	7596953	RW	30/10/06	dense
424087	7597400	MM	16/9/05	scattered
424136	7597397	MM	16/9/05	scattered
424238	7597551	MyM	16/9/05	scattered
424455	7597828	MM	30/10/06	scattered
424467	7597906	MM	30/10/06	scattered
424494	7597840	MM	30/10/06	scattered
424498	7597950	MM	30/10/06	scattered
424511	7597875	MM	30/10/06	scattered
424520	7597992	MM	30/10/06	scattered
424546	7597946	MM	30/10/06	scattered
424549	7598034	MM	30/10/06	scattered
424565	7598075	MM	30/10/06	scattered
424567	7598004	MM	30/10/06	scattered
424577	7598125	MM	30/10/06	scattered
424607	7598094	MM	30/10/06	scattered
424613	7598183	MM	30/10/06	scattered
424632	7598137	MM	30/10/06	scattered
424642	7598245	MM	30/10/06	scattered
424648	7598172	MM	30/10/06	scattered
424658	7598276	MM	30/10/06	scattered

Easting (WGS84)	Northing (WGS84)	Recorder	Date	No. of Individuals
424666	7598203	MM	30/10/06	scattered
424681	7598239	MM	30/10/06	scattered
424684	7598262	MM	30/10/06	scattered
424685	7598329	MM	30/10/06	scattered
424699	7598417	MM	30/10/06	scattered
424702	7598284	MM	30/10/06	scattered
424727	7598469	MM	30/10/06	scattered
424732	7598340	MM	30/10/06	scattered
424821	7598498	MM	16/9/05	scattered
424931	7598864	MM	30/10/06	scattered

Records of *Chloris barbata from the Mesa K study area.

Easting (WGS84)	Northing (WGS84)	Recorder	Date	No. of Individuals
422838	7596593	RW	10/11/06	scattered

Records of *Citrullus colocynthis from the Mesa K study area.

Easting (WGS84)	Northing (WGS84)	Recorder	Date	No. of Individuals
422824	7596988	MM	16/9/05	1
422838	7596593	RW	10/11/06	scattered
423596	7597818	MyM	16/9/05	1
424088	7597451	MM	16/9/05	scattered
424549	7598473	MM	30/10/06	1
424565	7598075	MM	30/10/06	
424567	7598471	MM	30/10/06	1
424597	7598485	MM	30/10/06	7
424616	7598492	MM	30/10/06	3
424683	7598430	MM	30/10/06	
424727	7598503	MM	30/10/06	
424967	7598790	MM	30/10/06	2
425002	7598774	MM	30/10/06	

Records of *Euphorbia hirta from the Mesa K study area.

Easting (WGS84)	Northing (WGS84)	Recorder	Date	No. of Individuals
422838	7596593	PH	11/11/06	1
422899	7596962	MM	16/9/05	scattered

Records of *Lactuca serriola from the Mesa K study area.

Easting (WGS84)	Northing (WGS84)	Recorder	Date	No. of Individuals
422838	7596593	PH	11/11/06	1

Records of *Malvastrum americanum from the Mesa K study area.

Easting (WGS84)	Northing (WGS84)	Recorder	Date	No. of Individuals
422771	7597136	RW	9/11/06	
422785	7596448	PH	8/11/06	5
424073	7596953	RW	30/10/06	
424138	7597106	RW	30/10/06	
424238	7597551	MyM	16/9/05	scattered
424455	7597828	MM	30/10/06	
424511	7597875	MM	30/10/06	
424546	7597946	MM	30/10/06	
424581	7597899	RW	30/10/06	1
424838	7598570	MM	16/9/05	scattered
424909	7598468	MM	16/9/05	scattered
424995	7598943	MM	30/10/06	
425083	7598607	MM	30/10/06	

Records of *Passiflora foetida var. hispida from the Mesa K study area.

Easting (WGS84)	Northing (WGS84)	Recorder	Date	No. of Individuals
422838	7596593	RW	10/11/06	scattered

Records of *Setaria verticillata from the Mesa K study area.

Easting (WGS84)	Northing (WGS84)	Recorder	Date	No. of Individuals
422735	7596535	PH	10/11/06	10
422838	7596593	RW	10/11/06	scattered
422872	7596536	RW	10/11/06	1

Records of *Solanum nigrum from the Mesa K study area.

Easting (WGS84)	Northing (WGS84)	Recorder	Date	No. of Individuals
422838	7596593	PH	11/11/06	1
423052	7596456	MM	16/9/05	2

Records of *Sonchus ?asper from the Mesa K study area.

Easting (WGS84)	Northing (WGS84)	Recorder	Date	No. of Individuals
422824	7596988	MM	16/9/05	scattered
422874	7597171	MM	16/9/05	1

