
**FLORA AND VEGETATION SURVEY
OF THE BALLA BALLA EXPORT FACILITIES,
PROPOSED INFRASTRUCTURE CORRIDOR
WITHIN L47/690**

**Prepared for
FORGE RESOURCES LTD**

June 2013

FRL1301/020/13

Prepared by



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ABBREVIATIONS

ARRP Act: *Agriculture and Related Resources Protection Act 1976*

BAM Act: *Biosecurity and Agriculture Management Act 2007*

BOM: Bureau of Meteorology

DAF: Department of Agriculture and Food

DEC: Department of Environment and Conservation

DSEWPC: Department of Sustainability, Environment, Water, Population and Communities

EPA: Environmental Protection Authority

EPBC Act: *Environment Protection and Biodiversity Conservation Act 1999*

EP Act: *Environmental Protection Act 1986*

IBRA: Interim Biogeographical Regionalisation for Australia

MCPL: Matiske Consulting Pty Ltd

PEC: Priority Ecological Community

TEC: Threatened Ecological Community

TSSC: Threatened Species Scientific Committee

WC Act: *Wildlife Conservation Act 1950*

1. SUMMARY

Mattiske Consulting Pty Ltd (MCPL) was commissioned in April 2013 by Forge Resources Ltd to conduct a Level 2 flora and vegetation survey of the proposed infrastructure corridor within miscellaneous tenement L47/690. This infrastructure forms part of the Balla Balla Export Facilities (see Figure 1).

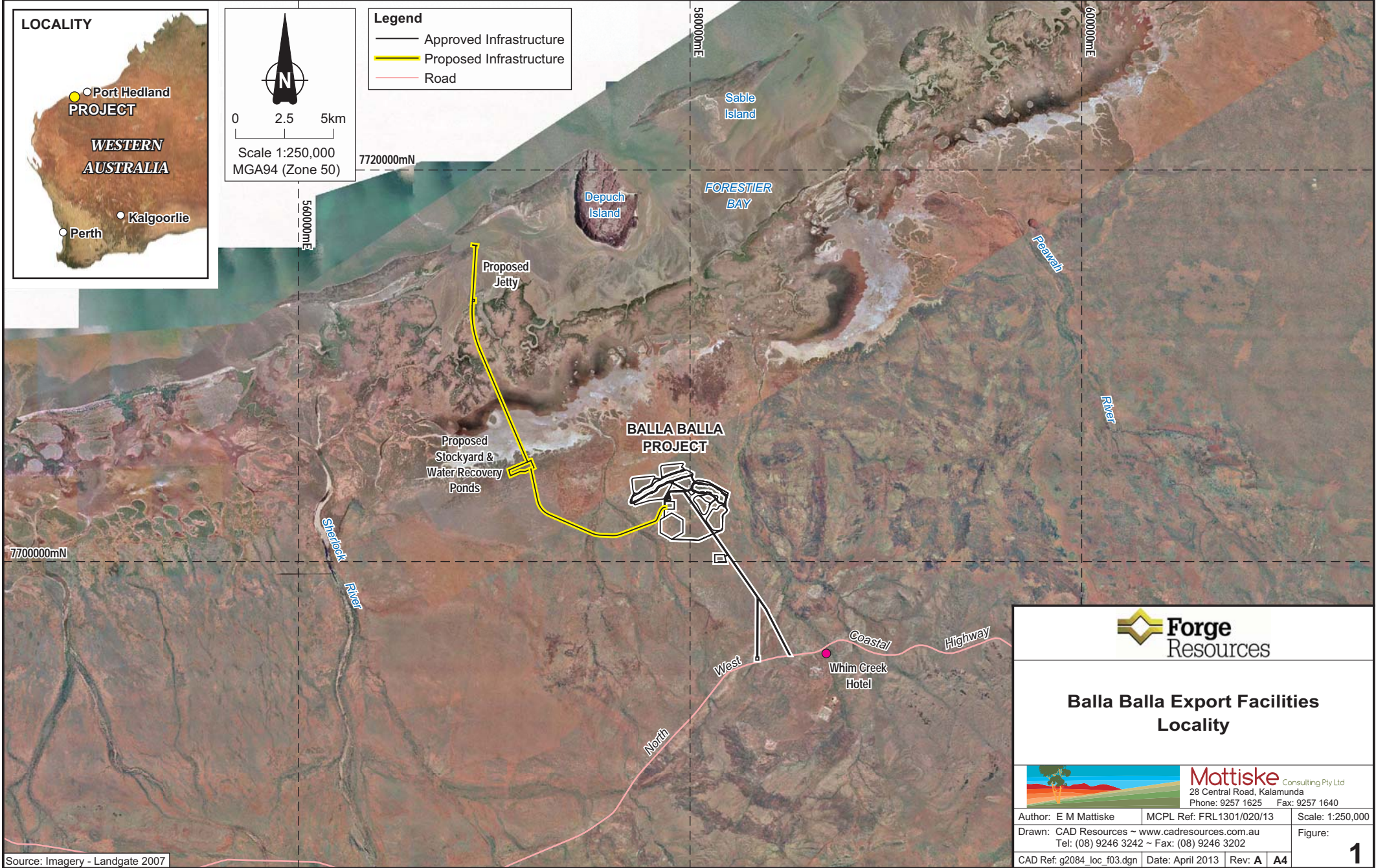
Flora

The desktop search did not highlight any threatened flora species likely to be recorded within tenement L47/690. One priority flora species, *Heliotropium muticum* (Boraginaceae – P1), was previously recorded to the south-west of the proposed infrastructure corridor by MCPL (2011). This species is described as an ascending to spreading perennial herb to 30 cm tall (Craven 1996; Department of Environment and Conservation {DEC} 2013a). Few details are available on specific site preferences, however records housed at the WA Herbarium indicate it has been collected from brown-red sandy/loamy clays (DEC 2013a). No threatened or priority flora species (including *Heliotropium muticum*) were recorded during the April 2013 survey. Several other Priority species have been recorded in the wider project area although these were not located on the current proposed alignment (Aston Environmental Services 2005 and Mattiske Consulting (2006, 2008)).

A total of 100 vascular plant taxa were recorded in the proposed infrastructure corridor and surrounding tenement L47/690 during the April 2013 survey. Five of the recorded plant taxa are introduced (weed) species. These species are commonly recorded in nearby coastal areas and further inland in the Pilbara bioregion and none are listed as declared plants (Biosecurity and Agriculture Management Act 2007, adopted on May 1st, 2013) according to the Western Australian Department of Agriculture and Food (2013) database. Several of the introduced species recorded have the potential to spread rapidly into disturbed areas and therefore vehicle hygiene measures should be implemented and maintained during on-ground activities. Of particular concern are **Aerva javanica* (Kapok Bush) and **Cenchrus ciliaris* (Buffel Grass). The latter may be more difficult to manage as it has been widely planted as a pasture species and has become established in pastoral areas of the Pilbara bioregion over many decades. Also recorded were **Malvastrum americanum* (Spiked Malvastrum) and **Portulaca oleracea* (Purslane), which tend to concentrate in open disturbed areas and **Vachellia farnesiana* (Mimosa Bush), which is widespread in disturbed area including roadsides, creeks and floodplains throughout the Pilbara.

Vegetation

The vegetation of the survey area was comprised of a mangrove community, tidal flats with samphires, coastal sand dunes, and a mosaic of tussock and hummock grasslands with occasional *Acacia* spp. and mixed shrublands.



LOCALITY

○ Port Hedland PROJECT

WESTERN AUSTRALIA

○ Perth ○ Kalgoorlie

0 2.5 5km

Scale 1:250,000
MGA94 (Zone 50)

Legend

- Approved Infrastructure
- Proposed Infrastructure
- Road

Forge Resources

Balla Balla Export Facilities Locality

Mattiske Consulting Pty Ltd
28 Central Road, Kalamunda
Phone: 9257 1625 Fax: 9257 1640

Author: E M Mattiske	MCPL Ref: FRL1301/020/13	Scale: 1:250,000
Drawn: CAD Resources ~ www.cadresources.com.au Tel: (08) 9246 3242 ~ Fax: (08) 9246 3202		Figure:
CAD Ref: g2084_loc_f03.dgn	Date: April 2013	Rev: A A4

1

Source: Imagery - Landgate 2007

The survey area lies within the Abydos Plain system of the Fortescue Botanical Province of the Eremaean Botanical Province (Beard 1975). The following Abydos Plain vegetation associations occur within the survey area:

- 127 – bare areas, mud flats.
- 589 – mosaic of *Eragrostis* tussock grassland, *Astrebla* mixed tussock grassland, *Chrysopogon* mixed tussock grassland, *Sporobolus* tussock grassland and *Triodia* open hummock grassland.

The proposed infrastructure corridor is likely to impact < 1 % of both vegetation associations 127 and 589 across the entire state.

At a regional and national level, the marine and tidal communities provide habitat values for significant fauna species, including several unique birds (Kendrick and Stanley 2001). At a local and state level, however, the most significant flora values relate to the Priority 3 'Horseflat land system of the Roebourne Plains' ecological community. The given DEC boundaries of this priority ecological community (PEC) intercept the proposed infrastructure corridor (Figure 1). This PEC is defined by DEC (2013b) and Van Vreeswyk *et al.* (2004) below:

The Horseflat land system PEC is broadly described as gilgaied clay pans supporting tussock grasslands and minor grassy snakewood shrublands. It occurs from Cape Preston to Balla Balla, surrounding Karratha and Roebourne (DEC 2013b). Perennial tussock grasses include *Eragrostis xerophila* and other *Eragrostis* spp., *Eriachne* spp., and *Dichanthium* spp. The community also supports a suite of annual grasses including *Sorghum* spp. and rare *Astrebla* spp. (DEC 2013b). Threats include grazing, weed invasion and fragmentation.

The Horseflat land system is further described by Van Vreeswyk *et al.* (2004) and the PEC incorporates the following units:

- Unit 3: **Gilgaied plains** – self-mulching cracking clays with mostly tussock grasslands (*Eragrostis xerophila* with *Chrysopogon fallax* and *Eriachne benthamii*).
- Unit 5: **Alluvial plains** – non-cracking, with some self-mulching cracking clays with tussock grasslands (*Eragrostis xerophila*, *Eriachne benthamii*, *Chrysopogon fallax*, **Cenchrus ciliaris*); or tussock grasslands with *Atriplex bunburyana*; or occasionally *Triodia* spp. hummock grasslands.
- Unit 7: **Drainage depressions** (occasional) – deep red/brown non-cracking clays and red loamy earths with dense tussock grasslands (*Eriachne benthamii*, *Chrysopogon fallax*) with occasional eucalypt trees and shrubs.

Some sites surveyed in the southern section of the proposed infrastructure corridor (vegetation community G8), from the proposed Balla Balla mine site in the east, to the proposed stockyard and water recovery ponds in the north-west (Figure 1), bare resemblance to this PEC. The tussock grasslands commonly support *Eragrostis xerophila* (and occasionally *Eragrostis eriopoda*) and *Eriachne* spp. (*Eriachne helmsii* and *Eriachne pulchella*) and occur on red-brown cracking clays. *Chrysopogon fallax* was also occasionally recorded in these sites. These Poaceae (grass) species are not restricted to the PEC occurrence, and commonly occur within and outside the Pilbara bioregion. It was noted during the field survey that the area falling within the PEC boundary also included large areas of acacia shrublands and hummock grasslands.

If one accepts the broad PEC boundary as supplied by the DEC (specifically pertaining to polygon ID 1878 in Figure 1), it is still unlikely that the proposed infrastructure corridor will result in major impacts to the PEC. Based on currently available data, the proposed infrastructure corridor disturbance would be less than 1.9 % of the area of polygon ID 1878. In addition, this is only a small, localised impact, as the PEC extends to Cape Preston and has multiple occurrences across the Roebourne plains. The consideration of impacts should also take into account the current condition of the vegetation resembling the PEC, which is heavily grazed and ranged from degraded to very good.

2. INTRODUCTION

Mattiske Consulting Pty Ltd (MCPL) was commissioned in April 2013 by Forge Resources Ltd to undertake a Level 2 vegetation mapping survey of the proposed Balla Balla Export Facilities infrastructure corridor (see Figure 1).

2.1 Location and Scope of Proposal

The survey area included the proposed jetty, stockyard and water recovery ponds and associated slurry pipeline, conveyor causeway and laydown infrastructure form part of the Balla Balla Export Facilities and are located within tenement L47/690. These areas are collectively referred to as the proposed infrastructure corridor. This work is supplementary to the earlier studies on the nearby Balla Balla project area and as such occurs with pastoral areas.

2.2 Western Australia's flora – A legislative perspective

The legislative protection of flora within Western Australia is principally governed by three Acts, namely:

- Wildlife Conservation Act 1950 (WC Act);
- Environmental Protection Act 1986 (EP Act); and
- Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).

These three acts provide for the protection of threatened flora, fauna (and fauna habitats) and ecological communities, while also addressing specific threats such as the clearing of native vegetation (see Appendix A section A.1.).

Where flora has been gazetted as threatened flora under the WC Act, it is an offence "to take" such flora without the written consent of the Minister. The WC Act states that "to take" flora includes to gather, pluck, cut, pull up, destroy, dig up, remove or injure the flora or to cause or permit the same to be done by any means. Under the EPBC Act, a person must not take an action that has or will have a significant impact on a listed threatened species without approval from the Commonwealth Minister for Sustainability, Environment, Water, Population and Communities, unless those actions are not prohibited under the Act.

In addition to legislative protection, the Department of Environment and Conservation (DEC) categorises priority flora using five categories, P1 to P5, to denote the conservation priority status of such species, with P1 listed species being the most threatened, and P5 the least. A similar listing is applied to priority ecological communities. Both threatened and priority listings are regularly reviewed by the relevant agencies, and may have their status changed when more information on the species or community becomes available. Appendix A section A.2 sets out definitions of both threatened and priority flora.

At the State level, ecological communities may be considered as threatened under the EP Act once they have been identified as such by the Western Australian Threatened Ecological Communities Scientific Advisory Committee. At the Commonwealth level, some Western Australian Threatened Ecological Communities (TECs) are listed as threatened, under the EPBC Act.

Under the EPBC Act, a person must not take an action that has or will have a significant impact on a listed threatened ecological community without approval from the Commonwealth Minister for the Sustainability, Environment, Water, Population and Communities, unless those actions are not prohibited under the Act. These ecological communities and associated legislation are discussed in Appendix A section A.3.

Under the EP Act, the clearing of native vegetation requires a permit to do so, from the DEC or the Department of Mines and Petroleum, unless that clearing is exempted under specific provisions listed in Schedule 6 of the Act, or are prescribed in the Environmental Protection (Clearing of Native Vegetation) Regulations 2004. The EP Act, defines "native vegetation" as indigenous aquatic or terrestrial vegetation, and includes dead vegetation unless that dead vegetation is of a class declared by regulation to be excluded from this definition but does not include vegetation in a plantation.

Under Section 51A of the EP Act, "clearing" means the killing or destruction of, the removal of, the severing or ringbarking of trunks or stems of, or the doing of any other substantial damage to, some or all of the native vegetation in an area, and includes the draining or flooding of land, the burning of vegetation, the grazing of stock, or any other act or activity, that causes any of the aforementioned consequences or results. Appendix A section A.4 sets out additional information relevant to the clearance of native vegetation as described under the EP Act, including the ten clearing principles.

Flora or vegetation may be locally or regionally significant in addition to statutory listings by the State or Federal Government. While not legislatively protected, these factors are taken into consideration during the assessment of mining proposals, clearing proposals and other proposed development; Guidance Statement 51 specifically states:

“A broad consideration of the ecological processes that influence sites and their ecological functions is required; statutory lists of Declared Rare and Priority Flora are only a small subset of biodiversity. Proponents should ensure that flora and vegetation surveys provide sufficient information to address both biodiversity conservation and ecological function values within the context of the type of proposal being considered and the relevant EPA objectives for protection of the environment” (EPA 2004).

Appendix A describes what factors may lead to a species or community to be considered locally or regionally significant.

2.3 Declared Pests

The Biosecurity and Agriculture Management Act 2007 (BAM Act) defines a declared pest as a prohibited organism. As of May 1st, 2013, this act replaces the Agriculture and Related Resources Protection Act 1976. Declared plant species are introduced taxa (weeds) that are considered to be particularly invasive, especially with respects to the agricultural environment. The declared plants have been assigned to specific categories, P1 to P5, which determines the form of control which applies to the declared plant. Appendix A section A.6 lists the categories of control codes for declared plants and the associated management requirements. The current listing of declared plant species is available at the Department of Agriculture and Food (DAF) website (DAF 2013).

3. OBJECTIVES

The aim of this survey was to assess the flora and vegetation values of the proposed infrastructure corridor as part of the Balla Balla Export Facilities project. Specifically, the objectives include:

- Undertake a desktop study of the flora and vegetation of the proposed infrastructure corridor, with an emphasis on threatened and priority flora, and threatened and priority ecological communities;
- Undertake a Level 2 flora and vegetation survey of the proposed infrastructure corridor, and collect and identify the vascular plant species present;
- Review the conservation status of the vascular plant species recorded by reference to current literature and current listings by the DEC and plant collections held at the Western Australian State Herbarium, and listed by the DSEWPC under the EPBC Act 1999;
- Define and map the vegetation communities in the proposed infrastructure corridor;
- Define and map the location of any threatened and priority flora located within the infrastructure corridor;
- Define any management issues related to flora and vegetation values;
- Provide recommendations on the local and regional significance of the vegetation communities; and
- Prepare a report summarising the findings.

4. METHODS

4.1 Desktop Review

A desktop assessment was conducted using the FloraBase DEC (2013g) and NatureMap (DEC 2007 -) databases, to identify the possible occurrence of threatened and priority flora and threatened and priority ecological communities with the proposed infrastructure corridor. The EPBC Act Protected Matters Search Tool (DSEWPC 2013a) was used to determine whether matters of national environmental significance or other matters protected by the EPBC Act were likely to occur within the proposed infrastructure corridor.

The NatureMap search parameters used were a 20 km radius 'by circle' at 20° 45' 17" S, 117° 41' 20" E. The EPBC Act Protected Matters Search Tool (DSEWPC 2013a) was also centred on the aforementioned co-ordinates.

In addition, historical documentation and vegetation mapping of the region, principally that of Beard (1975) and MCPL (2006; 2008; 2011), that provide extensive resource material for the floristics and vegetation of the Balla Balla project area, was reviewed.

4.2 Field Survey Methods

A Level 2 field assessment of the flora and vegetation of the proposed infrastructure corridor within tenement L47/690 was undertaken by two experienced botanists from MCPL between the 17th - 18th April, 2013. Access was assisted by the use of a helicopter for one of the survey days. The latter assisted in access across the tidal flat and mangrove areas. The survey was conducted in accordance with methods outlined in Guidance Statement 51 (EPA 2004). All botanists held valid collection licences to collect flora for scientific purposes, issued under the WC Act. The geographic coordinates defining the proposed infrastructure corridor were supplied by Forge Resources Ltd. Aerial photographic maps of the proposed infrastructure corridor were prepared and supplied by CAD Resources (Carine, Western Australia). Survey sites for the proposed infrastructure corridor were selected using aerial photographic maps and field observations and accessed either via helicopter or vehicle. A total of 52 survey sites were selected to sample all vegetation types (with replication) within the survey area, Appendix B.

The flora and vegetation was described and sampled systematically at each survey site, and additional opportunistic collecting was undertaken wherever previously unrecorded plants were observed. At each survey site the following floristic and environmental parameters were noted:

- GPS location (MGA94, Zone 50);
- Topography;
- Soil type and colour;
- Outcropping rocks and their type;
- Percentage litter cover and percentage bare ground; and
- Time since fire.

For each vascular plant species, the average height and percentage cover (both alive and dead material) was recorded.

All plant specimens collected during the field surveys were dried and processed in accordance with the requirements of the Western Australian Herbarium (PERTH). The plant species were identified through comparisons with pressed specimens housed at the Western Australian Herbarium (PERTH). Where appropriate, plant taxonomists with specialist skills were consulted. Nomenclature of the species recorded is in accordance with the DEC (2013a).

4.3 Data Analysis

A species accumulation curve, based on accumulated species versus sites surveyed was prepared, to indicate the level of adequacy of the survey effort (Estimate S - Colwell 2006). As the number of survey sites increases, and correspondingly the size of the area surveyed increases, there should be a diminishing number of new species recorded. At some point, the number of new species recorded becomes essentially asymptotic. The asymptotic value was determined using Michaelis-Menten modelling and provides an incidence based coverage estimator of species richness (ICE - Chao 2004). When the number of new species being recorded for survey effort expended approaches this asymptotic value, the survey effort can be considered to be adequate.

PRIMER v6 (Plymouth Routines in Multivariate Ecological Research) statistical analysis software was used to analyse species-by-site data and discriminate sites on the basis of their species composition (Clarke and Gorley 2006). Singletons (species occurring in a single site) with a cover of less than 0.5 % were excluded from further analysis. To down weight the relative contributions of quantitatively dominant species a presence/absence transformation was applied to the data set. Transformed data were analysed using a series of multivariate analysis routines including Hierarchical Clustering (CLUSTER), Non-metric Multidimensional Scaling (MDS) and Similarity Percentages (SIMPER). Results were used to inform and support interpretation of aerial photography and delineation of individual plant communities. The descriptions of plant communities within the survey area are based on the NVIS structural forms of Australian vegetation developed by DEH (2003).

5. DESKTOP SURVEY RESULTS

The proposed infrastructure corridor lies within the Abydos Plain system of the Fortescue Botanical District of the Eremaean Botanical Province (Beard 1975; Beard 1990). More recently, the vegetation of Western Australia has been assigned to bioregions and subregions under the Interim Biogeographical Regionalisation for Australia (IBRA7), with the survey area falling within the Roebourne subregion (PIL4) of the Pilbara bioregion. Geologically, the Balla Balla project area lies within the Pilbara Craton.

5.1 Climate

Beard (1990) described the climate of the Fortescue Botanical District as arid-tropical with summer rain (250-300 mm annually). Payne and Tille (1992) describe the Roebourne Plains district as arid, receiving approximately 300 mm of rainfall annually. Rainfall is highly variable in this area, with a summer peak often associated with the north-west monsoons. Tropical cyclones typically occur from January to March and can result in the average annual rainfall being exceeded in a single event (Payne and Tille 1992).

Roebourne is the closest active Bureau of Meteorology (BOM) weather station to the Balla Balla proposed infrastructure corridor and is located approximately 67 km west. Rainfall and temperature data from Roebourne is illustrated in Figure 2. More than three times the average rainfall was received in January 2013 prior to the flora and vegetation survey (Figure 2). However, no major rainfall events occurred in February or March 2013.

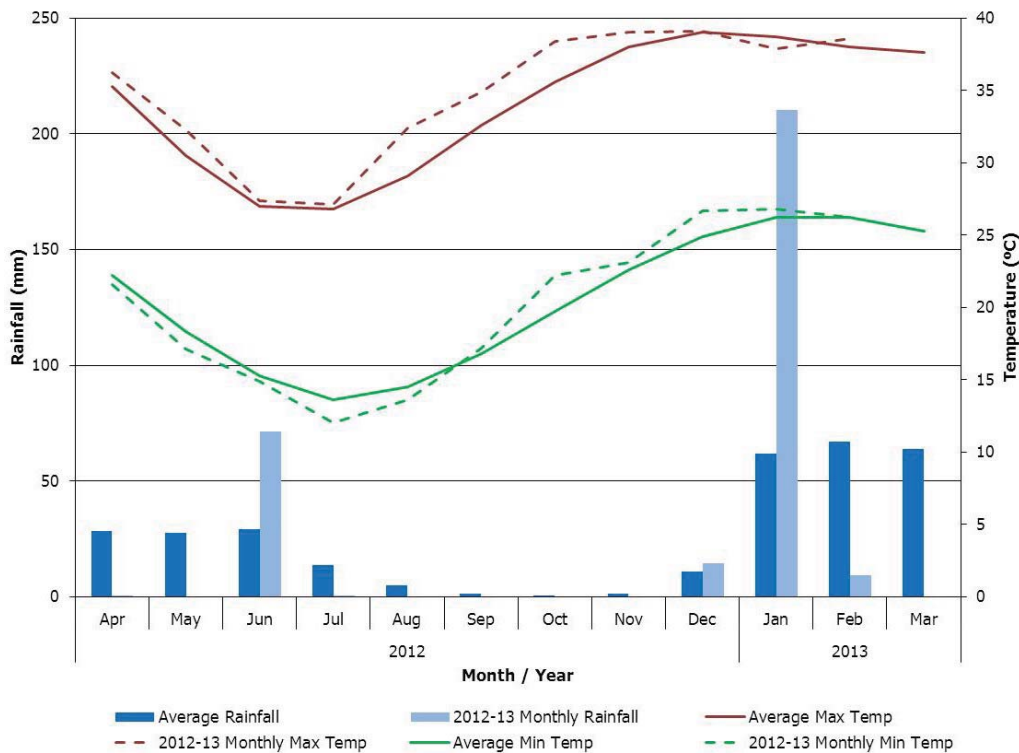


Figure 2: Climatic data for Roebourne (BOM 2013)

Note: Long term average rainfall and temperature data, together with monthly rainfall and average maximum and minimum temperature data for the period April 2012 to March 2013 are shown (BOM 2013).

5.2 Geology, Soils and Topography

The coastal Pilbara areas according to Raymond and Retter (2010) are largely defined by quaternary metamorphosed ultramafic rocks with more mafic intrusive and non-carbonate chemical sediments on the peninsulas. Kendrick and Stanley (2001) describe the PIL4 subregion as resistant linear ranges of basalts with minor exposures of granites that occur across the coastal plains.

Marine habitat mapping (LeProvost, I 2012 – provided by Forge Resources Ltd) indicates that the proposed infrastructure corridor predominantly covers floodplain, large areas of algae mat, samphire flats, mangroves, and crosses tidal creeks and sand dunes. The latter mapping was undertaken at a larger regional scale (1:50,000).

5.3 Regional Vegetation

Beard (1975) mapped and described the following Abydos Plain vegetation associations that occur within the wider survey area (Figure 3):

- Vegetation Association 127 – Bare areas, mud flats.
- Vegetation Association 589 – Mosaic of *Eragrostis* tussock grassland, *Astrebla* mixed tussock grassland, *Chrysopogon* mixed tussock grassland, *Sporobolus* tussock grassland and *Triodia* open hummock grassland.

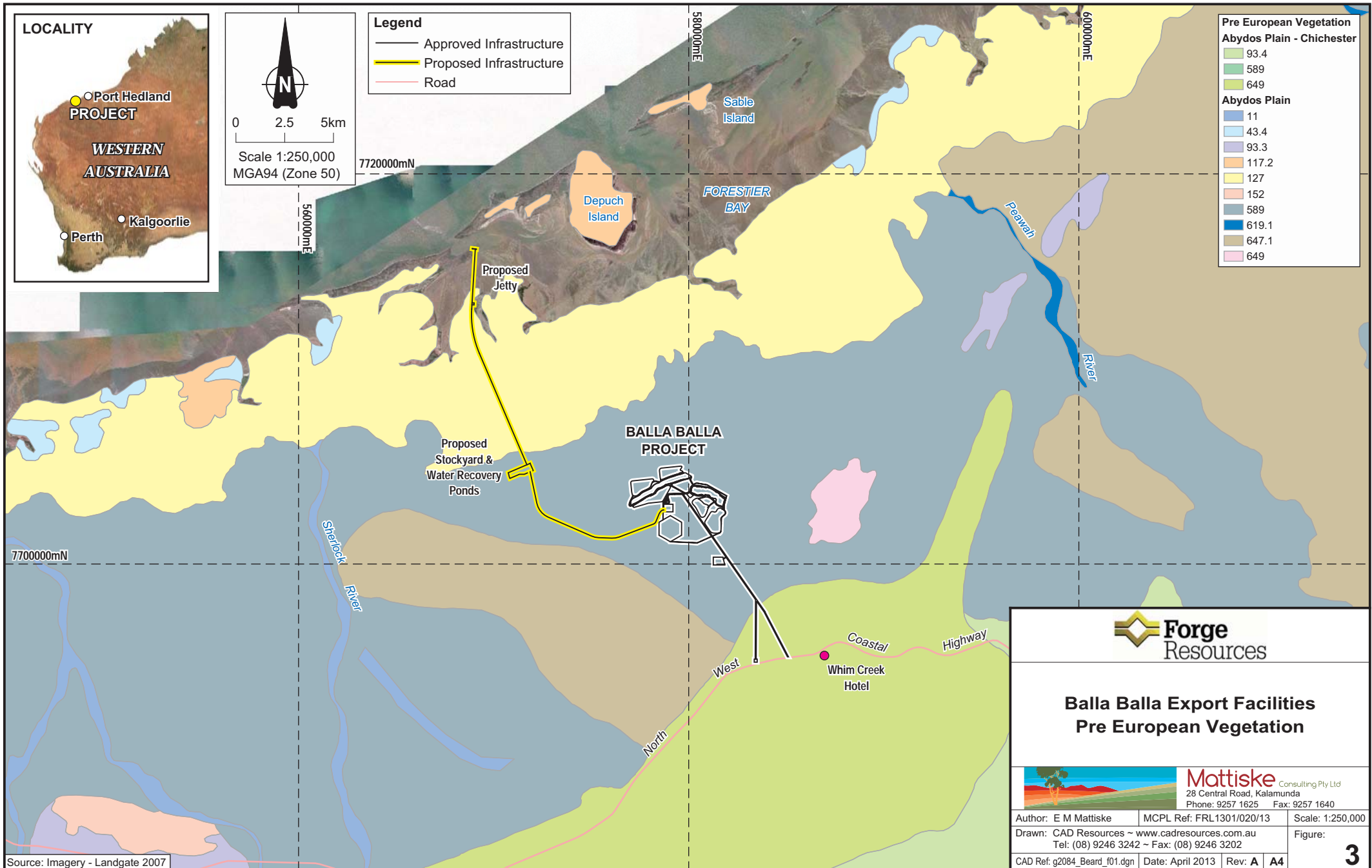
The proposed infrastructure corridor is likely to impact < 1 % of the total area (across Western Australia) of both vegetation associations 127 and 589.

The vegetation of the PIL4 subregion was broadly described by Kendrick and Stanley (2001) as a grass savannah of mixed bunch and hummock grasses, and dwarf shrub steppe of *Acacia stellaticeps* or *Acacia pyrifolia* and *Acacia inaequilatera*. The subregion is further comprised of uplands with *Triodia* hummock grasslands; ephemeral creeklines with *Eucalyptus victrix* - *Corymbia hamersleyana* woodlands; and marine alluvial flats and river deltas comprised of samphires, *Sporobolus* or mangal communities (Kendrick and Stanley 2001).

5.4 Threatened and Priority Ecological Communities

None of the TECs listed in the Pilbara region are likely to be encountered in the proposed infrastructure corridor and surrounding tenement L47/690 (DEC 2013c).

There are 30 PECs listed and defined in the Pilbara region (DEC 2013b). One of these PECs intercepts the proposed infrastructure corridor (Figure 1 – ID 1878). This PEC is called the 'Horseflat land system of the Roebourne Plains' and is Priority 3. Vegetation community G8 is dominated by *Eragrostis xerophila* and other Poaceae (grass) species. Based on currently available data, the proposed infrastructure corridor disturbance would be less than 1.9 % of the area of polygon ID 1878 (Figure 1). It occurs from Cape Preston to Balla Balla, surrounding Karratha and Roebourne (DEC 2013b). The given DEC boundaries of this PEC intercepts the proposed infrastructure corridor, between the proposed Balla Balla mine site in the east and the proposed stockyard and water recovery ponds in the north-west.



The Horseflat land system PEC is broadly described as gilgaied clay pans supporting tussock grasslands and minor grassy snakewood shrublands. Perennial tussock grasses include *Eragrostis xerophila* and other *Eragrostis* spp., *Eriachne* spp., and *Dichanthium* spp. The community also supports a suite of annual grasses including *Sorghum* spp. and rare *Astrelba* spp. (DEC 2013b). Threats include grazing, weed invasion and fragmentation. This PEC incorporates the following units described under the Horseflat land system by Van Vreeswyk et al. (2004):

- Unit 3 Gilgaied plains – self-mulching cracking clays with mostly tussock grasslands (*Eragrostis xerophila* with *Chrysopogon fallax* and *Eriachne benthamii*).
- Unit 5 Alluvial plains – non-cracking, with some self-mulching cracking clays with tussock grasslands (*Eragrostis xerophila*, *Eriachne benthamii*, *Chrysopogon fallax*, **Cenchrus ciliaris*); or tussock grasslands with *Atriplex bunburyana*; or occasionally *Triodia* spp. hummock grasslands.
- Unit 7 Drainage depressions (occasional) – deep red/brown non-cracking clays and red loamy earths with dense tussock grasslands (*Eriachne benthamii*, *Chrysopogon fallax*) with occasional eucalypt trees and shrubs.

At a regional and national level, the marine and tidal communities provide habitat values for significant fauna species, including several unique birds (Kendrick and Stanley 2001). At a local and state level, however, the most significant flora values relate to the Priority 3 'Horseflat land system of the Roebourne Plains' ecological community.

5.5 Previous Botanical Surveys

Astron Environmental Services (2005) and Mattiske Consulting Pty Ltd (2006, 2008 and 2011) have undertaken other flora and vegetation surveys of the proposed Balla Balla operations and associated infrastructure. The latter mapping projects highlighted three Priority species (*Gomphrena cucullata* P2, *Acacia glaucocaesia* P3, *Themeda* sp. Hamersley Station (M.E. Trudgen 11431) P3, a species of *Mimulus* that could be a Priority) and a potential Priority Ecological Community (Roebourne Plains Grassland Communities). The latter studies differed in the scale of mapping and as a result there are some differences in local mapping between the older mapping and the more recent detailed mapping on the proposed infrastructure. These studies delineated a range of vegetation communities were classified as bunch grasslands, hummock grasslands, river/creepline vegetation associations or coastal chenopod or mangrove communities.

The previous MCPL studies (2006; 2008; and 2011) delineated a range of vegetation communities including bunch grasslands, hummock grasslands, river/creepline vegetation associations or coastal chenopod or mangrove communities. Bunch grasslands are generally dominated by *Eragrostis xerophila* and hummock grasslands by mixed *Triodia* spp., usually with emergent shrubs (*Acacia pyrifolia*, *Acacia inaequilatera*, *Grevillea wickhamii*, *Grevillea pyramidalis*). Vegetation of the river systems was broadly defined as *Eucalyptus camaldulensis* – *Eucalyptus victrix* association with a range of *Melaleuca* spp. and *Acacia* spp. shrubs forming the mid-storey. The previous MCPL studies were conducted at different scales (compared to 1:20,000 of the current survey).

5.6 Wetlands

Kendrick and Stanley (2001) describe the mangroves (including those around the Balla Balla area) as wetlands of subregional significance. These mangroves are primarily significant as fauna habitats for several unique birds (Kendrick and Stanley 2001).

5.7 Threatened and Priority Flora

It is unlikely that any threatened flora species pursuant to subsection (2) of section 23F of the WC Act and as listed by the DEC (2013a, 2013d), or pursuant to section 179 of the EPBC Act and as listed by the DSEWPC (2013a), have the possibility of occurring within tenement L47/690.

One priority flora species, as listed by the DEC (2013a), has the possibility of occurring within tenement L47/690. This species, *Heliotropium muticum* (P1), was previously recorded by MCPL (2011) in vegetation community HG2, to the south-west of the project area.

Heliotropium muticum (**P1**) **BORAGINACEAE** – an ascending to spreading perennial herb, to 30 cm tall. Few ecogeographic details are available; however records housed at the WA Herbarium indicate this species has been collected from brown-red sandy/loamy clays (Craven 1996; DEC 2013a). The WA Herbarium houses ten records from the Port Hedland area.

Several other Priority species have been recorded in the wider project area (Aston Environmental Services 2005 and Mattiske Consulting 2006, 2008) although these were not located on the current proposed alignment.

5.8 Introduced flora (weeds)

Five introduced (weed) species have been previously recorded within or nearby the proposed infrastructure corridor (Appendix C). These weed species include **Aerva javanica*, **Cyperus rotundus*, **Indigofera hochstetteri*, **Vachellia farnesiana* and **Cenchrus ciliaris*. None are declared pest organisms pursuant to section 22 of the *BAM Act* 2007.

6. FIELD SURVEY RESULTS

6.1 Flora

A total of 101 vascular plant taxa, representative of 69 genera and 27 families, were recorded in the L47/690 survey area. The majority of taxa recorded were representative of the Fabaceae (27 taxa), Poaceae (21 taxa) and Malvaceae (10 taxa) families (see Appendix C for a species list). Of the 101 taxa recorded, approximately 17 % are considered annual herbs or grasses.

A species accumulation curve was used to evaluate the sampling adequacy and is presented in Figure 4. The Incidence based Coverage Estimator (ICE) of species richness was 124.35. Based on this value and the total of 100 species recorded, approximately 80 % of the flora potentially present within the survey area was recorded.

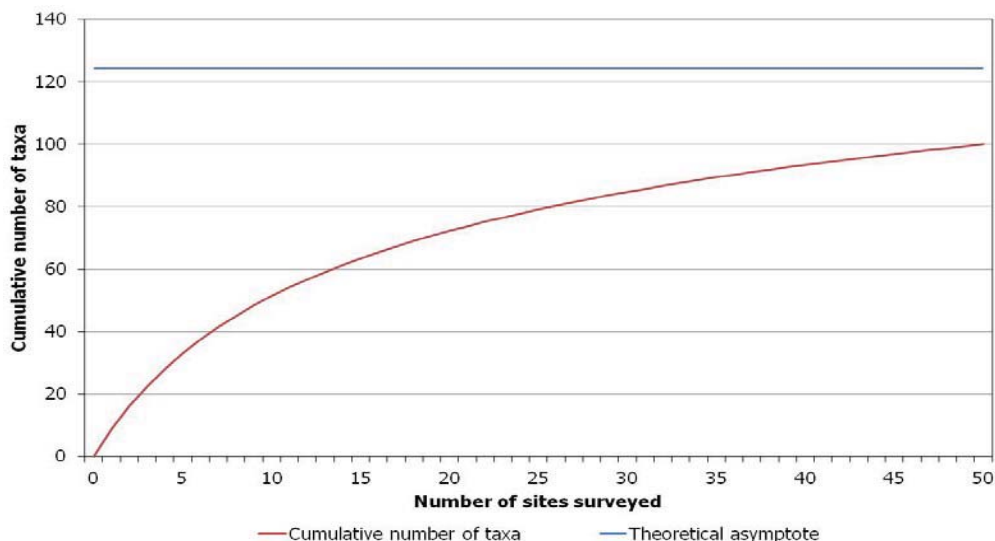


Figure 4: Average randomised species accumulation curve

Note: Field survey data was used to calculate both a species accumulation curve and a theoretical maximum number of species (asymptotic value) within the survey area.

6.2 Threatened and Priority Flora

No threatened flora species pursuant to subsection (2) of section 23F of the WC Act and as listed by the DEC (2013a, 2013d), or pursuant to section 179 of the EPBC Act and as listed by the DSEWPC (2013a), were recorded within the proposed infrastructure corridor and surrounding tenement L47/690.

No priority flora species as listed by the DEC (2013a, 2013d) were recorded within the proposed infrastructure corridor and surrounding tenement L47/690 in 2013.

6.3 Introduced flora (weeds)

A total of five introduced (weed) taxa were recorded within the proposed infrastructure corridor (see Appendices C and D). These species are commonly recorded in nearby coastal areas and further inland in the Pilbara bioregion and none are listed as declared plants (Biosecurity and Agriculture Management Act 2007, adopted on May 1st, 2013) according to the Western Australian Department of Agriculture and Food (2013) database. Several of the introduced species recorded have the potential to spread rapidly into disturbed areas and therefore vehicle hygiene measures should be implemented and maintained during on-ground activities. Of particular concern are **Aerva javanica* (Kapok Bush) and **Cenchrus ciliaris* (Buffel Grass). The latter may be more difficult to manage as it has been widely planted as a pasture species and has become established in pastoral areas of the Pilbara bioregion over many decades. Also recorded were **Malvastrum americanum* (Spiked Malvastrum) and **Portulaca oleracea* (Purslane), which tend to concentrate in open, disturbed areas and **Vachellia farnesiana* (Mimosa Bush), which is widespread in disturbed areas including roadsides, creeks and floodplains throughout the Pilbara.

The following is a summary of the introduced species as recorded:

- **Aerva javanica* (Kapok Bush) – prefers calcareous soils, perennial herb that flowers and fruits most of the year. Introduced to assist with revegetation of degraded land and is now widespread from the Kimberley to Carnarvon areas (Hussey *et al.* 2007). This species was recorded at nine *survey sites in April 2013*.
- **Cenchrus ciliaris* (Buffel Grass) – a tufted, often tussocking perennial. Widely planted as pasture species it has become a widespread weed of roadsides, creeklines, river edges and floodplains from Geraldton to the Pilbara (Hussey *et al.* 2007). This species was recorded at ten survey sites in April 2013.
- **Malvastrum americanum* (Spiked Malvastrum) – an erect, hairy perennial plant to 1.5 m tall. It is inedible to herbivores and is a weed of river and creek margins, wasteland and arid zone habitats from the Kimberley to the Pilbara and Gascoyne regions (Hussey *et al.* 2007). This species was recorded at two survey sites in April 2013.
- **Portulaca oleracea* (Purslane) – a prostrate, succulent annual (Hussey *et al.* 2007). This species was recorded at six survey sites in April 2013.
- **Vachellia farnesiana* (Mimosa Bush, prev. *Acacia farnesiana*) – a dense, sprawling, spiny shrub. It is a widespread weed of roadsides, creeks, rivers and disturbed floodplains throughout the pastoral regions from the Kimberley to Carnarvon and Wiluna (Hussey *et al.* 2007). This species was recorded at four survey sites in April 2013.

6.4 Vegetation Mapping

The vegetation communities were based on a 22% similarity (see Figure 5) and were subdivided into five major groupings and then further refined into eight vegetation communities and three mosaic communities. The analyses were based on presence-absence data with singletons removed prior to analysis. The eight vegetation communities were either refined based on previous mapping, or defined as per below (excluding three mosaic communities and four other, non-vegetative communities), Figure 6.1 to 6.3:

The decision to differentiate these as separate vegetation groups, as compared to the Bray and Curtis PRIMER v6 analysis (Figure 5), was based on a combination of factors. These included:

1. An identifiable physical environmental characteristics, e.g. flats and mangroves;
2. Underlying landforms; and
3. Differentiation based on particular soil characteristics.

The following communities were defined and mapped:

- Ch2** - Sparse samphire shrubland of *Tecticornia* sp. and *Suaeda arbusculoides* (with occasional emergent *Avicennia marina*) on brown clayey, tidal mudflats abutting mangroves.
- G7a** – Grassland of *Spinifex longifolius*, *Eulalia aurea*, *Eriachne aristidea*, *Eriachne* sp. with occasional shrubs (*Threlkeldia diffusa*, *Sesuvium portulacastrum*) on pale brown-orange sand dunes and slopes. The weeds, **Aerva javanica* and **Cenchrus ciliaris*, are common in this dune community.
- G8** – Open tussock grassland of *Aristida contorta*, *Eragrostis xerophila*, *Chrysopogon fallax*, (occasionally with *Triodia pungens*), *Eriachne helmsii* with mixed low shrubs and herbs, on red-brown cracking clay plains.
- M1a** – Open mangrove forest to mangrove woodland of *Avicennia marina* with occasional dense pockets of *Rhizophora stylosa* on brown clayey, tidal mudflats and creek banks.
- S4** – Open shrubland of *Acacia coriacea* subsp. *pendens* over open tussock grassland of *Spinifex longifolius* and other mixed grasses, with occasional low shrubs (*Threlkeldia diffusa*, *Rhagodia preissii* subsp. *obovata*, *Salsola australis*) on pale brown-orange sand dunes and slopes. The weeds, **Aerva javanica* and **Cenchrus ciliaris*, are common in this dune community.
- S5** – Sparse Acacia shrubland (*Acacia arida*, *Acacia sclerosperma* subsp. *sclerosperma*, *Acacia inaequilatera*) with mixed low shrubs over open hummock grassland of *Triodia wiseana* on red-brown clayey-loam on flats.

S6 – Sparse Acacia shrubland (*Acacia inaequilatera*, *Acacia ancistrocarpa*, *Acacia pyrifolia*) over open grassland of *Triodia pungens* and *Chrysopogon fallax* with mixed shrubs on red-brown sandy/clayey-loam floodplains adjacent to major creeklines.

W2 – Open woodland of *Eucalyptus victrix* - *Eucalyptus camaldulensis* or *Corymbia hamersleyana* over sparse shrubland of *Acacia trachycarpa*, *Acacia tumida*, *Acacia pyrifolia* and *Carissa lanceolata* over open grassland (*Triodia pungens*, *Chrysopogon fallax* and mixed shrubs) on red sandy-loam in major creeklines.

Mosaic communities:

G8-S5 (see mosaic of communities above)

S5-HG2 (see below for HG2 description)

S6-HG2 (see below for HG2 description)

Other:

AM – algae mat.

TC – tidal creek with no vegetation, but commonly fringed by mangroves.

TM – tidal mudflat, no vegetation (with the exception of occasional samphires/mangroves).

OW – Open water.

The description of one vegetation community, HG2 was included from Mattiske Consulting (2011) mapping and is defined below:

HG2 – Hummock grassland of *Triodia pungens* and *Triodia wiseana* with *Chrysopogon fallax* and **Cenchrus ciliaris* and emergent *Acacia inaequilatera* over mixed shrubs, herbs and grasses on red-brown clay soils on flats, with occasional seasonally waterlogged areas.

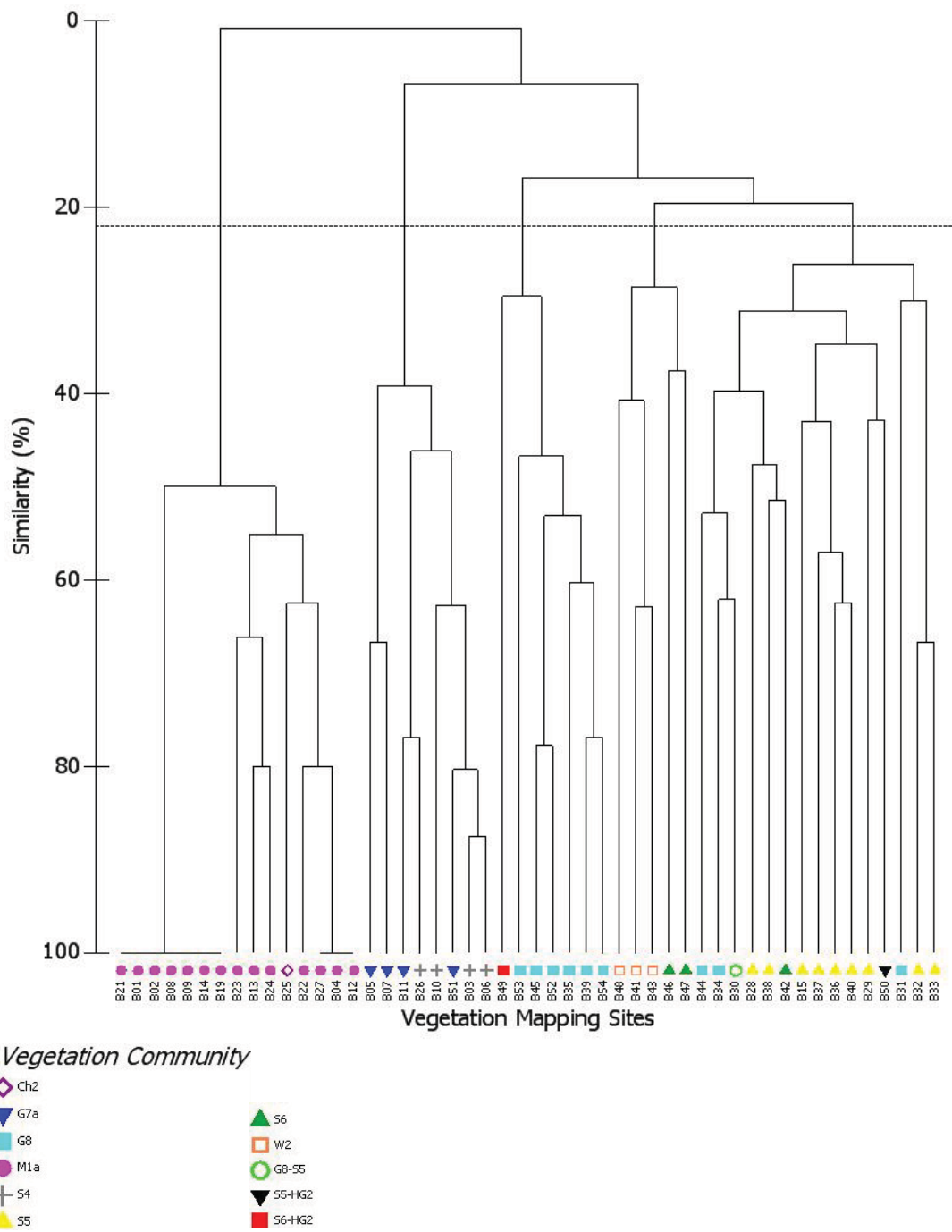


Figure 5: Cluster dendrogram of the vegetation mapping sites based on presence-absence data, using the Bray Curtis Similarity measure

568000mE

570000mE

572000mE

7716000mN

7716000mN

7714000mN

7714000mN

7712000mN

7712000mN

7710000mN

7710000mN

568000mE

570000mE

572000mE

Vegetation Legend

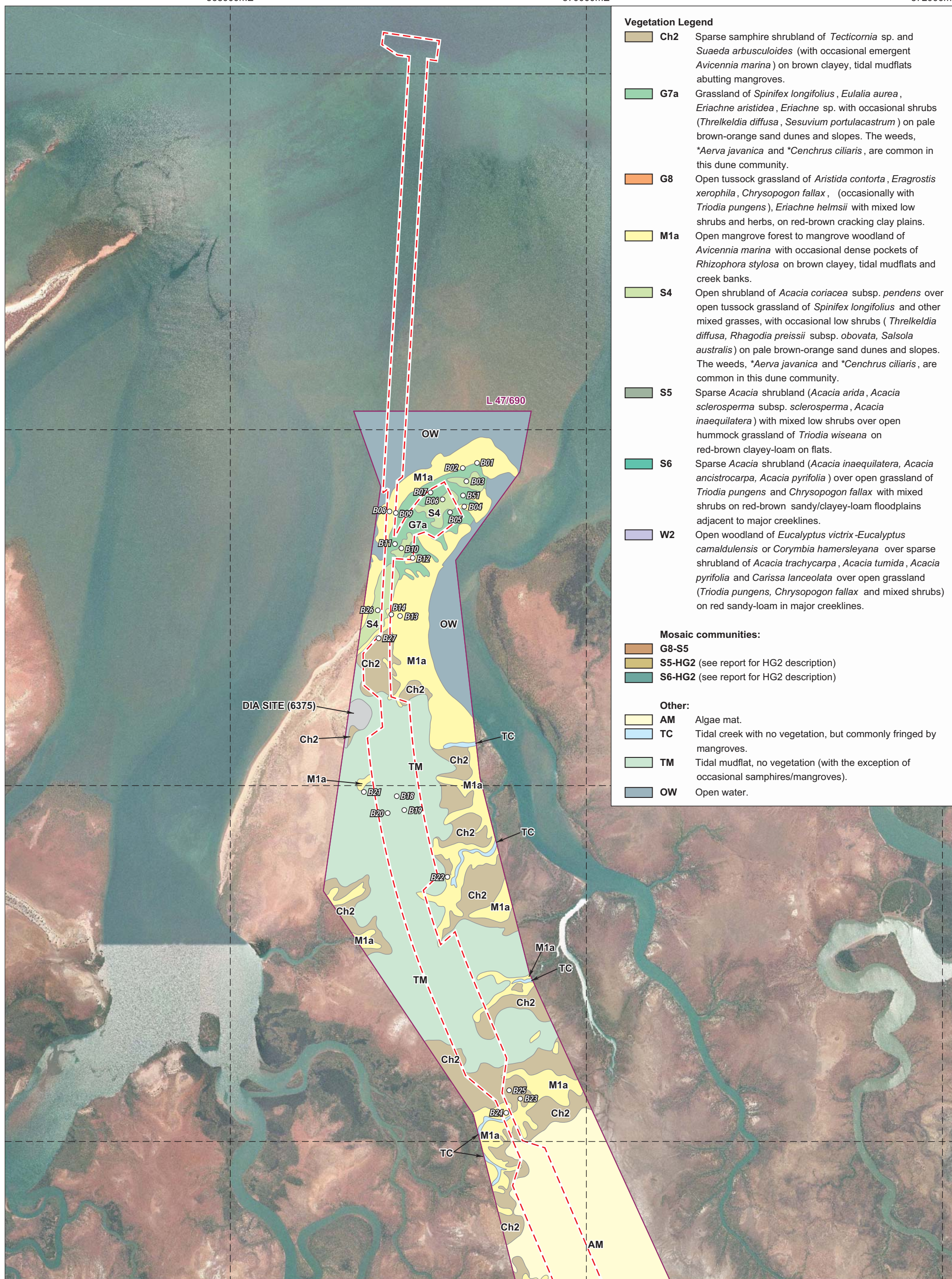
- Ch2** Sparse samphire shrubland of *Tecticornia* sp. and *Suaeda arbusculoides* (with occasional emergent *Avicennia marina*) on brown clayey, tidal mudflats abutting mangroves.
- G7a** Grassland of *Spinifex longifolius*, *Eulalia aurea*, *Eriachne aristidea*, *Eriachne* sp. with occasional shrubs (*Threlkeldia diffusa*, *Sesuvium portulacastrum*) on pale brown-orange sand dunes and slopes. The weeds, *Aerva javanica* and *Cenchrus ciliaris*, are common in this dune community.
- G8** Open tussock grassland of *Aristida contorta*, *Eragrostis xerophila*, *Chrysopogon fallax*, (occasionally with *Triodia pungens*), *Eriachne helmsii* with mixed low shrubs and herbs, on red-brown cracking clay plains.
- M1a** Open mangrove forest to mangrove woodland of *Avicennia marina* with occasional dense pockets of *Rhizophora stylosa* on brown clayey, tidal mudflats and creek banks.
- S4** Open shrubland of *Acacia coriacea* subsp. *pendens* over open tussock grassland of *Spinifex longifolius* and other mixed grasses, with occasional low shrubs (*Threlkeldia diffusa*, *Rhagodia preissii* subsp. *obovata*, *Salsola australis*) on pale brown-orange sand dunes and slopes. The weeds, *Aerva javanica* and *Cenchrus ciliaris*, are common in this dune community.
- S5** Sparse *Acacia* shrubland (*Acacia arida*, *Acacia sclerosperma* subsp. *sclerosperma*, *Acacia inaequilatera*) with mixed low shrubs over open hummock grassland of *Triodia wiseana* on red-brown clayey-loam on flats.
- S6** Sparse *Acacia* shrubland (*Acacia inaequilatera*, *Acacia ancistrocarpa*, *Acacia pyrifolia*) over open grassland of *Triodia pungens* and *Chrysopogon fallax* with mixed shrubs on red-brown sandy/clayey-loam floodplains adjacent to major creeklines.
- W2** Open woodland of *Eucalyptus victrix*-*Eucalyptus camaldulensis* or *Corymbia hamersleyana* over sparse shrubland of *Acacia trachycarpa*, *Acacia tumida*, *Acacia pyrifolia* and *Carissa lanceolata* over open grassland (*Triodia pungens*, *Chrysopogon fallax* and mixed shrubs) on red sandy-loam in major creeklines.

Mosaic communities:

- G8-S5**
- S5-HG2** (see report for HG2 description)
- S6-HG2** (see report for HG2 description)

Other:

- AM** Algae mat.
- TC** Tidal creek with no vegetation, but commonly fringed by mangroves.
- TM** Tidal mudflat, no vegetation (with the exception of occasional samphires/mangroves).
- OW** Open water.



Legend

- Proposal Area
- Forge Tenement
- PEC Boundary
- MCPL Sites

Sheet Layout:

Client:



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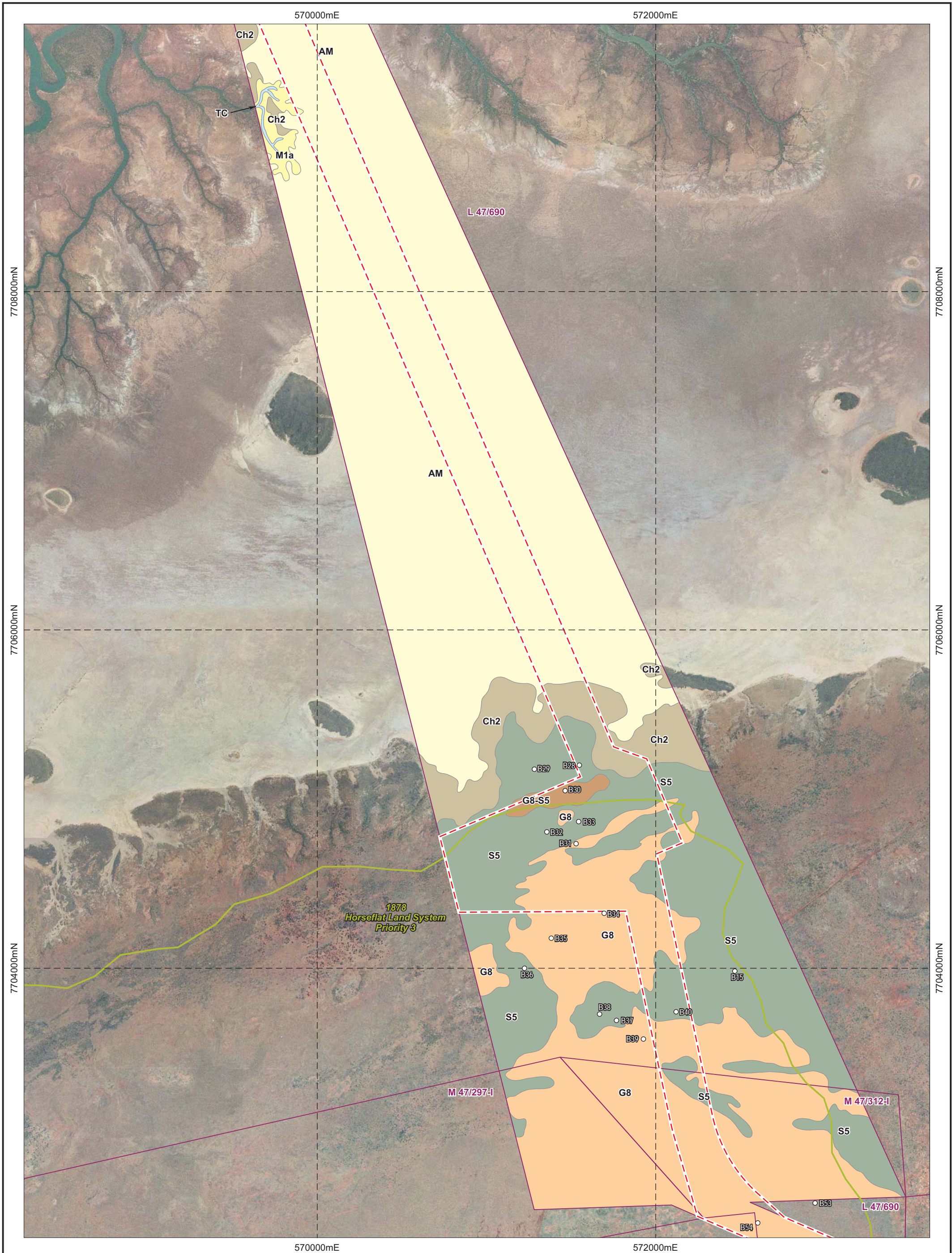
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Date: May 2013 Rev: C | A3

Mattiske Consulting Pty Ltd
28 Central Road, Kalamunda WA 6076 - Tel: 9257 1625 - Fax: 9257 1640

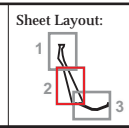
Author: E M Mattiske MCPL Ref: FRL1301/020/13
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**Balla Balla Export Facilities
Proposed Infrastructure Corridor
and Vegetation Mapping
Sheet 1 of 3**

Figure:
6.1



Legend
 - Proposal Area
 - Forge Tenement
 - PEC Boundary
 - MCP Sites
 Note: For vegetation legend - refer to figure 6.01



Client:
 Forge Resources

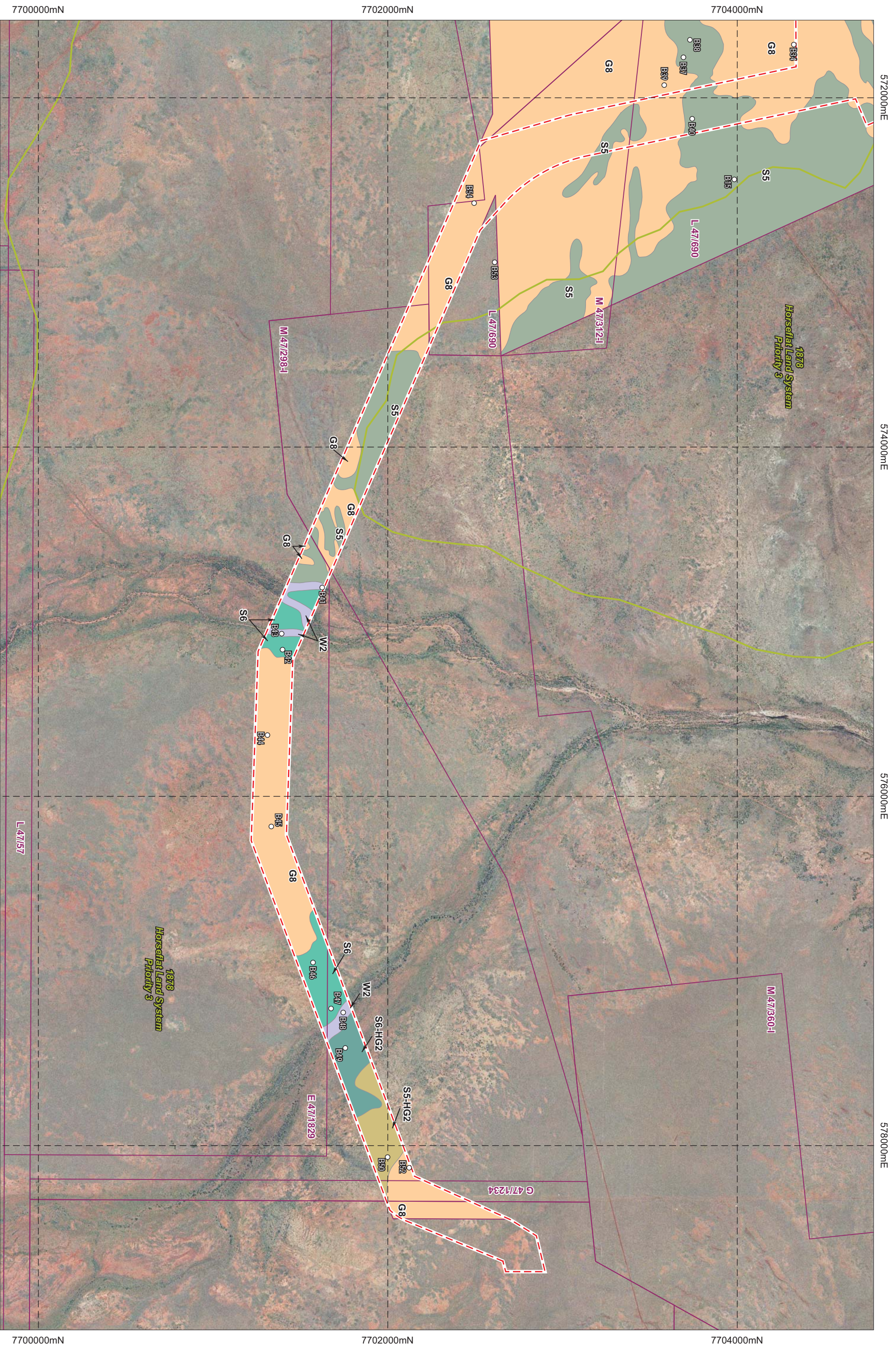


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 Date: May 2013 | Rev: C | A3

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**Balla Balla Export Facilities
 Proposed Infrastructure Corridor
 and Vegetation Mapping
 Sheet 2 of 3**

Figure:
6.2



Legend

- Construction Footprint
- Forge Tenement
- PEC Boundary
- MCP Sites

Note: For vegetation legend - refer to figure 6.01

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Client: Forge Resources

Author: E.M. Matyska
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28 Central Road, Kalamunda WA 6076 - Tel: 957 6625 - Fax: 957 1600
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Date: May 2013 Rev: C / A3

Balla Balla Export Facilities
Proposed Infrastructure Corridor
and Vegetation Mapping
Sheet 3 of 3

Figure: 6.3

The extent of the respective vegetation communities summarised in Table 1. There were overlaps in the species composition of some of the S4, S6, S7, S6-HG2a and S7-HG2a and latter may be in part to relate to pastoral activities.

Table 1: Summary of Extent of Vegetation Mapping Units within tenement L47/690 - Balla Balla Export Facilities Infrastructure Corridor

VEGETATION COMMUNITY	TOTAL SURVEY AREA (HA)	PROPORTION OF TOTAL SURVEY AREA (%)	PROPOSED AREA (HA)	PROPOSED AREA AS % OF TOTAL AREA
AM	511.7105	33.42082	23.35	4.56
C2	111.4169	7.276854	5.94	5.34
DIA Site	2.036016	0.132976	-	-
G7a	13.28856	0.867902	1.25	9.444
G8	341.2909	22.29038	33.10	9.694
G8-S6	6.392401	0.4175	1.38	21.52
M1a	78.15297	5.104323	1.84	2.35
OW	43.30642	2.828427	0.22	0.51
S4	8.51933	0.556414	2.15	25.27
S6	256.7466	16.76862	47.25	18.40
S6-HG2a	9.286778	0.606538	2.14	23.06
S7	14.8407	0.969276	3.67	24.74
S7-HG2a	7.978644	0.521101	2.04	25.54
TC	3.098272	0.202354	0.07	2.24
TM	118.3162	7.72746	10.56	8.92
W2	4.731995	0.309056	1.13	23.79
Total	1531.11	100.00	136.09	8.89

6.5 Threatened and Priority Ecological Communities

None of the TECs listed in the Pilbara region were recorded in the proposed infrastructure corridor and surrounding tenement L47/690 (DEC 2013c). One of the PEC's (the 'Horseflat land system of the Roebourne Plains', Priority 3) as defined by the Department of Environment and Conservation (2013b) has some values in common with the grassland communities as defined (vegetation mapping code G8) within the proposed infrastructure corridor (Figures 6.1 to 6.3). Vegetation community G8 is dominated by *Eragrostis xerophila* and other Poaceae (grass) species. The PEC occurs from Cape Preston to Balla Balla, surrounding Karratha and Roebourne (DEC 2013b). The given DEC boundaries of this PEC intercepts the proposed infrastructure corridor, between the proposed Balla Balla mine site in the east and the proposed stockyard and water recovery ponds in the north-west. Based on currently available data, the proposed infrastructure corridor disturbance would be less than 1.9 % of the area of polygon ID 1878 (Figure 1). At a local and state level, however, the most significant flora values relate to the Priority 3 'Horseflat land system of the Roebourne Plains' ecological community.

6.6 Vegetation Condition

Vegetation condition ranged from Excellent in the tidal-mangrove communities to Very Good on the sand dunes. Tussock grasslands were degraded in small parts mainly due to grazing, but mostly in Very Good condition.

7. DISCUSSION

7.1 Flora

A total of 100 vascular plant taxa were recorded in the proposed infrastructure corridor and surrounding tenement L47/690 during the April 2013 survey.

A total of 101 vascular plant taxa, representative of 69 genera and 27 families, were recorded in the L47/690 survey area. Of the 101 taxa recorded, approximately 17 % are considered annual herbs or grasses. As there was a lack of rain in the weeks prior to the survey some specimens were lacking flowering fruiting material. Despite the lack of rain, it is estimated that approximately 80 % of the flora potentially present within the survey area was recorded.

No threatened flora species were expected or recorded in the proposed infrastructure corridor. One priority flora species, *Heliotropium muticum* (Boraginaceae – P1), was previously recorded to the south-west of the proposed infrastructure corridor by MCPL (2011); however no Priority species were recorded in the 2013 assessment. Several other Priority species have been recorded in the wider project area (Aston Environmental Services 2005 and Mattiske Consulting (2006, 2008) although these were not located on the current proposed alignment.

Five of the recorded plant taxa are introduced (weed) species. These species are commonly recorded in nearby coastal areas and further inland in the Pilbara bioregion and none are listed as declared plants (*Biosecurity and Agriculture Management Act 2007*, adopted on May 1st, 2013) according to the Western Australian Department of Agriculture and Food (2013) database. Several of the introduced species recorded have the potential to spread rapidly into disturbed areas and therefore vehicle hygiene measures should be implemented and maintained during on-ground activities. Of particular concern are **Aerva javanica* (Kapok Bush) and **Cenchrus ciliaris* (Buffel Grass). The latter may be more difficult to manage as it has been widely planted as a pasture species and has become established in pastoral areas of the Pilbara bioregion over many decades. Also recorded were **Malvastrum americanum* (Spiked Malvastrum) and **Portulaca oleracea* (Purslane), which tend to concentrate in open, disturbed areas and **Vachellia farnesiana* (Mimosa Bush), which is widespread in disturbed areas including roadsides, creeks and floodplains throughout the Pilbara.

The desktop search did not highlight any threatened flora species likely to be recorded within tenement L47/690. One priority flora species, *Heliotropium muticum* (Boraginaceae – P1), was previously recorded to the south-west of the proposed infrastructure corridor by MCPL (2011). This species is described as

an ascending to spreading perennial herb to 30 cm tall (Craven 1996; Department of Environment and Conservation {DEC} 2013a). Few details are available on specific site preferences, however records housed at the WA Herbarium indicate it has been collected from brown-red sandy/loamy clays (DEC 2013a). No threatened or priority flora species (including *Heliotropium muticum*) were recorded during the April 2013 survey. Several other Priority species have been recorded in the wider project area although these were not located on the current proposed alignment (Aston Environmental Services 2005 and Mattiske Consulting (2006, 2008).

7.2 Vegetation

The vegetation of the survey area was comprised of a mangrove community, tidal flats with samphires, coastal sand dunes, and a mosaic of tussock and hummock grasslands with occasional *Acacia* spp. and mixed shrublands.

The survey area lies within the Abydos Plain system of the Fortescue Botanical Province of the Eremaean Botanical Province (Beard 1975). The following Abydos Plain vegetation associations occur within the survey area:

- 127 – bare areas, mud flats.
- 589 – mosaic of *Eragrostis* tussock grassland, *Astrebla* mixed tussock grassland, *Chrysopogon* mixed tussock grassland, *Sporobolus* tussock grassland and *Triodia* open hummock grassland.

The proposed infrastructure corridor is likely to impact < 1 % of both vegetation associations 127 and 589 across the entire state.

At a regional and national level, the marine and tidal communities provide habitat values for significant fauna species, including several unique birds (Kendrick and Stanley 2001). At a local and state level, however, the most significant flora values relate to the Priority 3 'Horseflat land system of the Roebourne Plains' ecological community. The given DEC boundaries of this priority ecological community (PEC) intercepts the proposed infrastructure corridor (Figure 1). This PEC is defined by DEC (2013b) and Van Vreeswyk et al. (2004).

Some sites surveyed in the southern section of the proposed infrastructure corridor, from the proposed Balla Balla mine site in the east, to the proposed stockyard and water recovery ponds in the north-west (Figure 1), bare resemblance to this PEC. The tussock grasslands commonly support *Eragrostis xerophila* (and occasionally *Eragrostis eriopoda*) and *Eriachne* spp. (*Eriachne helmsii* and *Eriachne pulchella*) and occur on red-brown cracking clays. *Chrysopogon fallax* was also occasionally recorded in these sites. These Poaceae (grass) species are not restricted to the PEC occurrence, and commonly occur within and outside the Pilbara bioregion. It was noted during the field survey that the area falling within the PEC boundary also included large areas of *Acacia* shrublands and hummock grasslands.

If one accepts the broad PEC boundary as supplied by the DEC (specifically pertaining to polygon ID 1878 in Figure 1), it is still unlikely that the proposed infrastructure corridor will result in major impacts to the PEC. Based on currently available data, the proposed infrastructure corridor disturbance would be less than 1.9 % of the area of polygon ID 1878. In addition, this is only a small, localised impact, as the PEC extends to Cape Preston and has multiple occurrences across the Roebourne plains. The consideration of impacts should also take into account the current condition of the vegetation resembling the PEC, which is heavily grazed and ranged from degraded to very good.

7.3 Survey Constraints and Limitations

An assessment of the survey against a range of factors which may have had an impact on the outcomes of the present survey was made (Table 2). Based on this assessment, the present survey has not been subject to any major constraints; with the exception of the drier conditions which may have influenced the range of plant species that were flowering and fruiting.

Table 2: Potential limitations affecting the flora and vegetation survey of the proposed infrastructure corridor, Balla Balla

POTENTIAL SURVEY LIMITATION	IMPACT ON CURRENT SURVEY
Sources of information and availability of contextual information (i.e. pre-existing background versus new material).	Not a constraint: Adequate information was available in the form of databases (DEC 2007-) and DSEWPC (2013a) and previous vegetation surveys (MCPL 2006; 2008; 2011).
Scope (i.e. what life forms, etc. were sampled?).	Not a constraint: Approximately 17 % of the taxa sampled are considered annual herbs or grasses.
Proportion of flora collected and identified (based on sampling, timing and intensity).	Not a constraint: The proportion of flora sampled was adequate. Approximately 80 % of the flora potentially present within the survey area was sampled (refer to section 7.1). A significant range of annual species were recorded. Although a number of specimens collected were unidentifiable to species level due to lack of fruiting or flowering material; the 80% coverage was considered to be adequate.
Completeness and further work which might be needed (i.e. was the relevant survey area fully surveyed?).	Not a constraint: The relevant survey areas and surrounding tenement were surveyed adequately.
Mapping reliability.	Not a constraint: Two different vegetation mapping reports (MCPL 2008; 2011) cover sections of the proposed infrastructure corridor. The codes defined in this report do not necessarily coincide with those used in the previous reports due to different scales of mapping. The mapping on the proposed infrastructure is considered more than adequate due to the comprehensive sampling.
Timing, weather, season, cycle.	Potential constraint: The survey was conducted post-wet season, although most of the rainfall for the area was received in January (> 200 mm), with less than 20 mm received in February, and no rainfall recorded for March. The drier coastal conditions near the survey area may have led to a lower coverage of some species.
Disturbances (fire, flood, accidental human intervention, etc.).	Not a constraint: The survey area was able to be accessed by vehicle and helicopter and was in parts, traversed by foot.
Intensity (in retrospect, was the intensity adequate?).	Not a constraint: A total of 52 vegetation mapping sites were chosen across representative vegetation types.
Resources (i.e. were there adequate resources to complete the survey to the required standard?).	Not a constraint: Adequate resources were made available, including previous vegetation mapping.
Access problems (i.e. the ability to access the survey area).	Not a constraint: Sites were accessible by helicopter and vehicle.
Experience levels (i.e. the degree of expertise in plant identification to taxon level).	Not a constraint: Both experienced botanists have undertaken previous surveys in the Pilbara IBRA7 bioregion. Experienced taxonomists were consulted (along with reference material) at the Western Australian Herbarium where required.

8. CONCLUSION AND RECOMMENDATIONS

In response to the proposed clearing of vegetation within tenement L47/690 - Balla Balla Export Facilities project, it is recommended to:

- Limit ground disturbance and clearing of vegetation to designated areas and access routes;
- Maintain existing drainage systems, ensuring tracks and other infrastructure areas do not disrupt or divert historic water flow patterns;
- Minimise soil disturbance during clearing and practice standard vehicle hygiene to ensure introduced (weeds) species do not become further established within tenement L47/690 - Balla Balla.

Overall, in terms of impacts, none of the species or vegetation types are restricted to the survey area. The impacts of the proposed tenement L47/690 infrastructure will be minimal and not influence the conservation status of the species or the communities recorded within the survey area.

9. ACKNOWLEDGEMENTS

The authors would like to thank Angela Johnson and site personnel from Forge Resources Ltd for their assistance with this project.

10. PERSONNEL

The following MCPL personnel were involved in this project:

NAME	POSITION	PROJECT INVOLVEMENT	FLORA COLLECTION PERMIT
Dr E.M. Mattiske	Managing Director & Principal Ecologist	Planning, management, report preparation	N/A
Mrs B. Koch	Senior Botanist	Plant identification	N/A
Ms N. Murdock	Experienced Botanist	Fieldwork, data interpretation, report preparation	SL010396; 24-1213
Mr R. Dharmarajan	Experienced Botanist	Planning, fieldwork, plant identifications, report preparation	SL010385
Ms J. Ellery	Experienced Botanist	Plant identifications	N/A

11. REFERENCES

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A.1. Overview of Western Australia's flora

Western Australia has a unique and diverse flora, and is recognised as one of the world's 34 biodiversity hotspots (Myers *et al.* 2000). In this context, Western Australia possesses a high degree of species richness and endemism. This is particularly pronounced in the south-west region of the state. There are currently over 10,000 plant species known to occur within Western Australia (DEC 2013a), and scientific knowledge of many of these species is limited.

The unique flora of Western Australia is potentially under threat due to historical clearing practices associated with agricultural, mining and human habitation activities. As a consequence of these historical clearing practices a number of flora species have become threatened or have the potential to become threatened as their habitat is impacted by human activity. In addition, some areas of the State have been affected by past clearing practices such that entire ecological communities are under threat.

At the Commonwealth level, under the EPBC Act, a nomination process exists to list a threatened species or ecological community. Additions or deletions to the lists of threatened species and communities are made by the Minister for Sustainability, Environment, Water, Populations and Communities, on advice from the Federal Threatened Species Scientific Committee. The EPBC Act lists of threatened flora and ecological communities are published on the Department of Sustainability, Environment, Water, Populations and Communities (DSEWPC) website (DSEWPC 2013a, 2013b).

Ecological communities that are deemed to be threatened are also afforded protection under the EP Act. Listings of threatened species and communities are reviewed annually by the Western Australian Threatened Species Scientific Committee (TSSC), which is a body appointed by the Minister for the Environment and supported by the DEC.

The TSSC reviews threatened and specially protected flora (and fauna) listings on an annual basis. Recommendation for additions or deletions to the listings of specially protected flora (and fauna) is made to the Minister for the Environment by the TSSC, via the Director General of the DEC and the WA Conservation Commission. Under Schedule 1 of the WC Act, the Minister for the Environment may declare that a class or description of flora to be threatened flora throughout the State, by notice published in the *Government Gazette* (DEC 2013e).

The following sections describe these threatened and priority flora and ecological communities, and outline the legislative protection afforded to them.

A.2. Threatened and priority flora

Flora within Western Australia that is considered to be under threat may be classed as either threatened or priority flora. At the Commonwealth level, under the EPBC Act, threatened species can be listed as extinct, extinct in the wild, critically endangered, endangered, vulnerable, or conservation dependent, by the Commonwealth Minister for Sustainability, Environment, Water, Population and Communities. Under the EPBC Act, a person must not take an action that has, or will have, a significant impact on a listed threatened species without approval from the Commonwealth Minister for Sustainability, Environment, Water, Population and Communities, unless those actions are not prohibited under the Act. Table I sets out definitions of threatened flora under federal legislation. The current EPBC Act list of threatened flora may be found on the DSEWPC (2013a) website.

At the State level, the WC Act provides for taxa of native flora (and fauna) to be specially protected because they are subject to identifiable threats. Protection of these taxa has been identified as being warranted because they may become extinct, are threatened, or are otherwise in need of special protection. Where flora has been gazetted as threatened flora under the WC Act, it is an offence "to take" such flora without the written consent of the Minister. The WC Act states that "to take" flora includes to gather, pluck, cut, pull up, destroy, dig up, remove or injure the flora or to cause or permit the same to be done by any means.

Priority flora constitute species which are considered to be under threat, but for which there is insufficient information available concerning their distribution and/or populations to make a proper evaluation of their conservation status. Such species are considered to potentially be under threat, but do not have legislative protection afforded under the WC Act.

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The DEC categorises priority flora according to their conservation priority, using five categories, P1 to P5, to denote the status of such species, with P1 listed species being the most threatened and P5 the least. Priority flora species are regularly reviewed, and may have their status changed when more information on the species becomes available. Table II sets out State definitions of both threatened and priority flora.

Table I: Federal definition of threatened flora species

Note: Adapted from the EPBC Act.

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

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Table II: State definition of threatened and priority flora species
Note: Adapted from DEC (2013a).

CODE	CATEGORY
T	<p>Threatened Flora (Declared Rare Flora – Extant)</p> <p>Taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such (Schedule 1 under the WC Act).</p> <p>Threatened flora (Schedule 1) are further ranked by DEC according to their level of threat using IUCN Red List criteria:</p> <ul style="list-style-type: none"> • CR: Critically Endangered – considered to be facing an extremely high risk of extinction in the wild; • EN: Endangered – considered to be facing a very high risk of extinction in the wild; or • VU: Vulnerable – considered to be facing a high risk of extinction in the wild.
P1	<p>Priority One – Poorly Known Species</p> <p>Taxa that are known from one or a few collections or sight records (generally less than five), all on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, Shire, Westrail and Main Roads WA road, gravel and soil reserves, and active mineral leases and under threat of habitat destruction or degradation. Taxa may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes.</p>
P2	<p>Priority Two – Poorly Known Species</p> <p>Taxa that are known from one or a few collections or sight records, some of which are on lands not under imminent threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, vacant Crown land, water reserves, etc. Taxa may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes.</p>
P3	<p>Priority Three – Poorly Known Species</p> <p>Taxa that are known from collections or sight records from several localities not under imminent threat, or from few but widespread localities with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Taxa may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and known threatening processes exist that could affect them.</p>
P4	<p>Priority Four – Rare Threatened and other species in need of monitoring</p> <p>(i) Rare - Taxa that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These taxa are usually represented on conservation lands.</p> <p>(ii) Near Threatened - Taxa that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable.</p> <p>(iii) Taxa that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.</p>
P5	<p>Priority Five – Conservation Dependent Species</p> <p>Taxa that are not threatened but are subject to a specific conservation program, the cessation of which would result in the taxon becoming threatened within five years.</p>

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A.3. Threatened and priority ecological communities

An ecological community is defined as a naturally occurring biological assemblage that occurs in a particular type of habitat composed of specific abiotic and biotic factors. Under the EPBC Act, a person must not take an action that has or will have a significant impact on a listed threatened ecological community without approval from the Commonwealth Minister for the Sustainability, Environment, Water, Population and Communities, unless those actions are not prohibited under the Act. A description of each of these categories of TECs is presented in Table III. The current EPBC Act list of threatened ecological communities can be located on the DSEWPC (2013d) website.

At the State level, ecological communities may be considered as threatened once they have been identified as such by the Western Australian Threatened Ecological Communities Scientific Advisory Committee. A threatened ecological community is defined, under the EPBC Act, as an ecological community listed, designated or declared under a written law or a law of the Commonwealth as threatened, endangered or vulnerable. There are four State categories of threatened ecological communities, or TECs; a description of each of these categories of TECs is presented in Table IV. Some, but not all, Western Australian TECs are also listed as threatened under the EPBC Act.

Ecological communities identified as threatened, but not listed as threatened ecological communities, can be classified as priority ecological communities (PECs). These communities are under threat, but there is insufficient information available concerning their distribution to make a proper evaluation of their conservation status.

The DEC categorises PECs according to their conservation priority, using five categories, P1 to P5, to denote the conservation priority status of such ecological communities; these categories are defined in Table V. A list of current PECs can be viewed at the DEC (2013f) website.

Table III: Federal definition of threatened ecological communities

Note: Adapted from DSEWPC (2013b).

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

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Table IV: State definition of threatened ecological communities
Note: Adapted from DEC (2013d).

CODE	CATEGORY
PTD	<p>Presumed Totally Destroyed</p> <p>An ecological community will be listed as Presumed Totally Destroyed if there are no recent records of the community being extant and either of the following applies:</p> <ul style="list-style-type: none"> (i) records within the last 50 years have not been confirmed despite thorough searches or known likely habitats or; (ii) all occurrences recorded within the last 50 years have since been destroyed.
CE	<p>Critically Endangered</p> <p>An ecological community will be listed as Critically Endangered when it has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future, meeting any one of the following criteria:</p> <ul style="list-style-type: none"> (iv) The estimated geographic range and distribution has been reduced by at least 90% and is either continuing to decline with total destruction imminent, or is unlikely to be substantially rehabilitated in the immediate future due to modification; (v) The current distribution is limited i.e. highly restricted, having very few small or isolated occurrences, or covering a small area; (vi) The ecological community is highly modified with potential of being rehabilitated in the immediate future.
E	<p>Endangered</p> <p>An ecological community will be listed as Endangered when it has been adequately surveyed and is not Critically Endangered but is facing a very high risk of total destruction in the near future. The ecological community must meet any one of the following criteria:</p> <ul style="list-style-type: none"> (i) The estimated geographic range and distribution has been reduced by at least 70% and is either continuing to decline with total destruction imminent in the short term future, or is unlikely to be substantially rehabilitated in the short term future due to modification; (ii) The current distribution is limited i.e. highly restricted, having very few small or isolated occurrences, or covering a small area; (iii) The ecological community is highly modified with potential of being rehabilitated in the short term future.
V	<p>Vulnerable</p> <p>An ecological community will be listed as Vulnerable when it has been adequately surveyed and is not Critically Endangered or Endangered but is facing high risk of total destruction in the medium to long term future. The ecological community must meet any one of the following criteria:</p> <ul style="list-style-type: none"> (i) The ecological community exists largely as modified occurrences that are likely to be able to be substantially restored or rehabilitated; (ii) The ecological community may already be modified and would be vulnerable to threatening process, and restricted in range or distribution; (iii) The ecological community may be widespread but has potential to move to a higher threat category due to existing or impending threatening processes.

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Table V: State definition of priority ecological communities
Note: Adapted from DEC (2013d).

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

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A.4. Clearing of native vegetation

Under the EP Act, the clearing of native vegetation requires a permit to do so, from the DEC or the Department of Mines and Petroleum, unless that clearing is exempted under specific provisions listed in Schedule 6 of the Act, or are prescribed in the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*.

Under the EP Act, "native vegetation" means indigenous aquatic or terrestrial vegetation, and includes dead vegetation unless that dead vegetation is of a class declared by regulation to be excluded from this definition but does not include vegetation in a plantation.

Under Section 51A of the EP Act, "clearing" means the killing or destruction of, the removal of, the severing or ringbarking of trunks or stems of, or the doing of any other substantial damage to, some or all of the native vegetation in an area, and includes the draining or flooding of land, the burning of vegetation, the grazing of stock, or any other act or activity, that causes any of the aforementioned consequences or results.

Under the EP Act, ten principles are set out, under which native vegetation should not be cleared. These principles state that native vegetation should not be cleared, if:

- a. it comprises a high level of biological diversity;
- b. it comprises the whole or a part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous to Western Australia;
- c. it includes, or is necessary for the continued existence of, threatened flora;
- d. it comprises the whole or a part of, or is necessary for the maintenance of, a threatened ecological community;
- e. it is significant as a remnant of native vegetation in an area that has been extensively cleared;
- f. it is growing in, or in association with, an environment associated with a watercourse or wetland;
- g. the clearing of the vegetation is likely to cause appreciable land degradation;
- h. the clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area;
- i. the clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water; or
- j. the clearing of the vegetation is likely to cause, or exacerbate, the incidence or intensity of flooding.

The *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*, under Regulation 5, sets out prescribed clearing actions that do not require a clearing permit, as defined in Section 51C of the EP Act.

Under the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*, under Regulation 6 – "environmentally sensitive areas" are defined as "the area covered by vegetation within 50 m of threatened flora, to the extent to which the vegetation is continuous with the vegetation in which the threatened flora is located".

Under the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* - Regulation 6 (environmentally sensitive areas), the area covered by a threatened ecological community, is similarly considered an environmentally sensitive area and therefore non-permitted, unless Ministerial approval is granted.

A.5. Local and regional significance

Flora or vegetation may be locally or regionally significant in addition to statutory listings by the State or Federal Government. Whilst not legislatively protected, these factors are taken into consideration during the assessment of mining proposals, clearing proposals and other proposed development; Guidance Statement 51 specifically states:

"A broad consideration of the ecological processes that influence sites and their ecological functions is required; statutory lists of Declared Rare and Priority Flora are only a small subset of biodiversity. Proponents should ensure that flora and vegetation surveys provide sufficient information to address both biodiversity conservation and ecological function values within the context of the type of proposal being considered and the relevant EPA objectives for protection of the environment" (EPA 2004).

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

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

Vegetation may be significant because the extent is below a threshold level and a range of other reasons, including:

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

Vegetation communities are locally significant if they contain priority flora species or contain a range extension of a particular taxon outside of the normal distribution. They may also be locally significant if they are very restricted to one or two locations or occur as small isolated communities. In addition, vegetation communities that exhibit unusually high structural and species diversity are also locally significant. Vegetation communities are regionally significant where they are limited to specific landform types, are uncommon or restricted plant community types within the regional context, or support populations of threatened flora. Determining the significance of flora and vegetation may be applied at various scales, for example, a vegetation community may be nationally significant and governed by statutory protection as well as being locally and regionally significant.

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A.6. Declared Organisms (including Introduced plant species)

The *Biosecurity and Agriculture Management Act 2007* (*BAM Act*) replaced the *Agriculture and Related Resources Protection Act 1976*. Organisms are grouped into four main classifications;

- Declared pests (section 22).
- Permitted (section 11)
- Prohibited (section 12)
- Permitted Requiring a permit (73, BAM Regulations 2013)

The Western Australian Organism List (WAOL) has been created to summarize the declared status of Organisms that have been classified as part of the enactment of the [Biosecurity and Agriculture Management Act 2007](#) (*BAM Act*).

Under the *Biosecurity and Agriculture Management Act 2007* (the *BAM Act*), all declared pests are placed in one of three categories, namely C1 (exclusion), C2 (eradication) or C3 (management), as delineated below:

The **C1 category (Exclusion)** - Pests will be assigned to this category if they are not established in Western Australia and control measures are to be taken, including border checks, in order to prevent them entering and establishing in the State.

The **C2 category (Eradication)** – Pests will be assigned to this category if they are present in Western Australia in low enough numbers or in sufficiently limited areas that their eradication is still a possibility.

The **C3 category (Management)** – Pests will be assigned to this category if they are established in Western Australia but it is feasible, or desirable, to manage them in order to limit their damage. Control measures can prevent a C3 pest from increasing in population size or density or moving from an area in which it is established into an area which currently is free of that pest.

Organisms that are unlisted are those that have not been declared by the Minister for Agriculture and Food as permitted, prohibited or declared pests, and therefore are not included on the WAOL. Section 15(2) states unlisted organisms cannot be imported, except with a permit. This provision requires therefore that people must seek permission to bring undeclared organisms across the border into Western Australia so that an assessment can be made about any biosecurity threats they may pose to the State.

APPENDIX B: VEGETATION MAPPING SITE LOCATIONS ON TENEMENT L47/690, BALLA BALLA

SITE	LOCATION (GDA94, Z50)	
	EASTING (mE)	NORTHING (mN)
B01	569386	7713814
B02	569306	7713784
B03	569326	7713710
B04	569314	7713568
B05	569234	7713535
B06	569192	7713609
B07	569124	7713647
B08	568930	7713533
B09	568894	7713541
B10	568961	7713334
B11	568925	7713358
B12	569024	7713280
B13	568953	7712953
B14	568904	7712961
B15	572467	7703983
B18	568934	7711941
B19	568977	7711862
B20	568884	7711845
B21	568750	7711964
B22	569220	7711486
B23	569629	7710240
B24	569550	7710161
B25	569566	7710288
B26	568828	7712986
B27	568833	7712828
B28	571549	7705200
B29	571283	7705177
B30	571465	7705049
B31	571530	7704737
B32	571357	7704805
B33	571545	7704866
B34	571695	7704324
B35	571383	7704177
B36	571224	7704000
B37	571768	7703692
B38	571668	7703729
B39	571928	7703582
B40	572120	7703742
B41	574804	7701625
B42	575160	7701398
B43	575068	7701392
B44	575650	7701311
B45	576172	7701334
B46	576951	7701572
B47	577215	7701676
B48	577238	7701744
B49	577441	7701756
B50	578066	7701998
B51	569307	7713630
B52	578127	7702123
B53	572942	7702612
B54	572603	7702494

APPENDIX C: VASCULAR PLANT SPECIES RECORDED IN SURVEY SITES ON TENEMENT L47/690, BALLA BALLA

Note: * denotes introduced (weed) species; P1-P5 denote priority flora species (DEC 2013c).

FAMILY	SPECIES	NATUREMAP RECORD	MCPL 2013 RECORD
ACANTHACEAE	<i>Avicennia marina</i>	+	+
AIZOACEAE	<i>Sesuvium portulacastrum</i>		+
AMARANTHACEAE	* <i>Aerva javanica</i> <i>Gomphrena canescens</i> <i>Hemichroa diandra</i> <i>Ptilotus astrolasius</i> <i>Ptilotus auriculifolius</i> <i>Ptilotus nobilis</i> <i>Ptilotus obovatus</i>	+ + + + +	+ + +
APOCYNACEAE	<i>Carissa lanceolata</i>	+	+
ARALIACEAE	<i>Trachymene oleracea</i> subsp. <i>oleracea</i>	+	
ASTERACEAE	<i>Pentalepis trichodesmoides</i> <i>Pluchea dentex</i> <i>Pluchea rubelliflora</i> <i>Pterocaulon sphacelatum</i> <i>Pterocaulon sphaeranthoides</i> <i>Streptoglossa decurrens</i> <i>Streptoglossa liatroides</i>	+ + + + + +	+ + +
BORAGINACEAE	<i>Ehretia saligna</i> var. <i>saligna</i> <i>Heliotropium muticum</i> (P1) <i>Heliotropium ovalifolium</i> <i>Trichodesma zeylanicum</i>	+ + + +	+ +
CAPPARACEAE	<i>Capparis spinosa</i> var. <i>nummularia</i>	+	
CHENOPODIACEAE	<i>Rhagodia preissii</i> subsp. <i>obovata</i> <i>Salsola australis</i> <i>Suaeda arbusculooides</i> <i>Tecticornia halocnemoides</i> <i>Tecticornia</i> sp. Dennys Crossing (K.A. Shepherd & J. English KS 552) <i>Tecticornia</i> sp. <i>Threlkeldia diffusa</i>	+ + + + +	+ + + + +
CLEOMACEAE	<i>Cleome uncifera</i> subsp. <i>uncifera</i> <i>Cleome viscosa</i>	+ 	+
COMBRETACEAE	<i>Terminalia canescens</i>	+	
CONVOLVULACEAE	<i>Bonamia alatisemina</i> <i>Bonamia media</i> <i>Evolvulus alsinoides</i> <i>Ipomoea muelleri</i> <i>Ipomoea pes-caprae</i> subsp. <i>brasiliensis</i> <i>Polymeria ambigua</i> <i>Polymeria calycina</i>	+ + + +	+ + + + +

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Note: * denotes introduced (weed) species; P1-P5 denote priority flora species (DEC 2013c).

FAMILY	SPECIES	NATUREMAP RECORD	MCPL 2013 RECORD
FABACEAE (continued)	<i>Leptosema anomalum</i>	+	
	<i>Lotus cruentus</i>		+
	<i>Neptunia dimorphantha</i>		+
	<i>Rhynchosia minima</i>	+	+
	<i>Senna artemisioides</i> subsp. <i>oligophylla</i>	+	+
	<i>Senna glutinosa</i> subsp. <i>glutinosa</i>	+	+
	<i>Senna notabilis</i>	+	+
	<i>Sesbania cannabina</i>	+	
	<i>Swainsona ?decurrens</i>		+
	<i>Swainsona pterostylis</i>	+	
	<i>Tephrosia rosea</i>		+
	<i>Tephrosia supina</i>	+	+
* <i>Vachellia farnesiana</i>	+	+	
	<i>Vigna</i> sp. Hamersley Clay (A.A. Mitchell PRP 113)	+	
GOODENIACEAE	<i>Goodenia muelleriana</i>		+
	<i>Goodenia tenuiloba</i>		+
	<i>Scaevola amblyanthera</i> var. <i>centralis</i>	+	
	<i>Scaevola spinescens</i>	+	+
LAMIACEAE	<i>Clerodendrum tomentosum</i> var. <i>lanceolatum</i>	+	
LAURACEAE	<i>Cassytha capillaris</i>	+	
MALVACEAE	<i>Brachychiton acuminatus</i>	+	
	<i>Corchorus sidoides</i>	+	
	<i>Corchorus tridens</i>		+
	<i>Corchorus walcottii</i>		+
	<i>Corchorus</i> sp.		+
	<i>Gossypium australe</i>	+	+
	<i>Hibiscus leptocladus</i>	+	
	<i>Keraudrenia nephrosperma</i>	+	
	* <i>Malvastrum americanum</i>		+
	<i>Sida clementii</i>	+	
	<i>Sida fibulifera</i>	+	+
	<i>Sida</i> sp. Pilbara (A.A. Mitchell PRP 1543)	+	
	<i>Sida</i> sp.		+
	<i>Triumfetta appendiculata</i>	+	+
	<i>Triumfetta clementii</i>		+
<i>Triumfetta propinqua</i>	+		
<i>Triumfetta ramosa</i>	+		
<i>Waltheria indica</i>		+	
MOLLUGINACEAE	<i>Mollugo molluginea</i>	+	
MORACEAE	<i>Ficus aculeata</i> var. <i>indecora</i>	+	
	<i>Ficus brachypoda</i>	+	
MYRTACEAE	<i>Corymbia ferritcola</i>	+	
	<i>Corymbia hamersleyana</i>	+	+
	<i>Corymbia opaca</i>	+	

APPENDIX C: VASCULAR PLANT SPECIES RECORDED IN SURVEY SITES ON TENEMENT L47/690, BALLA BALLA

Note: * denotes introduced (weed) species; P1-P5 denote priority flora species (DEC 2013c).

FAMILY	SPECIES	NATUREMAP RECORD	MCPL 2013 RECORD
MYRTACEAE (continued)	<i>Eucalyptus camaldulensis</i> <i>Eucalyptus camaldulensis</i> subsp. <i>obtusa</i> <i>Eucalyptus victrix</i>	+ +	+ +
NYCTAGINACEAE	<i>Boerhavia coccinea</i> <i>Boerhavia gardneri</i>	+	+
OLEACEAE	<i>Jasminum didymum</i> subsp. <i>lineare</i>	+	
PHYLLANTHACEAE	<i>Flueggea virosa</i> subsp. <i>melanthesoides</i> <i>Phyllanthus maderaspatensis</i> <i>Phyllanthus reticulatus</i> <i>Phyllanthus reticulatus</i> var. <i>glaber</i>	+ + + +	+
PLUMBAGINACEAE	<i>Muellerolimon salicorniaceum</i>	+	
POACEAE	<i>Aristida contorta</i> <i>Aristida holathera</i> <i>Brachyachne convergens</i> * <i>Cenchrus ciliaris</i> <i>Chrysopogon fallax</i> <i>Cymbopogon ambiguus</i> <i>Enneapogon caerulescens</i> <i>Eragrostis eriopoda</i> <i>Eragrostis tenellula</i> <i>Eragrostis xerophila</i> <i>Eriachne aristidea</i> <i>Eriachne helmsii</i> <i>Eriachne pulchella</i> <i>Eriachne pulchella</i> subsp. <i>dominii</i> <i>Eriochloa pseudoacrotricha</i> <i>Eulalia aurea</i> <i>Iseilema dolichotrichum</i> <i>Sorghum plumosum</i> <i>Spinifex longifolius</i>	+ + + + +	+ + + + + + + + + + + + + + + + + + + +
POACEAE (continued)	<i>Sporobolus australasicus</i> <i>Themeda triandra</i> <i>Triodia angusta</i> <i>Triodia epactia</i> <i>Triodia pungens</i> <i>Triodia wiseana</i> Poaceae sp.	+ + + + +	+ + + + + +
PORTULACACEAE	* <i>Portulaca oleracea</i>		+
PROTEACEAE	<i>Grevillea pyramidalis</i> <i>Grevillea pyramidalis</i> subsp. <i>leucadendron</i> <i>Grevillea pyramidalis</i> subsp. <i>pyramidalis</i> <i>Hakea lorea</i>	+ +	+ +
RHIZOPHORACEAE	<i>Rhizophora stylosa</i>		+

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FAMILY	SPECIES	NATUREMAP RECORD	MCPL 2013 RECORD
RUBIACEAE	<i>Oldenlandia argillacea</i>	+	
SANTALACEAE	<i>Santalum lanceolatum</i>	+	+
SAPINDACEAE	<i>Alectryon oleifolius</i> <i>Alectryon oleifolius</i> subsp. <i>oleifolius</i> <i>Atalaya hemiglauca</i> <i>Diplopeltis eriocarpa</i> <i>Dodonaea coriacea</i>	+ + + + +	+
SCROPHULARIACEAE	<i>Eremophila longifolia</i> <i>Myoporum montanum</i>	+ +	+
SOLANACEAE	<i>Solanum cleistogamum</i> <i>Solanum horridum</i> <i>Solanum lasiophyllum</i> <i>Solanum phlomoides</i>	+ + + +	+
THYMELAEACEAE	<i>Pimelea ammocharis</i>	+	
VIOLACEAE	<i>Hybanthus aurantiacus</i>	+	+
ZYGOPHYLLACEAE	<i>Tribulus occidentalis</i>	+	

