Reconnaissance Flora & Vegetation Assessment

Lake Way SOP Demonstration Plant Project

March 2019
Version 1

Prepared by:
Botanica Consulting
PO Box 2027
Boulder WA 6432
90930024

Disclaimer

This document and its contents are to be treated as confidential and are published in accordance with and subject to an agreement between Botanica Consulting (BC) and the client for whom it has been prepared and is restricted to those issues that have been raised by the client in its engagement of BC. Neither this document nor its contents may be referred to or quoted in any manner (report or other document) nor reproduced in part or whole by electronic, mechanical or chemical means, including photocopying, recording or any information storage system, without the express written approval of the client and/or BC.

This document and its contents have been prepared utilising the standard of care and skill ordinarily exercised by Environmental Scientists in the preparation of such documents. All material presented in this document is published in good faith and is believed to be accurate at the time of writing. Any person or organisation who relies on or uses the document and its contents for purposes or reasons other than those agreed by BC and the client without primarily obtaining the prior written consent of BC, does so entirely at their own risk. BC denies all liability in tort, contract or otherwise for any loss, damage or injury of any kind whatsoever (whether in negligence or otherwise) that may be endured as a consequence of relying on this document and its contents for any purpose other than that agreed with the client.

Quality Assurance

An internal quality review process has been implemented to each project task undertaken by BC. Each document and its contents are carefully reviewed by core members of the Consultancy team and signed off at Director Level prior to issue to the client. Draft documents are submitted to the client for comment and acceptance prior to final production.

Document Job Number: 2019/10

Prepared by:
Lauren Pick
Senior Environmental Consultant
Botanica Consulting

Approved by:
Jim Williams
Director
Botanica Consulting

Contents **Page No.**

Tables

Figures

Appendices

Glossary

Acronym	Description
ANCA	Australian Nature Conservation Agency.
BAM Act	*Biosecurity and Agriculture Management Act 2007*, WA Government.
BC Act	*Biodiversity and Conservation Act 2016,* WA Government.
Botanica	Botanica Consulting.
BoM	Bureau of Meteorology.
DAFWA	Department of Agriculture and Food (now DPIRD), WA Government.
DBCA	Department of Biodiversity, Conservation and Attractions (formerly DPaW), WA Government.
DEC	Department of Environment and Conservation (now DBCA), WA Government.
DER	Department of Environment Regulation (now DWER), WA Government.
Development Envelopes	On-Playa Development Envelope Off-Playa Development Envelope
DMIRS	Department of Mines, Industry Regulation and Safety (formerly DMP), WA Government
DMP	Department of Mines and Petroleum (now DMIRS), WA Government.
DotEE	Department of the Environment and Energy (formerly DSEWPaC), Australian Government.
DoW	Department of Water (now DWER), WA Government.
DpaW	Department of Parks and Wildlife (now DBCA), WA Government.
DPIRD	Department of Primary Industries and Regional Development, WA Government
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities (now DotEE,), Australian Government.
DWER	Department of Water and Environmental Regulation (formerly OEPA, DER and DoW), WA Government
EP Act	*Environmental Protection Act 1986,* WA Government.
EP Regulations	Environmental Protection (Clearing of Native Vegetation) Regulations 2004, WA Government.
EPA	Environmental Protection Authority, WA Government.
EPBC Act	*Environment Protection and Biodiversity Conservation Act* 1999, Australian Government.
ESA	Environmentally Sensitive Area.
Ha	Hectare (10,000 square metres).
IBRA	Interim Biogeographic Regionalisation for Australia.
IUCN	International Union for the Conservation of Nature and Natural Resources – commonly known as the World Conservation Union.
Km	Kilometre (1,000 metres).
MVG	Major Vegetation Groups.
NVIS	National Vegetation Information System.
OEPA	Office of the Environmental Protection Authority (now DWER), WA Government.
PEC	Priority Ecological Community.
Project	Lake Way SOP Demonstration Plant Project.
SLP	Salt Lake Potash Limited.
TEC	Threatened Ecological Community.
WA	Western Australia.
WAHERB	Western Australian Herbarium.
WAM	Western Australian Museum, WA Government.
WC Act	*Wildlife Conservation Act* 1950, WA Government.

Executive Summary

Botanica Consulting (Botanica) was commissioned by Pendragon Environmental Solutions to undertake a reconnaissance flora and vegetation survey of the Lake Way SOP Demonstration Plant Project on-playa and off-playa Development envelopes (referred to as the 'Development envelopes'). The survey covered an area of approximately 5726 ha, located approximately 6 km south of Wiluna, Western Australia. The survey was conducted from 22nd to 24th February 2019.

Three vegetation types were identified within the survey area, which were represented by a total of 11 Families, 20 Genera and 42 flora Taxa. No Threatened Flora or Threatened Ecological Communities (TEC) as listed under the Western Australian *Biodiversity Conservation (BC) Act 2016* or Commonwealth *Environment Protection and Biodiversity Conservation (EPBC) Act 1999* are known to occur within the Development envelopes. No Priority Flora or Priority Ecological Communities (PEC)[1] as listed by Department of Biodiversity, Conservation and Attractions (DBCA) are known to occur within the Development envelopes. No significant vegetation or flora were identified within the Development envelopes.

The Development envelopes do not contain any world or national heritage places and do not occur within a Bush Forever site. There are no wetlands of international importance (Ramsar Wetlands), national importance (Australian Nature Conservation Agency (ANCA) Wetlands) or conservation category wetlands within the Development envelopes. The Development envelopes are not located within DBCA Managed Land and do not contain any Environmentally Sensitive Areas (ESA) listed under the *Environmental Protection (EP) Act 1986*.

[1] Only refers to PECs related to vegetation assemblages

1 Introduction

1.1 Project Description

The Lake Way SOP Demonstration Plant Project (the Project) is a greenfields project to abstract brine resources from the Lake Way playa and adjoining Paleochannel to produce a Sulfate of Potash (SOP) product for export. Infrastructure associated with the Lake Way SOP Demonstration Plant Project shall include:

- On-playa infrastructure: trenches, evaporation ponds, brine pipeline, causeway and roads.
- Off-playa infrastructure: processing plant, process water pipeline and brine pipeline.

A map of the proposed infrastructure is provided in Figure 1-2.

BC was commissioned by Pendragon Environmental Services to undertake a reconnaissance flora and vegetation survey of the on-playa and off-playa Development envelopes (referred to as the "Development Envelopes'). The assessment covered an area of approximately 5726 ha, located approximately 6 km south of Wiluna, Western Australia (Figure 1-2). The survey was conducted from 22nd to 24th February 2019.

1.2 Objectives

The flora/ vegetation assessment was conducted in accordance with the requirements of a reconnaissance flora/vegetation survey as defined in *Technical Guidance - Flora and Vegetation Surveys for Environmental Impact Assessment – December 2016* (EPA, 2016a). The objectives of the assessment were to:

- Gather background information on flora and vegetation in the assessment area (literature review, database and map-based searches);
- Identify significant flora, vegetation/ecological communities;
- Conduct a field survey to verify / ground truth the desktop assessment findings through survey;
- Undertake floristic community mapping to a scale appropriate for the bioregion and described according to the National Vegetation Information System (NVIS) structure and floristics; and
- Undertake vegetation condition mapping.

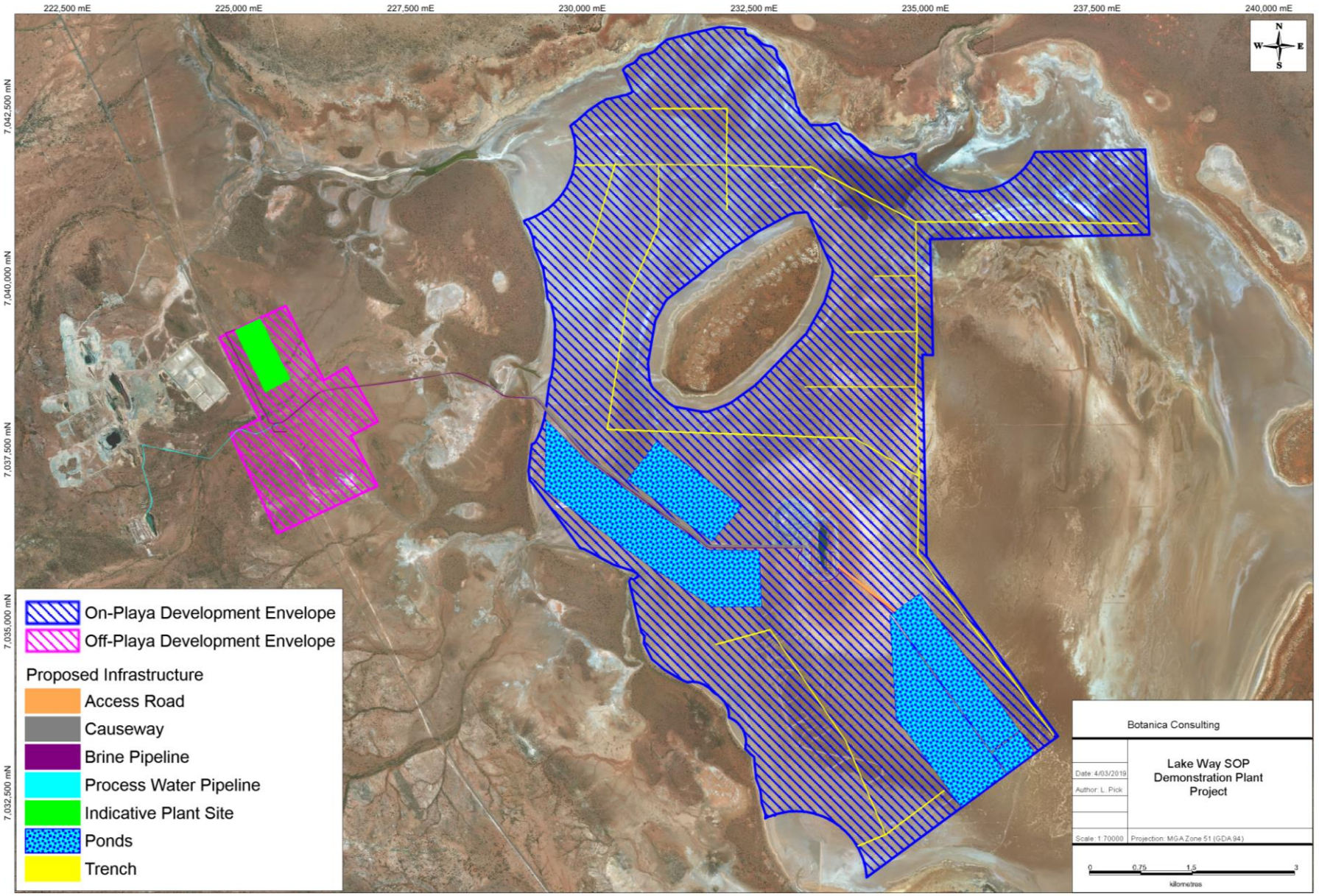


Figure 1-1: Lake Way SOP Demonstration Plant Project

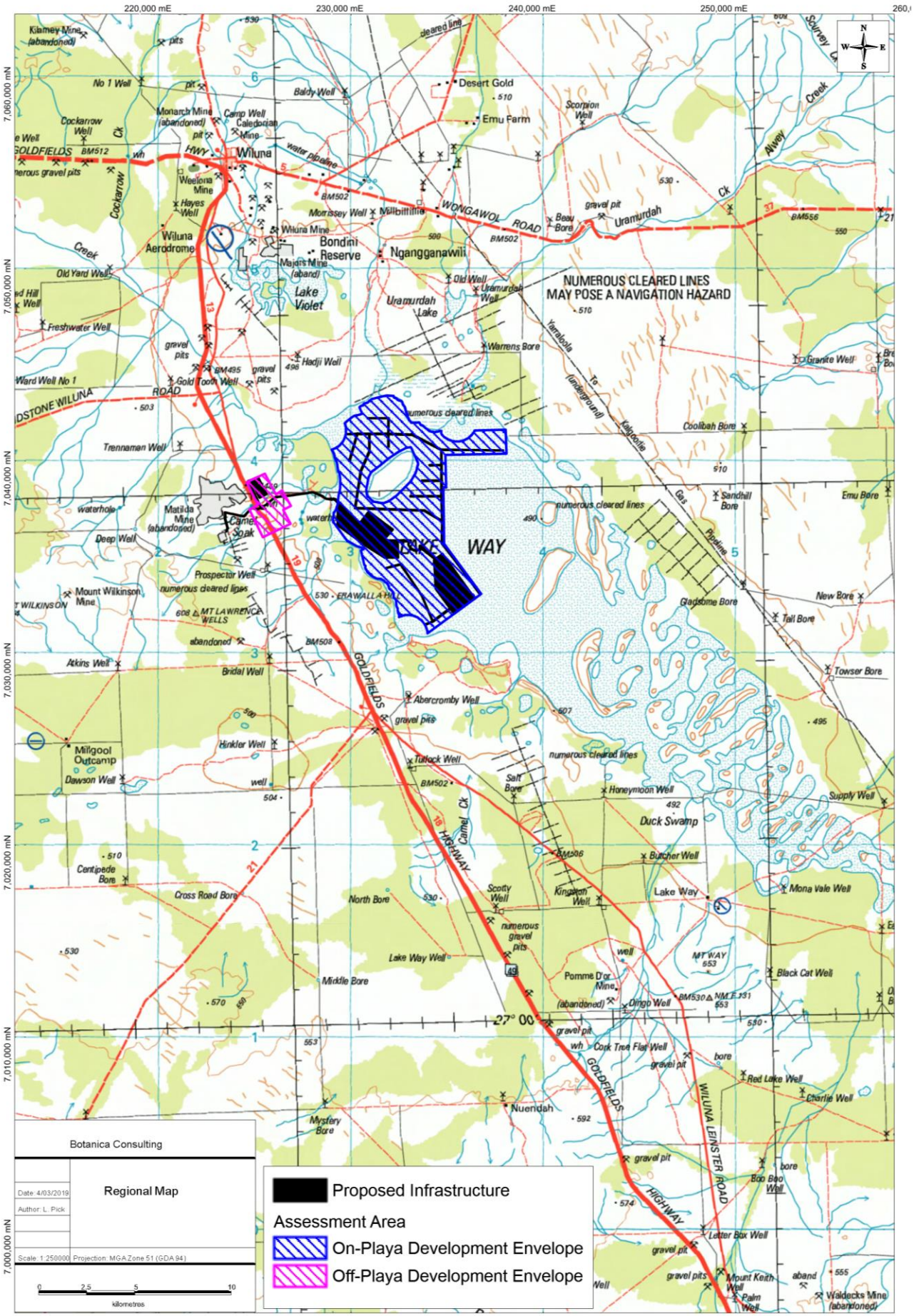


Figure 1-2: Regional map of the Lake Way SOP Demonstration Plant Project

2 Regional Biophysical Environment

2.1 Regional Environment

The Project lies within the Murchison Bioregion of the Eremaean Province of WA in a region known as the Austin Botanical District. The Murchison Region is further divided into subregions, based on the Interim Biogeographic Regionalisation of Australia (IBRA), with the Project located within the Eastern Murchison (MUR1) subregion as shown in Figure 2-1.

The landscape of the Murchison Bioregion comprises low hills, mesas of duricrust separated by flat colluvium and alluvial plains (Commonwealth Government, 2008). It is dominated by the Archaean (over 2500 million years ago) granite greenstone terrain of the Yilgarn Craton (Commonwealth Government, 2008). Alluvial soils and sands mantle the granitic and greenstone units of the Yilgarn Craton. These soils are shallow, sandy and infertile. Underlying the soils in low areas is a red-brown siliceous hard pan (Curry et al. 1994). The soils in the eastern half of the bioregion are typically red sands, calcareous red earth soil, duplex soil and clays. There are 41 vegetation associations (hummock grasslands, succulent steppe or low woodlands) that have at least 85 per cent of their total area in the bioregion. The bioregion is rich and diverse in both its flora and fauna but most species are wide ranging and usually occur in adjoining regions (McKenzie, May and McKenna, 2002).

The Eastern Murchison subregion comprises the northern parts of the craton's Southern Cross and Eastern Goldfields Terrains and is characterised by internal drainage and extensive areas of elevated red desert sandplains with minimal dune development. Salt Lake systems are associated with the occluded paleodrainage system. Broad plains of red-brown soils and breakaways complexes as well as red sandplains are widespread. Vegetation is dominated by Mulga woodlands and is often rich in ephemerals, hummock grasslands, saltbush shrublands and Samphire shrublands (McKenzie *et. al.,* 2002). The Eastern Murchison subregion comprises diverse mulga woodlands, which occur on low greenstone belts. The sand plains have red loamy earths and red deep sands which are found on the sandy banks.

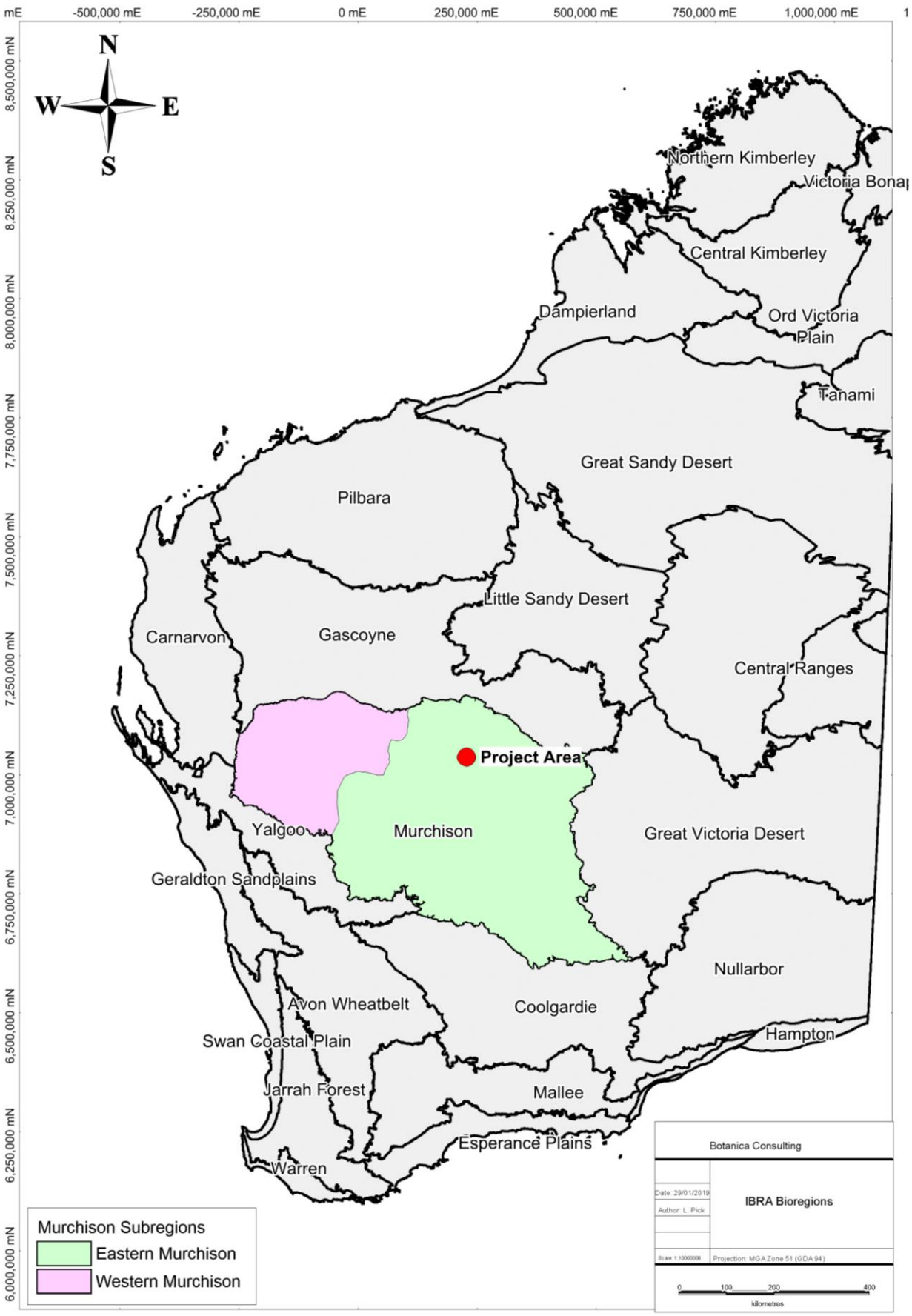


Figure 2-1: Map of IBRA Bioregions in relation to the Lake Way SOP Demonstration Plant Project
Note-Project area not to scale

2.2 Soils and Landscape Systems

The Project lies within the Murchison Province and the Ashburton Province of Western Australia.

The Murchison Province consists of hardpan wash plains and sandplains (with some stony plains, hills, mesas and salt lakes) on the granitic rocks and greenstone of the Yilgarn Craton. This Province is located in the inland Mid-west and northern Goldfields between Three Springs, the Gascoyne River, Wiluna, Cosmo Newberry and Menzies (Tille, 2006).

The Ashburton Province consists of hills and ranges (with stony plains and hardpan wash plains) on the sedimentary and granitic rocks of the Capricorn Orogen. This Province is located in the southern Pilbara/ northern Gascoyne between Nanutarra, Jigalong, Gascoyne River, Wiluna and Lake Carnegie (Tille, 2006). The Murchison Province and Ashburton Province are further divided into soil-landscape zones, with the Project located within the Salinaland Plains Zone (279) and Paroo Uplands Zone (293).

The Salinaland Plains Zone comprises of sandplains (with hardpan wash plains and some mesas, stony plains and salt lakes) on granitic rocks (and some greenstone) of the Yilgarn Craton. Soils include red sandy earths, red deep sands, red shallow loams and red loamy earths with some red-brown hardpan shallow loams, salt lake soils and red shallow sandy duplexes. Vegetation is dominated by mulga shrublands with spinifex grasslands (and some halophytic shrublands and eucalypt woodlands). This zone is located in the northern Goldfields from Lakes Barlee and Lake Ballard to Wiluna and Laverton (Tille, 2006).

The Paroo Uplands Zone comprises of hills, hardpan wash plains and stony plains (with sandplains) on Yerrida, Bryah and Padbury Basins sedimentary rocks and Marymia Inlier granitic and volcanic rocks. Soils include red-brown hardpan shallow loams with red loamy earths and stony soils and some red shallow sands, red shallow loams, red sandy earths and red deep sands. Vegetation is dominated by mulga shrublands (with some spinifex, Eucalypts and halophytic shrubs). This zone is located in the North-eastern Goldfields between Meekatharra, Wiluna and Kumarina Roadhouse (Tille, 2006).

Each zone is further divided into soil landscape systems, with the Project located within three soil landscape systems as shown in Table 2-1 and Figure 2-2 below.

Table 2-1: Soil Landscape Systems within the Lake Way SOP Demonstration Plant Project

Landscape System/ Mapping Unit	Description
Carnegie System (279Ca)	Salt lakes with fringing saline alluvial plains, kopi dunes and sandy banks, supporting halophytic shrublands and acacia tall shrublands.
Gabanintha System (279Ga)	Greenstone ridges, hills and footslopes supporting sparse acacia and other mainly non-halophytic shrublands.
Killara System (279Ki)	Basalt hills supporting open mulga shrublands with patchy spinifex.

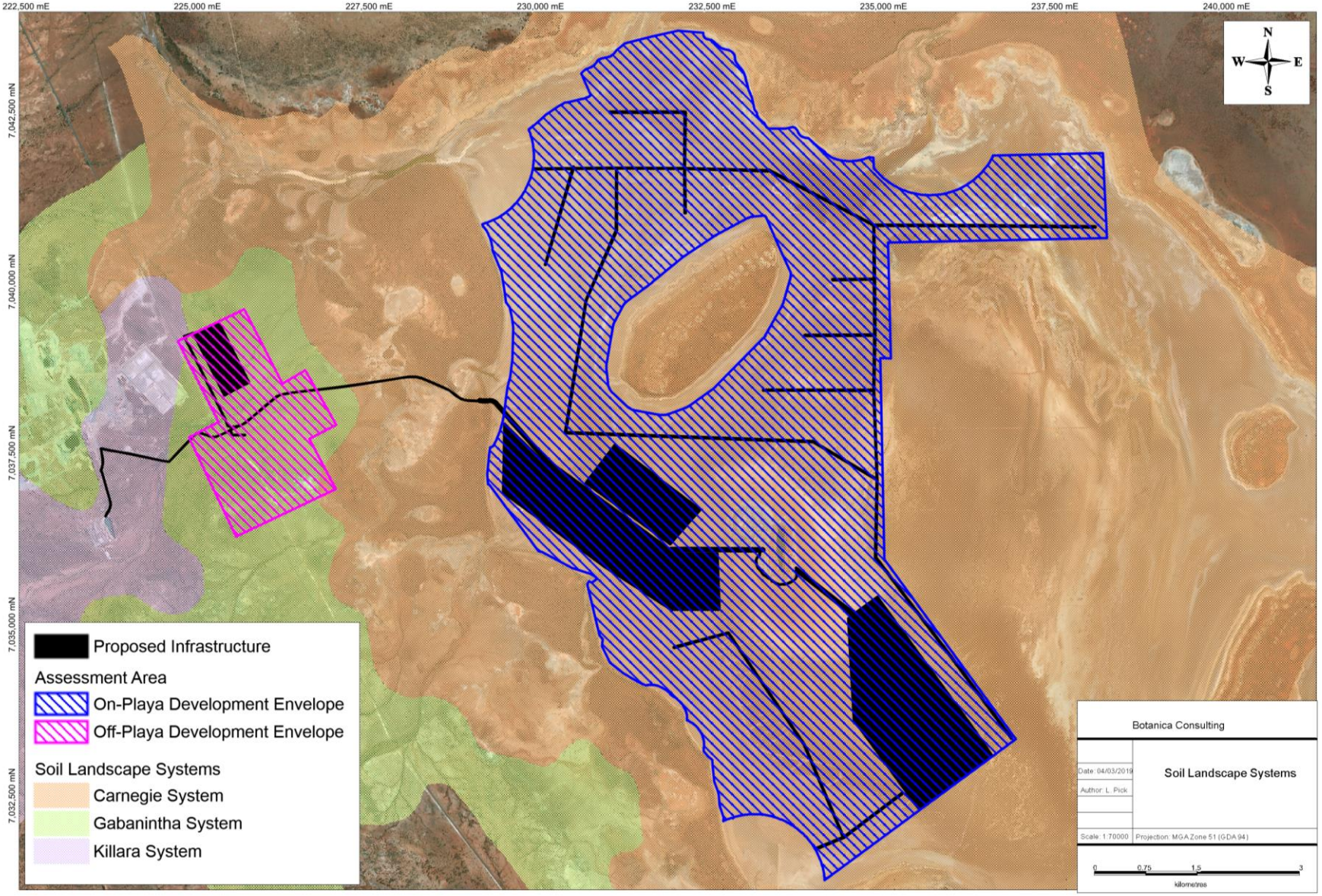


Figure 2-2: Soil landscape systems within the Lake Way SOP Demonstration Plant Project

2.3 Remnant Vegetation

The Project is located within the Austin Botanical District within the Eremaean Botanical Province. This botanical district is predominantly Mulga low woodlands on plains, often rich in ephemerals, which reduce to scrub on hills. It is also characterised by hummock grasslands, Saltbush shrublands and Samphire shrublands (Beard, 1990). The Eremaean Province is the largest of the three botanical provinces within Western Australia. The vegetation of the Austin Botanical District of the Murchison Region is predominantly low mulga (*Acacia aneura*) woodlands on plains and reduced to scrub on hills. This district is often associated with a tree steppe of *Eucalyptus* spp. and *Triodia basedowii* on sand plains.

The Department of Agriculture and Food Western Australia (DAFWA) GIS file (2011) indicates that the Project is located within five Pre-European Beard vegetation associations of the Wiluna System (Table 2-2 and Figure 2-3). The extent of these vegetation associations, as specified in the 2017 Statewide Vegetation Statistics (DBCA, 2017) is provided in Table 2-2.

Areas retaining less than 30% of their pre-European vegetation extent generally experience exponentially accelerated species loss, while areas with less than 10% are considered “endangered” (EPA, 2000). Development within the Project will not significantly reduce the extent of pre-European vegetation.

Table 2-2: Pre-European Vegetation Associations within the Lake Way SOP Demonstration Plant Project

Vegetation Association	Pre-European extent remaining (%)	% of Current extent within DBCA managed lands	Vegetation Description (Beard, 1990)
Wiluna 39	98.8	0	Shrublands; mulga scrub
Wiluna 40	99.00	0	Shrublands; Acacia scrub, various species
Wiluna 125	99.72	0	Bare areas; salt lakes
Wiluna 560	100.00	0	Mosaic: Shrublands; bowgada scrub / Succulent steppe; samphire
Wiluna 561	89.91	0	Succulent steppe with low woodland; mulga over saltbush

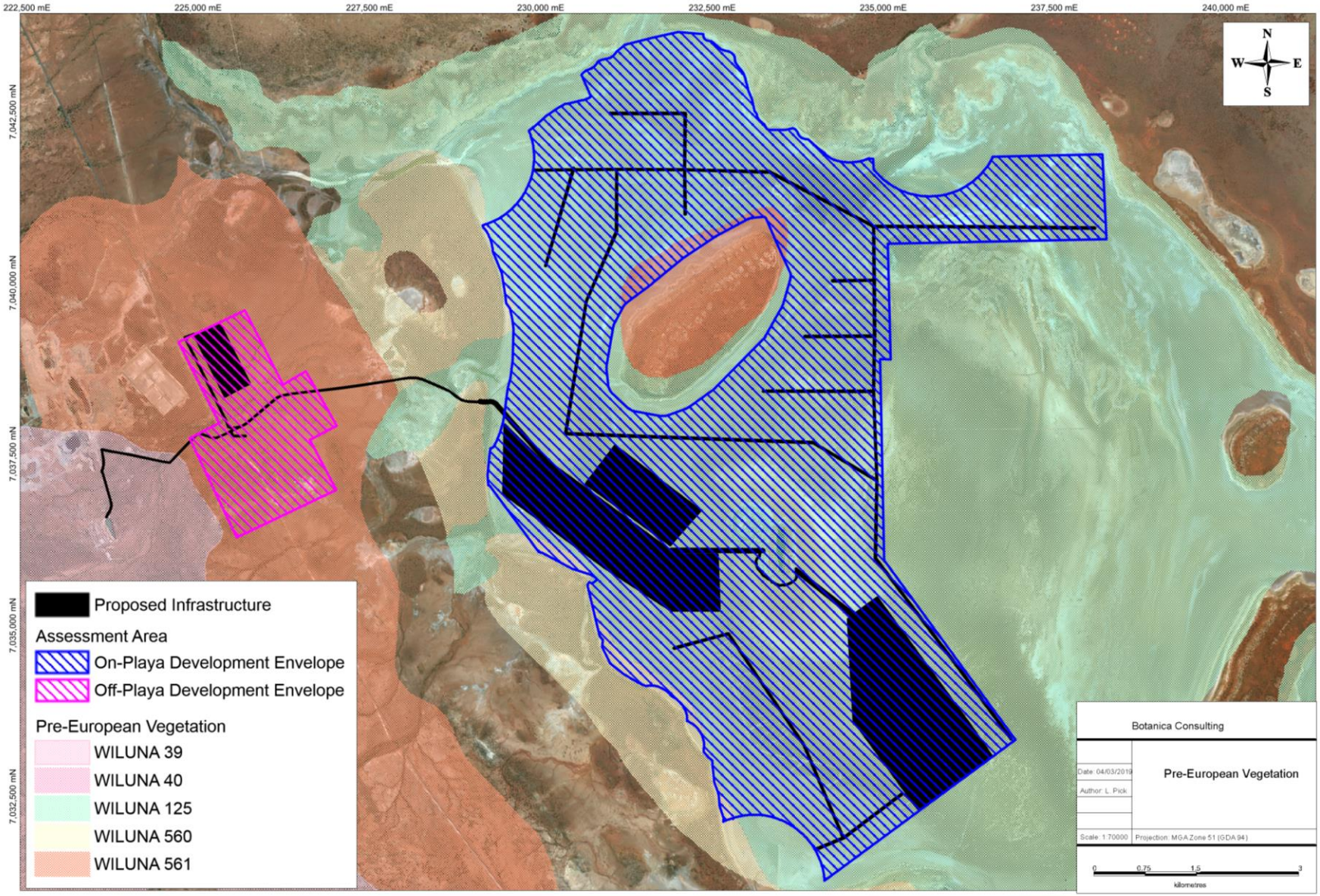


Figure 2-3: Pre-European Vegetation within the Lake Way SOP Demonstration Plant Project

2.4 Climate

The climate of the Eastern Murchison subregion is characterised as an arid climate with mainly winter rainfall and annual rainfall of approximately 200 mm (Beard, 1990; Cowan, 2001). Climate data for the Wiluna weather station (#13012) located approximately 6 km north of the Project is shown in Figure 2-4 (BoM, 2018). Monthly mean maximum temperature at Wiluna ranges from 38ºC during January to 19.4ºC in July. Mean monthly rainfall ranges from 38 mm in February to 5 mm in September, whilst the mean annual rainfall is 263 mm (Figure 2-4). Monthly rainfall received in 2019 (January-February) was below average (Figure 2-5).

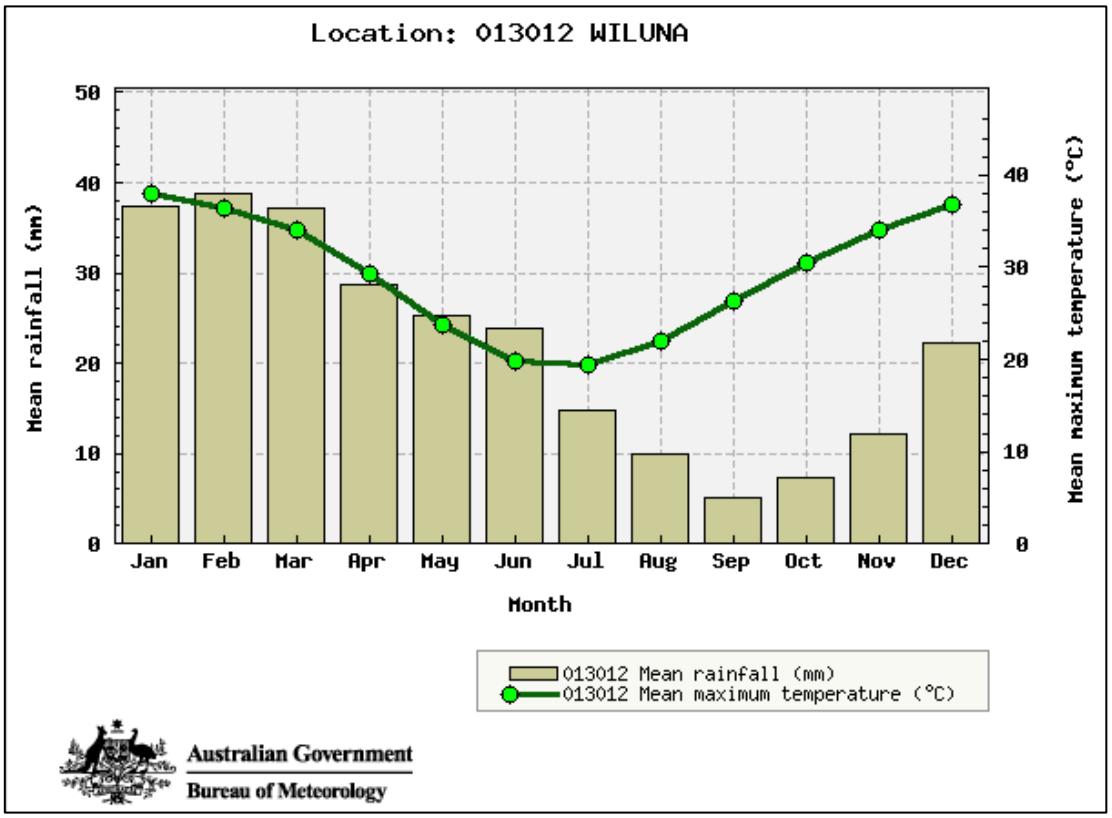


Figure 2-4: Average Climate Data for the Wiluna weather station #13012 (BoM, 2018)

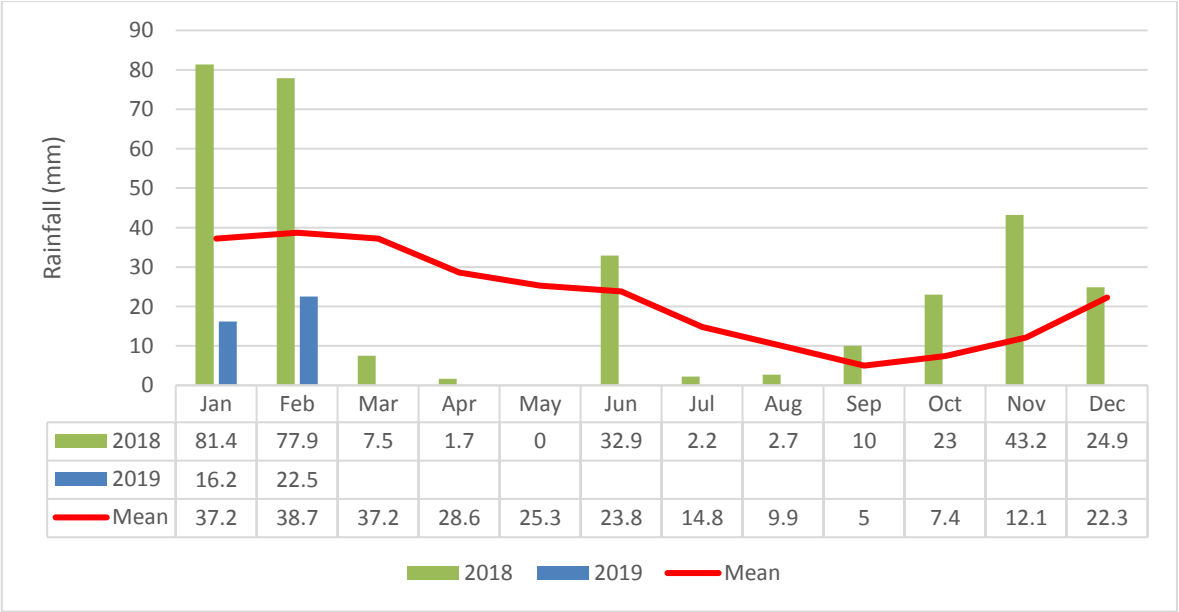


Figure 2-5: Monthly rainfall for the Wiluna weather station #13012 (BoM, 2019)

2.5 Hydrology

According to the Geoscience Australia database (2001), there are no drainage lines within the development envelopes. The on-playa development envelope is located within Lake Way. A map showing the surface hydrology of the local area is provided in Figure 2-6.

According to the Bureau of Meteorology (2018b) *Groundwater Dependent Ecosystem Atlas,* there are no aquatic Groundwater Dependent Ecosystems (GDE) within the Project. Vegetation surrounding Lake Way has high potential to contain the following terrestrial GDE: *Salt lakes with extensively fringing saline plains, dunes and sandy banks, supporting low halophytic shrublands and scattered tall Acacia shrublands.* As shown in Figure 2-6, the on-playa development envelope comprises of bare salt lake (playa) with no vegetation (including samphire vegetation) present within the on-playa development envelope (see Figure 2-6a). No samphire vegetation is located within the off-playa development envelope. All proposed infrastructure (off-playa and on-playa) is located outside of samphire vegetation.

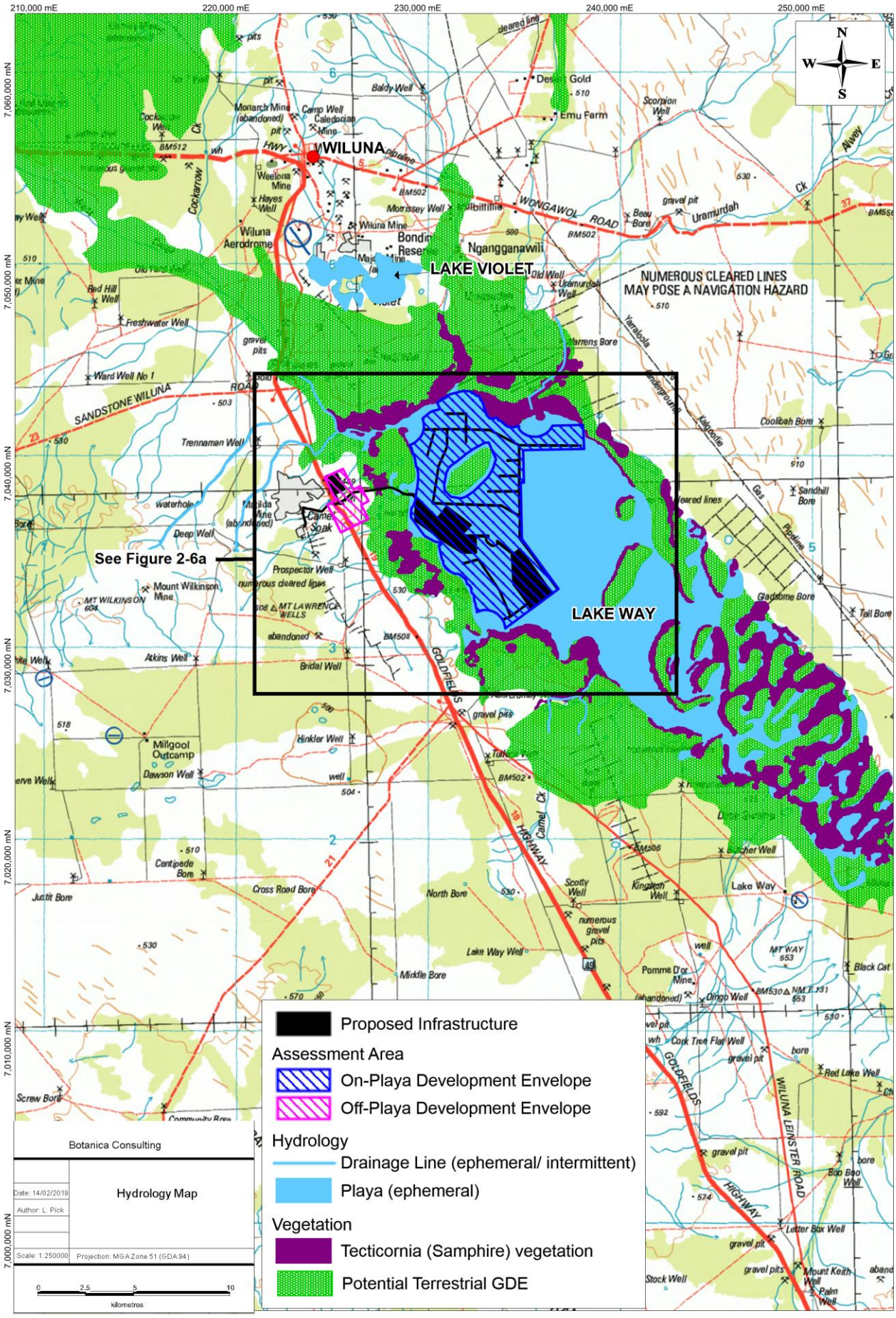


Figure 2-6: Hydrology of the Lake Way SOP Demonstration Plant Project

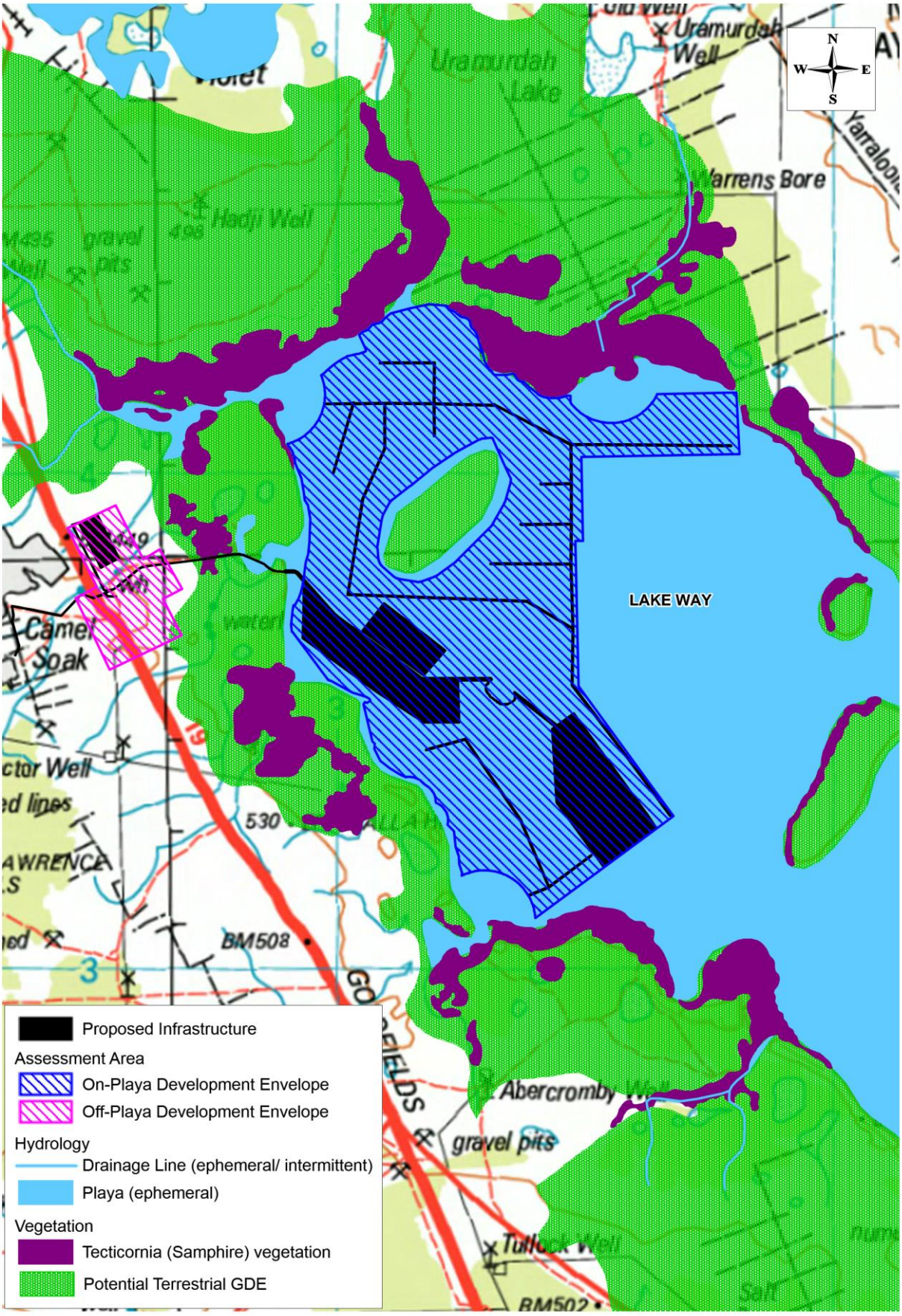


Figure 2-6a: Hydrology of the Lake Way SOP Demonstration Plant Project

2.6 Land Use

The dominant land uses of the Eastern Murchison subregion include grazing native pastures (85.47%), unallocated crown reserves (11.34%), conservation (1.4%) and mining (1.79%) (Cowan, 2001). The Project is located within the Lake Way Pastoral Lease (L3114/1164) and Millbillillie Pastoral Lease (L3114/1260).

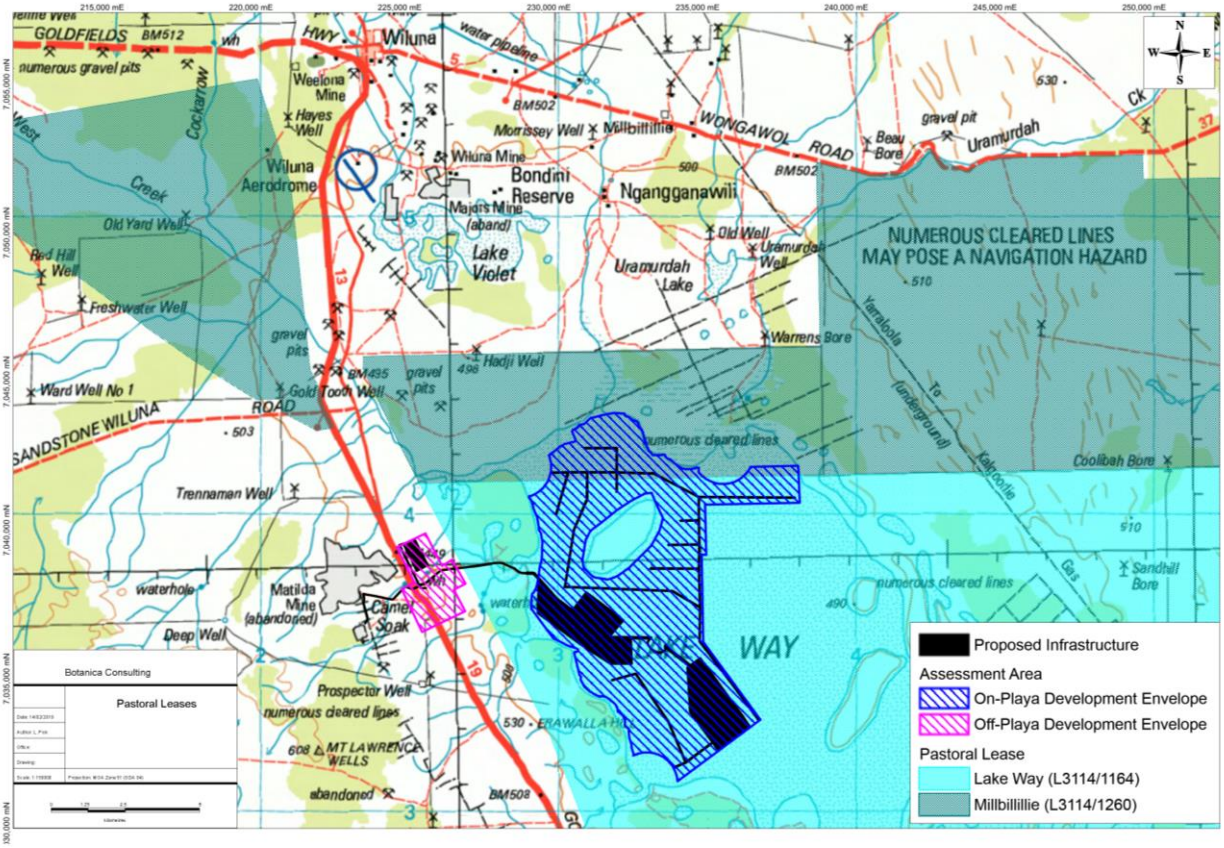


Figure 2-7: Pastoral Leases within the Lake Way SOP Demonstration Plant Project

3 Methodology

3.1 Desktop Assessment

3.1.1 Literature Review

A literature review was undertaken of previous flora and vegetation assessments conducted for the Toro Energy Wiluna Uranium Project Public Environmental Review (EPA Assessment 1819 & 2002) and the Blackham Resources Limited Matilda Gold Project. Documents reviewed included:

- Actis, 2012. Tecticornia review: Wiluna uranium project. Unpublished report for Toro Energy Limited.
- Animal Plant Mineral (2015a), Vegetation Clearing Permit Application, Matilda Gold Project, Support Information for Matilda Mine Site Native Vegetation Clearing (Purpose) Permit Application, October 2015.
- Animal Plant Mineral (2015b), Level One Biological Survey, Matilda Gold Project, Murchison Western Australia, November 2015. Prepared for Blackham Resources Limited.
- Bennett Environmental Consulting. (2002). *Vegetation of areas impacted by construction of a causeway for exploration drilling at Lake Way Wiluna Gold*. Unpublished report.
- Botanica 2018, Reconnaissance Flora/Vegetation & Fauna Survey Lake Way Project Processing Facility and Pond. Unpublished report prepared for Salt Lake Potash Limited.
- Ecologia. (2013). *Desktop Biological assessment – Matilda Gold Project*. Unpublished Report for Blackham Resources.
- Ecologia Environment, 2015. *Maireana prosthecochaeta* Confirmation and Targeted Flora Survey. Unpublished report prepared for Toro Energy Limited.
- Ecologia Environment, 2016a. Assessment of Tecticornia Communities Associated with Lake Way and Lake Maitland. Unpublished report prepared for Toro Energy Limited.
- Ecologia Environment, 2016b. Flora and Vegetation Consolidation and Conservation Assessment. Unpublished report prepared for Toro Energy Limited.
- Ecologia Environment, 2016c. Cumulative Impact Assessment.
- Niche Environmental Services, 2011. Assessment of the Flora and Vegetation at the Toro Energy Wiluna Uranium Project: Lake Way, Centipede and Borefield. Report prepared for Toro Energy Limited.
- Niche Environmental Services, 2014. Assessment of the flora and vegetation at the Toro Energy Wiluna Uranium Project: Millipede Development envelope. Unpublished Report for Toro Energy Limited.
- Outback Ecology, 2007. Lake Way and Centipede Baseline Vegetation and Flora Survey. Unpublished report prepared for Toro Energy Limited.
- Outback Ecology, 2010a. Level 2 Flora and Vegetation Assessment – June 2010. Unpublished report prepared for Toro Energy Limited.
- Outback Ecology, 2010b. Lake Way, Centipede West Deposit and Haul Road Corridor Baseline Survey Report – November 2010. Unpublished report prepared for Toro Energy Limited.

3.1.2 Database Searches

Searches of the following databases were undertaken to aid in the compilation of a list of flora taxa within the Development envelopes:

- DBCA Priority/ Threatened Flora Database Search (DBCA, 2019a)
- DBCA Priority/ Threatened Ecological Communities Database Search (DBCA, 2019b)
- DBCA NatureMap Database (DBCA, 2018);
- DotEE Protected Matters search tool (DotEE, 2018).

The NatureMap and Protected Matters Search were conducted for an area encompassing a 20km radius of the centre coordinates -26.75194 S 120.20056 E. It should be noted that these lists are based on observations from a broader area than the Development envelopes (20km radius) and therefore may include taxa not present. The databases also often include very old records that may be incorrect or in some cases the taxa in question have become locally or regionally extinct. Information from these sources should therefore be taken as indicative only and local knowledge and information also needs to be taken into consideration when determining what actual species may be present within the specific area being investigated.

The conservation significance of flora taxa was assessed using data from the following sources:

- *Environment Protection and Biodiversity and Conservation* (EPBC) *Act 1999*. Administered by the Australian Government (DotEE);
- *Biodiversity Conservation* (BC) *Act 2016*. Administered by the WA Government (DBCA);
- Red List produced by the Species Survival Commission (SSC) of the World Conservation Union (also known as the IUCN Red List – the acronym derived from its former name of the International Union for Conservation of Nature and Natural Resources). The Red List has no legislative power in Australia but is used as a framework for State and Commonwealth categories and criteria; and
- Priority Flora list. A non-legislative list maintained by DBCA for management purposes (released 11th September 2018).

Table 3-1 below provides the definitions of conservation significant species.

Table 3-1: **Definitions of Conservation Significant Species**

Code	Category
State categories of threatened and priority species	
Threatened Species (T) Listed by order of the Minister as Threatened in the category of critically endangered, endangered or vulnerable under section 19(1), or is a rediscovered species to be regarded as threatened species under section 26(2) of the Biodiversity Conservation Act 2016 (BC Act).	
CR	**Critically Endangered** Threatened species considered to be "facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with criteria set out in the ministerial guidelines". Listed as critically endangered under section 19(1)(a) of the BC Act in accordance with the criteria set out in section 20 and the ministerial guidelines. Published under the Wildlife Conservation (Rare Flora) Notice 2018 for critically endangered flora.
EN	**Endangered** Threatened species considered to be "facing a very high risk of extinction in the wild in the near future, as determined in accordance with criteria set out in the ministerial guidelines". Listed as endangered under section 19(1)(b) of the BC Act in accordance with the criteria set out in section 21 and the ministerial guidelines. Published under the Wildlife Conservation (Rare Flora) Notice 2018 for endangered flora.

Code	Category
VU	**Vulnerable** Threatened species considered to be "facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with criteria set out in the ministerial guidelines". Listed as vulnerable under section 19(1)(c) of the BC Act in accordance with the criteria set out in section 22 and the ministerial guidelines. Published under the Wildlife Conservation (Rare Flora) Notice 2018 for vulnerable flora.
Extinct species Listed by order of the Minister as extinct under section 23(1) of the BC Act as extinct or extinct in the wild.	
EX	**Extinct** Species where "*there is no reasonable doubt that the last member of the species has died*", and listing is otherwise in accordance with the ministerial guidelines (section 24 of the BC Act). Published as presumed extinct under the *Wildlife Conservation (Rare Flora) Notice 2018* for extinct flora.
EW	**Extinct in the Wild** Species that *"is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; and it has not been recorded in its known habitat or expected habitat, at appropriate seasons, anywhere in its past range, despite surveys over a time frame appropriate to its life cycle and form*", and listing is otherwise in accordance with the ministerial guidelines (section 25 of the BC Act). Currently there are no threatened flora species listed as extinct in the wild. If listing of a species as extinct in the wild occurs, then a schedule will be added to the applicable notice.
Priority species Possibly threatened species that do not meet survey criteria, or are otherwise data deficient, are added to the Priority Flora Lists under Priorities 1, 2 or 3. These three categories are ranked in order of priority for survey and evaluation of conservation status so that consideration can be given to their declaration as threatened flora. Species that are adequately known, are rare but not threatened, or meet criteria for near threatened, or that have been recently removed from the threatened species list for other than taxonomic reasons, are placed in Priority 4. These species require regular monitoring. Assessment of Priority codes is based on the Western Australian distribution of the species, unless the distribution in WA is part of a contiguous population extending into adjacent States, as defined by the known spread of locations.	
P1	**Priority 1: Poorly-known species** Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes. Such species are in urgent need of further survey.
P2	**Priority 2: Poorly-known species** Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, e.g. national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes. Such species are in urgent need of further survey.
P3	**Priority 3: Poorly-known species** Species that are known from several locations, and the species does not appear to be under imminent threat, or from few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several locations but do not meet adequacy of survey requirements and known threatening processes exist that could affect them. Such species are in need of further survey.
P4	**Priority 4: Rare, Near Threatened and other species in need of monitoring** (a) Rare. Species 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 species are usually represented on conservation lands. (b) Near Threatened. Species that are considered to have been adequately surveyed and that are close to qualifying for vulnerable but are not listed as Conservation Dependent.

Code	Category
	(c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.
Commonwealth categories of threatened species	
EX	**Extinct** Taxa where there is no reasonable doubt that the last member of the species has died.
EW	**Extinct in the Wild** Taxa where it 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.
CR	**Critically Endangered** Taxa that are facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
EN	**Endangered** Taxa which are not critically endangered and is facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria.
VU	**Vulnerable** Taxa which are not critically endangered or endangered and is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
CD	**Conservation Dependent** Taxa which are the focus of a specific conservation program the cessation of which would result in the species becoming vulnerable, endangered or critically endangered; or (b) the following subparagraphs are satisfied: (i) the species is a species of fish; (ii) the species is the focus of a plan of management that provides for actions necessary to stop the decline of, and support the recovery of, the species so that its chances of long term survival in nature are maximised; (iii) the plan of management is in force under a law of the Commonwealth or of a State or Territory; (iv) cessation of the plan of management would adversely affect the conservation status of the species.

A search of the DBCA Priority Ecological Communities (PEC) and Threatened Ecological Communities (TEC) database was also conducted within a 20 km radius of the Development envelopes (DBCA, 2019b). Table 3-2 represents the definitions of conservation significant communities.

Table 3-2: Definition of conservation significant communities

Category Code	Category
State categories of Threatened Ecological Communities (TEC)	
PD	**Presumed Totally Destroyed** An ecological community will be listed as Presumed Totally Destroyed if there are no recent records of the community being extant and either of the following applies: • records within the last 50 years have not been confirmed despite thorough searches or known likely habitats or; • all occurrences recorded within the last 50 years have since been destroyed.
CR	**Critically Endangered** An ecological community will be listed as Critically Endangered when it has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future, meeting any one of the following criteria: 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; The current distribution is limited i.e. highly restricted, having very few small or isolated occurrences, or covering a small area; The ecological community is highly modified with potential of being rehabilitated in the immediate future.
EN	**Endangered** An ecological community will be listed as Endangered when it has been adequately surveyed and is not Critically Endangered but is facing a very high risk of total destruction in the near future. The ecological community must meet any one of the following criteria: 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; The current distribution is limited i.e. highly restricted, having very few small or isolated occurrences, or covering a small area; The ecological community is highly modified with potential of being rehabilitated in the short-term future.
VU	**Vulnerable** An ecological community will be listed as Vulnerable when it has been adequately surveyed and is not Critically Endangered or Endangered but is facing high risk of total destruction in the medium to long term future. The ecological community must meet any one of the following criteria: The ecological community exists largely as modified occurrences that are likely to be able to be substantially restored or rehabilitated; The ecological community may already be modified and would be vulnerable to threatening process, and restricted in range or distribution; The ecological community may be widespread but has potential to move to a higher threat category due to existing or impending threatening processes.
Commonwealth categories of Threatened Ecological Communities (TEC)	
CE	**Critically Endangered** If, at that time, an ecological community is facing an extremely high risk of extinction in the wild in the immediate future (indicative timeframe being the next 10 years).
EN	**Endangered** If, at that time, an ecological community is not critically endangered but is facing a very high risk of extinction in the wild in the near future (indicative timeframe being the next 20 years).

Category Code	Category
VU	**Vulnerable** If, at that time, an ecological community is not critically endangered or endangered, but is facing a high risk of extinction in the wild in the medium–term future (indicative timeframe being the next 50 years).
Priority Ecological Communities (PEC)	
P1	**Poorly-known ecological communities** Ecological communities with apparently few, small occurrences, all or most not actively managed for conservation (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) and for which current threats exist.
P2	**Poorly-known ecological communities** Communities that are known from few small occurrences, all or most of which are actively managed for conservation (e.g. within national parks, conservation parks, nature reserves, State forest, un-allocated Crown land, water reserves, etc.) and not under imminent threat of destruction or degradation.
P3	**Poorly known ecological communities** 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: 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; Communities made up of large, and/or widespread occurrences, that may or not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing and inappropriate fire regimes.
P4	**Ecological communities that are adequately known, rare but not threatened** or meet criteria for near threatened, or that have been recently removed from the threatened list. These communities require regular monitoring.
P5	**Conservation Dependent ecological communities** Ecological communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.

3.2 Field Assessment

Botanica conducted a reconnaissance flora and vegetation survey covering an area of approximately 5726 ha. The survey was conducted from 22nd-24th February 2019, with the area traversed on foot and by 4WD by two Botanica staff members.

Prior to the commencement of field work, aerial photography was inspected and obvious differences in the vegetation assemblages were identified. The different vegetation communities identified were then inspected during the field survey to assess their validity. A handheld GPS unit was used to record the coordinates of the boundaries between existing vegetation communities. At each sample point (relevé), the following information was recorded:

- GPS location;
- Photograph of vegetation;
- Dominant taxa for each stratum;
- All vascular taxa (including annual taxa);

- Landform classification;
- Vegetation condition rating;
- Collection and documentation of unknown plant specimens; and
- GPS location, photograph and collection of flora of significance if encountered.

Unknown specimens collected during the survey were identified with the aid of samples housed at the Botanica Herbarium and WA Herbarium. Vegetation was classified in accordance with the NVIS Vegetation Type classification based on visual descriptions of locations in the field.

3.2.1 Personnel involved

Jim Williams - Environmental Consultant/ Director (Diploma of Horticulture)
Lauren Pick-Environmental Consultant (BSc Conservation Biology/ Zoology)

3.2.2 Scientific licences

Table 3-3: Scientific Flora Licences of Botanica Staff coordinating the survey

Licensed staff	Permit Number	Valid
Jim Williams	SL012391 (Licence to take flora for scientific purposes)	26/05/2018 to 27/05/2019
Lauren Pick	SL012392 (Licence to take flora for scientific purposes)	26/05/2018 to 27/05/2019

3.3 Survey limitations and constraints

It is important to note that flora and fauna surveys will entail limitations notwithstanding careful planning and design. Potential limitations are listed in Table 3-5.

The conclusions presented in this report are based upon field data and environmental assessments and/or testing carried out over a limited period of time and are therefore merely indicative of the environmental condition of the site at the time of the field assessments. Also, it should be recognised that site conditions can change with time. Information not available at the time of this assessment which may subsequently become available may alter the conclusions presented.

Some species are reported as potentially occurring based on there being suitable habitat (quality and extent) within the survey area or immediately adjacent. The habitat requirements and ecology of many of the species known to occur in the wider area are however often not well understood or documented. It can therefore be difficult to exclude species from the potential list based on a lack of a specific habitats or microhabitats within the survey area. As a consequence of this limitation, the potential species list produced is most likely an overestimation of those species that actually utilise the survey area for some purpose.

In recognition of survey limitations, a precautionary approach has been adopted for this assessment. Any flora and fauna species that would possibly occur within the survey area (or immediately adjacent), as identified through ecological databases, publications, discussions with local experts/residents and the habitat knowledge of Botanica, has been listed as having the potential to occur.

Table 3-4: Limitations and constraints associated with the survey

Variable	Potential Impact on Survey	Details
Access problems	Minor constraint	The survey was conducted via 4WD and on foot. Due to Aboriginal heritage values within the survey area, access to islands within Lake Way was limited.
Competency/ Experience	Not a constraint	The Botanica personnel that conducted the survey were regarded as suitably qualified and experienced. **Coordinating Botanist** Jim Williams, **Data Interpretation:** Jim Williams & Lauren Pick
Timing of survey, weather & season	Minor constraint	The survey was conducted outside of the EPA recommended primary survey period for the Eremaean Province (March-June). Rainfall in the months preceding the survey was below average and much of the vegetation was dry/ sterile.
Area disturbance	Not a constraint	Area has been disturbed by existing pastoral and exploration activities. However, vegetation was mostly intact.
Survey Effort/ Extent	Not a constraint	Survey intensity was appropriate for the size/significance of the area with a reconnaissance flora and vegetation survey completed to identify vegetation types and significant flora/ vegetation.
Availability of contextual information at a regional and local scale	Not a constraint	Threatened flora database searches provided by the DBCA were used to identify any potential locations of Threatened/Priority taxa. BoM, DWER, DPIRD, DBCA and DoEE databases were reviewed to obtain appropriate regional desktop information on the biophysical environment of the local region. Botanica were able to obtain information about the area from previous flora/ vegetation assessments conducted within the local region which provided context on the local environment.
Completeness	Minor constraint	Few of the plants during the survey were in flower, an annual species were present. It is estimated that approximately 65% of the flora within the survey area were able to be fully identified. The vegetation types for this study were based on visual descriptions of locations in the field. The distribution of these vegetation communities/ fauna habitats outside the survey area is not known, however vegetation types identified were categorised via comparison to vegetation distributions throughout WA specified in the NVIS Major Vegetation Groups (DoEE, 2017b).

4 Results

4.1 Desktop Assessment

According to the results of the NatureMap search (DBCA, 2018), a total of 446 flora taxa have been recorded within a 20 km radius of the Development envelopes. Dominant genera include *Eucalyptus, Acacia, Eremophila* and *Maireana.*

Results of database searches/ literature review identified fifteen introduced taxa as potentially occurring within a 20 km radius of the Development envelopes (Table 4-1). According to the DPIRD, none of these taxa are listed as a Declared Plant under the BAM Act.

Table 4-1: Introduced flora potentially occurring within the Lake Way SOP Demonstration Plant Project

Introduced Taxon	Database Search (NatureMap/ Protected Matters Search)	Literature Review (Previous flora assessments)
Bidens bipinnata (Bipinnate Beggartick)		*
Brassica tournefortii (Mediterranean Turnip)		*
Carpobrotus sp.		*
Centaurea melitensis (Maltese Cockspur)		*
Citrullus amarus		*
Cynodon dactylon (Couch)	*	
Cyperus rotundus (Nut Grass)	*	
Flaveria trinervia (Speedy Weed)	*	
Limonium sinuatum (Perennial Sea Lavender)	*	
Lysimachia arvensis (Pimpernel)		*
Medicago sativa (Alfalfa)	*	
Polypogon monspeliensis (Annual Beardgrass)	*	
Rumex vesicarius (Ruby Dock)	*	*
Sonchus oleraceus (Common Sowthistle)		
Tribulus terrestris (Caltrop)	*	

The results of the literature review, combined search of the DBCA's Flora of Conservation Significance databases (DBCA, 2018a), NatureMap search (DBCA, 2018) and DotEE protected matters search (DotEE, 2018) recorded no Threatened Flora or Priority Flora within the Development envelopes. No Threatened Flora and ten Priority Flora were listed by on the databases as occurring within a 20km radius of the Development envelopes (map provided in Appendix 1).

These Priority Flora taxa were assessed and ranked for their likelihood of occurrence within the Development envelopes (Table 4-2). The rankings and criteria used were:

- Unlikely: Area is outside of the currently documented distribution for the species/no suitable habitat (type, quality and extent) was identified as being present during the field/desktop study.

- Possible: Area is within the known distribution of the species in question and habitat of at least marginal quality was identified as being present during the field/desktop study, supported in some cases by recent records being documented from within or near the area.

- Known to Occur: The species in question was positively identified as being present during field surveys.

In addition to these Priority Flora records, results of the literature review identified five new *Tecticornia* taxa, five potentially new *Tecticornia* taxa and four range extension taxa which were recorded during existing surveys of the Lake Way, Centipede and Millipede Deposits (Table 4-3). It is important to note, all records of these taxa are located outside of the current Development envelopes and none have been formally listed as new taxa/ protected under the BC Act.

Table 4-2: Likelihood of occurrence for Threatened and Priority Flora within the Lake Way SOP Demonstration Plant Project

Taxon	EPBC Act	BC Act	DBCA Priority Rating	Description (WAHERB, 2019)	Database Search	Literature Review	Likelihood of occurrence in Development envelopes
Eremophila arachnoides subsp. *arachnoides*			P3	Broom-like shrub, to 3 m high, branches with circular, discrete tubercles. Fl. white/blue-purple, Sep. Shallow loam over limestone.	*	*	Possible
Eremophila congesta			P1	Upright shrub, to 1.2 m high. Fl. purple-blue, Aug to Sep. Lateritic outcrops in greenstone hills, stony quartzite slopes.	*	*	Possible
Euryomyrtus inflata			P3	Shrub, 0.3-0.7 m high, leaves dull green, fruits erect. Fl. white-pink, Jun to Jul. Deep red sand. Flat plain.	*		Possible
Frankenia confusa			P4	Low, diffuse shrub, to 0.75 m high, to 0.75 wide. Fl. pink, Sep. Wet pale brown sand, brown clay, grey soil. Banks of rivers & waterholes, river floodplains.	*	*	Possible
Goodenia lyrata			P3	Prostrate herb, with lyrate leaves. Fl. Yellow, Aug. Red sandy loam. Near claypan.	*		Possible
Hemigenia exilis			P4	Erect, multi-stemmed shrub, 0.5–2 m high. Fl. Blue, purple, white, Apr/Sep–Nov. Laterite. Breakaways, slopes.	*		Possible
Homalocalyx echinulatus			P3	Shrub, 0.45-1 m high. Fl. Pink, Jun to Sep. Laterite. Breakaways, sandstone hills.	*	*	Possible
Paspalidium distans			P4	Rhizomatous, tufted perennial, grass-like or herb, 0.15-0.8 m high. Fl. Green, Mar to Sep. Loam. River banks.	*		Unlikely
Stackhousia clementii			P3	Dense broom-like perennial, herb, to 0.45 m high. Fl. green/yellow/brown. Skeletal soils. Sandstone hills.	*	*	Possible
Tecticornia sp. Lake Way (P. Armstrong 05/961)			P1	No description available. Occurs within samphire vegetation	*		Possible
Tecticornia sp. Sunshine Lake (K.A. Shepherd et al. KS 867)			P1	No description available. Occurs within samphire vegetation.	*	*	Possible

Table 4-3: Other Significant Flora recorded adjacent to the Lake Way SOP Demonstration Plant Project

Taxon	Locality (Ecologia, 2016)
New Taxa	
Tecticornia aff. halocnemoides s.l. 'large ovate seed aggregate'	Lake Way: Common on the edge of the main salt lake and minor tributary to the south of Millipede/Centipede.
Tecticornia sp. aff. Burnerbinmah (inflated fruit)	Lake Way: Recorded scattered along the minor tributary in the south of Millipede.
Tecticornia sp. aff. globulifera (small)	Lake Way: Very common on the edge of the main lake bed and minor tributaries.
Tecticornia sp. aff. laevigata (non-rotated fruitlets)	Lake Way: Common on the main lake bed and minor tributaries.
Tecticornia sp. aff. undulata (broad articles)	Lake Way: Common on the main lake bed and minor tributaries.
Potential New Taxa	
?Tecticornia sp. aff. globulifera (small)	Lake Way: Scattered on the main lake bed.
Tecticornia sp. aff. laevigata	Lake Way: Common on the main lake bed of the Centipede and Millipede
Tecticornia sp. aff. pruinosa	Lake Way: Very common on the main lake bed of the Centipede/Millipede and Lake Way Deposits. Also recorded on the minor tributaries of both areas.
Tecticornia sp. aff. undulata	Lake Way: Very common on the main lake bed of the Centipede/Millipede and Lake Way Deposits. Also recorded on the minor tributaries of the Lake Way Deposit.
Tecticornia sp. halocnemoides beaked seed aggregate	Lake Way: Common on the main lake bed and the minor tributary running north from the Lake Way Deposit.
Range extension	
Maireana luehmannii	Recorded towards the southern end of the Millipede Deposit and just outside the haul road near Lake Maitland.
Scaevola tomentosa	Common within the Millipede and Centipede Deposits.
Sporobolus caroli	One location in the southern end of the Millipede Deposit.
Tecticornia tenuis	Recorded at three locations from Lake Way on the floodplain to the south of Millipede.

4.2 Field Assessment

4.2.1 Vegetation Types

Three broad vegetation types were identified within the survey area (Table 4-4) which were represented by a total of 11 Families, 20 Genera and 42 flora Taxa as listed in Appendix 2. A map showing the vegetation types present in the survey area is provided in Figure 4-1.

Table 4-4: Summary of vegetation types within the Lake Way SOP Demonstration Plant Project

Landform	Major Vegetation Group	Vegetation Code	Vegetation Type	Area (ha)	Area (%)
Open Depression	Acacia Forest and Woodland (MVG 6)	OD-AFW1	Low open woodland of *Acacia incurvaneura* over mid shrubland of *Eremophila jucunda*/*Senna artemisioides* subsp. *helmsii* and low open tussock grassland of *Eragrostis eriopoda* in drainage line	22	0.4
Closed Depression	N/A (Bare salt lake)	CD-SL	Bare salt lake (playa)	5290	92.4
Quartz Rocky Plain	Acacia Forest and Woodland (MVG 6)	QRP-AFW1	Low open woodland of *Acacia incurvaneura* over mid shrubland of *Eremophila jucunda*/*Senna artemisioides* subsp. *helmsii* and low open tussock grassland of *Eragrostis eriopoda* on quartz-rocky plain	327	5.7

Landform	Major Vegetation Group	Vegetation Code	Vegetation Type	Area (ha)	Area (%)
	Chenopod Shrublands, Samphire Shrublands and Forblands (MVG 22)	QRP-CSSSF1	Low closed shrubland of *Frankenia pauciflora* over low forbland of *Sclerolaena densiflora* on quartz-rocky plain	73	1.3
N/A	N/A (Cleared vegetation)	CV	Cleared Vegetation	14	0.2
Total				**5726**	**100**

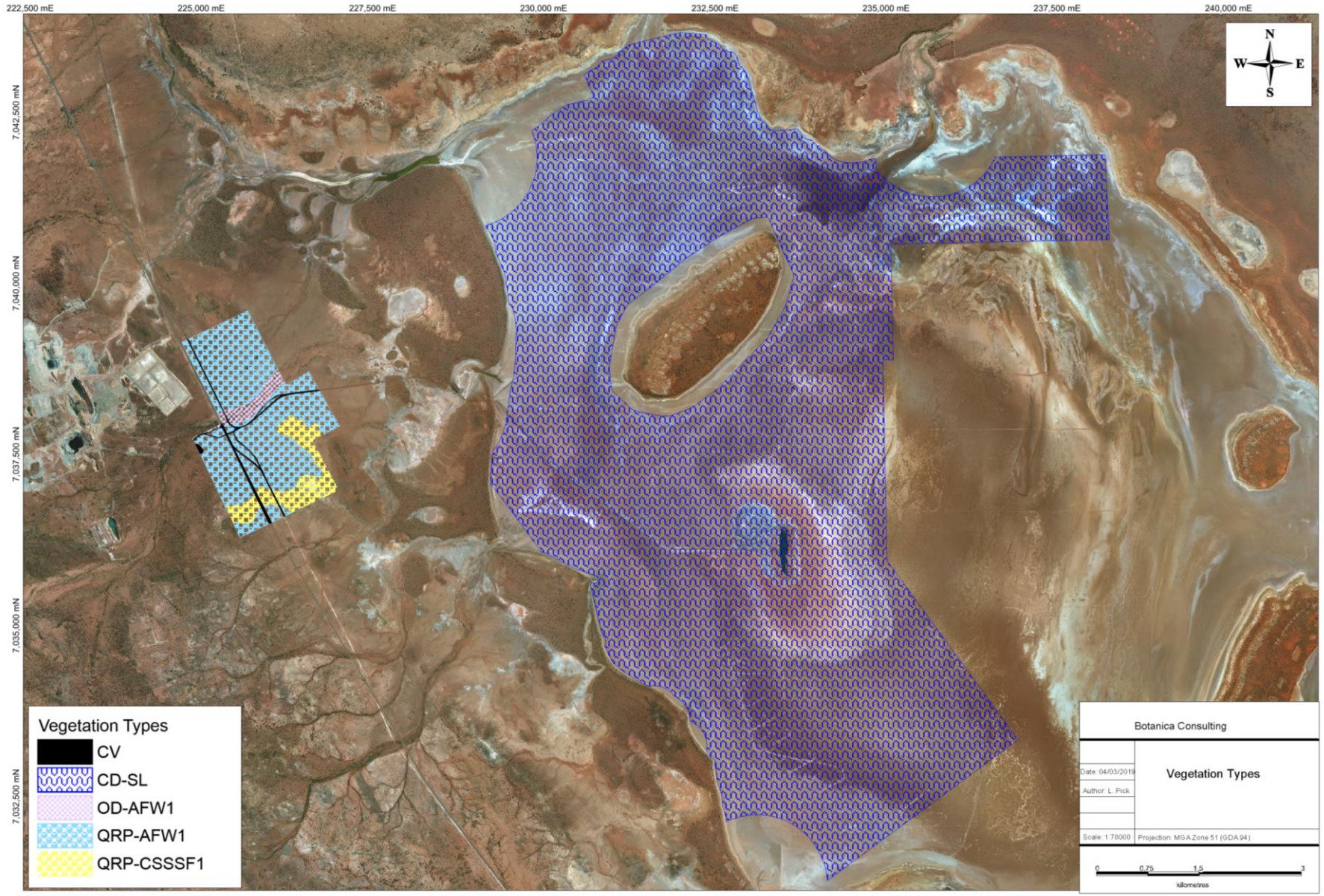


Figure 4-1: Vegetation types within the Lake Way SOP Demonstration Plant Project

Open Depression: Acacia Forests and Woodlands

4.2.1.1 Low open woodland of *Acacia incurvaneura* over mid shrubland of *Eremophila jucunda/Senna artemisioides* subsp. *helmsii* and low open tussock grassland of *Eragrostis eriopoda* in drainage line (OD-AFW1)

The total flora recorded within this vegetation type was represented by a total of 8 Families, 11 Genera and 22 Taxa (Plate 4-1). Dominant taxa are shown in Table 4-5. According to the NVIS, this vegetation type is best represented by the MVG 6–Acacia Forests and Woodlands (DotEE, 2017b).

Table 4-5: Low open woodland of *Acacia incurvaneura* over mid shrubland of *Eremophila jucunda/Senna artemisioides* subsp. *helmsii* and low open tussock grassland of *Eragrostis eriopoda* in drainage line

Life Form/Height Class	Canopy Cover	Dominant taxa present
Tree <5m	5-10%	*Acacia incurvaneura*
Shrub 1-2m	30-70%	*Eremophila jucunda* *Senna artemisioides* subsp. *helmsii*
Tussock Grass <0.5m	10-30%	*Eragrostis eriopoda*

Plate 4-1: Low open woodland of *Acacia incurvaneura* over mid shrubland of *Eremophila jucunda/Senna artemisioides* subsp. *helmsii* and low open tussock grassland of *Eragrostis eriopoda* in drainage line

Quartz Rocky Plain: Acacia Forests and Woodlands

4.2.1.2 Low open woodland of *Acacia incurvaneura* over mid shrubland of *Eremophila jucunda/Senna artemisioides* subsp. *helmsii* and low open tussock grassland of *Eragrostis eriopoda* on quartz-rocky plain (QRP-AFW1)

The total flora recorded within this vegetation type was represented by a total of 9 Families, 16 Genera and 31 Taxa (Plate 4-2). Dominant taxa are shown in Table 4-6. According to the NVIS, this vegetation type is best represented by the MVG 6–Acacia Forests and Woodlands (DotEE, 2017b).

Table 4-6: Low open woodland of *Acacia incurvaneura* over mid shrubland of *Eremophila jucunda/Senna artemisioides* subsp. *helmsii* and low open tussock grassland of *Eragrostis eriopoda* on quartz-rocky plain

Life Form/Height Class	Canopy Cover	Dominant taxa present
Tree <5m	5-10%	*Acacia incurvaneura*
Shrub 1-2m	30-70%	*Eremophila jucunda* *Senna artemisioides* subsp. *helmsii*
Tussock Grass <0.5m	10-30%	*Eragrostis eriopoda*

Plate 4-2: Low open woodland of *Acacia incurvaneura* over mid shrubland of *Eremophila jucunda/Senna artemisioides* subsp. *helmsii* and low open tussock grassland of *Eragrostis eriopoda* on quartz-rocky plain

Quartz Rocky Plain: Chenopod Shrublands, Samphire Shrublands and Forblands

4.2.1.3 Low closed shrubland of *Frankenia pauciflora* over low forbland of *Sclerolaena densiflora* on quartz-rocky plain (QRP-CSSSF1)

The total flora recorded within this vegetation type was represented by a total of 10 Families, 14 Genera and 24 Taxa (Plate 4-3). Dominant taxa are shown in Table 4-7. According to the NVIS, this vegetation type is best represented by the MVG 22–Chenopod Shrublands, Samphire Shrublands and Forblands (DotEE, 2017b).

Table 4-7: Low closed shrubland of *Frankenia pauciflora* over low forbland of *Sclerolaena densiflora* on quartz-rocky plain

Life Form/Height Class	Canopy Cover	Dominant taxa present
Shrub <0.5	>70%	*Frankenia pauciflora*
Forb <0.5m	30-70%	*Sclerolaena densiflora*

Plate 4-3: Low closed shrubland of *Frankenia pauciflora* over low forbland of *Sclerolaena densiflora* on quartz-rocky plain

4.2.2 Vegetation Condition

Based on the vegetation condition rating scale adapted from Keighery, 1994 and Trudgen, 1988 (Appendix 3), all three vegetation types were rated as 'Very Good'. 'Very Good' condition depicts that vegetation structure has some relatively slight signs of damage caused by human activities since European settlement. For example, some signs of damage to tree trunks caused by repeated fire, the presence of some relatively non-aggressive weeds, or occasional vehicle tracks.

Table 4-8: Vegetation Condition within the Lake Way SOP Demonstration Plant Project

Landform	Major Vegetation Group	Vegetation Code	Vegetation Type	Vegetation Condition
Open Depression	Acacia Forest and Woodland (MVG 6)	OD-AFW1	Low open woodland of *Acacia incurvaneura* over mid shrubland of *Eremophila jucunda*/*Senna artemisioides* subsp. *helmsii* and low open tussock grassland of *Eragrostis eriopoda* in drainage line	Very Good
Closed Depression	N/A (Bare salt lake)	CD-SL	Bare salt lake (playa)	N/A
Quartz Rocky Plain	Acacia Forest and Woodland (MVG 6)	QRP-AFW1	Low open woodland of *Acacia incurvaneura* over mid shrubland of *Eremophila jucunda*/*Senna artemisioides* subsp. *helmsii* and low open tussock grassland of *Eragrostis eriopoda* on quartz-rocky plain	Very Good
	Chenopod Shrublands, Samphire Shrublands and Forblands (MVG 22)	QRP-CSSSF1	Low closed shrubland of *Frankenia pauciflora* over low forbland of *Sclerolaena densiflora* on quartz-rocky plain	Very Good
N/A	N/A (Cleared vegetation)	CV	Cleared Vegetation	Completely Degraded

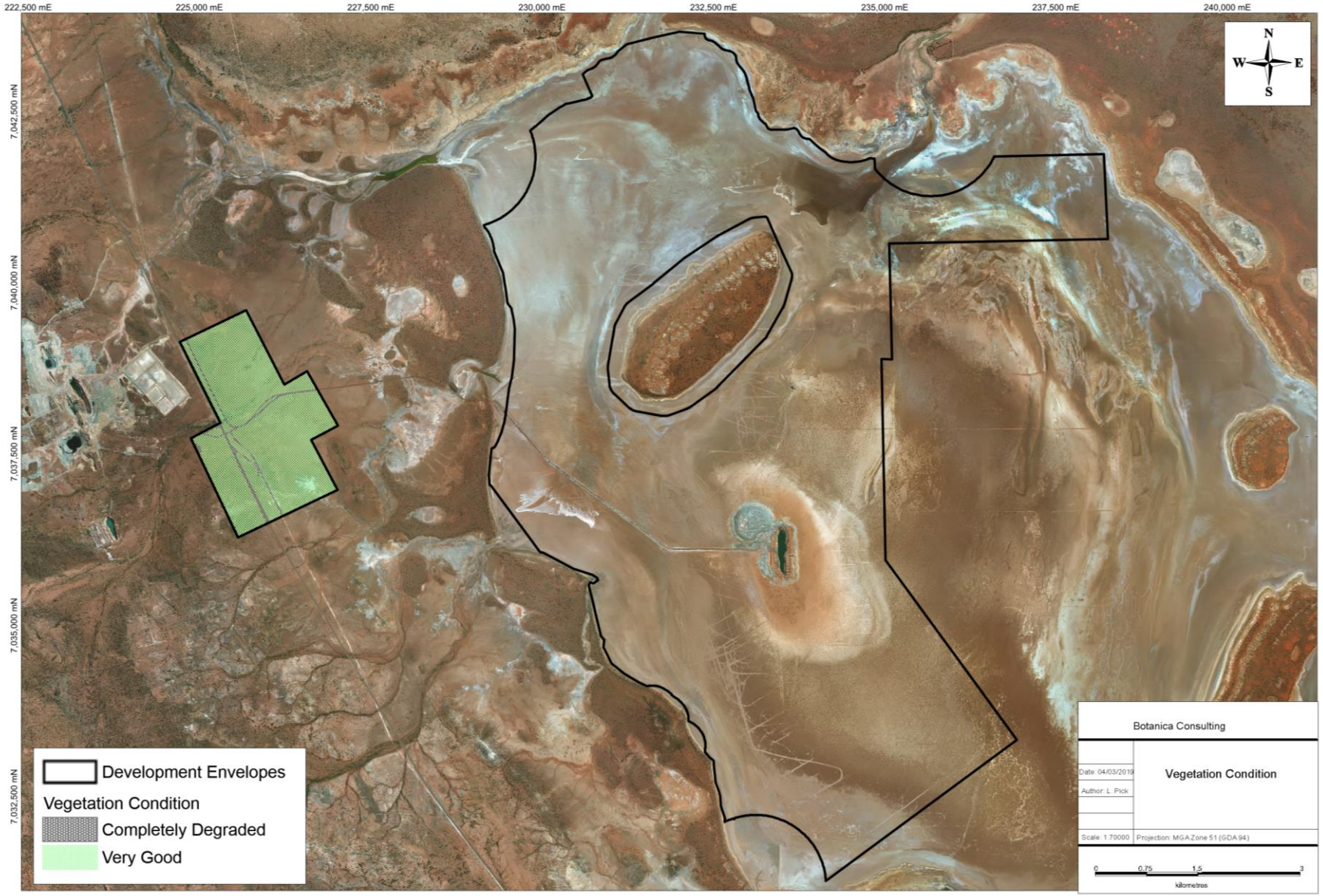


Figure 4-2: Vegetation condition within the Lake Way SOP Demonstration Plant Project

4.2.3 Introduced Plant Species

No introduced taxa were identified during the field assessment.

4.2.4 Significant Flora

According to the EPA *Environmental Factor Guideline for Flora and Vegetation* (EPA, 2016b) significant flora includes:

- Flora being identified as threatened or priority species;
- Locally endemic flora or flora associated with a restricted habitat type (e.g. surface water or groundwater dependent ecosystems);
- New species or anomalous features that indicate a potential new species;
- Flora representative of the range of a species (particularly, at the extremes of range, recently discovered range extensions, or isolated outliers of the main range);
- Unusual species, including restricted subspecies, varieties or naturally occurring hybrids; and
- Flora with relictual status, being representative of taxonomic groups that no longer occur widely in the broader landscape.

No significant flora were identified within the Development envelopes.

4.2.5 Significant Vegetation

According to the EPA *Environmental Factor Guideline for Flora and Vegetation* (EPA, 2016b) significant vegetation includes:

- vegetation being identified as threatened or priority ecological communities
- vegetation with restricted distribution
- vegetation subject to a high degree of historical impact from threatening processes
- vegetation which provides a role as a refuge
- vegetation providing an important function required to maintain ecological integrity of a significant ecosystem.

No significant vegetation was identified within the Development Envelopes.

No Threatened Ecological Communities (TEC) listed under State or Commonwealth legislation were recorded within the Development Envelopes. Five Priority 1 Ecological Communities (PEC) occur within a 20km radius of the Development envelopes (see Appendix 1) two of which intersect the on-playa development envelope:

1. Hinkler Well calcrete groundwater assemblage type on Carey palaeodrainage on Lake Way Station (intersects the on-playa development envelope);
2. Lake Violet calcrete groundwater assemblage types on Carey palaeodrainage on Millbillillie Station (intersects the on-playa development envelope);
3. Lake Way South calcrete groundwater assemblage type on Carey palaeodrainage on Lake Way Station;
4. Uramurdah Lake calcrete groundwater assemblage type on Carey palaeodrainage on Millbillillie Station; and
5. Wiluna BF calcrete groundwater assemblage type on Carey palaeodrainage on Millbillillie Station

These PECs that occur within/near the Development envelopes are underground invertebrate assemblages and are not pertinent to vegetation.

4.3 Matters of National Environmental Significance

None of the following matters of national environmental significance as defined by the Commonwealth EPBC Act were identified within the Development envelopes:

- world heritage properties
- national heritage places
- wetlands of international importance (often called 'Ramsar' wetlands after the international treaty under which such wetlands are listed)
- nationally threatened species and ecological communities
- Commonwealth marine areas
- the Great Barrier Reef Marine Park
- nuclear actions (including uranium mining) a water resource, in relation to coal seam gas development and large coal mining development.

4.4 Matters of State Environmental Significance

There are no wetlands of national importance (ANCA Wetlands) or conservation category wetlands within the Development envelopes. The Development envelopes do not contain any TEC as listed under the BC Act or EP Act. No Threatened Flora taxon listed under the BC Act are known to occur within the Development envelopes. The Development envelopes are not located within DBCA managed land and do not contain any ESA as listed under the EP Act.

A map showing areas of conservation significance in relation to the Project is provided in Appendix 1.

5 Bibliography

Actis, 2012. Tecticornia review: Wiluna uranium project. Unpublished report for Toro Energy Limited.

Animal Plant Mineral (2015a), Vegetation Clearing Permit Application, Matilda Gold Project, Support Information for Matilda Mine Site Native Vegetation Clearing (Purpose) Permit Application, October 2015.

Animal Plant Mineral (2015b), Level One Biological Survey, Matilda Gold Project, Murchison Western Australia, November 2015. Prepared for Blackham Resources Limited.

ASRIS (2014), *Atlas of Australian Soils Database.* Australian Soil Resource Information System Australian Government (2018), *National Map.* Australian Government.

Bennett Environmental Consulting. (2002). *Vegetation of areas impacted by construction of a causeway for exploration drilling at Lake Way Wiluna Gold*. Unpublished report.

Botanica 2018, Reconnaissance Flora/Vegetation & Fauna Survey Lake Way Project Processing Facility and Pond. Unpublished report prepared for Salt Lake Potash Limited.

Beard, J.S., (1990), *Plant Life of Western Australia*, Kangaroo Press Pty Ltd, NSW.

Bennett Environmental Consulting. (2002). *Vegetation of areas impacted by construction of a causeway for exploration drilling at Lake Way Wiluna Gold*. Unpublished report.

Blackwell, M. J. and Trudgen, M. E. (1980). Report on the Flora and Vegetation of the Lake Way Joint Venture Uranium Development envelope: together with an assessment of the impact of this project upon the landscape, flora and vegetation of this area and its regeneration potential.

BoM, (2018), Wiluna weather station Climate Data, Bureau of Meteorology.
Available: http://www.bom.gov.au/climate
Accessed: 28th November 2018

Cowan, (2001), *A Biodiversity Audit of Western Australia's 53 Biogeographical Region in 2001-Murchison Region (MUR1-Eastern Murchison)*, Department of Conservation and Land Management.

Curry, P.J., Payne, A.L., Leighton, K.A., Hennig, P. and Blood, D.A. (1994) *Technical Bulletin: An inventory and condition survey of the Murchison River catchment, Western Australia (No. 84).* Department of Agriculture WA.

DAFWA (2011), *Pre-European Vegetation - Western Australia (NVIS Compliant Version GIS file),* Department of Agriculture and Food Western Australia

DAFWA (2014), *Soil Landscape System of Western Australia,* Department of Agriculture and Food Western Australia

DBCA (2017). *2017 Statewide Vegetation Statistics*. Department of Biodiversity, Conservation and Attractions

DBCA (2018a), *Nature Map Database search,* Department of Biodiversity, Conservation and Attractions
Available: https://naturemap.dpaw.wa.gov.au/
Accessed: 1st September 2018

DBCA (2019a), *Threatened Flora Database search results*, Department of Biodiversity, Conservation and Attractions. Results obtained January 2019.

DBCA (2019b), *Threatened Flora Database search results*, Department of Biodiversity, Conservation and Attractions. Results obtained January 2019.

DotEE, (2012), *Interim Biogeographic Regionalisation for Australia (IBRA), Version 7,* Department of the Environment and Energy.

DotEE (2015b), *National Vegetation Information System (NVIS) Version 7*, Department of the Environment and Energy

DotEE (2018a), *Protected Matters Search Tool, Environment Protection and Biodiversity Conservation Act 1999,* Department of the Environment and Energy
Available: http://www.environment.gov.au/epbc/protected-matters-search-tool
Accessed: 1st September 2018

DotEE (2018b) Species Profiles and Threats Database, Department of Environment and Energy
Available: http://www.environment.gov.au/sprat
Accessed: 12th October 2018
DPaW (2017), Interim guideline for preliminary surveys of night parrot (*Pezoporus occidentalis*) in Western Australia. Released by Department of Parks and Wildlife

DPIRD (2018), *Declared Organism-database search,* Department of Primary Industries and Regional Development, Western Australia
Available: https://www.agric.wa.gov.au/bam/western-australian-organism-list-waol
Accessed: 22nd October 2018

Ecologia Environment, 2015. 'Maireana prosthecochaeta Confirmation and Targeted Flora Survey'.

Ecologia Environment, 2016a. 'Assessment of Tecticornia Communities Associated with Lake Way and Lake Maitland'. Unpublished report prepared for Toro Energy Limited.

Ecologia Environment, 2016b. Flora and Vegetation Consolidation and Conservation Assessment.

Ecologia Environment, 2016c. Cumulative Impact Assessment.

EPA, (2016a), *Technical Guidance - Flora and Vegetation Surveys for Environmental Impact Assessment – December 2016.* Environmental Protection Authority

Niche Environmental Services, 2011. 'Assessment of the Flora and Vegetation at the Toro Energy Wiluna Uranium Project: Lake Way, Centipede and Borefield'. Report prepared for Toro Energy Limited, February 2011.

Niche Environmental Services, 2014. Assessment of the flora and vegetation at the Toro Energy Wiluna Uranium Project: Millipede Development envelope. Unpublished Report for Toro Energy.

Outback Ecology, 2007. Lake Way and Centipede Baseline Vegetation and Flora Survey. Unpublished report prepared for Toro Energy Limited.

Outback Ecology, 2010a. Level 2 Flora and Vegetation Assessment – June 2010. Unpublished report prepared for Toro Energy Limited.

Outback Ecology, 2010b. Lake Way, Centipede West Deposit and Haul Road Corridor baseline Survey Report – November 2010. Unpublished report prepared for Toro Energy Limited.

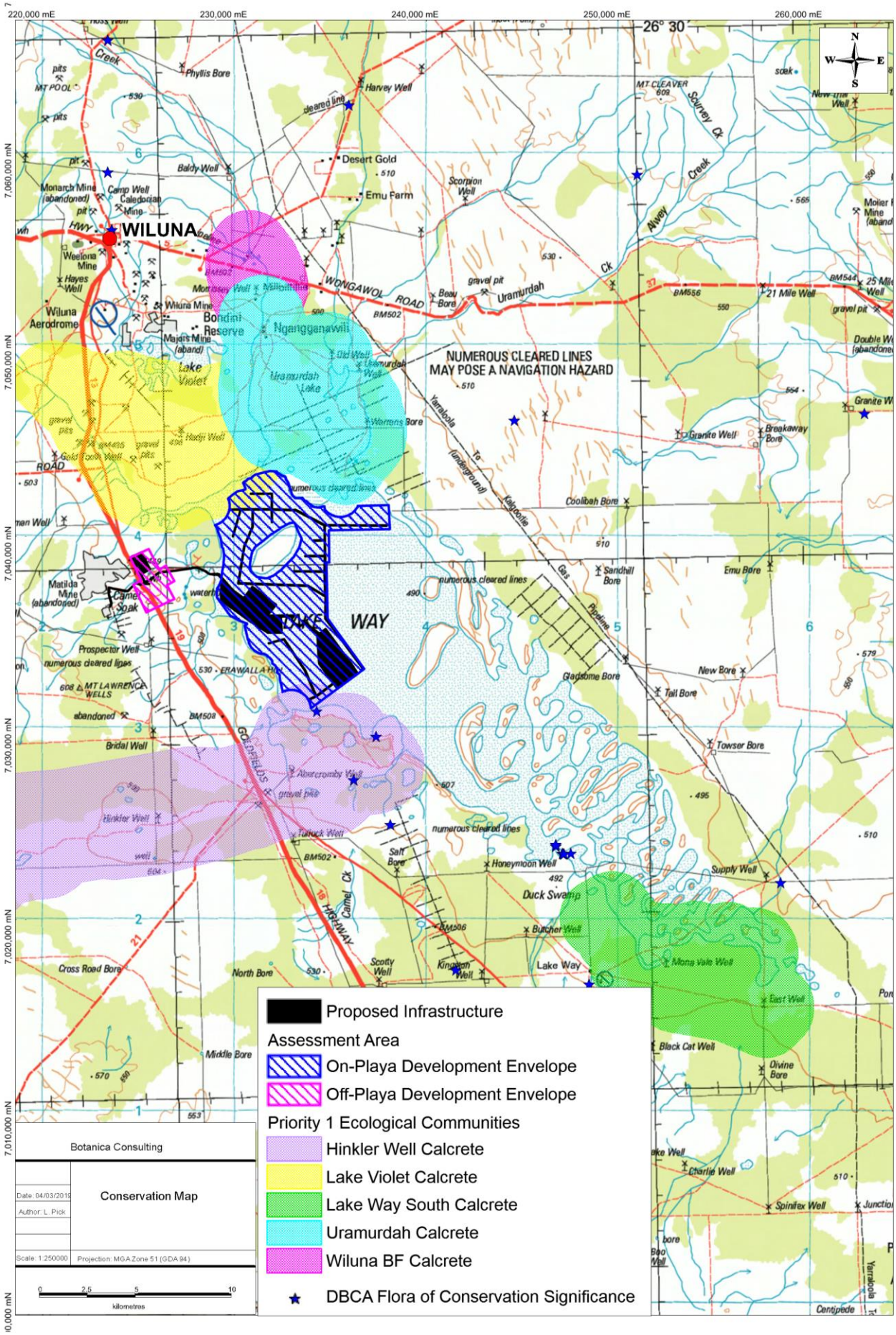
Pringle, H. J. R, Van Vreeswyk, A. M. E. and Gilligan, S. A. (1994), An inventory and condition survey of the north-eastern Goldfields, Western Australia. Technical Bulletin No. 87. Department of Agriculture, Western Australia.

Shepherd, D. P., Beeston, G. R. and Hopkins, A. J. M. (2002) *Native Vegetation in Western Australia. Extent, Type and Status*, Department of Agriculture, Western Australia

Tille, P. (2006), *Soil Landscapes of Western Australia's Rangelands and Arid Interior*, Department of Agriculture and Food Western Australia

WAHERB, (2018), *Florabase – Information on the Western Australian Flora,* Department of Biodiversity, Conservation and Attractions.
Available: https://florabase.dpaw.wa.gov.au/
Accessed 28th November 2018

Appendix 1: Regional map of conservation areas



Appendix 2: Species List

Family	Genus	Taxon	DD-AFW1	QRP-AFW1	QRP-CSSSF1
Amaranthaceae	*Ptilotus*	*divaricatus*			*
Amaranthaceae	*Ptilotus*	*helipteroides (A)*		*	
Amaranthaceae	*Ptilotus*	*nobilis (A)*		*	
Amaranthaceae	*Ptilotus*	*obovatus*		*	
Asteraceae	*Cratystylis*	*subspinescens*	*	*	
Asteraceae	*Erymophyllum*	*compactum (A)*			*
Chenopodiaceae	*Atriplex*	*bunburyana*			*
Chenopodiaceae	*Atriplex*	*codonocarpa (A)*		*	*
Chenopodiaceae	*Maireana*	*carnosa*			*
Chenopodiaceae	*Maireana*	*contorta*	*	*	
Chenopodiaceae	*Maireana*	*convexa*			*
Chenopodiaceae	*Maireana*	*georgei*			*
Chenopodiaceae	*Maireana*	*pyramidata*	*	*	*
Chenopodiaceae	*Maireana*	sp. (sterile)			*
Chenopodiaceae	*Maireana*	*triptera*	*	*	
Chenopodiaceae	*Rhagodia*	*eremaea*	*	*	
Chenopodiaceae	*Salsola*	*australis (A)*		*	
Chenopodiaceae	*Sclerolaena*	*cuneata*	*	*	*
Chenopodiaceae	*Sclerolaena*	*densiflora*	*	*	*
Chenopodiaceae	*Sclerolaena*	*eriacantha*			*
Chenopodiaceae	*Sclerolaena*	*eurotioides*	*	*	*
Chenopodiaceae	*Tecticornia*	*disarticulata*			*
Chenopodiaceae	*Tecticornia*	*halocnemoides*			*
Fabaceae	*Acacia*	*caesaneura*	*	*	
Fabaceae	*Acacia*	*incurvaneura*	*	*	
Fabaceae	*Acacia*	*kempeana*	*	*	
Fabaceae	*Acacia*	*tetragonophylla*	*	*	*
Fabaceae	*Acacia*	*aptaneura*	*	*	
Fabaceae	*Senna*	*artemisioides* subsp. ×*artemisioides*	*	*	
Fabaceae	*Senna*	*artemisioides* subsp. *helmsii*	*	*	*
Fabaceae	*Senna*	*charlesiana*	*	*	*
Frankeniaceae	*Frankenia*	*pauciflora*	*	*	*
Goodeniaceae	*Scaevola*	*spinescens*	*	*	*
Lamiaceae	*Teucrium*	*teucriiflorum*			*

Family	Genus	Taxon	DD-AFW1	QRP-AFW1	QRP-CSSSF1
Myrtaceae	*Melaleuca*	*leiocarpa*			*
Poaceae	*Aristida*	*contorta (A)*		*	*
Poaceae	*Enteropogon*	*ramosus*		*	
Poaceae	*Eragrostis*	*eriopoda*	*	*	
Scrophulariaeceae	*Eremophila*	*forrestii* subsp. *forrestii*	*	*	
Scrophulariaeceae	*Eremophila*	*jucunda*	*	*	
Scrophulariaeceae	*Eremophila*	*spinescens*	*	*	
Scrophulariaeceae	*Eremophila*	*pterocarpa* subsp. *acicularis*	*	*	
Solanaceae	*Solanium*	*lasiophyllum*	*	*	*

Appendix 3: Vegetation Condition Rating

Vegetation Condition Rating	South West and Interzone Botanical Provinces	Eremaean and Northern Botanical Provinces
Pristine	Pristine or nearly so, no obvious signs of disturbance or damage caused by human activities since European settlement.	
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species. Damage to trees caused by fire, the presence of non-aggressive weeds and occasional vehicle tracks.	Pristine or nearly so, no obvious signs of damage caused by human activities since European settlement.
Very Good	Vegetation structure altered, obvious signs of disturbance. Disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.	Some relatively slight signs of damage caused by human activities since European settlement. For example, some signs of damage to tree trunks caused by repeated fire, the presence of some relatively non-aggressive weeds, or occasional vehicle tracks.
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. Disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.	More obvious signs of damage caused by human activity since European settlement, including some obvious impact on the vegetation structure such as that caused by low levels of grazing or slightly aggressive weeds.
Poor		Still retains basic vegetation structure or ability to regenerate it after very obvious impacts of human activities since European settlement, such as grazing, partial clearing, frequent fires or aggressive weeds.
Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. Disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds at high density, partial clearing, dieback and grazing.	Severely impacted by grazing, very frequent fires, clearing or a combination of these activities. Scope for some regeneration but not to a state approaching good condition without intensive management. Usually with a number of weed species present including very aggressive species.
Completely Degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native trees and shrubs.	Areas that are completely or almost completely without native species in the structure of their vegetation; i.e. areas that are cleared or ‘parkland cleared’ with their flora comprising weed or crop species with isolated native trees or shrubs.