

<b>Title:</b> Yeelirrie Conservation Species Management Plan		<b>Doc. No.</b> CAM-MP-018
<b>Date Issued:</b> 14 May 2015	<b>Date Revised:</b> 3 September 2015	<b>Rev. No.</b> 4

**Record of Revisions**

Rev. No.	Date	Description of Revision	Prepared/Revised by
0	14/05/2015	Initial Version	<i>G. Cockerton</i>
1	19/05/2015	Reviewed and Updated	<i>G. Cockerton &amp; S. Williamson</i>
2	24/06/2015	Updated to include additional information	<i>S. Williamson</i>
3	20/07/2015	Updated to include research plan	<i>T. Duff</i>
4	3/09/2015	Updated to expand Section 3.1.6	<i>T. Duff</i>

Title of Document Owner: Environmental Manager  
 Next review by (month, day, year): 24<sup>th</sup> June 2018

**Approvals**

<b>Author</b>		
Environmental Manager	S. Williamson	3/09/2015
<b>Title</b>	<b>Name</b>	<b>Date</b>
<b>Reviewer</b>		
Environmental Advisor	T. Duff	3/09/2015
<b>Title</b>	<b>Name</b>	<b>Date</b>
<b>Approver</b>		
Environmental Manager	S. Williamson	3/09/2015
<b>Title</b>	<b>Name</b>	<b>Date</b>

<b>Title:</b> Yeelirrie Conservation Species Management Plan		<b>Doc. No.</b> CAM-MP-018
<b>Date Issued:</b> 14 May 2015	<b>Date Revised:</b> 3 September 2015	<b>Rev. No.</b> 4

## 1 Introduction

Western Botanical was commissioned by Cameco Australia Pty Ltd (Cameco) to prepare a Conservation Species Management Plan for of the Yeelirrie Uranium Project (the Project). The plan addresses management planning for vascular flora species with conservation significance; Priority Flora and Threatened Flora (Declared Rare Flora) listed by the Department of Parks and Wildlife (DPaW), which are known within the proposed development footprint. This plan is designed to guide management of conservation significant species during the life of the Project.

Cameco has a hierarchical approach to management of impacts to flora with conservation significance within the project footprint focusing on:

1. Avoidance of direct and indirect impacts to conservation significant flora where possible;
2. Minimisation of direct and indirect impacts to conservation significant flora where some impacts are unavoidable;
3. Conservation of in-situ populations and habitats supporting Threatened Flora;
4. Where Threatened Flora is unavoidably to be impacted, development and implementation of (i) an approved Interim Recovery Plan, and (ii) an approved Translocation Plan to ensure no net loss of biological values relating to the Threatened Flora species.

### 1.1 Flora and Vegetation of the Yeelirrie Tenements

The flora and vegetation of the Project tenements have been assessed in extensive and detailed surveys conducted over the period 2008 to 2010 and are described in Western Botanical report WB655 (2010), WB653 (2011) and in the supplementary addendum WB839 (2015a). The Local Study Area, inclusive of the Development Envelope, associated infrastructure and the proposed road alignment from Yeelirrie Station to the Goldfields Highway, is known to support 467 native species with from 198 genera and 62 families inclusive of 11 weed species. Of the native flora, one species is listed at Threatened Flora and 12 species are listed by DPaW as Priority Flora including two P1, eight P3 and two P4 species.

### 1.2 Known Flora with Conservation Significance

Priority species are acknowledged as generally being data deficient, with insufficient information on their overall distribution and population numbers being publicly available to thoroughly ascertain their conservation status. Information on Priority Species is often best developed within and nearby major development projects through the flora and vegetation assessments conducted for the Environmental Impact Assessment process. However, many extensive areas of the state have been poorly assessed to date and the regional information available for these species is often lacking. Consequently, it is likely that the Priority listing of the Priority Species noted within this Conservation Species Management Plan may change over time as more information becomes available, and that amendments to management practices for some listed Priority Species may be required in future.

<b>Title:</b> Yeelirrie Conservation Species Management Plan	<b>Doc. No.</b> CAM-MP-018
<b>Date Issued:</b> 14 May 2015	<b>Date Revised:</b> 3 September 2015
	<b>Rev. No.</b> 4

Currently the Local Study Area is known to support one Threatened species and 12 Priority Flora species, which are detailed in Table 1. These species are described and discussed in detail within Western Botanical (2011) and Western Botanical (2015a) reports WB653 and WB839, respectively.

**Table 1: Conservation Significant Flora Known within the Local Study Area**

<b>Threatened Flora</b>	
<b>Vulnerable (VU)</b>	<i>Atriplex</i> sp. Yeelirrie Station (L. Trotter & A. Douglas LCH25025), is present in two populations that possess similar levels of genetic diversity, but exhibit a surprising level of genetic differentiation given their proximity (Clarke <i>et al</i> 2012).
<b>Priority Flora</b>	
<b>Priority 1</b>	<i>Rhagodia</i> sp. Yeelirrie Station (K.A. Shepherd <i>et al.</i> KS1396) <i>Neurachne lanigera</i>
<b>Priority 3</b>	<i>Baeckea</i> sp. Sandstone (C.A. Gardner s.n. 26 Oct 1963) <i>Bossiaea eremaea</i> <i>Calytrix uncinata</i> <i>Eremophila arachnoides</i> subsp. <i>arachnoides</i> <i>Euryomyrtus inflata</i> <i>Sauropus ramosissimus</i> <i>Sida picklesiana</i>
	<i>Thryptomene</i> sp. Leinster (B.J. Lepschi & L.A. Craven 4362)
	<b>Priority 4</b>
	<i>Olearia arida</i> <i>Comesperma viscidulum</i>

Eight of the conservation significant species *Neurachne lanigera* P1, *Baeckea* sp. Sandstone (C.A. Gardner s.n. 26 Oct 1963) P3, *Calytrix uncinata* P3, *Sauropus ramosissimus* P3, *Sida picklesiana* P3, *Thryptomene* sp. Leinster (B.J. Lepschi & L.A. Craven 4362) P3, *Olearia arida* P4 and *Comesperma viscidulum* P4 are known in the vicinity of the Project but are not recorded within the proposed Development Envelope and are therefore not directly impacted by the Project, Figure 1.

The Project will have a direct impact on four of the conservation significant species listed in Table 1, including the Threatened Flora *Atriplex* sp. Yeelirrie Station (L. Trotter & A. Douglas LCH25025), which is discussed in more detail below. The three other species to be impacted are *Bossiaea eremaea* P3, *Eremophila arachnoides* subsp. *arachnoides* P3 and *Euryomyrtus inflata* P3. The impact to these species is considered to be low due to the small percentage of impact (Table 2) within the Local Study Area. *Bossiaea eremaea* P3 and *Euryomyrtus inflata* P3 are also well represented in the broader north-eastern Goldfields. Management of Priority species which are not impacted by the Project or are only considered to be impacted to low degrees are discussed in Section 2.

<b>Title:</b> Yeelirrie Conservation Species Management Plan		<b>Doc. No.</b> CAM-MP-018
<b>Date Issued:</b> 14 May 2015	<b>Date Revised:</b> 3 September 2015	<b>Rev. No.</b> 4

**Table 2: Priority Flora to be Impacted by the Project**

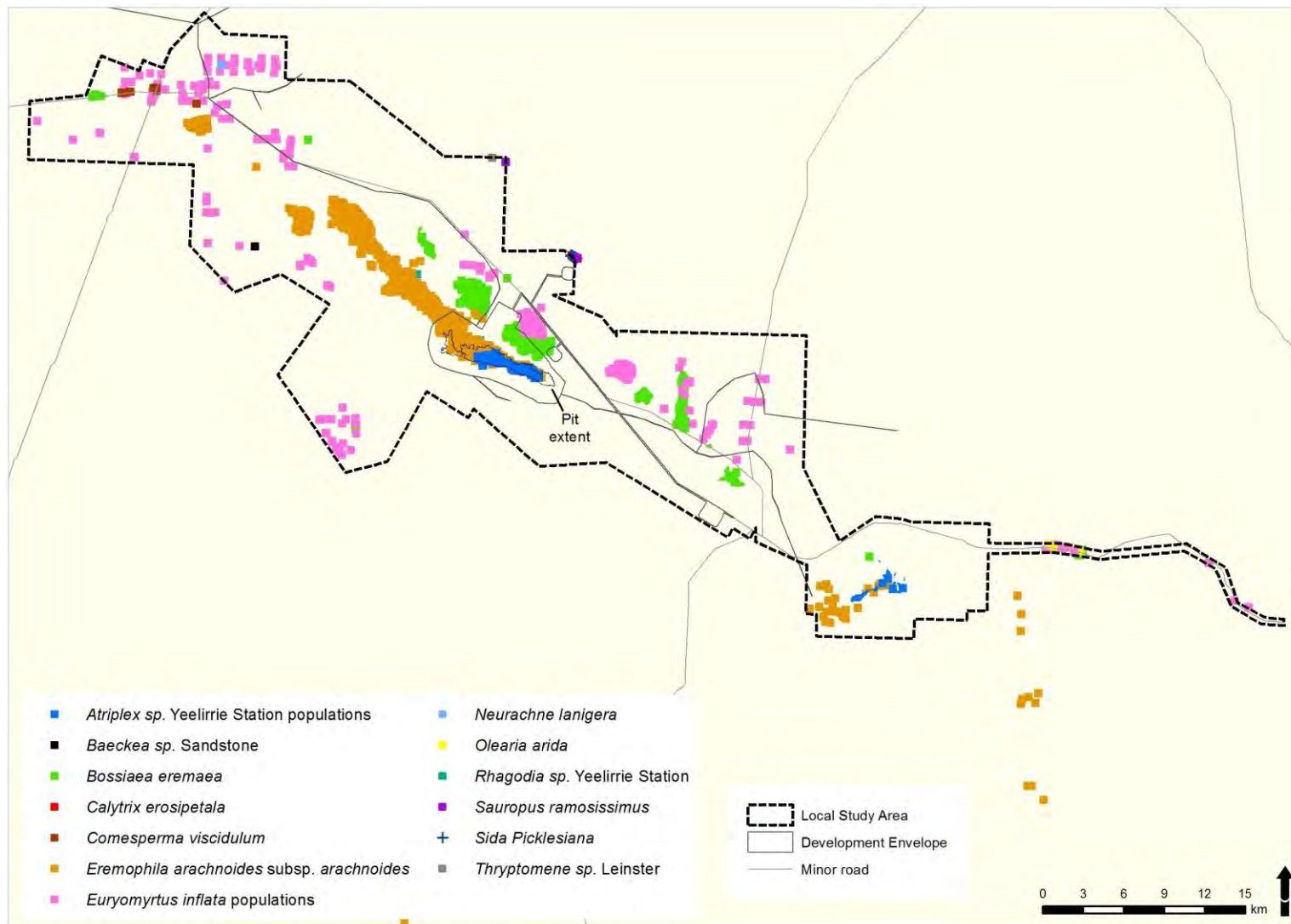
Species Name	Status	Number of Plants within Local Study Area	Plants Proposed to be Cleared
<i>Bossiaea eremaea</i>	P3	36442	1562 (4.29%)
<i>Eremophila arachnoides</i> subsp. <i>arachnoides</i>	P3	43255	5120 (11.84%)
<i>Euryomyrtus inflata</i>	P3	134520	410 (0.30%)

It should also be noted that the priority one species *Rhagodia* sp. Yeelirrie Station (K.A. Shepherd *et al.* KS1396), which occurs both within and outside the Development Envelope could potentially be indirectly impacted by the Project. Cameco proposes to protect the species within the Development Envelope by establishing clearing restrictions for the area and will investigate ways of protecting the population that occurs outside of the Development Envelope. Due to proposed alterations in the surface water flow there is the potential for an indirect impact on the 100 plants (4.8% of the total population). *Rhagodia* sp. Yeelirrie Station (K.A. Shepherd *et al.* KS1396) is most likely more tolerant to inundation than most species, as the population occurs on the fringes of a clay pan that already experiences long periods of inundation.

*Atriplex* sp. Yeelirrie Station (L. Trotter & A. Douglas LCH25025) (Threatened) will be impacted to a significant (Moderate to High) degree by the proposed Project.

*Atriplex* sp. Yeelirrie Station (L. Trotter & A. Douglas LCH25025) (Threatened) is known from two populations that possess similar levels of genetic diversity, but exhibit a surprising level of genetic differentiation given their proximity, both occurring on moderately saline red/brown clay within the Yeelirrie palaeochannel. Development of the Project will take 80,542 plants of *Atriplex* sp. Yeelirrie Station (representing approximately 30% of the total population) within an area of 76 ha (representing approximately 37% of the total population's area of occupancy). *Atriplex* sp. Yeelirrie Station is discussed in more detail within Section 3.

An analysis of the relative impacts to each species with conservation significance, the proportion of known populations and individuals of these species within the Project footprint, is presented in the *Species Impact Table* (Table 3). This assessment follows the IUCN process of evaluation of recent, current or projected impacts to the extent of occurrence or numbers of individuals of each conservation significant species present within or adjacent to the Project footprint. The definition of 'population' within states is based upon a desktop interpretation of maps depicting known populations as noted on the Australia's Virtual Herbarium (AVH) website and is therefore limited in the level of definition.



**Figure 1: Priority species within the Local Study Area**

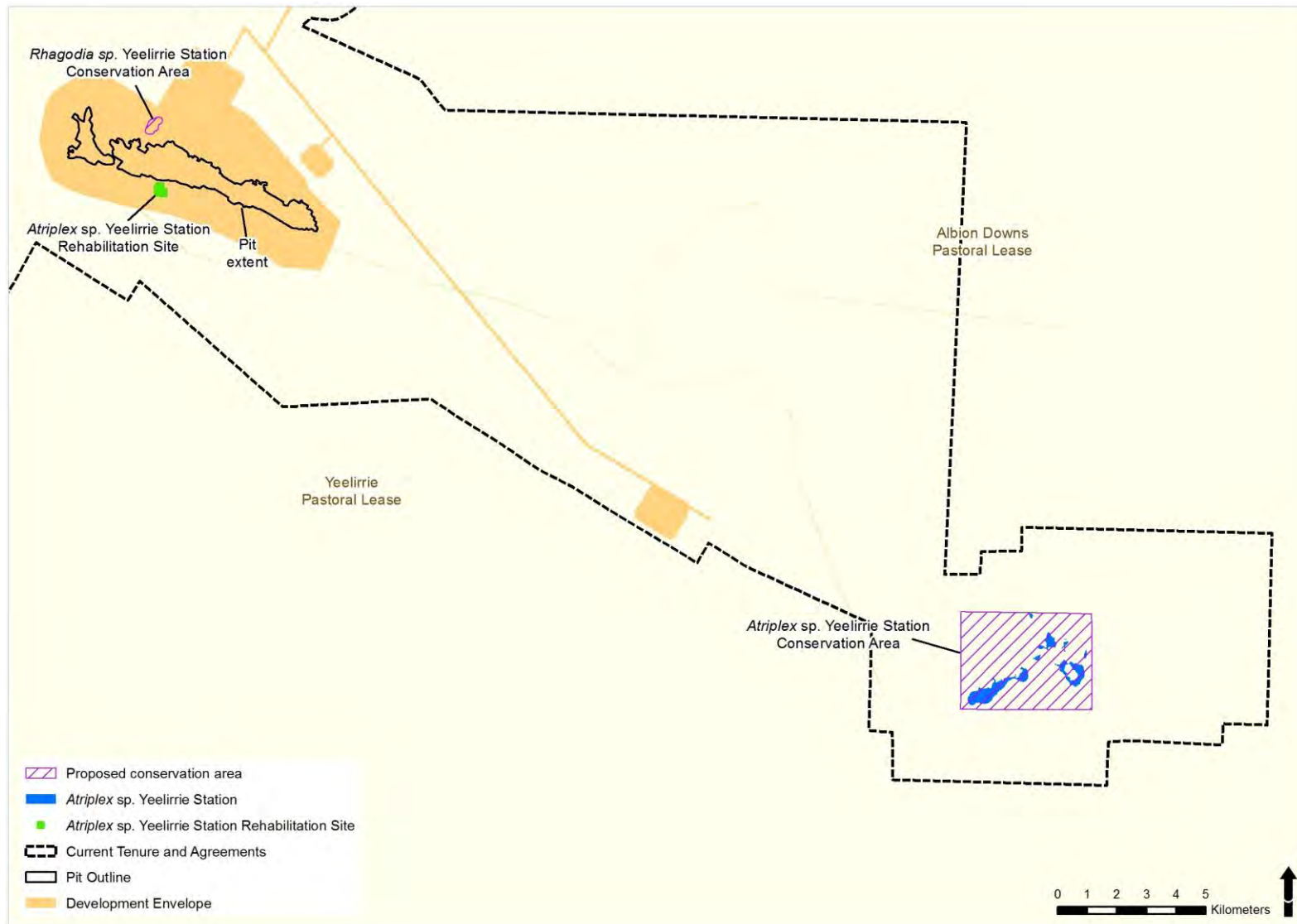


Figure 2: Proposed Conservation Areas

**Table 3: Species Impact Table**

Cons. Status	Taxon	Impacts on Populations						Impacts on Number of Individuals			
		Total # Populations known	# Populations within Local Study Area <sup>1</sup>	# Populations to be impacted	Area of Occupancy (ha) (% of Overall)	% Known Populations to be impacted	Ranking	# Individuals known	# Individuals to be impacted	% Known Individuals to be impacted	Ranking
Threatened Flora Vulnerable (VU) D2	<i>Atriplex sp.</i> Yeelirrie Station	2 populations (WA)	2	1 (Orebody)	206 ha	50	High	275,297	80,542	30.71	High
	Eastern Genotype	1 (10 sub-populations)	1	0	130 ha (63.31%)	0	Not Impacted	190,755	0	0	Not Impacted
	Western Genotype	1 (2 sub-populations)	1	1 (Orebody)	76 ha (36.69%)	100	High	84,542	84,542	100	High
Priority 1	<i>Rhagodia sp.</i> Yeelirrie Station	7 (WA)	5	0	Not assessed	0	Not Impacted	2,201	0	0	Not Impacted
Priority 1	<i>Neurachme lanigera</i>	5 (WA), 2 (SA) (1 population at Yeelirrie)	1	0	Not assessed	0	Not Impacted	Not quantified	0	0	Not Impacted
Priority 3	<i>Baeckea sp.</i> Sandstone	~6 (WA) (1 population at Yeelirrie)	1	0	Not assessed	0	Not Impacted	Not quantified	0	0	Not Impacted
Priority 3	<i>Bossiaea eremaea</i>	~9 (WA) (13 sub-populations at Yeelirrie)	1	1 (Infrastructure)	1663.2	Small % of population to be impacted	Low	36,442 in Yeelirrie Study Areas, not quantified elsewhere	1562	4.29	Low
Priority 3	<i>Calytrix uncinata</i>	~18 (WA)	0	0	Not assessed	0	Not Impacted	Not quantified	0	0	Not Impacted

<sup>1</sup> Local Study Area as defined in Western Botanical (2011) report WB653.

Cons. Status	Taxon	Impacts on Populations						Impacts on Number of Individuals			
		Total # Populations known	# Populations within Local Study Area <sup>1</sup>	# Populations to be impacted	Area of Occupancy (ha) (% of Overall)	% Known Populations to be impacted	Ranking	# Individuals known	# Individuals to be impacted	% Known Individuals to be impacted	Ranking
Priority 3	<i>Eremophila arachnoides</i> subsp. <i>arachnoides</i>	7 (WA) (7 sub-populations known in the Yeelirrie palaeochannel, Yeelirrie, Albion Downs and Yakabindie Stations)	1	1 (Orebody and Infrastructure)	28.13	Small % of population to be impacted	Low	43,255 in Yeelirrie study areas, not quantified elsewhere	5120	11.84	Low
Priority 3	<i>Euryomyrtus inflata</i>	10	10	2	18550.7	Small % of population to be impacted	Low	134,520	410	0.30	Low
Priority 3	<i>Sauropus ramosissimus</i>	~8 (WA) ~20 (NT) 2 (SA) ~9 (Qld) ~8 (NSW)	2	0	Not assessed	0	Not Impacted	Not quantified	0	0	Not Impacted
Priority 3	<i>Sida picklesiana</i>	~7 (WA)	1	0	Not assessed	0	Not Impacted	Not quantified	0	0	Not Impacted
Priority 3	<i>Thryptomene</i> sp. Leinster	~8 (WA)	1	0	Not assessed	0	Not Impacted	Not quantified	0	0	Not Impacted
Priority 4	<i>Olearia arida</i>	~12 (WA) 2 (NT) 2 (SA)	1	0	Not assessed	0	Not Impacted	Not quantified	0	0	Not Impacted
Priority 4	<i>Comesperma viscidulum</i>	~13 (WA) ~12 (NT) ~7 (SA)	0	0	Not assessed	0	Not Impacted	Not quantified	0	0	Not Impacted



<b>Title:</b> Yeelirrie Conservation Species Management Plan		<b>Doc. No.</b> CAM-MP-018
<b>Date Issued:</b> 14 May 2015	<b>Date Revised:</b> 3 September 2015	<b>Rev. No.</b> 4

## 2 Management of Priority Species

Priority species known to occur within the Local Study Area will be managed using the following principles:

1. Avoidance or minimisation of impacts.
2. Stripping and stockpiling of overburden and surface materials containing seeds for use in future rehabilitation.
3. Collection of seed for use in future rehabilitation trials and operational rehabilitation. Specifically *Eremophila arachnoides* subsp. *arachnoides* and *Rhagodia* sp. Yeelirrie Station will be targeted, with other species included as available.
4. Rehabilitation trials and research including *Eremophila arachnoides* subsp. *arachnoides* and *Rhagodia* sp. Yeelirrie Station, with other species as available.
5. Monitoring and reporting of management progress.

Of the twelve priority species within the Local Study Area, nine will not be directly impacted by the Project and three are unavoidably impacted to minor degrees (see Table 3). Those species not impacted directly will be managed as for all other non-impacted vegetation around the mine site. This will be through mapping of the locations of the plants within the Development Envelope, strict clearing management protocols, avoidance of impacts and routine monitoring to ensure compliance. Those species that are represented within the Development Envelope and are unavoidably impacted to some degree will be managed through protocols noted above.

*Eremophila arachnoides* subsp. *arachnoides* (P3) is a significant component of the shrub stratum on calcrete-influenced soils and has a substantial soil seed bank. A substantial population of *Eremophila arachnoides* subsp. *arachnoides* is present within the area of the Eastern Population of *Atriplex* sp. Yeelirrie Station and would be protected by the management measures proposed by Cameco to protect the Eastern Genotype, including in the first instance, fencing, to exclude cattle from neighbouring properties and other feral grazing animals such as goats and camels.

*Rhagodia* sp. Yeelirrie Station (P1) will not be directly impacted by development of the Project. However, a single population of the species (~100 plants) lies within the Development Envelope, adjacent to the proposed infrastructure area. Cameco commits to avoiding direct impacts to this population and will undertake investigations and trials to determine the suitability of *Rhagodia* sp. Yeelirrie Station for use in the rehabilitation as Cameco develops the Mine Closure Plan and associated completion criteria.

All actions to be undertaken in the management of each conservation significant species are summarised in Table 4.

**Table 4: Summary Management Actions for Threatened and Priority Species**

Cons. Status	Taxon	Avoidance of Impacts	Minimisation of Impacts	Seed Bank Management, Seed Collection and Propagation Research	Trailled for reintroduction in Rehabilitation	Conservation In-Situ	Recovery Plan	Translocation Plan
Threatened Flora Vulnerable (VU) D2	<i>Atriplex</i> sp. Yeelirrie Station Eastern Genotype	Yes				Yes		
Threatened Flora Vulnerable (VU) D2	<i>Atriplex</i> sp. Yeelirrie Station Western Genotype	No	No	Yes	Yes	No	Yes	Yes
Priority 1	<i>Rhagodia</i> sp. Yeelirrie Station (K.A. Shepherd et. al. KS1396)	Yes		Yes	Yes	Yes		
	<i>Neurachne lanigera</i>	Yes				Yes		
Priority 3	<i>Baeckea</i> sp. Sandstone (C.A. Gardner s.n. 26 Oct 1963)	Yes				Yes		
	<i>Bossiaea eremaea</i>	No	Yes	Yes	Yes	Yes		
	<i>Calytrix uncinata</i>	Yes				Yes		
	<i>Eremophila arachnoides</i> subsp. <i>arachnoides</i>	No	Yes	Yes	Yes	Yes		
	<i>Euryomyrtus inflata</i>	No	Yes	Yes	Yes	Yes		
	<i>Sauropus ramosissimus</i>	Yes				Yes		
	<i>Sida picklesiana</i>	Yes				Yes		
Priority 4	<i>Thryptomene</i> sp. Leinster (B.J. Lepschi & L.A. Craven 4362)	Yes				Yes		
	<i>Olearia arida</i>	Yes				Yes		
	<i>Comesperma viscidulum</i>	Yes				Yes		

<b>Title:</b> Yeelirrie Conservation Species Management Plan		<b>Doc. No.</b> CAM-MP-018
<b>Date Issued:</b> 14 May 2015	<b>Date Revised:</b> 3 September 2015	<b>Rev. No.</b> 4

### 3 *Atriplex* sp. Yeelirrie Station (L. Trotter & A. Douglas LCH25025)

As previously discussed, a new species, *Atriplex* sp. Yeelirrie Station (Threatened) was discovered during baseline environmental surveys of the Project area. The species has been recognised as a rare, new species of *Atriplex* (Chenopodiaceae a type of salt bush) comprising two populations that possess similar levels of genetic diversity, but exhibit a surprising level of genetic differentiation given their proximity, described here as the Western and Eastern Populations. The Western Population lies wholly within the economic orebody and encompasses two sub-populations that are located in close proximity to each other. The Eastern Population, some 30 km east of the Western Population, encompasses 10 sub-populations in close proximity to each other. As the Eastern and Western populations have a surprising level of genetic differentiation, the populations may need to be managed separately for conservation purposes. As such, these two populations are considered separately within this Conservation Species Management Plan.

Implementation of the Project will involve total removal of the Western Population, taking 84,542 plants over an area of 76 ha, representing approximately 30% of the overall population and 37% of the overall area of occupancy of this species. The Eastern Population of *Atriplex* sp. Yeelirrie Station, 190,755 plants over an area 130 ha, will not be impacted by the Project and will be fully conserved. A number of studies and investigations have been undertaken in order to better understand the species and the impact the Project will have on the species. Key findings from some of the investigations are discussed below.

#### 3.1 *Atriplex* sp. Yeelirrie Station Investigations

##### 3.1.1 *A review of the taxonomy of the species*

Part funding was provided to DPaW's Western Australian Herbarium to assist them to undertake a review to define the taxonomy of *Atriplex* sp. Yeelirrie Station, Eastern and Western populations. A paper dealing with the taxonomy of the species has been prepared by K.A. Shepherd and K.R. Thiele but remains unpublished at this stage. In summary, the research paper describes:

- A rare, new, tetraploid *Atriplex*, restricted to two populations that are approximately 30 km apart in arid Western Australia, is supported as distinct from other known species by morphological and molecular evidence. While the level of genetic differentiation is similar to that previously reported between subspecies in other *Atriplex*, the new taxon has been described as a single species, although the research paper is currently in draft form and has yet to be peer reviewed (Shepherd *et al*, unpublished).

##### 3.1.2 *Baseline flora survey*

Flora and vegetation surveys of the total study area were undertaken from December 2008 to December 2010, during which a total of 39 field visits were conducted. The proposed level of disturbance determined the level of survey detail in each study area. Local study area surveys included mapping the vegetation communities and searching for, quantifying and

<b>Title:</b> Yeelirrie Conservation Species Management Plan		<b>Doc. No.</b> CAM-MP-018
<b>Date Issued:</b> 14 May 2015	<b>Date Revised:</b> 3 September 2015	<b>Rev. No.</b> 4

distinguishing the extent of populations of significant species. *Atriplex* sp. Yeelirrie Station is a new species recognised during these surveys that was listed as Priority One by the DEC in September 2009.

During the regional surveys, particular focus was placed on locating additional populations of *Atriplex* sp. Yeelirrie Station. Initially six paleodrainage and lake systems were selected for investigation based on the distribution of suitable land types, including four land systems: Cunyu, Cosmo, Mileura and Melaleuca, and their associated vegetation associations. A targeted flora survey was undertaken utilising a helicopter to visit the lake systems and select areas for targeted on-ground surveys. On-ground surveys were undertaken at the southern end of the Yeelirrie palaeochannel and Lake Miranda, Lake Way, Lake Mason and Lake Noondie. A second targeted flora survey was undertaken, utilising a helicopter, to search for additional populations of *Atriplex* sp. Yeelirrie Station at a further seven lake systems or paleodrainage systems. These systems were selected for investigation based on the presence of the Cunyu and Mileura land systems and having similar soil characteristics to the natural *Atriplex* sp. Yeelirrie Station populations. No additional populations of *Atriplex* sp. Yeelirrie Station were located.

### 3.1.3 Seed collection and germination testing (2011 and 2014)

*Atriplex* sp. Yeelirrie Station produces seed annually, generally following significant rainfall events. A single seed is held in each bract. Bracts are indehiscent and stay on the plant for a period greater than 12 months. The seed is tightly held in the bract but can be extracted mechanically. Seed was collected from *Atriplex* sp. Yeelirrie Station during October and November 2010. At the time of collection both fresh bracts (produced in 2010) and old bracts (produced prior to 2010) were present on the plants in the populations that were targeted on the resource areas. The purpose of the seed collection program was to collect, process and store seed to undertake investigations into its viability and germination and for future use in rehabilitation or translocation trials. Seed collected, approximately 3.69 million seeds removed from the enclosing bracts, continues to be stored for future use (Landcare Services, 2011).

Germination and Viability testing was conducted on representative samples of fresh and old seed in 2011 (Table 4).

**Table 4. Seed Germination and Viability Results, 2011**

Material tested	Germination Rate	Viability
Fresh excised seed	78%	96%
Old excised seed	73%	79%
Fresh seed in-bract	0%	85%
Old seed in-bract	22%	66%

Additional germination testing was conducted in late 2014 on the seed collected in August that year under DRF Permit 35-1415. The results showed germination rates of old and new seed did not vary significantly with rates between 72% and 92% observed, however, seed retained within the bracts did not begin to germinate at high rates (up to

<b>Title:</b> Yeelirrie Conservation Species Management Plan		<b>Doc. No.</b> CAM-MP-018
<b>Date Issued:</b> 14 May 2015	<b>Date Revised:</b> 3 September 2015	<b>Rev. No.</b> 4

50%) until 3 weeks of testing while seeds excised from the bracts germinated rapidly in the second week.

In summary, the findings were that fresh seed has a higher viability rate than older seed and fresh seed excised from the bracts germinates at a higher rate than old excised seed. Germination rates are lower when the seed is retained in the bract, presumably due to a chemical germination inhibition, which does begin to break-down after about 3 weeks. As fruits age, the rate of germination inhibition is reduced.

### 3.1.4 Population dynamics

During the baseline field surveys, a third population of the species was discovered. This population of 109 individuals is growing in an area that was disturbed by exploration activities conducted in the 1980's and was subsequently rehabilitated in 1994. A further 7 live plants have been noted in rehabilitation north of the deposits (still within the orebody). It is believed that *Atriplex* sp. Yeelirrie Station seed was introduced to the site with soil during trail mining. The population, described as the Rehabilitation Population, has been assessed and statistically compared with the Western Population in August 2014:

- There was no significant difference in the ratio of male to female plants between the populations.
- There was no significant difference in the proportion of plants scored as juvenile vs mature between the populations.
- Plants in the Rehabilitation Population were significantly larger in all dimensions, 24% taller, 99% wider and 75% broader than plants in the Western Population. Consequently, plants in rehabilitation had a larger overall plant volume (72%).
- Plants in the Rehabilitation Population also had large portions of their canopies that were dead. When this was taken into account and the live volumes of plants were assessed, plants in the Rehabilitation Population had live canopies that were 42% smaller than those in the Western Population.
- As no plants in either the Rehabilitation Population or Western Population were flowering, there was no difference in flowering rate between these two sites. However, the mature plants at the Eastern Population were noted as flowering (and growing) vigorously. This probably reflected the higher soil moisture noted in soil samples taken at the Eastern Population in August 2014.
- Plants holding fruiting bracteoles were scored on a scale of 0 to 3 (nil to large amounts of fruits on the plant). Plants in the Rehabilitation Population scored 239% higher for the number of plants holding fresh fruits on the plant and had a higher score (252%) for the amount of fresh fruits held on the plants compared to the Western Baseline Population. Some fruits were dissected in-situ at the Rehabilitation Population and were found to consistently have a firm, robust viable seed within. The fruits collected from plants under the DRF permits issued (35-1415 and 162-1415) have not yet been assessed for seed fill, viability or germinability.

<b>Title:</b> Yeelirrie Conservation Species Management Plan		<b>Doc. No.</b> CAM-MP-018
<b>Date Issued:</b> 14 May 2015	<b>Date Revised:</b> 3 September 2015	<b>Rev. No.</b> 4

- There was no difference in the frequency of plants holding older fruits and no difference in the abundance of older fruits held on plants between populations.
- The soils of the Rehabilitation Population are markedly different to the soils supporting the Western Population. The soil of the rehabilitated site is a hard setting, non-saline, well drained, neutral sandy loam compared to the moderately saline, alkaline self mulching light to medium clay at the surface grading to an alkaline, moderately saline, strongly pedal medium clay at depth.
- The vegetation associated with *Atriplex* sp. Yeelirrie Station at the Rehabilitation Population site has a relatively high species richness of 41 species. Species composition is typical of the undisturbed adjacent *Acacia ayersiana* mulga woodland vegetation on hardpan plains (HPMS vegetation association of Western Botanical, 2011) and the addition of a wide range of chenopods that are typically included in minesite rehabilitation in the Goldfields of W.A. This contrasts strongly with the relatively low species richness of the naturally occurring vegetation communities supporting *Atriplex* sp. Yeelirrie Station on the saline smectite clay soils where six species were recorded in the Western Population and nine species in the Eastern Population. Four species within the Rehabilitation population are also found in the Western Population: two of the dominant species from the latter population *Atriplex* sp. Yeelirrie Station and *Lawrenzia densiflora*, the annual herb *Zygophyllum compactum* and the ubiquitous annual species *Salsola tragus*. The *Atriplex* sp. Yeelirrie Station and *Lawrenzia densiflora* are also dominant species found at the Eastern Population.
- The Rehabilitation Population and Western natural population were assessed again in March 2015 (Western Botanical 2015c). This found that 35% of the plants within the Rehabilitation Population had died over the preceding summer period while 14% of the plants within the Western Population had died over the same period.

### 3.1.5 *Habitat hydrogeology*

Cameco engaged Soilwater Consultants (Soilwater, 2015) to investigate the landform and soils associated with the Western and Eastern populations of *Atriplex* sp. Yeelirrie Station and where the species occurs. The purpose of this study was to characterise the habitat as a preliminary step to identifying similar locations for possible future establishment of a population of *Atriplex* sp. Yeelirrie Station. Trenches were dug using a backhoe to allow for inspection and sampling of soil profiles.

The Eastern and Western populations both occur within areas experiencing similar geomorphic processes and have therefore developed comparable soil profiles. Both population areas are underlain by calcrete formations at shallow depths which have developed within the upper layers of the sediments (Quaternary aged), partially filled the palaeodrainage valley. The trench investigation work within the low lying clay pan areas uncovered a uniformly consistent soil profile comprising of a variable depth of reddish brown clays (typically 0.3 to 0.6 m in depth) overlying a friable, calcareous loam typically 1 m in depth often containing gypsum rich horizons which in turn overlies the calcrete formation.

<b>Title:</b> Yeelirrie Conservation Species Management Plan		<b>Doc. No.</b> CAM-MP-018
<b>Date Issued:</b> 14 May 2015	<b>Date Revised:</b> 3 September 2015	<b>Rev. No.</b> 4

Soil characteristics including, physical, chemical and mineralogical properties were investigated and the results from this work showed that within the claypans, in the Yeelirrie Paleodrainage System, little variation in soil properties occurred. A broad salinity tolerance was identified within the surface soils, and an EC value of around 500 mS/m was identified as being optimal to plant growth. Plants do occur in surface soils of higher salinity of up to 1,000 mS/m, albeit at an apparent cost to the health of the plant.

Given the limited variation on soil characteristics, it is considered that the apparent distribution of *Atriplex* sp. Yeelirrie Station within these areas is likely to be influenced by other factors.

From careful examination of the micro-topographic location of the *Atriplex* sp. Yeelirrie Station plants, within the Western and Eastern populations, it is apparent that plants occupy slight rises in the clay pan surface to remain 'dry' when the clay pan proper is inundated, suggesting that they may not be able to tolerate inundation. It is considered that this susceptibility to water logging is likely to be the key driver influencing the presence/absence of *Atriplex* sp. Yeelirrie Station.

### 3.1.6 Plant root investigations

The investigation of rooting behaviour of the *Atriplex* sp. Yeelirrie Station has shown the majority of root exploration to be limited to the upper clay horizon, with large lateral roots confined to this area. Root structure was generally found to consist of a 20-30 cm vertical root structure extending from the stem, with the larger root structures then extending laterally. Finer roots (< 2 mm diameter) were seen to exploit the underlying calcareous loam in some of the locations investigated, however root extension was not noted to occur into the calcrete layer or below an approximate depth of 1.2 – 1.5 m, and root exploration is considered unlikely to encompass the underlying calcrete formation. With this in mind, sampling and detailed analysis of the soil materials collected during this investigation concentrated on the upper two soil units identified (i.e. clay and calcareous loam). The *Atriplex* sp. Yeelirrie Station can therefore be considered as shallow rooting and heavily reliant on wetting of the surficial soils to abstract sufficient moisture to meet their transpiration requirements. This shallow rooted behaviour also suggests that this species has specialised morphological adaptations that allow it to survive during the long hot summer period.

Investigation of the rooting behaviour of *Atriplex* sp. Yeelirrie Station was also carried out within the rehabilitation site. The behaviour of the roots exposed during excavation at this site was similar to those recorded at the natural sites with a vertical root structure extending down approximately 25 cm into the soil profile with large lateral roots then extending outwards from here. Fine roots continued to explore the deeper profile soil material, which in the case of the rehabilitation site consisted of highly weathered blocky sedimentary material.

<b>Title:</b> Yeelirrie Conservation Species Management Plan		<b>Doc. No.</b> CAM-MP-018
<b>Date Issued:</b> 14 May 2015	<b>Date Revised:</b> 3 September 2015	<b>Rev. No.</b> 4

## 3.2 Management of *Atriplex* sp. Yeelirrie Station

### 3.2.1 Western Genotype

As the Western Population of *Atriplex* sp. Yeelirrie Station lies wholly within the economic orebody minimisation or avoidance of impacts is not possible. Development of the Project will result in the complete removal of this population. To support the removal of the Western Population Cameco propose to both protect the Eastern Population and to re-establish the Western Genotype at a new locations.

### 3.2.2 Protection of the Eastern Genotype

The Eastern Population of *Atriplex* sp. Yeelirrie Station will not be impacted by development activity related to the Project and Cameco proposes permanent protection of the entire Eastern Population. This will be achieved through fencing of the population to exclude livestock from neighbouring pastoral leases. Tenure options including the establishment of a *Conservation Area* will be investigated to determine the best option to ensure long term protection.

### 3.2.3 Re-Establishment of the Western Genotype

In order to preserve the genetic diversity of the Western Population, Cameco proposes to establish new populations of *Atriplex* sp. Yeelirrie Station (Western Genotype only). The results of the preliminary investigations discussed above have supported the development of a list of criteria against which to assess new sites that may be suitable to host new population of *Atriplex* sp. Yeelirrie Station (Western Genotype). These include sites that,

- have land tenure suitable to provide long term conservation;
- have landscape and soil characteristics similar to those of healthy populations within the the Western and Eastern population areas;
- are not subject to inundation;
- do not support species with conservation significance that may be displaced by the introduction of *Atriplex* sp. Yeelirrie Station;
- do not support species that might hybridize with *Atriplex* sp. Yeelirrie Station;
- are not within proximity to the eastern population to result in hybridization;
- are reasonably accessible; and
- are of a suitable size to support a sustaining population.

Using this criteria, suitable land systems across three pastoral leases, Yeelirrie and Altona Stations held by Cameco, and Lake Mason Station which is held by DPaW, were studied and a number of areas within Lake Mason Station were identified for further investigation.

Three field investigations were conducted in 2015 in order to assess potentially suitable translocation sites (Western Botanical, 2015b and Soilwater Consultants, 2015). Four sites were assessed as being moderately suitable as potential new host sites, exhibiting suitable soil and landform characteristics and not supporting other species with conservation significance that might be displaced by the introduction of *Atriplex* sp. Yeelirrie Station. A



<b>Title:</b> Yeelirrie Conservation Species Management Plan		<b>Doc. No.</b> CAM-MP-018
<b>Date Issued:</b> 14 May 2015	<b>Date Revised:</b> 3 September 2015	<b>Rev. No.</b> 4

potential limitation is the size of the four sites. While the suitable areas within the sites wasn't determined, they are smaller than the area of the Western Population. The results indicate that the key soil and landform characteristics do occur away from the natural population areas.

Prior to commencing work on the ground to establish the new population, Cameco would undertake further work to address the following:

1. Conduct further desktop and field work to locate additional new host sites that meet the site selection criteria.
2. Confirm permission and land access arrangements with DPaW as required.
3. Ongoing implementation of activities contributing to a research plan to further understand the species and to support potential translocation.
4. Development of an Interim Recovery Plan, leading to a full Recovery Plan in consultation with DPaW.
5. Development of a Translocation Plan in consultation with DPaW.

### 3.3 Summary

Cameco consider that the investigations conducted so far into aspects of ecological function and habitat of *Atriplex* sp. Yeelirrie Station provide multiple lines of evidence to reasonably support the proposition that a new population of *Atriplex* sp. Yeelirrie Station can be established to replace the population that would be taken by the development of the Project. Establishment of a new population will protect and maintain the genetic diversity observed in the natural populations. In summary, the following work supports this proposition:

- Individual plants hold seed over several seasons. Seed can be readily harvested and stored and will maintain viability for reasonable periods of time.
- Seed is readily able to be germinated and should respond well to direct seeding methods. *Atriplex* species have been cultivated for agricultural applications on a range of soil types and there is a strong body of expertise developed over techniques for successful revegetation from seed.
- As evidenced by the rehabilitation population and soil investigations, the species is able to grow on a range of soil types, including soils that exhibit different salinity and profile characteristics to the soils of the natural populations but there are levels of soil salinity and inundation periods that would restrict successful re-establishment.
- Potential translocation sites with similar soil and landscape characteristics have been assessed and shown to occur at Lake Mason (with some limitations).

Cameco proposes to continue the research work along the lines of previous investigations with the aim of establishing new populations of *Atriplex* sp. Yeelirrie Station (Western Population). The research completed to date and the proposed research for the next three years is summarised in Table 5 below.

**Table 5. *Atriplex* sp. Yeelirrie Station Research**

Task	Status / Description
<b>2014</b>	
Preliminary assessment of the Rehabilitation Population of <i>Atriplex</i> sp. Yeelirrie Station – compared with the population dynamics of the Western Population.	Population census of Rehabilitation Population undertaken, demographic studies commenced, vegetation and soil profiles described (Western Botanical 2014).
Seed germination testing of <i>Atriplex</i> sp. Yeelirrie Station (Western Genotype) - seed collected in 2010.	Seed germination testing undertaken, demonstrated viable and germinable seed present within populations in both 2010 and 2014. Demonstrated short term dormancy which is overcome by removal of the enclosing bracts and/or leaching (Landcare Services 2011, Western Botanical 2015, unpublished data).
<b>2015</b>	
Preliminary assessment of the Rehabilitation Population of <i>Atriplex</i> sp. Yeelirrie Station – compared with the population dynamics of the Western Population.	Demographic studies expanded in March 2015 (Western Botanical 2015c) and further soil profile assessments undertaken in April 2015.
Resolve the taxonomic status of <i>Atriplex</i> sp. Yeelirrie Station.	Part funding was provided to DPaW's Western Australian Herbarium to assist them to undertake a review to define the taxonomy of <i>Atriplex</i> sp. Yeelirrie Station (Eastern and Western Genotype). A paper dealing with the taxonomy of the species has been prepared but remains unpublished at this stage. In summary, the research paper describes - A rare, new, tetraploid <i>Atriplex</i> , restricted to two populations that are approximately 30 km apart in arid Western Australia, is supported as distinct from other known species by morphological and molecular evidence. While the level of genetic differentiation is similar to that previously reported between subspecies in other <i>Atriplex</i> , the new taxon has been described as a single species, although the research paper is currently in draft form and has yet to be peer reviewed (Shepard <i>et al</i> , unpublished)
Establish a statistical framework that can be applied to measure the success of any future translocation program.	Meetings have been held with DPaW and agreement on sampling methodology for the demographic assessment and statistical framework for analysis has been developed. Data from the Western and Eastern Populations of <i>Atriplex</i> sp. Yeelirrie Station has been collected and will be presented for review to confirm the analysis techniques are suitable to use in the future to assess new translocated populations.
Identify possible translocation sites and undertake site analysis and hydrogeological assessment	A field trip to identify potential translocation sites at Lake Mason has been completed and a number of sites identified. Test pits have been dug to assess soil test in comparison to soil types on the Western populations. Western Botanical 2015b, 2015c)

Task	Status / Description
<b>2016</b>	
Undertake an environmental assessment for the introduction of <i>Atriplex</i> sp. Yeelirrie Station into new locations.	This will include a flora survey to determine all current flora at the proposed translocation sites.
Continue to develop Conservation Species Management Plan in consultation with DPaW.	Prepare plan in consultation with DPaW to ensure proposed work for maintaining genetic diversity is sufficient.
Develop Interim Recovery Plan (IRP) in consultation with DPaW	Prepare report and submit for approval.
Develop Trial Translocation Plan (TTP) in consultation with DPaW	Prepare report and submit for approval.
Collect and process seed from the Western Population of <i>Atriplex</i> sp. Yeelirrie Station.	Implement annual seed collecting programme to continue to build stored seed bank from the Western Population. Lodge seed with the Threatened Flora Seed Centre (DPaW).
Undertake seed treatment, germination trials and pot trials. Testing on newly collected seed and stored seed (various ages).	Engage experienced plant nursery to undertake germination trials of seed of various ages and to trial seed treatments prior to the commencement of field trials.
<b>2017</b>	
Collect and process seed from the Western Population.	Implement annual seed collecting programme to continue to build stored seed bank from the Western Population. Lodge seed with the Threatened Flora Seed Centre (DPaW).
Undertake planting in selected and approved translocation trial sites.	Implementation of TTP - undertake trials at proposed translocation sites.
Field visit to trial translocation sites to monitor success.	Undertake a field visit and prepare a brief report summarising the findings and relay results to DPaW.
<b>2018</b>	
Assess and report on the success of the 2017 plantings	Undertake a field visit and prepare a brief report summarising the findings and relay results to DPaW.
Undertake planting in translocation sites	Building on the techniques and experience for the previous year's programme continue to implement the TTP.

#### 4 References

Australia's Virtual Herbarium website (<http://avh.ala.org.au/>) accessed May 2015.

Clarke LJ, Jardine D, Byrne M, Shepherd K, Lowe AJ. 2012. *Significant population genetic structure detected for a new and highly restricted species of Atriplex (Chenopodiaceae) from Western Australia, and implications for conservation management*. Australian Journal of Botany **60**: 32–41.

Department of Parks and Wildlife, Florabase website (<https://florabase.dpaw.wa.gov.au/>) accessed May 2015.

Department of Parks and Wildlife, Nature Conservation Covenant Program (<http://www.dpaw.wa.gov.au/management/off-reserve-conservation/nature-conservation-covenant-program>)

International Union for Conservation of Nature (2012) IUCN Red List Categories and Criteria Version 3.1 Second Edition. (<http://www.iucnredlist.org/>)

Landcare Services (2011) *Atriplex sp. Yeelirrie Station (L. Trotter & A. Douglas LCH25025) Seed Collection Program Report, February 2011*. Consultants report prepared for URS Australia Pty Ltd and BHP Billiton Yeelirrie Development Company Pty Ltd. Report ref LCS693.

Shepherd KA, Thiele KR, Sampson J, Coates D, Byrne M. (unpublished) *Recognition of a rare, new species of Atriplex (Chenopodiaceae) comprising two genetically distinct populations in arid Western Australia: implications for taxonomy and conservation*. (Draft).

Soilwater Consultants (2015). *Atriplex sp. Yeelirrie Station Investigation*. Report for Cameco Australia Pty Ltd, 23 June 2015. CAM-0002-1-2.

Western Botanical (2011) *Flora and Vegetation Survey, Baseline Report, February 2011*. Consultants report to URS Australia Pty Ltd for BHP Billiton Yeelirrie Development Company. Report WB653.

Western Botanical (2014) *Demography Study of Atriplex sp. Yeelirrie Station, August 2014*. Consultants report prepared for Cameco Australia Pty Ltd. Report ref WB836

Western Botanical (2015a) *Addendum to Report WB653: Yeelirrie Project Flora and Vegetation Survey (February 2011) March 2015*. Consultants report prepared for Cameco Australia. Report WB839

Western Botanical (2015b) *Initial Review of Lake Mason for Potential Translocation Sites for Atriplex sp. Yeelirrie Station*. Consultants report prepared for Cameco Australia Pty Ltd. Report ref WB848.

Western Botanical (2015c) *Population & Demography Study (Phase 1) of Atriplex sp. Yeelirrie Station, May 2015*. Consultants report prepared for Cameco Australia Pty Ltd. Report ref WB844.