4. Results

4.1.1 Desktop Assessment

Previous botanical studies

There have been few detailed botanical studies in this region of the Great Sandy Desert. Generally, previous botanical studies have been conducted by biological consulting companies. This includes a second-phase detailed flora and vegetation assessment (360 Environmental 2017), a first-phase Level 2 flora and vegetation assessment (Ecologia 2017), a Level 1 Flora and vegetation assessment (Outback Ecology 2012) and a Traditional Owner flora survey (Desert Wildlife Services 2010). The results of these surveys are summarised below.

Second-Phase Detailed Flora and Vegetation Assessment (360 Environmental 2017)

In 2017, 360 Environmental conducted a Detailed flora and vegetation assessment which formed the second-phase of the Ecologia 2017 survey.

A total of 34 (50 m x 50 m) quadrats and four transects of 3 m x 3 m quadrats (24 quadrats) were established to define the vegetation communities in the study area. The survey included several islands in the Lake and a proposed infrastructure area to the east of the proposed southern infrastructure area. A total of 253 taxa were recorded. Three Priority flora taxa were recorded in the study area: *Tecticornia globulifera* (P1), *Goodenia virgata* (P2) and *Goodenia modesta* (P3).

Single-Phase Level 2 Flora and Vegetation Assessment (Ecologia 2017)

In 2016, Ecologia conducted a single-phase level 2 flora and vegetation assessment. This survey provided preliminary data to inform and support the approval of the Sulphate of Potash project at Lake Mackay for Agrimin.

A total of 31 (50 m x 50 m) quadrats, six transects of 3 m x 3 m quadrats (36 quadrats) were established to enable the vegetation communities to be defined. The survey also comprised two islands on the Lake. A total of 214 taxa were recorded. Four Priority flora taxa were recorded in the study area: *Tecticornia globulifera* (P1), *Goodenia virgata* (P2), *Thysanotus* sp. Desert East of Newman (P2) and *Stackhousia clementii* (P3).

Level 1 Flora and Vegetation Assessment – Lake Mackay Theseus Project (Outback Ecology 2012)

In 2012, Outback Ecology conducted a level 1 flora and vegetation assessment at Lake Mackay.

The survey included nine quadrats and 11 releves which were used to define seven community types. A total of 141 native taxa were recorded. Of these, *Goodenia anfracta* is currently listed as a Priority 1 species.

Traditional Owner Flora Survey, Biological Resources of the Kiwirrkurra Region (Desert Wildlife Services 2010)

A flora survey was also conducted by Desert Wildlife Services in the study area at Lake Mackay. 117 taxa were identified in the survey. Three Priority species were identified, these included *Goodenia virgata* (P2), *Goodenia modesta* (P3) and *Dampiera atriplicina* (P3).

Threatened and Priority flora

A total of 12 Priority flora taxa were identified as potentially occurring in the survey area, based on DBCA database searches (DBCA 2017a; DBCA 2017b), NatureMap (DBCA 2017c), the DEE Protected Matters Search Tool (DEE 2017) and records from previous botanical studies. No Threatened/EPBC listed species were identified in the database searches (Appendix 2 [Figure 6]).

The desktop assessment identified three Priority species as possibly occurring and three species as likely to occur. Seven taxa were considered unlikely to occur based on proximity of previous records and suitable habitat (Table 7). Table 7 shows the Priority flora potentially occurring, based on specific habitat requirements, and distance from the western and southern survey area.

Table 7: Conservation significant flora potentially occurring within the survey area

Species	Conservation status		Description (WAH 2017)	Distance to nearest record	Potential to occur
	EPBC Act	DBCA			
Maireana sp. Patience	-	P1	A small shrub with white flowers. Habitat for this species occurs on red sand, laterite and gully edges.	Unknown	**Unlikely –** Preferred soil type/habitat does not occur within the survey area.
Mitrasacme katjarranka	-	P1	An ephemeral herb, caespitose, to 5 cm. Short vegetative stems, glabrous. Leaves conduplicate, inflorences with few flowers. Small white flowers to 5 mm long. Flowering and fruiting recorded in both May and July. A slender orchid 20–30 cm tall with a single hairy leaf, 10–20 cm long and 5–10 mm wide. Habitat includes the swales of red sand dunes and in red sand over lateritic sandstone (DBCA 2015).	280 km	**Unlikely –** Preferred soil type/habitat does not occur within the survey area.
Philotheca eremicola	-	P1	Shrub, 40 cm high, with congested, glabrous, glossy leaves, narrowly fusiform 2.5mm long. Red skeletal laterite. Rocky slopes in shrubland. Habitat includes crumbling clay loams at the base of hills.	460km	**Unlikely –** Preferred soil type/habitat does not occur within the survey area.
Tecticornia globulifera	-	P1	Perennial shrub reaching 30 -50 cm. Vegetative articles globular to obovoid, not compressed, green or pink to red. Species has been observed flowering from August and forming mature fruits in November. Habitat includes moderately saline flats on red-brown gritty clay associated with other samphire species.	<100 km	**Possible –** Preferred soil type/habitat occurs within the survey area. However, only previously recorded on the lake islands.
Eremophila jamesiorum	-	P2	A tall wispy shrub 150 – 200 cm high. Branches terete, grey, glabrous and glandular papillate. Leaves alternate. Sessile, linear and green. Flowers pink, white to mauve.	400 km	**Unlikely –** Preferred soil type/habitat does not occur within the survey area.
Goodenia virgata	-	P2	Ascending to erect, virgate perennial herb up to 40 cm high. Flowers yellow, flowering in July. Habitat includes red sandy loam, near salt pans.	50 km	**Likely –** Preferred soil type/habitat occurs within the survey area. Previously found near the survey area (Ecologia 2017; 360 Environmental 2017).
Thysanotus sp. Desert East of Newman	-	P2	Self-supporting perennial hern (with tuberous roots), distinguished by the long, equal anthers and pseudo-cymose branching. Purple flowers, flowering from August to October. Habitat for this species occurs on red-brown loamy sand or red sand, sometimes silty. Sand plain, pisolitic buckshot plain.	50 km	**Possible –** Preferred soil type/habitat occurs within the survey area.
Dampiera atriplicina	-	P3	A spreading robust shrub, which grows to 50 cm. It has flat, hairy and dense leaves. Flowers are purple, flowering in May, June and July. It prefers red sand and grows on sand ridges.	<100 km	**Possible –** Preferred soil type/habitat occurs within the survey area.
Eragrostis lanicaulis	-	P3	A knotty or bulbous rhizomatous perennial grass, that grows to 45 – 50 cm. Flowering from March to May or August to October. Habitat for this species occurs on red sandy clay flats.	280 km	**Unlikely –** Preferred soil type/habitat does not occur within the survey area.
Goodenia modesta	-	P3	A herb reaching 50 cm with flat leaves 7-70mm long and 2-10 mm wide with sparse hairs. Flowers yellow, flowering from January to December. Preferred habitat includes red loam, sand.	20 km	**Likely –** Preferred soil type/habitat occurs within the survey area. Previously found near survey area (360 Environmental).

Species	Conservation status		Description (WAH 2017)	Distance to nearest record	Potential to occur
	EPBC Act	DBCA			
Korthalsella leucothrix	-	P3	A arasitic shrub with apex obtuse leaves. Flowers white, flowering in August. Found on *Acacia acuminata* and *Acacia craspedocarpa*.	489 km	**Unlikely –** Preferred soil type/habitat does not occur within the survey area.
Stackhousia clementii	-	P3	A dense, broom-like perennial herb reaching 45 cm. Flowers vary from green, yellow to brown. Preferred habitat includes skeletal soils, sandstone hills.	<1 km	**Likely –** Preferred soil type/habitat occurs within the survey area. Previously found near survey area (Ecologia 2017).

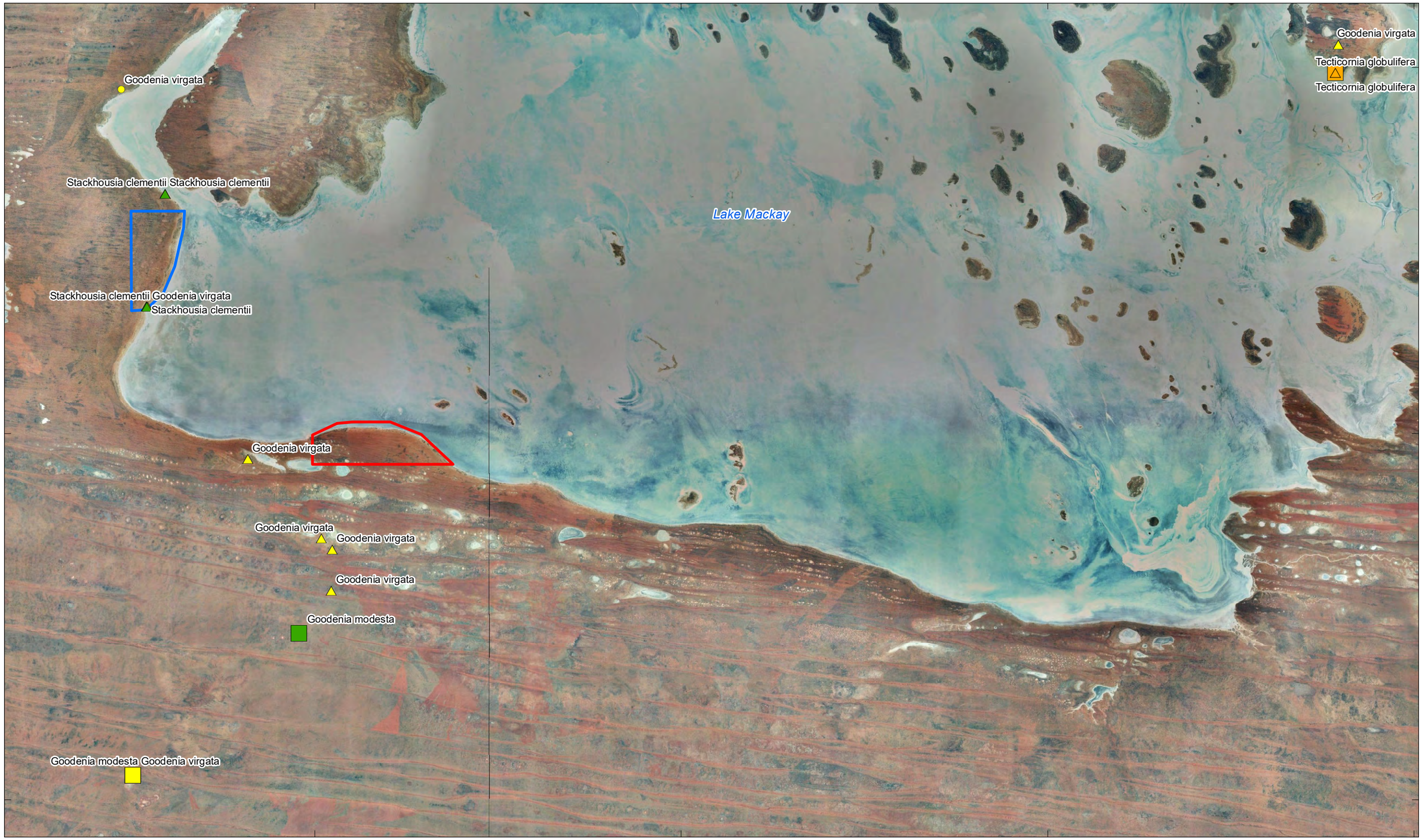

Figure 6: DBCA threatened and priority flora records and previous survey records

Legend

Priority Flora (DBCA, 2017)
- Priority 2

Priority Flora (Ecologia, 2017)
- P1
- P2
- P3

Priority Flora (360 Environmental, 2017)
- P1
- P2
- P3

- Proposed southern infrastructure area
- Proposed western infrastructure area

Scale 1:200,000 at A3

0 2,000 4,000 6,000 m

N

Coordinate System: GDA 1994 MGA Zone 52
Note that positional errors may occur in some areas
Date: 20/12/2017
Author: JCrute
Source: Flora: DBCA 2017, 360 Environmental 2017 & Ecologia 2017.
Path: Q:\Consult\2017\AGI\AGI17481\01_GIS_documents\ArcMap_documents\AGI17481_G013_RevC.mxd

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Threatened and Priority Ecological Communities

No commonwealth or state listed TECs or PECs were identified within 60 km of the study area.

4.1.2 Overview of Flora Survey Results

Native flora

A total of 60 native vascular plant taxa from 42 plant genera and 26 plant families were recorded from quadrats within the western survey area. Most taxa were recorded within the Poaceae (12 taxa) and the Chenopodiaceae (8 taxa) families (Appendix 3). The most diverse genera were *Tecticornia* (Chenopodiaceae) and *Eragrostis* (Poaceae). None of the flora recorded in the survey area were introduced species. The site data sheets are presented in Appendix 4.

Due to poor material, five specimens could only be identified to the genus level. None are considered to represent conservation significant species.

Based on the data collected from 22 quadrats (10 50 m x 50 m quadrats and 6 3 m x 3 m quadrats) a species accumulation curve was generated and is illustrated below in Figure 7. The species accumulation tool routine plots (and lists) the increasing total number of different species observed as sites are successively pooled (Samples [number of species observed in sites] curve in Figure 7). One extrapolator (Chao 2 Mean) was plotted to help predict the true total number of species that would be observed as the number of sites tends to infinity (the asymptote of the species accumulation curve). The asymptotic value was determined using Michealis-Menten modelling (Colwell *et al.* 2004). Using this analysis, the incidence based coverage estimator of species richness was a total of 51 taxa recorded from the quadrat sites (Samples curve), while the Chao 2 Mean extrapolator curve gave an estimated range of 60 taxa. The recorded taxa from quadrat sites represents approximately 85% of the predicted species richness from the western survey area.

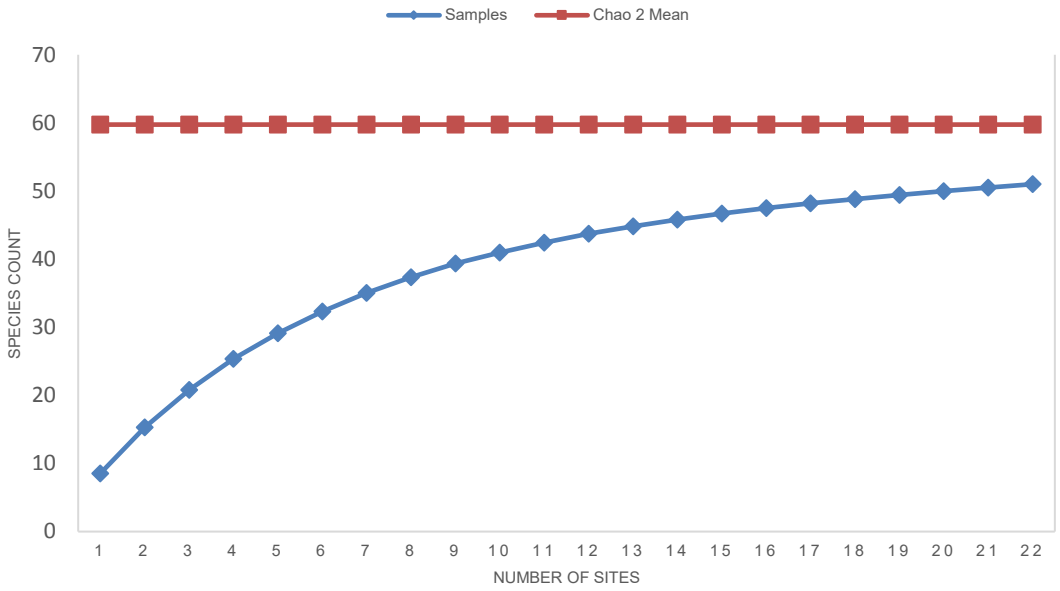

Figure 7: Species accumulation curve and Chao 2 Mean estimated number of species based on all Quadrat data.

Threatened and Priority flora

No Threatened flora species as listed under the EPBC Act or pursuant to the WC Act or Priority listed flora species were recorded within the western or southern survey area at the time of assessment. Targeted searches were undertaken for the potentially occurring Priority flora but none were observed. This may be attributed to the timing of flowering for the species, as the prime flowering period for the region is from May to July (EPA 2016).

Other conservation significant flora

Five specimens collected in the western and southern survey area belong to five unknown and potentially new taxa, designated here as *Tecticornia* aff. *calyptrata* [M. Stone LM01.05], *Tecticornia* aff. *calyptrata* [M. Stone LM01.06], *Tecticornia* aff. *calyptrata* [M. Stone LM02.03], *Tecticornia* aff. *calyptrata* [A. Dalton LM OP.03] and *Tecticornia* aff. *halocnemoides* subsp. *longispicata* [M. Stone LM01.04]. The five specimens of potential new taxa will be submitted to the WAH, at the request of taxonomist specialist, Kelly Shepherd.

The locations of these specimens recorded in the survey area are presented in Figure 8a and Figure 8b.

***Tecticornia* aff. *calyptrata* [M. Stone LM01.05]**

This taxon was recorded from five quadrats (LM01, LM02, LM03, LM10 and LMT0102) in the western survey area (Figure 8a). It was located on orange brown clay soils in the lake margin vegetation dominated by *Scaevola collaris*, *Frankenia cordata* and *Tecticornia* aff. *calyptrata* [M. Stone LM01.06]. Typical associated species included *Lawrencia squamata, Surreya diandra* and *Maireana luehmannii*. It has morphological affinities with *Tecticornia calyptrata*. however, it is distinct from the typical *T. calyptrata* that is known from Wiluna and is more analogous to the Northern Territory form of this species (K. Shepherd, WA Herbarium, pers. comm.).

***Tecticornia* aff. *calyptrata* [M. Stone LM01.06]**

This taxon was recorded from two quadrats (LM01 and LM02) in the western survey area (Figure 8a). It was located on orange brown clay soils in the lake margin vegetation dominated by *Scaevola collaris* and *Frankenia cordata* and *Tecticornia* aff. *calyptrata* [M. Stone LM01.05]. Typical associated species included *Lawrencia squamata* and *Surreya diandra.* It has morphological affinities with *Tecticornia calyptrata* however, it is distinct from the typical *T. calyptrata* that is known from Wiluna and is more analogous to the Northern Territory form of this species (K. Shepherd, WA Herbarium, pers. comm.).

***Tecticornia* aff. *calyptrata* [M. Stone LM02.03]**

This taxon was recorded from five quadrats (LMT0102, LMT0202, LM02, LM03 and LM10) in the western survey area (Figure 8a). It was located on orange brown clay soils in the lake margin vegetation dominated by *Scaevola collaris*, *Stackhousia* sp. Lake Mackay (P.K Latz 12870) and *Lawrencia squamata*. Typical associated species included *Surreya diandra* and *Eragrostis falcata*. It has morphological affinities with *Tecticornia calyptrata*, however, it is distinct from the typical *T. calyptrata* that is known from Wiluna and is more analogous to the Northern Territory form of this species (K. Shepherd, WA Herbarium, pers. comm.).

***Tecticornia* aff. *calyptrata* [A. Dalton LM OP.03]**

This taxon was recorded from one location in the southern survey area (Figure 8b). It was located on orange brown clay soils in the lake margin vegetation dominated by *Scaevola collaris* and *Frankenia cordata*. Typical associated species included *Lawrencia squamata* and *Surreya diandra* and mixed *Tecticornia* spp. It has morphological affinities with *Tecticornia calyptrata*, however, it is distinct from the typical *T. calyptrata* that is known from Wiluna and is analogous to the Northern Territory form of this species (K. Shepherd, WA Herbarium, pers. comm.).

***Tecticornia* aff. *halocnemoides* subsp. *longispicata* [M. Stone LM01.04]**

This taxon was recorded from five quadrats (LM01, LM03, LM10, LMT0101, LMT0201) in the western survey area (Figure 8a). It was located on orange brown clay soils in the lake margin vegetation dominated by *Scaevola collaris* and *Frankenia cordata*. Typical associated species included *Lawrencia squamata, Surreya diandra* and *Tecticornia halocnemoides* subsp. *longispicata*. It has morphological affinities with *Tecticornia halocnemoides* subsp. *Longispicata*, however, it is distinct from the typical *T. halocnemoides* subsp. *longispicata* as the vegetative articles and floral bracts are much narrower than the typical form of the species (K. Shepherd, WA Herbarium, pers. comm.).

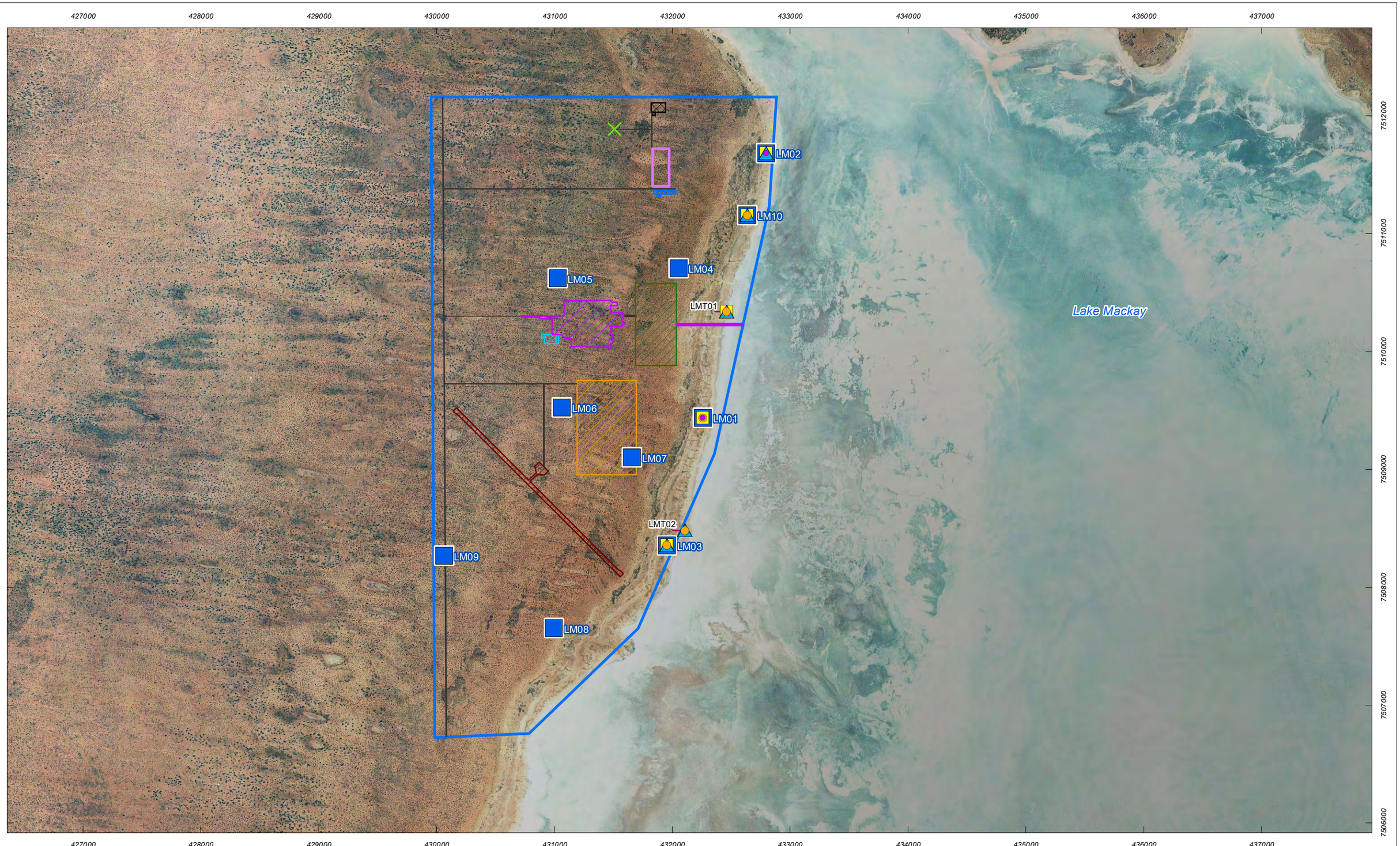

Figure 8a: Conservation significant flora recorded in the western proposed infrastructure area

Scale 1:30,000 at A3

0 500 1,000 1,500 m

Coordinate System: GDA 1994 MGA Zone 52
Note that positional errors may occur in some areas
Date: 21/12/2017
Author: JCrute
Source: Survey area: AGI 11/2017.
Path: Q:\Consult\2017\AGI\AGI17481\01_GIS_documents\ArcMap_documents\AGI17481_G015_RevC.mxd

Legend

Species

- *Tecticornia* aff. *calyptrata* [M. Stone LM01.06]
- *Tecticornia* aff. *halocnemoides* subsp. *longispicata* [M. Stone LM01.04]
- *Tecticornia* aff. *calyptrata* [M. Stone LM02.03]
- *Tecticornia* aff. *calyptrata* [M. Stone LM01.05]

- Quadrat
- Transect

Mine design

- Communications tower
- Camp
- Processing plant
- Causeway link to on-lake infrastructure
- Airstrip
- Road
- Solar heating system
- Stockpile
- Truck facilities
- Vehicle facilities
- Wastewater treatment plant
- Proposed western infrastructure area

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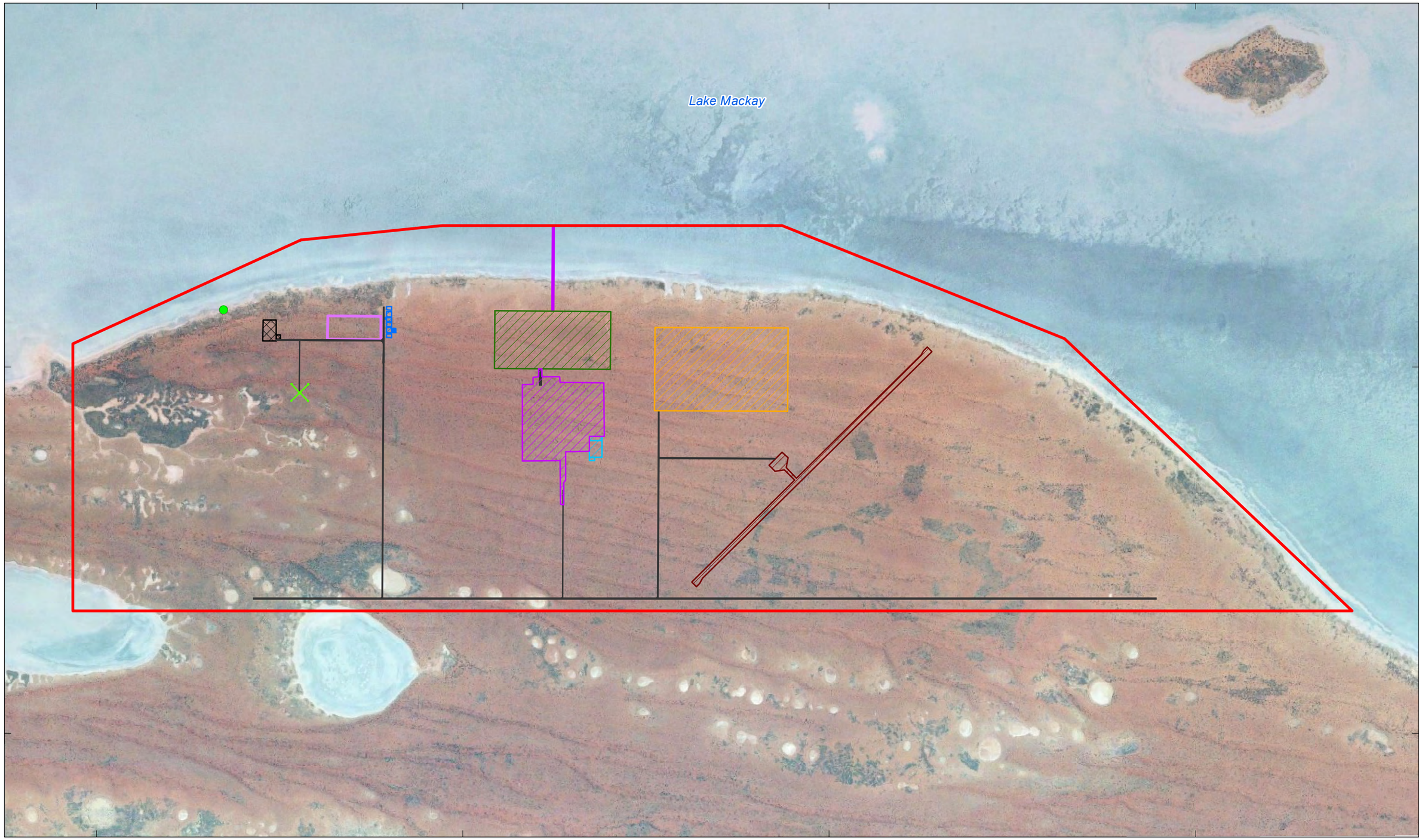

Figure 8b: Conservation significant flora recorded in the southern proposed infrastructure area

Scale 1:22,000 at A3

0 220 440 660 880 m

Coordinate System: GDA 1994 MGA Zone 52
Note that positional errors may occur in some areas
Date: 20/12/2017
Author: JCrute
Source: Survey area: AGI 11/2017.
Path: Q:\Consult\2017\AGI\AGI17481\01_GIS_documents\ArcMap_documents\AGI17481_G016_RevB.mxd

Legend

Species

- *Tecticornia* aff. *calyptrata* [A. Dalton LMOP.03]

- Proposed southern infrastructure area

Mine layout

- Airstrip
- Camp
- Causeway link to on-lake infrastructure
- Communications tower
- Processing plant
- Road
- Solar heating system
- Stockpile
- Truck facilities
- Vehicle facilities
- Wastewater treatment plant

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