TECHNICAL MEMORANDUM
Flora and Vegetation Assessment
Windarling Wastewater Treatment Plant

PROJECT NUMBER	EP22-058(02)	**DOC. NUMBER**	EP22-058(02)--004 SCM
PROJECT NAME	Windarling Wastewater Treatment Plant	**CLIENT**	Mineral Resources Limited
AUTHOR	SCM	**REVIEWER**	TAA
VERSION	1	**DATE**	28/04/2023

1. INTRODUCTION

1.1. Project background

Emerge Associates (Emerge) were engaged by Mineral Resources Limited to undertake a flora and vegetation assessment within the Windarling Wastewater Treatment Plant (WWTP) effluent disposal areas (spray fields) and adjacent remnant vegetation (herein referred to as the 'site').

The site is located approximately 89 kilometres (km) north-west of the townsite of Koolyanobbing within the Shire of Yilgarn. The site extends over approximately 23.41 ha and is bounded by remnant vegetation to the west, north, north-west and south-east, and the Windarling Village mine camp to the north-east. The location of the site is shown in **Figure 1**.

1.2. Purpose and scope of work

The flora and vegetation assessment is required to support a clearing permit application for the ongoing operation of the Windarling WWTP. Specifically, the scope of work was to provide sufficient detail on the flora and vegetation values within the site to inform the application process.

As part of the scope of work the following tasks were completed:

- Desktop review of relevant background information pertaining to the site and surrounds, including database searches for conservation significant flora species and ecological communities.
- A field survey to record a comprehensive list of flora species and assess vegetation type and condition.
- Identification of potential habitat for conservation significant flora and vegetation and an assessment of likelihood of occurrence.
- Documentation of the desktop assessment, methodology, field survey and results into a report.

2. METHODS

2.1. Desktop assessment

A search was conducted for threatened and priority flora that may occur or have been recorded within a 50 km radius of the site using the *Protected Matters Search Tool* (DAWE 2022), *NatureMap* (DBCA 2022) and DBCA's threatened and priority flora database (reference no. 20-0622FL).

A search was also conducted for threatened ecological communities (TECs) and priority ecological communities (PECs) that may occur or have been recorded within a 50 km radius of the site using the *Protected Matters Search Tool* (DAWE 2022) and DBCA's threatened and priority ecological communities database (reference no. 08-0622EC).

Prior to undertaking the field survey, information on the habitat preferences of threatened and priority flora species and communities identified from database searches was reviewed. This was compared to existing environmental information available for the site, such as geomorphology, soils, regional vegetation and historical aerial imagery (WALIA 2023) to identify species and communities for which habitat may occur in the site.

2.2. Field survey

Two botanists from Emerge visited the site on 1 October 2022 to conduct the flora and vegetation field survey. During the survey the site was traversed on foot and the composition of vegetation was recorded. Photographs were taken throughout the field visit to show particular site conditions.

Plant specimens collected during the field survey were dried, pressed and named in accordance with requirements of the Western Australian Herbarium (2023). Identification of specimens occurred through comparison with named material and through the use of taxonomic keys. Flora species not native to Western Australia are denoted by an asterisk ('*') in text and raw data.

2.2.1. Sampling

Sampling of the vegetation was undertaken using non-permanent quadrats. The position of each sample was recorded with a hand-held GPS unit. The data recorded within each quadrat included:

- site details (site name, site number, observers, date, location)
- environmental information (slope, aspect, bare-ground, rock outcropping soil type and colour class, litter layer, topographical position time since last fire event)
- biological information (vegetation structure and condition, degree of disturbance and species present).

A total of eight locations were sampled, comprised of 5 x 5 m quadrats, as shown in **Figure 2**.

Additionally, plant taxa not observed within samples were recorded opportunistically as the botanists traversed the site.

2.2.2. Targeted searches

The suitability of habitat within the site for conservation significant flora and ecological communities was assessed (refer **Section 2.1**). Areas of suitable habitat were traversed along transects and searched for conservation significant species, as required.

2.2.3. Vegetation condition

Vegetation condition was assigned at each sample and changes in vegetation condition were also noted and mapped across the site. The condition of vegetation was assessed using the Keighery (1994) scale (**Table 1**).

Table 1: Vegetation condition scale applied during the field assessment

Condition category	Definition (Keighery 1994)
Pristine	Pristine or nearly so, no obvious signs of disturbance.
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.
Very good	Vegetation structure altered obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.
Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
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 or shrubs.

2.3. Mapping and analysis

2.3.1. Conservation significant flora and communities

Based on the database searches and information recorded during the field survey, an assessment of the likelihood of occurrence of threatened and priority flora species and communities within the site was undertaken using the categories outlined in **Table 2**.

Table 2: Likelihood of occurrence assessment categories and definitions

Likelihood	Definition
Recorded	The species was recorded during the current field survey.
Likely	The site contains suitable habitat for the species and it is likely the species may occur based on presence of a recent historical record within or close to the site.
Possible	The site contains suitable habitat for the species but there is no other information to suggest that the species may occur within or close to the site.
Unlikely	The site does not contain suitable habitat for the species or the site contains suitable habitat for the species within which thorough targeted searches were completed and conclusion has been made that the species is unlikely to be present.

2.3.2. Plant community and vegetation condition determination

The plant communities within the site were identified from the data collected during the field survey. The vegetation was described according to the dominant species present using the structural formation descriptions of the *National Vegetation Inventory System* (NVIS) (NVIS Technical Working Group 2017). The identified plant communities were mapped on aerial photography during the field survey and boundaries were interpreted from aerial photography and notes taken in the field. Vegetation condition was mapped on aerial photography based on notes recorded during the field survey to define areas with differing condition.

2.3.3. Threatened and priority ecological communities

Areas of native vegetation potentially representing a TEC or PEC were assessed against key diagnostic characteristics and thresholds relating to size and/or vegetation condition thresholds.

3. RESULTS AND DISCUSSION

3.1. General

The north-eastern portion of the site supports a wastewater treatment plant, including an open evaporation pond and storage tanks. Two roads, one running east-west and the other extending to the north in the central portion of the site are present. A review of historical aerial imagery shows that the wastewater plant was constructed between 2001 and 2012, whilst the roads were constructed between 2001 and 2007 (WALIA 2023). The remainder of the site supports remnant vegetation.

3.2. Flora

3.2.1. Desktop assessment

The database search results identified a total of 19 threatened and 61 priority flora species occurring or potentially occurring within a 50 km radius of the site. Information on these species including their habitat preferences and flowering period is provided in **Appendix A**.

Based on background information available for the site, suitable habitat was considered to potentially occur within the site for three threatened and 14 priority flora species as shown in **Table 3**.

Table 3: Conservation significant flora species considered to have potential to occur in the site based on known habitat preferences

Species	Level of significance		Life strategy	Habitat	Flowering period
	State	EPBC Act			
Seringia exastia	-	CR	P	Pindan (red soil) heathland on flat land with Triodia sp. and scattered trees.	Apr-Dec
Eremophila viscida	EN	EN	P	Granitic soils, sandy loam. Stony gullies, sandplains.	Sep-Nov
Acacia adinophylla	P1	-	P	Stony loamy or sandy soils, clay. Ironstone ridges, undulating plains.	Sep-Nov
Hemigenia dulcis	P1	-	P	Sandy orange to brown soil.	Apr, Oct
Hysterobaeckea ochropetala subsp. *ochropetala*	P1	-	P	Orange brown gravelly sandy loam, yellow/brown clay loam. Sandy flats and slopes.	Sep-Nov
Goodenia jaurdiensis	P2	-	P	Red clayey loam with laterite or banded ironstone gravel or quartz pebbles. Low-lying plains and lower slopes.	Sep-Oct
Alyxia tetanifolia	P3	-	P	Sandy clay, loam, concretionary gravel. Drainage lines, near lakes.	May-Nov

Table 3: Conservation significant flora species considered to have potential to occur in the site based on known habitat preferences (continued)

Species	Level of significance		Life strategy	Habitat	Flowering period
	State	EPBC Act			
Austrostipa blackii	P3	-	P	Red/red-brown silty sand, sandy clay loam, sometimes with fine sandy gravel. Winter wet depression, rocky banded ironstone formation ridges, hillside (basalt), rangeland.	Sep-Nov
Calotis sp. Perrinvale Station (R.J. Cranfield 7096)	P3	-	A	Red clay loam or sand.	Unknown
Cyathostemon verrucosus	P3	-	P	Yellow sand, yellow sandy clay or yellow loamy sand. Yellow sandplain.	Mar-Apr, Jul-Dec
Hibbertia lepidocalyx subsp. *tuberculata*	P3	-	P	Yellow-orange/red loam, yellow sandy soils, ironstone gravel.	Unknown
Lepidium genistoides	P3	-	P	Sandy loam.	Sep-Oct
Phlegmatospermum eremaeum	P3	-	A	Stony loam.	Jun or Aug to Oct
Rinzia triplex	P3	-	P	Yellow to red, often gravelly or lateritic soils. Sandy plains.	Jun-Sep
Eremophila caerulea subsp. *merrallii*	P4	-	P	Sand, clay or loam. Undulating plains.	Oct-Dec
Eucalyptus formanii subsp. *formanii*	P4	-	P	Red sandy loam, sometimes with ironstone	Dec or Jan-Apr

CR=critically endangered, EN=endangered, P1-P4=priority 1-priority 4, a=annual, p=perennial

3.2.2. Species inventory

A total of 96 native and six non-native (weed) flora species were recorded within the site during the field survey, representing 34 families and 69 genera. The dominant families containing native taxa were Asteraceae (18 native and two non-native taxa) and Chenopodiaceae (12 native taxa). The most common genus was *Acacia* with nine species.

A species list is provided in **Appendix B**.

3.2.3. Threatened and priority flora

No threatened or priority flora were recorded in the site.

The habitat within the site is not considered specifically suitable for any of the threatened or priority flora species identified in the desktop assessment. As none of these species were recorded during the field survey they are not considered to occur.

An assessment of the likelihood of occurrence of conservation significant species is provided in **Appendix A**.

3.3. Vegetation

3.3.1. Desktop assessment

The database search results identified seven PECs and no TECs occurring or potentially occurring within a 50 km radius of the site. Information on these communities is provided in **Appendix C**.

Based on geomorphology, soils and regional vegetation patterns, none of the PECs were considered to have potential to occur in the site.

3.3.2. Plant communities

Four plant communities **AaLdSa**, **EcEooSaa**, **EcEtEb** and **EooAa** were recorded within the site, in addition to areas cleared of vegetation.

The **EooAa** plant community is located within the western portion of the site, whilst the **EcEooSaa** community is located within the eastern portion. Plant communities **AaLdSa** and **EcEtEb** were located within the spray fields within the central portion. These plant communities had higher understorey cover than the surrounding remnant vegetation. The remainder of the site has been cleared of native vegetation for roads and WWTP infrastructure.

A description and the area of each plant community is provided in **Table 4** and representative photographs of each are provided in **Plate 1** to **Plate 4**. The location of each plant community is shown in **Figure 2**. Raw sample data is provided in **Appendix D**.

Table 4: Plant communities present within the site

Plant community	Description	Area (ha)
AaLdSa	Tall shrubland to open shrubland of *Acacia aneura* over chenopod shrubland of *Enchylaena tomentosa* over forbland of *Erodium cygnorum*, **Lepidium didymum* and **Sagina apetala* and grassland of *Lachnagrostis filiformis* (**Plate 1**).	1.83
EcEooSaa	Woodland of *Eucalyptus concinna* and *Eucalyptus oleosa* subsp. *oleosa* over sparse shrubland of *Senna artemisioides* subsp. *×artemisioides* over low open shrubland of *Ptilotus obovatus* and *Roepera eremaea* with climber of *Vincetoxicum lineare* (**Plate 2**).	8.04
EcEtEb	Woodland of *Eucalyptus concinna* over chenopod shrubland of *Rhagodia drummondii* and *Enchylaena tomentosa* over forbland of **Erigeron bonariensis*, **Sagina apetala* and **Sonchus oleraceus* and isolated clumps of *Austrostipa elegantissima* (**Plate 3**).	0.77
EooAa	Open woodland of *Eucalyptus oleosa* subsp. *oleosa* over tall shrubland of *Acacia aneura* over *forbland* of *Dianella revoluta* over isolated grasses *Amphipogon caricinus* var. *caricinus* (**Plate 4**).	11.68

^the remainder of the site (1.09 ha) supports unsealed roads and the wastewater treatment plant which are cleared of vegetation

*Plate 1: Plant community **AaLdSa** in 'very good' condition*

*Plate 2: Plant community **EcEooSaa** in 'excellent' condition*

*Plate 3: Plant community **EcEtEb** in 'very good' condition*

Plate 4: Non-native vegetation in 'completely degraded' condition

3.3.3. Vegetation condition

Vegetation condition within the site ranged from 'excellent' to 'very good' as detailed in **Table 5** and shown in **Figure 3**.

The structure of **AaLdSa** and **EcEtEb** plant communities has been influenced by the application of wastewater effluent, with higher understorey cover and weed cover than surrounding adjacent remnant vegetation. For this reason, these communities were determined to occur in very good rather than excellent condition.

Table 5: Vegetation condition categories within the site

Condition category (Keighery (1994))	Size (ha)
Pristine	0
Excellent	19.72
Very good	2.6
Good	0
Good - degraded	0
Degraded	0
Completely degraded	1.09

3.3.4. Threatened and priority ecological communities

No threatened or priority ecological communities were identified within the site.

4. CONCLUSIONS

4.1. Flora

A total of 82 native and six weed species were recorded within the site. No threatened or priority flora species were recorded. None of the threatened or priority flora species identified in the desktop assessment are considered to occur within the site due to a lack of suitable habitat and because they were not recorded during the field survey.

4.2. Vegetation

Four native plant communities were identified:

- **AaLdSa** and **EcEtEb** occur within the spray fields within the central portions of the site, and are in 'very good' condition, due to increased weed cover.
- **EooAa** occurs within the western portion of the site in 'excellent' condition.
- EcEooSaa occurs within the eastern portion of the site in 'excellent' condition.
- The remainder of the site comprise tracks cleared of native vegetation in 'completely degraded' condition.

The plant communities do not represent any TECs or PECs.

5. REFERENCES

[redacted]

5.2. Online references

The online resources that have been utilised in the preparation of this report are referenced in **Section 5.1**, with access date information provided in **Table R1**.

Table R1: Access dates for online references

Reference	Date accessed	Website or dataset name
DAWE (2022)	7 June 2022	Protected Matters Search Tool
DBCA (2022)	8 June 2022	NatureMap
WALIA (2023)	5 February 2023	Landgate Map Viewer

Figures

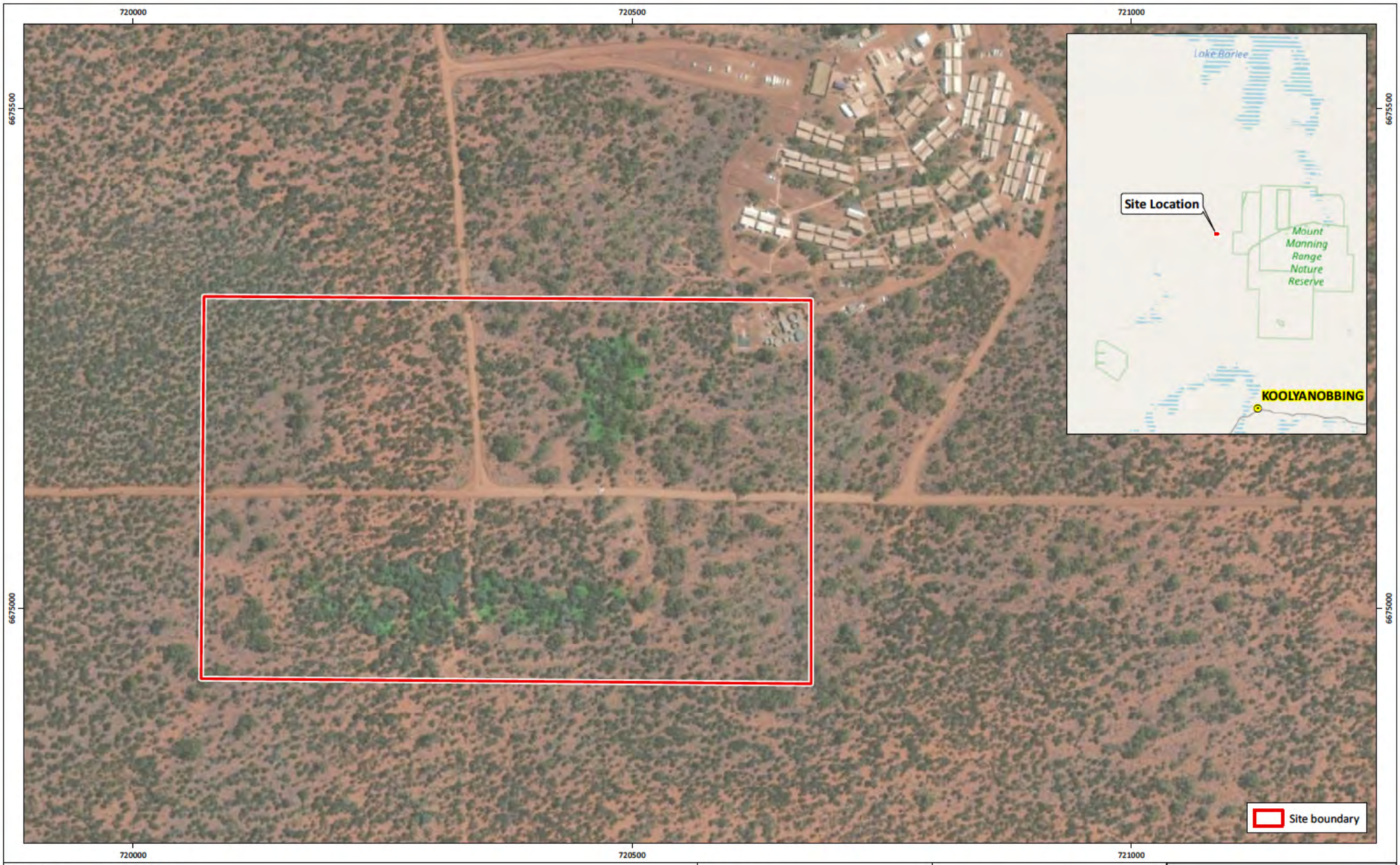

Figure 1: Site Location

Project: Flora and Vegetation Assessment
Windarling Wastewater Treatment Plant
Client: Mineral Resources Limited

Plan Number:
EP22-058(02)–F17
Drawn: SCM
Date: 27/04/2023
Checked: SCM
Approved: TAA
Date: 22/05/2023

N

0 50 100 150
Metres
Scale: 1:5,000@A4
GDA 1994 MGA Zone 50

emerge ASSOCIATES

Figure 2: Plant Communities

Project: Flora and Vegetation Assessment
Windarling Wastewater Treatment Plant
Client: Mineral Resources Limited

Plan Number:
EP22-058(02)–F18

Drawn:	SCM
Date:	27/04/2023
Checked:	SCM
Approved:	TAA
Date:	22/05/2023

N

0 50 100
Metres

Scale: 1:3,500@A4

GDA 1994 MGA Zone 50

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Figure 3: Vegetation Condition

Project: Flora and Vegetation Assessment
Windarling Wastewater Treatment Plant
Client: Mineral Resources Limited

Plan Number:
EP22-058(02)–F19
Drawn: SCM
Date: 27/04/2023
Checked: SCM
Approved: TAA
Date: 22/05/2023

N

0 50 100
Metres
Scale: 1:3,500@A4
GDA 1994 MGA Zone 50

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Appendix A

Conservation Significant Flora Species and Likelihood of Occurrence Assessment

Species name	Level of significance		Life strategy	Habitat	Flowering period	Likelihood of occurrence
	WA	EPBC Act				
Dasymalla axillaris	CR	CR	P	Sandy soils.	Jul-Dec	Unlikely
Leucopogon spectabilis	CR	CR	P	Shallow red-brown loam, ironstone. In rock crevices on exposed ridges.	Sep-Oct	Unlikely
Tetratheca paynterae subsp. *paynterae*	CR	EN	P	Brown clay loam, silty sandy or clayey loam, ironstone, jasperite. Mid-upper slopes, rock crevices, ridges and cliffs.	Unknown	Unlikely
Seringia exastia	-	CR	P	Pindan (red soil) heathland on flat land with Triodia sp. and scattered trees.	Apr-Dec	Unlikely
Eremophila viscida	EN	EN	P	Granitic soils, sandy loam. Stony gullies, sandplains.	Sep-Nov	Unlikely
Eucalyptus brevipes	EN	EN	P	White or yellow sand, sandy loam. Granite outcrops.	Oct	Unlikely
Melaleuca sciotostyla	EN	EN	P	Orange clayey sand with lateritic pebbles. Scree slopes.	Aug	Unlikely
Myriophyllum lapidicola	EN	EN	A	Waterholes on granite outcrops.	Sep	Unlikely
Ricinocarpos brevis	EN	EN	P	Rocky hillslopes, rock outcrops.	Jun-Jul	Unlikely
Roycea pycnophylloides	VU	EN	P	Sandy soils, clay. Saline flats.	Sep	Unlikely
Tetratheca paynterae subsp. *cremnobata*	VU	EN	P	Shallow red-brown loam, clayey silt, ironstone. Outcrops, ridges, breakaways, rocky slopes.	Jun	Unlikely
Tetratheca paynterae	-	EN	P	Brown clay loam, silty sandy or clayey loam, ironstone, jasperite. Mid-upper slopes, rock crevices, ridges, cliffs, breakaways.	Apr-Nov	Unlikely
Eucalyptus crucis subsp. *crucis*	EN	VU	P	Sand, loam. Granite outcrops.	Oct-Dec or Jan-Mar	Unlikely
Tetratheca aphylla subsp. *aphylla*	VU	VU	P	Red-brown loam, sandy loam, banded ironstone. Crevices in cliffs and outcrops, slopes, valleys, ridges.	Sep-Oct	Unlikely
Tetratheca harperi	VU	VU	P	Stony loam. Rocky outcrops, rock crevices.	May or Sep-Nov	Unlikely
Tetratheca aphylla	-	VU	P	Yellow sand, red to brown loams, yellow clay loam, gravel, banded ironstone, laterite. Slopes, valleys, ridges, rock outcrops, cliffs.	Sep-Oct	Unlikely
Acacia adinophylla	P1	-	P	Stony loamy or sandy soils, clay. Ironstone ridges, undulating plains.	Sep-Nov	Unlikely

Species name	Level of significance		Life strategy	Habitat	Flowering period	Likelihood of occurrence
	WA	EPBC Act				
Baeckea sp. Helena and Aurora Range (G.J. Keighery 4424)	P1	-	P	Well-drained, deep yellow sand. Moderately exposed flat plains.	Dec	Unlikely
Balaustion unguiculatum	P1	-	P	Granite outcrops.	Sep-Oct	Unlikely
Beyeria rostellata	P1	-	P	Skeletal red sandy to clay soils over baned ironstone substrates.	May-Sep	Unlikely
Calothamnus superbus	P1	-	P	Yellow/brown sand with pebbles. Sandplains.	Jul	Unlikely
Chamelaucium sp. Koolyanobbing (V. Clarke 644)	P1	-	P	Pale yellow sand soil. Sandplain	Oct	Unlikely
Eremophila hamulata	P1	-	P	Brown, clay loam on the margins of granite rocks. Brownish red, ironstone soils in creek lines. Sandy soils.	Aug-Oct	Unlikely
Hemigenia dulcis	P1	-	P	Sandy orange to brown soil.	Apr, Oct	Unlikely
Hysterobaeckea ochropetala subsp. *ochropetala*	P1	-	P	Orange brown gravelly sandy loam, yellow/brown clay loam. Sandy flats and slopes.	Sep-Nov	Unlikely
Jacksonia jackson	P1	-	P	Stony loam, clay, ironstone gravel. Hill.	Jul-Sep	Unlikely
Lepidosperma jacksonense	P1	-	P	Silty, sandy loam with chert outcrops. Mod-slopes.	?Apr-May	Unlikely
Persoonia leucopogon	P1	-	P	Yellow sand or sandy clay.	Oct-Dec	Unlikely
Pterostylis xerampelina	P1	-	P	Granite or ironstone outcrops.	Sep (limited information)	Unlikely
Verticordia elizabethiae	P1	-	-	Flats surrounding salt lakes.	Oct-Dec	Unlikely
Acacia ascendens	P2	-	P	Weathered granite. Scree slopes of granite breakaways.	Jun-Sep	Unlikely
Brachysola halganiacea	P2	-	P	Deep yellow sands. Flats	Oct	Unlikely
Comesperma rhadinocarpum	P2	-	P	Sandy soils.	Oct-Nov	Unlikely
Goodenia jaurdiensis	P2	-	P	Red clayey loam with laterite or banded ironstone gravel or quartz pebbles. Low-lying plains and lower slopes.	Sep-Oct	Unlikely
Hakea rigida	P2	-	P	Sandy soils, yellow sand.	Sep-Oct	Unlikely
Malleostemon sp. Adelong (G.J. Keighery 11825)	P2	-	P	Red sand.	Oct	Unlikely

Species name	Level of significance		Life strategy	Habitat	Flowering period	Likelihood of occurrence
	WA	EPBC Act				
Thysanotus sp. Yellowdine (A.S. George 6040)	P2	-	A/P	Yellow sand.	Nov-Dec	Unlikely
Acacia cylindrica	P3	-	P	Yellow/brown sand, gravelly soils. Undulating plains, flats.	Aug-Oct	Unlikely
Acacia formidabilis	P3	-	P	Yellow or red/brown sand. Undulating plains, hillsides.	Aug-Sep	Unlikely
Alyxia tetanifolia	P3	-	P	Sandy clay, loam, concretionary gravel. Drainage lines, near lakes.	May-Nov	Unlikely
Austrostipa blackii	P3	-	P	Red/red-brown silty sand, sandy clay loam, sometimes with fine sandy gravel. Winter wet depression, rocky banded ironstone formation ridges, hillside (basalt), rangeland.	Sep-Nov	Unlikely
Banksia lullfitzii	P3	-	P	Yellow sand. Sandplains.	Mar-May	Unlikely
Bossiaea sp. Jackson Range (G. Cockerton & S. McNee LCS 13614)	P3	-	P	White/grey sandy loam. Duricrust outcrop.	Mar	Unlikely
Calotis sp. Perrinvale Station (R.J. Cranfield 7096*)*	P3	-	A	Red clay loam or sand.	Unknown	Unlikely
Calytrix creswellii	P3	-	P	Yellow sand, sometimes with lateritic gravel. Sandplains.	Sep-Dec	Unlikely
Cyathostemon verrucosus	P3	-	P	Yellow sand, yellow sandy clay or yellow loamy sand. Yellow sandplain.	Mar-Apr, Jul-Dec	Unlikely
Drosera eremaea	P3	-	A/P	Banded ironstone formation scree. Red orange loamy sand with extensive outcropping. Granite outcrops.	Aug-Sep	Unlikely
Euryomyrtus recurva	P3	-	P	Yellow/red sand, brown/yellow sandy clay. Gravel pits, catchment slopes.	Jul-Sep	Unlikely
Grevillea georgeana	P3	-	P	Stony loam/clay. Ironstone hilltops & slopes.	Jan or Mar or Sep-Nov	Unlikely
Hibbertia lepidocalyx subsp. *tuberculata*	P3	-	P	Yellow-orange/red loam, yellow sandy soils, ironstone gravel.	Unknown	Unlikely
Homalocalyx grandiflorus	P3	-	P	Yellow sand. Sandplains.	Oct-Dec.	Unlikely
Hydrocotyle eichleri	P3	-	A	sandy loam soils surrounding the margins of inland salt lakes and saline pans.	?Sep	Unlikely

Species name	Level of significance		Life strategy	Habitat	Flowering period	Likelihood of occurrence
	WA	EPBC Act				
Hysterobaeckea cornuta	P3	-	P	Yellow sand, often with lateritic gravel. Sandplains.	Oct-Dec	Unlikely
Labichea eremaea	P3	-	P	Red sand.	Aug-Sep	Unlikely
Lepidium genistoides	P3	-	P	Sandy loam.	Sep-Oct	Unlikely
Lepidosperma ferricola	P3	-	P	Well-drained stony loam, silty clay, banded ironstone. On rocky ledges, scree slopes, crevices and ravines.	Unknown	Unlikely
Lepidosperma sp. Pigeon Rocks (H. Pringle 30237)	P3	-	P	Dry, orange sand, granite loam. Granite hills.	Oct	Unlikely
Leptospermum macgillivrayi	P3	-	P	Loam. Decaying granite outcrops.	Aug-Sep	Unlikely
Leucopogon sp. Yanneymooning (F. Mollemans 3797)	P3	-	P	White-grey sandy clay, brown gritty loam over granite, skeletal soils. Tops of valleys, hills and breakaways.	May	Unlikely
Melichrus sp. Bungalbin Hill (F.H. & M.P. Mollemans 3069)	P3	-	P	Dry, yellow-orange or white sand. Flat sandplain.	Apr-Sep	Unlikely
Mirbelia ferricola	P3	-	P	Red sandy clay loam to brown sandy loam on banded ironstone formation outcropping. Banded ironstone formation mid slope to crest. Sometimes near or in drainage line.	Jun, Aug-Nov	Unlikely
Neurachne annularis	P3	-	P	Shallow red-brown sandy loam, yellowish-red loam, sometimes with ironstone gravel or stones. Among rocks on tops, sides and bases of banded ironstone ranges.	Sep-Oct	Unlikely
Notisia intonsa	P3	-	A	Clay soils. Flood plain, depressions.	Sep	Unlikely
Philotheca coateana	P3	-	P	Red sand.	Aug-Sep	Unlikely
Philotheca deserti subsp. *brevifolia*	P3	-	P	Red sandy clay.	Sep	Unlikely
Phlegmatospermum eremaeum	P3	-	A	Stony loam.	Jun or Aug to Oct	Unlikely
Pityrodia scabra subsp. *dendrotricha*	P3	-	P	Brown sand over gravel or deep yellow sand near gypsum dunes.	Jul	Unlikely
Rinzia triplex	P3	-	P	Yellow to red, often gravelly or lateritic soils. Sandy plains.	Jun-Sep	Unlikely

Species name	Level of significance		Life strategy	Habitat	Flowering period	Likelihood of occurrence
	WA	EPBC Act				
Stenanthemum newbeyi	P3	-	P	Clayey sand, clay or loam over laterite or ironstone. Hillslopes.	Aug-Sep or Dec or Jan	Unlikely
Stylidium choreanthum	P3	-	P	White/yellow or red sand. Plains.	Sep-Nov	Unlikely
Styphelia saxicola	P3	-	P	Red brown loamy clay, light brown clay, orange sandy clay loam. Granite rocks with occasional quartz ground cover, rocky laterised ironstone breakaway.	Apr-May, Jul-Sep	Unlikely
Verticordia mitodes	P3	-	P	Yellow sand. Undulating plains.	Oct-Jan	Unlikely
Banksia arborea	P4	-	P	Stony loam. Ironstone hills.	Mar-May	Unlikely
Eremophila caerulea subsp. *merrallii*	P4	-	P	Sand, clay or loam. Undulating plains.	Oct-Dec	Unlikely
Eucalyptus formanii subsp. *formanii*	P4	-	P	Red sandy loam, sometimes with ironstone	Dec or Jan-Apr	Unlikely
Grevillea erectiloba	P4	-	P	Gravelly loam. Lateritic ridges.	Sep-Oct	Unlikely
Sowerbaea multicaulis	P4	-	P	Yellow-brown sand.	Oct-Dec or	Unlikely

Note: T=threatened, CE=critically endangered, E=endangered, V=vulnerable, P1=Priority 1, P2=Priority 2, P3=Priority 3, P4=Priority 4, P=perennial, PG=perennial geophyte, A=annual. Species considered to potentially occur within the site are shaded green

Appendix B

Flora Species List

Family	Status	Species
Amaranthaceae		
		Ptilotus ?divaricatus
		Ptilotus exaltatus
		Ptilotus gaudichaudii
		Ptilotus holosericeus
		Ptilotus obovatus
Apocynaceae		
		Vinctoxicum lineare
Araliaceae		
		Hydrocotyle sp.
		Trachymene ornata
Asparagaceae		
		Lomandra marginata
		Thysanotus manglesianus
Asteraceae		
		Asteraceae sp.
		Bellida graminea
		Calocephalus multiflorus
		Calotis hispidula
		Cephalipterum drummondii
	*	*Erigeron bonariensis*
		Gilberta tenuifolia
		Gilruthia osbornei
		Millotia myosotidifolia
		Olearia humilis
		Olearia muelleri
		Olearia pimeleoides
		Podolepis rugata
		Pseudognaphalium luteoalbum
		Rhodanthe laevis
		Roebuckiella ciliocarpa
		Schoenia cassiniana
		Senecio glossanthus
	*	*Sonchus oleraceus*
		Waitzia acuminata var. *acuminata*
Brassicaceae		
	*	*Lepidium didymum*
		Lepidium oxytrichum
		Stenopetalum filifolium
Caryophyllaceae		
	*	*Sagina apetala*
Casuarinaceae		
		Allocasuarina sp.
Chenopodiaceae		
		Atriplex sp. (sterile)
		Atriplex ?vesicaria
		Einadia nutans
		Enchylaena tomentosa

Family	Status	Species
		Maireana georgei
		Maireana ?pentatropis
		Maireana sp. (sterile)
		Maireana trichoptera
		Maireana triptera
		Rhagodia drummondii
		Sclerolaena diacantha
		Sclerolaena fusiformis
Crassulaceae		
		Crassula colorata var. *colorata*
Cucurbitaceae		
	*	*Cucumis myriocarpus*
Cupressaceae		
		Callitris ?columellaris
Cyperaceae		
		Isolepis ?congrua
Ericaceae		
		Leucopogon sp. Clyde Hill (M.A. Burgman 1207)
Fabaceae		
		Acacia aneura
		Acacia burkittii
		Acacia ?caesaneura
		Acacia incurvaneura
		Acacia ?ligulata
		Acacia ramulosa var. ramulosa
		Acacia sp. 1
		Acacia sp. 2
		Acacia tetragonophylla
	*	*Medicago polymorpha*
		Senna artemisioides subsp. *×artemisioides*
Geraniaceae		
		Erodium cygnorum
Goodeniaceae		
		Goodenia havilandii
		Goodenia rosea
		Scaevola spinescens
Hemerocallidaceae		
		Dianella revoluta
Lamiaceae		
		Prostanthera althoferi
		Prostanthera grylloana
Malvaceae		
		Sida ?calyxhymenia
Montiaceae		
		Calandrinia eremaea
Myrtaceae		
		Eucalyptus concinna
		Eucalyptus loxophleba subsp. *lissophloia*

Family	Status	Species
		Eucalyptus oleosa subsp. *oleosa*
Pittosporaceae		
		?Pittosporum sp.
Plantaginaceae		
		Plantago drummondii
Poaceae		
		Amphipogon caricinus var. caricinus
		Aristida contorta
		Austrostipa elegantissima
		Austrostipa scabra
		Lachnagrostis filiformis
		Monachather paradoxus
Proteaceae		
		Grevillea nematophylla
		Hakea ?preissii
Pteridaceae		
		Cheilanthes sieberi
Rutaceae		
		Philotheca brucei
Santalaceae		
		Exocarpos aphyllus
		Santalum acuminatum
Sapindaceae		
		Dodonaea rigida
Scrophulariaceae		
		Eremophila alternifolia
		Eremophila decipiens subsp. *decipiens*
		Eremophila eriocalyx
		Eremophila granitica
		Eremophila oppositifolia subsp. *angustifolia*
		Eremophila sp.
Solanaceae		
		Nicotiana ?rotundifolia
		Solanum lasiophyllum
		Solanum nummularium
Thymelaeceae		
		Pimelea spiculigera var. thesioides
Zygophyllaceae		
		Roepera apiculata
		Roepera eremaea

*=non-native

Appendix C

Conservation Significant Communities and Likelihood of Occurrence Assessment

Code	Community name	TEC/ PEC	Level of significance		Likelihood of occurrence
			State	EPBC Act	
Die Hardy BIF	Die Hardy Range/Diemels vegetation complex	PEC	P1	-	Unlikely
Helena and Aurora Range BIF	Helena and Aurora Range vegetation complexes (banded ironstone formation)	PEC	P1	-	Unlikely
Johnston Range BIF	Johnston Range Vegetation Complexes (banded ironstone formation)	PEC	P1	-	Unlikely
Koolyanobbing BIF	Koolyanobbing vegetation complex (banded ironstone formation)	PEC	P1	-	Unlikely
Mount Jackson BIF	Mount Jackson Range vegetation complexes (banded ironstone formation)	PEC	P1	-	Unlikely
Mount Manning BIF	Mount Manning Range vegetation complex (banded ironstone formation)	PEC	P1	-	Unlikely
Windarling BIF	Windarling Ranges vegetation complex (banded ironstone formation)	PEC	P1	-	Unlikely

Note: TEC=threatened ecological community, PEC=priority ecological community, P1=priority 1

Appendix D

Sample Data

Vegetation Sample Data

Windarling Wastewater Treatment Plant

Sample Name: Q1

Project no.: EP22-058
Date: 1/10/2022 **Status** Permanent
Author: SCM,ASF Q1: Page 1 of 2

Quadrat and landform details

Sample type:	quadrat	Size:	5 x 5 m
NW corner easting:	720479.8098	NW corner northing:	6675239.635
Altitude (m):	444	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	slightly damp	Landform:	flat
Time since fire:	no evidence	Disturbance:	high - weeds, effluent spray
Soil type/texture	clay/loam with organic layer	Bare ground (%):	1
Rocks (%) and type:	1%, ironstone	Soil colour:	red/
Litter:	80% (leaves,twigs,branches)	Vegetation condition:	very good

Vegetation Sample Data

Windarling Wastewater Treatment Plant

Sample Name: Q1

Project no.: EP22-058

Date: 1/10/2022 **Status** Permanent

Author: SCM,ASF Q1: Page 2 of 2

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Atriplex sp. (sterile)	2
	Austrostipa elegantissima	0.1
	Enchylaena tomentosa	25
	Eremophila granitica	5
*	*Erigeron bonariensis*	25
	Eucalyptus concinna	30
*	*Lepidium didymum*	25
	Lepidium oxytrichum	1
	Pseudognaphalium luteoalbum	2
*	*Sagina apetala*	0.1
	Scaevola spinescens	5
	Solanum lasiophyllum	1
*	*Sonchus oleraceus*	5

Vegetation Sample Data

Windarling Wastewater Treatment Plant

Sample Name: Q2

Project no.: EP22-058
Date: 1/10/2022 **Status** Permanent
Author: SCM,ASF Q2: Page 1 of 2

Quadrat and landform details

Sample type:	quadrat	Size:	5 x 5 m
NW corner easting:	720492.6111	NW corner northing:	6675194.577
Altitude (m):	445	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	dry	Landform:	flat
Time since fire:	no evidence	Disturbance:	high - weeds, effluent spray
Soil type/texture	clay/ with organic layer	Bare ground (%):	1
Rocks (%) and type:	1%, ironstone	Soil colour:	red/
Litter:	60% (leaves,twigs,branches)	Vegetation condition:	very good

Vegetation Sample Data

Windarling Wastewater Treatment Plant

Sample Name: Q2

Project no.: EP22-058

Date: 1/10/2022 **Status** Permanent

Author: SCM,ASF Q2: Page 2 of 2

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Austrostipa elegantissima	0.1
	Calandrinia eremaea	0.1
*	*Cucumis myriocarpus*	5
	Einadia nutans	0.1
	Enchylaena tomentosa	0.1
*	*Erigeron bonariensis*	20
	Eucalyptus concinna	50
*	*Lepidium didymum*	5
	Lepidium oxytrichum	0.1
	Plantago drummondii	0.1
	Ptilotus obovatus	1
	Rhagodia drummondii	15
	Roepera eremaea	0.1
*	*Sagina apetala*	5
	Sclerolaena fusiformis	0.5
*	*Sonchus oleraceus*	2

Vegetation Sample Data

Windarling Wastewater Treatment Plant

Sample Name: Q3

Project no.: EP22-058
Date: 1/10/2022 **Status** Permanent
Author: SCM,ASF Q3: Page 1 of 2

Quadrat and landform details

Sample type:	quadrat	Size:	5 x 5 m
NW corner easting:	720551.554	NW corner northing:	6675179.425
Altitude (m):	448	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	dry	Landform:	flat
Time since fire:	no evidence	Disturbance:	low - adjacent track
Soil type/texture	clay/	Bare ground (%):	1
Rocks (%) and type:	1%, ironstone	Soil colour:	orange/
Litter:	95% (leaves,twigs,bark)	Vegetation condition:	excellent

Vegetation Sample Data

Windarling Wastewater Treatment Plant

Sample Name: Q3

Project no.: EP22-058

Date: 1/10/2022 **Status** Permanent

Author: SCM,ASF Q3: Page 2 of 2

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Acacia burkittii	0.1
	Acacia sp. 2	0.1
	Austrostipa elegantissima	0.1
	Enchylaena tomentosa	1
	Eucalyptus oleosa subsp. oleosa	50
	Olearia muelleri	5
	Ptilotus obovatus	1
	Roepera eremaea	0.1
	Senna artemisioides subsp. ×artemisioides	10
	Sida ?calyxhymenia	0.1
	Vincetoxicum lineare	0.1

Vegetation Sample Data

Windarling Wastewater Treatment Plant

Sample Name: Q4

Project no.: EP22-058
Date: 1/10/2022 **Status** Permanent
Author: SCM,ASF Q4: Page 1 of 2

Quadrat and landform details

Sample type:	quadrat	Size:	5 x 5 m
NW corner easting:	720418.0876	NW corner northing:	6675236.432
Altitude (m):	448	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	dry	Landform:	flat
Time since fire:	no evidence	Disturbance:	no evidence -
Soil type/texture	clay/	Bare ground (%):	2
Rocks (%) and type:	2%, ironstone	Soil colour:	orange/
Litter:	95% (bark,twigs,leaves)	Vegetation condition:	excellent

Vegetation Sample Data

Windarling Wastewater Treatment Plant

Sample Name: Q4

Project no.: EP22-058

Date: 1/10/2022 **Status** Permanent

Author: SCM,ASF Q4: Page 2 of 2

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Austrostipa elegantissima	0.1
	Eucalyptus concinna	80
	Maireana trichoptera	0.1
	Ptilotus obovatus	5
	Senna artemisioides subsp. ×artemisioides	5
	Solanum nummularium	1
	Vincetoxicum lineare	0.1

Vegetation Sample Data

Windarling Wastewater Treatment Plant

Sample Name: Q5

Project no.: EP22-058
Date: 1/10/2022 **Status** Permanent
Author: SCM,ASF Q5: Page 1 of 2

Quadrat and landform details

Sample type:	quadrat	Size:	5 x 5 m
NW corner easting:	720287.3994	NW corner northing:	6675065.378
Altitude (m):	451	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	dry	Landform:	flat
Time since fire:	no evidence	Disturbance:	low - weeds, clearing
Soil type/texture	clay/	Bare ground (%):	70
Rocks (%) and type:	2%, ironstone	Soil colour:	orange/
Litter:	25% (logs,leaves,branches)	Vegetation condition:	excellent

Vegetation Sample Data

Windarling Wastewater Treatment Plant

Sample Name: Q5

Project no.: EP22-058

Date: 1/10/2022 **Status** Permanent

Author: SCM,ASF Q5: Page 2 of 2

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Acacia ?caesaneura	2
	Acacia aneura	15
	Amphipogon caricinus var. caricinus	0.1
	Asteraceae sp.	0.1
	Austrostipa scabra	0.1
	Bellida graminea	0.1
	Crassula colorata var. colorata	0.1
	Dianella revoluta	2
	Erodium cygnorum	0.5
	Gilruthia osbornei	1
	Goodenia rosea	0.5
	Hydrocotyle sp.	0.1
	Olearia pimeleoides	2
	Pimelea spiculigera var. thesioides	0.1
	Plantago drummondii	0.1
	Roebuckiella ciliocarpa	0.1
	Sagina apetala	0.1
	Schoenia cassiniana	0.1
	Solanum nummularium	0.1
	Trachymene ornata	0.1
	Vincetoxicum lineare	0.1

Vegetation Sample Data

Windarling Wastewater Treatment Plant

Sample Name: Q6

Project no.: EP22-058
Date: 1/10/2022 **Status** Permanent
Author: SCM,ASF Q6: Page 1 of 2

Quadrat and landform details

Sample type:	quadrat	Size:	5 x 5 m
NW corner easting:	720378.1449	NW corner northing:	6675062.789
Altitude (m):	447	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	dry	Landform:	flat
Time since fire:	no evidence	Disturbance:	no evidence -
Soil type/texture	clay/ with organic layer	Bare ground (%):	1
Rocks (%) and type:	1%, ironstone	Soil colour:	orange/
Litter:	99% (leaves,branches,other)	Vegetation condition:	excellent

Vegetation Sample Data

Windarling Wastewater Treatment Plant

Sample Name: Q6

Project no.: EP22-058

Date: 1/10/2022 **Status** Permanent

Author: SCM,ASF Q6: Page 2 of 2

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Acacia ?caesaneura	2
	Acacia tetragonophylla	2
	Dianella revoluta	2
	Eremophila eriocalyx	1
	Eucalyptus oleosa subsp. oleosa	80
	Senna artemisioides subsp. ×artemisioides	1

Vegetation Sample Data

Windarling Wastewater Treatment Plant

Sample Name: Q7

Project no.: EP22-058
Date: 1/10/2022 **Status** Permanent
Author: SCM,ASF Q7: Page 1 of 2

Quadrat and landform details

Sample type:	quadrat	Size:	5 x 5 m
NW corner easting:	720397.7351	NW corner northing:	6674995.305
Altitude (m):	445	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	dry	Landform:	flat
Time since fire:	no evidence	Disturbance:	high - weeds, effluent spray
Soil type/texture	clay/ with organic layer	Bare ground (%):	1
Rocks (%) and type:	1%, ironstone	Soil colour:	orange/
Litter:	10% (leaves,twigs,branches)	Vegetation condition:	very good

Vegetation Sample Data

Windarling Wastewater Treatment Plant

Sample Name: Q7

Project no.: EP22-058

Date: 1/10/2022 **Status** Permanent

Author: SCM,ASF Q7: Page 2 of 2

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Acacia ?caesaneura	2
	Acacia aneura	25
	Austrostipa elegantissima	0.1
	Austrostipa scabra	2
	Enchylaena tomentosa	5
	Erodium cygnorum	0.1
	Lachnagrostis filiformis	1
*	*Lepidium didymum*	35
	Lepidium oxytrichum	0.1
	Nicotiana ?rotundifolia	0.1
	Pseudognaphalium luteoalbum	0.1
*	*Sagina apetala*	35
	Solanum nummularium	2

Vegetation Sample Data

Windarling Wastewater Treatment Plant

Sample Name: Q8

Project no.: EP22-058
Date: 1/10/2022 **Status** Permanent
Author: SCM,ASF Q8: Page 1 of 2

Quadrat and landform details

Sample type:	quadrat	Size:	5 x 5 m
NW corner easting:	720265.2792	NW corner northing:	6674986.861
Altitude (m):	445	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	damp	Landform:	flat
Time since fire:	no evidence	Disturbance:	high - weeds, effluent spray
Soil type/texture	clay/ with organic layer	Bare ground (%):	5
Rocks (%) and type:	2%, ironstone	Soil colour:	red/
Litter:	2% (leaves,,)	Vegetation condition:	very good

Vegetation Sample Data

Windarling Wastewater Treatment Plant

Sample Name: Q8

Project no.: EP22-058

Date: 1/10/2022 **Status** Permanent

Author: SCM,ASF Q8: Page 2 of 2

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Acacia aneura	30
	Enchylaena tomentosa	2
	Erodium cygnorum	5
	Lachnagrostis filiformis	15
*	*Lepidium didymum*	40
	Pseudognaphalium luteoalbum	0.1
	Ptilotus obovatus	2
*	*Sagina apetala*	30
	Solanum lasiophyllum	2
*	*Sonchus oleraceus*	2