



**Critical Habitat Assessment-
Eucalyptus rhomboidea and
*Stenanthemum bremerense***

**Prepared For
Audalia Resources Limited**

November 2020

Disclaimer

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

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

Critical Habitat in this document refers to the definitions herein, and does not infer any definition or use of the term under the *Biodiversity Conservation Act 2016*. Its use is in relation to the requirements of the Environmental Scoping Document for the Medcalf Project (Audalia 2019).

Quality Assurance

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

Document Job Number: 2019/124

Prepared by: Lauren Pick
Senior Environmental Consultant
Botanica Consulting

Reviewed by: Andrea Williams
Director
Botanica Consulting

Approved by: Jim Williams
Director
Botanica Consulting

Contents

1	DESCRIPTION	1
1.1	Taxon Identification	1
1.2	Conservation Status.....	1
1.3	Taxonomic Description.....	3
1.4	Distribution & Habitat	5
1.5	Population Extent	5
2	CRITICAL HABITAT ASSESSMENT.....	7
2.1	Areas of Occupancy	10
2.2	Optimal Habitat.....	13
2.3	Sub-optimal Habitat.....	16
2.4	Critical Habitat.....	21
3	REFERENCES	24

List of Tables

Table 1: Assessment of <i>Eucalyptus rhomboidea</i> against IUCN Criteria	1
Table 2: Assessment of <i>Stenanthemum bremerense</i> against IUCN Criteria	2
Table 3: Summary of un-burnt <i>Eucalyptus rhomboidea</i> populations.....	5
Table 4: Summary of un-burnt <i>Stenanthemum bremerense</i> populations.....	6
Table 5: Critical habitat definition.....	8
Table 6: Extent of Critical, Optimal and Sub-Optimal Habitat.....	21

List of Figures

Figure 1: Area of occupancy- <i>E. rhomboidea</i>	11
Figure 2: Area of occupancy- <i>S. bremerense</i>	12
Figure 3: Area of occupancy/ Optimal habitat- <i>E. rhomboidea</i>	14
Figure 4: Area of occupancy/ Optimal habitat- <i>S. bremerense</i>	15
Figure 5: Area of occupancy/ Optimal habitat/ Sub-optimal habitat: soils and landscape systems- <i>E. rhomboidea</i>	17
Figure 6: Area of occupancy/ Optimal habitat/ Sub-optimal habitat: vegetation types- <i>E. rhomboidea</i> 18	
Figure 7: Area of occupancy/ Optimal habitat/ Sub-optimal habitat: soils and landscape systems- <i>S. bremerense</i>	19
Figure 8: Area of occupancy/ Optimal habitat/ Sub-optimal habitat: vegetation types- <i>S. bremerense</i> 20	
Figure 9: Critical, optimal and sub-optimal habitat- <i>E. rhomboidea</i>	22
Figure 10: Critical, optimal and sub-optimal habitat- <i>S. bremerense</i>	23

List of Attachments

Attachment 1: Population Descriptions

Attachment 2: Habitat Photographs

Attachment 3: Botanica (2020). Detailed Flora & Vegetation Survey. Medcalf Vanadium Mining Project and Proposed Haul Road. Prepared for Audalia Resources Limited. October 2020. Version 3

Attachment 4: Soils of the Audalia Medcalf area. Prepared by Neil Lantzke for Audalia Resources Limited. Western Horticultural Consulting (2019).

1 DESCRIPTION

1.1 Taxon Identification

Eucalyptus rhomboidea

Eucalyptus rhomboidea was collected for the first time in 1979 by K. Newbey. In 1998 D. Nicolle made several collections of *E. rhomboidea* along the main Bremer Range track as part of a PhD research program which included comparative herbarium, glasshouse and field studies of *E. rhomboidea*. As a result of this work the species was formally described Hopper and Nicolle (2007).

Stenanthemum bremerense

This species was previously known as *Stenanthemum* sp. Bremer Range (G.J. Keighery 1687) and was formally named as *S. bremerense* in 2007 (Rye, 2007).

1.2 Conservation Status

Eucalyptus rhomboidea

E. rhomboidea was initially listed as Priority 5 (“taxa for high priority monitoring”) in 1989. In 2007 Hopper and Nicolle identified that the species was at risk from present and future mining activity in the Bremer Range. *E. rhomboidea* is currently listed as Priority 4 by DBCA and has been nominated by DBCA to be listed as a Threatened Species under the *Biodiversity Conservation Act 2016* (BC Act).

E. rhomboidea has been nominated to be listed as Endangered (EN) under World Conservation Union (IUCN 2001) criteria B1ab(iii,v)+B2ab(iii,v) due to its extent of occurrence being less than 5,000km² and area of occupancy being less than 500km², with a continuing decline observed, estimated, inferred or projected in area, extent and/or quality of habitat and number of mature individuals.

This species has not currently been nominated to be listed as Threatened under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Stenanthemum bremerense

S. bremerense is currently listed as Priority 4 taxa by DBCA and is being considered for nomination by DBCA as a Threatened Species under the *Biodiversity Conservation Act 2016* (BC Act).

A summary of the current conservation status of each species (under IUCN Criteria) and the proposed mining impacts on conservation status is provided in **Table 1** and **Table 2**. The assessment indicates that mining will not increase the potential ‘Endangered’ status of *E. rhomboidea*. The assessment indicates *S. bremerense* does not currently meet IUCN categories for Threatened status and proposed mining will not increase the potential for ‘Threatened’ status.

Table 1: Assessment of *Eucalyptus rhomboidea* against IUCN Criteria

Listing Criteria		Current Status	Proposed Mining Impacts
A.	Population size reduction (evidence of decline)	There is currently insufficient quantitative information to assess against this criterion. However, based on available information it would appear <i>E. rhomboidea</i> would not currently meet Criterion A.	No change-mining will result in ~5% reduction in population size which does not meet any of the Threatened Criteria
B.	Geographic range (EOO and AOO, number of locations and evidence of decline)	Currently meets the criteria for Endangered B1 ab(iii,v) and B2 ab(iii,v)	No change from Endangered-proposed mining will not reduce extent of occurrence below 100km ² or area of occupancy below 10km ² (Critically Endangered Criteria)
C.	Small population size and decline	There is currently insufficient information to meet Criterion C.	No change-mining will result in ~5% reduction in population size which does not meet any of the Threatened Criteria

Listing Criteria		Current Status	Proposed Mining Impacts
	(population size, distribution and evidence of decline)		
D.	Very small or restricted population (population size)	Meets the criteria for Vulnerable D2.	No change from Vulnerable-proposed mining will not reduce number of mature individuals below 250 (Endangered Criteria)
E.	Quantitative analysis (statistical probability of extinction)	Currently insufficient information to assess against criteria.	Currently insufficient information to assess against criteria.

Table 2: Assessment of *Stenanthemum bremerense* against IUCN Criteria

Listing Criteria		Current Status	Proposed Mining Impacts
A.	Population size reduction (evidence of decline)	There is currently insufficient quantitative information to assess against this criterion. However, based on available information it would appear <i>S. bremerense</i> would not currently meet Criterion A.	No change-mining will result in ~8% reduction in population size which does not meet any of the Threatened Criteria
B.	Geographic range (EOO and AOO, number of locations and evidence of decline)	There is currently insufficient quantitative information to assess against this criterion. However, based on available information it would appear <i>S. bremerense</i> would not currently meet all the requirements of Criterion B.	Proposed mining will have minimal impact on extent of occurrence or area of occupancy. Currently 25 known populations, only two of which are proposed to be impacted.
C.	Small population size and decline (population size, distribution and evidence of decline)	There is currently insufficient information to meet Criterion C.	No change-mining will result in ~8% reduction in population size which does not meet any of the Threatened Criteria.
D.	Very small or restricted population (population size)	Based on available information it would appear <i>S. bremerense</i> would not currently meet Criterion A.	No change-proposed mining will not reduce number of mature individuals below 1000 (Vulnerable Criteria), Area of Occupancy will remain above 20km ² and number of locations will not be reduced below 5.
E.	Quantitative analysis (statistical probability of extinction)	Currently insufficient information to assess against criteria.	Currently insufficient information to assess against criteria.

1.3 Taxonomic Description

Eucalyptus rhomboidea

Tree, non-sprouter (mallet), 8-18m tall. Bark smooth throughout, dull, grey to light grey over cream to orange-brown or yellow-brown, decorticating in strips and short ribbons. Branchlets pruinose, pith glands absent. Cotyledons bisected. Seedlings leaves opposite for >20 pairs, linear at first, soon becoming sessile and strongly decurrent, ovate to elliptic, undulate, up to 40 mm long x 32 mm wide, more or less concolorous, dull, blue-green, glaucous, especially on new growth. Adult leaves disjunct, pendulous, petioles 23-30 mm long; lamina lanceolate, 110-115 mm long x 18-35 mm wide, concolorous, dull, blue-green; reticulation moderately dense, oil glands abundant, mostly at intersections of veinlets. Inflorescences axillary, unbranched, held erect, 7-flowered; peduncles somewhat angular, 7-12 mm long; pedicels stout, 1-5-3.5 mm long. Buds pruinose, rhomboid (diamond-shaped), 9-11.5 mm long; operculum conical, 6-7 mm long, smooth, scar present. Stamens irregularly flexed, all fertile; anthers basifixed, ovoid, opening by slits. Flowers creamy-yellow. Ovules in 4 vertical rows. Fruits held erect, usually pruinose, especially when young, shortly pedicellate, obconical although often slightly contracted at rim, 7.5-8.5 mm long x 7.5-9 mm diam., smooth; disc \pm level and often prominent, 1-2 mm wide; valves (3)4; style tips exerted. Seed angular-ovoid, dull to slightly glossy, grey-brown, finely reticulate (Hopper & Nicolle, 2007).

E. rhomboidea is a non-sprouter species known in the series (Nicolle et al. 2006), regenerating from fire by seedlings only. Buds begin to form in April. Thought to be pollinated by nectar seeking birds and insects.



Plate 1: Image of *Eucalyptus rhomboidea* (Botanica Consulting)

Stenanthemum bremerense

Shrubs erect or low and spreading, usually (0.2)0.3–0.6 m high, reportedly up to 1.4 m high, singlestemmed at base, sometimes becoming multi-branched at base. Young stems with a dense ferruginous indumentum at first of stellate hairs and larger antrorse to patent simple hairs 0.5–0.8 mm long, becoming glabrous. Stipules free or connate at base for up to c. one-quarter of their length, 2.7–4 mm long, acuminate, with denticulate margins, dark red-brown, becoming black with age; outer surface sometimes denticulate along midrib, with a few short simple hairs or glabrous; inner surface often hairy along midvein. Petioles 1–2.5 mm long, densely hairy on undersurface, glabrous on upper surface. Leaf blades conduplicate at first, broadly obovate, 3–9 × 2.5–5 mm, entire, with more or less flat margins, with a recurved apical glabrous point 0.3–0.4 mm long; lower surface with 2–4 main lateral veins on each side of midvein, minutely stellate-hairy and with antrorse simple hairs 0.5–0.8 mm long, some of the hairs ferruginous especially along the margin and veins; upper surface smooth or with minute broad protrusions at maturity. Flower clusters few- to many-flowered, 5–12 mm diam., white. Floral tube 2.5–4 mm long (enlarging to 4–5.5 mm in fruit); adnate part of tube c. 0.8 mm long, very densely hairy; free part up to 3 mm long, moderately densely hairy, with appressed simple hairs 0.4–0.7 mm long. Sepals 1.5–2 mm long, widely spreading and recurved, with appressed or antrorse simple hairs 0.3–0.5 mm long outside. Petals 0.6–0.9 mm long, shortly clawed. Disc apparently absent. Ovary with summit glabrous. Style up to 3.5 mm long. Fruit c. 2.5 mm long, hairy. Seeds c. 1.7 mm long; body c. 1.4 × 1 mm, off-white with a black base and distinctly mottled with brown markings above; aril c. 1 mm long, clear-translucent, 3-lobed.

Flowering period is mainly recorded from April to June but also recorded in October and November (Rye, 2007).



Plate 2: Image of *Stenanthemum bremerense* (Botanica Consulting)

1.4 Distribution & Habitat

Eucalyptus rhomboidea

E. rhomboidea is known only from the Bremer Range which is listed as a Priority 1 Ecological Community (PEC), located approximately 100 km west, south-west of Norseman, Western Australia. This species is restricted to areas of greenstone within the Bremer Range, over a linear area of approximately 19km. It occurs on a variety of habitats including creeklines/ low gravelly rises and mid gravelly/ lateritic-greenstone rises often in areas with *Eucalyptus eremophila*, *E. salubris*, *E. flocktoniae*, *E. salmonophloia*, *E. cylindrocarpa*.

Detailed descriptions of identified habitats for each population is provided in Attachment 1. Photographic records of *E. rhomboidea* habitats are provided in Attachment 2.

Stenanthemum bremerense

S. bremerense is endemic to the South West Botanical Province of Western Australia, known from many collections in the Bremer Range area and also from a single isolated atypical collection from near Marvel Loch (Rye, 2007). *S. bremerense* occurs on the top or sides of laterite outcrops and breakaways and in other sites with lateritic gravel or pebbles, often in areas with *Allocasuarina* and/or *Melaleuca* species dominant.

Detailed descriptions of identified habitats for each population is provided in Attachment 1. Photographic records of *S. bremerense* habitats are provided in Attachment 2.

1.5 Population Extent

Eucalyptus rhomboidea

A total of nine populations of *E. rhomboidea* have been recorded (total of 15,606 plants), including six unburnt populations which occur within the Hill 436 region of the Bremer Range. A summary of the population extent for these un-burnt populations is provided in **Table 3**. An additional three populations occurred within the Bremer Range (located at Mt Gordon and Mt Glasse) which according to DBCA had an approximate 19 km² population area, however in 2019 these populations were disturbed by fire.

Table 3: Summary of un-burnt *Eucalyptus rhomboidea* populations

Population No.	Current Area Occupied (Ha)	Population Condition
1	7.36	Good-Very Good
2	0.62	Very Good
3	0.25	Good
4	0.05	Very Good
5	0.94	Good-Very Good
6	2.43	Very Good
TOTAL	11.65	

Stenanthemum bremerense

Currently there are twenty-five known un-burnt populations of *S. bremerense* (total of 40,126 plants), which extend between Maggie Hayes/ Mt Holland the Hill 436 region of the Bremer Range. A summary of the population extent for the current populations is provided in **Table 4**. Two additional populations occurred within the Bremer Range (located at Mt Glasse), based on DBCA records, however in 2019 these populations were disturbed by fire.

Table 4: Summary of un-burnt *Stenanthemum bremerense* populations

Population No.	Current Area Occupied (Ha)	Population Condition
1	1.61	Good-Very Good
2	0.3	Very Good
3	29.14	Good-Very Good
4	0.84	Good-Very Good
5	2.63	Good-Very Good
6	0.77	Good-Very Good
7	0.61	Very Good
8	3.54	Very Good
9	0.76	Very Good
10	3.82	Very Good
11	2.15	Good
12	0.68	Very Good
13	1.24	Very Good
14	0.81	Very Good
15	0.37	Very Good
16	0.16	Very Good
17	0.2	Very Good
18	0.23	Very Good
19	0.57	Good
20	0.67	Very Good
21	0.01	Very Good
22	4.67	Very Good
23	0.23	Very Good
24	0.09	Very Good
25	0.39	Very Good
TOTAL	56.49	

2 CRITICAL HABITAT ASSESSMENT

As required by the Medcalf Project Environmental Scoping Document (Audalia 2019), studies were conducted for *E. rhomboidea* and *S. bremerense* to facilitate impact assessment for the Medcalf Project. The studies required included targeted searches for both species (Botanica, 2020) and soil assessments (Western Horticultural Consulting, 2019), in order to further define the habitat, and specifically to identify critical habitat, optimal habitat and sub-optimal habitat for each species. Copies of these studies which have been used to inform the definition of critical habitat proposed in this report are provided in Attachment 3 and 4.

Based on these assessments, it was identified that *E. rhomboidea* grows on a range of soil groups at a range of positions in the landscape. This species was found growing on 'Alkaline red shallow loamy duplex' soils that occur on the lower, mid and upper slopes. It was found growing on 'Loamy gravel' soils on the lateritic plateau at the top of the landscape and on the mid slopes. It was also found growing on 'Shallow gravel' soils, below a breakaway (based on soil descriptions by Western Horticultural Consulting, 2019). *E. rhomboidea* was found in a variety of habitats including within creeklines and low to mid gravelly rises and lateritic slopes (Botanica pers. comms). Specifically *E. rhomboidea* was identified within four floristic groups from the local mapping by Botanica (2020):

1. Low open woodland of *Eucalyptus salmonophloia* over mixed shrubs on clay-loam plain (CLP-EW1).
2. Mid mallee shrubland of *Eucalyptus* spp. over mid shrubland of *Melaleuca pauperiflora* and mixed low shrubland on clay-loam plain (CLP-MWS1).
3. Regrowth mid open mallee woodland of *Eucalyptus livida* over mid open shrubland of *Hakea pendens* and open low shrubland of *Goodia medicaginea* on hillslope (HS-MWS1).
4. Mid open mallee woodland of *Eucalyptus livida* over heathland of *Allocasuarina/Hakea/Melaleuca* and open low sedge of *Lepidosperma sanguinolentum* on hillslope (HS-MWS3).

S. bremerense grows in loamy gravel soils and is found on the lateritic plateau at the top of the landscape and on areas of gravelly rises on the mid to lower slopes (based on soil descriptions by Western Horticultural Consulting, 2019). *S. bremerense* was found in a variety of habitats including sandy/ gravelly plains to low rise and lateritic slopes/ ridges (Botanica pers. comms). Specifically *S. bremerense* was identified within five floristic groups from the local mapping by Botanica (2020):

1. Low open woodland of *Eucalyptus salmonophloia* over mixed shrubs on clay-loam plain (CLP-EW1).
2. Mid mallee shrubland of *Eucalyptus* spp. over mid shrubland of *Melaleuca pauperiflora* and mixed low shrubland on clay-loam plain (CLP-MWS1).
3. Regrowth mid open mallee woodland of *Eucalyptus livida* over mid open shrubland of *Hakea pendens* and open low shrubland of *Goodia medicaginea* on hillslope (HS-MWS1).
4. Mid open mallee woodland of *Eucalyptus livida* over heathland of *Allocasuarina/Hakea/Melaleuca* and open low sedge of *Lepidosperma sanguinolentum* on hillslope (HS-MWS3).
5. Regrowth mixed low shrubland on hillslope (HS-OS1).

As critical habitat definitions have not been provided by DBCA for either species, critical habitat has been assessed based on the critical habitat definition provided in **Table 5**. Due to recent fires, not all potential habitats for *E. rhomboidea*/ *S. bremerense* could be assessed, therefore in addition to technical studies/ field assessments conducted within the Bremer Range, spatial database information on regional vegetation units, soils and landscape systems obtained from Government authorities were also used to determine potential critical habitat. A map of the proposed critical habitat for each species (including areas of additional occurrences of similar habitat that may contain undiscovered populations of the species or be suitable for future translocations) is provided in **Figure 9** and **Figure 10**.

Table 5: Critical habitat definition

Term	Definition	Detail/ Comment	
		<i>Eucalyptus rhomboidea</i>	<i>Stenanthemum bremerense</i>
Area of Occupancy (AO)	The area within which the populations are found	Known occurrence of <i>E. rhomboidea</i> populations.	Known occurrence of <i>S. bremerense</i> populations.
Optimal Habitat (OH)	Includes area of occupancy and other areas that meet all of the criteria that the area of occupancy exhibits	<p>Areas of alkaline red shallow loamy duplex' soils that occur on the lower, mid and upper slopes. 'Loamy gravel' soils on the lateritic plateau at the top of the landscape and on the mid slopes and 'shallow gravel' soils, below a breakaway identified during soil investigations conducted by Neil Lantzke (Western Horticultural Consulting, 2019).</p> <p>Area of suitable habitat between the populations which includes creeklines and low to mid gravelly rises and lateritic-greenstone slopes and vegetation types mapped by Botanica Consulting (Botanica, 2020) which are known to support <i>E. rhomboidea</i> populations including;</p> <ul style="list-style-type: none"> • CLP-EW1 (<i>E. salmonophloia</i> woodland) • CLP-MWS1 (Mallee woodland over <i>Melaleuca pauperiflora</i>) • HS-MWS1 (<i>E. livida</i> mallee woodland) • HS-MWS3 (<i>E. livida</i> mallee woodland over heathland of <i>Allocasuarina/ Hakea/ Melaleuca</i>) 	<p>Loamy gravel soils and is found on the lateritic plateau at the top of the landscape and on areas of gravelly rises on the mid to lower slopes identified during soil investigations conducted by Neil Lantzke (Western Horticultural Consulting, 2019).</p> <p>Area of suitable habitat between the populations which includes sandy/ gravelly plains to low rise and lateritic slopes/ ridges and vegetation types mapped by Botanica Consulting (Botanica, 2020) which are known to support <i>S. bremerense</i> populations including;</p> <ul style="list-style-type: none"> • CLP-MWS1 (Mallee woodland over <i>Melaleuca pauperiflora</i>) • HS-MWS1 (<i>E. livida</i> mallee woodland) • HS-MWS3 (<i>E. livida</i> mallee woodland over heathland of <i>Allocasuarina/ Hakea/ Melaleuca</i>) • HS-OS1 (Regrowth mixed low shrubland)
Sub-optimal Habitat (SOH)	Area that is lacking in one or two of the criteria that the area of occupancy exhibits, and the plants	Soil Landscape Systems specified by the Department of Primary Industries and Regional Development (DPIRD, 2014) and Soil Mapping Units specified in the Atlas of	Soil Landscape Systems specified by the Department of Primary Industries and Regional Development (DPIRD, 2014) and Soil Mapping Units specified in the Atlas of

Term	Definition	Detail/ Comment	
		<i>Eucalyptus rhomboidea</i>	<i>Stenanthemum bremerense</i>
	are not found there, but may provide surrounding or linking habitat.	<p>Australian Soils (Geoscience Australia, 2009) within which <i>E. rhomboidea</i> records occur.</p> <p>Pre-European Vegetation associations mapped by Beard specified by the DPIRD database (DPIRD, 2018) within which <i>E. rhomboidea</i> records occur</p>	<p>Australian Soils (Geoscience Australia, 2009) within which <i>S. bremerense</i> records occur.</p> <p>Pre-European Vegetation associations mapped by Beard specified by the DPIRD database (DPIRD, 2018) within which <i>S. bremerense</i> records occur.</p>
Critical Habitat (CH)	<ul style="list-style-type: none"> • Optimal Habitat; AND • Areas of similar habitat surrounding and linking populations (these providing potential habitat for population expansion and for pollinators) 	Includes all aspects described above.	Includes all aspects described above.

2.1 Areas of Occupancy

The area of occupancy is based on a line that joins the outer locations of individual or groups of plants. Area of occupancy presented is based on pre-fire DBCA records of *E. rhomboidea*/*S. bremerense* and population mapping conducted by Botanica in 2019.

Eucalyptus rhomboidea

Figure 1 shows the areas of occupancy based on pre-fire DBCA records of *E. rhomboidea* and population mapping conducted by Botanica in 2019. Areas of occupancy are indisputably defined as critical habitat – the proposed critical habitat boundary encompasses all areas of occupancy. Areas of occupancy would be also described as optimal habitat.

Stenanthemum bremerense

Figure 2 shows the areas of occupancy based on DBCA records and population mapping conducted by Botanica in 2019. Areas of occupancy are indisputably defined as critical habitat – the proposed critical habitat boundary encompasses all areas of occupancy. Areas of occupancy would be also described as optimal habitat.

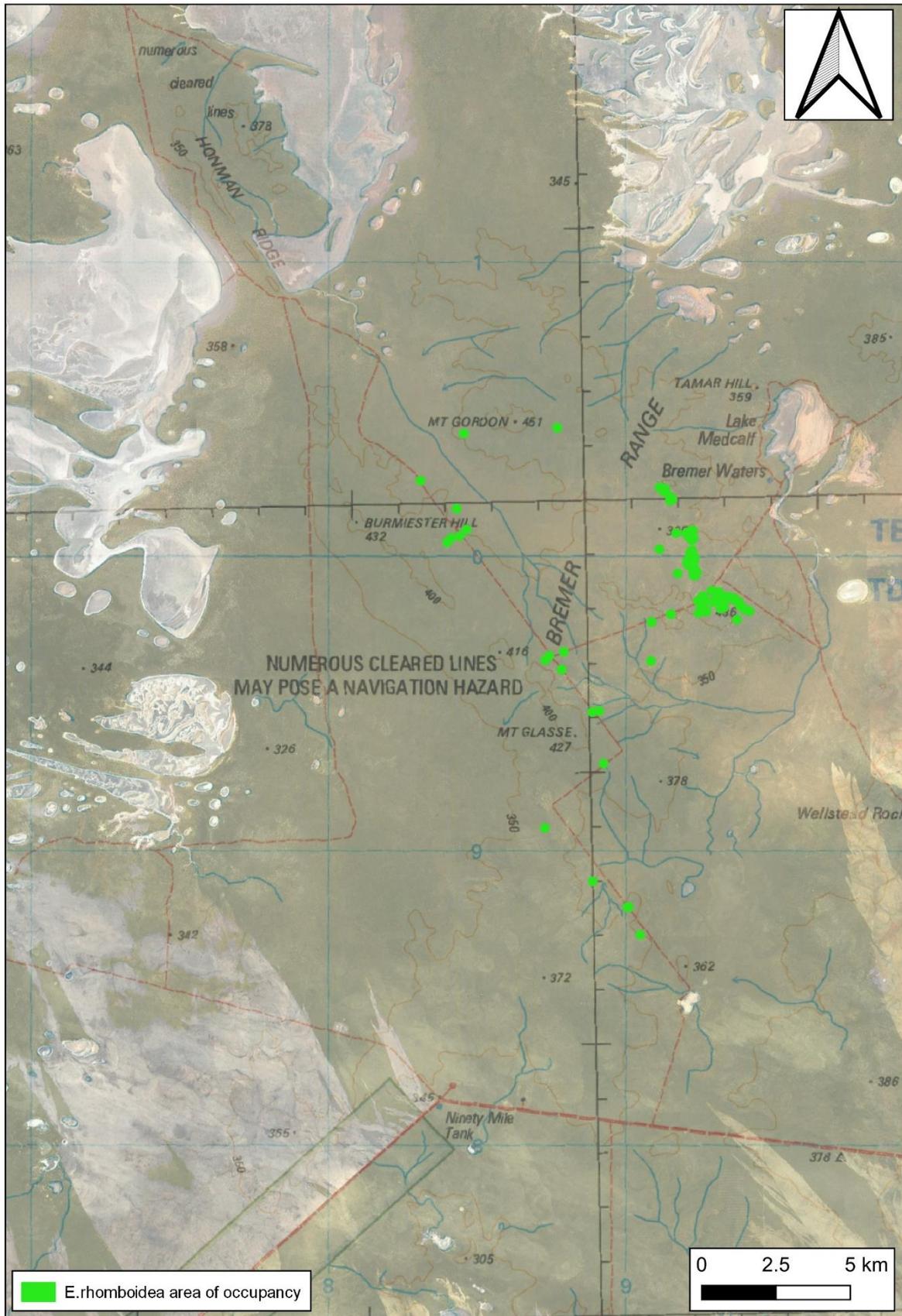


Figure 1: Area of occupancy-*E. rhomboidea*

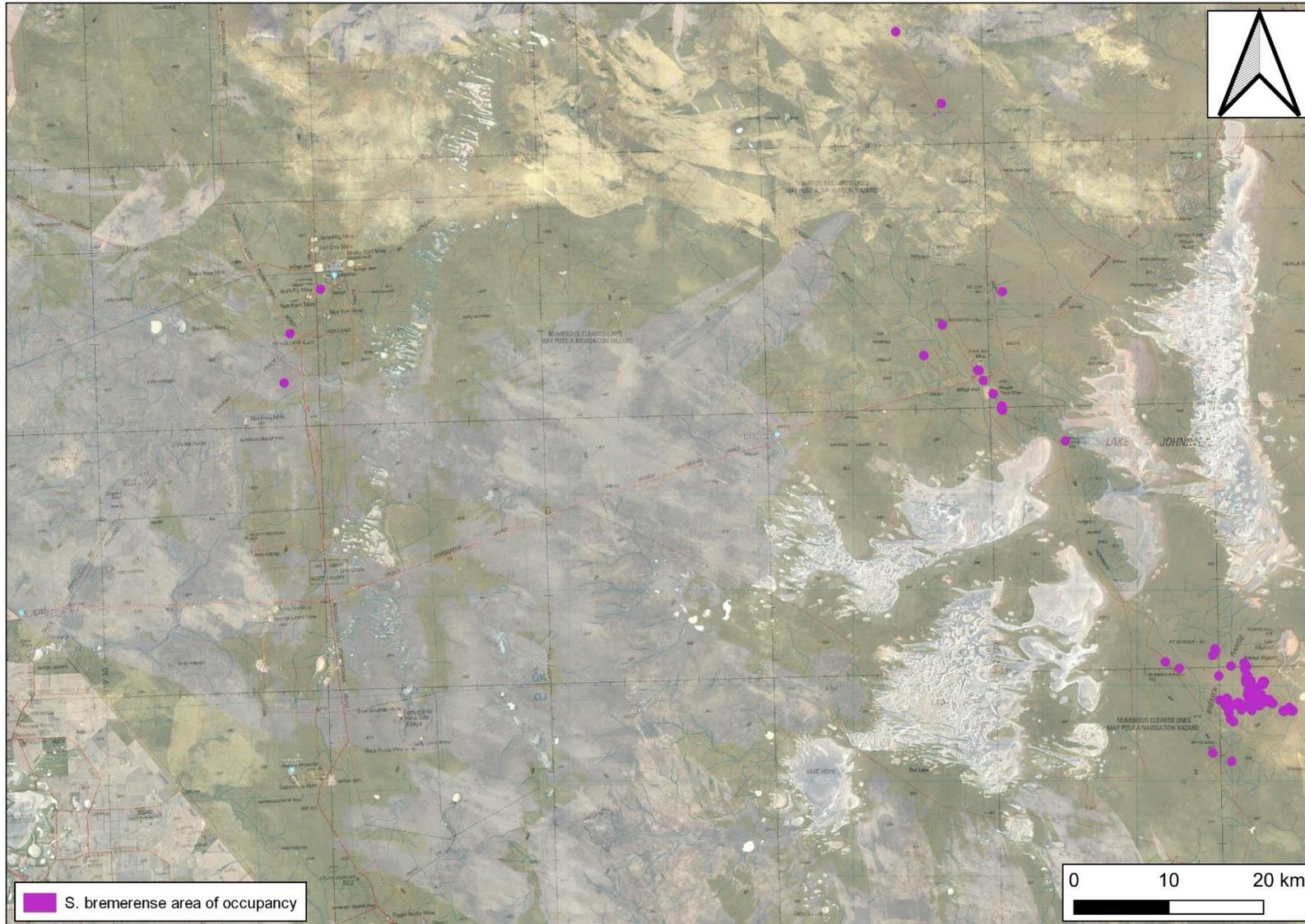


Figure 2: Area of occupancy-*S. bremerense*

2.2 Optimal Habitat

Optimal habitat has been designated as the habitat immediately surrounding *E. rhomboidea* and *S. bremerense* populations, based on known affiliations with geology, soil, landscape position, landform, drainage and vegetation associations (based on local studies conducted for each species at Bremer Range provided in Attachment 3 and 4) with no apparent physical, chemical or biological reason why the plants could not grow in this habitat.

Eucalyptus rhomboidea

Figure 3 shows the optimal habitat for *E. rhomboidea*. *E. rhomboidea* grows on a range of soil groups at a range of positions in the landscape. This species was found growing on 'Alkaline red shallow loamy duplex' soils that occur on the lower, mid and upper slopes. It was found growing on 'Loamy gravel' soils on the lateritic plateau at the top of the landscape and on the mid slopes. It was also found growing on 'Shallow gravel' soils, below a breakaway (Western Horticultural Consulting, 2019). *E. rhomboidea* was found in a variety of habitats including within creeklines and low to mid gravelly rises and lateritic slopes (Botanica pers. comms).

E. rhomboidea populations were identified within a variety of vegetation types mapped by Botanica including *E. salmonophloia* woodland (CLP-EW1), Mallee woodland over *Melaleuca pauperiflora* (CLP-MWS1), *E. livida* mallee woodland (HS-MWS1) and *E. livida* mallee woodland over heathland of *Allocasuarina/ Hakea/ Melaleuca* (HS-MWS3).

Stenanthemum bremerense

Figure 4 shows the optimal habitat for *S. bremerense*. *S. bremerense* grows in loamy gravel soils and is found on the lateritic plateau at the top of the landscape and on areas of gravelly rises on the mid to lower slopes (Western Horticultural Consulting, 2019). *S. bremerense* was found in a variety of habitats including sandy/ gravelly plains to low rise and lateritic slopes/ ridges (Botanica pers. comms).

S. bremerense populations were identified within a variety of vegetation types mapped by Botanica including Mallee woodland over *Melaleuca pauperiflora* (CLP-MWS1), *E. livida* mallee woodland (HS-MWS1), *E. livida* mallee woodland over heathland of *Allocasuarina/ Hakea/ Melaleuca* (HS-MWS3) and Regrowth mixed low shrubland (HS-OS1).

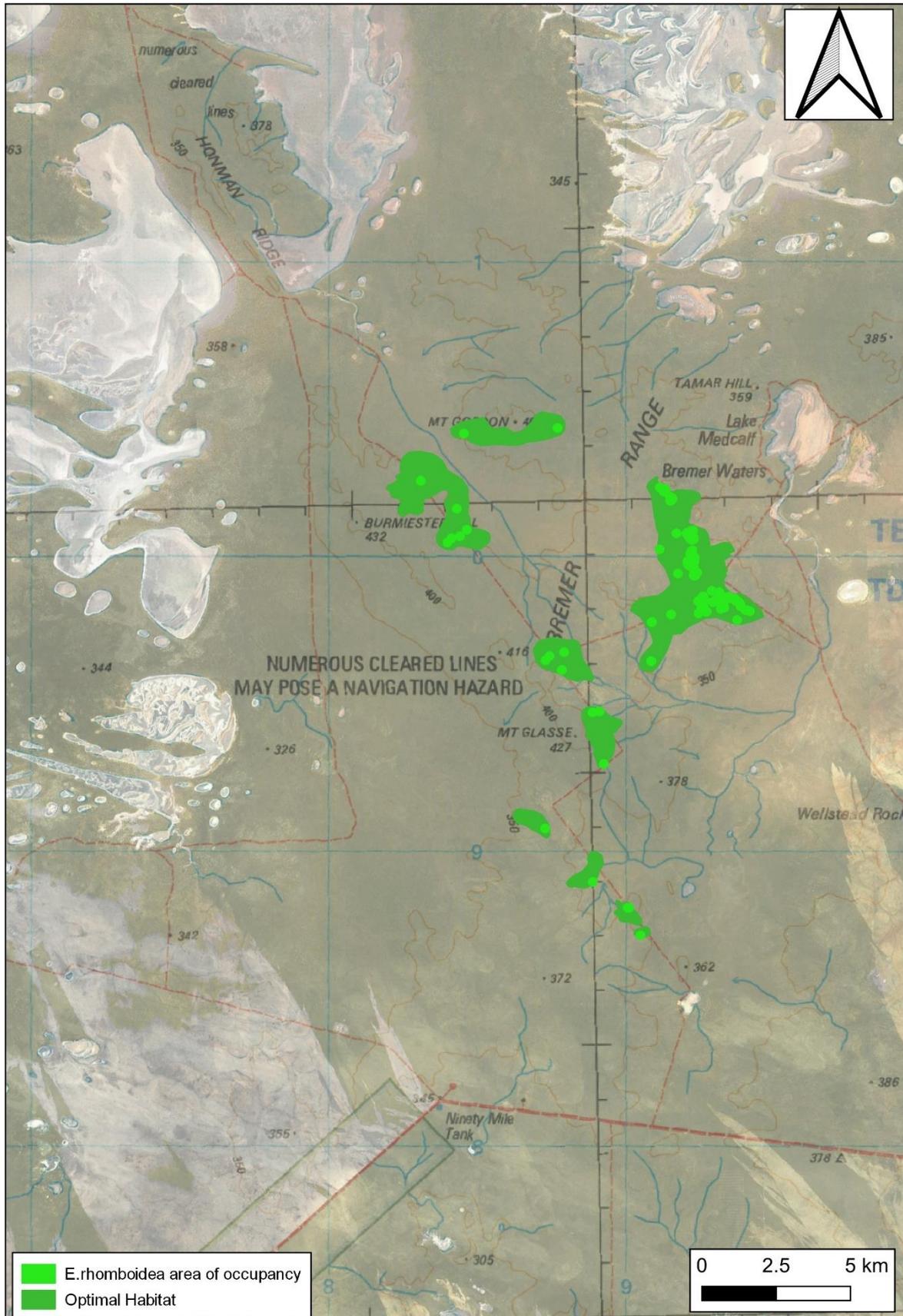


Figure 3: Area of occupancy/ Optimal habitat-*E. rhomboidea*

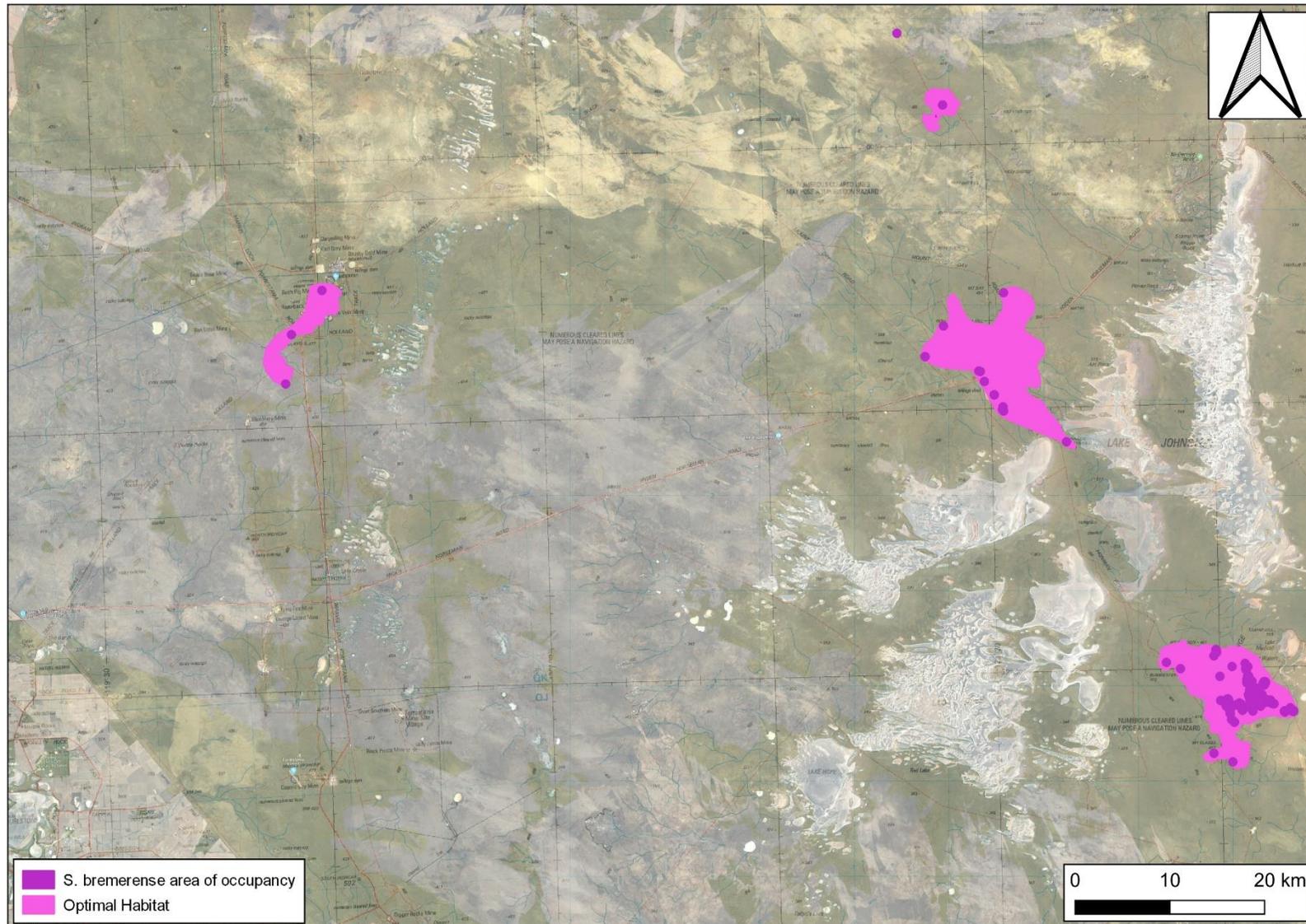


Figure 4: Area of occupancy/ Optimal habitat-*S. bremerense*

2.3 Sub-optimal Habitat

Sub-optimal habitat is considered to be area that the species may be able to grow, but is not preferred or optimal. Sub-optimal habitat has been identified as the habitat within the critical habitat boundary, outside of the area of occupancy and optimal habitat. Logically this may extend further in distance, include other soil and vegetation types, landscape positions etc, but it needs to be limited in some way to enable definition of areas. The extent of sub-optimal habitat has been based on local studies conducted for each species at Bremer Range (provided in Attachment 3 and 4) and a combination of spatial boundaries of both soil landscape systems/ soil mapping units and pre-European vegetation associations within which each species has been previously recorded.

Eucalyptus rhomboidea

As shown in **Figure 5**, *E. rhomboidea* occurs in two soil landscape systems/ soil mapping units, obtained from the DPIRD database (2014) and Geoscience Australia (2009). *E. rhomboidea* occurs on a variety of soils and landforms ranging from mid to low lateritic rises-greenstone hillslopes and creeklines.

Figure 6 shows *E. rhomboidea* occurs within two broad pre-European vegetation associations, including Morell and Dundas Blackbutt woodland and malle scrub.

Stenanthemum bremerense

As shown in **Figure 7**, *S. bremerense* occurs in four soil landscape systems/ soil mapping units, obtained from the DPIRD database (2014) and Geoscience Australia (2009). *S. bremerense* occurs on a variety of soils on the top or sides of laterite outcrops and breakaways and in other sites with lateritic gravel or pebbles.

Figure 8 shows *S. bremerense* occurs within eight broad pre-European vegetation associations, including Morell and Dundas Blackbutt woodland, Salmon gum and Morrel woodland, *E. transcontinentalis* woodland, malle scrub, Casuarina thicket on greenstone hills and Acacia/ Casuarina/ Melaleuca thicket.

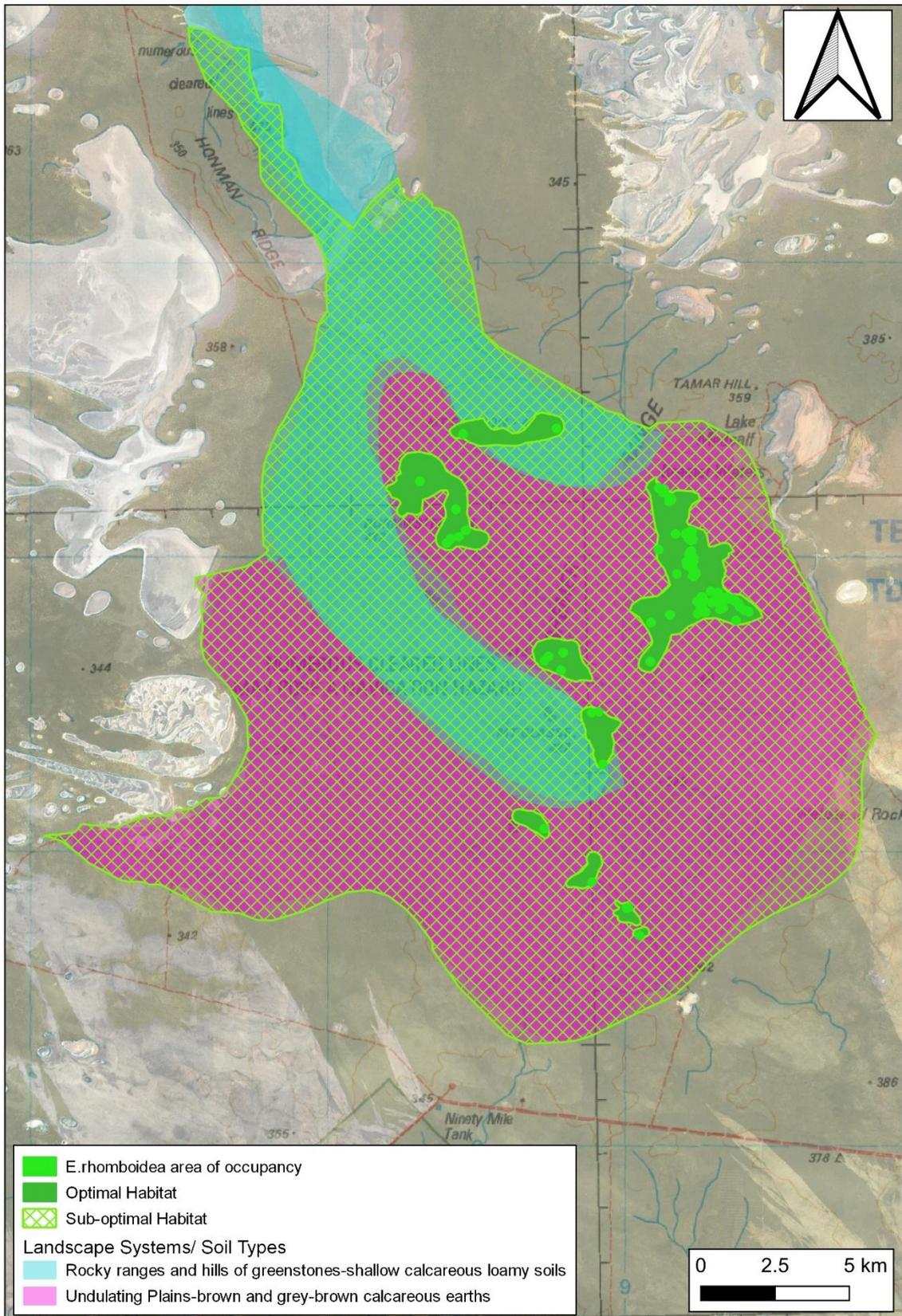


Figure 5: Area of occupancy/ Optimal habitat/ Sub-optimal habitat: soils and landscape systems-*E. rhomboidea*

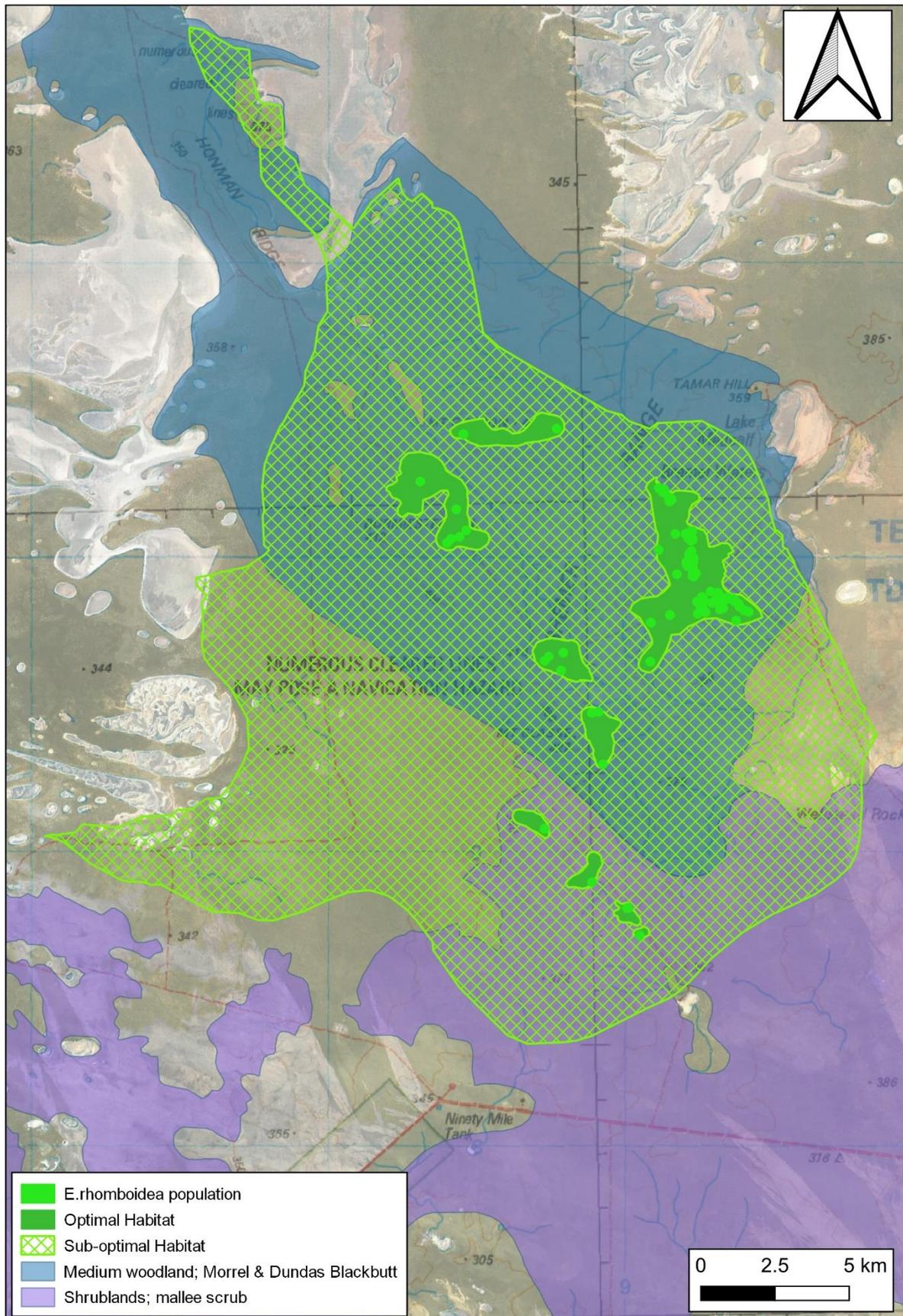


Figure 6: Area of occupancy/ Optimal habitat/ Sub-optimal habitat: vegetation types-*E. rhomboidea*

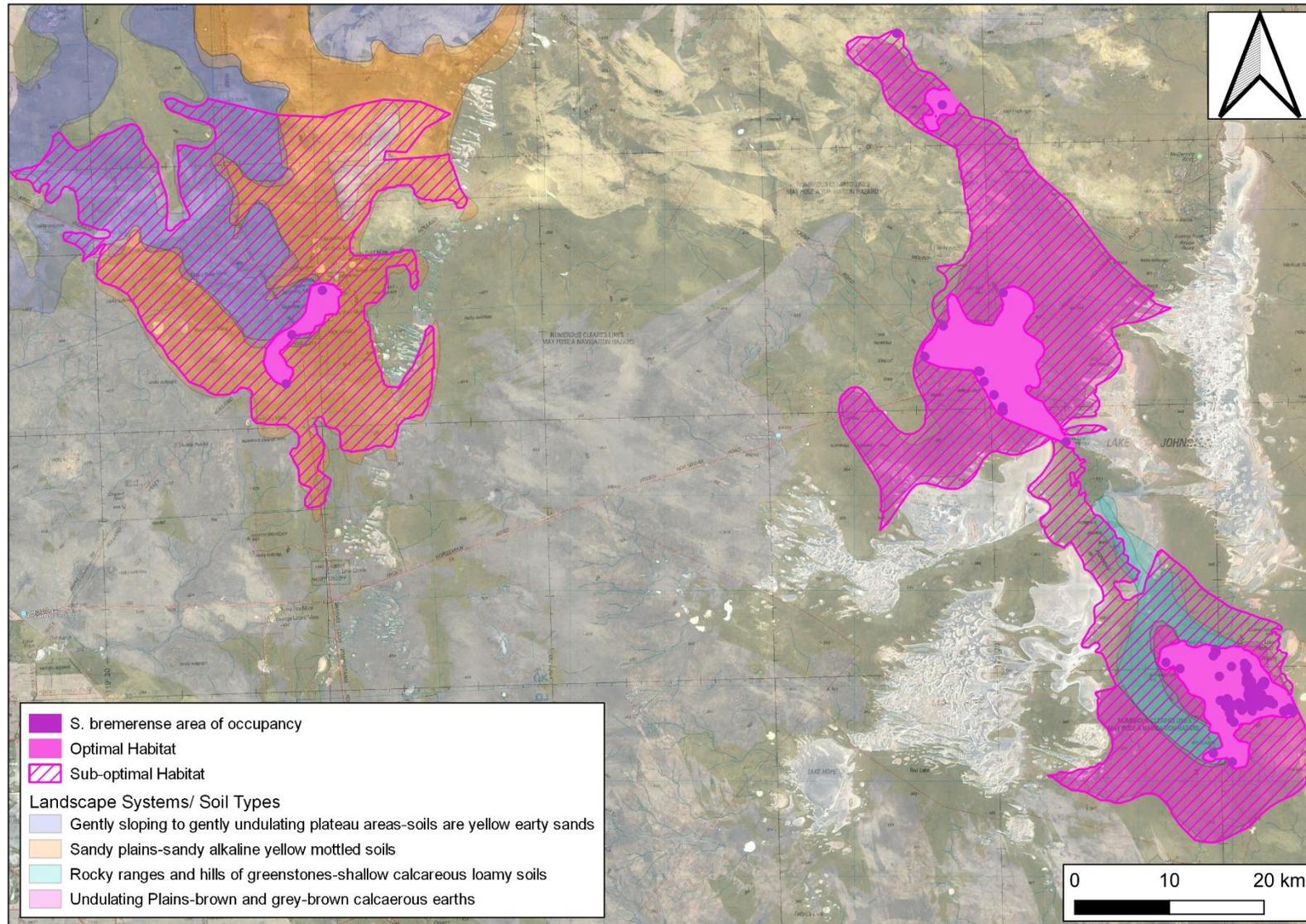


Figure 7: Area of occupancy/ Optimal habitat/ Sub-optimal habitat: soils and landscape systems-*S. bremerense*

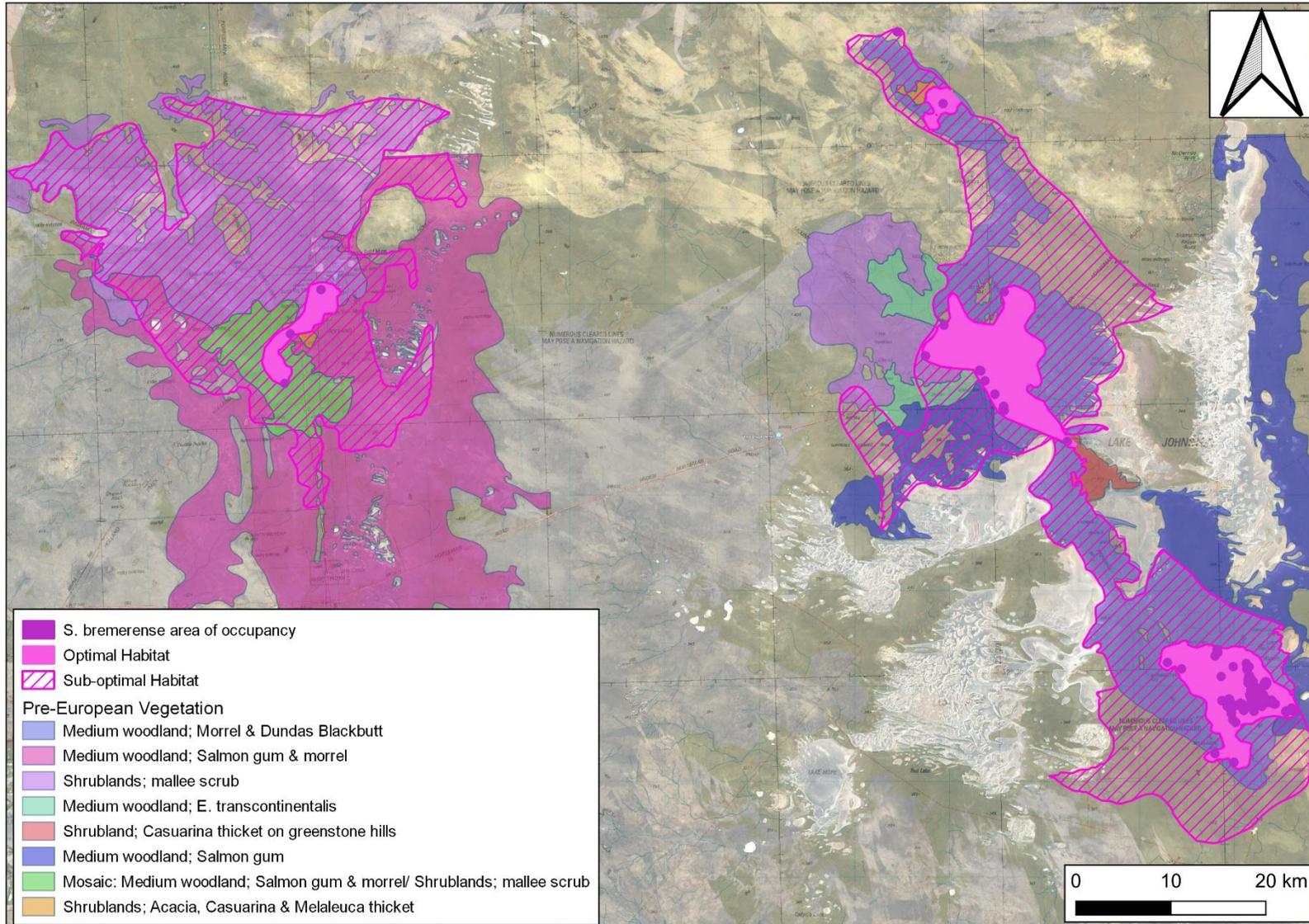


Figure 8: Area of occupancy/ Optimal habitat/ Sub-optimal habitat: vegetation types-*S. bremerense*

2.4 Critical Habitat

Critical habitat includes area of occupancy, optimal habitat and critical habitat. Because of the need to retain linkages between populations for potential pollinators, it is proposed that all landforms and vegetation units between populations (which have been identified as sub-optimal habitat) be considered critical habitat. Maps of the critical habitat for *E. rhomboidea* and *S. bremerense* are provided in **Figure 9** and **Figure 10**.

A summary of the extent of proposed critical habitat, optimal habitat and sub-optimal habitat (including the occupied and unoccupied area within each habitat) is provided in **Table 6**.

Table 6: Extent of Critical, Optimal and Sub-Optimal Habitat

Habitat	Extent (ha)	Occupied area (ha)	Unoccupied area (ha)
<i>Eucalyptus rhomboidea</i>			
Critical Habitat	42,775	12*	42,763
Optimal Habitat	2481	12*	2,469
Sub-Optimal Habitat	40,294	0	40,294
<i>Stenanthemum bremerense</i>			
Critical Habitat	221,008	56*	220,952
Optimal Habitat	23,554	56*	23,498
Sub-Optimal Habitat	197,454	0	197,454

*Excludes fire impacted populations

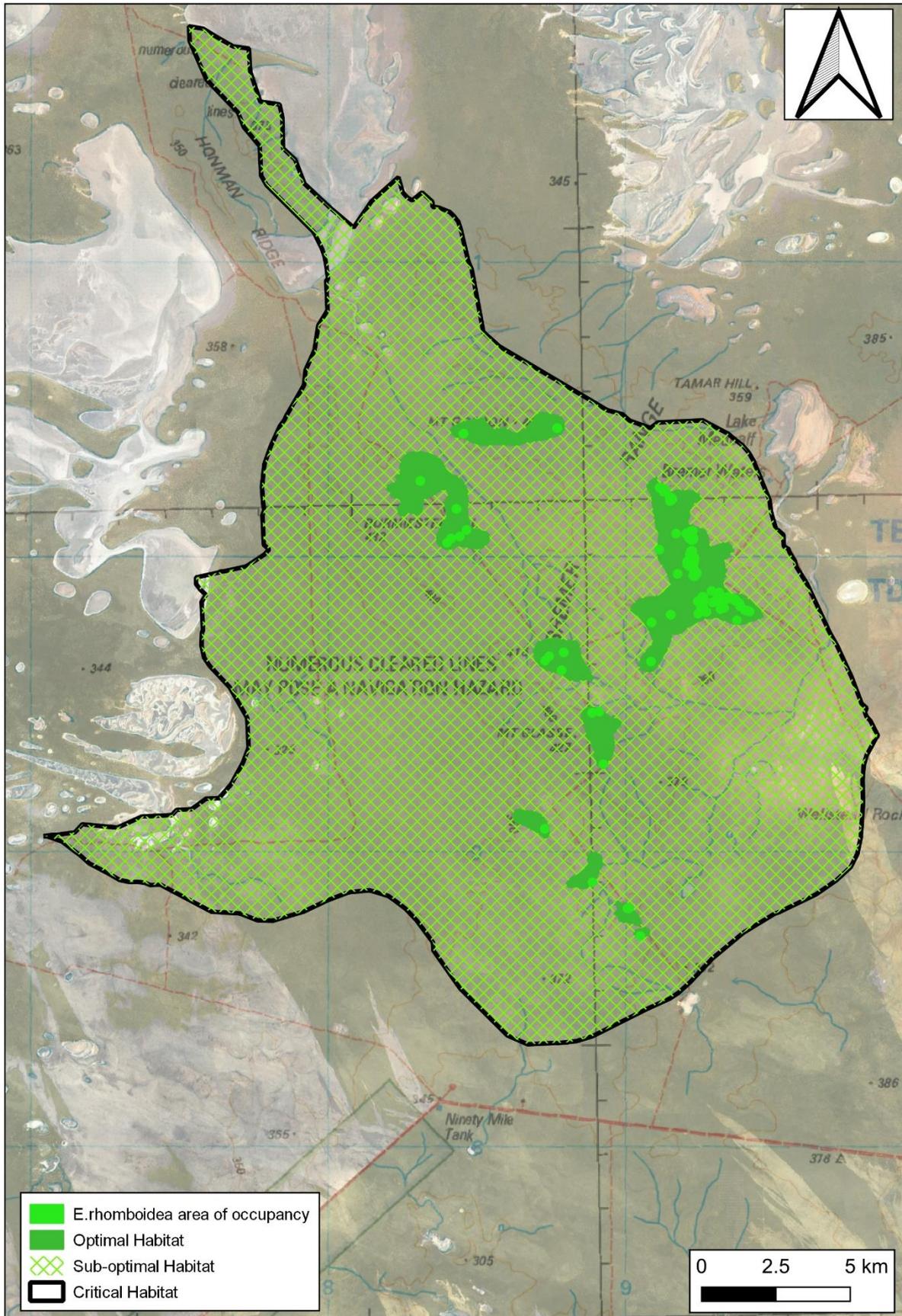


Figure 9: Critical, optimal and sub-optimal habitat-*E. rhomboidea*

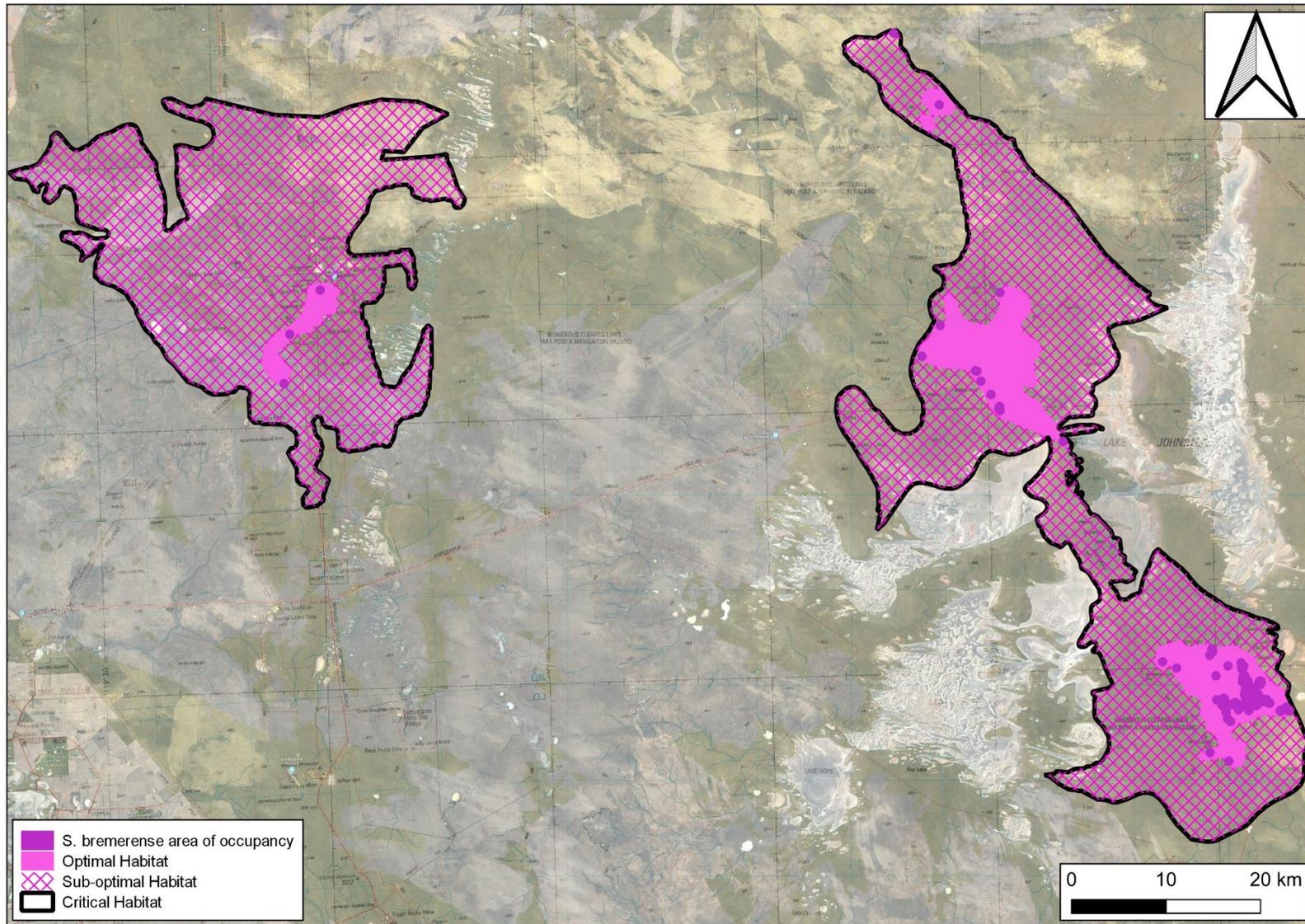


Figure 10: Critical, optimal and sub-optimal habitat-*S. bremerense*

3 REFERENCES

- ASRIS (2014), Atlas of Australian Soils Database, Australian Soil Resource Information System.
- Audalia (2019). Audalia Resources Limited Medcalf Project Environmental Scoping Document. 26 March 2019. Prepared for Audalia Resources Limited by Preston Consulting Pty Ltd.
- Botanica (2020). Detailed Flora & Vegetation Survey. Medcalf Vanadium Mining Project and Proposed Haul Road. Prepared for Audalia Resources Limited. October 2020. Version 3.
- DBCA (2019), 2018 Statewide Vegetation Statistics incorporating the CAR Reserve Analysis (Simplified Report). Department of Biodiversity, Conservation and Attractions.
- DEC, (2011). Implementing Recovery Actions for Bremer *Marianthus* (*Marianthus aquilonaris*). Department of Environment and Conservation, Western Australia.
- DPIRD (2014), Soil Landscape System of Western Australia, Department of Primary Industries and Regional Development.
- DPIRD (2018), Pre-European Vegetation - Western Australia (NVIS Compliant Version GIS file), Department of Primary Industries and Regional Development.
- Geoscience Australia (2009), Spatial Database on Atlas of Australian Soils. Created by National Resource Information Centre.
- GRM (2020). Lake Medcalf Hydrogeological and Hydrological Study Survey Water Assessment. Prepared by Groundwater Resource Management.
- Hopper, S.D & Nicolle, D. (2007). *Diamond Gum (Eucalyptus rhomboidea: Myrtaceae), a new threatened species endemic to the Bremer Range of the Southwest Australian Floristic Region*. *Nuytsia* 17: 185-194.
- Rye, B.L. (2007). *New species and keys for Cryptandra and Stenanthemum in Western Australia*. *Nuytsia* 16(2): 325-382.
- Western Horticultural Consulting (2019). Soils of the Audalia Medcalf area. Prepared by Neil Lantzke for Audalia Resources Limited.

Attachment 1: Population Descriptions

Taxon	Population ID	Population Area (ha)	% Mature	% Juvenile	Flowering/ Seeding	Habitat Description	Condition/ Threats to Population
<i>Eucalyptus rhomboidea</i> (P4)	ER1	7.36	100	0	Seeding	Within creekline and low gravelly rises either side of creekline. Open woodland (<i>E. salmonophloia</i> / <i>E. transcontinentalis</i>) with low shrub understorey (<i>Dodonaea stenozyga</i> / <i>Acacia intricata</i>)	Good-Very Good/ Fire
<i>Eucalyptus rhomboidea</i> (P4)	ER2	0.62	100	0	Seeding	Low gravel rise. Open woodland (<i>E. salmonophloia</i> / <i>E. transcontinentalis</i>) with low shrub understorey (<i>Dodonaea stenozyga</i> / <i>Melaleuca pauperiflora</i>)	Very Good/ Fire
<i>Eucalyptus rhomboidea</i> (P4)	ER3	0.25	60	40	Seeding	Mid gravelly/ lateritic rise. Mallee woodland of <i>Eucalyptus livida</i> and low open shrub understorey (<i>Exocarpos aphyllus</i> / <i>Acacia erinacea</i>)	Good/ Fire, Mining
<i>Eucalyptus rhomboidea</i> (P4)	ER4	0.05	50	50	Seeding	Mid gravelly/ lateritic rise. Mallee woodland of <i>Eucalyptus livida</i> and low open shrub understorey (<i>Goodia medicaginea</i>)	Very Good/ Fire
<i>Eucalyptus rhomboidea</i> (P4)	ER5	0.94	70	30	Seeding	Mid gravelly/ lateritic rise. Mallee woodland of <i>Eucalyptus livida</i> and low shrub (<i>Melaleuca hamata</i> / <i>Dodonaea bursariifolia</i>) and sedge understorey (<i>Lepidosperma sanguinolentum</i>)	Good-Very Good/ Fire, Mining
<i>Eucalyptus rhomboidea</i> (P4)	ER6	2.43	65	35	Seeding	Mid gravelly rise. Open woodland (<i>E. transcontinentalis</i>) with low shrub understorey (<i>Dodonaea stenozyga</i> / <i>Melaleuca pauperiflora</i>)	Very Good/ Fire
<i>Stenanthemum bremerense</i> (P4)	SB1	1.61	100	0	Flowering	Sandy/ Gravelly plain/ low rise. Dense mid shrubland (<i>Melaleuca hamata</i>) with low sedge understorey (<i>Lepidosperma sanguinolentum</i>)	Good-Very Good/ Fire, Mining
<i>Stenanthemum bremerense</i> (P4)	SB2	0.3	100	0	Flowering	Lateritic ridge/ gravelly rise. Dense mid shrubland (<i>Melaleuca hamata</i>) with low sedge understorey (<i>Lepidosperma sanguinolentum</i>)	Very Good/ Fire/ Mining
<i>Stenanthemum bremerense</i> (P4)	SB3	29.14	100	0	Flowering	Lateritic ridge/ gravelly rise. Dense mid shrubland (<i>Melaleuca hamata</i>) with low sedge understorey (<i>Lepidosperma sanguinolentum</i>)	Good-Very Good/ Fire, Mining
<i>Stenanthemum bremerense</i> (P4)	SB4	0.84	100	0	Flowering	Sandy/ Gravelly plain/ low rise. Dense mid shrubland (<i>Melaleuca hamata</i>) with low sedge understorey (<i>Lepidosperma sanguinolentum</i>)	Good-Very Good/ Fire
<i>Stenanthemum bremerense</i> (P4)	SB5	2.63	100	0	Flowering	Sandy/ Gravelly plain/ low rise. Dense mid shrubland (<i>Melaleuca hamata</i>) with low sedge understorey (<i>Lepidosperma sanguinolentum</i>)	Good-Very Good/ Fire
<i>Stenanthemum bremerense</i> (P4)	SB6	0.77	100	0	Flowering	Sandy/ Gravelly plain/ low rise. Dense mid shrubland (<i>Melaleuca hamata</i>) with low sedge understorey (<i>Lepidosperma sanguinolentum</i>)	Good-Very Good/ Fire
<i>Stenanthemum bremerense</i> (P4)	SB7	0.61	100	0	Flowering	Sandy/ Gravelly plain/ low rise. Dense mid shrubland (<i>Melaleuca hamata</i>) with low sedge understorey (<i>Lepidosperma sanguinolentum</i>)	Very Good/ Fire
<i>Stenanthemum bremerense</i> (P4)	SB8	3.54	100	0	Flowering	Sandy/ Gravelly plain/ low rise. Dense mid shrubland (<i>Melaleuca hamata</i>) with low sedge understorey (<i>Lepidosperma sanguinolentum</i>)	Very Good/ Fire
<i>Stenanthemum bremerense</i> (P4)	SB9	0.76	100	0	Flowering	Sandy/ Gravelly plain/ low rise. Dense mid shrubland (<i>Melaleuca hamata</i>) with low sedge understorey (<i>Lepidosperma sanguinolentum</i>)	Very Good/ Fire
<i>Stenanthemum bremerense</i> (P4)	SB10	3.82	100	0	Flowering	Sandy/ Gravelly plain/ low rise. Dense mid shrubland (<i>Melaleuca hamata</i>) with low sedge understorey (<i>Lepidosperma sanguinolentum</i>)	Very Good/ Fire

Taxon	Population ID	Population Area (ha)	% Mature	% Juvenile	Flowering/ Seeding	Habitat Description	Condition/ Threats to Population
<i>Stenanthemum bremerense</i> (P4)	SB11	2.15	100	0	Flowering	Sandy/ Gravelly low rise within rehabbed gravel pit. Mallee shrubland of <i>Eucalyptus eremophila</i> over regrowth mid shrubland (regrowth <i>Acacia sp./Melaleuca sp.</i>)	Good/ Fire, Mining
<i>Stenanthemum bremerense</i> (P4)	SB12	0.68	100	0	Flowering	Sandy/ Gravelly low rise. Mallee shrubland of <i>Eucalyptus eremophila</i> over mid shrubland (<i>Melaleuca hamata/ Casuarina spp.</i>) with low sedge understorey (<i>Lepidosperma sanguinolentum</i>)	Very Good/ Fire
<i>Stenanthemum bremerense</i> (P4)	SB13	1.24	100	0	Flowering	Sandy/ Gravelly low rise. Mallee shrubland of <i>Eucalyptus eremophila</i> over mid shrubland (<i>Melaleuca hamata</i>) with low sedge understorey (<i>Lepidosperma sanguinolentum</i>)	Very Good/ Fire
<i>Stenanthemum bremerense</i> (P4)	SB14	0.81	100	0	Flowering	Sandy/ Gravelly plain/ low rise. Dense mid shrubland (<i>Melaleuca hamata</i>) with low sedge understorey (<i>Lepidosperma sanguinolentum</i>)	Very Good/ Fire
<i>Stenanthemum bremerense</i> (P4)	SB15	0.37	100	0	Flowering	Sandy/ Gravelly plain/ low rise. Dense mid shrubland (<i>Melaleuca hamata</i>) with low sedge understorey (<i>Lepidosperma sanguinolentum</i>)	Very Good/ Fire
<i>Stenanthemum bremerense</i> (P4)	SB16	0.16	100	0	Flowering	Sandy/ Gravelly plain/ low rise. Dense mid shrubland (<i>Melaleuca hamata</i>) with low sedge understorey (<i>Lepidosperma sanguinolentum</i>)	Very Good/ Fire
<i>Stenanthemum bremerense</i> (P4)	SB17	0.2	100	0	Flowering	Sandy/ Gravelly plain/ low rise. Dense mid shrubland (<i>Melaleuca hamata</i>) with low sedge understorey (<i>Lepidosperma sanguinolentum</i>)	Very Good/ Fire
<i>Stenanthemum bremerense</i> (P4)	SB18	0.23	100	0	Flowering	Sandy/ Gravelly plain/ low rise. Dense mid shrubland (<i>Melaleuca hamata</i>) with low sedge understorey (<i>Lepidosperma sanguinolentum</i>)	Very Good/ Fire
<i>Stenanthemum bremerense</i> (P4)	SB19	0.57	100	0	Flowering	Sandy/ Gravelly plain/ low rise. Dense mid shrubland (<i>Melaleuca hamata</i>) with low sedge understorey (<i>Lepidosperma sanguinolentum</i>)	Good/ Fire, Mining
<i>Stenanthemum bremerense</i> (P4)	SB20	0.67	100	0	Flowering	Sandy/ Gravelly plain/ low rise. Dense mid shrubland (<i>Melaleuca hamata</i>) with low sedge understorey (<i>Lepidosperma sanguinolentum</i>)	Very Good/ Fire
<i>Stenanthemum bremerense</i> (P4)	SB21	0.01	100	0	Flowering	Sandy/ Gravelly plain/ low rise. Dense mid shrubland (<i>Melaleuca hamata</i>) with low sedge understorey (<i>Lepidosperma sanguinolentum</i>)	Very Good/ Fire
<i>Stenanthemum bremerense</i> (P4)	SB22	4.67	100	0	Flowering	Sandy/ Gravelly plain/ low rise. Dense mid shrubland (<i>Melaleuca hamata</i>) with low sedge understorey (<i>Lepidosperma sanguinolentum</i>)	Very Good/ Fire
<i>Stenanthemum bremerense</i> (P4)	SB23	0.23	100	0	Flowering	Sandy/ Gravelly plain/ low rise. Dense mid shrubland (<i>Melaleuca hamata</i>) with low sedge understorey (<i>Lepidosperma sanguinolentum</i>)	Very Good/ Fire
<i>Stenanthemum bremerense</i> (P4)	SB24	0.09	100	0	Flowering	Sandy/ Gravelly plain/ low rise. Dense mid shrubland (<i>Melaleuca hamata</i>) with low sedge understorey (<i>Lepidosperma sanguinolentum</i>)	Very Good/ Fire
<i>Stenanthemum bremerense</i> (P4)	SB25	0.39	100	0	Flowering	Sandy/ Gravelly plain/ low rise. Dense mid shrubland (<i>Melaleuca hamata</i>) with low sedge understorey (<i>Lepidosperma sanguinolentum</i>)	Very Good/ Fire

Attachment 2: Habitat Photographs

Attachment 3: Botanica (2020). Detailed Flora & Vegetation Survey. Medcalf Vanadium Mining Project and Proposed Haul Road. Prepared for Audalia Resources Limited. October 2020. Version 3

**Attachment 4: Soils of the Audalia Medcalf area. Prepared by Neil Lantzke for Audalia Resources Limited.
Western Horticultural Consulting (2019)**