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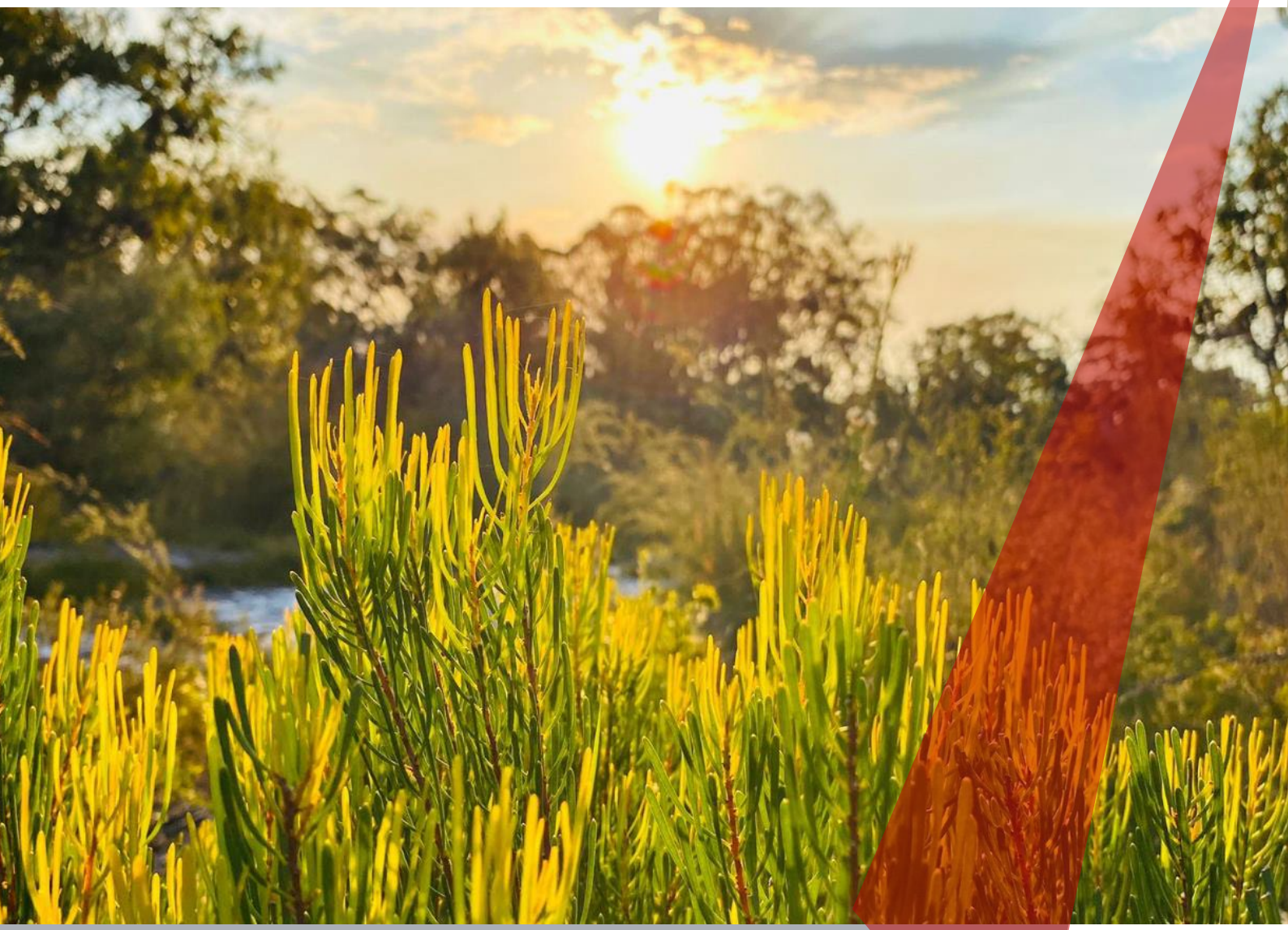

ML1124/ML7064 Glass Sand Mine Rehabilitation Monitoring 2023

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Glossary of Terms

Acronym	Description
cm	Centimetres
EA	Environmental Authority, specifically EPML00349813
EMP	Environmental Management Plan, specifically *Rehabilitation of Disturbed Areas at ML1124, ML1132 and ML7064 North Stradbroke Island* (UNIMIN, 2009)
km	Kilometres
m	Metres
ML	Mining Lease
SIS	Sorenson's Index of Similarity
sp.	Species (singular)
spp.	Species (plural)
sub sp.	Sub species

1 Introduction

The Sibelco Silica Sand Mine Glass Mining Leases (ML) 1124 and 7064 is situated approximately 4 km north-east of the township of Dunwich on North Stradbroke Island, Southeast Queensland. Both leases have been mined and rehabilitated progressively since 1975. Between 2018 and 2021, Sibelco has undertaken rehabilitation in the remaining disturbed areas to progress towards relinquishment in the coming years. To achieve this, the rehabilitation must meet condition F2-1(a) of the Environmental Authority (EA) EPML00349813. This is evaluated using monitoring methods detailed in Section 5.2 of *Rehabilitation of Disturbed Areas at ML1124, ML1132 and ML7064 North Stradbroke Island* (UNIMIN, 2009), hereafter referred to as the Glass Environmental Management Plan (EMP).

To meet the requirements stipulated above, Ausecology Pty Ltd ("Ausecology") was engaged by Sibelco to conduct monitoring at reference sites, and rehabilitation monitoring sites. The primary objective of this monitoring is to assess the progress and quality of the rehabilitation when compared to remnant vegetation at reference sites. Ausecology conducted the scheduled monitoring between 25th and 30th September 2023.

This report details a summary of the methodology used to conduct these activities and presents results for each rehabilitation area when compared to the requirements under the EA.

2 Methodology

This section details the revegetation completion criteria, the survey sites, data collection and analysis, and limitations of the work.

2.1 Revegetation completion criteria

The Glass EMP specifies conditions that must be reached in the establishment of rehabilitated flora. For rehabilitated areas, two categories of criteria are to be met (as presented in Table 2-1), including:

- Species type and diversity
- Species percent comparison

Significant species are not mentioned in the criteria; however, they are defined in Section 3.3 of the Glass EMP, and include:

- *Acacia baueri* subsp. *baueri* (Vulnerable under the NC Act 1992)
- *Boronia rosmarinifolia* (culturally significant)
- *Boronia safrolifera* (culturally significant)
- *Boronia falcifolia* (culturally significant)

Records of these species will be included in the results section.

Table 2-1 Revegetation completion criteria as per Glass EMP

Rehabilitation Parameter	Rehabilitation Objectives	Possible Indicators	Nature of completion criteria	Description
Sustainable Land Use	Establish specified self-sustaining natural vegetation or habitat	Species type and diversity	The index of similarity has increased for 3 consecutive years after the value has reached 50%	A site is deemed compliant if, when compared to a reference site, it has recorded increasing Sorenson's Index of Similarity (SIS) values over 0.5 (50%) for four consecutive years (i.e., the first monitoring event where 0.5 is met, then an increase year on year, for 3 consecutive years after the first year).
Sustainable Land Use	Establish specified self-sustaining natural vegetation or habitat	Species percent comparison	Species comprising more that 15% of the reference areas, the difference in percentage between reference and rehabilitation areas is within ±20%.	The 20% difference refers to the percentage abundance of the species. For example, for a species comprising 20% of the reference area, this species must be present at a proportion between 16% and 20% of the rehabilitated area.

2.2 Methodology

2.2.1 Survey sites

A total of six rehabilitation sites were monitored in September 2023, being previously monitored sites G1, G2, G3, G4, G5, and G6. Table 2-2 provides a summary of the rehabilitation sites and the monitoring history for each. All rehabilitation plots were in areas mapped as RE 12.2.10 on the Qld Regulated Vegetation Management preclearance mapping. Areas of RE 12.2.10 were dominated by *Eucalyptus planchoniana,* the key diagnostic canopy species for RE 12.2.10. Three reference sites of RE 12.2.10 were also measured in September 2023 and were compared against the September 2023 monitoring results for the six Glass rehabilitation sites. Due to variation within regional ecosystem types, it is more appropriate to compare a rehabilitation site to a suite of reference sites to evaluate the success of the rehabilitation (Gravina et al., 2011). Therefore, rather than averaging reference site data, each rehabilitation site was compared to each reference site independently.

Table 2-2 Summary of rehabilitation sites and monitoring history

Site	Rehabilitation Establishment Year	Year(s) Monitored				
		2019	2020	2021	2022	2023
G1	2018	✓	✓	✓	✓	✓
G2	2019		✓	✓	✓	✓
G3	2020			✓	✓	✓
G4	2021				✓	✓
G5	2021				✓	✓
G6	2021				✓	✓

2.2.2 Survey methodology

At each monitoring site a 50 m tape was laid out (Figure 2-1). Within a 50 m by 2 m area (1 m either side of the tape) a stem count for each species was recorded. It should be noted, some species are extremely difficult to determine how many individuals are present due to being multi-stemmed or rhizomatous with subterranean stem junctions. Therefore, for species of the sedge and rush families (*Cyperaceae, Restionaceae, Hemerocallidaceae, Juncaceae*), grass family (*Poaceae*), and the *Lomandra* (mat-rushes), *Cassytha* (dodder laurels), *Austromyrtus* (midyim) and *Xanthorrhoea* (grass-trees) genera, the foliage projective cover (FPC) of the individual species was recorded within the 50 m by 2 m area (1 m either side of the tape) instead of a stem count.

Additional flora species were noted within a 10 m by 50 m plot to contribute to the species list. A 10 m by 50 m plot is considered a standard plot type for measuring the species richness of a site where diversity is highest in the lower strata (Eyre et al., 2015; Neldner et al., 2022).

Start and end points of the 50 m transects were located using a GNSS GPS device.

Photos were taken from the start and end points along the transect tape at each site.

Quaternary assessments as per Neldner et al. (2022) were performed at each site, to verify the suitability of the reference sites and the comparison of rehabilitation sites to reference sites representing a certain RE.

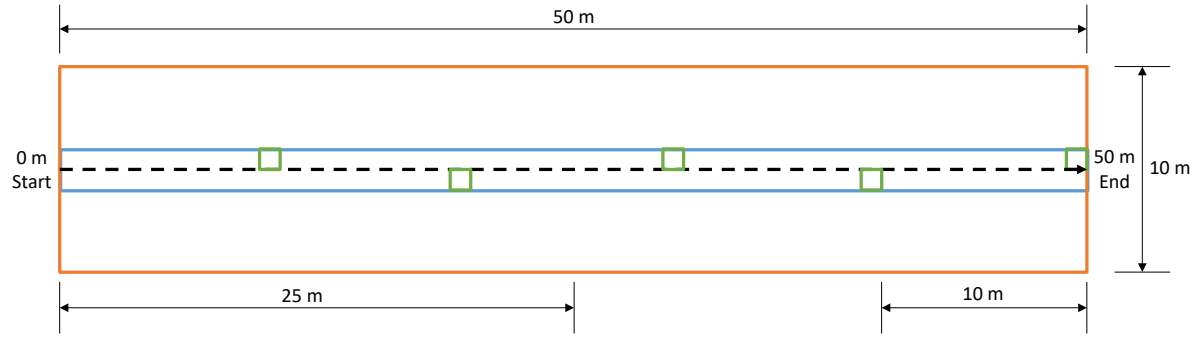


Figure 2-1 Monitoring plot layout

2.3 Analysis

Data analysis was performed as per Section 5.2 of the Glass EMP and included two components: (1) Index of Similarity, and (2) Species Percent Comparison.

2.3.1 Species composition

Sorenson's Index of Similarity (SIS) was employed to compare the species richness of rehabilitation sites to reference sites as measured in a 10 m by 50 m plot. It was calculated for each rehabilitation site in comparison to a corresponding reference site using the formula:

$$SIS = \frac{2c}{a+b}$$

Where:

a = species richness of the rehabilitation site

b = species richness of the reference site

c = number of species found at the rehabilitation site and the reference site

The result of this index is a value between 0 and 1, where 0 is completely different and 1 is identical.

2.3.2 Species abundance

To identify if certain flora species are too sparse or over abundant within rehabilitated areas compared to the reference sites, the percent contribution of dominant species (i.e., those that contribute over 15% of stems to a reference site) are compared with each corresponding rehabilitation site.

The species abundance methodology is stated in Section 5.2 of the Glass EMP, and although it compares the percent contribution of species dominant in the reference sites to their percent contribution in rehabilitation sites, it does not indicate which species are dominant in the rehabilitation. Therefore, the analysis was also performed in reverse by identifying species contributing more than 15% to the stem density of rehabilitation sites and comparing that to the percent contribution of those species to each of the reference sites.

The criteria is considered met if **A** is

$$> \left(\mathrm{B} + (\mathrm{B} \times 0.2)\right) \; and \; < (\mathrm{B} - (\mathrm{B} \times 0.2))$$

A = The Reference site proportion for a species (if over 15%)

B = The rehabilitation site proportion for that species

3 Results

3.1 Site descriptions

3.1.1 Rehabilitation sites

The six rehabilitation sites within the Glass Mine include G1, G2, G3, G4, G5, and G6. The species composition of all six sites was confirmed to be still most similar to regional ecosystem (RE) 12.2.10 which is described by the Queensland Herbarium (2018) as: "Mallee *Eucalyptus planchoniana* +/- *Corymbia gummifera*, *E. racemosa* subsp. *racemosa*, *Banksia aemula* woodland on dunes and sand plans, especially southern sand mass islands. Usually deeply leached soils".

Rehabilitation site G1 is located within an area rehabilitated in 2018 and was monitored for the fifth consecutive year (Appendix A; Figure 3-1). Tree species include *E. planchoniana, E. racemosa, C. gummifera and B. aemula* ranging from 1 m to 4.5 m in height. The shrub layers are sparse with *Ricinocarpos pinifolius* the most abundant tall shrub species whilst *Acacia ulicifolia* is the most abundant low shrub species. The ground layer is sparse and dominated by *Caustis recurvata, Eriachne pallescens* and *Eragrostis* spp. Non-native species include, *Megathyrsus maximus** and *Praxelis clematidea**. New growth of plants was observed, and flowering and fruiting, indicating reproduction and natural regeneration, was evident within the G1 site (Figure 3-1).

The 2019 rehabilitation is represented by site G2 which was monitored for the fourth consecutive year (Figure 3-2). Tree density remains sparse and is dominated by *E. planchoniana* and *B. aemula* with a maximum tree height of 4.3 m. The tall shrub layer is yet to form, however there is a moderate density of species which will develop a tall shrub layer in the future, including *Leptospermum polygalifolium, L. trinervium* and *R. pinifolius.* The low shrub layer is dense with *Ochrosperma lineare*, *A. ulicifolia* and *Woollsia pungens* being the most abundant low shrub species. The ground layer is sparse and consists of native and exotic grasses and forbs with three species, *Imperata cylindrica, Caustis recurvata and Praxelis clematidea**, observed as the most abundant. Flowering and fruiting of tree species was also observed on this site.

Site G3 was rehabilitated in 2020 and was first monitored in 2021. The landform at G3 includes a flat bench top which slopes down towards the west into a valley before flattening out into an ephemeral water body (Figure 3-3). The survey area is located along the southern face of the valley running along contour at the lower half of the slope. The tree layer is sparse and low with a maximum height of 3.5 m. Dominant species include *E. planchoniana* and *B. aemula* with *Angophora leiocarpa, C. gummifera* and *E. racemosa* also present. Defined shrub layers are yet to separate, however tall shrub species include, *Leptospermum polygalifolium, L. semibaccatum* and *L. trinervium,* while *A. ulicifolia, Hibbertia linearis* and *Ochrosperma linearis* dominate the low shrub layer. The ground layer is dominated by bare ground however, a high native grass and forb species richness was observed, including, *Laxmannia gracilis*, *Pteridium esculentum, Cymbopogon refractus* and *Eriachne pallescens.* Several non-native species were observed including, *Cynodon dactylon*, Eleusine indica** and *Melinis repens**. The gully erosion feature caused by water draining towards the ephemeral water to the west of the 2020 rehabilitation area (as noted in the 2020 report) persists directly downslope of the G3 site.

Sites G4, G5, and G6 were rehabilitation to RE 12.2.10 in 2021 and were first monitored in 2022. The landform at G4 includes a gently undulating sand slope surrounded by rehabilitated woodland. The landform at G5 and G6 are both located on flatter sand substrate. The tree layer at all new Glass rehabilitation sites is very sparse and low and includes *C. gummifera*, *Allocasuarina littoralis*, *E. planchoniana*, *A. concurrens*, and *B. aemula*. Defined shrub layers are yet to separate, however tall shrub species were absent except for *A. suaveolens* where some scattered individuals were approximately 1.5 m in height. Most shrub species were very low with the most dominant in abundance/density of low shrubs included: *Ochrosperma lineare*, *A. ulicifolia*, *Hibbertia linearis*,

Laxmannia gracilis, *Bossiaea heterophylla*, *Dillwynia retorta*, *Monotoca* sp. (Fraser Island P. Baxter 777). Flowering and fruiting of *A. ulicifolia* and *A. suaveolens* was observed at each of the newly established sites.

During surveys in 2023 the rehabilitation areas were generally noted to be growing well, however some stressed plants and dieback were observed around the rehabilitation, which may be due to heat, sun exposure, lack of water, or likely a combination of these (Figure 3-5 to Figure 3-8). Yearly monitoring will continue to assess this, but plants will likely recover on their own once rainfall increases and further growth provides more shade and protection to the immature plants.

Figure 3-1 Stratification of G1, rehabilitated in 2018

Figure 3-2 G2 site representing 2019 rehabilitation

Figure 3-3 G3 site representing 2020 rehabilitation, looking towards ephemeral body at bottom of slope

Figure 3-4 The G6 site demonstrating current moderately dense cover of shrubs and understorey

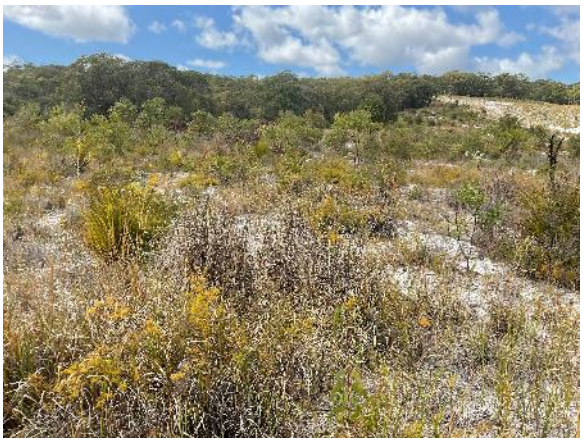


Figure 3-5 Showing the ground cover and improving stratification near the G2 site

Figure 3-6 Young Eucalyptus racemosa near site G2 showing symptoms of stress

Figure 3-7 Shrub near G2 which has died, possibly from stress as was commonly observed in area

Figure 3-8 Young Eucalyptus planchoniana near site G2 reproducing with old fruit and new flower buds

3.1.2 Reference sites

As the target RE for the rehabilitation was RE 12.2.10, three reference sites were monitored to cover the different canopy species composition and community structure of the RE 12.2.10 surrounding the rehabilitation (Table 3-1; Appendix A). No disturbance or substantial differences to the reference vegetation communities were observed in 2023 when compared to data captured during the previous monitoring event in 2022.

The reference site P7, is a woodland co-dominated by *Eucalyptus planchoniana* and *E. racemosa* with scattered *Corymbia gummifera* to 14 m. The REF2 reference site is considered more open than P7 and is dominated by a 10 m canopy of mallee *E. planchoniana* and *Banksia aemula* with scattered *E.s racemosa* and *C. gummifera*. REF1 reference site has a similar community structure to REF2 but is co-dominated by *E. planchoniana* and *C. gummifera* however, *E. racemosa* is absent. A commonality between all reference sites is a low tree layer of *B. aemula* at varying densities.

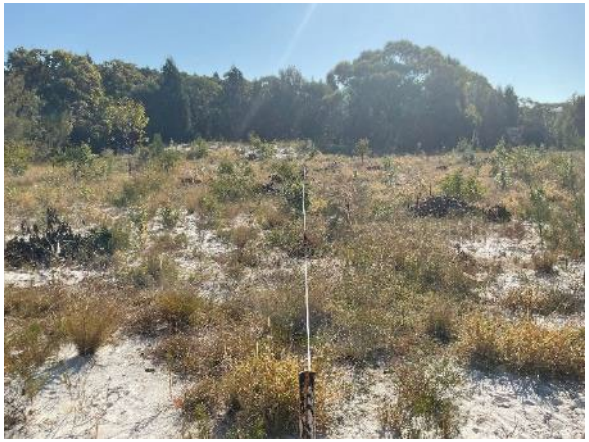
All three reference sites had a tall shrub layer, comprised of *Leptospermum trinervium, Ricinocarpos pinifolius* and *Monotoca* sp. (Fraser Island P. Baxter 777), which was mid-dense at P7 and REF1, but very sparse at REF2. *Xanthorrhoea johnsonii* can be considered a tall shrub in mature undisturbed form, however at all three sites was present in a trunkless form in the ground layer. At site P7, *Leptospermum polygalifolium* and *Baeckea frutescens* formed a tall shrub layer over the latter half of the transect.

Each reference site contained a diverse low shrub layer often dominated by the following shrub species: *Ochrosperma linearis, Homoranthus virgatus, Styphelia leptospermoides, Boronia rosmarinifolia, A. ulicifolia* and *Dillwynia retorta*. Common ground cover species included, *Caustis recurvata, Coleocarya gracilis* and *Platysace ericoides*.

Table 3-1 Description of rehabilitation and reference sites sampled during the 2022 monitoring event

Site	Description	Transect Start	Transect End
Rehabilitation Sites			
G1	Tree layer beginning to form with *Eucalyptus planchoniana, Corymbia gummifera* and *E. racemosa* reaching up to 4.3 m in height. Heath understorey dominated by tall and low shrub species. Rehabilitation established in 2018.		
G2	Shrubland of *Eucalyptus planchoniana, Corymbia gummifera, Banksia aemula* and *E. racemosa* to a height of 4.3 m. Diverse tall and low shrub species dominated by *Ochrosperma lineare, Acacia ulicifolia* and *Aotus lanigera.* Rehabilitation established in 2019. Surveys in 2023 noted that dieback and stress symptoms were present but were not as significant as previous years, and that the good wet season conditions have shown improved growth of plants.		

Site	Description	Transect Start	Transect End
G3	Very sparse dwarf shrubland with tree species at a maximum of 1.1 m. *Eucalyptus planchoniana* is the dominant tree, with *Corymbia gummifera* and *Angophora leiocarpa* subdominant. Diverse shrub species dominated by *Acacia ulicifolia, Hibbertia linearis* and *Ochrosperma lineare.* Surveys in 2023 recorded noticeable growth in trees and other plants, however moderate stress symptoms were persisting.		
G4	Dwarf shrubland dominated by mixed species including, *Acacia ulicifolia*, *Ochrosperma lineare*, *Laxmannia gracilis*, *Hibbertia linearis*, *Bossiaea heterophylla*, *Woollsia pungens*, *Dillwynia retorta*, and *Monotoca* sp. (Fraser Island P. Baxter 777). Tree species recorded included, *Acacia concurrens*, *Allocasuarina littoralis*, *Banksia aemula* and *Eucalyptus planchoniana*, however, cover and density were noted as very low. Surveys in 2023 noted dieback associated with young Eucalypt trees and very few Eucalypt species are surviving within the site. Moderate to severe stress of herbs and forbs was also observed throughout site.		

Site	Description	Transect Start	Transect End
G5	Dwarf shrubland dominated by mixed species including, *Acacia ulicifolia*, *Ochrosperma lineare*, *Laxmannia gracilis*, *Hibbertia linearis*, *Bossiaea heterophylla*, *Woollsia pungens*, *Dillwynia retorta*, *Acacia concurrens*, *Persoonia virgata* and *Monotoca* sp. (Fraser Island P. Baxter 777). Tree species recorded included, *Acacia concurrens*, *Allocasuarina littoralis*, *Banksia aemula* and *Eucalyptus planchoniana*, however, cover and density were noted as very low.		
G6	Dwarf shrubland dominated by mixed species including, *Acacia ulicifolia*, *Ochrosperma lineare*, *Laxmannia gracilis*, *Hibbertia linearis*, *Bossiaea heterophylla*, *Woollsia pungens*, *Aotus lanigera, and Acacia suaveolens*. Tree species recorded include, *Allocasuarina littoralis*, *Banksia aemula*, *Corymbia gummifera*, and *Eucalyptus planchoniana*, however cover and density were noted as very low. Surveys in 2023 noted a general increased cover of low shrubs and forbs across the site. *Acacia suaveolens* was beginning to form a slightly taller shrub layer of approximately 1.5m, but many of these shrubs have died back.		

Site	Description	Transect Start	Transect End
Reference Sites			
P7	Woodland to 14 m of *E. planchoniana* and *Eucalyptus racemosa*, with *Corymbia gummifera* and a subcanopy of *Banksia aemula* to 8 m and a dense ground layer of native tall and low shrubs.		
Ref1	Low open forest of mallee *Eucalyptus planchoniana* and *Corymbia gummifera* to 10 m with a *Banksia aemula* subcanopy to 6 m. Absence of recent fire likely resulting in a particularly high cover of tall shrubs species.		

Site	Description	Transect Start	Transect End
Ref2	Low open forest of mallee *Eucalyptus planchoniana* with *Banksia aemula* and scattered *Eucalyptus racemosa* and *Corymbia gummifera* to 10 m. A subcanopy of *Banksia aemula* present to 6 m.		

3.2 Species type and diversity

Table 3-2 compares the SIS values for rehabilitation sites and reference sites recorded from 2019 to 2023. The table shows that no sites are currently meeting the compliance criteria, being "*increasing Sorenson's Index of Similarity (SIS) values over 0.5 (50%) for four consecutive years*". Though the SIS values are ≥0.5, all sites in 2023 and some have shown increases or similar values in consecutive years. SIS values for G1 increased for all three reference sites between 2019 and 2020, then decreased in subsequent years, with an increase in 2023. In 2021, G2 decreased in SIS value when compared to sites P7 and Ref1, however these have either shown to maintain or slightly increase in SIS value between 2021 and 2023. Site G3 has shown a slight fluctuation between 2021 and 2023 but all sites were >0.5 in 2023. Sites G4, G5, and G6 have only been monitored since 2022 and therefore cannot meet the criteria, however all sites showed an increase, and all met >0.5 in 2023. All sites are ≥0.5 compared to the three reference sites in 2023.

A full list of species observed in 2023 is shown in Appendix B.

Table 3-2 Year-on-year comparison of Sorenson's Index of Similarity (SIS) recorded at rehabilitation sites
(green = on way to meeting criteria >0.5 and increasing year on year; orange = not meeting criteria <0.5, or decrease since last result, grey = not assessed).

Site	Rehabilitation Establishment Year	SIS Per Monitoring Year														
		P7					Ref1					Ref2				
		2019	2020	2021	2022	2023	2019	2020	2021	2022	2023	2019	2020	2021	2022	2023
G1	2018	0.55	0.71	0.55	0.53	0.61	0.47	0.69	0.54	0.53	0.59	0.48	0.67	0.55	0.53	0.58
G2	2019		0.75	0.59	0.59	0.59		0.64	0.51	0.54	0.54		0.63	0.55	0.54	0.56
G3	2020			0.55	0.51	0.62			0.53	0.50	0.60			0.49	0.45	0.56
G4	2021				0.59	0.62				0.50	0.60				0.56	0.65
G5	2021				0.53	0.59				0.44	0.51				0.54	0.61
G6	2021				0.58	0.64				0.52	0.59				0.49	0.61

3.2.1 Significant species

Two significant species were recorded in the reference sites, *Boronia rosmarinifolia* was found in all three sites while *Boronia safrolifera* was found in site Ref2 (Table 3-3). *B. rosmarinifolia* was the only species recorded in the rehabilitation sites, at sites G1, G4, G5 and G6. As mentioned in Section 2.1 above, significant species do not form part of the completion criteria but have been included here out of interest.

Table 3-3 Significant flora species recorded in reference sites and presence/absence from rehabilitation sites

	Reference			Rehabilitation					
Species	P7	Ref1	Ref2	G1	G2	G3	G4	G5	G6
Boronia rosmarinifolia	✓	✓	✓	✓			✓	✓	✓
Boronia safrolifera			✓						

3.3 Species percent comparison

The stem count and FPC cover data for all sites is shown in Appendix C.

Total stem counts were conducted within 2 m by 50 m plots. The three reference sites recorded an average of 309.7 stems and ranged from 102 stems at Ref1 to 477 stems at Ref2 (Table 3-4). The average stem density in the rehabilitation sites was higher than the reference sites, with an average of 397.0 stems, ranging from 25 stems at G1 to 812 at G4.

A summary of dominant species (i.e., Species comprising more that 15% of the reference areas) within reference and rehabilitation sites, including stem counts and the proportion of the total for each species per site is shown in Table 3-5. There were four species regarded as dominant across the three reference sites: *Ochrosperma lineare, Strangea linearis, Styphelia leptospermoides* and *Woollsia pungens.*

Strangea linearis at 19% and *Styphelia leptospermoides* at 18% were dominant at Ref1 however were not recorded in similar proportions any of the other reference or rehabilitation sites.

Ochrosperma lineare was a dominant species occurring in high abundance at five of the six rehabilitation sites. At site G4 and G6, the species made up 58% and 50% of the total stems recorded at the sites respectively. The species also occurred on each of the three reference sites, although was only dominant at P7.

Common species at the rehabilitation sites included *Acacia ulicifolia, Ricinocarpos pinifolius, Monotoca scoparia, Monotoca sp. (Fraser Island P. Baxter 777) Hibbertia linearis Homoranthus virgatus* and *Laxmannia gracilis*. However, despite being frequently encountered in the rehabilitation sites, these species were not comparatively abundant in the reference sites.

Site G1 recorded the lowest total stem count of all the monitored sites, with 25 total stems recorded for eight species. *Ricinocarpos pinifolius, Woollsia pungens* and *Acacia ulicifolia* collectively made up over 70% of all stems recorded at the site. Notably, G1 was the only site that recorded *R. pinifolius* in a substantial number.

An analysis was undertaken to determine if the proportion of each species at a rehabilitation site was within ± 20% of the reference proportion, for any species with a proportion over 15% of the reference site. No rehabilitation sites are meeting this criterion as they are either over or under the ±20% of the reference site proportion.

3.3.1 Shrub foliage projective cover

The presence of herbaceous species as well as *Austromyrtus* (midyim) and *Xanthorrhoea* (grass-trees) genera was recorded as foliage cover in lieu of stem counts. Three reference sites recorded an average of 24% shrub FPC and ranged from 0% at Ref2 to 43% at P7 (Table 3-4). The average shrub FPC in the rehabilitation sites was 15%, ranging from 5% at G1 to 28% at G5.

The percentage cover of each dominant species (i.e., Species comprising more that 15% of the reference areas) per site and mean cover for reference and rehabilitation sites is presented in Table 3-6. Two species, *Xanthorrhoea johnsonii,* and *Baloskion pallens* were recorded as dominant within the reference sites at Ref1 and P7 respectively (Table 3-6). Neither species were recorded at the other reference site or any of the rehabilitation sites (Table 3-6).

An analysis was undertaken to determine if the proportion of each species at a rehabilitation site was within ± 20% of the reference proportion, for any species with a proportion over 15% of the reference site. No rehabilitation sites are meeting this criterion as they are all well below the ±20% of the reference site proportion.

Table 3-4 Total and mean stem counts and Shrub FPC for reference and rehabilitation sites in 2023

	Reference sites			Rehabilitation sites					
	P7	Ref1	Ref2	G1	G2	G3	G4	G5	G6
Total stem count	350	102	477	25	154	95	812	290	634
Mean stem count	309.7			397.0					
Total Shrub FPC	43%	30%	0%	12%	18%	15%	5%	28%	11%
Mean Shrub FPC	24%			15%					

Table 3-5 Stem count (n) and proportion of site total (%) for dominant species (i.e., >15%) at reference and rehabilitation sites in 2023 with dominant species and sites highlighted blue

	Reference								Rehabilitation													
	P7		Ref1		Ref2		Mean		G1		G2		G3		G4		G5		G6		Mean	
Species	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Ochrosperma lineare	54	15%	3	3%	61	13%	39.3	10%		0%	51	33%	19	21%	472	58%	104	36%	319	50%	193.0	33%
Strangea linearis	4	1%	19	19%	36	8%	19.7	9%		0%		0%	1	1%		0%	2	1%		0%	1.5	0%
Styphelia leptospermoides	10	3%	18	18%	11	2%	13.0	8%		0%	1	1%	1	1%		0%	1	0%		0%	1.0	0%
Woollsia pungens	134	38%	14	14%	189	40%	112.3	31%	1	4%	30	19%	1	1%	97	12%	80	28%	80	13%	48.2	13%

Table 3-6 Foliage projective cover (%) for dominant herbaceous species (plus Austromyrtus (midyim) and Xanthorrhoea (grass-trees)) genera at reference and rehabilitation sites in 2023 with dominant species and sites highlighted blue

	Reference				Rehabilitation						
Species	P7	Ref1	Ref2	Mean	G1	G2	G3	G4	G5	G6	Mean
Baloskion pallens	20%	0%	0%	20%	0%	0%	0%	0%	0%	0%	0%
Xanthorrhoea johnsonii	0%	25%	0%	16%	0%	0%	0%	0%	0%	0%	0%

4 Summary of assessment against criteria

The objective of the monitoring survey in 2023 was to monitor rehabilitation established between 2018 and 2021 on ML1124 and ML7064 as well as to assess them against success criteria to fulfil condition F2-1(a) of the Environmental Authority EPML00349813 using methodology detailed in Section 5.2 of the Glass EMP. A summary of the two criteria and current progress towards meeting these as of 2022 is presented in Table 4-1.

All the rehabilitation sites are yet to meet the success criteria.

Table 4-1 Summary of assessment against revegetation criteria in 2023 (compliant = green and ✓; not yet compliant = purple and ☐)

Criteria	Rehabilitation Site and Establishment Year					
	G1 (2018)	G2 (2019)	G3 (2020)	G4 (2021)	G5 (2021)	G6 (2021)
Species type and diversity	☐	☐	☐	☐	☐	☐
Species dominance comparison	☐	☐	☐	☐	☐	☐
Overall	☐	☐	☐	☐	☐	☐

5 Discussion

5.1 Assessment against criteria

5.1.1 Species type and diversity

Overall, the rehabilitation sites are not yet compliant with the revegetation criteria pertaining to species composition. Although many of the rehabilitation sites have partially met the criteria by recording SIS values ≥0.5, none of the sites have recorded three consecutive increases in an SIS above 0.5 yet.

As discussed in the 2022 report, the different species composition between rehabilitation and reference sites is likely due to several factors including:

- The tube stock and seed mixes used for rehabilitation not including all reference site species.
- The relatively early development stage of the rehabilitation which has a low, sparse canopy and understory cover compared to the reference sites affecting the composition of recruiting species.
- Native and exotic grass and forb species able to establish since native cover is still low.

As the structure of the rehabilitation communities develops and species naturally recruit from nearby areas, it is expected that the species composition of the rehabilitation sites will increase in similarity to the reference sites.

Across the rehabilitation areas, several shrub and ground understorey species were observed to be experiencing symptoms of stress, have been sun-bleached or were experiencing dieback. Tree species abundance and density for the areas was also observed as very low. It is likely that some of the young tree extant in areas will experience stress and potentially dieback. It is therefore recommended that infill planting of tree species that represent the target REs is undertaken to facilitate the early establishment of a canopy as well as provide some shade for those shrub and understorey species. In addition, the non-native weedy grass, *Megathyrsus maximus* was observed in moderately dense patches across most of G4 site. It is recommended that treatment of this weed should be undertaken to assist the succession of native plants.

Although Significant Species is not included as a criterion for the Glass EMP, it was noted that Boronia rosmarinifolia was found at four of the 6 rehabilitation sites, while B. safrolifera has not been recorded at any rehabilitation sites.

5.1.2 Species percent comparison

The species abundance criteria presented in Section 2.1 compares the abundance of dominant species within the reference and rehabilitation vegetation communities. A species is considered dominant when it represents more than 15% of the total stem count. The criteria for species percent comparison states that for species that are dominant in reference sites, the same species must be within 20% of the reference percentage within the rehabilitation areas. What is not clear in the wording of this criterion is does a species have to be dominant at all three reference sites to be used in the criterion and therefore present in the rehabilitation sites. Alternatively, if a species only needs to be dominant at one reference site to be used in the criterion, is this an achievable criteria, given the species is not dominant at one or two out of three reference sites. Furthermore, abundance, as stems per hectare, was used as a measure of dominance, however foliage projective cover could also be used to measure this criterion.

None of the rehabilitation sites are currently meeting this criterion for all dominant species. For the dominant species at the reference sites *Ochrosperma lineare* and *Woollsia pungens*, some of the rehabilitation sites are

showing stem counts which are developing towards this benchmark. However, for the dominant species *Strangea linearis* and *Styphelia leptospermoides*, none of the rehabilitation sites are showing substantial stem counts of these species.

Greater stem densities of a greater range of species is expected in the rehabilitation sites, and particularly the most recently established sites, due to the higher ground cover characteristic of areas following disturbance. As the vegetative communities advance in age, stem density is expected to decrease to resemble a structure more alike to the reference communities. Furthermore, several species that were recorded as dominant in the rehabilitation sites are only found in lower densities at the reference sites. This is likely due to the affinity of species such as *Acacia ulicifolia* for recruiting in recently disturbed communities. As the structure of the rehabilitated communities continues to develop, the abundance of different species will fluctuate in line with available habitat (e.g., shade-tolerant species will become more dominant as the canopy grows and closes).

5.2 Summary

None of the sites are currently meeting the Glass revegetation completion criteria. The recommended actions to aid the rehabilitation areas towards meeting the criteria are as follows:

1. Supplemental planting of tree species is recommended across the rehabilitation areas, particularly around sites G3, G4, G5 and G6 to increase tree species diversity and cover as this will aid to shelter the smaller recruiting plants and begin to reflect the reference site structure more closely.
2. Similarly, the density of species identified as dominant in the reference sites should be monitored in the rehabilitated sites and if the species are not returning, supplemental planting or seeding of these species, including *Ochrosperma lineare, Strangea linearis, Styphelia leptospermoides* and *Woollsia pungens* may be required to meet this criterion.
3. Continued monitoring of the minor erosion around G2 and G3 sites to ensure future weather events do not damage the area.
4. Weed monitoring and control should be maintained across the area, particularly focussed on the cover of *Megathyrsus maximus** and *Praxelis clematidea**.
5. Take care with the removal of species such as *Acacia concurrens*, as although this species has been identified as an issue in rehabilitation, it may be allowed to persist in small numbers, to avoid areas being stripped of all taller shrubs which are serving to protect other recruiting species. Similarly, allowing some pockets of dense *Allocasuarina* should be allowed as this is an important habitat feature of glossy black-cockatoo (eastern) (*Calyptorhynchus lathami lathami*), which is listed as Vulnerable under the *Nature Conservation Act 1992* and the *Environment Protection and Biodiversity Conservation Act 1999.*

6 References

Ausecology (2021) *Rehabilitation Monitoring Report for ML1124 2017 Rehabilitation Area*

Ausecology (2022) *Rehabilitation Monitoring Report for ML1124 2017 Rehabilitation Area*

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Gravina, A., McKenna, P., Glenn, P. (2011). Evaluating the success of mineral sand mine rehabilitation on North Stradbroke Island, Queensland: Comparisons with reference eucalypt communities. *Proceedings of the Royal Society of Queensland.* **117:** 420 – 435.

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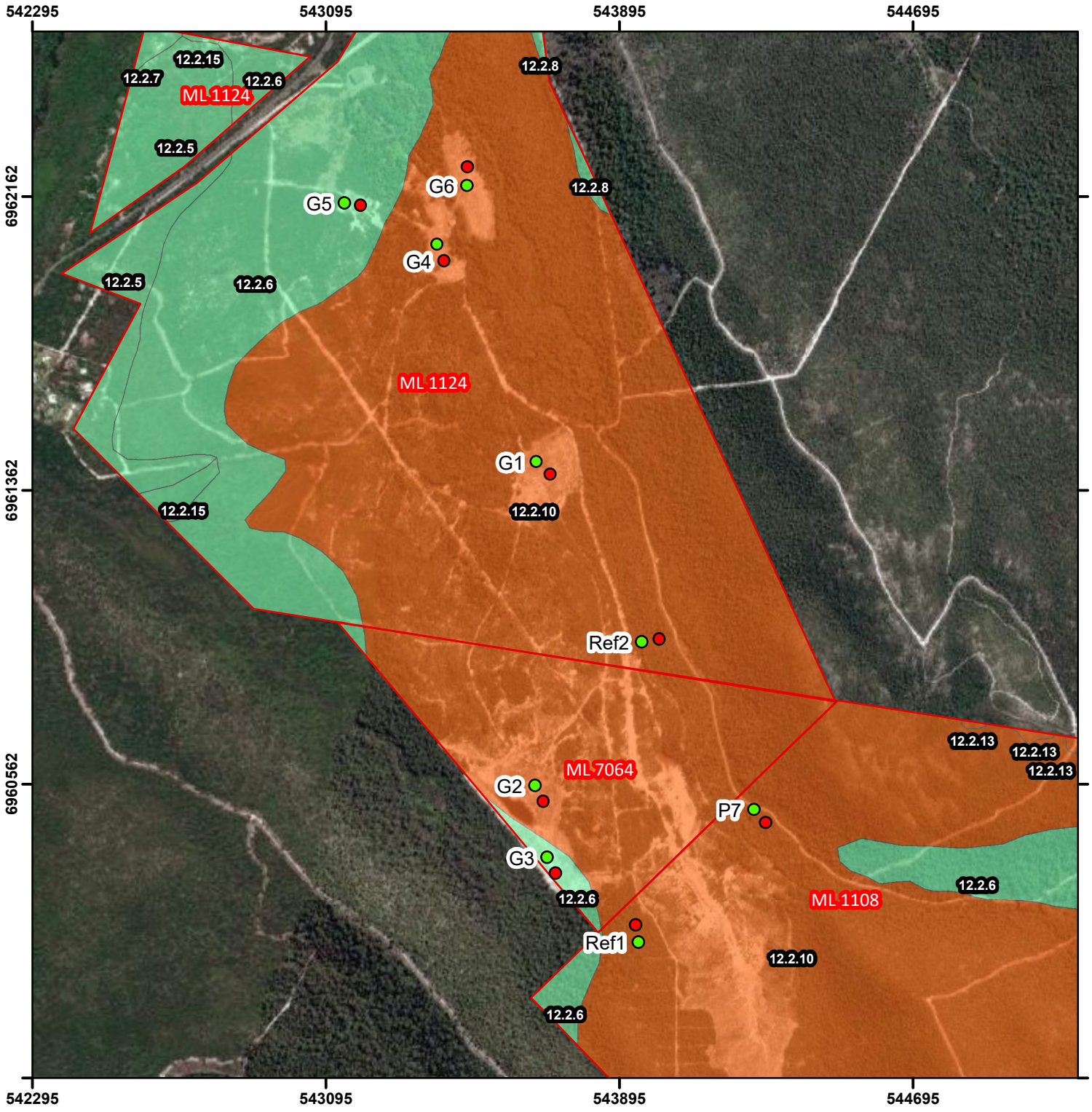
UNIMIN (2009) *Rehabilitation of Disturbed Areas at ML1124, ML1132 and ML7064 North Stradbroke Island*.

Appendix A – Mapping



Ausecology

Appendix A:

Vegetation Monitoring Sites
Glass Mining Lease
North Stradbroke Island 2022

N

0 200 400 600 800

Meters

Scale: 1:8000

Coordinate System: GDA 1994 MGA Zone 56
Datum: GDA 1994

Legend

Mining Leases

Transect Position

End

Start

Pre-Clear Regional Ecosystems

Pre-clearing area containing Of Concern RE

Pre-clearing area that is a Least Concern RE

Data sources:
Mining Lease Boundaries

Document History:

Rev	Reason for Issue	Author	Reviewer	Approver	Date
A	Internal Draft	NC	AD	RR	21/07/2021
1	Issue for infomation	JS	RE	RR	06/08/2021
2	Issue for infomation	JS	AD	RR	21/07/2022

Document Path: C:\Users\Ausecology admin\Ausecology Dropbox\Jennifer Secken\GIS\001_PROJECTS\SIBELCO\237 - Sibelco - Vance Lease Sand Mine\04_Cartography\07_Vance Lease\AppendixA_Sibelco_GlassLease_Rev0.mxd

Appendix B – 2023 Species List

Scientific Name	Life Form	Status	G1	G2	G3	G4	G5	G6	P7	Ref1	Ref2
Acacia concurrens	Tree			✓	✓		✓				✓
Acacia suaveolens	Shrub			✓		✓	✓	✓			✓
Acacia ulicifolia	Shrub		✓	✓	✓	✓	✓	✓	✓	✓	✓
Allocasuarina littoralis	Tree		✓	✓	✓	✓	✓	✓			
Andropogon virginicus	Grass	*		✓	✓	✓	✓				
Angophora leiocarpa	Tree		✓		✓						
Aotus lanigera	Shrub		✓	✓	✓	✓		✓	✓	✓	✓
Aristida jerichoensis	Grass		✓								
Austromyrtus dulcis	Shrub								✓	✓	
Baeckea frutescens	Shrub								✓		
Baloskion pallens	Forb								✓		
Banksia aemula	Tree	Significant sp	✓	✓	✓	✓	✓	✓	✓	✓	✓
Boronia rosmarinifolia	Shrub	Significant sp	✓			✓	✓	✓	✓	✓	✓
Boronia safrolifera	Shrub	Significant sp									✓
Bossiaea ensata	Shrub							✓			
Bossiaea heterophylla	Forb		✓	✓		✓	✓	✓	✓		✓
Brachyloma scortechinii	Shrub		✓	✓			✓		✓	✓	
Callitris columellaris	Tree				✓						
Cassytha pubescens	Forb				✓				✓	✓	✓
Caustis recurvata	Forb		✓	✓	✓	✓	✓	✓	✓	✓	✓
Cenchrus sp.	Grass						✓				
Coleocarya gracilis	Forb		✓						✓	✓	✓
Conospermum taxifolium	Shrub				✓		✓		✓		✓
Conyza bonariensis	Shrub	*					✓				
Corymbia gummifera	Tree		✓	✓	✓	✓		✓	✓	✓	
Crotalaria incana	Shrub	*					✓				

Scientific Name	Life Form	Status	G1	G2	G3	G4	G5	G6	P7	Ref1	Ref2
Cymbopogon refractus	Grass				✓		✓				
Cyperus polystachyos	Forb			✓			✓				
Dianella caerulea	Forb		✓								
Dillwynia retorta	Shrub			✓		✓	✓	✓	✓	✓	✓
Dodonaea triquetra	Shrub		✓	✓	✓		✓	✓	✓		
Doodia aspera	Forb				✓						
Elaeocarpus reticulatus	Tree									✓	
Eleusine indica	Grass	*			✓						
Emilia sonchifolia	Forb	*		✓							
Entolasia marginata	Grass			✓	✓	✓		✓	✓	✓	
Epacris pulchella	Shrub								✓		✓
Eragrostis interrupta	Grass		✓	✓	✓						
Eragrostis parviflora	Grass		✓								
Eriachne pallescens	Grass		✓	✓	✓	✓	✓	✓			
Eucalyptus planchoniana	Tree		✓	✓	✓		✓	✓	✓	✓	✓
Eucalyptus racemosa	Tree		✓						✓		✓
Gahnia sieberiana	Forb			✓							
Gompholobium virgatum	Shrub							✓			
Hibbertia acicularis	Forb								✓		
Hibbertia linearis	Shrub		✓	✓	✓	✓	✓	✓	✓		✓
Homoranthus virgatus	Shrub		✓	✓	✓	✓	✓	✓	✓	✓	✓
Jacksonia stackhousei	Shrub					✓	✓	✓	✓		✓
Laxmannia gracilis	Forb		✓	✓	✓	✓	✓	✓	✓		
Leptospermum polygalifolium	Shrub			✓	✓				✓		
Leptospermum semibaccatum	Shrub		✓								✓
Leptospermum trinervium	Shrub			✓			✓		✓	✓	✓

Scientific Name	Life Form	Status	G1	G2	G3	G4	G5	G6	P7	Ref1	Ref2
Leucopogon virgatus	Shrub								✓		
Lomandra elongata	Forb		✓							✓	
Lomandra laxa	Grass								✓		
Lomandra longifolia	Forb				✓					✓	
Lomatia silaifolia	Shrub				✓						
Lophostemon confertus	Tree		✓					✓			
Megathyrsus maximus	Grass	*	✓				✓				
Melinis repens	Grass	*			✓	✓	✓				
Monotoca scoparia	Shrub		✓		✓				✓	✓	✓
Monotoca sp. (Fraser Island P.Baxter 777)	Shrub		✓		✓	✓	✓	✓	✓	✓	✓
Ochrosperma lineare	Shrub		✓	✓	✓	✓	✓	✓	✓	✓	✓
Paspalum scrobiculatum	Grass			✓							
Paspalum urvillei	Grass	*		✓			✓				
Patersonia sericea	Forb		✓		✓		✓	✓	✓	✓	
Persoonia virgata	Shrub			✓	✓	✓	✓	✓	✓	✓	✓
Petrophile canescens	Shrub		✓	✓	✓		✓				
Phyllota phylicoides	Shrub								✓	✓	
Pimelea linifolia	Shrub			✓	✓				✓	✓	✓
Platysace ericoides	Forb				✓	✓	✓		✓	✓	✓
Praxelis clematidea	Forb	*		✓			✓				
Pseudanthus orientalis	Shrub		✓	✓							
Pteridium esculentum	Forb			✓	✓		✓				
Ricinocarpos pinifolius	Shrub		✓	✓	✓	✓		✓	✓	✓	✓
Schizaea dichotoma	Forb									✓	
Sporobolus virginicus	Grass				✓	✓	✓				
Strangea linearis	Shrub		✓	✓	✓	✓	✓		✓	✓	✓

Scientific Name	Life Form	Status	G1	G2	G3	G4	G5	G6	P7	Ref1	Ref2
Styphelia deformis	Shrub								✓		✓
Styphelia ericoides	Shrub		✓					✓	✓	✓	✓
Styphelia leptospermoides	Shrub								✓	✓	✓
Styphelia viridis subsp. breviflora	Shrub										✓
Utricularia lateriflora	Forb			✓							
Woollsia pungens	Shrub		✓	✓	✓	✓	✓	✓	✓	✓	✓
Xanthorrhoea johnsonii	Shrub		✓	✓	✓	✓		✓	✓	✓	✓
Zieria laxiflora	Shrub		✓	✓	✓	✓	✓	✓	✓	✓	✓

** exotic species*

Appendix C – 2023 Stem Count & FPC Cover Data

			Reference Sites			Rehabilitation Sites					
Species	**Life Form**	**NC Act Status**	**P7**	**Ref1**	**Ref2**	**G1**	**G2**	**G3**	**G4**	**G5**	**G6**
Stem Count											
Acacia concurrens	Tree									6	
Acacia suaveolens	Shrub					2					1
Acacia ulicifolia	Shrub		6	3	4	10	11	23	52	10	59
Aotus lanigera	Shrub		4				5	3	7	1	8
Austromyrtus dulcis	Shrub			2	1						
Baeckea frutescens	Shrub		27								
Boronia rosmarinifolia	Shrub		6	9	10				4		2
Boronia safrolifera	Shrub				7						
Bossiaea heterophylla	Forb								9		
Brachyloma scortechinii	Shrub		8	1	7		6		1	3	4
Conospermum taxifolium	Shrub		2		10			1	4	6	4
Crotalaria incana	Shrub	*								1	
Dillwynia retorta	Shrub		8		31		2		19	13	5
Dodonaea triquetra	Shrub								2	1	
Doodia aspera	Forb							1			
Epacris pulchella	Shrub		17		6						
Gompholobium virgatum	Shrub								1		2
Hibbertia linearis	Shrub				8			5	34	2	34
Homoranthus virgatus	Shrub			3	8			4		19	18
Laxmannia gracilis	Forb						13	12	32	12	28
Leptospermum polygalifolium	Shrub		16	15	3		1	2	1		
Leptospermum semibaccatum	Shrub				14						
Leptospermum trinervium	Shrub		1	8			5			5	1
Lomandra longifolia	Forb							1			

			Reference Sites			Rehabilitation Sites					
Species	**Life Form**	**NC Act Status**	**P7**	**Ref1**	**Ref2**	**G1**	**G2**	**G3**	**G4**	**G5**	**G6**
Lomatia silaifolia	Shrub							1			
Monotoca scoparia	Shrub				23	1	5	5	54		
Monotoca sp. (Fraser Island P. Baxter 777)	Shrub		7	3	7	2	1	3	7	17	31
Ochrosperma lineare	Shrub		54	3	61		51	19	472	104	319
Persoonia virgata	Shrub		11		18	1	6	3	1	1	5
Petrophile canescens	Shrub					1				2	
Pimelea linifolia	Shrub		1	1	2		1		2		
Platysace ericoides	Forb						1	1		1	21
Ricinocarpos pinifolius	Shrub		25	2	3	7	7	4			1
Strangea linearis	Shrub		4	19	36			1		2	
Styphelia deformis	Shrub			1	10						
Styphelia ericoides	Shrub		8		5		8		11	2	10
Styphelia leptospermoides	Shrub		10	18	11		1	1		1	
Styphelia viridis subsp. breviflora	Shrub				1				1		
Woollsia pungens	Shrub		134	14	189	1	30	1	97	80	80
Zieria laxiflora	Shrub		1		2			5	1	1	1
FPC (%)											
Andropogon virginicus	Grass	*					3%	5%			
Aristida jerichoensis	Grass					1%					
Baloskion pallens	Forb		20%								
Blechnum camfieldii	Forb						1%				
Cassytha pubescens	Forb							1%			3%
Caustis recurvata	Forb		4%	3%		5%	1%	1%	1%	2%	3%
Cenchrus sp	Grass	*								5%	

			Reference Sites			Rehabilitation Sites					
Species	**Life Form**	**NC Act Status**	**P7**	**Ref1**	**Ref2**	**G1**	**G2**	**G3**	**G4**	**G5**	**G6**
Coleocarya gracilis	Forb		9%			1%				2%	1%
Cymbopogon refractus	Grass							1%			
Cyperus polystachyos	Forb						1%				
Dianella caerulea	Forb					1%					
Emilia sonchifolia	Forb	*					1%				
Entolasia marginata	Grass										1%
Eragrostis interrupta	Grass							1%			
Eriachne pallescens	Grass						1%		1%		
Gahnia sieberiana	Forb						1%				
Imperata cylindrica	Grass						4%				
Jacksonia stackhousei	Shrub								1%		1%
Laxmannia gracilis	Forb		2%								
Lomandra elongata	Forb					1%					
Lomandra laxa	Grass		1%								
Lomandra longifolia	Forb			1%							
Melinis repens	Grass	*						1%		1%	
Paspalum scrobiculatum	Grass						1%				
Paspalum urvillei	Grass	*					1%			10%	
Patersonia sericea	Forb		1%	1%		1%				1%	
Praxelis clematidea	Forb	*					1%			1%	
Pteridium esculentum	Forb							1%			
Sporobolus virginicus	Grass							3%	1%	5%	1%
Xanthorrhoea johnsonii	Shrub		6%	25%		2%	1%	1%	1%	1%	1%
Xanthosia pilosa	Shrub						1%				

*NC Act Status - * exotic species*