Red Hill Quarry

Assessment of Rehabilitation, Southern Face

December 2013

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ASSESSMENT OF REHABILITATION ON THE SOUTHERN FACES

1.0 Background

The assessment of the rehabilitation on the batter faces at the southern end of the pit was reviewed in December 2013.

That rehabilitation seeks to provide visual management of he completed and backfilled faces when viewed from outside the pit and from longer distance.

2.0 Methods used

There are difficulties in assessing the vegetation on the batters and slopes. The slopes are at the angle of repose for the dumped materials such as overburden.

As such the hardened surface can be slippery and present a hazard to walking on the slopes in a number of locations, but particularly where the slopes are high or are above drops of the face of the quarry.

The slopes were not walked on, on safety grounds but the vegetation was assessed by walking along the upper or lower edge of the rehabilitation and reviewing it from the edges.

As such the data provides a guide and is close to the true values but is not to the same accuracy as using measuring tapes. The other factor is that the slopes are not horizontal and this distorts the area measured.

The methods used are similar to those used in past assessments so direct comparisons can be made.

- In each assessment $10m^2$ plots were estimated measured using a small tape, or where too dangerous to do so, the sides of the plots were visually estimated.

- As there were relatively low numbers of stems in each sample, measurements were necessary only to determine whether a particular stem lay in or out of the sample. The sample areas are shown in Figure 2.

- The plots were selected to provide an unbiased average of the rehabilitation of the slope by placing samples in the best, worst and average vegetation coverage areas, in a proportion that visually matched the overall coverage of that slope.

- The assessment of rehabilitation was to provide data relating to the success of the rehabilitation in light of changed rehabilitation relating mainly to the species mixture.

  Other general observations were made that are discussed in the conclusions.

3.0 Soil Conditions

On the natural granite slopes the soils vary from 1 – 4 metres, increasing in more weathered areas and up slope under the laterite profile.

Natural soils are commonly pale yellow loams and sandy loams on weathered granite with red brown loam on weathered dolerite dykes.

A thin dark brown to grey brown sandy loam and loam topsoil covers the sloping valley soils.

The subsoils are pale white and red brown mottled gibbsite and kaolin rich loams and clays.

The substrate for rehabilitation is formed from the soils and weathered rock overburden which is removed to provide access to the granite basement. These overburden materials are used to create screening bunds and to backfill completed parts of the pit and faces.

The overburden therefore forms the main substrate for rehabilitation. The amount of overburden available depends on the thickness of the soil profile that is cleared. The topsoil is thin, making it difficult to separate from the overburden when clearing land. Topsoil is therefore available in only limited amounts for use in rehabilitation.

On the benches on the south face and other rehabilitated faces there is less soil moisture available than under natural conditions. In natural conditions the basement rock is irregular, contains fractures and depressions that hold moisture and recharge over a broad area with soil moisture able to move through the soils. For example on the natural valley slopes soil moisture entering the soils from up slope is flowing through the soil. The soils are also more irregular allowing additional moisture to enter.

On the other hand on rehabilitated backfilled faces there is little to no soil moisture entering from up slope. Soil moisture results from recharge directly into the backfill. This is also reduced because of the steeper slopes, and more rapid runoff. In addition capillary action and natural soakage removes water from the backfill.

In addition the backfilled faces face north and are therefore exposed to harsh solar activity and higher temperatures than natural soils. This contributes to higher solar radiation, contribute to evapotranspiration and a drying of the soils in summer. In reality the growth conditions on the rehabilitated north and west faces are not present under natural conditions.

4.0 Natural Vegetation Communities

The main natural vegetation communities are;

- Woodland to Open Woodland of *Eucalyptus marginata* subsp. *thalassica – Corymbia calophylla* with scattered understorey, including *Dryandra lindleyana*, *Xanthorrhoea gracilis, Calothamnus sanguineus* and *Lepidosperma squamatum*.

  This site-vegetation type occurs on low undulating sandier soils, although the soils can range from grey leached surface sands to sandy-gravels.

- Woodland to Open Woodland of *Eucalyptus marginata* subsp. *thalassica - Corymbia calophylla* with low dense understorey, including *Dryandra armata* var. *armata, Hakea undulata, Hakea stenocarpa, Hakea trifurcata* and *Lepidosperma squamatum*.

  This site-vegetation type occurs on low undulating sandy gravel to gravel soils over shallow soils.

- Open Woodland of *Eucalyptus wandoo* subsp. *wandoo* and *Eucalyptus accedens* with dense understorey, including *Hakea incrassata, Allocasuarina humilis, Dryandra armata* var. *armata, Hakea undulata* and *Hakea trifurcata.*

This site-vegetation type occurs on the upper slopes of the undulating hills with clay-loams on shallow soils.

- Lithic complex and Open to Closed Heath of Proteaceae - Myrtaceae species, including *Hakea incrassata, Hakea stenocarpa, Dryandra armata* var *armata, Hakea undulata, Melaleuca trichophylla*, *Calothamnus rupestris* (Priority 4), *Allocasuarina humilis* and *Hypocalymma angustifolium*.

  This site-vegetation type occurs on the steeper rocky slopes dominated by granite basement at relatively shallow.

5.0 Rehabilitation

The rehabilitation up to 2007 used a selected mixture of local species known to provide good cover and be successful. The main aims were to provide a good cover and habitat.

From 2008 onwards there was a swing towards increased local provenance species. In 2012 and 2013 seeds have been again collected from site and used to grow tube plants and a local seed source.

One consequence of this appears to be a reduction in the percentage of tree species within the overall mixture.

The key over-riding rehabilitation objective on the backfilled benches is visual management through the use of local provenance species.

Every plant takes a portion of the available water. The species and growth patters is therefore important. There is a finite amount of soil moisture.

The other factor is the various species and forms of plants have different root structure. Most smaller plants have surface roots and shorter fibrous roots. On the other hand trees have fibrous surface roots in addition to deeper taproots. It is therefore likely that only trees will be able to access the soil moisture at the base of the backfilled benches.

If small shrubs take a proportion of the soil moisture and yet do not produce significant ground cover, then to provide the highest level of visual management it will be more efficient to select species better able to grow taller and provide better cover.

The assessments were therefore aimed at determining whether the change to a larger range of local provenance species is appropriate and has produced the same visual cover as previous rehabilitation using selected species.

6.0 Results

In 2011 a total of 61 species had been recorded on site in all rehabilitation.

In 2013 a total of 43 species were observed on the backfilled faces of the southern faces. This will be an underestimate because only plants able to be seen from the benches have been identified and included.

These are shown in the tables below where comparisons can be made.

In all rehabilitation at Red Hill, the total number of species is 94 species. The richness and variation in plant type across all the rehabilitation is high and meets good rehabilitation criteria. However within any particular piece of rehabilitation there are less species.

There are changes in the species from year to year as the availability of individual species changed. There is also variation from year to year and location to location because of the need to mix species from individual trays.

The percentage cover both vertically and horizontally is also shown. There is a direct comparison available between Areas 10 and 11, that is rehabilitation completed in 2009 and 2010 to see if the vegetation cover is sustainable.

The questions then arise.

- Is the rehabilitation on the southern face sustainable?

- Has the change in species type been beneficial in terms of habitat and visual management?
- Are there any modifications to the rehabilitation techniques that will lead to better outcomes?

Is the rehabilitation on the southern face sustainable?

The rehabilitation completed in 2009 and 2010 is sustainable. In 2011 that rehabilitation had achieved 56% and 45% vertical ground cover. By December 2013 the vegetation cover had increased to 72% and 54% respectively. The horizontal coverage and increased from 64% and 56% in 2011 to 82% and 72% respectively in December 2013.

Certainly the rehabilitation is sustainable considering the dry years that have occurred through 2009 to 2013.

At two years Area 10 (2009 rehabilitation) had a cover of 56% vertical and 64% horizontal. By comparison Area 11 (2010 rehabilitation) at three years had a cover of 54% and 72%. Whilst this is higher the additional cover is likely to be related to growth rates, with the additional growth year. Although not showing I the data results, visual observation suggests that the latest vegetation has a higher proportion of smaller shrub species that is not developing as much vegetation and visual cover as previous rehabilitation.

From the previous studies and assessments of rehabilitation, the longer term rehabilitation ends up with about 25 common and successful species, even though many more species were originally installed.

It is yet to be seen whether the species richness of the vegetation will decrease over time. The indications are obtained from Areas 10 and 11 rehabilitation conducted in 2009 and 2010. In 2011 there were 61 species present, but within that rehabilitation, in December 2013 this had dropped to 43 species although that may be a slight under estimate.

This reduction matches previous rehabilitation and is not unexpected because of the harsh soil conditions on the rehabilitated faces.

Has the change in species type been beneficial in terms of habitat and visual management?

As noted above field observations suggest that there are less tree species being planted and less of the larger faster growing *Acacias* that provide rapid cover and regrowth such as *Acacia saligna* and *Acacia microbotrya*. These observations are not backed by the field data so far but are a general impression.

The impression is that there are species being planted that will be taking soil moisture and yet will not be capable of providing any real visual or ground cover, such as *Anigozanthos manglesii, Patersonia juncea, Daviesia spp, Gastrolobium spp, Leucopogon spp,Stylidium spp, Tripteroccus brunonis* and *Hibbertia spp.*

It is likely that most of these have germinated from topsoil although some are obviously installed from tube plants.

There are also some species that although local are better suited to wetter sites and soils that are more moist, such as *Viminaria juncea*.

There is also a lack of groundcover species. These have been planted as tube plants but they do not survive, such as *Kennedia prostrata , Kennedia coccinea* and *Hardenbergia comptoniana*. Whilst in theory groundcovers are highly suitable they are in fact not normally colonizing plants and ground in relatively sheltered positions in the forest, particularly the *Kennedia*s. The soil conditions on the backfilled faces are simply too harsh for such species.

Table 1A **C, M, U** indicates a species was observed, (C = common species, M = moderately common species and U = uncommon species)

SPECIES OBSERVED IN THE REHABILITATION	SOUTHERN BENCHES – December 2013					ALL AREAS – December 2011			
	Total rehabilitation on southern benches	**2012**	**2011**	**2010 Area 11**	**2009 Area 10**	**2006 – 2010 Area 10 Area 11**	**2003 – 2005 Area 9**	**1996 – 1997 Area 8**	**1996 – 1997 Area 6**
Acacia alata	M	C		C		M			
Acacia celastrifolia						U	C	C	
Acacia extensa	C	C	C	C	C	C	C		
Acacia huegelii						U			
Acacia microbotrya							C		
Acacia pulchella	C	C	C	C		C	M		
Acacia saligna	C	C	C	C	C	C	C	C	C
Acacia sp	U	C				U			
Actinotus leucocephalus						C			
Adenanthos barbiger						M			
Adenanthos cygnorum	U			C					
Allocasuarina fraseriana						C		C	
Alocasuarina huegeliana	M	C			C				
Allocasuarina humilis	M		C		C	M			
Anigozanthos manglesii	M	C			C				
Banksia grandis	M	C	C			C			
Beaufortia purpurea						U			
Bossiaea eriocarpa	M			C	C	M	M		
Callistemon phoeniceus	C	C	C		C	U			
Calothamnus rupestris						U			
Calothamnus quadrifidus	C	C	C	C	C	C	C	C	C
Calothamnus rupestris	C		C	C	C				
Calothamnus sanguineus									
Calystachys lanceolata									
Chorizema ilicifolium						U			
Daviesia incrassata						U			
Daviesia divaricata						U			
Daviesia sp	M	C	C						
Dryandra (Banksia) lindleyana	U	C							
Dryandra (Banksia) sessilis						M	M		
Dryandra (Banksia) squarrosa	U	C							
Eucalyptus accedens	C	C	C	C	C	C	C		
Eucalyptus calophylla	C	C	C	C	C	C	C	C	C
Eucalyptus marginata						U		C	

Table 1B **C, M, U** indicate a species was observed, (C = common species, M = moderately common species and U = uncommon species)

SPECIES OBSERVED IN THE REHABILITATION	SOUTHERN BENCHES – December 2013					ALL AREAS – December 2011			
	Total rehabilitation on southern benches	**2012**	**2011**	**2010 Area 11**	**2009 Area 10**	**2006 – 2010 Area 10 Area 11**	**2003 – 2005 Area 9**	**1996 – 1997 Area 8**	**1996 – 1997 Area 6**
Eucalyptus patens						C			
Eucalyptus rudis?						U			
Eucalyptus wandoo	C	C	C	C	C	C	C	C	C
Gastrolobium bilobium									
Gastrolobium calycinum									
Gastrolobium spinosum	U		C						
Gastrolobium villosum						C			
Gompholobium capitum?						U			
Grevillea bipinnatifida						U			
Grevillea endlicheriana						U			
Grevillea synaphea									M
Guichenotia ledifolia	U			C					
Gyrostemon ramulus	M	C	C						
Hakea cristata	M		C	C					
Hakea erinaceae	U		C						
Hakea lissocarpha						U	U		M
Hakea petiolaris	C		C	C	C	M			
Hakea prostrata						C		C	C
Hakea trifurcata	C	C	C	C			U		
Hakea undulata								U	C
Hakea sp?						U			
Hardenbergia comptoniana	C	C	C		C	M	M		
Hemigenia incana									
Hibbertia hypericoides						M			
Hibbertia subvaginata						M			
Hibbertia cuneiformis	C		C	C	C				
Hovea chorizemifolia						U			
Hypocalymma angustifolium						M			
Juncus pallidus	U		C			M		M	
Kennedia coccinea						M			
Kennedia prostrata						M	U		
Kunzea glabrescens?	M	C	C						
Kunzea recurva	M	C	C						
Leptospermum erubescens						U	C		
Leucopogon capitellatus?						U			

Table 1C **C, M, U** indicates a species was observed, (C = common species, M = moderately common species and U = uncommon species)

SPECIES OBSERVED IN THE REHABILITATION	SOUTHERN BENCHES – December 2013					ALL AREAS – December 2011			
	Total rehabilitation on southern benches	**2012**	**2011**	**2010 Area 11**	**2009 Area 10**	**2006 – 2010 Area 10 Area 11**	**2003 – 2005 Area 9**	**1996 – 1997 Area 8**	**1996 – 1997 Area 6**
Lomandra purpurea?	U	C							
Melaleuca incana	C	C	C	C					
Melaleuca lateritia						U			
Melaleuca radula	M	C	C						
*Melaleuca nesophila (1 plant)?**						U			
Melaleuca trichophylla	M	C	C			M			U
Mirbelia dilatata						C	M		
Paplionaceae sp							U		
Paraserianthes lophantha	U	C				M			
Patersonia juncea	C		C	C	C	U			
Petrophile biloba						M			
Pimelia suaveolens	U			C		U	U		
Pimelia ciliata						M			
Ptilotus polystachyus								U	
Regelia sp	U			C					
Schoenus clandestinus						U			
Sollya heterophylla								C	
Stylidium repens?						U			
Synaphea pinnata?							U		
Synaphea spinulosa						U			
Taxandria linearifolia	U		C						
Thomasia glutinosa									U
Tripterococcus brunonis	U			C		U			
Trymalium ledifolium								M	C
Viminea juncea	C		C	C	C		C		
Total species observed	43	Not all species are listed for each rehabilitation area				61	22	16	11
								17	

Table 2A

AREA 10 - Rehabilitated 2009

2011 Sample Data

AREA 10 Counted December 2011 Sample number	No species In 10m²	Number of mature and older stems in 10m² sample	Number of seedlings in 10m² sample (includes seedlings)	Number of plants of tree species	Vertical ground cover afforded by 10m² sample	Lateral visual cover afforded by 10m² sample
1	12	25	3	5	40%	60%
2	6	24	4	3	60%	70%
3	9	16	4	4	70%	80%
4	6	18	2	3	70%	70%
5	4	14	2	0 (2 dead)	15%	15%
6	2	7	0	7	80%	90%
Average	**6.5**	**17.3**	**2.5**	**3.7**	**56%**	**64%**

AREA 10 - Rehabilitated 2009

2013 Sample Data

AREA 10 Counted December 2013 Sample number	No species In 10m²	Number of mature and older stems in 10m² sample	Number of seedlings in 10m² sample (includes seedlings) Included with mature and older stems	Number of plants of tree species	Vertical ground cover afforded by 10m² sample	Lateral visual cover afforded by 10m² sample
1		16			80%	80%
2		13			70%	100%
3		24			60%	80%
4		18			80%	90%
5		21			70%	60%
6						
Average		**18.4**			**72%**	**82%**

Table 2B

AREA 11 - Rehabilitated 2010

2011 Sample Data

AREA 11 Counted December 2011 Sample number	No species In 10m²	Number of mature and older stems in 10m² sample	Number of seedlings in 10m² sample (includes seedlings)	Number of plants of tree species	Vertical ground cover afforded by 10m² sample	Lateral visual cover afforded by 10m² sample
1	12	17	2	3	30%	50%
2	7	11	2	2	25%	30%
3	10	9	1	4	60%	50%
4	5	10	9	4	50%	70%
5	6	10	1	6	60%	80%
Average	**8.4**	**11.2**	**3.0**	**19**	**45%**	**56%**

AREA 11 - Rehabilitated 2010

2013 Sample Data

AREA 11 Counted December 2013 Sample number	No species In 10m²	Number of mature and older stems in 10m² sample	Number of seedlings in 10m² sample (includes seedlings) Included with mature and older stems	Number of plants of tree species	Vertical ground cover afforded by 10m² sample	Lateral visual cover afforded by 10m² sample
1		17			30%	60%
2		16			40%	70%
3		10			80%	50%
4		10			50%	100%
5		14			70%	80%
6						
Average		**13.4**			**54%**	**72%**

Table 2C

AREA 13 - Rehabilitated 2012

2013 Sample Data

AREA 11 Counted December 2013 Sample number	No species In 10m²	Number of mature and older stems in 10m² sample	Number of seedlings in 10m² sample (includes seedlings) Included with mature and older stems	Number of plants of tree species	Vertical ground cover afforded by 10m² sample	Lateral visual cover afforded by 10m² sample
1		11			80%	60%
2		17			70%	80%
3		19			70%	70%
4		19			80%	100%
5		20			70%	80%
6						
Average		**17.2**			**74%**	**78%**

7.0 Future Rehabilitation

7.1 Faces for high visual management

Whilst the rehabilitation has been excellent and is forming the tasks for which it was planted, it is noted that there appears to be a reduction in the species richness on the backfilled southern faces. This has been noted previously in other areas of rehabilitation.

Also there is a significant potential issue to rehabilitation for visual management, which is the requirement for local provenance species and the reduced number of suitable larger species that will grow in such harsh conditions and provide good visual management. The following are the only ones available.

- Four Eucalypts - *Eucalyptus accedens, E. marginata, E. wandoo*, *Corymbia calophylla*.
- Two Acacia – *Acacia microbotrya, A. saligna*.
- Two Sheoak – *Allocasuarina fraseriana, A. huegeliana*, both of which can be quite spindly.
- One Wedding Bush – *Ricnocarpos glaucus*. (This has not previously been grown at Red Hill).

That is not to say that non local species should be used, but rather how they are used may be important.

That is, if a wide range of species are planted, after some years the rehabilitation becomes dominated by about 25 species in harsh conditions. To put this into perspective consider the following.

- If the ground covers such as *Kennedia* spp do not survive after 2 – 3 years why plant them if they do not grow well and therefore modify the microclimate or add significant nitrogen.

- Which has the potential to provide the best long term visual cover; one Marri tree and one Kangaroo Paw or two Marri trees?

- Sites with restricted species still provide good fauna habitat and with species selection can be designed to provide food resources over a longer time frame.

The question then needs to be asked, is it better planting just the 25 species that are known to do well and provide the required cover.

From the observations at Red Hill and other locations where visual management is important restricting species is the best management.

If species are not restricted and say 50 species are planted then the following occurs.

- The number of plants of the more successful species in a given area is normally reduced and the plants are more scattered.

- The species that may not survive in the long term may take resources such as water in the short term potentially restricting growth of the more successful species in the initial stages.

- The planting procedures any mixing species from trays and tubes can lead to areas where there are more shrubs and fewer trees than in other areas.

- If 2 000 local native species are planted using 50 species and after 3 years only 25 species remain, then the potential number of the original plants might only be around 1 000 potential plants. This costs more, and reduces the potential long term plant density.

7.2 Dieback and Substrate Constrained Areas

It is unlikely that high species richness rehabilitation will be able to be established in dieback affected soils, and that in visually sensitive areas it is preferable that fast growing dense tall vegetation is established.

Some of these areas could be existing disturbed ground or ground at closure for which there is insufficient overburden or topsoil.

Thee are also areas such as the old Herne Hill site that has an existing tree cover not necessarily of local native species over a hard substrate or soil constrained by previous hardstand or other factors. Decisions need to be made on whether the existing trees are to be removed, and the whole earthworks recontoured and replanted.

The existing trees are providing habitat now, but some are considered invasive such as *Eucalyptus camaldulensis*. Should they be removed or should the local Provenance species be planted between the existing trees.

If the trees are removed and the soil substrates re-worked it is likely that a significant seed store of the non local species will still exist and will need to be managed. This will also open the area to a period of visual impact.

On the other hand should the non local trees be retained and a managed buffer of local provenance vegetation be established around that area where any non local tree or shrub is removed through ongoing management.

On the other hand there will be areas adjoining sensitive vegetation where high quality species rich habitat should be installed.

8.0 Recommendations

In addition to the Dieback and Weed mapping and baseline information it is recommended that a map be produced of the various substrate soils to direct rehabilitation outcomes.

These maps will need to be updated from time to time as ground is closed, opened and land uses change.

This suggest mapping is to include areas of;

- High visual management west and north faces,
- Soil or substrate constrained areas
- Existing and required high quality local habitat.

8.1 Faces for high visual management

From the data I recommend that the rehabilitation of the backfilled benches have the key objective of visual management rather than species richness.

It is recommended that the following criteria be used on rehabilitated faces where visual management is the critical attribute. This particularly affects those facing north and west. It is recommended that

- Fewer species that are proven to be the best colonisers and be sustainable in the long term.
- Be the fastest growing species.
- Be capable of providing the best long term cover, that is larger shrubs and trees.
- Be capable of regenerating and spreading from self seeding.
- Be species adapted to warmer drier soils rather than moister cooler soils.
- Tube plants with over seeding of a few selected common species that are known regenerating and colonising species.

The recommended species are shown in the table 3 under the column “Recommended for Visual Management”.

It is recommended that a site plan be developed in which the disturbed areas are categorised into areas of rehabilitation based on their habitat potential, proximity to adjoining high quality vegetation, visual management and other ecological and environmental values.

Suggested Rehabilitation Category	**Objective of Rehabilitation**	**Methodology**
Visual Management	Provide high quality fast growing local species that provides sustainable visual management.	• Use approximately 25 species known to provide dense fast ground and visual cover. See Species List in Table 3. • Species should be selected as good self seeders and re-sprouters adapted for drier conditions and harsh soil conditions. • Local provenance plants, seed collected from site, and topsoil. • Revegetation should be tube plants with a possible light overseed of

		selected species, *Eucalyptus* and *Acacia*. **Planting Rates** • Minimum of 3000 plants per hectare including; • Minimum 10 Eucalypt trees per 100 m^2. *Eucalyptus accedens, E. marginata, E. wandoo*, *Corymbia calophylla*. • Minimum 15 large shrubs *Acacia*; *Acacia saligna, A. microbotrya, Allocasuarina fraseriana, A. huegeliana, Ricnocarpos glaucus, Banksia grandis, Hakea prostrata.*

8.2 Dieback and Substrate Constrained Areas

The site mapping for weeds and dieback should be used to identify constrained locations. To this can be added mapping of areas of constrained soils.

In dieback impacted areas, select species that are known to be dieback resistant and ensure that a significant proportion of the species planted are resistant.

In substrate constrained areas, work with Department of Parks and Wildlife with respect to the aims for rehabilitation of each area to develop a rehabilitation strategy and completion criteria.

Suggested Rehabilitation Category	**Objective of Rehabilitation**	**Methodology**
Dieback and Constrained Native Vegetation	Provide a diverse cover of local native species in constrained areas, such as dieback, old rehabilitation, old hardstand at Herne Hill, etc	• Use a wide range of diverse species known to be sustainable in the constrained areas. For example in dieback impacted areas plant a significant proportion of dieback resistant species. • Use tube plants and as necessary overseeding. • Local provenance plants, seed collected from site, and topsoil. • Revegetation should be tube plants with a possible light overseed of selected species, *Eucalyptus* and *Acacia*. • Consideration can be given to foliar spraying with Phos-inject 200, Chemfos 400 or Agric-fos 600 at the correct concentrations.

		Planting Rates • Minimum of 2000 plants per hectare including; • Minimum 10 Eucalypt trees per 100 m^2. *Eucalyptus accedens, E. marginata, E. wandoo*, *Corymbia calophylla*. • Minimum 10 large shrubs *Acacia*; *Acacia saligna, A. microbotrya, Allocasuarina fraseriana, A. huegeliana, Ricnocarpos glaucus, Banksia grandis*

8.3 Local Habitat

In areas not constrained, locations where high quality habitat is required, buffers and other such locations a species rich, diverse and dense habitat should form the required rehabilitation.

Suggested Rehabilitation Category	**Objective of Rehabilitation**	**Methodology**
Local Habitat	Provide a species rich dense cover of native vegetation in environmentally sensitive and edge areas, vegetation buffers, wildlife habitat etc.	• Plant species rich dense rehabilitation from local native species collected from site. • Use a wide range of diverse species matching the adjoining habitat. • Use tube plants and as necessary overseeding. • Local provenance plants, seed collected from site, and topsoil. • Revegetation should be tube plants with a possible light overseed of selected species, *Eucalyptus,* Proteaceae and *Acacia*. **Planting Rates** • Minimum of 3 000 plants per hectare^2. • Minimum 15 Eucalypt trees per 100 $m^{2.}$ *Eucalyptus accedens, E. marginata, E. patens, E. wandoo*, *Corymbia calophylla*. • Minimum 10 Large *Shrubs; Acacia saligna, A. microbotrya. Allocasuarina fraseriana, A. huegeliana, Banksia grandis.*

Table 3

SUITABILITY OF SPECIES FOR VISUAL MANAGEMENT ON BACKFILLED SOUTHERN AND WESTERN PIT FACES

	Species present In rehabilitation **C -** Common **M -** Moderate **U -** Uncommon	**Tree species Hardy Sustainable** **X -** Suitable for all soils **W -** Requires protected or moist soils	**Shrub Hardy Sustainable** **X -** Suitable for all soils **W -** Requires protected or moist soils	**Readily seeds – resprouts under harsh conditions** **X -** Suitable for all soils **W -** Requires protected or moist soils	**Recommended for Visual Management** **X -** Suitable for all soils **W -** Requires protected or moist soils	**Better suited to more protected areas where high species richness and habitat are required.** **X -** Suitable for all soils **W -** Requires protected or moist soils **S –** Small plant to increase species richness **T –** Tree **B –** Tall shrub
Acacia alata	M					XS
Acacia celastrifolia			X	X	X	X
Acacia extensa	C					W
Acacia huegelii						XS
Acacia microbotrya		X	X	X	X	XB
Acacia pulchella	C		X		X	X
Acacia saligna	C	X	X	X	X	XB
Acacia sp	U					
Actinotus leucocephalus						XS
Adenanthos barbiger			X			XS
Adenanthos cygnorum	U					X
Allocasuarina fraseriana		X	X	X	X	XB
Alocasuarina huegeliana	M	X	X	X	X	XB
Allocasuarina humilis	M					X
Anigozanthos manglesii	M					XS
Banksia grandis	M			X	X	XB
Beaufortia purpurea						X
Bossiaea eriocarpa	M					XS
Callistemon phoeniceus	C		W			WB
Calothamnus rupestris			X	X	X	X
Calothamnus quadrifidus	C		X	X	X	X
Calothamnus sanguineus			X	X	X	X
Calystachys lanceolata						X
Chorizema ilicifolium						XS
Daviesia incrassata			X			XS
Daviesia divaricata			X			XS

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Daviesia sp (Banksia) sp	M					
Dryandra (Banksia) lindleyana	U		X			XS
Dryandra (Banksia) sessilis			X		X	XB
Dryandra (Banksia) squarrosa	U	X	X		X	XB
Eucalyptus accedens	C	X		X	X	XT
Eucalyptus (Corymbia) calophylla	C	X		X	X	XT
Eucalyptus marginata		X			X	XT
Eucalyptus patens		W			W	WT
Eucalyptus rudis		W			W	WT
Eucalyptus wandoo	C	X		X	X	XT
Gastrolobium bilobium						XS
Gastrolobium calycinum						XS
Gastrolobium spinosum	U					XS
Gastrolobium villosum						XS
Gompholobium capitum?						XS
Grevillea bipinnatifida			X			XS
Grevillea endlicheriana			X			XS
Grevillea synaphea						XS
Guichenotia ledifolia	U					X
Gyrostemon ramulus	M					XS
Hakea cristata	M		X		X	X
Hakea erinaceae	U		X			X
Hakea lissocarpha			X		X	X
Hakea petiolaris	C		X		X	XB
Hakea prostrata			X		X	XB
Hakea trifurcata	C		X		X	XB
Hakea undulata			X			X
Hakea sp?						
Hardenbergia comptoniana	C					X
Hemigenia incana			X			XS
Hibbertia hypericoides						XS

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Hibbertia subvaginata			X			XS
Hibbertia cuneiformis	C		X			X
Hovea chorizemifolia						XS
Hypocalymma angustifolium			WX			WX
Juncus pallidus	U					
Kennedia coccinea						X
Kennedia prostrata						X
Kunzea glabrescens	M		X			XB
Kunzea recurva	M		X		X	XB
Leptospermum erubescens			X		X	XB
Leucopogon capitellatus?						XS
Lomandra purpurea?	U	X				XS
Melaleuca incana	C		X		X	X
Melaleuca lateritia			W			W
Melaleuca radula	M		X		X	X
Melaleuca trichophylla	M		X		X	X
Mirbelia dilatata			X	X	X	XB
Paplionaceae sp						
Paraserianthes lophantha	U		W	W	W	WB
Patersonia juncea	C					XS
Petrophile biloba					X	XS
Pimelia suaveolens	U					XS
Pimelia ciliata						XS
Ptilotus polystachyus						
Regelia sp	U					X
Ricinocarpos glaucus			X	X	X	XB
Schoenus clandestinus						WS
Sollya heterophylla						W
Stylidium repens?						XS

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Synaphea pinnata?						XS
Synaphea spinulosa						XS
Taxandria linearifolia	U		W	W	W	WB
Thomasia glutinosa						XS
Tripterococcus brunonis	U			X		XS
Trymalium ledifolium			X			X
Viminea juncea	C		W	W	W	WB