Appendix K

Moora Quartzite Mine Rehabilitation Plan (Ecoscape 2012)

Moora Quartzite Mine Rehabilitation Plan - Final

Simcoa Operations Pty Ltd

science+design

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- Daniel Mance, Environmental Officer, Simcoa
- Shannon Mackenzie, Director, Mine Earth
- Stacey Gregory, Principal Consultant, Mine Earth

Summary

Simcoa Operations Pty Ltd (Simcoa) operates a quartzite mine north of Moora in Western Australia. The mine contains silica dioxide, which Simcoa is currently extracting for their silicon Smelter in Kemerton, near Bunbury. Simcoa requires a Rehabilitation Plan (RP) so the mine can meet the requirements set by the Environmental Protection Agency (EPA), Department of Environment and Conservation (DEC) and Department of Mines and Petroleum (DMP).

The Rehabilitation Plan has been prepared in 3 stages:

1. **Rehabilitation Audit**: The Existing Environment was studied to determine what specific items need to be considered in the rehabilitation of the Mine Site (**Section 2**). Similarly, the Current Rehabilitation Practices were audited to determine any areas of improvement (**Section 3**).

   As a result of this examination, both Sections contain text boxes termed "Rehabilitation Notes". Each Note summarised an identified issue, recommended an action and listed which Section the action was addressed within the Rehabilitation Plan. A summary of the 28 Rehabilitation Notes is presented in **Table 1.**

2. **Domain Model Plan:** The Mine Site was divided by its site characteristics and end land uses into the following Rehabilitation Domains (**Section 4**):
   a) *TEC Buffer* – the waste rock dumps to be rehabilitated with a species composition and structure similar to the adjacent Coomberdale Chert TEC
   b) *Revegetation* – flat open areas to be rehabilitated with vegetation similar in composition and structure to the local vegetation community.
   c) *Pasture* – low value fodder for cattle grazing
   d) *Screening* – using local tree and large shrub species to visually screen the Mine Site from the adjacent Midland Road.

   The open pits and any access roads or firebreaks to be retained were not to be rehabilitated, so were excluded from the domains.

   Appropriate treatments were then determined for each Rehabilitation Domain to achieve their end land use while considering their site characteristics. The Domain Model Plan is summarised in **Table 2.**

3. **Rehabilitation Techniques:** Practical information was presented to aid site personnel in carrying out the recommended appropriate treatments in terms of landscape design (**Section 5**), revegetation techniques (**Section 6**), weed control (**Section 7**), mine hygiene (**Section 8**), monitoring and maintenance (**Section 9**) and revegetation trials (**Section 10**).

Table 1: Summary of Rehabilitation Notes for Simcoa's Moora Quartzite mine's rehabilitation works

No.	Issue	Action	Addressed
2.1 Physical Environment			
1	Most of the annual rainfall in the Mine Site occurs in winter.	Revegetation activities should be planned to utilise the winter rainfall (May to September) to maximise success of native seed germination and establishment.	Sections 6.2.5 and 6.3.3
2	The Mine Site may continue to receive lower than average rainfall in the near future, which may prolong or even prevent rehabilitation works meeting their KPIs.	Rainfall patterns should continue to be monitored and if the trend continues, the rehabilitation KPIs may need to be reconsidered and amended to those which are achievable in a drier environment	Section 6.6
3	The Mine Site has specific landform features.	Rehabilitation efforts should be directed towards resembling the local landforms where possible. Specific features that could be mimicked include rocky outcrops, local elevated hills and gentle slopes towards drainage and river flats.	Section 5.1
2.2 Biological Environment			
4	As the mining operation will result in surface geology being structurally changed, revegetation will be unable to restore all or any of the local vegetation associations.	Revegetation should be focused on returning a basic resemblance to local vegetation structure, rather than attempting to restore local vegetation associations, promoting local species that can grow in the broken rock substrate.	Section 6.2
5	A State listed TEC occurs within and adjacent to the Mine Site, part which is being cleared for mining activities.	Revegetation outcome should be focused on helping to conserve the identified TEC in terms of species diversity, promoting dominant species and in vegetation structure where possible.	Section 6.2
6	The Mine Site contains two threatened flora species - *Acacia aristulata* and *Daviesia dielsii.*	Revegetation trials should be conducted to determine whether it is possible to establish self sustainable populations of these species.	Sections 6.2 and 10.2
7	There is no quantified information on the original weed cover of the Mine Site, therefore it cannot be determined whether the EPA criterion of 10% weed cover is feasible.	Examine the remnant vegetation the in Mine Site to determine the weed cover.	Section 7.1
8	The Mine Site is known to contain 34 weed species, of different biological forms (grasses, geophytes or broad leaf herbs).	Weed control activities at Simcoa should be divided into addressing weed species according to their biology and method of control.	Section 7.4 and Appendix Five
9	The Mine Site is known to contain ten High Priority weed species which may be significant threats to the local vegetation and cause considerable weed cover in rehabilitated areas.	Weed control activities should be developed to identify and target individuals or populations of the High Priority weed species to minimise weed cover in rehabilitated areas to EPA completion criteria.	Section 7.3 and Appendix Five
10	Mining activities in the Mine Site may further fragment and isolate local remnant vegetation, which may impact on the long term sustainability of local fauna populations.	The rehabilitation design should consider providing ecological corridors where practicable for local fauna species to move between remnant vegetation.	Sections 4.2 and 4.3
11	The Mine Site may serve as a habitat for as many as six locally occurring conservation significant fauna species.	Rehabilitation should consider providing suitable fauna habitat, in terms of food source and breeding sites, to assist in the conservation of these species.	Section 6.1
12	The Mine Site and adjacent TEC are vulnerable to introduction of Dieback from unhygienic mine activities.	All rehabilitation activities within the Mine Site should include hygiene prevention and management procedures for possible introduction and spread of the plant diseases.	Section 8.1
3.1 Physical Design			
13	Ripping could be a useful technique for encouraging revegetation success in areas where soil is compacted and not composed of waste rock material.	Future revegetation work should consider ripping where appropriate and practical to relieve soil compaction for future revegetation works.	Section 5.2
14	After topsoil and remnant vegetation sources are depleted, future revegetation methods risk losing seed to wind and rain erosion.	Where practicable, soil scarification treatment should be considered prior to seeding to provide niches for seeds to be lodged in and to limit loss of seeds to wind and rain erosion.	Section 5.3
3.2 Revegetation Strategy			
15	There are not enough topsoil and mulch resources for future rehabilitation works.	New substitute sources and/or techniques are required to overcome this shortfall and ensure adequate revegetation success.	Sections 6.3 and 10.3
16	Current harvest time of vegetation may not be obtaining the maximum amount and diversity of viable seeds and propagules for revegetation.	Need to examine whether there is an optimal time for harvesting of vegetation in order to increase revegetation success.	Section 10.1.3

17	There has been native seed collected for rehabilitation works.	Seed collecting if practicable should continue in the Mine Site and in adjacent vegetation to improve abundance and diversity in revegetated areas.	Section 6.3.3
18	There is no procedure for the proper storage of collected native seeds.	A seed storage procedure needs to be developed for the storage of collected seeds to prolong their viability and to protect them from being eaten by bugs.	Section 6.3.3
19	Native seeding trials to date have been unsuccessful.	Further seeding trials are needed to improve revegetation success. Improvements may include testing for viability, dormancy breaking treatments, site preparation, timing and type seed mix. The trials need to be regularly monitored and reported upon so to select suitable species.	Section 10.1
20	Previous seeding trials for successful germination of conservation significant flora *Acacia aristulata* (TF) *and Daviesia dielsii* (TF) have been unsuccessful.	New revegetation trials need to be developed and implemented for threatened flora.	Section 10.2
21	There have been limited trials in using fertiliser and harvested vegetation to improve revegetation outcomes.	More detailed scientific trials are needed to determine methods of improving revegetation outcomes, particularly to overcome the limited topsoil and vegetation resources. Such methods may include soil scarification and variation in types, amount and chemical composition of fertiliser.	Section 10.3
22	Revegetation efforts have not yet met the EPA criterion for 70% native cover.	Need to improve revegetation efforts to increase native vegetation cover or renegotiate criterion if not practicably achievable.	Sections 6.3, 6.4, 6.5 and 10.1.3
23	The value of EPA criterion for native vegetation cover (70%) needs to be reconsidered as it may not be achievable in such site conditions.	Recommend that the EPA criterion wording be changed to “maximum achievable cover”.	Section 4.5
3.3 Weed Management Strategy			
24	Site staff are unable to identify significant weed species which may degrade revegetation works.	Develop a guide for assist site staff in identifying and controlling significant weed species	Sections 7 and Appendix Four
25	Weed cover in rehabilitated sites exceeds EPA criterion (<10%).	Implement a Weed Control Program to target weed species that are known to contribute to weed cover in rehabilitated sites.	Section 7
26	The value of the EPA criterion for weed cover (<10%) needs to be reconsidered as it may not be achievable in such site conditions.	Recommend that the EPA criterion wording be changed to “minimal achievable cover”.	Section 4.5
3.4 Mine Hygiene Procedure			
27	The Procedure does not discuss hygiene practices for incoming vegetation or soil materials for future rehabilitation works, which may be contaminated (topsoil, tubestock).	If such practices are to occur, the Procedure should be expanded to discuss how to minimise the risk of introducing diseases and/or weeds from such sources.	Section 8

Table 2: Summary of Domain Model Rehabilitation Plan for Simcoa's Moora Quartzite Mine

Rehabilitation Domain			Rehabilitation Works				
Name	**Site Characteristics**	**End Land Uses**		**Physical Design**	**Revegetation**	**Weed Control**	**Hygiene Procedure**
TEC Buffer	Waste rock material, elevated topography	A buffer for the adjacent TEC An ecological corridor between the TEC and adjacent remnant vegetation	Treatments	1. Topography - Resemble local hill landscape 2. Ripping – None (impractical) 3. Soil scarification - None (impractical)	1. Species selection - Local native species characteristic of adjacent TEC where possible 2. Methods - Topsoil, brush, broadcast seed, tubestock may be required for certain species	1. Strategy - Eradicate or reduce High Priority weed species populations while having minimal impact on revegetation and prevent their spread into the adjacent TEC if they are known to not already occur in TEC 2. Methods - Manual removal, wicker wiping, spot spraying	1. Plant Diseases – Prevent introduction of Dieback 2. Weeds - Prevent introduction of High Priority Weeds or new weed species into Domain and adjacent TEC
			KPIs	1. Landform resembles local hill landscape 2. Vegetation successfully establishing in soil	1. Species composition and structure resembles adjacent TEC 2. Maximum achievable native cover 3. Self-sustaining populations of conservation significant flora	1. Minimal achievable weed cover 2. Low presence of High Priority Weeds	1. No disease infections 2. No new weed species detected
Revegetation	Compacted soil, relatively flat topography	Resemble local vegetation community An ecological corridor between the TEC and adjacent remnant vegetation	Treatments	1. Topography - Some gentle grading may be required adjacent to waste rock dumps 2. Ripping – if practical, relieve soil compaction where necessary 3. Soil scarification – When practical due to substrate, where any seeding or brush layering is to occur	1. Species selection – Local native species resembling local vegetation community 2. Methods - Topsoil, brush, broadcast seed, tubestock may be required for certain species	1. Strategy - Eradicate or reduce High Priority weed species populations while having minimal impact on revegetation 2. Methods - Manual removal, wicker wiping, spot spraying	1. Plant Diseases – Prevent introduction of Dieback 2. Weeds - Prevent introduction of High Priority Weeds or new wed species into Domain
			KPIs	1. Relatively flat terrain 2. Vegetation successfully establishing in soil	1. Species composition and structure resembles local vegetation community 2. Maximum achievable native cover 3. Self-sustaining populations of conservation significant flora	1. Minimal achievable weed cover 2. Low presence of High Priority Weeds	1. No disease infections 2. No new weed species detected
Pasture	compacted soil, relatively flat topography, adjacent to paddocks	Low value pasture for cattle	Treatments	1. Topography - Some gentle grading may be required adjacent to waste rock dumps 2. Ripping – If practical, relieve soil compaction where necessary 3. Soil scarification - When practical due to substrate, where any seeding or brush layering is to occur	1. Species selection – Pasture species capable of growing in post-mine site soil 2. Method - Broadcast seeding	1. Strategy - General weed control 2. Method – Spot spraying	1. Plant Diseases – Prevent introduction of Dieback 2. Weeds - Prevent introduction of High Priority Weeds into Domain
			KPIs	1. Relatively flat terrain 2. Vegetation successfully establishing in soil	1. Species composition of pasture plants 2. Maximum achievable cover of pasture	1. Minimal achievable weed cover	1. No disease infections 2. No new weed species detected
Visual Screening	Compacted soil, relatively flat topography, adjacent to Midland Road	Visual screening of Mine Site from adjacent Midland Road	Treatments	1. Topography - Some gentle grading may be required 2. Ripping – If practical, relieve soil compaction where necessary 3. Soil scarification - Not required	1. Species selection – Large local tree and shrub species 2. Method - Tubestock	1. Strategy – Minimise weed cover to allow tubestock to establish and mature 2. Methods - Manual removal, wicker wiping, spot spraying	1. Plant Diseases – Prevent introduction of Dieback 2. Weeds - Prevent introduction of High Priority Weeds into Domain
			KPIs	1. Relatively flat terrain 2. Vegetation successfully establishing in soil	1. Species composition of local native trees and large shrubs 2. Maximum achievable native cover	1. Minimal achievable weed cover 2. Low presence of High Priority Weeds	1. No disease infections 2. No new weed species detected

1.0 Introduction

1.1 Background

Simcoa Operations Pty Ltd (Simcoa) operates a quartzite mine north of Moora in Western Australia, herein referred to as the 'Mine Site'. The mine contains silica dioxide, which Simcoa is currently extracting for their silicon Smelter in Kemerton, near Bunbury. Simcoa is currently operating the mine under the following leases:

- Mining Leases M70/191, M70/1292, M70425 and M70/424
- Exploration Lease E70/2750
- General Purpose Lease G70/71, G70/92 and G70/93.

Simcoa requires a Rehabilitation Plan (RP) so the mine can meet the environmental approvals and tenement conditions set by the Environmental Protection Agency (EPA), Department of Environment and Conservation (DEC) and Department of Mines and Petroleum (DMP).

1.2 Mine Site

1.2.1 LOCATION

The Mine Site is located approximately 13 km north of Moora, adjacent to Geraldton Road. It is surrounded by some remnant vegetation and a privately owned wheat farm. Access to the mine is via Kiaka Road, which leads east from Midland Road. The Tenements occur in Interim Biogeographic Region for Australia (IBRA) region of the Avon Wheatbelt, specifically in the north-west portion of the Avon Wheatbelt 2 IBRA sub-region, approximately 2 km east to the Dandaragan Plateau subregion border.

Figure 1: Location of Mine Site

Imagery: Bing Maps Aerial (2010)

GDA 1994 MGA Zone 50

AUTHOR: JN CHECKED: SB

DATE: APRIL 2012 PROJECT NO: 2681-11

MOORA QUARTZITE MINE REHABILITATION AND CLOSURE PLAN

CLIENT: SIMCOA

PROJECT LAYOUT

Scale 1:6,500 @ A4

0 100 200 m

Figure 2

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1.3 EPA Legal Compliance

1.3.1 RELEASE OF MINISTERIAL STATEMENT 0813

According to Ministerial Statement No 0813 (2009), Simcoa is required to progressively rehabilitate the mine site area in accordance with the following Ministerial conditions:

4. Re-establishment of vegetation in the rehabilitation area to be comparable in species composition with that of pre-mining vegetation such that the following criteria are met:
   a) Revegetation to achieve the re-establishment of an area of vegetation coverage (not including weed species) of not less than 70 percent of the rehabilitation area as defined in Schedule 1.
   b) Weed coverage less than 10 percent.
   c) Within a timeframe specified in the rehabilitation schedule required.
5. A schedule of the rate of rehabilitation acceptable to the CEO.

The Ministerial Statement also states that Simcoa is to undertake the following:

- in liaison with DMP and DEC, monitor annually the performance of rehabilitation by condition 8-3.
- Submit annually a report of the rehabilitation performance monitoring required by condition 8-4 to the CEO.

It should be noted that the Ministerial Statement does not define how the rehabilitation is to be comparable in species composition, such as diversity or vegetation structure. As such this condition is open to interpretation. Further liaison is required between Simcoa, DEC and DMP to establish what KPIs may be used to determine whether the species composition of rehabilitated sites are satisfactory.

Also, the Ministerial Statement does not detail how the vegetation coverage and weed cover percentages were determined and whether they considered site factors. It is currently unknown whether these figures are achievable. Further liaison is recommended between Simcoa, DEC and DMP to establish what KPIs are to be used to determine what percentages of vegetation coverage and weeds of rehabilitated sites are deemed satisfactory.

1.3.2 SIMCOA'S COMPLIANCE TO MINISTERIAL STATEMENT 0813

Several environmental factors were known at the time of the Ministerial Statement, however they were not discussed in the report:

- Several species of Threatened Flora (TF) were located in the mine site lease, notably *Acacia aristulata* and *Daviesia dielsii*.
- Rehabilitation trials have shown that *Regelia megacephala* can be successfully regenerated but individual plants are unlikely to survive in the long term in the modified environment after mining, although the seed can be sustained.

- Part of the area is considered to be within the Chert Coomberdale Threatened Ecological Community (TEC). Of particular importance is the area adjoining Cairn Hill, which is located within the Simcoa leases (M70/424). Cairn Hill is considered to be the "jewel in the crown" of the Coomberdale Chert area as it is species rich and contains populations of conservation significant flora, including *Regelia megacephala*, *Acacia aristulata* and *Daviesia dielsii*.

Strategic Environmental Solutions (2001) submitted an amendment proposal, under S.46 of the Environmental Protection Act, which discussed these factors and proposed an alternative strategy to best conserve the Chert Coomberdale TEC while allowing Simcoa to continue mining operations in the Western Ridge mining area.

The EPA Bulletin 1027 (2001) "Extension of Quartz Mining and Strategy for Resource and Biodiversity Conservation" responded to the amendment proposal and concluded in the following recommended changes related to rehabilitation and conservation:

1. Simcoa is committed to carrying out rehabilitation trials with any DRF species removed by their mining operations. Rehabilitation trials with other priority species will also be established, in addition to the successful germination and establishment demonstrated with *Regelia megacephala* to date.
2. Simcoa would relinquish its Mining Lease over Cairn Hill in order to:
    a) ensure that *Acacia aristulata* and other Declared Rare and Priority Flora species are protected in secure conservation reserves
    b) obtain Government commitment to work co-operatively with Simcoa on a long-term strategy to meet the twin objectives of guaranteed mining access to the chert resources (for the Company) and conservation of representative examples of the Coomberdale TEC (for the State and community) in secure reserves.
3. Simcoa would be providing a package of other conservation benefits including botanical surveys, developing a strategic approach to mining to protect flora, possible purchase of land with significant conservation.

1.3.3 COMPLETION CRITERIA MEETING

In 2002, Simcoa met with key regulators and stakeholders (including the then CALM, DMP and consultants) to discuss completion criteria for Moora Quartzite mine (Simcoa 2002). The meeting agreed that since the original substrate is destroyed during the mining process, it was not practical to rehabilitate the site to its original species. In particular, it was agreed that the substrate had changed to one with could not support sustainable populations of *Regelia megacephala*.

The management of Cairn Hill was also discussed. It was proposed that Cairn Hill be handed over to DEC for conservation as an A-Class Reserve. This transfer would act as an offset to the mining activities within the Western Ridge and would result in better conservation of the Chert Coomberdale TEC. It was also acknowledged that the relinquishment of Cairn Hill would be an

"overcompensation" for the rights to mine the Western Ridge, so Simcoa would have "credit" for future mining works.

1.3.4 ACTIONS TO DATE

To date, Simcoa has completed or is undertaking the following actions (**Table 3**):

Table 3: Simcoa's Actions to date in meeting environmental conditions

No.	Action	Environmental Condition
1	Handed over leases containing Cairn Hill to DEC	EPA Bulletin 1027 Criteria Meeting
2	Hired a botanist to completed an extensive botanic surveys of the region and share the reports with DEC: a) Trudgen and Associates (2006) *A Flora Survey, Floristic Analysis and Vegetation Survey of the Coomberdale Chert TEC* b) Trudgen and Associates (2012) *An extension of a flora survey, floristic analysis and vegetation survey of areas of the Coomberdale Chert TEC to include a further area.*	EPA Bulletin 1027
3	Fenced off the conservation sections of Cairn Hill	EPA Bulletin 1027
4	Produced compensation in the area north of Cairn Hill and arranged for the adjoining vegetation to Cairn Hill to be protected.	EPA Bulletin 1027
5	In liaison with DMP and DEC, monitor annually the performance of rehabilitation by condition 8-3.	Ministerial Statement 0813
6	Submit annually a report of the rehabilitation performance monitoring required by condition 8-4 to the CEO.	Ministerial Statement 0813

1.4 DMP Legal Compliance

The M70/191 and Tenement Conditions have the following rehabilitation requirements:

- Exploration: Unless otherwise directed by the District Mining Engineer:
  - topsoil being removed and stockpiled for replacement prior to the excavation of costeans, trenches or pits
  - all excavations being progressively refilled as sampling proceeds, and the topsoil returned as soon as possible
  - all excavations and surface disturbances made by the tenement holder being refilled and the ground rehabilitated to the satisfaction of the property holder.
- The lease preparing a management and rehabilitation plan for the mine site including the results of trials into rehabilitation of the site back to native vegetation. Such plan being submitted to the State Mining Engineer for his written approval.
- All topsoil being removed ahead of all mining operations from sites such as pit areas, waste disposal areas, ore stockpile areas, pipeline, haul roads and new access roads and being stockpiled for later respreading or immediately respread as rehabilitation progresses.
- At the completion of operations, or progressively where possible, all access roads and other disturbed areas being covered with topsoil, deep ripped and revegetated with local native grasses, shrubs and trees to the satisfaction of the State Mining Engineer.

- On the completion of operations or progressively where possible, all waste dumps, tailing storage facilities, stockpiles or other mining related landforms must be rehabilitated to form safe, stable, non-polluting structures which are integrated with the surrounding landscape and support self-sustaining, functional ecosystem comprising suitable, local provenance or an alternatively agreed outcome to the satisfaction of an Environmental Officer, DMP.
- All costeans and other disturbances to the surface of the land made as a result of exploration, including drill pads, grid lines and access tracks, being backfilled and rehabilitated to the satisfaction of the Environmental Officer, Department of Industry and Resources (DoIR). Backfilling and rehabilitation being required no later than 6 months after excavation unless otherwise approved in writing by the Environmental Officer, DoIR.

1.5 Simcoa's Rehabilitation Commitment

Simcoa's rehabilitation strategy for Moora is as follows (Simcoa 2010):

> *"To carefully plan waste dumps as buffers adjacent to areas of the threatened ecological community of native vegetation in order to ameliorate further damage to these areas. Rehabilitation will involve the restoration of the land surface in order to maximise water retention and minimise erosion, and the revegetation with topsoil and seeds derived from local native plants, supplemented by locally derived seeds of rare vegetation where appropriate. All revegetated areas will be fenced off from stock. The mine work force will be educated regarding the significance and importance of the rare vegetation."*

Simcoa's current rehabilitation objectives are as follows (Simcoa 2010):

- amelioration of degraded areas of the Coomberdale Quartzite "Threatened Ecological Community" adjacent to mining area
- establishment of stable vegetation of local plant species on waste dumps and other areas affected by mining
- re-establishment where appropriate of the geographically restricted species *Regelia megacephala*
- establishment of populations in the rehabilitation of the declared rare flora species found in the mined areas
- regular recording of rehabilitation, with the plots in the older rehabilitation areas recorded at three year intervals and the plots in the younger rehabilitation areas recorded annually
- stabilisation of slopes on waste dumps and minimisation of erosion
- waste dump construction including fine material and medium scale surface undulations to improve water retention and infiltration
- seed mix going into the rehabilitation areas (including seed for brush) chosen to suit the conditions prevailing in the rehabilitation sites

- seed applied to the regeneration areas sourced locally (ie within a few kilometres of the mine and preferably from areas adjacent to the Coomberdale Quartzite "Threatened Ecological Community"
- exclusion of stock from the rehabilitation area
- education of mine work force regarding the significance of the rare vegetation.

1.6 Rehabilitation Aim and Objectives

The aim of the Rehabilitation Plan is to revegetate a majority of the Mine Site to a state that resembles the original vegetation. The remaining areas are to be revegetated in a manner that will suit its end land use.

The objectives of the Rehabilitation Plan are focused on satisfying the Mine Closure Plan completion criteria:

1. to plan revegetation works so that rehabilitated areas will have maximum vegetation cover
2. to plan weed control works so that rehabilitated areas have minimal weed cover
3. to plan revegetation works that is practically achievable, will be self sustainable and satisfies the best suit end land use
4. to provide a schedule of rehabilitation that is acceptable to the EPA CEO.

An additional objective has been devised to consider the rare flora of the site:

5. To plan revegetation trials to determine the most successful methods of establishing self-sustaining conservation significant flora populations.

1.7 Structure of Report

1.7.1 REHABILITATION AUDIT

The existing environment was researched to determine the Mine Site's original physical and biological characteristics. The data was then used as a baseline to determine factors relevant to successful rehabilitation of the site (**Section 2**), including:

- geology and topology
- vegetation structure
- site condition
- native and weed species

An audit was then performed to identify issues in Simcoa's rehabilitation operations (**Section 3**) in terms of:

- Physical Design
- Revegetation
- Weed Control
- Mine Hygiene.

As a result of this examination, both Sections contain text boxes termed “Rehabilitation Notes”. Each Rehabilitation Note contains:

- an identified item relevant to the rehabilitation of the Mine Site (Issue)
- a recommendation how to address the Issue (Action)
- section numbers where the action was implemented in the Rehabilitation Plan (Addressed).

1.7.2 DOMAIN MODEL PLAN

Section 4 describes how the Rehabilitation Plan was developed**.** The Rehabilitation Domain Model (Mikli & Kaesehagen 2009) was used, which was based on the International Council on Mine Closure and Metals (ICMM 2008) Domain Model.

Areas to be revegetated can be divided into Domains with restoration goals, according to their site characteristics (eg soil characteristics and topography) and End Land Use (eg visual screen, fauna habitat, resemble original vegetation). Rehabilitation Treatments can then be designed for each domain to use or overcome site characteristics to reach their rehabilitation goal. Key performance indicators (KPI) are then developed to assess whether the Treatments are achieving the rehabilitation goals. This rehabilitation domain approach is summarised in **Figure 3**.

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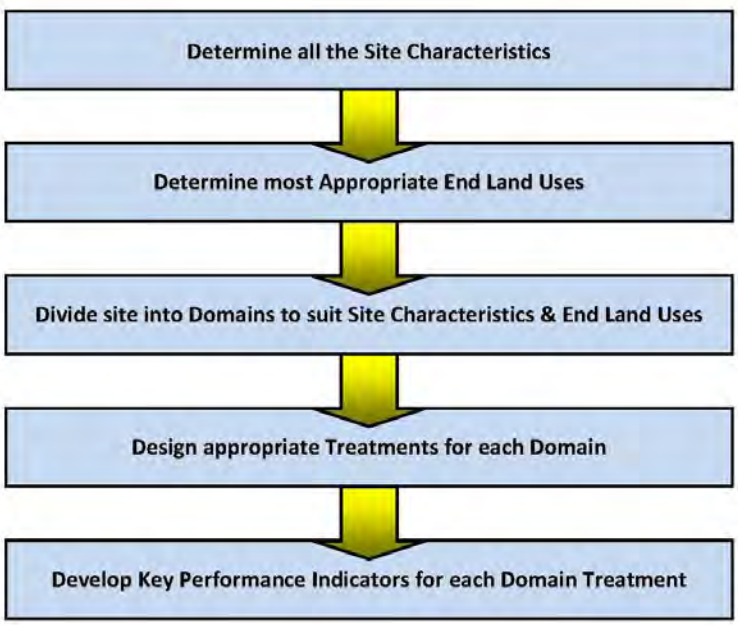

Figure 3: Rehabilitation Domain Model outline

1.7.3 OPERATIONS AND TECHNIQUES

The Rehabilitation Plan also contains detailed descriptions on rehabilitation practices. This information is to provide "hands on" practical information to educate site workers in how to implement the recommended treatments for each rehabilitation domain:

- **Section 5** details how to improve Physical Design, such as shaping of waste rock dumps. It also discusses various site preparation techniques to improve revegetation outcomes, such as ripping and soil scarification.
- **Section 6** explains how appropriate local native species have been chosen for revegetation works, as well as the following revegetation techniques:
  - collection, storage, treatment and broadcasting of native seeds
  - planting tubestock
  - how to apply harvested vegetation to rehabilitated areas (brushing).
- **Section 7** details how the known weed species were prioritised in level of threat to rehabilitation, and how best to identify and control high priority weed species.
- **Section 8** expands on hygiene procedures to minimise the risk of introduction and spread of plant diseases and weeds.
- **Section 9** explains how to undertake monitoring of rehabilitated sites and determine appropriate maintenance activities.
- **Section 10** recommends a series of trials to find out how to improve revegetation outcomes, particularly in native diversity, establishing conservation significant flora and finding topsoil substitutes.

2.0 Existing Environment

The following section examines the environmental characteristics of the Mine Site to determine implications required to develop the Rehabilitation Plan. Notes on their implications for Rehabilitation are presented as boxed text throughout the Section.

2.1 Physical Environment

2.1.1 CLIMATE

The Mine Site is characterised by a mild Mediterranean type climate with hot dry summers and mild wet winters. The climate varies seasonally, with rainfall, temperature and winds following a well-defined annual cycle. The majority of the rainfall occurs in the winter months with 90% falling between April and October (**Figure 4**). The mean total rainfall is 473.5mm. Mean summer rainfall is minimal, between 11.1 and 14.0 mm. The amount of rainfall begins to increase in May and is highest in June with 89.7 mm, before beginning to decline in August. In the last four years, the mean rainfall has decreased by around a third to 322.3 mm.

Historic temperature records from the Walebing weather station, located approximately 12.5 km south-east of the Mine Site, indicate that lowest temperatures are in July with an average daily minimum and maximum temperature of approximately 5.4°C and 16.1°C, respectively. The Records from the Bureau of Meteorology (BOM 2011) indicate that highest temperatures occur in January with an average daily minimum and maximum temperatures of 16.7°C and 33.9°C, respectively.

REHABILITATION NOTE 1

Issue: Most of the annual rainfall in the Mine Site occurs in winter.

Action: Revegetation activities should be planned to utilise the winter rainfall (May to September) to maximise success of native seed germination and establishment.

Addressed: Sections 6.2.5 and **6.3.3**

REHABILITATION NOTE 2

Issue: The Mine Site may continue to receive lower than average rainfall in the near future, which may prolong or even prevent rehabilitation works meeting their KPIs.

Action: Rainfall patterns should continue to be monitored and if the trend continues, the rehabilitation KPIs may need to be reconsidered and amended to those which are achievable in a drier environment.

Addressed: Section 6.6

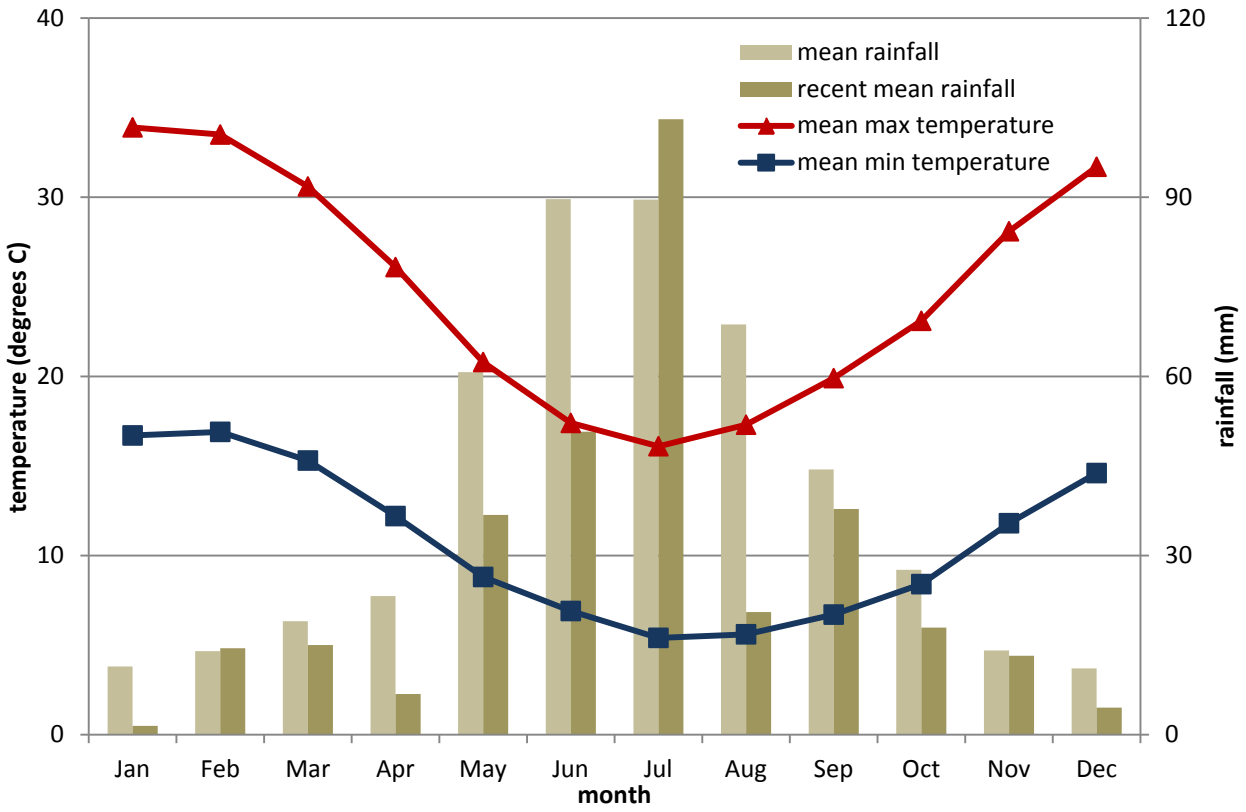

Figure 4: Mean monthly temperature and rainfall at Walebing weather station

2.1.2 GEOLOGY AND TOPOLOGY

Landform

The Department of Agriculture and Food (DAFWA 2007) *Soil Systems dataset* indicate the Mine Site is located within the Cooroow 7, Ranfurly 1 and Burabidge Hill 7 Soil sub-systems. The subsystems are detailed in **Table 4**.

Table 4: Mapped soil types at Mine Site (DAFWA 2007b)

System	Subsystem	Landform	Geology	Vegetation
Cooroow	258Cw_7	Very gently to moderately inclined hill slope and hill crests	Middle or late Proterozoic, Moora group, Noondine Quartz; shallow soils.	Wandoo, Salmon Gum, Acacia spp.
Ranfurly	256Ra_1	Alluvial plain of Moore River	loamy earths, clays and minor sandy earths	Woodland of Eucalyptus salmonophloia, Eucalyptus wandoo, Eucalyptus loxophleba
Burabidge Hill	256Bg_7	Mid slope, gently undulating rises adjacent to valley plain and drainage line	Colluvium, lithic sand . Shallow to deep loamy duplex, red sandy earth and red shallow loam.	York Gum, Salmon Gum, Acacia spp.

Overall the site's landform can be described as open with low relief and local elevated hills, locally merging with undulated rises and depressions. There are some drainage lines cross the northern and south-western sections of the leases. The mine site itself is located on a topographic rise which backs onto a rocky outcrop to the east. A gentle slope occurs from the outcrop gradually to the west and onto the nearby Coonderoo River flats (Actis 2011). The area being mined consists of rocky outcrops. Very little topsoil is present.

REHABILITATION NOTE 3

Issue: The Mine Site has specific landform features.

Action: Rehabilitation efforts should be directed towards resembling the local landforms where possible. Specific features that could be mimicked include rocky outcrops, local elevated hills and gentle slopes towards drainage and river flats.

Addressed: Section 5.1

2.2 Biological Environment

2.2.1 VEGETATION

Vegetation Condition

There is little quantified information on the vegetation condition of the Mine Site before mining activities started. Trudgen (1985) described the vegetation as being in good condition in some parts and degraded or recently burnt in others. The main cause of the degradation was grazing from livestock and clearing.

However, Trudgen (2006) quantitatively describes the condition of the surrounding vegetation as mostly varying from Poor to Very Good, with some small areas being Very Poor to Degraded (Trudgen scale). It is highly likely that the Mine Site's pre-existing vegetation was also of Poor to Very Good condition. The Trudgen Condition Scale is detailed in **Table 5.**

A study of the adjacent vegetation by CALM (2000) listed weeds, grazing, clearance and fire as the main causes of degradation. It is most likely that weed cover has also considerably degraded the Mine Site's vegetation.

Table 5: Trudgen Condition Scale

Scale	Condition
Excellent	Pristine or nearly so; no obvious signs of damage caused by the activities of European man.
Very Good	Some relatively slight signs of damage caused by the activities of European man.
Good	More obvious signs of damage caused by the activities of European man, including some obvious impact on the vegetation structure such as that caused by low levels of grazing or by selective logging.
Poor	Still retains basic vegetation structure or ability to regenerate to it after very obvious impacts of activities of European man, such as grazing, partial clearing (chaining) or frequent fires.
Very Poor	Severely impacted by grazing, very frequent fires, clearing or a combination of these activities. Scope for some regeneration but not to a state approaching good condition without intensive management. Usually with a number of weed species including very aggressive species.
Degraded	Areas that are completely or almost completely without native species in the structure of their vegetation; ie. areas that are cleared or 'parkland cleared' with their flora comprising weed or crop species with isolated native trees or shrubs.

Vegetation Associations and Communities

A systematic survey of the native vegetation in Western Australia was undertaken by John S. Beard during the 1970s, who described vegetation systems within Western Australia at a scale of 1:250,000 in the south west of Western Australia and at a scale of 1:1,000,000 in the less developed areas of the state. The Vegetation Survey of Western Australia maps and explanatory memoirs (1974-1981) are credited to J.S. Beard.

Beard (1979) *Vegetation of the Perth Area, Western Australia* indicates two vegetation associations occur in the Mine Site:

- Unit 1041 - Low Woodland of Rock Sheoak (*Allocasuarina huegeliana*) and Jam (*Acacia acuminata*)
- Unit 142 – Medium woodland of York Gum (*Eucalyptus loxophleba*) and Salmon Gum (*Eucalyptus salmonophloia*).

However, this mapping is at regional scale and the borders of the associations can be slightly incorrect at ground level. Unit 1041 is typical of the rocky outcrops in the Mine Site, whereas Unit 142 is typical of the surrounding area. Only Unit 1041 occurs in the areas being mined.

Trudgen (1985) originally recorded four vegetation associations in the Mine Site. The vegetation associations corresponded to variations in surface geology and topology (eg rockiness, hills). Trudgen also described commonly occurring species in four degraded areas. Full descriptions of the four vegetation communities and common native species in the degraded areas are detailed in Table 6.

Table 6: Descriptions of four Vegetation Associations in Mine Site (Trudgen 1985)

Short description	Full Description	Occurrence
Kunzea sp. Open Scrub	60% *Kunzea praestans* with 5% *Banksia sessilis* and understorey of 40% *Hibbertia subvaginata*. Occasional emergent trees of *Allocasuarina huegeliana* and scattered individuals or shrubs and herbs such as *Bossiaea eriocarpa, Acacia scirpifolia, Isopogon divergens* and *Melaleuca scabra*	On slopes and in disturbed areas
Regelia megacephala Open Scrub	60% *Regelia megacephala* with 5% *Banksia sessilis* with an understorey of *Hibbertia subvaginata* and scattered *Olearia axillaris*. Occasional emergent trees of *Allocasuarina huegeliana* and *Acacia acuminata* and scattered individual shrubs of *Xanthorrhoea preissii, Trymalium floribundum, Cheilanthes austrotenuifolia* and *Stypandra imbricata*.	On rocky and high point areas of site, where higher ground is flat and deeper soils are developed
Allocasuarina huegeliana Low Open Woodland	15% *Allocasuarina huegeliana* with an understorey of 15% *Kunzea* sp, 5% *Calytrix leschenaultia* and scattered *Xanthorrhoea preissii*.	One small area, gentle slope
Allocasuarina campestris Open Scrub	40-50% *Allocasuarina campestris* with some *Xanthorrhoea preissii, Austrostipa elegantissima, Cheilanthes austrotenuifolia, Acacia acuminata, Hakea lissocarpha* and *Kunzea* sp.	Flat hilltop, Surrounded by degraded areas
Degraded Areas	Overstorey - *Allocasuarina huegeliana, Banksia sessilis, Acacia acuminata* Understorey – *Hibbertia subvaginata, Regelia megacephala, Olearia axillaris* Herbs and small shrubs – *Gyrostemon ramulosus*	Depressions, backfill, scrapes

REHABILITATION NOTE 4

Issue: As the mining operation will result in surface geology being structurally changed, revegetation will be unable to restore all or any of the local vegetation associations.

Action: Revegetation should be focused on returning a basic resemblance to local vegetation structure, rather than attempting to restore local vegetation associations, promoting local species that can grow in the broken rock substrate.

Addressed: Section 6.2

State and Federal Significance

Threatened Ecological Communities (TECs) are categorised at both State level (DEC 2010) and Commonwealth level (DEWHA 1999).

One State listed TEC (Coomberdale Quartz hills) has been recorded within and adjacent to the Mine Site. The description for the TEC is given in **Table 7.** Native flora known to occur in the TEC are listed in **Appendix One**.

Table 7: TEC recorded in Simcoa's Moora Quartzite mine

No.	Name	Description	DEC Rating	DEWHA Rating
51	Coomberdale Quartz hills	Heath dominated by one or more of *Regelia megacephala, Kunzea praestans* and *Allocasuarina campestris* on ridges and slopes of the Quartz hills of the Coomberdale floristic region.	Endangered	-

REHABILITATION NOTE 5

Issue: A State listed TEC occurs within and adjacent to the Mine Site, part which is being cleared for mining activities.

Action: Revegetation outcome should be focused on helping to conserve the identified TEC in terms of species diversity, promoting dominant species and in vegetation structure where possible.

Addressed: Section 6.2

2.2.2 NATIVE FLORA

Native Flora Inventory

A total of 160 native flora species were recorded within and immediately adjacent to the Mine Site (Trudgen 1985, Griffin 1991, Parker 1991, CALM 2000, Trudgen 2007, Trudgen 2011). A full inventory of flora recorded on site is presented in **Appendix One**.

State and Federal Significance

Flora species require Threatened Flora (TF) or Priority conservation status where populations are geographically restricted or threatened by local processes. The DEC enforces regulations under Government of Western Australia's *Wildlife Conservation Act* (GWA 1950) to conserve TF and protect significant populations. Rare flora species are gazetted under Sub-Section 2 of Section 23F of the *Wildlife Conservation Act*, thereby making it an offence to remove or damage rare flora without Ministerial approval. All Declared and Priority flora are listed in DEC (2011) *Declared Rare and Priority Flora List*. Flora are also classified and protected at a federal level through the Australian Government (1999) under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

A total of eight significant species are known to occur within and immediately adjacent to the Mine Site. Three species are listed as Endangered in the EBPC Act (Australian Government 1999) and four are listed as Threatened by DEC (2008). The remaining three species were rated between Priority 2 and Priority 4 by DEC (2008). The species identified are listed in **Table 8**. Of these, only three species (*Acacia aristulata*, *D. dielsii* and *R. megacephala*) have been recorded in the Mine Site (Trudgen 2011).

Table 8: Threatened and priority species known to occur in or adjacent to Mine Site

Scientific Name	Recorded In Mine Site	DEC	SEWPAC	Flowering Time
Acacia aristulata	*	Threatened	Endangered	Sep-Dec
Baeckea sp. Moora		Priority 3		Nov-Dec
Cryptandra glabriflora		Priority 2		May-Aug
Daviesia dielsii	*	Threatened	Endangered	Jul
Goodenia arthrotricha		Threatened		Oct-Nov
Regelia megacephala	*	Priority 4		Oct-Dec
Synaphea quartzitica		Threatened	Endangered	Jul-Aug
Tricoryne sp. Wongan Hills		Priority 2		(Unknown)

One species was previously reported as threatened or priority species but has now been classified as non-threatened. *Goodenia acutum* (previously *Nemcia acuta*) was previously rated at Priority 3 but is now declassified.

REHABILITATION NOTE 6

Issue: The Mine Site contains two threatened flora species - *Acacia aristulata* and *Daviesia dielsii*.

Action: Revegetation trials should be conducted to determine whether it is possible to establish self sustainable populations of these species.

Addressed: Sections 6.2 and **10.2**

2.2.3 WEEDS

Weed Cover

There is little information available regarding the weed cover of the Mine Site before mining commenced. A baseline vegetation survey was conducted in the Mine Site by Trudgen (1985) did not include any quantified assessment weed cover. A study of the adjacent vegetation by CALM (2000) mentions that the weed cover is "high" in some areas (no other measurement details given). As a result, it cannot be determined whether the EPA criterion for 10% weed cover represents the pre-existing condition or whether it is a feasible benchmark.

The Mine Site currently contains some remnant vegetation. These areas may be used as reference sites to establish the Mine Site's pre-mining weed cover.

REHABILITATION NOTE 7

Issue: There is no quantified information on the original weed cover of the Mine Site, therefore it cannot be determined whether the EPA criterion of 10% weed cover is feasible.

Action: Examine the remnant vegetation the in Mine Site to determine the weed cover.

Addressed: Section 7.1

Weed Inventory

A total of 34 weed species has been recorded in and immediately adjacent to the Mine Site. A weed inventory is provided in **Appendix One**.

Weed Life forms

Weed species were separated into three groups:

1. Grass weeds – 15 species
2. Geophyte weeds (ie those that propagate from bulbs, corms and tubers) – 2 species
3. Broad leaf herb weeds – 17 species.

Separation of weed species into groups was chiefly based according to their biology and similarities in methods of control. The grouping was to aid in understanding what types of weeds are the biggest threat to the Mine Site and what main control actions would be needed to reduce their diversity and presence.

REHABILITATION NOTE 8

Issue: The Mine Site is known to contain 34 weed species, of different biological forms (grasses, geophytes or broad leaf herbs).

Action: Weed control activities at Simcoa should be divided into addressing weed species according to their biology and method of control.

Addressed: Section 7.4 and **Appendix Five**

Priority Weeds

The priority rating of each recorded weed species was determined after examining:

- the ratings under the following weed evaluation systems:
  - Environmental Weed Census and Prioritisation – Swan Coastal Plain (EWCP) by the DEC (DEC 2008)
  - Environmental Weed Strategy of Western Australia (EWSWA) by the Department of Conservation and Land Management (CALM 1999)
  - Dixon and Keighery (1995) Recommended methods to control specific weed species
- whether it was listed by Commonwealth of Western Australian governments:
  - Weed of National Significance (WONS) (Weed Australia 2008)

- DAFWA (1976) Agricultural and Related Resources Protection Act (ARRPA).

None of the recorded weed species were listed by WONS or ARRPA. Ten species were determined to be high priority to control, as they were deemed by EWCP and EWSWA as highly invasive species that can degrade native vegetation, or were observed to contribute to weed cover in revegetated waste rock dumps. Six of the species are grasses and four are broad leaf herbs.

The full methodology and ratings for all recorded weed species is presented in **Appendix Two**. The calculated High Priority weeds species are listed in **Table 9**.

Table 9: High Priority weeds species in Simcoa's Moora Quartzite mine

Life Form	Scientific Name	Common Name	EWCP	EWSWA	Rehab sites
Grass	*Avena barbata*	Bearded Oat	Moderate	Very High	Common on dumps
	Bromus diandrus	Great Brome	High	Very High	
	Cynodon dactylon	Couch	Moderate	Very High	
	Ehrharta calycina	Perennial Veldt Grass	High	Very High	
	Ehrharta longiflora	Annual Veldt Grass	FAR	Moderate	common and high cover
	Vulpia myuros var. *hirsuta*	Rat's Tail Fescue	Unrated	Unrated	Very common and contributes to weed cover
Broad Leaf Herb	*Centaurea melitensis*	Maltese Cockspur	Moderate	High	One recording of 15% cover
	Hypochaeris glabra	Flatweed	Moderate	High	common and sometimes high cover
	Arctotheca calendula	Capeweed	Moderate	High	occasionally contributes to weed cover
	Erodium botrys	Long Storkbill	FAR	Low	sometimes contributed to weed cover

REHABILITATION NOTE 9

Issue: The Mine Site is known to contain ten High Priority weed species which may be significant threats to the local vegetation and cause considerable weed cover in rehabilitated areas.

Action: Weed control activities should be developed to identify and target individuals or populations of the High Priority weed species to minimise weed cover in rehabilitated areas to EPA completion criteria.

Addressed: Section 7.3 and **Appendix Five**

2.2.4 FAUNA

Fauna Inventory

A total of 198 fauna species were determined by Bamford (2001) that may occur within and immediately adjacent to the Mine Site. Of these, 11 species are amphibians, 66 are reptiles, 96 are birds and 25 species are mammals, of which 5 are introduced.

Fauna Habitat

The Mine Site is connected to some of the adjacent vegetation. This connection is becoming weaker as vegetation is cleared for mining. The isolation of the remnant vegetation means that fauna populations have further difficulty in finding food sources, breeding partners and breeding habitat. This may have an impact in the long term sustainability of local fauna populations.

REHABILITATION NOTE 10

Issue: Mining activities in the Mine Site may further fragment and isolate local remnant vegetation, which may impact on the long term sustainability of local fauna populations.

Action: The rehabilitation design should consider providing ecological corridors where practicable for local fauna species to move between remnant vegetation.

Addressed: Sections 4.2 and **4.3**

Conservation Significant Fauna

A total of 12 fauna species that may occur around the Mine Site were reported by Bamford (2001) as conservation significant. Recent revisions in the conservation ratings have meant the Square-tailed Kite (*Lophoictinia isura*) is no longer listed, reducing the number of conservation significant species to 11. A further five species were also removed as the area being mined does not have their habitat requirements (eg tall trees).

A list of the remaining six species and their habitat requirements is presented in **Table 10**.

Table 10. Conservation Significant Fauna expected to occur in Moora Quartzite Mine

Fauna Species	SEWPAC	DEC	Habitat Requirements
Mammal			
Chuditch (*Dasyurus geoffroii*)	Vulnerable	T	Any remnant vegetation
Reptile and Amphibian			
Carpet Python (*Morelia spilota*)		P4	Ridges and rocks
Bird			
Bush Stone-curlew (*Burhinus grallarius*)		P4	Open Woodland
Major Mitchell's Cockatoo (*Cacatua leadbeateri*)		Other	Banksia and Hakea for feeding
Rufous Fieldwren (*Calamanthus campestris* subsp. *montanellus*)		P4	Scrubby heath, saltbush
Crested Bellbird (*Oreoica gutturalis* subsp. *gutturalis*)		P4	Shrubland

REHABILITATION NOTE 11

Issue: The Mine Site may serve as a habitat for as many as six locally occurring conservation significant fauna species.

Action: Rehabilitation should consider providing suitable fauna habitat where practicable, in terms of food source and breeding, to assist in the conservation of these species.

Addressed: Section 6.1

Pest Fauna

Bamford (2001) determined that five introduced species may be present in the Mine Site. Of these, rabbits are considered to be the most serious potential threat as they may degrade revegetation efforts. However, there have been no signs to date of grazing, diggings or warrens have been observed on the waste rock dumps. This is most likely due to the hard substrate being unsuitable habitat. It is therefore considered unlikely that rabbits pose a significant threat to rehabilitation efforts.

2.2.5 DISEASES

The Mine Site received on average over 400 mm rainfall annual. This amount of rainfall places it within an area declared by (CALM 2003) as vulnerable to dieback infection (*Phytophthora cinnamomi*). DEC (2011) have issued management procedures for dieback of bushlands in the Moora District.

To date, there have been no known occurrences of any plant diseases within the Mine Site, although no formal testing has been conducted. It is critical that these diseases are not introduced to the Mine Site, otherwise it may threaten the adjacent TEC.

REHABILITATION NOTE 12

Issue: The Mine Site revegetation areas and adjacent TEC are vulnerable to introduction of dieback from unhygienic mine activities.

Action: All rehabilitation activities within the Mine Site should include hygiene prevention and management procedures for possible introduction and spread of dieback.

Addressed: Section 8.1

3.0 Current Rehabilitation Practices

The following section examines Simcoa's Rehabilitation works to determine areas of improvement to be incorporated into the Rehabilitation Plan. The information was collated from personal communication with Simcoa's staff Andrew Obal, Kees Visser and Daniel Mance. Rehabilitation Notes are presented throughout the Section as shaded boxed text.

3.1 Physical Design

Simcoa's Physical Design process involves the transferral of waste materials from mine pits and piling and shaping them into dumps that resemble the local hills. The process is further described below.

3.1.1 WASTE ROCK DUMPS

Waste rock dumps serve the purpose of storing undesired soil ground material away from mining activities.

Waste material (sand material <3mm, silt and low grade quartzite) are deposited onto the dumps using dump trucks. The dumps are then shaped using a dozer operated by an independent earthmoving contractor. The dozer operator pushes the material across the slope gradient to prevent the formation of erosion channels. The dumps are shaped on an incremental basis as material becomes available. Slopes are generally at around 20 degrees in order to prevent erosion. The dumps are contoured to fit in with the general landform of the area. The current dumps appear relatively stable and show little sign of erosion.

3.1.2 RIPPING

Soils may be compacted from use of heavy machinery. This compaction reduces soil aeration, moisture infiltration and root penetration. Seedlings are less likely to survive and establish in such conditions, leading to poor revegetation work over many years (Buchanan 1989). Deep ripping may relieve this compaction and promote faster and more successful revegetation.

Ripping is not required nor practical on the waste rock dumps. It is believed that the nature of the hard rock substrate makes the act unfeasible. Also, previous rehabilitation works have had some success in establishing seedlings without the need of ripping. However, ripping may be a useful technique in future revegetation works in other soil compacted locations on the Mine Site, such as for roads and hardstands. These areas are accessible to ripping machinery and are not composed of large waste rock material.

REHABILITATION NOTE 13

Issue: Ripping could be a useful technique for encouraging revegetation success in areas where soil is compacted and not composed of waste rock material.

Action: Future revegetation work should consider ripping where appropriate and practical to relieve soil compaction for future revegetation works.

Addressed: Section 5.2

3.1.3 SOIL SURFACE PREPARATION

A common revegetation technique is to scarify the soil surface before seeding. This scarification provides small niches for seed to be secured. This action can reduce the amount of seed lost to wind and rain erosion and increase the survival and establishment of germinated seeds.

Soil scarification is not currently performed in revegetation works. This treatment is not considered necessary in the current general rehabilitation works, as the main source of seeds are from the topsoil and remnant vegetation brushing. As these materials are blended before being spread onto the dumps, the seeds are secured by burial.

However, as the topsoil and remnant vegetation resources are limited, future revegetation works may need to use broadcast seed of branch layering as a replacement source of propagules. As the seeds from these methods are placed on the soil surface, they are vulnerable to being removed by erosion. Such practices should consider surface preparation to help secure the seeds.

It should be noted that soil surface preparation is similar to ripping as a practical method. It may not be achievable on difficult substrates such as waste rock dumps. However, it could be a feasible option on other sites such as on former roads and hardstands.

REHABILITATION NOTE 14

Issue: After topsoil and remnant vegetation sources are depleted, future revegetation methods risk losing seed to wind and rain erosion.

Action: Where practicable, soil scarification treatment should be considered prior to seeding to provide niches for seeds to be lodged in and to limit loss of seeds to wind and rain erosion.

Addressed: Section 5.3

3.2 Revegetation

Simcoa's main revegetation process is the removal of topsoil and vegetation material from remnant vegetation areas within the mining lease and spreading them onto newly constructed waste rock dumps. Several trials have been conducted to determine more efficient methods of revegetation. These processes and trials are further described below.

3.2.1 TOPSOIL AND BRUSH

Topsoil is a significant component in the success of a revegetation project. Good topsoil contains native plant propagules, mycorrhiza (symbiotic fungi), nutrients and organic matter. Harvested vegetation (brush) may also assist revegetation works through providing organic matter, native seeds and act as a barrier to wind and rain erosion. It is essential that these resources are efficiently used to maximise rehabilitation efforts (DMP 2011)..

Topsoil and brush are harvested before the commencement of active mining each year, usually around May. Harvest time is chosen to suit mining operations and to minimise storage time. It is currently unknown whether the brush contains any viable seeds (ie if the branches contain unopened capsules of mature seeds). Because there is extremely limited available topsoil and remnant vegetation in the Mine Site, all material is harvested and used regardless of its quality (eg weeds).

The remnant vegetation is cleared and pushed into heaps. No active mulching occurs – the size of the brush is the result of the clearing act by machinery (broken branches of shrubs). Topsoil is limited in distribution as cap rock is exposed in many locations. Where topsoil does occur, it is then scraped up to 10cm using a dozer. Both the mulch and vegetation are combined together into a dump truck by a wheeled loader and then piled into temporary storage areas.

The topsoil /brush mix is usually used within a week. The short time frame means that the temporary piles do not need to be covered. The heights of the storage piles are currently unknown. The mixture is then spread onto newly completed dumps as they become available, at an approximate thickness of 2 to 3 cm; the surface ratio being three to five times larger than the area cleared.

The amount of topsoil and mulch resources is limited; it is estimated that there is only 4 ha of remnant vegetation available. It has been identified that this amount is inadequate to meet future rehabilitation needs. Future rehabilitation works will need to consider new revegetation techniques to overcome the shortage of topsoil and seed source.

REHABILITATION NOTE 15

Issue: There are not enough topsoil and mulch resources for future rehabilitation works.

Action: New substitute sources and/or techniques are required to overcome this shortfall and ensure adequate revegetation success.

Addressed: Sections 6.3 and **10.3**

REHABILITATION NOTE 16

Issue: Current harvest time of vegetation may not be obtaining the maximum amount and diversity of viable seeds and propagules for revegetation.

Action: Need to examine whether there is an optimal time for harvesting of vegetation in order to increase revegetation success.

Addressed: Section 10.1.3

3.2.2 SEED COLLECTION

Simcoa commissioned Rhonda Tonkin from Western Wildflower Farm to collect native seeds in 2004, 2005 and 2006. Seed was only collected within the Mine Site, not from any adjacent or nearby areas. Seed collection was stopped as it was determined that it was difficult to collect enough seed to make it a viable rehabilitation option.

The total amount of stored is currently unknown, but it is understood that it was only enough for revegetation trials (discussed below in **Section 3.2.3**), not large scale rehabilitation works. Species that were collected are listed in **Appendix One**. A small amount of seed is left over from the trial and is currently stored within sealed paper envelopes in the office. There are currently no procedures for the storage of collected native seeds.

Simcoa staff have also collected seed on an ad hoc basis. No specific species are targeted. Seeds are dried in the office before being spread. Some germination has been observed by the Mine Site Manager. No detailed records have been kept of Simcoa's seed collecting activities.

A seed collection program should be reconsidered, particularly when the topsoil and vegetation resources are known to be inadequate to complete future rehabilitation works. Seed collection need not be restricted to the Mine Site, it should expand to adjacent vegetation areas so to maximise the diversity and amount of seeds while still preserving provenance. Any seed collection activities will require an appropriate seed collection licence from the DEC.

To date, there has been no program to specifically collect seeds from conservation significant flora within the Mine Site. A seed collection program is particularly important for significant flora, to maximise size of sustainable populations in rehabilitation works.

REHABILITATION NOTE 17

Issue: There has been little native seed collected for rehabilitation works.

Action: Seed collecting if practicable should continue in the Mine Site and in adjacent vegetation to improve abundance and diversity in revegetated areas.

Addressed: Section 6.3.2

REHABILITATION NOTE 18

Issue: There is no procedure for the proper storage of collected native seeds.

Action: A seed storage procedure needs to be developed for the storage of collected seeds to prolong their viability and to protect them from being eaten by bugs.

Addressed: Section 6.3.3

3.2.3 SEEDING TRIALS

Simcoa conducted two direct seeding trials to determine whether the species diversity could be increased on the dumps. The first trial was conducted in July 2004 and the second in June 2005, both in the Main Waste Dump Area 24 (Trudgen 2007). Species tested are listed in **Appendix One**.

The timing of the seeding was considered to not be optimal, as the site had missed one to two months of autumn-winter rainfall. Emerging seedlings would have little time to establish before the dry hot spring and summer. This would have resulted in a significant level of seedling mortality.

There was no site preparation before seed broadcasting, such as surface scarification. Topsoil had not previously been spread on this slope. As a result, many seeds may have been removed by wind or rain. Remaining seedlings would have found it difficult to establish into the waste material, resulting in even more mortalities.

The quantity of seeds used per species was related to its mature plant size or life form. Amounts of seed were expressed in terms of proportions, rather than actual quantities or ratios:

- Tall shrubs – small proportion
- Medium shrubs – small to moderate proportion
- Small shrubs – large proportion
- Sedges, herbs, grasses and annuals – small to moderate size

There is some question on the composition of the seed mix. No tree species were included in the species mix, despite several species occurring in the area. Also, small shallow rooted and annual species are sometimes not included in revegetation works as many of these species generally cannot survive and be self-sustaining in early revegetation conditions. Often these species are introduced when the site has vegetation cover, or eventually colonise from adjacent native vegetated areas. It is also unknown whether any of the seeds were viable, as they had not been tested for viability before the trials commenced.

Very few seeds were observed to have germinated from the trials (Simcoa Operations Pty Ltd, 2005, 2006, 2007, 2008). Neither trial was successful in establishing plants from broadcast seed.

REHABILITATION NOTE 19

Issue: Native seeding trials to date have been unsuccessful.

Action: Further seeding trials are needed to improve revegetation success. Improvements may include testing for viability, dormancy breaking treatments, site preparation, timing and type seed mix. The trials need to be regularly monitored and reported upon so to select suitable species.

Addressed: Section 10.1.1

3.2.4 THREATENED FLORA TRIAL

A seeding trial has been conducted using the two Threatened flora species recorded in the Mine Site:

- *Daviesia dielsii* in Area 13 in 2005
- *Acacia aristulata* in Area 20 in 2006.

Seeds were broadcast within a 1m radius of a marked peg. Seeds were not tested for viability or treated for dormancy. The surface was not scarified. Neither of these species have been observed during annual monitoring in either plots since the start of the trial (Simcoa Operations Pty Ltd, 2005, 2006, 2007, 2008). Neither trial was successful in establishing populations of either Threatened flora species.

REHABILITATION NOTE 20

Issue: Previous seeding trials for successful germination of conservation significant flora *Acacia aristulata* (TF) *and Daviesia dielsii* (TF) have been unsuccessful.

Action: New revegetation trials need to be developed and implemented for threatened flora.

Addressed: Section 10.2

3.2.5 BRUSH AND FERTILISER TRIALS

Simcoa has conducted several small revegetation trials.

One trial was conducted using combinations of fertiliser and brush (Griffin and Associates 1991; Parker 1991). The following results and comments are noted:

1. **Fertiliser** - Fertiliser appeared to assist weed growth and not native plant growth. However, the report does not contain details such as the chemical composition or type of fertiliser used. It is still possible that an appropriate fertiliser treatment may assist in enhancing rehabilitation works, particularly when topsoil and brush material sources are exhausted.
2. **Brush** - The trial demonstrated that the brush material of *Regelia megacephala, Allocasuarina huegeliana* and *Allocasuarina campestris*, containing capsules, released their seeds which successfully germinated. The authors believe that the topsoil is devoid of these particular species, making brushing or seeding a necessary process to establish these species onto rehabilitation sites.

A second trial was conducted in 2008, using only branches (Trudgen 2011). Approximately two cubic metres of branches of *Regelia megacephala* and *Allocasuarina huegeliana,* bearing seed capsules, were laid across a 0.2 ha bare section of a recently constructed waste rock dump. No seedlings had been observed to have germinated in February 2012. It is highly probable that the seeds were blown away by the wind, as the branches were spread far apart and the soil surface was not prepared in a manner to provide niches to capture the seeds (eg surface scarification). It is also currently unknown whether the seeds in the branch capsules were viable at the time of harvest.

REHABILITATION NOTE 21

Issue: There have been limited trials in using fertiliser and harvested vegetation to improve revegetation outcomes.

Action: More detailed scientific trials are needed to determine methods of improving revegetation outcomes, particularly to overcome the limited topsoil and vegetation resources. Such methods may include soil scarification and variation in types, amount and chemical composition of fertiliser.

Addressed: Section 10.3

3.2.6 REVEGETATION MONITORING

Formal independent rehabilitation monitoring has been conducted roughly every three years by Trudgen and Associates. Simcoa conducts internal monitoring of it rehabilitation annually to comply with the EPA criteria. Current monitoring records also do not record total native vegetation cover, only that of individual species, making it difficult to determine whether rehabilitation works are reaching the EPA criterion of 70% native cover. By summing the individual covers, a rough figure could be estimated for each quadrat. The latest monitoring report (Trudgen 2011) indicated that almost all of the quadrats have approximately 30-50% native cover. Only Quadrat R91/02 exceeded the 70% threshold (~75%).

It should be questioned why the 70% native vegetation figure was set by the EPA. It must be realised that such a figure may be impractical to achieve in this mine site's conditions. It is recommended that this criterion be revaluated and perhaps reworded to "maximum achievable cover". For this to occur, Simcoa will need to negotiate with the OEPA and complete a S.46c variation to conditions.

The cover is mostly comprised of a low diversity of large perennial trees and shrubs, mostly:

- *Regelia megacephala* (P4)
- *Allocasuarina huegeliana*
- *Allocasuarina congesta*
- *Hibbertia subvaginata.*

Over time, *Allocasuarina* plants have outcompeted the other local native species and dominate the revegetation. There is a severe decline in native diversity, with species such as *R. megacephala* disappearing on the older waste rock dumps.

The Two TF species have been recorded in the rehabilitation works. However, the priority flora *R. megacephala* has not been successfully established as a self-sustaining population, because the species cannot compete against other shrub species in broken substrate material.

REHABILITATION NOTE 22

Issue: Revegetation efforts have not yet met the EPA criterion for 70% native cover.

Action: Need to improve revegetation efforts to increase native vegetation cover or renegotiate criterion if not practicably achievable.

Addressed: Sections 6.3, 6.4, 6.5 and **10.1.3**

REHABILITATION NOTE 23

Issue: The value of EPA criterion for native vegetation cover (70%) needs to be reconsidered as it may not be achievable in such site conditions.

Action: Recommend that the EPA criterion wording be changed to "maximum achievable cover".

Addressed: Section 4.5

3.3 Weed Management

3.3.1 CURRENT PRACTICES

There are few weed control activities occurring in the Mine Site. Tracks and incoming vehicles and equipment are inspected for weed seeds as part of Simcoa's hygiene practices (refer to **Section 3.4**). No other formal weed monitoring or control is conducted within the Mine Site, particularly in the remnant vegetation or rehabilitation areas. There is a potential risk of weeds being introduced from the remnant vegetation areas into the rehabilitation areas via topsoil.

A weed inventory of the Mine Site is known, however their threat statuses has not been identified before this report, nor whether they were listed by DEC or SEWPAC. Mine staff are not trained how to identify or control any significant weed species.

It should be noted that weed management is exacerbated by the Mine Site being adjacent to pastures and roads. Simcoa cannot prevent new weed species entering the site from these land uses.

REHABILITATION NOTE 24

Issue: Site staff are unable to identify significant weed species which may degrade revegetation works.

Action: Develop a guide for assist site staff in identifying and controlling significant weed species

Addressed: Sections 7 and **Appendix Four**

3.3.2 CURRENT WEED INFESTATION

Weed cover in the rehabilitation areas has been regularly measured as part of rehabilitation reports by Trudgen Consulting. Weed cover has been observed to increase over time, being around 5-10% in its first year, and increasing to over 40% after 5 years. This cover exceeds the EPA criterion of 10% cover. As discussed in **Section 2.2.3**, the major weed species contributing to weed cover were:

- Annual Veldt Grass (*Ehrharta longiflora*)
- Rat's Tail Fescue (*Vulpia myuros var. hirsuta*)
- Flatweed (*Hypochaeris glabra*)
- Cape Weed (*Arctotheca calendula*)
- Long Storkbill (*Erodium botrys*).

These weed species need to be targeted to reduce weed cover in order to improve rehabilitation success and for the mine to meet the EPA criterion.

Similar to native vegetation cover, it must be questioned as to how the EPA set the criterion for weed cover at 10%. There has been no record to indicate what the previous weed cover was in the pre-mining vegetation. It should be accepted that such a figure may not be practical for the Mine Site. It is recommended that this figure be reconsidered and perhaps the wording changed to "minimal achievable weed cover". Similar for native cover, Simcoa will need to negotiate with the OEPA and complete a S.46c variation to conditions.

REHABILITATION NOTE 25

Issue: Weed cover in rehabilitated sites exceeds EPA criterion (<10%).

Action: Implement a Weed Control Program to target weed species that are known to contribute to weed cover in rehabilitated sites.

Addressed: Section 7

REHABILITATION NOTE 26

Issue: The value of the EPA criterion for weed cover (<10%) needs to be reconsidered as it may not be achievable in such site conditions.

Action: Recommend that the EPA criterion wording be changed to "minimal achievable cover".

Addressed: Section 4.5

3.4 Hygiene Practices

3.4.1 CURRENT PRACTICES

Simcoa prepared Standard Operation Procedure No 11 in 2006 that outlines procedures for minimising the introduction of weeds and diseases in the Mine Site.

The document details:

- why the procedures are important (the protection of vegetation of high conservation significance)
- who is responsible for ensuring this procedure is followed and enforced
- what equipment is to be assessed.

The document also details a procedure for all incoming vehicles to be stopped at inspection points and examined for any soil, slurry or vegetation material. Any discovered material is to be cleaned before the vehicle may proceed further into the Mine Site. In addition, all tracks and hygiene points are to be inspected monthly for weeds by the Mine Manager and weed control to be carried out as necessary.

The Procedure No 11 also does not discuss hygiene practices for incoming vegetation or soil materials, as the only items currently entering the site are equipment, infrastructure and personnel. However, future rehabilitation practices may result in the importation of such material which could potentially be contaminated (eg topsoil, tubestock).

REHABILITATION NOTE 27

Issue: The Procedure No. 11 does not discuss hygiene practices for incoming vegetation or soil materials for future rehabilitation works, which may be contaminated (topsoil, tubestock).

Action: If such practices are to occur, the Procedure should be expanded to discuss how to minimise the risk of introducing diseases and/or weeds from such sources.

Addressed: Section 8

4.0 Domain Model Rehabilitation Plan

The following plan follows the system Rehabilitation Domain Model (Mikli and Kaesehagen (2009), which is based on the ICMM (2008) Domain Model.

4.1 Determine all Site Characteristics

The following site characteristics were considered in establishing Rehabilitation Domains:

- **Soil characteristics:** Most of the Mine Site contains primarily quartz and minimal soil, whereas the waste rock dumps contain quartzite, sand material and silt.
- **Landform:** the Mine Site is open relief with local elevated hills and a ridge, with the exception of the waste rock dumps.
- **Topography:** There is some natural variation in topography in the Mine Site, which has been increased as a result of the construction of open pits and waste rock dumps.
- **Compaction**: Some of the flat areas in the Mine Site are compacted from heavy vehicles, particularly hardstands, infrastructure areas and roads. The waste rock dumps may be also be compacted as a result of their formation.
- **Adjacent land uses**: The Mine Site has three adjacent land uses:
  - Conservation (Coomberdale Chert TEC and remnant vegetation)
  - Pasture (cattle fodder)
  - Transport – Midland Road and Railway.

4.2 Determine End Land Uses

The Mine Site could be divided into its End Land Use. Five End Land Uses were identified:

1. **TEC Buffer:** The waste rock dumps occur adjacent to the Coomberdale Chert TEC. This rehabilitation domain may act as a buffer to prevent degradation of the TEC from edge effects such as weed invasion. The buffer may also contribute as an ecological corridor for local native fauna to adjacent remnant vegetation.
2. **Resemble Native Vegetation***:* Some flat areas may be revegetated to resemble the local native vegetation in terms of structure and diversity, as part of the EPA requirements. The revegetated areas may also contribute as an ecological corridor for local native fauna between adjacent remnant vegetation and the TEC. It should be noted that the level of resemblance will be practically restricted by the altered substrate material.
3. **Pasture:** Some flat areas may be converted to a low value pasture for cattle grazing or as a thoroughfare for cattle to be moved between paddocks. Suitable sites should be located adjacent to existing paddocks for easy access to cattle.
4. **Screening:** Part of the Mine Site may be planted with local trees and large shrubs to screen it from the public's view from Midlands Road.

5. **No Rehabilitation End Land Use:** The Open Pits have no future practical end land use. Also, some of the existing roads and tracks may be kept to serve as firebreaks and/or access roads. These areas do not require to be rehabilitated if they are to be used.

4.3 Divide Mine Site into Domains

4.3.1 REHABILITATION DOMAINS

The Rehabilitation Domains were modelled on the seven Mine Closure Domains by Mine Earth (**Map 1** in **Appendix Three**). The Mine Closure Domains were either combined or further divided, according to their site characteristics and possible end land uses (Table **11**).

Table 11: Rehabilitation Domains for Mine Site

Mine Closure Domain	Site Characteristic	End Land Uses	Rehabilitation Domain
Landforms (Waste Rock Dumps and ROM Pad)	Waste rock material, elevated topography	A buffer for the adjacent TEC An ecological corridor between the TEC and adjacent remnant vegetation	TEC Buffer
Ore Processing and Handling	Compacted soil, relatively flat topography, close to Landforms	Resemble local vegetation community An ecological corridor between the TEC and adjacent remnant vegetation	Revegetation
Non-process Infrastructure	Compacted soil, relatively flat topography, close to Landforms	Low value pasture	Pasture
Water Infrastructure			
Other Assets			
Roads and Hardstand Areas		Some roads/ tracks to be retained for access/ firebreaks	No Rehabilitation End Land Use
Open Pit	Deep inert pit	None	
OPTION	Adjacent and parallel to roads	Screening Mine Site from Public	Screening

The Rehabilitation Domains are presented in **Map 2** in **Appendix Three**.

4.4 Design Appropriate Treatments for each Rehabilitation Domain

The following section describes what activities are required for the End Land Use of each Rehabilitation Domain. There are four main activities described. Note that the "No End land Use" domain has been excluded, as it has no rehabilitation requirements.

4.4.1 PHYSICAL DESIGN

Three Physical Design features have been identified as necessary for the Rehabilitation Domains:

1. **Topography**: changing the shape of the area
2. **Ripping**: relieving soil compaction (where practical)
3. **Soil Scarification**: to improve revegetation success of any seeding works (where practical).

The three Physical Design techniques are further discussed in **Section 5**. The requirements for each Rehabilitation Domain is summarised in **Table 12**.

Table 12: Treatments for Rehabilitation Domains

Rehabilitation Domain	Physical Design Treatment		
	Topography	**Ripping**	**Soil Scarification**
TEC Buffer	Resemble local hill landscape	None (impractical)	None (impractical)
Revegetation	Some gentle grading may be required adjacent to waste rock dumps	If practical, relieve soil compaction where necessary	When practical due to substrate, where any seeding or brush layering is to occur
Pasture	Some gentle grading may be required adjacent to waste rock dumps	If practical, relieve soil compaction where necessary	When practical due to substrate, where any seeding or brush layering is to occur
Visual Screening	Some gentle grading may be required	If practical, relieve soil compaction where necessary	Not required

4.4.2 REVEGETATION

Two main factors need to be considered when revegetating a Rehabilitation Domain:

1. **Species selection:** Selecting appropriate plant species appropriate to substrate, rather than what species originally occurred in that location
2. **Revegetation Method:** selecting which methods are most efficient to revegetation of the Domain

Revegetation techniques are discussed in **Section 5**. The revegetation requirements for each Rehabilitation Domain is summarised in **Table 13**.

Table 13: Revegetation Treatments for Rehabilitation Domains

Rehabilitation Domain	Revegetation Treatment	
	Species Selection	**Method**
TEC Buffer	Local native species characteristic of adjacent TEC where possible	Topsoil, brush, broadcast seed, tubestock may be required for certain species
Revegetation	Local native species resembling local vegetation community	Topsoil, brush, broadcast seed, tubestock may be required for certain species
Pasture	Pasture species capable of growing in post-mine site soil	Broadcast seeding
Visual Screening	Large local tree and shrub species	Tubestock

4.4.3 WEED CONTROL

As discussed in **Sections 2.2.3** and **3.3**, High Priority weed species are a threat as they can reduce rehabilitation success and are a threat to the adjacent TEC. There are two weed control factors that should be considered for each Rehabilitation Domain:

1. **Strategy:** What the weed control should do to aid the Domain in reaching its End Land Use
2. **Method:** Which techniques are best to carry out the weed control in each Domain.

It should be noted that manual control is only practical for individual plants or small populations. Herbicides will be required for larger infestations. Herbicide control techniques are discussed in **Section 5**. The weed control requirements for each Rehabilitation Domain is summarised in **Table 14**.

Table 14: Weed Control Treatments for Rehabilitation Domains

Rehabilitation Domain	Weed Control Treatment	
	Strategy	**Method**
TEC Buffer	- Eradicate or reduce High Priority weed species populations while having minimal impact on revegetation - Prevent their spread into the adjacent TEC if they are known to not already occur in the TEC	Manual removal, wicker wiping, spot spraying
Revegetation	Eradicate or reduce High Priority weed species populations while having minimal impact on revegetation	Manual removal, wicker wiping, spot spraying
Pasture	General weed control	Spot spraying
Visual Screening	Minimise weed cover to allow tubestock to establish and mature	Manual removal, wicker wiping, spot spraying

4.4.4 MINE HYGIENE

As discussed in **Sections 2.2.5** and **3.4**, mine hygiene procedures should be in place in each Rehabilitation Domain to minimise the introduction and spread of:

1. Plant Diseases: particularly Dieback
2. Weeds: particularly High Priority Weeds

An update on mine hygiene procedures is discussed in **Section 5**. The mine hygiene requirements for each Rehabilitation Domain is summarised in **Table 15**.

Table 15: Mine Hygiene Treatments for Rehabilitation Domains

Rehabilitation Domain	Mine Hygiene Treatment	
	Plant Diseases	**Weeds**
TEC Buffer	Prevent introduction of Dieback	Prevent introduction of High Priority Weeds or new weed species into Domain and adjacent TEC
Revegetation	Prevent introduction of Dieback	Prevent introduction of High Priority Weeds or new weed species into Domain
Pasture	Prevent introduction of Dieback	Prevent introduction of High Priority Weeds or new weed species into Domain
Visual Screening	Prevent introduction of Dieback	Prevent introduction of High Priority Weeds or new weed species into Domain

4.5 Develop Detailed Key Performance Indicators

Key Performance Indicators (KPIs) are needed to measure how works in the Rehabilitation Domains are reaching their End Land Use and meeting EPA criteria. The following

Table 16 summarises the KPIs of each activity for each Rehabilitation Domain.

It should be noted that the following KPIs are general statements and are not quantified measurements:

- minimal achievable weed cover (at variance to the EPA criteria of less than 10%)
- maximum achievable native cover (at variance to the EPA criteria of more than 70%)
- Species composition and structure resembles Adjacent TEC on comparable substrate.
- Species composition and structure resembles local vegetation community on comparable substrate.

As rehabilitation progresses and what can be practically achieved becomes apparent, Simcoa should liaise with the DMP, EPA and DEC to agree on definitions for the exact and practical thresholds for these KPIs.

Table 16: Key Performance Indicators for measuring rehabilitation works in Domains

Rehabilitation Domain	Key Performance Indicator			
	Physical Design	**Revegetation**	**Weed Control**	**Mine Hygiene**
TEC Buffer	1. Landform resembles local hill landscape 2. Vegetation successfully establishing in soil	1. Species composition and structure resembles Adjacent TEC 2. Maximum achievable native cover 3. Self-sustaining populations of conservation significant flora	1. Minimal achievable weed cover 2. Low presence of High Priority Weeds	1. No Dieback infections 2. No new weed species detected
Revegetation	3. Relatively flat terrain 4. Vegetation successfully establishing in soil	4. Species composition and structure resembles local vegetation community 5. Maximum achievable native cover 6. Self-sustaining populations of conservation significant flora	3. Minimal achievable weed cover 4. Low presence of High Priority Weeds	3. No Dieback infections 4. No new weed species detected
Pasture	5. Relatively flat terrain 6. Vegetation successfully establishing in soil	7. Species composition of pasture plants 8. Maximum achievable cover of pasture	5. Minimal achievable weed cover	5. No Dieback infections 6. No new weed species detected
Screening	7. Relatively flat terrain 8. Vegetation successfully establishing in soil	9. Species composition of local native trees and large shrubs 10. Maximum achievable native cover	6. Minimal achievable weed cover 7. Low presence of High Priority Weeds	7. No Dieback infections 8. No new weed species detected

5.0 Physical Design Techniques

Physical design generally refers to the shaping and grading of a site to provide stability, hydrological compatibility and visual compatibility with the surrounding area. The site must be prepared to reduce risk of rain and wind erosion. Drainage must be considered to prevent long term gullying or degradation to revegetation efforts. Slopes should be designed to reduce the velocity of runoff as the catchment of the slope increases. The final shape of the works should also be similar to the surrounding landscape to allow the site to look natural and blend in and not be an eyesore (Mineral Council of Australia 1998).

In this report, physical design also refers to the physical preparation of the site to enhance rehabilitation works. The main two factors discusses are ripping (to relieve soil compaction) and surface scarification (for seed broadcasting).

5.1 Topography

5.1.1 WASTE ROCK DUMPS

The waste rock dumps should be constructed in a manner that can maximise the disposal volume of waste material within a limited surface area, while providing slopes that are gentle enough to reduce water erosion from rain and allow establishment of vegetation. DMP generally recommends that the slope should be less than 20^0, however this angle may vary from site to site, depending on soil stability – more stable dumps can be 20^0 slightly higher while less stable dumps should be considerably lower. Also, the slopes should not have an overly convex profile (**Figure 5**).

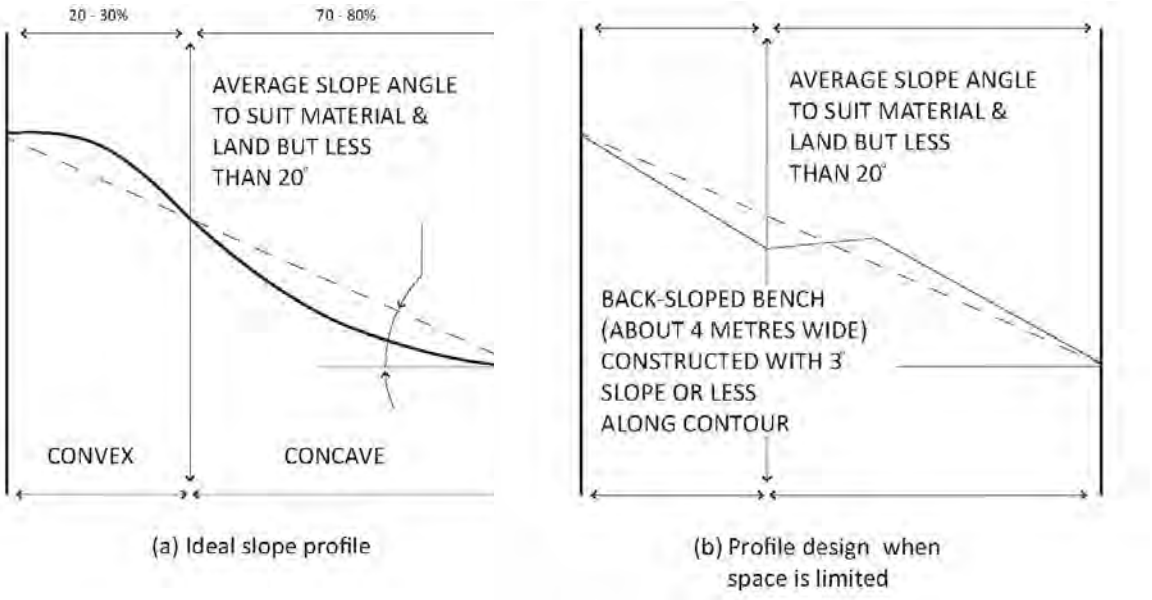

Figure 5: Shaping overburden dumps (Minerals Council of Australia 1998)

If erosion is proven to be a significant issue to the site, contour benches or other erosion control methods should be integrated into the design. Benches should be located in the middle of the slope.

The following guide describes limits of operating equipment on slopes (Minerals Council of Australia 1998):

- Ripping – up to 28 degrees
- Normal agricultural machinery – up to 19 degrees
- Bulldozers to push material up slopes – up to 22 degrees
- Spreading of topsoil – up to 19 degrees.

The dumps should also resemble the surrounding hill landscape in terms of height and size. Avoid long straight ridges and sharp angles, as this is visually unnatural. The natural shaping should also assist in reducing erosion as it will mimic the natural landscape's geological formation in response to local climate conditions.

Drainage from waste rock dumps can be directed into the surrounding area, however the surrounding surface elevation must be considered as it will affect water flow and drainage. Even slight variations in surface elevation can affect soil moisture levels and subsequent vegetation types that can be established. Concentrated water flow may also degrade the surrounding land. Water can also be directed into the pits, provided the water is not of low quality.

The maximum recommended slopes suitable for the surrounding land uses are as follows:

- pasture – 15 degrees
- roads – 12 degrees.

If possible, materials used in the construction of waste rock dumps should include those that have moisture holding capacity. This will improve the moisture holding retention within the dumps and should encourage revegetation growth. Examples of materials include organic matter (vegetation, manure, compost) and clay. It is acknowledged that securing such material may be impractical.

5.1.2 GRADING

As discussed above, any flat land adjacent to waste rock dumps are susceptible to drainage issues. Ponding and erosion may occur as a result of the surface elevation directing water flow. Gentle grading is recommended to adjust the soil surface to a gentle slope away from the dumps. This will reduce the velocity of waste rock drainage while dissipating the volume. This should also reduce the overall soil moisture profile and thus minimise any affect on vegetation type (eg no dampland vegetation).

5.2 Ripping Compacted Soil

Soils may be compacted from use of heavy machinery during construction. This compaction reduces soil aeration, moisture infiltration and root penetration. Seedlings are highly unlikely to survive and establish in such conditions, leading to poor or failed revegetation work over many years (Buchanan 1989).

Deep ripping may relieve this compaction and promote faster and more successful revegetation. Ripping should occur sometime before planting (a few months to up to a year) so the soil has time to settle and moisture penetrate deeply into the ground. It should be done when the soil is dry, to maximise shattering and reduce any clay glazing. Ripping should follow the contours of the land to allow capture and absorption of rain water. The ideal depth is between 0.5 and 1m. The distance between rips should match the depths (Buchanan 1989; Dalton 1993).

It should be noted that ripping should occur before any application of residual herbicides, to minimise penetration of the herbicides into the soil profile containing tree roots. If ripping must be done after application of residual herbicides, the ripper should have wings to throw away the contaminated soil from where the seed and tubestock are to be planted (Dalton 1993).

Ripping is only practical on substrates without large rock material. Therefore this treatment may not be considered for waste rock dumps.

5.3 Soil Scarification

Soil scarification is the preparation of the soil surface to maximise seed germination and establishment. It is useful for both brushing (when branches are laid on top of soil) and seed broadcasting methods. It involves the mechanical harrowing of the surface to provide niches for seed to lodge in, to reduce it being removed by wind or rainfall. It also increases the chances of the seeds to successfully extend their radicles (embryo roots) into the soil and begin to establish. Suitable soil scarification may greatly increase the number of native plants establishing in a rehabilitated area, particularly on slopes where wind and rain may easily remove any seeds lying on top of the soil surface (EPA 1995, MCA 1998).

There are several soil scarification technique options, depending on the size and access of the area. Small or difficult to access sites may be raked by hand, while larger and flatter areas may be scraped using machinery. Scarification should occur immediately before seeding.

Like ripping, soil scarification is only practical on substrates without large rock material. Therefore this treatment may not be considered for waste rock dumps.

6.0 Revegetation Techniques

6.1 Species Selection

6.1.1 CANDIDATE SPECIES

Seeds should be sourced from local provenance (usually within 5km of the Mine Site). They also need to be those matching the vegetation complexes. Provenance is paramount to preserving local genetics of plants.

Ideally the species used in revegetation would consist of the entire suite of plants that naturally occur at the site. This requires a comprehensive species list and the ability to propagate all the species. Additional species can be determined by examining the relevant literature for species which occurred in matching soil and vegetation associations. Appropriate species should be chosen based upon whether they were most likely to have been local and whether they were practical for the revegetation process.

All species used for seeding into Vacant Crown Land (VCL) usually needs to be accepted by DEC before they can be used.

Not all local plants may be included in seed collection. Many species are known to be extremely poor in either seed germination or establishment. It is expected that other local species should colonise the site over time.

A candidate species list should be developed after considering the following factors (Mineral Council of Australia 1998):

- have proven to grow well in previous revegetated areas within the local area, as these species demonstrate promise in establishment and survival in disturbed conditions
- are observed to grow in habitats that match the soil and drainage conditions of the rehabilitated site
- can produce sufficient viable seed to harvest economically
- have fauna habitat value, particular to conservation significant fauna
- are legume species that are good colonisers and will improve soil fertility
- are conservation significant flora, to assist in increasing their populations.

6.1.2 REHABILITATION DOMAIN SPECIES

The candidate list should then be broken down into separate Rehabilitation Domain species lists; those that suit the end land use and site characteristics of each Rehabilitation Domain:

- **TEC Buffer**: local native species that are characteristic or at least occur in the adjacent Coomberdale Chert TEC and provide habitat value to significant fauna

- **Revegetation**: local native species that are characteristic or at least occur in the local remnant vegetation and provide habitat value to significant fauna
- **Screening**: local native trees and large shrubs.

The Pasture Domain differs from the other Rehabilitation Domains in that its end land use requires exotic pasture plants. The species selection for this Domain should instead be a commercial blend of fodder species which should not present a weed threat to the natural revegetation areas.

The Rehabilitation Domain species lists are presented in **Appendix One.**

6.2 Seeding

6.2.1 PROS AND CONS

Seeding is typically a highly economical, practical and reliable method of establishing many species in large areas. Further, seeding may result in a random distribution of species, allowing for a more natural appearance to revegetated sites (Minerals Council of Australia 1998). Also, seeding allows for more wind-stable mature plants to establish, as the root systems have not been disturbed (Dalton 1993).

However, seeding may not be effective for certain works:

- The price of a seed mix is highly variable as some species prices may vary from as little as $50/kg to over $7000/kg (Tranen 2010).
- Seeds of species desired for rehabilitation may not be available in suitable quantities.
- Seeds of species required may not be highly viable and able to readily quickly establish on the site.
- Seeds are vulnerable to predation by local fauna such as insects and birds.
- Emerging seedlings may not be able compete with present weeds.
- Some species may not respond well to standard seed treatment (eg require a specialised dormancy breaking treatment) (Minerals Council of Australia 1998).
- Success of seed germination and seedling establishment is highly vulnerable to seasonal variations (Dalton 1993).

Species should only be chosen for direct seeding if proven to have:

- decent viability and germination success
- can be obtained commercially in sufficient quantities
- are economically affordable.

ALCOA has recently released a report of germination trials of over 1100 species that occur in the Swan Coastal Plain and Jarrah Forest that may assist in selecting species of decent to high germination success (Cromer 2007). The commercial and economic status of species seed can be obtained through consultation with seed suppliers.

6.2.2 COLLECTION AND PURCHASE

Ideally plant material should be sourced from near the site, with no more than one third of the available seed being collected from any individual plant and numerous "parent" plants used. This avoids issues of:

- inbreeding where too few "parents" are used and the seedlings produced lack vigour
- genetic pollution due to the introduction of dissimilar genetic material (from a different area) which can result in sterile plants or a form of a species not native to the site becomes rampant.

However sourcing material nearby maybe quite difficult due to extensive disturbance and/or clearing in the vicinity and there is presently a dearth of information in the public domain with regard to the distances at which genetic variation becomes important for native species. The precautionary principle needs to be taken in sourcing material as close to the site as possible and attention given to record keeping and obvious morphological differences between plants occurring onsite and seedlings planted.

The following items are important in securing native seeds (EPA 1995, MCA 1998, DMP 2011):

- Collection should focus on the seed of species that are known to be practical to collect, have at least reasonable level of viability and retain that viability for at least several years.
- Most native species are collected during the summer months (from spring flowering) however there are species (such as Macrozamias) that are best collected during winter.
- Seeds of some species (such as *Clematis*) are recalcitrant (very short lived). Such species should only be collected if they are planned to be used the following winter.
- Seeds should be collected when fully ripened to maximise viability. Collecting too early both damages the reproductivity of the plant and greatly lowers revegetation success.
- Seed collection must be undertaken with the appropriate licence from the DEC. Pickers must have their licences updated to be permitted to collect in the desired areas.
- It is forbidden to collect from road reserves or road sides, unless the collector has special permission from the Main Roads Department and the DEC.
- Collectors must seek and obtain permission from land owners before collecting seed from private land.
- Only 20% of seeds may be collected from a plant and from an area. This is to maintain sustainability of both the plant population and future seed collection.
- Seed collecting should be conducted in a manner that does not harm the parent plant. (Technically only seed pods are to be taken, although this is often impractical - so the ends of branches together with the seed pods are cut off with secateurs for many species). Removal of the entire plant is forbidden.
- Records must be maintained by the collector as to the location, amount and date of seed collected of each species.

- Declared and Priority species must not be collected without special written permission from the DEC.
- OS&H issue - Collectors should wear full PPE (boots, pants and long sleeved shirt, hat, safety sunnies, gloves and sunscreen) in the field.

Ideally it is advantageous to have seeds independently tested for viability so to understand their likelihood for germination success, but this option can be expensive. Viability results can also be compared to Alcoa's germination records to work out any "bad batches" of seed. In some cases, companies can refuse purchase of seeds if the viability of a seed batch is below expectations.

A Native Species Identification Guide is located in **Appendix Five**. The guide is to assist in identifying the most important native flora species for revegetation, in order to assist in seed collection. The species were selected if they were one or more of the following:

- conservation significant
- locally dominant
- characteristic of the Coomberdale Chert TEC.

6.2.3 SEED STORAGE

The following items are important for efficient storage of seeds (EPA 1995, MCA 1998, DMP 2011):

- Seeds should be kept in airtight bags that have been treated with CO_2 so as to kill any insects present in the seed collection. The seed material should be inspected for pest damage, mould and fungus on a regular basis and action taken to avoid seed deterioration.
- Seeds should be stored in vermin proof containers above ground level, away from light, in secure, dry, well-ventilated storage facilities protected from temperature extremes (preferably air conditioned).
- It should be noted that seeds of certain plant species can only be stored for several years before they lose viability. Records must be maintained to ensure that the seeds are replaced within a period of time to ensure the entire stock is of high viability. Ideally the old seeds should be broadcasted back in their appropriate vegetation community, as some seeds may still germinate and contribute to the area's flora presence.
- Some species (such as *Persoonia*) require to be immediately stored in refrigerated conditions after collection to preserve viability.

6.2.4 SEED TREATMENT

Seed batches should be treated to break their dormancy before they are sown. Up to 75% of the seeds should be treated to encourage germination in the first year. The remaining dormant seed will form part of the soil seed bank and are expected to germinate in later years, assisting in promoting long term revegetation success. The two main types of seed treatment are described below.

Smoke

It is well known that smoke contributes greatly to the germination of Australian native seeds. Work by Kings Park has isolated the chemical responsible and have named it karrikin (Flematti et al. 2004), after the Noongar word for smoke "karrik". Karrikin is a plant growth regulator that is formed and released from the burning of plant material. It acts as a stimulant to break seed dormancy. The commonly accepted theory is that native plants have adapted to produce seeds that germinate after a bushfire, to take advantage of the ash nutrients released and of space and light.

Seed smoking is now a common practice in revegetation. There are two main methods to smoke seeds. Many commercial seed suppliers have a seed smoking chamber and offer it as a service. Smoke water (smoke bubbled through water) is also commercially available. Seeds can be treated by simply spraying a thin layer of the liquid.

All species should receive smoke treatment, as this treatment cannot damage the seeds and can only promote germination.

Scarification

Many native seeds, such as legumes, have hard seed coats which are impermeable to air and water. Germination of the seeds cannot occur until the coat is cracked. In nature this is done over time by sand scarification in the top soil. Revegetating areas with such seed may result in seed germination not occurring for many years.

To hasten revegetation success, the seeds may be artificially scarified to crack the seed coats. One methods include brief exposure in boiling water (EPA 2005), however this is impractical for large scale works. A more appropriate method is to used specialised scarification machines that use coarse sandpaper to mechanically abrade the seeds. Many native seed suppliers have such machines and offer them as a service.

All species with hard coated seeds, such as members of *Acacia* genera, should be scarified to promote germination. No fine or soft seeds should be scarified, as this will most likely damage the seeds.

6.2.5 BROADCASTING SEED

Seeding rates vary from site to site and depend on local condition and the type and condition of the seeds. The generally accepted industry rates for native seed broadcasting are:

- completely bare areas – 6 to 8 kg/ ha
- areas with some remnant vegetation – 3 to 4 kg/ ha.

Inert material (eg sand) should be mixed into the seed mix as filler. Seeds should ideally be broadcasted in early winter just after first rains to allow minimal loss from predation and wind before the rain can settle the seeds into the soil and start germination (EPA 2005).

Seeds used for revegetation need to first be tested for viability to ensure an adequate percentage of the seeds are alive. Seed batches purchased from suppliers need to be independently tested by a qualified seed testing laboratory to determine percentage viability of each species. Seed batches that are found to have percentage viabilities below than what is expected for that species will be returned to the supplier and the purchase refunded.

6.3 Brushing

6.3.1 PROS AND CONS

One problem in using broadcast seeding in revegetation is the limited choice of species to collect seeds from. Species that retain unopened fruit for over a year (bradysporous species) are rarely used in seed mixtures as such because of the difficulty of collection. One potential method of direct seeding such species is by spreading foliage with the capsules directly onto the site. The seeds are then shed when the capsules dry out (EPA 1995; Nicholls 1983). This process, termed brushing, may prove to be a relatively cheap and easy method of revegetating spoils using Myrtaceae genera with capsule fruits, such as *Calothamnus, Kunzea, Melaleuca* and *Regelia.*

Brushing is used successfully in Western Australia. Mulch of stripped native vegetation provides 85 % of the germinable seeds that occur on rehabilitated sand mine soils at Eneabba (Peterson & Herpich 1996). Thirty one taxa, from Myrtaceae, Casuarinaceae and Proteaceae, including species of *Melaleuca, Leptospermum* and *Eucalyptus*, established from seeds in the applied mulch (Bellairs 1990).

In addition to seed provision, brushing is valuable in rehabilitation for restoring insects and other biota; some nutrient recycling; and, formation of micro-sites (Pywell, Webb & Putwain 1995; Ross, Simcock & Gregg 1995). When the branches dry, the seeds are released into a secondary mulch of fallen leaves, which may assist in forming a seedbed, allowing long-term germination of up to five years (Nicholls 1983). The branches may also improve the growing environment by increasing humidity and temperature (Porteous 1993), providing organic matter and protection from wind and water erosion (Bell, Carter & Hetherington 1986) and reducing the entry of grasses and other weeds to the site. Some consider this method potentially more economical than broadcast seeding (Pywell, Webb & Putwain 1995).

6.3.2 METHOD

There are several steps for brushing to be successful. Firstly, the site of harvesting must be easily accessible to transport the branches, and also must be near the revegetation site, so the species are ecologically suited to the new site (Nicholls 1983).

Secondly, the method of harvesting and applying the branches is important. Dense, brush like branches are ideal for brushing, as the material is easy to cut, transport and lay (Nicholls 1983). The branches should be laid thickly enough to break the impact of rain, but not so thickly as to prevent germination (Porteous 1993). Fifty to sixty percent cover is usually ideal on standard slopes (Nicholls 1983), lowering to thirty percent cover on gentle slopes (Simcock *pers comm*.). The branches should be laid across the slope to capture falling debris and reduce run off. Material can be tied down with stakes or biodegradable netting on sites with steep slopes or wind problems (Nicholls 1983; Porteous 1993).

6.4 Climate Change

Recent local climate patterns have indicated a significant drop in total annual rainfall. Revegetation activities are totally dependent on the Mine Site receiving adequate rainfall for seedlings to germinate and for revegetation to establish and survive. Irrigation is not an option as the installation is cost prohibitive and the Mine Site is unlikely to secure enough water.

If the amount of rainfall continues to decline or not occur over a suitable period, the EPA criteria and associated KPIs will become increasingly difficult to achieve. In such circumstances, Simcoa will need to liaise with DMP, EPA and DEC over how to address the low rainfall and whether the completion criteria may be amended.

7.0 Weed Control Techniques

7.1 Collecting Baseline Data on Weed Cover

It is vital that baseline data be obtained for an understanding of the weed cover. This will allow for a proper evaluation of the rehabilitation efforts and help determine any impediments. It will also help in the evaluation of the EPA criterion of 10% weed cover and determine whether they are suitable and realistic for the site.

As there is still some remnant vegetation in the Mine Site, these areas can be used as reference sites. It is recommended that at least 3 sites across the site be surveyed to establish any variation in the weed cover. An area of 10 m by 10m should be randomly chosen at each site and the percentage weed cover determined. Surveying should be conducted in late Spring to coincide with the annual monitoring works.

The results of this baseline assessment will help determine the next course of action:

- If the baseline percentage weed cover average proves to be close to the current rehabilitation sites (>40%), Simcoa should submit an S.46c variation to conditions to amend the EPA criterion of 10% weed cover to a figure that matches the pre-existing environment. Weed control works should not be necessary.
- If the baseline percentage weed cover proves to be close to 10%, weed control activities will be required to reduce weed cover in the rehabilitation areas to meet the EPA criterion.
- If the baseline proves to between the EPA criterion and the rehabilitation dumps (ie 20-30%), Simcoa should both submit a S.46c form and undertake weed control activities.

7.2 Weed Strategy

If it is determined that rehabilitation sites' weed cover exceeds the baseline weed cover, weed control work will be required to reduce the presence of weeds. A strategy is required to best reduce weed cover with minimal time and with minimal resources.

The following Weed Strategy has a two stage approach:

1. **Species-led Control**: A species-led control should first be undertaken. High Priority Weeds should be targeted first to eliminate or at least reduce their populations.
2. **Site-led Control**: Once High Priority weeds are controlled, a site-led control should be undertaken to reduce any areas that have high weed cover.

7.3 Weed Species Priority

As discussed in the previous section, resources should be first focused at controlling High Priority weeds, as these are considered the most invasive and threatening to the Mine Site. However, weed species which were determined as High Priority should not be excluded from control activities if there are enough resources available.

In general:

- species with a final rating or 5 or 6 (High Priority) should be targeted first
- species with a final rating of 3 or 4 (Moderate Priority) should be controlled opportunistically if resources allow after targeted control of High Priority Weeds
- species with a final rating of 1 or 2 (Low Priority) should be controlled opportunistically if resources allow after control of Moderate and High Priority Weeds.

It should also be noted that as weed control of priority species progresses, other weed species which previously may not have been rated as highly, may become more important. Therefore, it is important to keep weed control programmes flexible and updated according to monitoring data, to ensure that as bushland condition changes and weed species dominance changes, the control activities are adjusted accordingly.

The priority of all known weed species in and around the Mine Site is presented in **Table 16**. Guide sheets on how to identify and control each High Priority weed species are provided in **Appendix Five**. A table summarising how to control all weed species is also presented in **Appendix Five**.

7.4 Optimal Times to Control Weeds

Most weed species have optimal times of the year when they should be controlled. Weed control operations are best conducted targeting many species as possible during their optimal times to reduce the number of site visits required. This would reduce the need for management and minimise the costs and resources. It is more important to target all high priority weed species during these operations, and only include moderate and low priority weed species if resources allow.

The optimal times to target the most amount of weed species is in August (27 species). This is common time where plants are actively growing from the winter rain and being more susceptible to absorbing the herbicide, and before the can set seed. Further works are required in May and November to target the remaining five species whose active growth and seed set times occurs in other times of the year.

The optimal times are presented in **Table 16**.

Table 17: Optimal control times for controlling weeds in Simcoa Quartzite Mine, Moora

PRIORITY	WEED SPECIES		OPTIMAL CONTROL TIME											
	Scientific Name	Common Name	J	F	M	A	M	J	J	A	S	O	N	D
High	*Avena barbata*	Bearded Oat												
	Bromus diandrus	Great Brome												
	Centaurea melitensis	Maltese Cockspur												
	Cynodon dactylon	Couch												
	Ehrharta calycina	Perennial Veldt Grass												
	Ehrharta longiflora	Annual Veldgrass												
	Hypochaeris glabra	Smooth Cats Ear												
	Arctotheca calendula	Cape Weed												
	Erodium botrys	Long Storksbill												
	Vulpia myuros var. *hirsuta*	Rat's Tail Fescue												
Moderate	*Aira caryophyllea*	Silvery Hair Grass												
	Aira cupaniana	Silvery Hair Grass												
	Briza maxima	Blowfly Grass												
	Bromus rubens	Red Brome												
	Erodium cicutarium	Common Storkbill												
	Helichrysum luteoalbum	Jersey Cudweed												
	Pentameris airoides	False Hair Grass												
	Petrorhagia dubia	Velvet Pink												
	Polypogon monspeliensis	Annual Barbgrass												
	Romulea rosea	Guildford Grass												
	Solanum nigrum	Black Nightshade												
	Sonchus oleraceus	Common Sowthistle												
	Urospermum picroides	False Hawkbit												
	Ursinia anthemoides	Ursinia												
	Trifolium arvense	Hare's Foot Clover												
Low	*Brachypodium distachyon*	False Broome												
	Bromus alopecuros	Weedy Brome												
	Conyza bonariensis	Flaxleaf Fleabane												
	Cucumis myriocarpus	Prickly Paddy Melon												
	Lysimachia arvensis	Pimpernel												
	Oxalis corniculata	Yellow Wood Sorrel												
	Avellinia michelii	Avellinia												
	Monoculus monstrosus	Stinking Roger												
	Zaluzianskya divaricata	Spreading Nightphlox												

Optimal control time

7.5 Weed Types

It is important to understand the biology of each identified weed species in order to determine the best way to control them. Knowledge should focus on how the plant grows and propagates in order to both remove the existing plants and to prevent future generations. As such, the identified weed species were separated into four types, according to their biology and the type of control methods.

The following section describes the biology of each of the four weed types and notes which of the above control method are the most effective to control that type. It also lists which weed species belongs to that weed type and their priority.

7.5.1 GRASSES, SEDGES AND RUSHES

Grass, sedge and rush species are all monocots. As such, they have similar physiology which makes them susceptible to certain herbicides that may not be as harmful to broad leaf plants. Using grass selective herbicides such as Fusilade® may assist in controlling monocot weeds while having minimal impact to adjacent broad leaf native plants. Herbicides may be applied through wicker wiping or spot spraying.

Many of these species are highly competitive with native plants and can dominate the understorey. Most monocot weeds, particularly annuals, produce high numbers of seeds to ensure seedling recruitment in the following year. It is therefore vital to control infestations before they set seed to prevent further spread of these populations.

Cynodon dactylon (Couch) is a lawn grass, so can also spread by rhizomes and stolons. If the grasses cover the ground, effectively forming a lawn, they may in some circumstances be controlled by smothering them in black plastic in summer. If the grasses are invading into bushland areas, they may be controlled by manually gathering the spreading rhizomes/ stolons and removing them off the site.

A total of 15 weeds species were grasses. Six of them are rated High Priority:

- *Avena barbata* (Bearded Oat).
- *Bromus diandrus* (Great Brome)
- *Cynodon dactylon* (Couch)
- *Ehrharta calycina* (Perennial Veldt Grass)
- *Ehrharta longifolia* (Annual Veldt Grass)
- *Vulpia myuros* var. *hirsuta*.

The remaining nine grass species are Low to Moderate Priority to control:

- *Aira caryophyllea* (Silver Hair Grass)
- *Aira cupiana* (also Silver Hair Grass)
- *Avellinia michelii* (Avellinia)
- *Brachypodium distachyon* (False Brome)
- *Briza maxima* (Blowfly Grass)
- *Bromus alopecuros* (Weedy Brome)
- *Bromus rubens* (Red Brome)
- *Pentameris airoides (False Hair Grass)*
- *Polypogon monspeliensis* (Annual Barbgrass).

No sedge or rush weed species were recorded.

7.5.2 GEOPHYTES

Many geophyte weeds are 'garden escapes'; originally planted in people's gardens for aesthetics where seeds have entered adjacent bushland. Most of these species are Irises (family Iridaceae) from the cape region of South Africa. The similar climate and soil types made the Perth metropolitan region and south west highly suitable for these species to proliferate and become major environmental weeds. The Geraldton Sandplain region is generally less ideal but still suitable for many geophyte species.

Only two geophyte species has been recorded in the Mine Site:

- *Oxalis corniculata* (Yellow Wood Sorrel) – Low Priority
- *Romulea rosea* (Guildford Grass) – Moderate Priority.

Geophyte weeds are plants capable or reproducing though underground propagules such as bulbs, corms and tubers. Normal weed control practices are inefficient, as the parent plant may be killed, but the plants may return from sprouting underground propagules. Weed control therefore requires targeting the propagules as well as the parent plant.

If the populations are small, it may be practical to manually remove the plants. Care must be taken to dig around each plant and ensure that all of the underground propagules are also removed, otherwise new plants will appear in the following year.

Certain herbicides such as chlorsulfuron, metsulfuron and 2, 2 DPA are often used to control geophytes, as they can poison both the parent plant and the underground propagules. Such herbicides are best applied when the plants are flowering to maximise the absorption into the propagules. Application can be carried out by either wicker wiping or spot spraying, depending on the species (eg wicker wiping is ineffective on Guildford Grass but is highly effective on Watsonia). Special care must be taken to ensure that adjacent native plants are not exposed to these harmful chemicals.

7.5.3 BROAD LEAF HERBS

Along with grasses, broad leaf herbs are usually the most common type of weed species in a bushland. Most species do not invade good condition bushland, rather they are opportunists that enter when a site is disturbed. Broad leaf herbs are generally easier to control than geophytes, as they only spread by seed and do not have underground propagules. Such weeds should therefore be controlled before they can set seed, as this is their only method of reproduction.

Broad leaf herbs are can be controlled though most general methods. Small populations should be manually removed before they set seed. Care must be taken to remove the crown and taproot, otherwise plants may resprout. Most species are susceptible to glyphosate when activity growing, although other herbicides may be required on some glyphosate tolerant species. Herbicide

application may be though either wicker wiping or spot spraying, depending on the size and nature of the infestation in each reserve.

Four of the recorded broad leaf herb species are rated as High Priority to control:

- *Arctotheca calendula* (Cape Weed)
- *Centaurea melitensis* (Maltese Cockspur)
- *Erodium botrys* (Long Storkbill)
- *Hypochaeris glabra* (Flatweed).

The remaining 14 species are rated Low to Moderate priority to control:

- *Conyza bonariensis* (Flaxleaf Fleabane)
- *Cucumis myriocarpus* (Prickly Paddy Melon)
- *Erodium cicutarium* (Common Storkbill)
- *Helichrysum luteoalbum* (Jersey Cudweed)
- *Lysimachia arvensis* (Pimpernel)
- *Monoculus monstrosus* (Stinking Roger)
- *Pentameris airoides* (False Hair Grass)
- *Petrorhagia dubia* (Velvet Pink)
- *Solanum nigrum* (Black Nightshade)
- *Sonchus oleraceus* (Common Sowthistle)
- *Urospermum picroides* (False Hawkbit)
- *Ursinia anthemoides* (Ursinia)
- *Trifolium arvense* (Hare's Foot Clover)
- *Zaluzianskya divaricata* (Spreading Nightphlox).

7.6 Herbicide Control Methods

A variety of control methods for each weed species has been provided in **Appendix Five**. Weed management recommendations are based on information from Moore and Moore (2008) *Herbiguide*, Brown and Brooks (2002) *Bushland Weeds*, and Dixon and Keighery (1995) *Recommended Methods to Control Specific Weed Species.*

It is necessary that the application of herbicides be in accordance to labelling requirements or the manufacturers Materials Safety Data Sheet (MSDS) and must be undertaken by personnel trained in the use of herbicide chemicals. The application of any herbicide for purposes not specified on the labelling requires an Off-Label Permit from the National Registration Authority in Canberra.

The application of herbicides must also be in accordance with water catchment restrictions. Chemical based weed control strategies in particular must recognise potential adverse impacts on water resources such as lakes, wetlands, streams, rivers and dams. Clearly, significant control

measures must be implemented in Public Drinking Water Sources Areas for the water we consume. The Department of Water's (DOW 2000) *Statewide Policy No.2 Pesticides in Public Drinking Water Sources Areas* will provide further advice on this matter.

Timing is crucial in having an effective impact on weeds. Generally, weed populations should be targeted when actively growing (ie usually in spring) to allow maximum uptake of the chemical, but before flowering, to prevent seed spread. In certain cases, this time window can sometimes be reduced to target weed species without harming native species (eg many annual grass weed species flower before native grasses) (Hussey & Wallace 2003). However, it should be noted that the timing for the targeting of specific weeds presented in this report is an estimate only, as it can vary according to time of year of fire and the impact of fire on native vegetation and the soil seed bank.

Where possible, a variety of herbicides were recommended for controlling each weed species. It is up to Simcoa to decide which herbicide is the most appropriate to use, depending on costs and availability of the herbicides.

It should also be noted that the herbicide treatments are a suggestion only and many were adapted from large scale agriculture rates. The types and rates of herbicides should be verified by a qualified weed scientist before any such methods are used on the Mine Site.

Details of herbicides recommended for controlling weeds in the Mine Site are also provided in **Appendix Four**.

7.6.1 TECHNIQUES

There are several recommended techniques in applying herbicides to weed species. These methods vary as to which is the most effective in treating certain weed species, depending on:

- form of weed (eg herb, shrub or tree)
- the size and distribution of weed populations in the area
- effectiveness in targeting the weeds without harming adjacent native plants.

1. Wicker Wiping

Herbaceous weed species may be treated with herbicide by wicker wiping. This involves sponge or rope soaked in a concentrated herbicide solution which is wiped against the leaves of the plant (Dixon & Keighery 1995). Wiping is often more effective in targeting weed plants and not harming adjacent native plants, however this process may be more labour intensive. Weeds most ideal for this treatment are small populations of small shrubs and broadleaf herbs.

2. Spot Spraying

Spot spraying involves fine spraying a weak solution of herbicide over the foliage of the weeds. Certain tree species may also be treated by spot spraying the base of the trunks with herbicides

diluted in diesel. Care must be taken to avoid spraying adjacent native plants. Use of selective herbicides may reduce impact of herbicides on native flora (Dixon & Keighery 1995).

Recommended dosages of each herbicide given were calculated for a 10L knapsack.

8.0 Mine Hygiene Procedure

8.1 Dieback Hygiene

8.1.1 DIEBACK MANAGEMENT

Prevention

There are two main factors in introducing plant diseases to the Mine Site:

- vehicle and foot traffic
- import of equipment and supplies.

It should be noted that Simcoa can only provide facilities and procedures to minimise the introduction and spread of diseases; the threats cannot be completely prevented.

Simcoa's site staff should continue to be trained in:

- identifying any disease outbreak
- knowing how to control the outbreak or minimise its spread.

Simcoa site staff should be given appropriate equipment to prevent diseases from being introduced into rehabilitated areas. The staff should continue to inspect and clean all footwear and vehicles before going to rehabilitated areas. Similar to vehicles, all incoming equipment should be inspected and cleaned if necessary (Hussey & Wallace 2003).

All incoming materials may potentially contain disease. Therefore Simcoa should ensure that materials only come from disease free sources. This includes any rehabilitation material, such as tubestock and soil. Such material may be obtained from certified sources (CALM 2003).

Any visiting contractors or consultants should be briefed on hygiene procedures before entering the site. This briefing may be part of the site induction.

8.2 Weed Hygiene

8.2.1 INTRODUCTION AND SPREAD OF WEEDS

Similar to plant diseases, weed seeds may be introduced and spread to the Mine Site through equipment, vehicles and footwear. It may also be introduced from infested adjacent lands, including the pasture and local vegetation. Remnant revegetation within the Mine Site contain weeds, however the exact species and infestation levels are currently unknown.

8.2.2 WEED MANAGEMENT

Prevention

All incoming equipment and vehicles should be examined and cleaned before being allowed to enter the Mine Site. This can be done at the same time and use the same facilities as disease inspections. Any on ground staff should be educated in how to clean their footwear to remove any weed seeds.

Any materials imported for revegetation works (such as tubestock, seeds and soil) should come from certified sources to minimise risk of weeds being introduced.

Control of weeds onsite

All on site Simcoa staff should be trained to identify and control High Priority Weeds. All areas should be routinely inspected and controlled for weeds; this includes along tracks and roads, around buildings and equipment and in remnant bushland. The Weed Management Guide Sheets in **Appendix Five** will aid in educating staff in effective identification and control.

9.0 Monitoring and Maintenance

9.1 Monitoring

Monitoring is essential to verify the progress of the Rehabilitation Plan and whether the works are suiting the End Land Uses and are progressing towards meeting the KPIs and EPA Criteria.

The current established quadrats should be continued to be monitored. New quadrats should be established each time an area has received initial revegetation work (ie topsoil and brush, any seeding or tubestock).

Items to be formally assessed include, but are not limited to, the following:

- native species diversity
- vegetation structure
- native vegetation cover
- weed species
- weed cover
- vegetation condition
- causes of any degradation of plant health
- signs of erosion or other site degradation.

The assessment should also make any comments and recommendations for maintenance of amendments in rehabilitation practices, if required.

9.2 Maintenance

Maintenance shall be conducted as deemed necessary by Simcoa to ensure each of the revegetation areas will comply with the KPIs and EPA criteria.

9.2.1 TREATMENTS

The following maintenance works may be required for each Rehabilitation treatment:

- **Physical Design**: infilling any gullies formed by erosion, minor reshaping or grading to redirect water flow
- **Revegetation**: infill planting of tubestock, seed broadcasting, brush layering
- **Weed Control**: targeting of High Priority weed species to reduce their cover
- **Hygiene**: containment of any disease outbreak.

Maintenance activities should follow the guidelines and procedures described in the relevant Sections of this report (**Sections 5** to **8**).

10.0 Revegetation Trials

As discussed in **Section 3.2,** trials are required to improve revegetation success and to meet the EPA criteria. The following trials are recommended to improve native species diversity, establish self-sustaining populations of conservation significant flora and to determine appropriate substitute material for topsoil and brush.

It should be noted that although much effort has been given here to detail each trial, such works should be further designed and conducted by an experienced restoration ecologist.

10.1 Diversity Trials

The diversity of the revegetation works may be improved by determining what other local native species may establish in the rehabilitation areas.

10.1.1 DIVERSITY TRIAL 1 – BROADCAST SEEDING

Seeding trials may determine which species may successfully establish the waste rock dumps via seeding. Such species can then be introduced in current and future rehabilitation areas to increase their native diversity.

A list of suitable candidate species for this trial has been presented in **Appendix One**. All species are known to be collectable and are generally reliable to have decent to high viability. The seed mix should be made in a manner that ensures that each species is fairly balanced. If there is only little seed of a particular species available, this should be considered in the assessment process (ie such species cannot be expected to produce as many seedlings as a species that had higher amount in the seed mix).

Prior to broadcasting, the seeds should be treated to break dormancy. All seeds should receive smoke treatment and hard coated seeds should be scarified. Broadcasting should be on at the start of winter rainfall (ie around end of May/ start of June). Seed treatment and broadcasting are further discussed in **Section 6.3**.

An appropriate sowing rate for the seeding trials is 10 kg/ ha (10g/ 10 sq m). Although the hectare rate may seem excessive, it will ensure that enough seeds of each species are present to germinate within the small trial area.

Trial plots should be at least 10 m by 10 m, marked with stakes and the position recorded with a handheld GPS. The surface within each trial areas should be scarified using a rake to ensure enough seeds may be lodged and not blown or washed away.

At least 3 (ideally 5), replicate trial plots are recommended to provide enough data for proper statistical analysis. Trials also may be repeated in various placements to determine whether certain species are more ideal for those conditions. For example, some native species may germinate and establish better on top of the waste rock dumps, while others perform better in more sheltered positions.

Each trial plot should be monitored on an annual basis. Any weeds observed should be removed in a manner that will not disturb the native seedlings (eg manual removal). Monitoring should occur for at least five years to determine which species can successfully establish in rehabilitated areas.

Monitoring should record the following for each native species:

- number of seedlings (abundance)
- health
- an estimate of average height
- cover.

The results of the trial should determine which species are most successful in establishing in the rehabilitated areas and whether they can contribute to native diversity and vegetation cover.

10.1.2 DIVERSITY TRIAL 2 – OPTIMAL HARVEST TIME FOR REMNANT VEGETATION

The topsoil and remnant vegetation material are simultaneously harvested in May to June, when mining activities occur. The current practice occurs on the logic that the topsoil and vegetation brush should be transferred as soon as possible onto newly structured waste rock dumps, so to minimise the degradation of the topsoil. It is also more practical to combine and spread the topsoil and brushing across the dumps in one operation.

While this practice is optimal for topsoil management, it is questionable as to whether the practice is optimal for obtaining the maximum amount of native seeds from harvesting the native vegetation in May to June. It is possible that the seeds being retained in the some of the species' capsules are immature or have already been released. If so, this means that the vegetation harvesting is resulting in a lower diversity and amount of seeds for rehabilitation. It also may be possible to harvest vegetation that contains less *Allocasuarina* seeds, so to delay, or even prevent, these species dominating on rehabilitation areas.

The following trial is to determine whether there is an optimal time to harvest the remnant native vegetation to improve the success of brushing in rehabilitation efforts.

Firstly, each species needs to be assessed for whether they retain their seeds (bradysporous) or drop their seeds into the seed soil bank (geosporous). Mature specimens of each bradysporous species should be inspected in the field and capsules opened every month for a year to determine when the seeds are viable. Records of their viability period of each bradysporous species should be kept. The

optimal time may then be determined when most bradysporous species have viable seeds retained in their capsules (and if possible, when mature *Allocasuarina* plants do not have viable seeds). When this optimal time is determined, the harvest time may be reconsidered in terms of practicability of site works.

10.2 Conservation Significant Species Trials

Under EPA Bulletin 1027 (2001), Simcoa has committed to conducting trials with any threatened flora removed by their mining operations. Trials should be conducted on the following threatened flora:

- *Acacia aristulata* (T)
- *Daviesii dielsii* (T).

Revegetation trials are needed to best use available seed sources to maximise population size for all conservation significant species. However, as *Acacia aristulata* and *Daviesii dielsii* are both Commonwealth and State listed, seeds may be unavailable or limited. Simcoa will need permission from the DEC to harvest any seeds of threatened flora from nearby local native vegetation.

Previous records indicate that some seedlings of both species have established on overburden dumps (Trudgen 2007), so both species have the potential to have self-sustaining populations.

10.2.1 CONSERVATION SIGNIFICANT SPECIES SEEDING TRIAL

Further trials should be conducted to test whether populations of the threatened species *A. aristulata* and *D. dielsii* may be established from seeding.

A seeding trial similar to that described in **Section 10.1.1** should be conducted. The only difference in the trial method is that the trial areas may be reduced to 5m x 5m. The seeding rate may also need to be reduced if there are not enough seeds available.

10.3 Topsoil Substitute Trials

It has been noted that the Mine Site will soon run out of topsoil and remnant vegetation. Both have been vital for current revegetation practices, particularly as a supply of native seeds and propagules and in supplying a “bed” for plants to establish in. While seed collection has been recommended to address the shortfall in propagules (**Section 3.3.2**), trials are needed to find suitable topsoil substitutes for future revegetation works.

A number of by-product materials have been identified on site that may prove appropriate:

- silt from the settlement pond
- 0-3 mm silica/ quartz fines.

Other locally available materials near the Mine Site should also be searched for, such as soil from nearby properties. Any imported material should be first be weed free and tested for contaminants and diseases (as part of the Mine Hygiene Procedures, further detailed in **Section 9**).

All of these materials should be first tested to determine whether they present any OSH concerns. Provided they are inert/ harmless, trials could be conducted to determine whether either or a combination of these materials may improve the growing conditions of seedlings compared to growing directly on the overburden material.

The trials should be conducted in a manner similar to the seeding trials, only the plot size should be expanded to allow for combination of substitute materials. For example, if only silt and silica/quartz fines are available, each plot area should be expanded to 20 m x 20 m and divided into four sections of 10 m of 10 m, with each section receiving one of the following treatments:

- no treatment (control)
- silt
- silica/ quartz fines
- silt and silica/ quartz fines.

If the substitute topsoil trials indicate that seedlings are suffering from nutrient deficiency, fertiliser trials may be considered. Such treatment should be done cautiously, using low amounts of native plant fertiliser, to discourage proliferation of weeds.

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Appendix One: Flora Tables

Table 18: Species inventory of native vegetation in and adjacent to Simcoa's Moora Quartzite Mine

Family	Species	Weed	EPBC	DEC
AMARANTHACEAE	*Ptilotus ?divaricatus*			
	Ptilotus polystachyus			
APAIACEAE	*Hydrocotyle callicarpa*			
	Trachymene cyanopetala			
	Trachymene ornata			
	Trachymene pilosa			
	Xanthosia fruticosa			
ASPARAGACEAE	*Chamaescilla* sp.			
	Dichopogon capillipes			
	Thysanotus manglesianus			
	Thysanotus patersonii			
ASTERACEAE	*Arctotheca calendula*	*		
	Blennospora drummondii			
	Centaurea melitensis	*		
	Conyza bonariensis	*		
	Gilberta tenuifolia			
	Helichrysum luteoalbum	*		
	Hyalosperma cotula			
	Hypochaeris glabra	*		
	Millotia tenuifolia			
	Olearia axillaris			
	Olearia dampieri subsp. *eremicola*			
	Podolepis canescens			
	Podolepis gracilis			
	Podolepis lessonii			
	Rhodanthe citrina			
	Rhodanthe laevis			
	Rhodanthe manglesii			
	Senecio glossanthus			
	Senecio quadridentatus			
	Sonchus oleraceus	*		
	Urospermum picroides	*		
	Ursinia anthemoides	*		
	Waitzia nitida			
	Monoculus monstrosus	*		
BORYACEAE	*Borya sphaerocephala*			
CAMPANULACEAE	*Wahlenbergia gracilenta*			
CASUARINACEAE	*Allocasuarina campestris*			
	Allocasuarina huegeliana			
CAYOPHYLLACEAE	*Petrorhagia dubia*	*		
	Silene gallica var. *gallica*			
CHENOPODIACEAE	*Salsola tragus* subsp. *tragus*			
COLCHICACEAE	*Burchardia congesta*			
CRASSULACEAE	*Crassula colorata*			
CUCURBITACEAE	*Cucumis myriocarpus*	*		
CYPERACEAE	*Gahnia drummondii*			
	Lepidosperma aff. *costale*			
	Lepidosperma tenue			
DILLENIACEAE	*Hibbertia subvaginata*			
DIOSCOREACEAE	*Dioscorea hastifolia*			
DROSERACEAE	*Drosera erythrorhiza*			
	Drosera macrantha			
ECDEIOCOLEACEAE	*Ecdeiocolea monostachya*			
ERICACEAE	*Astroloma pallidum*			
EUPHORBIACEAE	*Beyeria lechenaultii*			
	Ricinocarpos muricatus			

Family	Species	Weed	EPBC	DEC
FABACEAE	*Acacia ?erinacea*			
	Acacia ?scabra			
	Acacia acuminata subsp. *acuminata*			
	Acacia alata			
	Acacia aristulata		Endangered	Threatened
	Acacia congesta subsp. *congesta*			
	Acacia lasiocarpa var. *sedifolia*			
	Acacia microbotrya			
	Acacia restiacea			
	Acacia saligna			
	Acacia scirpifolia			
	Acacia stenoptera			
	Bossiaea eriocarpa			
	Bossiaea sp. Cairn Hill			
	Daviesia dielsii		Endangered	Threatened
	Daviesia gracilis			
	Daviesia hakeoides subsp. *subnuda*			
	Gompholobium sp.			
	Kennedia prostrata			
	Trifolium arvense var. *arvense*	*		
GERANIACEAE	*Erodium botrys*	*		
	Erodium cicutarium	*		
GOODENIACEAE	*Goodenia arthrotricha*			Threatened
	Goodenia berardiana			
	Scaevola phlebopetala			
	Velleia trinervis			
GYROSTEMONACEAE	*Gyrostemon ramulosus*			
HALORAGACEAE	*Glischrocaryon aureum*			
	Gonocarpus nodulosus			
HEMEROCALLIDACEAE	*?Agrostocrinum* sp.			
	Dianella revoluta			
	Stypandra glauca			
	Tricoryne sp. Wongan Hills			Priority 2
IRIDACEAE	*Patersonia graminea*			
	Romulea rosea	*		
LAMIACEAE	*Pityrodia dilatata*			
LAURACEAE	*Cassytha ?flava/ glabella/ ?racemosa*			
LORANTHACEAE	*Nuytsia floribunda*			
MALVACEAE	*Alyogyne huegelii* var. *grossulariifolia*			
	Guichenotia micrantha			
MYRTACEAE	*Babingtonia camphorosmae*			
	Baeckea sp. Moora			Priority 3
	Calothamnus hirsutus			
	Calothamnus quadrifidus			
	Calothamnus sanguineus			
	Calytrix leschenaultii			
	Eucalyptus camaldulensis var. *?obtusa*			
	Eucalyptus loxophleba var. *loxophleba*			
	Eucalyptus salmonophloia			
	Eucalyptus wandoo			
	Kunzea praestans			
	Melaleuca cordata			
	Melaleuca holosericea			
	Melaleuca scabra			
	Melaleuca sp.			
	Melaleuca uncinata			
	Regelia megacephala			Priority 4
	Verticordia nitens			

Family	Species	Weed	EPBC	DEC
ORCHIDACEAE	*Caladenia* sp.			
	Diuris sp.			
	Elythranthera brunonis			
	Leporella fimbriata			
OXALIDACEAE	*Oxalis corniculata*	*		
PITTOSPORACEAE	*Billardiera heterophylla*			
POACEAE	*Aira cupaniana*	*		
	Amphipogon strictus			
	Aristida contorta			
	Austrodanthonia caespitosa			
	Austrodanthonia acerosa			
	Austrostipa elegantissima			
	Austrostipa nitida			
	Austrostipa sp.			
	Austrostipa sp. Kiaka Rd			
	Austrostipa trichophylla			
	Austrostipa variabilis			
	Avena barbata/fatua	*		
	Brachypodium distachyon	*		
	Briza maxima	*		
	Bromus alopecuros	*		
	Bromus diandrus	*		
	Bromus rubens	*		
	Cynodon dactylon	*		
	Ehrharta calycina	*		
	Neurachne alopecuroidea			
	Pentameris airoides	*		
	Rytidosperma setaceum			
	Vulpia myuros var. *hirsuta*	*		
	Aira caryophyllea	*		
	Ehrharta calycina	*		
	Polypogon monspeliensis	*		
	Avellinia michelii	*		
POLYGALACEAE	*Comesperma integerrimum*			
POLYGONACEAE	*Muehlenbeckia adpressa*			
PRIMULACEAE	*Lysimachia arvensis*	*		
PROTEACEAE	*Banksia fraseri*			
	Banksia hewardiana			
	Banksia sessilis			
	Hakea lissocarpha			
	Hakea subsulcata			
	Isopogon divergens			
	Synaphea quartzitica			Threatened
	Grevillea biternata			
PTERIDACEAE	*Cheilanthes austrotenuifolia*			
RESTIONACEAE	*Desmocladus asper*			
	Desmocladus flexuosus			
RHAMNACEAE	*Cryptandra glabriflora*			
	Cryptandra glabriflora			Priority 2
	Trymalium daphnoides			
	Trymalium ledifolium			
	Trymalium odoratissimum			
RUBIACEAE	*Opercularia vaginata*			
RUTACEAE	*Boronia ramosa* subsp. *anethifolia*			
RUTACEAE	*Diplolaena angustifolia*			
SAPINDACEAE	*Dodonaea pinifolia*			
SCROPHULARIACEAE	*Zaluzianskya divaricata*	*		

Family	Species	Weed	EPBC	DEC
SOLANACEAE	*Solanum nigrum*	*		
	Anthocercis littorea			
	Solanum oldfieldii			
STYLIDIACEAE	*Stylidium caricifolium*			
	Stylidium leptophyllum			
STYLIDIACEAE	*Stylidium* sp.			
XANTHORRHOEACEAE	*Xanthorrhoea drummondii*			
TOTAL	**178**	**34**	**2**	**8**

Table 19: Recommended Revegetation Species for Simcoa's Moora Quartzite Mine

STRUCTURE		SPECIES	STATUS		REVEGETATION DOMAINS			FAUNA HABITAT				REVEGETATION METHOD	
Life form	**Height**	**Scientific Name**	**EPBC**	**DEC**	**TEC Buffer**	**Revegetation**	**Screening**	**Nesting**	**Food Source**	**Shrubland**	**Open Woodland**	**Seed and Tubestock**	**Tubestock only**
Tall Tree	4-10m	*Allocasuarina huegeliana*			*	*	*	*			*	*	
	5-20m	*Eucalyptus camaldulensis* var. *obtusa*			*	*	*	*	*		*	*	
	15m	*Eucalyptus loxophleba* var. *loxophleba*				*	*	*	*			*	
	4-30m	*Eucalyptus salmonophloia*					*	*	*		*	*	
	3-25m	*Eucalyptus wandoo*					*	*	*		*	*	
Small Tree/ Shrub	1-7m	*Acacia acuminata* subsp. *acuminata*			*	*	*		*			*	
	7m	*Acacia microbotrya*				x	*		*			*	
	1.5-6m	*Acacia saligna*			x	x	*		*			*	
	1-4m	*Acacia scirpifolia*			*	*	*		*			*	
	1-3m	*Allocasuarina campestris*			**	**	*					*	
	0.5-5m	*Banksia sessilis*			**	**	*		*			*	
	4.5m	*Xanthorrhoea drummondii*			**	**	*		*		*	*	
Large Shrub	2-4m	*Alyogyne huegelii*					x		*	*		*	
	0.2-6m	*Banksia fraseri*			**	**	x		*	*		*	
	1-5m	*Banksia hewardiana*			*	*	x		*	*		*	
	1-3m	*Hakea subsulcata*			*	*	x		*	*		*	
	2-5m	*Regelia megacephala*		P4	**	**	x			*		*	
Medium Shrub	0.3-2.1m	*Acacia alata*				x			*	*		*	
	0.5-2.5m	*Acacia congesta* subsp. *congesta*			*	*			*	*		*	
	0.5-1.5m	*Acacia restiacea*				x			*	*		*	
	0.3-1.5m	*Calothamnus hirsutus*			*	*			*	*		*	
	0.9-2m	*Calothamnus quadrifidus*			**	**			*	*		*	
	0.2-2m	*Calothamnus sanguineus*				x			*	*		*	
	0.3-1.5m	*Diplolaena angustifolia*			*	*				*		*	
	0.4-1.5m	*Hakea lissocarpha*				x			*	*		*	
	1-2m	*Kunzea praestans*			**	**				*		*	
	0.3-2m	*Melaleuca cordata*			*	*			*	*		*	
	0.2-1.7m	*Melaleuca holosericea*			*	*			*	*		*	
	0.2-1.5m	*Melaleuca scabra*				x			*	*		*	
	0.5-3m	*Olearia ?axillaris*				x				*		*	
	0.5-2m	*Olearia dampieri* subsp. *eremicola*				x				*		*	
Small Shrub	0.25-1m	*Acacia aristulata*	E	T	**	**			*	*	*	*	
	0.2-1m	*Acacia lasiocarpa* var. *sedifolia*				x			*	*	*	*	
	0.2-0.7m	*Acacia stenoptera*				x			*	*	*	*	
	0.2-1m	*Bossiaea eriocarpa*			*	*				*	*	*	
	0.2-1m?	*Bossiaea* sp. Cairn Hill				x				*	*	*	
	0.15-1m	*Calytrix leschenaultii*			**	**				*	*		*
	0.5-0.9m	*Daviesia dielsii*	E	T	**	**			*	*	*	*	
	0.3-0.6m	*Daviesia gracilis*				x			*	*	*	*	
	0.2-0.8m	*Daviesia hakeoides* subsp. *subnuda*			*	*			*	*	*	*	
	0.2-1m	*Dodonaea pinifolia*			*	*				*	*	*	
	0.3-1m	*Gompholobium* sp.				x				*	*	*	
	0.15-1.2m	*Hibbertia subvaginata*				**				*	*		*
	0.3-0.6m	*Pityrodia ?dilatata*				x				*	*	*	
Perennial Herb	0.3-1.5m	*Dianella revoluta*			*	*						*	
	0.3-0.8m	*Gahnia drummondii*				x						*	
	0.2-0.5m	*Patersonia graminea*			*	*						*	
	prostrate	*Kennedia prostrata*			x	*			*			*	
	0.05-0.3m	*Scaevola phlebopetala*			x	*						*	
	0.15-0.5m	*Thysanotus patersonii*			x	*						*	
TOTAL		**48**	**2**	**3**	**30**	**47**	**17**	**4**	**31**	**32**	**19**	**48**	**2**

Appendix Two: Prioritising Weeds

METHODOLOGY OF PRIORITISING WEEDS

RATING SYSTEMS

The priority ratings of each weed species were determined after examining:

- the ratings under the following weed evaluation systems:
  - Environmental Weed Census and Prioritisation (EWCP) by the DEC (2008)
  - Environmental Weed Strategy of Western Australia (EWSWA) by the Department of Conservation and Land Management (CALM 1999)
  - Dixon and Keighery (1995) Recommended methods to control specific weed species
- whether it was listed by Commonwealth of Western Australian governments:
  - Weed of National Significance (WONS) (Weed Australia 2008)
  - DAFWA (1976) Agricultural and Related Resources Protection Act (ARRPA).

The role of EWSWA is to highlight which weed species pose significant environmental risk in Western Australia. The EWSWA rating provides a basis for determining which weeds are most critical to control. The three characteristics used for determining the EWSWA rating are:

- *invasiveness* – ability to invade bushland in good to excellent condition
- *distribution* – wide current or potential distribution including consideration of known history of wide distribution elsewhere in the world
- *environment impacts* – ability to change the structure, composition and function of ecosystems, in particular to form a monoculture in a vegetation community.

EWSWA weed species were rated accordingly:

- *High* – have all three of the characteristics
- *Moderate* – have two of the characteristics
- *Mild* – have one of the characteristics
- *Low* – not deemed to have any of the characteristics.

However, EWSWA is a general guide for prioritising weeds across the State. EWCP rates weeds species as a threat in Swan Coastal Plain bushland conditions. A total of eight ratings are used, according to the risk each species poses to environmental assets in the region, based on invasiveness, ecological impact, current and potential distribution, and thus priority for management. In order of descending, priority, they are:

- Very High
- High
- Further Assessment Required (FAR)/ High
- Moderate/ High
- Moderate
- Low/ Moderate
- Low
- Further Assessment required (FAR)

Dixon and Keighery (1995) developed a rating system for 145 weed species. The rating system classified each species according to the threat they pose to bushland in the Perth Metropolitan region. The three classifications used were:

- *Priority 1* – major weeds, which are the most serious weeds within their ecosystem, often affecting many reserves or habitats in ways likely to permanently degrade them -
- *Priority 2* – nuisance weeds, which are generally found only in a few locations or ecosystems, usually in disturbed areas
- *Priority 3* – minor weeds, which have little known effect and occur in smaller numbers or are less competitive than *Priority 2* weeds.

The type of control for ARRPA declared weed species are listed below:

- *P1* – Prohibits movement of plants or their seeds within the State. This prohibits the movement of contaminated machinery and produce including livestock and feed.
- *P2* – Eradicate infestation to destroy and prevent propagation each year until no plants remain. The infested area must be managed in such a way that prevents the spread of seed or plant parts on or in livestock, fodder, grain, vehicles and/or machinery.
- *P3* – Control infestation in such a way that prevents the spread of seed or plant parts within and form the property on or in livestock, fodder, grain, vehicles and/or machinery. Treat to destroy and prevent seed set all plants.
- *P4* – Prevent the spread of infestation from the property on or in livestock, fodder, grain, vehicles and/or machinery. Treat to destroy and prevent seed set on all plants.

WONS was jointly declared by the Minister for Forestry and Conservation, the Minister for Agriculture, Fisheries and Forestry and the Minister for The Environment in 1999 as part of the *National Weeds Strategy*. The four characteristics used for determining where the species was of national significance were:

- invasiveness
- impacts
- potential for spread
- socioeconomic and environmental values.

Ranking Priority Weeds

The above sources were used to rank the recorded weed species in order of priority for control. Both the EWCP (Swan Natural Resource Management 2008) and EWSWA (CALM 1999) ratings were used because it allowed most weeds identified in the Reserve to be assigned a rating and thereby ranked. If only one source had been used, some of the weed species would have not been assigned a rating score.

The use of two rating systems does result in some conflict when assigning a ranking for a weed species. To overcome this issue, a matrix scoring system was developed to enable the ranking of the weed species. The matrix scoring system is summarised in **Table 20.** For the purposes of this study, the system gave a slight bias to the EWCP system, as this system was more relevant for the Reserve.

In addition, as weed species listed under either ARRPA or WONS are required by legislation to be controlled, any of these listed weed species recorded were automatically given a rating of 6.

Table 20: Matrix scoring system for rating weed priority

RATING SYSTEM		EWSWA				
		Unrated	Low	Mild	Moderate	High
EWCP	Unrated	1	1	3	4	5
	FAR	1	1	3	4	5
	Low	2	2	3	4	5
	L/M	2	3	4	4	5
	M	3	4	4	4	5
	M/H	4	4	4	5	6
	FAR/H	5	5	5	5	6
	H	5	5	5	6	6
	VH	6	6	6	6	6

If any weed species not assigned a rating by these any of the previous sources, the Dixon and Keighery (1995) rating system would then be used:

- Priority 1 = Rating 6
- Priority 2 = Rating 4
- Priority 3 = Rating 2

If any weed species were not given a rating be any of the previous systems, they would receive a default rating of 1.

If a species could not be fully identified, it was rated to highest known rating within that genus.

The priority of each weed species was then classified by the final rating:

- Species given a rating of 5 or 6 were *High Priority Weeds.*
- Species with a final rating of 3 or 4 were *Moderate Priority Weeds.*
- Species with a rating of 1 or 2 were *Low Priority Weeds.*

RESULTS

STATE AND NATIONAL SIGNIFICANCE

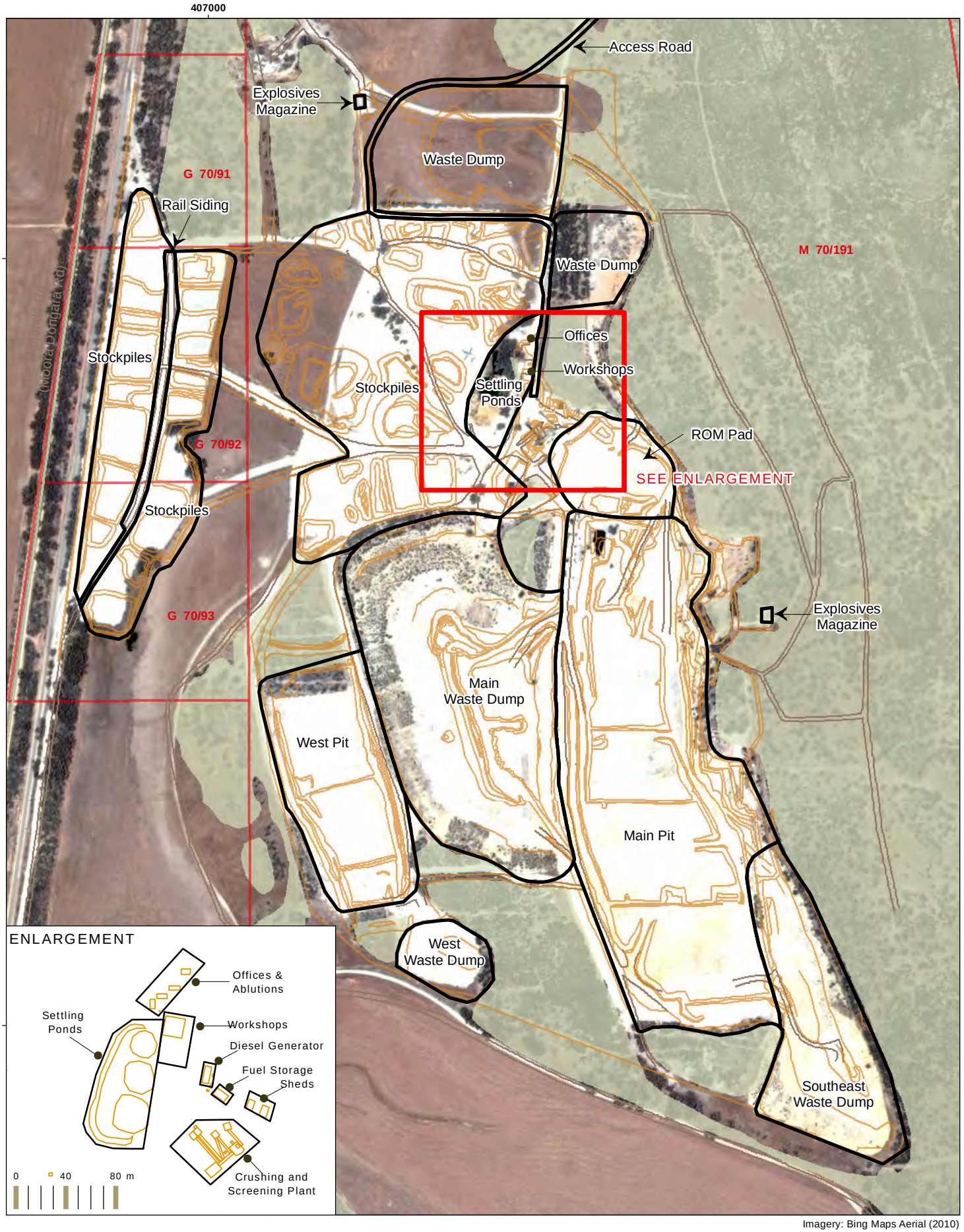
None of the recorded weed species were listed by WONS and/or ARRPA so no species had their rating scores increased to 6 (High Priority).

Arctotheca calendula (Capeweed), *Hypochaeris glabra* (Smooth Cat's Ear) and *Romulea rosea* (Guildford Grass) had calculated scores of 6 (High Priority). These species were not considered to be threats to the local area, so their scores were downgraded to 4 (Moderate Priority). Similarly, *Lysimachia arvensis* (Pimpernel) was calculated as 4 (Moderate Priority), but was downgraded to 2 (Low Priority).

Table 21: Priority rating of weed species in Moora Quartzite Mine

WEED SPECIES		PRIORITISATION								
Scientific Name	**Common Name**	**EWSWA**	**EWCP**	**WONS**	**ARRPA**	**Dixon & Keighery**	**Calculated Rating**	**Local significance**	**Final Rating**	**PRIORITY**
Avena barbata/ fatua	Bearded Oat/ Wild Oat	Moderate	Very High			1	6			
Bromus diandrus	Great Brome	High	Very High			3	6			
Centaurea melitensis	Maltese Cockspur	Moderate	High			3	6		**6**	**High**
Cynodon dactylon	Couch	Moderate	Very High			1	6			
Ehrharta calycina	Perennial Veldt Grass	High	Very High			1	6			
Aira cupaniana	Silvery Hair Grass	Moderate	Unrated			3	4			
Arctotheca calendula	Cape Weed	Moderate	High			3	6	No		
Briza maxima	Blowfly Grass	Moderate	FAR			2	4			
Bromus rubens	Red Brome	Moderate	FAR			3	4			
Helichrysum luteoalbum	Jersey Cudweed	Moderate	Low			3	4			
Hypochaeris glabra	Smooth Cats Ear	Moderate	High			3	6	No		
Pentameris airoides	False Hair Grass	Moderate	Moderate				4		**4**	**Moderate**
Petrorhagia dubia	Velvet Pink	Mild	Moderate			3	4			
Romulea rosea	Guildford Grass	High	FAR			1	5	No		
Solanum nigrum	Black Nightshade	Moderate	Moderate			2	4			
Sonchus oleraceus	Common Sowthistle	Moderate	FAR			3	4			
Urospermum picroides	False Hawkbit	Moderate	Moderate			3	4			
Ursinia anthemoides	Ursinia	Moderate	Moderate			3	4			
Brachypodium distachyon	False Broome	Low	FAR			3	2			
Bromus alopecuros	Weedy Brome	Low	Low				2			
Conyza bonariensis	Flaxleaf Fleabane	Low	Low			3	2		**2**	**Low**
Cucumis myriocarpus	Prickly Paddy Melon	Unrated	Low			3	2			
Lysimachia arvensis	Pimpernel	Moderate	FAR			3	4	No		
Oxalis corniculata	Yellow Wood Sorrel	Low	Low				2			
Zaluzianskya divaricata	Spreading Nightphlox	Low	Unrated				1		**1**	

Appendix Three: Maps



Imagery: Bing Maps Aerial (2010)

AUTHOR: JN CHECKED: SB

DATE: JUNE 2012 PROJECT NO: 2681-11

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MOORA QUARTZITE MINE REHABILITATION AND CLOSURE PLAN

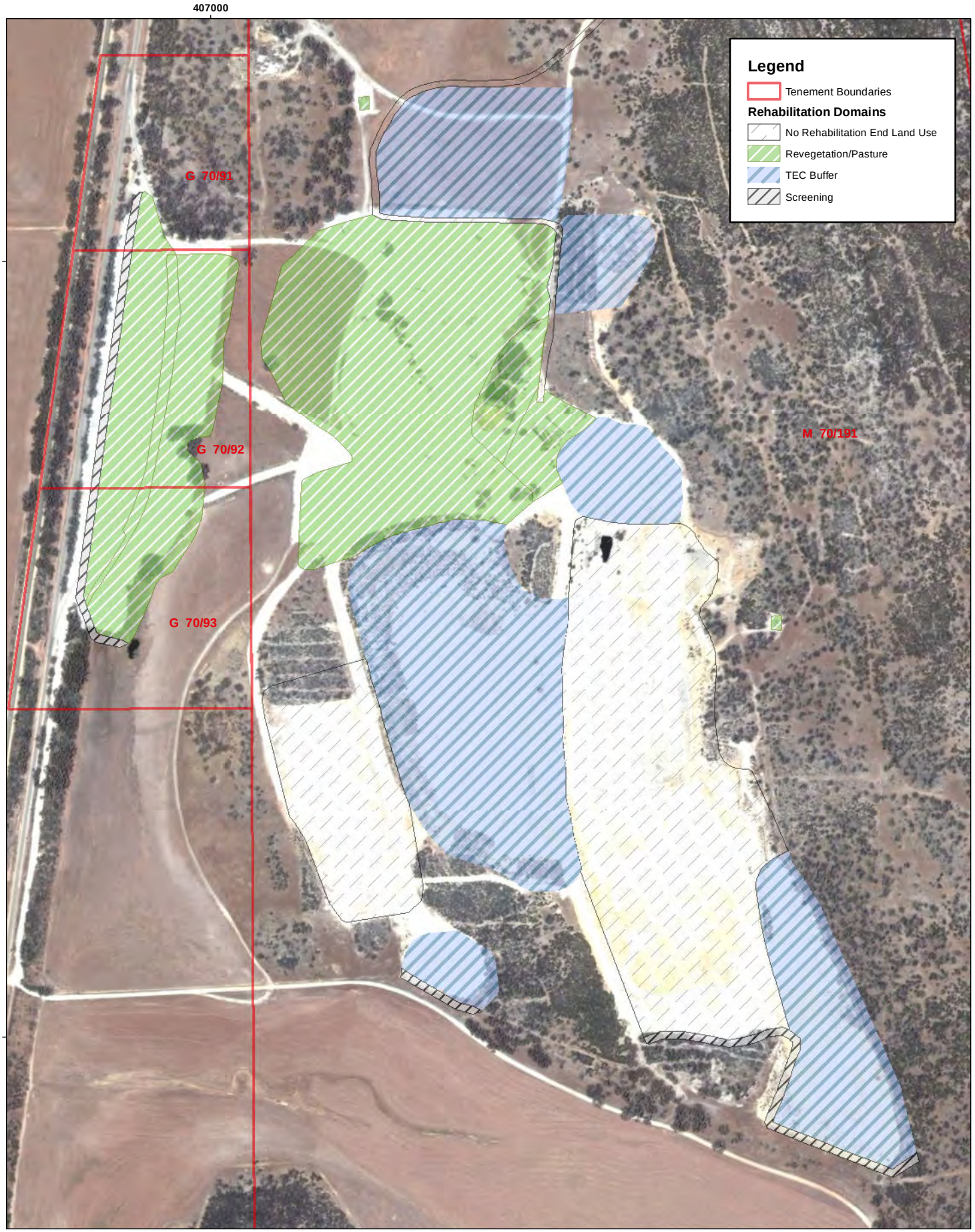
CLIENT: SIMCOA

MINE CLOSURE DOMAINS

Scale 1:6,500 @ A4

0 100 200 m

MAP 1



GDA 1994 MGA Zone 50

Imagery: Bing Maps Aerial (2010)

AUTHOR: JN CHECKED: SB

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MOORA QUARTZITE MINE REHABILITATION AND CLOSURE PLAN

CLIENT: SIMCOA

REHABILITATION DOMAINS

Scale 1:6,500 @ A4

0 100 200 m

MAP 2

Appendix Four: Weed Management

The following pages provide descriptions and a variety of control methods the weed and aggressive native species recorded in and around the Mine Site. Individual Weed Management Guide Sheets are provided for the high priority weed species. A summary of control methods for all of the weeds species is presented in **Table 22.**

Weed management recommendations are based on information from:

1. Brown and Brooks (2002) *Bushland Weeds*
2. Dixon and Keighery (1995) *Recommended methods to control specific weed species*
3. Moore and Wheeler (2008) *Southern Weeds and their control.*

Herbicide recommendations have superscripted numbers assigned to them to indicate which of these sources above provided the information on herbicide type and dosage.

The quantities of herbicides suggested for spot spraying rate have been calculated for a 10L backpack. It should be noted that surfactants should not be used near and wetlands or waterways. It is recommended that selective herbicides be implemented where practical to limit their impact on adjacent native plants.

Information on each of the recommended herbicide brands are summarised in **Table 12.**

It should be noted that manual control should always be considered first before using herbicides.

Bearded Oat (*Avena barbata*)

DESCRIPTION	
Appearance	Tufted annual grass to 1.5m tall. The loosely branched, usually one-sided inflorescence has large drooping, spikelets. The mature seeds are usually straw-coloured. Flowers in spring.
Habitat	Common species in uncropped situations, including roadsides, wasteland and disturbed bushland, occasionally extending into crop margins.
Comments	Easy to control. Native of the Mediterranean.
CONTROL	
Priority	High
Timing	July to October
Manual Control	Manually remove small populations before they set seed.
Wicker Wipe	Wicker wipe with 1:2 Roundup® to water.
Spot Spray	5 mL quizalofop (100g/L) **or** 8 mL Fusilade®Forte **or** 1 mL Verdict®520, plus 100 mL spray oil applied in winter before flowering will provide control with little effect on broad-leaved species [1 & 2] 100 mL of glyphosate in non-selective situations [2].

Great Brome (*Bromus diandrus*)

	DESCRIPTION
Appearance	Tufted annual grass to 90cm with softly hairy, flat or loosely folded leaves. Flowering spikes are either erect or drooping, to 15 – 25 cm long, and consist of a compound arrangement of oblong spikelets with very prominent, rough awns to 60 mm long.
Habitat	Widespread and serious weed of offshore islands, wetlands, road verges, granite rocks, pastures and crops throughout the south-west of WA.
Comments	Competes with natives. Fire hazard.
	CONTROL
Priority	High
Timing	June to August
Manual Control	Manually remove small populations before they set seed.
Wicker Wipe	Wicker wipe with 1:2 glyphosate to water.
Spot Spray	• 10 mL quizalofop (100g/L) plus 100 mL spray oil [1,2 & 3] • 16 mL Fusilade®Forte plus 100 mL spray oil [2] • 2 mL Verdict®520 plus 100 mL spray oil [2] • 10 mL glyphosate [2]

Couch (*Cynodon dactylon*)

DESCRIPTION	
Appearance	Prostrate perennial grass, spreading both above and below ground to several metres across, rooting at the nodes, and bluish-green leaves. Flowers in late spring and summer, producing windmill-like (digitate) inflorescences comprising two to seven purplish spikes.
Habitat	Mainly in highly disturbed areas. It is widely planted as a lawn grass and it invades wetlands and river edges in southern Western Australia.
Comments	Competes with native species. It is native to the Kimberley and the tropics worldwide.
CONTROL	
Priority	High
Timing	November to February
Manual Control	Shade out with black plastic during spring and autumn.
Wicker Wipe	No specific information. Suggest wicker wiping with 1:2 Roundup® to water.
Spot Spray	• 100 mL glyphosate + 25 mL Pulse when the grass is actively growing provides the best control. Repeat every 8 weeks or when regrowth reaches about 5 cm tall [1 & 2]. • Selective control can usually be achieved by spraying 16 mL Verdict®520 **or** 80 mL quizalofop (100g/L) **or** 125 mL Fusilade®Forte, plus 100 mL spray oil [2].

Annual Veldt Grass (*Ehrharta longiflora*)

	DESCRIPTION
Appearance	Tufted annual to 30cm tall. The greenish-purple inflorescence is a narrow panicle, to 15cm long, flowering in spring.
Habitat	It is a widespread weed of offshore islands, coastal dunes and sandy soils, from Shark Bay to Eucla and inland along disturbed creek lines and grazed woodlands in the western Wheatbelt.
Comments	Smothers small plants and competes with natives. A serious fire hazard.
	CONTROL
Priority	High
Timing	August to October
Manual Control	Manually remove small populations before they set seed.
Wicker Wipe	Not recommended.
Spot Spray	• 20 mL quizalofop (100g/L), **or** 32 mL Fusilade®Forte, **or** 4 mL Verdict®520, plus 100 mL spray oil before flowering stem emerges provides good control with little damage to broad-leaf species (1 & 2) • In non-selective situations 40 mL glyphosate applied up to flowering provides good control (2)

Photo Sources: http://florabase.calm.wa.gov.au/browse/photo/349

Perennial Veldt Grass (*Ehrharta calycina*)

DESCRIPTION	
Appearance	Tufted perennial grass to 80cm tall. The inflorescence is a drooping erect panicle of reddish-purple flowers, 7-22cm long. Flowers in spring.
Habitat	Widespread weed of roadsides and bushland on sandy soils, from Geraldton to Esperance and is especially common on the Swan Coastal Plain.
Comments	Serious environmental weed.
CONTROL	
Priority	High
Timing	June to September
Manual Control	Manual remove small populations before they set seed, ensuring crown removal. Do not slash.
Wicker Wipe	Wicker wipe with 1:2 glyphosate to water.
Spot Spray	• 80 mL quizalofop (100g/L) + wetting agent, follow up in subsequent years; utilise unplanned fires and spray regrowth and seedlings with 4 – 6 weeks [(1)].

Rat's Tail Fescue (*Vulpia myuros*)

DESCRIPTION	
Appearance	Annual tufted grasses to 70 cm high with fairly narrow one-sided inflorescence of numerous stalked spikelets each with 3-12 florets. The outer segment of each floret (lemma) has a straight bristle (awn)
Habitat	A weed of agricultural land and disturbed areas.
Comments	All are native to Europe and flower from late winter to early summer.
CONTROL	
Priority	High
Timing	July to September
Manual Control	Manually remove small populations before they set seed.
Wicker Wipe	Not recommended.
Spot Spray	• 5 mL glyphosate(450g/L) plus 25 mL wetting agent per 10 L water applied in winter before flowering will provide reasonably selective control in bushland. Use higher rates for higher levels of control in non selective situations. [2] • 10 mL simazine(500g/L) per 10 L of water applied before the Rat-tailed Fescue emerges or up to the 4 leaf stage in early winter will provide good control with little damage to most established native species. The grass selective herbicides such as Fusilade® and Verdict® have little effect on these grasses. [2]

Photo Sources: http://www.eol.org/pages/1115255
http://plants.usda.gov/java/largeImage?imageID=feme_001_avd.tif

Capeweed (*Arctotheca calendula*)

DESCRIPTION	
Appearance	An annual daisy with a flat basal rosette of deeply lobed leaves. The leaves are 3 to 25 cm long, green on the upper surface but the lower surface white-hairy. Flowers in late winter and spring producing daisy flower heads, up to 6 cm in diameter held on individual stalks, with the radiating yellow petals and tiny central black florets.
Habitat	A common weed of pastures, crops and roadsides, but also quite common in disturbed bushland. Mainly in disturbed areas where extra water/nutrients encourage lush growth.
Comments	Native of South Africa.
CONTROL	
Priority	High
Timing	June to November
Manual Control	Manually remove small populations before they set seed.
Wicker Wipe	Wicker wipe with 1: 2 glyphosate to water.
Spot Spray	• 2.5 g Lontrel®750 + 25 mL wetting agent applied in early growth stages will provide good control and is safe on many native species [1 & 2] • 10 mL glyphosate is also fairly selective in bushland and roadside situations if applied when young or at the budding stage [2]

Flatweed (*Hypochaeris glabra*)

	DESCRIPTION
Appearance	Flatweeds are annuals or short-lived perennials, with a basal rosette of leaves and yellow, dandelion-like flower heads at the top of slender, leafless stalks. The species has smooth leaves and heads up to 1.5cm across.
Habitat	Common weeds of lawns, horticultural areas, roadsides and bushland throughout the south-west.
Comments	Native to Europe, competes with native herbs especially in richer soils and disturbed areas.
	CONTROL
Priority	High
Timing	May to September
Manual Control	Use a weed fork to extract the taproot. Manually remove small populations before they set seed.
Wicker Wipe	Wicker wipe rosettes with 1: 2 glyphosate to water.
Spot Spray	• 4 g Lontrel®750 + 25 mL wetting agent [1] • For small infestations 50 mL Tordon®75-D will control growing plants and leave a soil residual to control seedlings for 12 months [2] • 100 mL glyphosate [3]

Photo Sources: http://www.rbgsyd.nsw.gov.au/__data/assets/image/0009/84546/Trifolium_arvense_flower_620.JPG

Long Storkbill (*Erodium botrys*)

DESCRIPTION	
Appearance	Sprawling annual herb to 40 cm high, with stalked, shiny deeply dissected leaves. The blue to purple flowers are in stalked clusters, each flower with 5 free petals. The distinctive 9-12 cm fruit is long, beak-like and splits into 5 fruitlets which, when mature, separate and twist so that each seed is attached to a spirally-twisted corkscrew-like awn. Flowers in winter and spring.
Habitat	Common weed of pasture, wasteland and roadsides.
Comments	Relatively tolerant to glyphosate. Native to the Mediterranean region
Priority	**High**
Timing	May to July
Manual Control	Manually remove small populations before they set seed.
Wicker Wipe	Not recommended
Spot Spray	• 80 mL 2,4-DB(400g/L) or 6 mL Lontrel® applied before flowering provides reasonably selective control in bushland (SW) • For highly selective control, use Verdict®520 at 2 mL plus 100 mL oil on actively growing seedlings. (SW) •

Photo Source http://upload.wikimedia.org/wikipedia/commons/f/f8/Erodium_botrys_2005-02-20.jpg
http://www.flowersinisrael.com/Erodiumbotrys_page.htm
http://www.flickr.com/photos/44055945@N06/5551235750/

Maltese Cockspur (*Centaurea melitensis*)

	DESCRIPTION
Appearance	Erect biennial to 80cm with lobed leaves and yellow, thistle-like flower heads borne terminally or on short upper branches. The bracts below the heads have a short, often reddish spine. The stems have non-prickly wings. It flowers in spring and summer.
Habitat	Usually occurs in disturbed areas
Comments	Native to the Mediterranean
	CONTROL
Priority	High
Timing	July to October
Manual Control	Manually remove small populations before they set seed.
Wicker Wipe	No specific information. Suggest wicker wiping with 1:2 Roundup® to water.
Spot Spray	No specific information, try: • 20 mL Access® for selective control • 100 mL Roundup® for non-selective control

Photo Source http://luirig.altervista.org/cpm/albums/bot-units44/centaurea-melitensis10280.jpg
http://beavercreek.nau.edu/Animal%20and%20Plant%20pages/species%20images/Invasive/Plants/Centaurea%20M.jpg
http://www.researchlearningcenter.com/bloom/pics/S9190CXR.jpg

Table 22: Control methods for weed species recorded at Moora Quartzite Mine

WEED SPECIES				CONTROL RECOMMENDATIONS				
Scientific Name	Common Names	Life form	Comments	Manual Control	Wicker Wipe	Spot Spray @10L water + 25mL surfactant	Blanket Spray per ha	Herbicide Timing
Grasses								
Aira caryophyllea and Aira cupaniana	Silvery Hairgrasses	Annual	Competes with small herbs	Not recommended	Not recommended	No specific information, try: Selective control 10 mL Fusilade® Non-selective control 100 mL Roundup®	No specific information, try Selective control 2 L Fusilade® 100 mL Verdict® Non-selective control 500 mL Roundup®	Aug-Oct
Avellinia michelii	Avellinia	Annual	Competes with natives	Not recommended	Not recommended	No specific information, try: Selective control 10 mL Fusilade® Non-selective control 100 mL Roundup®	No specific information, try Selective control 2 L Fusilade® 100 mL Verdict® Non-selective control 500 mL Roundup®	Jul-Sep
Avena barbata	Bearded Oat	Annual	Occurs mainly in highly disturbed areas. Easy to control.	Manually remove small populations before they set seed.	Wicker wipe with 1:2 Roundup® to water.	Selective control 5 mL Fusilade® 5 mL Sertin® 5 mL Targa® 2 mL Verdict® Non-selective control 50 mL Roundup® 10 mL Spray-seed®	Selective control 500 mL Fusilade® 300 mL Targa® 100 mLVerdict® 500 mL Sertin® Non-selective control 2 L Roundup®	Jul-Oct
Brachypodium distachyon	False Brome	Annual	Common weed of the bushlands near paddocks.	Manually remove small populations before they set seed.	No specific information. Suggest wicker wiping with 1:2 Roundup® to water.	No specific information, try: Selective control 10 mL Fusilade® Non-selective control 100 mL Roundup®	No specific information, try Selective control 2 L Fusilade® 100 mL Verdict® Non-selective control 500 mL Roundup®	Jul-Sep
Briza maxima	Blowfly Grass	Annual	Easy to control	Manually remove small populations before they set seed.	Wicker wipe with 1:2 Roundup® to water.	Selective control 10 mL Fusilade® 200 g Propon® 10 mL Verdict® 5 mL Sertin® 10 mL Targa® Non-selective control 50 mL Roundup® 10 mL Spray-seed®	No specific information, try Selective control 2 L Fusilade® 100 mL Verdict® Non-selective control 500 mL Roundup®	Jun-Sep
Bromus alopecuros, Bromus diandrus, Bromus rubens	Weedy Brome Great Brome Red Brome	Annual	Cometes with natives, fire hazard	Manually remove small populations before they set seed.	Wicker wipe with 1:2 Roundup® to water.	Selective control 16 mL Fusilade® Forte 10 mL Targa® 2 mL Verdict® 520 Non-selective control 10 mL Roundup®	Selective control 2 L Fusilade® 100 mL Verdict® Non-selective control 500 mL Roundup®	Jun-Aug

WEED SPECIES			CONTROL RECOMMENDATIONS					
Cynodon dactylon	Couch	Perennial	Competes with natives	Shade out with black plastic during spring and autumn	No specific information. Suggest wicker wiping with 1:2 Roundup® to water.	Selective control 125 mL Fusilade® Forte 16 mL Verdict®520 80 mL Targa® Non-selective control 100 mL Roundup®	Selective control 4 L Fusilade® 4 L Targa® 200 mL Verdict® Non-selective control 500 mL Roundup®	Nov-Feb
Ehrharta calycina	Perennial Veldt Grass	Perennial	Serious environmental weed	Manual remove small populations before they set seed, ensuring crown removal. Do not slash.	Wicker wipe with 1:2 Roundup® to water.	Selective control 5 mL Fusilade® 5 mL Sertin® 5 mL Targa® 2 mL Verdict® Non-selective control 50 mL Roundup® 10 mL Spray-seed®	Selective control 300 ml Targa® 100 ml Verdict® Non-selective control 2L Roundup®	Jun-Sep
Ehrharta longiflora	Annual Veldt Grass	Annual	Smothers small plants and competes with natives	Manually remove small populations before they set seed.	Not recommended	Selective control 32 mL Fusilade® Forte 4 mL Verdict®520 Non-selective control 40 mL Roundup® 10 mL Spray-seed®	Selective control 1 L Fusilade® 80 mL Verdict® Non-selective control 400 mL Roundup®	Aug-Oct
Pentameris airoides	False Hair Grass	Annual	Very common and widespread weed of granite rocks, woodlands, shrublands and disturbed sites. Competes with small herbs.	Not recommended	Not recommended	No specific information, try: Selective control 10 mL Fusilade® Non-selective control 100 mL Roundup®	No specific information, try Selective control 2L Fusilade® 100 mL Verdict® Non-selective control 500 mL Roundup®	Aug-Oct
Polypogon monspeliensis	Annual Barbgrass	Annual	Prefers moist soils	Manually remove small populations before they set seed.	Not recommended	No specific information, try: Selective control 10 mL Fusilade® Non-selective control 100 mL Roundup®	No specific information, try Selective control 2 L Fusilade® 100 mL Verdict® Non-selective control 500 mL Roundup®	Jul-Sep
Vulpia myuros var. *hirsuta*	Rat's Tail Fescue	Annual	Resistant to Fusilade and similar grass specific herbicides	Manually remove small populations before they set seed.	Not recommended	Selective control 10 ml Simazine® 500 Non-selective control 100 mL Roundup®	Selective control 500 mL Select® Non-selective control 500 mL Roundup®	Jul-Sep
Geophytes								
Oxalis corniculata	Yellow Wood Sorrel	Perennial	Flowers in spring and summer, reproducing from seeds produced in explosive, cylindrical capsules.	Not recommended because corms tend to break off unless soil is very loose.	Wicker wipe with 1: 2 Roundup® to water.	Selective control 0.1 g Ally® 0.1 g Brushoff ® 0.2 g Glean ® Non-selective control 100 mL glyphosate	No specific information, try, Selective control 50 g Logran 300 mL Spinnaker	Jul-Sep
Romulea rosea	Guildford Grass	Perennial	A weed of roadsides and pasture, also commonly occurring in bushland.	Not recommended because corms tend to break off unless soil is very loose.	Not recommended	Selective control 0.2 g Ally® 0.2 g Brushoff® 0.5 g Glean® 1 g Raptor®	Selective control 20 g Ally® 20 g Brushoff® 2 L Gramoxone®	Jul-Aug

WEED SPECIES			CONTROL RECOMMENDATIONS					
Herbs								
Arctotheca calendula	Cape Weed	Annual	Mainly in disturbed areas where extra water/nutrients encourage lush growth.	Manually remove small populations before they set seed.	Wicker wipe with 1: 2 Roundup® to water.	Non-selective control 100 mL Roundup®	Selective control 500-1000 mL Access® 500 mL Gramoxone®	Jun-Nov
Centaurea melitensis	Maltese Cockspur	Biennial	Usually occurs in disturbed areas	Manually remove small populations before they set seed.	No specific information. Suggest wicker wiping with 1:2 Roundup® to water.	No specific information, try: Selective control 20 mL Access® Non-selective control 100 mL Roundup®	No specific information, try: Selective control 500 mL Access® Non-selective control 500 mL Roundup®	Jul-Oct
Conyza bonariensis	Flaxleaf Fleabane	Annual	Produces large numbers of seed therefore difficult to control	Hand pulling after stem elongation is only effective on loose soils. Manually remove small populations before they set seed.	Wicker wipe with 1: 2 Roundup® to water.	Selective control 4 g Lontrel®750 Non-selective control 50 mL Tordon®75-D	Selective control 500 mL Lontrel® Non-selective control 50 mL Tordon® 75-D	Jun-Sep
Cucumis myriocarpus	Prickly Paddy Melon	Annual	Usually occurs in disturbed areas. Smothers native plants	Collect and destroy fruit before they release seeds.	Wicker wipe with 1: 2 Roundup® to water.	No specific information, try: Selective control 20 mL Access® Non-selective control 100 mL Roundup® 10 mL Spray-seed®	No specific information, try: Selective control 500 mL Access® Non-selective control 500 mL Roundup®	Oct-Jan
Erodium botrys, Erodium cicutarium	Long Storkbill, Common Storkbill	Annual	Commonly found on farmland, especially pastures. Relatively tolerant to glyphosate.	Manually remove small populations before they set seed.	Not recommended	Selective control 6 mL Lontrel® 2 mL Verdict® Non-selective control 2 L Spray-Seed®	Selective control 4 L Buticide® 100mL Verdict® Non-selective control 2 L Spray-Seed®	May-Jul
Helichrysum luteoalbum	Jersey Cudweed	Annual	Prefers damp sites	Manually remove small populations before they set seed.	No specific information. Suggest wicker wiping with 1:2 Roundup® to water.	No specific information, try: Selective control 20 mL Access® Non-selective control 100 mL Roundup®	No specific information, try: Selective control 500 mL Access® Non-selective control 500 mL Roundup®	Aug-Nov
Hypochaeris glabra	Flat Weed	Annual	Competes with native herbs, especially in disturbed areas.	Use a weed fork to extract the taproot. Manually remove small populations before they set seed.	Wicker wipe rosettes with 1: 2 Roundup® to water.	Selective control 4 g Lontrel®750 Non-selective control 100 mL Roundup® 50 mL Tordon®75-D	Selective control 500 mL Lontrel Non-selective control 2-3 L Roundup®	May-Sep
Lysimachia arvensis	Pimpernel	Annual	Competes with small herbs. Mainly a problem in moist badly disturbed areas when the plants become more vigorous. Therefore only worth controlling in these areas.	Manually remove small populations before they set seed.	No specific information. Suggest wicker wiping with 1:2 Roundup® to water.	Selective control 1.5 g Ally® 1.5 g Brushoff ® 1.5 g Glean® Non-selective control 50-100 mL Roundup®	Selective control 15g Glean Non-selective control 500 mL Roundup®	Aug-Jan
Monoculus monstrosus	Stinking Roger	Annual	Prefers damp sites	Manually remove small populations before they set seed.	No specific information. Suggest wicker wiping with 1:2 Roundup® to water.	No specific information, try: Selective control 20 mL Access® Non-selective control 100 mL Roundup®	No specific information, try: Selective control 500 mL Access® Non-selective control 500 mL Roundup®	Jul-Sep

WEED SPECIES			CONTROL RECOMMENDATIONS					
Petrorhagia dubia	Velvet Pink	Annual	More vigorous on disturbed sites. Competes with native plants.	Manually remove small populations before they set seed.	No specific information. Suggest wicker wiping with 1:2 Roundup® to water.	No specific information, try: Selective control 20 mL Access® Non-selective control 100 mL Roundup®	No specific information, try: Selective control 500 mL Access® Non-selective control 500 mL Roundup®	Jun-Sep
Solanum nigrum	Black Nightshade	Annual-Biennial	Readily spread by birds into bushland	Manually remove small populations before they set seed.	No specific information. Suggest wicker wiping with 1:2 Roundup® to water.	Selective control 20 mL Starane® 20 mL Access®	Selective control 1 L Starane® 1 L Access®	Jul-Dec
Sonchus oleraceus	Common Sowthistle	Annual	Mainly occurs in disturbed areas, growth is more vigorous where there is less competition. Native to Eurasia and North Africa.	Manually remove small populations before they set seed.	Wicker wipe with 1: 2 Roundup® to water.	Selective control 80 mL Buticide® 100 mL Tordon®75-D Non-selective control 50-75 mL Roundup®	Selective control 4 L Buticide®	Jun-Aug
Trifolium arvense	Hare's Foot Clover	Annual	A common weed of natural and cultivated land	Manually remove small populations before they set seed.	No specific information. Suggest wicker wiping with 1:2 Roundup® to water.	Selective control 0.1g Ally® 0.1 g Brushoff® 1 g Logran® 10 mL Lontrel® 10 mL Tordon® 75-D Non-selective control 100 mL Roundup®	Selective control 500mL Lontrel® 50 g Logran®	Jul-Sep
Urospermum picroides	False Hawkbit	Annual	Occurs in disturbed areas	Manually remove small populations before they set seed.	No specific information. Suggest wicker wiping with 1:2 Roundup® to water.	No specific information, try: Selective control 20 mL Access® Non-selective control 100 mL Roundup®	No specific information, try: Selective control 500 mL Access® Non-selective control 500 mL Roundup®	Jul-Sep
Ursinia anthemoides	Ursinia	Annual	Usually in disturbed areas. So common may not be practical to control in most instances.	Manually remove small populations before they set seed.	No specific information. Suggest wicker wiping with 1:2 Roundup® to water.	Non-selective control 50-75 mL Roundup®	No specific information, try: Selective control 500 mL Access® Non-selective control 500 mL Roundup®	May-Jul
Zaluzianskya divaricata	Spreading Nightphlox	Annual	Widespread and often abundant on roadsides, in paddocks and disturbed woodlands t	Manually remove small populations before they set seed.	No specific information. Suggest wicker wiping with 1:2 Roundup® to water.	No specific information, try: Selective control 20 mL Access® Non-selective control 100 mL Roundup®	No specific information, try: Selective control 500 mL Access® Non-selective control 500 mL Roundup®	Jul-Oct

Appendix Five: Native Species Identification Guide

The following guide is to help identify fourteen local native species and aid in seed collection. Species presented have at least one of the following attributes:

- Conservation significance
- Locally dominant
- Are characteristic of the Chert Coomberdale TEC.

With the exception of *Calothamnus quadrifidus*, all images shown were taken from the DEC Florabase website.

Acacia acuminata (Jam)

DESCRIPTION	
Growth Form	Small Tree/ Shrub
Appearance	Stems upright and stiff with smooth grey bark Flowers up to 3cm long rods Leaves bright green, very thing, almost terete, up to 7.5 cm long Pods brownish, flat and narrow
Size	Height 1 - 7 m Width up to 4 m
Flowering	Yellow July - October
Habitat	Variety of soils and habitats
Conservation Status	Commonwealth - None State - None
Comments	Food source for local native fauna Prefers sunny positions on western facing slopes
Revegetation Significance	Locally dominant flora

Acacia aristulata (Watheroo Wattle)

DESCRIPTION	
Growth Form	Small Shrub
Appearance	Stems erect or scrambling, white-grey and waxy Leaves light green, soft, thin and oblong, 7-10 x 2-3.5 mm Flowers globular 5-6 mm in width Seed pods once coiled to irregular twisted, <6 cm long x 4-5 mm wide
Size	Height 0.25 - 1 m Width up to 1 m
Flowering	Cream - White – Pale Yellow September - December
Habitat	Loamy or clayey sand over chert Low rocky ridges and hills, outcrops
Conservation Status	Commonwealth - Endangered State - Threatened
Comments	Food source for local native fauna
Revegetation Significance	Conservation significant flora

Allocasuarina campestris (Rock Sheoak)

DESCRIPTION	
Growth Form	Small Tree/ Shrub
Appearance	Erect stem with slightly rough brown bark Needle dull green leaves, up to 20 cm long Male flowers 5 - 28 mm long Female flowers small globule with red filaments Cones cylindrical, 19-42 mm long
Size	Height 1 - 3 m Width up to 2 m
Flowering	Red, conifer May - January
Habitat	Lateritic and sandy soils
Conservation Status	Commonwealth - None State - None
Comments	Potential nesting site for local native birds when mature
Revegetation Significance	Locally dominant flora Trees drop large amount of leaves, which smother ground, restricting weeds

Allocasuarina huegeliana (Rock Sheoak)

DESCRIPTION	
Growth Form	Tall Tree
Appearance	Stem erect and branching with rough grey bark Needle like leaves up to 10 cm long Male flowers light brown, similar in appearance to leaves Female flowers small globular spike Fruit ovoid conifer, 15-30 mm x 10-20 mm, brown turning grey over time
Size	Height 4 - 10 m Width up to 5m
Flowering	Red - Brown, conifer May - January
Habitat	Associated with granite
Conservation Status	Commonwealth - None State - None
Comments	Potential nesting site for local native birds when mature
Revegetation Significance	Locally dominant flora

Banksia fraseri

DESCRIPTION	
Growth Form	Large Shrub
Appearance	Stem is erect, scraggly with soft hairy branches Leaves are fern like, with stiff narrow leaflets, up to 10 cm long Flowers up to 6 cm in width Wood fruit produce 2 seeds per capsule
Size	Height 0.2 – 6 m Width up to 1 m
Flowering	Yellow – Green April - September
Habitat	Sand, limestone, laterite, granite Hill slopes and breakaways
Conservation Status	Commonwealth - None State - None
Comments	Food source for local native fauna Formerly named *Dryandra fraseri*
Revegetation Significance	Chert Coomberdale TEC characteristic flora

Banksia sessilis (Parrot Bush)

DESCRIPTION	
Growth Form	Small Tree/ Shrub
Appearance	Stem erect, densely textured and round crown Leaves bluish green, broad holly like and prickly, up to 6 cm long Flowers 5 cm in width, at end of branches Wood fruit produce 2 seeds per capsule
Size	Height 0.5 - 5 m Width up to 2m
Flowering	Cream – Yellow April - November
Habitat	Sand, limestone, laterite, granite
Conservation Status	Commonwealth - None State - None
Comments	Food source for local native fauna Formerly named *Dryandra sessilis* Rapid coloniser of cleared sandy sites
Revegetation Significance	Locally dominant flora

Calothamnus quadrifidus (One Sided Bottlebrush)

DESCRIPTION	
Growth Form	Medium Shrub
Appearance	Shape can be erect, compact or spreading, woody stem Leaves are flat, narrow and up to 2.5 cm long, can be slightly hairy Flowers and fruit occur along base of mature stems
Size	Height 0.9 - 2 m Width up to 2m
Flowering	Red June - December
Habitat	Wide variety of soils and habitats
Conservation Status	Commonwealth - None State - None
Comments	Food source for local native fauna
Revegetation Significance	Chert Coomberdale TEC characteristic flora

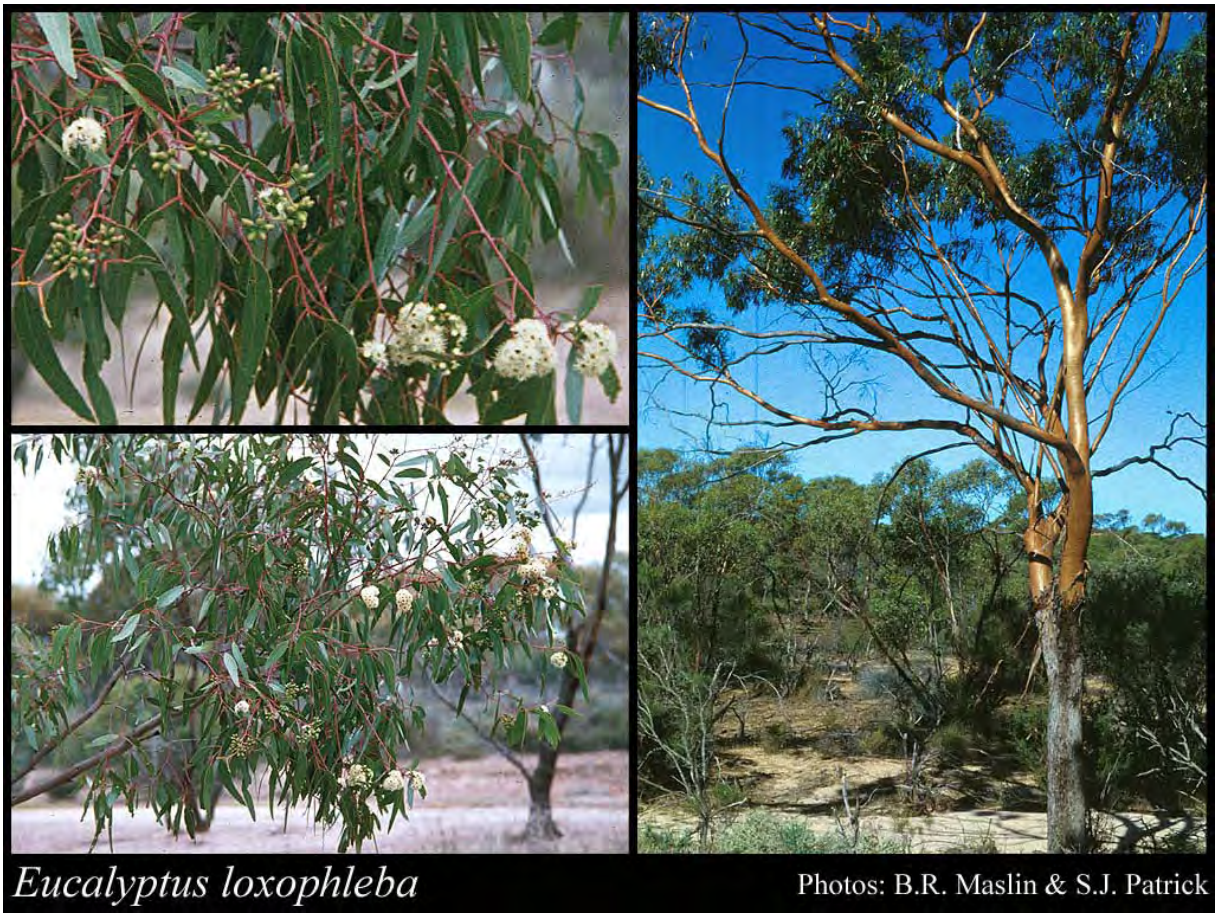
Calytrix leschenaultii

DESCRIPTION	
Growth Form	Small Shrub
Appearance	Erect compact stems Glabrous leaves, blade to linear shaped, 1-4 x 0.6-1.7 mm Flowers at end of stems, with 5-7 mm long petals and numerous stamens Seed at end of short stalk with bracts
Size	Height 0.15 - 1 m Width up to 1 m
Flower Colour	Purple - Violet - Pink – Blue June - November
Habitat	Sand, laterite, loam
Conservation Status	Commonwealth - None State - None
Comments	Species highly variable in appearance.
Revegetation Significance	Chert Coomberdale TEC characteristic flora

Daviesia dielsii (Diels' Daviesia)

	DESCRIPTION
Growth Form	Small Shrub
Appearance	Stems widely branching, spiny with dense branchlets, sometimes hairy Leaves flat and oblique/oval with a sharp point 2-4 x 1-3 mm Flowers small, rise from axils in upper leaves, 5-6 mm long Fruit triangular pod, about 1 cm long, convex
Size	Height 0.5 - 0.9 m Width up to 1.8 m
Flowering	Orange - Red July - August
Habitat	Sandy, Gravelly soils
Conservation Status	Commonwealth - Endangered State - Threatened
Comments	Food source for local native fauna Species has both hairy and hairless varieties
Revegetation Significance	Conservation significant flora

Eucalyptus loxophleba (York Gum)



DESCRIPTION	
Growth Form	Tall Tree
Appearance	Base of trunk has rough grey bark, becoming fibrous and peeling at top Main branches are smooth and tan coloured Leaves dark green, lanceolate and smooth Flower buds occur in groups of 5 to 12 Fruits are green cup-shaped capsules
Size	Height up to 15 m Width up to 3 m
Flowering	White July - December, or January - February
Habitat	Variety of habitats, near drainage lines
Conservation Status	Commonwealth - None State – None
Comments	Food source for local native fauna Nesting site for local native birds when mature
Revegetation Significance	Locally characteristic flora

Eucalyptus wandoo (Wandoo)

DESCRIPTION	
Growth Form	Tall Tree
Appearance	Smooth white-yellow bark, may be powdery Stem erect and branching Leaves pale green, lanceolata, taping up to 12 cm long Flower buds green and horned Fruit dark brown, grooved capsules
Size	Height 3 - 25 m Width up to 6 m
Flowering	Cream – White December - May
Habitat	Sandy loam, clay loam, gravel, laterite, granite Stony rises, undulating terrain
Conservation Status	Commonwealth - None State – None
Comments	Food source for local native fauna Nesting site for local native birds when mature
Revegetation Significance	Locally dominant flora

Kunzea praestans

DESCRIPTION	
Growth Form	Medium Shrub
Appearance	Several erect stems with many branches Oblong and rounded leaves, stiff, 5-7 x 2-3mm Flowers at ends of branches, round, up to 1 cm wide Fruit small woody capsules, 3 mm wide and up to 6mm long when open
Size	Height 1 - 2 m Width up to
Flowering	Pink – Purple September - October
Habitat	Laterite soils, hill slopes
Conservation Status	Commonwealth - None State - None
Comments	Plants may vary from being glabrous to hairy Known to hybridise with other Kunzea species.
Revegetation Significance	Locally dominant flora

Regelia megacephala

DESCRIPTION	
Growth Form	Large Shrub
Appearance	Erect stem, rigid and branching Leaves rounded, small and finely haired Flowers occur at end of branches, up to 1.5 cm wide Fruit woody capsules, up to 1 cm wide
Size	Height 2 - 5 m Width up to 1.5 m
Flowering	Purple - Red October - December
Habitat	Quartzite hills
Conservation Status	Commonwealth - None State - Priority 4
Comments	Naturally restricted to quartzite hills in Moora region
Revegetation Significance	Conservation significant flora

Xanthorrhoea drummondii (Grass Tree)

DESCRIPTION	
Growth Form	Small Tree/ Shrub
Appearance	Tree like monocot Trunk erect, often single Leaves green, stiff, up to 1m long and narrow, densely packed at top of trunk Flowers occur on single spike, up to 2m long
Size	Height up to 4.5 m Width up to 1 m
Flowering	Cream – White September – November, usually after fire
Habitat	Sand, laterite
Conservation Status	Commonwealth - None State - None
Comments	Food source for local native fauna
Revegetation Significance	Locally common flora