

FLORA

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Abstract

The Hill River Project ERMP does not adequately address the EPA guidelines particularly in its assessment of the conservation status of, and impact on, Declared Rare Flora (DRF) and regional endemic taxa. Although the conservation status of DRF is briefly reviewed there is no reference to their security on existing or proposed reserves and there are insufficient data relating to the numbers of populations and individuals that are known to exist. The ERMP lists 48 "vulnerable taxa" which occur in the Lesueur area. These taxa, however, were not surveyed and consequently their distribution and conservation status, and impact of the project on them, has not been determined. There are also a further 56 regionally endemic taxa occurring in the project area which require some assessment of their conservation status. Populations of taxa at the limit of their range and relictual species have not been treated in the ERMP although they represent a genetic resource unique to the Lesueur area.

There is some discordance between the proponents' and CALM's assessment of the impact of the project on numbers of individuals of DRF, particularly for *Asterolasia drummondii* and *Hakea megalosperma*.

Although the ERMP proposes to re-establish DRF and other regional endemics found in the project area, the data and methodologies provided are insufficient to confidently predict the survival of many taxa proposed for re-introduction.

Cryptogams have not been considered by the proponents.

3.1 INTRODUCTION

The proposed conservation reserve at Lesueur has a known vascular flora of 821 taxa, representing approximately 10% of the State's recognised vascular flora and a third of the taxa found in the Irwin Botanical District. Moreover, the area contains 111 of the 259 northern kwongan regional endemics, including seven species that have been gazetted as Declared Rare Flora (DRF) and 48 poorly known taxa considered to be threatened or vulnerable. Also occurring within the area are 81 taxa at their northern or southern distributional limits. The numbers of DRF, endemics and taxa at the edge of their geographic ranges are the highest of any area in the Irwin Botanical District. The proposed Lesueur conservation reserve ranks as one of the three most important areas for flora conservation in southern Western Australia (Griffin *et al.* 1990).

This chapter provides an assessment of those sections of the Hill River Project ERMP that pertain to the flora. The impact of the proposed development on the DRF and endemic species of the region and those of the Lesueur area will be discussed. The chapter also considers the re-establishment of regional endemic taxa.

3.2 ASSESSMENT OF THE ERMP

The ERMP for the Hill River Project is required to satisfy a number of guidelines as defined by the EPA (ERMP Attachment 1). With regard to Declared Rare and poorly known flora two key issues to be addressed by the project proponents in their ERMP were:

"detailed mapping of gazetted rare species as well as poorly known species" (ERMP Attachment 1, p. 7)

and to:

"consider the conservation status of rare or poorly known flora with particular emphasis on their security in conservation reserves" (ERMP Attachment 1, p. 6).

The proponents have not adequately addressed either of these issues.

Detailed mapping of Declared Rare and poorly known flora is not presented in the ERMP. Such data may have been withheld to ensure that the detailed locality information for DRF populations is not widely publicised, as is consistent with CALM Policy. However, the information that is provided is not adequate to determine the impact of the proposal and

there is no indication that any such mapping was carried out. Although the conservation status of the DRF is briefly mentioned, there is no reference to their security on existing or proposed conservation reserves and there are insufficient data relating to the numbers of populations and individuals that exist. For example, the approximate number of plants known for *Asterolasia drummondii*, *Banksia tricuspis* and *Hakea megalosperma* are provided (ERMP Section 4.2.1.5), but numbers for each population and the distribution of populations both within and outside the project area are not presented. Details on the numbers of plants, their distribution among populations and the distribution of these within the project area and the proposed conservation reserve at Lesueur are not presented for the remaining DRF species, namely *Acacia forrestiana*, *Eucalyptus lateritica*, *Eucalyptus suberea* and *Thelymitra stellata*.

The proponents make a number of statements in the ERMP in relation to the conservation status of DRF which require clarification or are inaccurate. These statements are that:

1. Other suitable sites for *Acacia forrestiana* exist (ERMP Section 4.2.1.5, p 4.17); however, they fail to mention where these sites are located or their conservation status.
2. *Banksia tricuspis* is stated as "occurring mostly in the Gairdner Range area" (ERMP Section 4.2.1.5, p 4.19). Current data available to CALM indicate that this species is endemic to the Gairdner Range, i.e. it does not occur elsewhere.
3. "Several hundred individuals" (ERMP Section 4.2.1.5, p 4.20) of *Eucalyptus lateritica* and *Eucalyptus suberea* exist. Less than 200 individuals of each species are known by CALM. These individuals are distributed among 13 and 12 populations respectively.
4. *Thelymitra stellata* has been the target of numerous surveys by the Western Australian Native Orchid Study and Conservation Group and botanists from CALM. The results of such surveys indicate that it is a very rare species and not poorly known as stated in the ERMP (Section 4.2.1.5, p 4.20). If "poorly known" was the most appropriate status for this species then it would not fulfil the survey requirements for declaration as a rare species as outlined in CALM's Policy Statement No. 9 (Hopper *et al.* 1990).

The proponents list and recognise the importance of 48 "vulnerable taxa" which occur in the proposed conservation reserve at Lesueur (ERMP Table 4.7); however, the distribution and conservation status of these species has not been determined. Therefore, no assessment has been made of the impact of the project

on these taxa nor their security on conservation reserves. This omission is of some concern to CALM given the large number of species involved and the very restricted distribution of many. All have a geographic range of less than 160 km with twenty six of these being very geographically restricted with a range of less than 50 km. In addition to the 48 "vulnerable taxa" and seven DRF species there are a further 56 regionally endemic taxa (Griffin *et al.* 1990) which occur within the project area and also require survey and an assessment of their conservation status.

The ERMP guidelines also require the issue of relic populations to be addressed (ERMP Attachment 1, p 3). These populations are often of special interest because of genetic divergence from mainstream populations and can be a valuable genetic resource (Hopper and Coates 1990). The 48 "vulnerable taxa" referred to in the ERMP are stated as including species "at the limits of their range or in areas outside their normal ranges or habitats" (ERMP Section 4.2.1.5, p 4-20); that is, the list includes species which have relic populations in the Lesueur area. Although some species in this category have been listed there are many others, including more common species, some disjunct, which are at the limit of their range. Typical examples are Jarrah (*Eucalyptus marginata*), Swamp Banksia (*Banksia littoralis*) and Bull Banksia (*Banksia grandis*) (Griffin *et al.* 1990). Populations of such species, however, have not been considered in the ERMP. Likewise, the impacts on populations of plant species which are considered to be relictual have not been assessed. Such species represent a valuable genetic resource. They include local endemics such as *Darwinia sanguinea*, *Hakea megalosperma*, *Hakea neurophylla*, species with disjunct distributions (*Hakea marginata*, *Isopogon sphaerocephalus*) and others (*Isopogon linearis*).

3.3 IMPACT OF THE PROJECT ON PLANT SPECIES

From available information, the impact of reducing population numbers on the risk of extinction for almost all rare, poorly known and regionally endemic taxa is unknown. Data on cryptogams in the Lesueur area have not been collected, so no statement on potential impacts on these groups can be made.

3.31 Declared Rare Flora

Available CALM survey data (Table 3.1) enable a quantitative assessment of the impact of the project on the numbers of the seven species of DRF affected in the proposed conservation reserve at Lesueur.

Within the impact zone (Table 3.1, Figure 1.1) all species except *Acacia forrestiana* would be affected.

Hakea megalosperma, *Eucalyptus lateritica*, *Banksia tricuspis*, and *Thelymitra stellata* would sustain the greatest loss of individual plants (19.6%, 15.5%, 10.6% and 9.1% of the total known respectively), while *Eucalyptus suberea* (8.3%) and *Asterolasia drummondii* (1.6%) would sustain smaller losses. Of the individuals currently known to occur within the conservation reserve proposed for the Lesueur area, 45.5% of *Thelymitra stellata*, 25% of *Eucalyptus lateritica*, 13.3% of *Hakea megalosperma*, 11.8 % of *Eucalyptus suberea* and 10.5% of *Banksia tricuspis* would be destroyed.

These data contrast with those provided by the proponents, based on the mine plan (ERMP Section 6.2.2) for some species, especially *Asterolasia drummondii*. In that case the proponents state that up to 50% of known individuals are within the zone of impact. However, CALM's data suggest that only about 1.6% of known individuals will be affected. Differences in the number of individuals which occur in the impact zone are also encountered for *Eucalyptus lateritica* and *Hakea megalosperma* where CALM's values for impact are 50% and 100% higher respectively. There is agreement that one population of *Thelymitra stellata* and no populations of *Acacia forrestiana* occur in the impact zone.

Whether or not the remaining plants in the proposed conservation reserve at Lesueur would constitute viable populations is a matter requiring careful research. Enzyme analysis of the mating systems of *Banksia tricuspis* (van Leeuwen and Coates unpublished) and of *Eucalyptus rhodantha* (Sampson 1988) have shown that normal levels of outbreeding of 60% or more may drop to around 30% or less when populations become small and isolated. An enhanced probability of population extinction is likely as a consequence unless active genetic management is practised (Soule 1987; Hopper and Coates 1990). This approach, combined with studies on population dynamics and other critical factors limiting recruitment, would be essential to develop an adequate understanding of the impact of the project on the rare flora in the Lesueur area.

3.32 Regional endemics

A preliminary analysis of the numbers of known populations of regional endemics affected by the project is possible, although we caution that many of these plants are poorly known, the exact locations of populations is vague and they require further survey to establish their precise distribution and abundance in the Lesueur area and elsewhere.

Griffin *et al.* (1990) determined that 259 plant species were endemic to the northern kwongan, the area between the Moore and Irwin Rivers and west of the Midlands Highway. Of the regional endemics,

95% of those which occur on proposed conservation reserves (42 in total) have been recorded only in the proposed conservation reserve at Lesueur. A further 139 currently occur on existing conservation reserves with 71 of these also in the proposed conservation reserve at Lesueur. The remainder are not represented on existing or proposed reserves (Table 3.2).

Analysis of the distribution of the regionally endemic species indicated that 111 occur in the proposed conservation reserve at Lesueur (Table 3.3). More regional endemics have been recorded from this proposed reserve than any other existing or proposed reserve in the northern kwongan.

All known populations of the 111 regional endemics were plotted onto a 1:1 000 000 base map showing boundaries of all existing and proposed conservation reserves in the northern kwongan. The total number of known, separately mapped populations was counted and their occurrence was determined in all existing and proposed conservation reserves, including the proposed conservation reserve at Lesueur. In addition, the possible occurrence of these regional endemics within the eastern block of the proposed conservation reserve at Lesueur and therefore possibly within the impact zone of the Hill River Project was determined.

A useful check on the accuracy of this approach in estimating impacts is available in the case of the seven species of DRF. Table 3.4 compares estimates of impact on known populations using the 1:1 000 000 mapping approach compared with accurate mapping at 1:50 000 using detailed field survey data. The average per cent difference between the two approaches is 14%. Thus, the impact statistics which follow should be interpreted as being accurate within about 15%.

Of the 111 regional endemics in the conservation reserve proposed for Lesueur (Burbidge *et al.* 1990, Appendix 2), two thirds (72, 65%) have populations within the eastern block of the proposed reserve. This coincides with the zone that will be impacted by this project. Regionally endemic taxa that will be affected (excluding the DRF species) include *Hypocalymma* aff. *ericifolium* (E.A. Griffin 1972), *Eucalyptus* aff. *haematoxylon*, *Thysanotus sparteus*, *Tetratheca remota*, *Persoonia rudis*, *Patersonia argyrea*, *Hakea auriculata* var. *spathulata*, *Gompholobium* aff. *polymorphum* and *Acacia plicata*.

If substantiated by further surveys of poorly known taxa among the regional endemics, these statistics indicate that the project would have a significant impact on a large number of the species of special conservation significance. In the context of regionally endemic species, eight taxa have been found to occur

Table 3.1

Impact on Declared Rare Flora in the Lesueur area of the proposed Hill River Project.

	<u>Total</u>		<u>In proposed conservation reserve</u>		<u>Impact area</u>	
	No. Pop	No. Plants	Pop	Plants	Pop	Plants
<i>Acacia forrestiana</i>						
number	5	920	4	820	0	0
% total populations	-	-	80.0	89.1	0	0
% PCR* populations	-	-	-	-	0	0
<i>Asterolasia drummondii</i>						
number	13	3342	11	1842	2	55
% total populations	-	-	84.6	55.1	15.4	1.6
% PCR populations	-	-	-	-	18.2	3.0
<i>Banksia tricuspis</i>						
number	72	19031	65	18940	13	2016
% total populations	-	-	90.3	97.2	18.1	10.6
% PCR populations	-	-	-	-	20.0	10.5
<i>Eucalyptus lateritica</i>						
number	13	260	8	160	2	40
% total populations	-	-	61.5	61.5	15.4	15.5
% PCR populations	-	-	-	-	25.0	25.0
<i>Eucalyptus suberea</i>						
number	12	240	9	170	1	20
% total populations	-	-	75.0	70.8	8.3	8.3
% PCR populations	-	-	-	-	11.1	11.8
<i>Hakea megalosperma</i>						
number	12	1326	7	1202	3	250
% total populations	-	-	58.3	90.6	25.0	19.6
% PCR populations	-	-	-	-	42.9	20.8
<i>Thelymitra stellata</i>						
number	12	55	4	11	1	5
% total populations	-	-	33.3	20.0	8.3	9.1
% PCR populations	-	-	-	-	25.0	45.5
MEAN						
% TOTAL POPULATIONS (± SE)	-	-	69.0 18.1	69.2 24.8	12.9 7.5	9.2 6.5
% PCR POPULATIONS (± SE)	-	-	-	-	20.3 12.3	16.7 14.4

*PCR = Proposed Lesueur Conservation Reserve

Table 3.2

Distribution of the 259 regional endemics of the northern kwongan by reservation status with reference to the proposed conservation reserve at Lesueur

<u>Taxa in existing reserves</u>		<u>Taxa in proposed reserves</u>		<u>Unreserved Taxa</u>
Total	Lesueur	Total	Lesueur	Total
139	71	42	40	78

Table 3.3

Distribution by reserve of the 259 regional endemics of the northern kwongan

<u>LOCATION</u>	<u>NO. OF TAXA</u>
RESERVES	
Alexander Morrison National Park	40
Badgingarra National Park	41
Beekeeper's Reserve	6
Beekeeper's Road Nature Reserve	13
Boothendarra Nature Reserve	14
Drover's Cave National Park	4
Lake Logue Nature Reserve	18
Minyulo Nature Reserve	5
Mt. Adams Road Nature Reserve	4
Namming Nature Reserve	4
Pinjarrega Nature Reserve	2
South Eneabba Nature Reserve	53
Southern Beekeeper's Reserve	1
Tathra National Park	20
Watheroo National Park	27
Watto Nature Reserve	6
PROPOSED RESERVES	
Proposed Arrowsmith Nature Reserve	6
Proposed Badgingarra National Park extension	6
Proposed Coomallo National Park	56
Proposed Mt Adams Nature Reserve	4
Proposed Lesueur conservation reserve	111

only in the eastern section of the proposed reserve at Lesueur (Table 3.5) and therefore may not be represented in the reserve should the project receive approval. All are represented elsewhere on conservation reserves.

Perhaps of greater concern are the nine taxa endemic to the proposed conservation reserve and the impact that the project will have on them (Griffin *et al.* 1990, Table 5.6). *Hypocalymma* aff. *ericifolium* (E.A. Griffin 1972) has two known populations, one of which occurs in the zone to be impacted by the project. Comparable figures for *Eucalyptus* aff. *haematoxylon* (E.A. Griffin 2451) are seven populations with a possibility of three being affected while *Persoonia rudis*, *Grevillea thelemanniana* ssp. *delta* and *Gompholobium* aff. *polymorphum* (E.A. Griffin 2304) each have three populations of which one may be affected. *Leucopogon plumuliflorus* has six populations of which one may be affected. None of the two known populations of *Andersonia longifolia*, five of *Phlebocarya pilosissima* ssp. *teretifolia* nor the one of *Restio* sp. (Briggs 7473 and Johnson) are known to occur in the impact zone. Urgent further survey of all these endemics is a high priority to adequately assess the impact of the project on the conservation status of these species.

There are twenty six very geographically restricted taxa (maximum range 50 km) that occur in the project area. Twenty of these taxa are not known on existing conservation reserves (Table 3.6).

3.33 Taxa at their northern or southern limit

There are 81 species within the proposed conservation reserve at Lesueur which exist at the northern and southern limit of their distribution. Of these, 45 may be affected by the project as they occur within the project impact zone or in the eastern section of the proposed reserve (Burbidge *et al.* 1990, Appendix 1). Ten are not found elsewhere on the proposed conservation reserve and six of these, including species such as *Acacia drummondii*, *Thelymitra crinita* and *Baumea preissii*, are at the northern limit of a continuous distribution. The remaining four, *Eucalyptus exilis*, *Goodenia fasciculata*, *Polypompholyx multifida* and *Utricularia menziesii* are disjunct northern outliers of otherwise more southern distributions. Populations of species with such distributions are significant because they may be of relictual origin, and therefore are of evolutionary significance and important in the conservation of the genetic resources of each species.

3.34 Widespread species

Populations of many widespread species will be destroyed should the project proceed. Depletion of such populations need not necessarily be of concern.

However, studies such as that of Coates and James (1979) and Coates (1980) on *Styloidium crossocephalum* indicate that major genetic variation may lie hidden within a common species. A project like the one proposed by the proponents in the ERMP has the potential to destroy local genetic races in such species, but the actual potential impact is unknown because no more than a handful of Lesueur's *ca* 700 widespread species have been studied throughout their range by population geneticists.

3.4 RE-ESTABLISHMENT OF REGIONAL ENDEMIC PLANTS

The proponents proposed to re-establish DRF and other rare regional endemics as part of the project's rehabilitation program. Although commendable, re-introduction and establishment of any of the regionally endemic taxa is likely to be a difficult task unless ecosystem reconstruction is achievable (see Rehabilitation, Chapter 7). Furthermore, if establishment is achieved there is still the need to ensure the long term survival of the new populations. Genetic structuring within populations, levels of genetic variability and inbreeding are all factors essential in population survival (Soule 1987), yet with the exception of *Banksia tricuspis*, *Eucalyptus lateritica* and *Eucalyptus suberea* this information is not available for regional endemics or any other taxa likely to be used in re-introduction programs. Given our current lack of understanding of genetic factors, competition and demographic factors in population survival the chances of successful re-establishment of rare plant populations is unlikely, without further extensive research.

The following are a number of issues, some relevant to points made in the ERMP, relating to the re-introduction of rare plant species to the Lesueur area which will need to be addressed.

1. Although seed from many Western Australian plant species can be readily collected and germinated there are some native species, particularly in certain groups (e.g. Epacridaceae, Restionaceae, Rutaceae) where this is not possible or has so far proved to be very difficult.
2. The ERMP provides no hard data on the propagation of DRF or any other regional endemic plant species targeted for rehabilitation programs.
3. The proponents state that potted plants of rare species will be used to re-establish such species on rehabilitation sites and that such re-establishment will not occur in the early stages of rehabilitation (ERMP Section 5.12.3). *Banksia tricuspis* would be best suited to introduction in the early stages of the rehabilitation program, especially if it is to be introduced as seed or seedlings. This approach

Table 3.4

Per cent mappable populations of Declared Rare Flora affected by the proposed Hill River Project

	Mapping Scale			
	1:1 000 000		1:50 000	
<i>Acacia forrestiana</i>	0%	(5) *	0%	(5)
<i>Asterolasia drummondii</i>	33%	(6)	15%	(13)
<i>Banksia tricuspis</i>	67%	(12)	18%	(72)
<i>Eucalyptus lateritica</i>	11%	(9)	15%	(13)
<i>Eucalyptus suberea</i>	17%	(12)	8%	(12)
<i>Hakea megalosperma</i>	33%	(9)	25%	(12)
<i>Thelymitra stellata</i>	17%	(6)	8%	(12)

* Total number of mappable populations known for the species

Table 3.5

Regional endemics, total number of known populations and the per cent on existing conservation reserves which are only found in the eastern section of the proposed Lesueur conservation reserve

Taxa	No. of known populations	Per cent on existing conservation reserves
<i>Banksia chamaephyton</i>	31	19%
<i>Beaufortia bicolor</i>	14	28%
<i>Dryandra</i> aff. <i>falcata</i> (E.A. Griffin 3459)	50	20%
<i>Dryandra</i> aff. <i>patens</i> (E.A. Griffin 1507)	22	18%
<i>Dryandra carlinoides</i>	89	10%
<i>Dryandra tortifolia</i>	7	14%
<i>Phlebocarya pilosissima</i> ssp. <i>pilosissima</i>	13	15%
<i>Stylidium maitlandianum</i>	15	20%

Table 3.6

Very geographically restricted taxa (maximum range 50 km) that occur within the Hill River Project area. Their total number of known mappable populations (at 1:1 000 000 scale) and the percentage of these populations on current conservation reserves.

Species	Total number mappable pop.	% on conservation reserves
<i>Acacia retrorsa</i>	8	12
<i>Banksia tricuspis</i>	12	0
<i>Darwinia helichrysoides</i>	9	0
<i>Daviesia</i> sp. (M.D. Crisp 6213)	5	20
<i>Daviesia epiphyllum</i>	4	0
<i>Daviesia</i> sp. (M.D. Crisp 5429)	8	0
<i>Dryandra sclerophylla</i>	35	22
<i>Eucalyptus</i> aff. <i>haematoxylon</i>	7	0
<i>Eucalyptus lateritica</i>	13	7
<i>Eucalyptus suberea</i>	11	0
Genus nov. aff. <i>Ecdeiocolea</i> E.A. Griffin 2157	7	28
<i>Gompholobium</i> aff. <i>polymorphum</i> (E.A. Griffin 2304)	3	0
<i>Grevillea acrobotrya</i> ssp. <i>uniforma</i>	6	0
<i>Grevillea thelemanniana</i> ssp. <i>delta</i>	2	0
<i>Hakea erinacea</i> var. <i>longiflora</i>	8	12
<i>Hakea neurophylla</i>	10	0
<i>Hypocalymma</i> aff. <i>ericifolium</i>	2	0
<i>Leucopogon plumuliflorus</i>	6	0
<i>Patersonia argyrea</i>	3	0
<i>Persoonia rudis</i>	3	0
<i>Phlebocarys pilosissima</i> ssp. <i>teretifolia</i>	5	0
<i>Stylidium aeonioides</i>	6	16
<i>Tetratheca remota</i>	2	0
<i>Thysanotus</i> aff. <i>sparteus</i>	3	0
<i>Thysanotus vernalis</i>	4	0
<i>Xanthosia tomentosa</i>	15	0

would be the most suitable because seedling recruitment under natural conditions does not occur unless there is some form of disturbance. Recruitment of *Banksia tricuspis* without disturbance is negligible. Another important feature to consider with this species is its site specificity with regard to soil type and aspect (microclimatic environment). Under natural conditions *Banksia tricuspis* has very specific site requirements. Indeed this is a factor that should be considered for all rare species when attempting to introduce them to rehabilitation sites.

4. Re-establishment of rare species in the rehabilitation area should take into consideration the genetic structure of populations under natural conditions. Moran & Hopper (1987) found that genetic structuring in populations of both *Eucalyptus lateritica* and *Eucalyptus suberea* is very important and needs to be considered if populations are to be managed (this includes re-establishing them in disturbed areas).
5. Cuttings may be an efficient way to re-establish some species in the rehabilitation sites (e.g. *Verticordia grandis*) but for rare species, the effect that such a procedure may have on the genetic structure within populations must be considered. If cuttings from only a few plants from one area are used, loss of genetic variability and inbreeding depression may reduce chances of long term population survival.
6. *Hakea megalosperma* usually only re-establishes naturally if root stocks are present as it is a very poor producer of seed, although a prolific resprouter after disturbance, especially fire. It is also a very site specific species, only growing on lateritic rises and not in deep sands. Prolific regeneration by self seeding is extremely unlikely,

contrary to statements in the ERMP (Section 5.12.3). This species probably also has an interesting genetic structure and is important because it is considered to be one of the oldest (relictual) members of the genus. Without a sufficient seed stock for re-establishment, *Hakea megalosperma* is likely to be a difficult species to re-introduce.

7. The use of fertilizers on the rehabilitation sites as suggested in the ERMP (Section 5.12.4) needs to be carefully considered for the following reasons:
 - it encourages the establishment of weeds.
 - it may encourage the rapid establishment of short-lived plants and some types of disturbance opportunists such as species of *Acacia*; such plants may cause a problem in terms of competition or may create a significant fire hazard.
 - some species may become dependent on the supply of fertilizers which could lead to their demise when the project is decommissioned and fertilizers are no longer applied.
 - it may lead to unnatural competition between species as some species may be able to more rapidly assimilate the additional nutrients and have a competitive advantage over other species.
 - some genera/species are not able to handle even the smallest application of fertilizers and die (e.g. some *Banksia* species, Lamont *et al.* 1985)
 - run-off from the rehabilitation dumps may have excess nutrient loads as a result of fertilizer application and this could cause problems with algal bloom in sedimentation ponds and along drainage lines.