"REHAB 86"

PRESCRIPTION FOR REHABILITATION OF BAUXITE MINES IN THE WESTERN JARRAH FOREST

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1. INTRODUCTION

1.1 Environmental aspects of bauxite mine planning, operations and rehabilitation in the jarrah forest are complex. Overlapping tenures and legislation are involved, together with interactions between land use and biological factors.

1.2 However, the complexity of the system must not deter the formulation and clear statement of objectives, strategies and most up-to-date techniques. This statement can then provide an agreed basis for review and up-date by all parties involved as well as operating guidelines for field personnel.

1.3 The first such statement was entitled "Rehab 80". It was produced by the State Department of Conservation and Land Management (CALM), who co-ordinated input from a range of organizations and specialist workers.

1.4 Following a period of implementation and further research and analysis, previous prescriptions were withdrawn and replaced by this prescription.

Rehab 86 is the current "State of the Art" document describing techniques to be used in bauxite mine rehabilitation in the jarrah forest.

1.5 New techniques (i.e departures from this prescription) may be introduced as research projects, as long as:

- the location and timing is approved by CALM in consultation with the Water Authority where water catchments are concerned.

- accepted research procedures for experimental design, measurement and follow-up are fulfilled.

1.6 The prescription will be reviewed annually, at which time new strategies or techniques will be considered for incorporation.

Input for this review will be considered from the interested groups or those involved in the rehabilitation operation. The review will be co-ordinated by CALM. Any proposed changes to objectives, strategies or operational techniques will be fully documented, outlining the reasons, and detailing the data to support the proposed change. They will be subject to comment and acceptance by appropriate government authorities and the mining company.

2. THE OBJECTIVE

The overall objective of bauxite mine rehabilitation in the jarrah forest is to maximise the forest's potential by:

Establishing a stable forest ecosystem, planned to enhance or maintain water, timber, recreation, conservation and/or other nominated forest values".

Specific goals (not listed in order of importance since priorities may vary with designated land use) are:

2.1 Water values: to ensure that mined areas provide acceptable water quality and quantity.

2.2 Timber: to grow a forest which has the potential for sawlog production.

2.3 Recreation: to maintain existing recreational values where possible and to provide increased opportunities for forest based recreational activities in accordance with CALM regional and divisional recreation plans.

2.4 Protection: to conserve the residual soils; to control dieback spread and to manage potential fire hazards.

2.5 Landscape: to create a rehabilitated landscape visually compatible with the adjoining indigenous forest.

2.6 Conservation: to favour the development of floral, faunal and soil characteristics compatible with the surrounding indigenous forest.

2.7 Economical management: to produce a rehabilitation system which can flourish (in the short term) and become self sustaining (in the long term) without continual applications of nutrient/management resources.

To meet multiple use forestry goals, long term rehabilitation management must be compatible with that of surrounding jarrah forest (in terms of points 2.1 - 2.7).

3. REHABILITATION STRATEGIES

These are:

3.1 The development of prescriptions for rehabilitation procedures for each mined area, in accordance with the designated land use priority and land use management plans.

3.2 To conduct research programmes to improve rehabilitation procedures. In the event of research information becoming available, then modification to this prescription may take place before the next review by mutual agreement.

3.3 The monitoring of rehabilitated areas to determine their capacity to sustain long-term production of the forest values listed in the objective, and

3.4 The development of remedial treatments should monitoring reveal that rehabilitation objectives are not achieved.

4. REHABILITATION PLANNING

Rehabilitation planning occurs at two levels:

i. The first is broad-scale regional minesite planning on a five year time scale.

ii. The second is annual detailed operational planning on a pit-by-pit basis.

4.1 Regional Planning: the mining company is required to produce an annually updated five year mining and management plan for government approval. Those plans should be drawn up in consultation with appropriate government departments and should consider the following regional aspects:-

- the sequence of mining and rehabilitation
- access for mining, public and future management
- location of mine facilities
- dieback control by hygiene and water management
- aesthetic and landscaping considerations
- fire protection planning
- integration of mining into land use plans so as to minimize adverse impact on priority uses
- requirements for long-term management
- broad description of site vegetation types and reconnaissance for rare flora and fauna
- water management systems and water course protection
- proximity to private property.

4.2 Annual Operational Planning : detailed conceptual proposals for each minepit should be prepared 12 - 18 month before rehabilitation. Each proposal should be jointly prepared by CALM, mining company staff and the Water Authority in water catchment areas and should consider the following specific factors:-

- pit identity (nominated by CALM).
- dieback hygiene, drainage, erosion control and water management specifying measures to be used from initial drilling through to completed rehabilitation;
- treatment and management of land over non-ore bodies within and adjacent to ore i.e. "islands" of unmined forest;
- species to be used;
- any special features to be incorporated or retained (e.g. pit walls) as part of the rehabilitated landscape;
- internal access to pits for future forest management;
- location of mining facilities/structures;
- scheduling in sensitive areas;
- rock management;
- movement, stockpiling and replacement of topsoil and overburden, in relation to dieback spread within and downslope of the pit.
- identification of features such as permeability, slope, waste islands, rocks, state of forest downslope, wetness of pit, thin overburden, sudden slope changes etc, which may require special handling;
- any research projects on the pit, including method and timing of decommissioning of the project at its conclusion.

The conceptual rehabilitation plans will be endorsed by the CALM district manager following discussions with other government agencies where appropriate.

Contentious or unusual areas will be referred to the Mining Operations Group.

Research proposals frequently will not be finalised until after the completion of conceptual plans. Such proposals, in the form of approved working plans, should be submitted no later than 1st

December 1985. Where the research project differs significantly from standard practice the means and time of decommissioning the project should be specified.

Research proposals, and other departures from the conceptual plan, should be jointly considered by the CALM district manager and the company and interested government departments.

4.4 Fire Protection Provisions

When conceptual plans are submitted to the CALM district office, the district manager will add guidelines for fire management

These will include -

1. Provision of access - arterial road access will be within 400m of protection zones (40km/hr access).

2. Fire breaks are required

   - to separate burning buffers from protection zones.
   - to break these protection zones into approximately 20 ha. cells.
   - inpit these fire breaks to be 40 m. wide and made up of sub-arterial access or mineral earth breaks and a strip of rehabilitation seeded with a modified mix with a reduced acacia component.
   - outside pit they are to be standard 3m fire lines.

3. Strategic low fuel zones

   - will be established such that no fire shall run more than 2 km. before encountering a low fuel buffer.
   - will be established as part of the Dwellingup and Jarrahdale townsite protection areas.
   - may be achieved using modified seed mixes forming groundcovers, or by reduced seeding rates, etc.

4. Water points

   The location and construction of water points will be agreed with the Water Authority in catchment areas.

5. DIEBACK MANAGEMENT

Bauxite mining and rehabilitation involves massive soil and vehicular movement under all weather conditions. Also mining can cause substantial modification to natural drainage patterns in the forest so close attention to dieback hygiene is essential.

The two key management aims are:

i. to minimise the spread of infection into dieback-free forest and minesites.

ii. to manage access and drainage so as not to expand areas which favour the survival and severity of the disease.

Dieback hygiene measures are specified in detail in other prescriptions dealing with drilling, timber salvage, clearing and topsoil handling - i.e operations not dealt with in this prescription.

Other dieback control requirements which are relevant to rehabilitation are listed below in sequence.

6. PREPARATION OF PITS FOR PLANTING

6.1 When mining is completed, the following earthworks will be carried out in the sequence below:

i. Deep ripping of compacted pit floors which may be covered with more than 0.5 metres of fill, batter material, fill from waste islands, boulders or tree trunks.

ii. Landscaping.

iii. Replacement of overburden, then topsoil.

iv. Deep or shallow ripping, or scarification as required.

v. The construction of water management structures such as contour and grade banks, waterways and sumps.

6.2 Landscaping: Pit walls will be battered and smoothed. Waste islands, and pit floor will be shaped and filled. Occasionally pit walls may be retained if prescribed in a recreation plan. In this case visitor safety needs to be considered e.g. perched boulders, long-term stability of cliff wall.

6.3 Overburden and topsoil will be evenly respread over all areas to be rehabilitated. The distribution of this material from pit to pit will be in accordance with the following requirements:

i. minimise the amount of infected material to be carried to dieback-free areas, as detailed in the conceptual plan.

ii. minimise the movement of topsoil and overburden.

iii. move soil mainly under dry conditions and, attempt to schedule soil movement during summer.

6.4 Unmined areas

Islands or inliers of low grade ore often occur within a pit. It is desirable that these areas remain undisturbed. However, there will be occasions when they are both cleared and stripped.

When this occurs either the area will be completely landscaped or the unmined caprock will be "popped" with explosives unless identified in the conceptual plan as being within a noise restriction zone to provide planting sites and minimise surface runoff unless identified in the conceptual plan as being within a noise restriction zone. Blasted craters will be graded level before respreading overburden and topsoil. These areas should be scarified on contour to avoid bringing up rocks.

6.5 Rock management

During the pit preparation work, care must be taken not to import, or bring to the surface, large boulders - which would make the future forest floor untrafficable. If boulders are brought to the surface enough rocks must be removed from the rehabilitated area to allow access for future management including fire control, silviculture, and other tending or harvesting operations. The removal of rocks may occur before or after planting provided the objective of avoidance of soil compaction and erosion control are not compromised.

6.6 Ripping

Deep ripping is required to fracture the compacted pit floor to allow root penetration and, water infiltration; to provide an "anchor" for the returned topsoil; and to control the overland flow of water.

In General

i. All of the rehabilitated areas require either contour or grade ripping,

ii. Deep ripping should be done using a winged tyne to maximise subsoil fracture; batters and banks need not be deep ripped, but must be scarified or shallow ripped. This avoids bringing up rocks, but still controls erosion and prepares a seed bed;

iii. The distance between parallel riplines will depend on soil conditions, but must ensure a continuous fracture of the compacted subsoil;

iv. Ripping should be as deep as possible and should not be less than 1.2 metres.

v. In areas where public access is to be encouraged, the ground surface may be levelled during and/or following deep ripping, provided control of soil erosion within pits is not compromised.

vi. To avoid bringing up rocks cleared, unmined areas should be scarified on contour.

7. WATER MANAGEMENT

7.1 Careful water management must be considered in every phase of the operation from initial clearing and road construction through to completion of rehabilitation.

7.2 A variety of water management systems may be adopted, depending on land use priority, site, and the nature of the specific catchment or storage facility.

7.3 Criteria for Success: irrespective of the system which is used, it must satisfy the following basic criteria:

- there must be minimum topsoil erosion within pits,

- on proclaimed catchments the system must meet standards of stream turbidity, salinity and biological purity described by the Water Authority. Off proclaimed catchments, streams draining an area influenced by mining must not increase unduly in turbidity, chemical or biological pollution,

- there must be no long-term ponds of water lying either within or below pits or roads unless planned.

- the need for long-term maintenance must be minimal,

- peak flood levels should not be increased by mining in catchments such that they endanger dams on the catchment;

- the system must be acceptable in terms of costs, aesthetics and the land use priority.

7.4 Water Management Systems

Pits may be designed and constructed so as to:-

(i) retain and infiltrate water;

(ii) discharge water, or

(iii) a combination of retention and discharge.

7.4.1 Water retention and infiltration will be achieved by:-

(i) infiltration and silt trapping in the contoured rip lines; and

(ii) collection of overland flow, either in a series of midslope contour banks and a pit bottom sump, or by a system of grade discharge banks directing overland flow to predetermined sump areas within the pit.

(iii) Each sump must have a minimum capacity to store the run-off from a storm of up to 10 days duration, and a re-currence interval of once in 15 years, with the worst temporal pattern calculated from meteorological records and mine pit characteristics. This design will be based on an accepted hydrological model.

Higher run-off storage capacities may be prescribed depending upon sensitivity of the area.

Stable overflow will be provided in all water storage areas so that more extreme run-off events will not cause severe erosion or damage.

(iv) Contour interceptor banks will be constructed at up to 10 m vertical intervals. Such banks may not exceed 1 m in height nor have steep sides which present an obstacle to future access. Where specified, contour interception banks must be provided with suitably constructed overflows and non-erodable spillways. Construction of these devices must be completed before the first Autumn rains.

(v) Grade discharge banks will connect to stabilised waterways or haul road drainage system which direct water to detention sumps.

(vi) Sump and drain locations will be indicated on the conceptual rehabilitation plans.

7.4.2 Water Discharge: where this is prescribed it will be achieved by:

(i) infiltration of silt trapping in the contoured or grade rip lines, and

(ii) control of overland flow by grade banks, waterways and slow release detention ponds or filter systems.

Grade banks should be constructed so as not to erode, and to be located at least along each 10 metre vertical contour within each pit. Distance apart should depend upon site characteristics and should be such that any potential erosion is contained between two grade banks, and does not create serious management problems such as accessibility, safety and loss of topsoil.

Waterways should collect discharge from grade banks and deliver water to the discharge system.

The discharge system from the detention pond or filter system should provide a major passageway for water; avoid long-term detrimental effects of silt and water on forest or stream vegetation; minimise forest soil erosion, and not significantly increase turbidity levels in forest streams. In addition in water catchment areas any discharge into the stream shall comply to the requirement of the Water Authority.

7.5 Unless planned, drainage from mine access roads, haul roads, mine site facilities or from pits must not flow uncontrolled into unmined dieback-free forest, but must be channelled (via ponds or filters) directly into the lowest part of the landscape as agreed.

7.6 All erosion control earthworks other than deep ripping with the winged tyne must be completed and effective before the first Autumn rains (i.e. generally before 30th April each year).

Winged tyne ripping effectively shatters the clay zone all year round.

Standards will be monitored and remedial action specified using an inspection and action checklist.

8. PLANTING

8.1 Planting Layout and Design

8.1.1 As a general rule, tree species will be established as mixtures. Monocultures may be planted in localised portions of the landscape.

Every mixture must include species indigenous to the Darling Range. Species mixes will be determined in advance and specified in the rehabilitation plan by CALM

8.1.2 Plant spacing will be varied according to the detailed site rehabilitation objectives. In some areas such as at prominent view points or vistas and along selected areas of road, areas may be left unplanted. In other instances, trees may be planted in small groups or clumps to minimise the rigid plantation effect created by row planting on a regular spacing.

8.1.3 Aim to achieve a stocking of about 625 planted trees/ha.

8.1.4 Do not plant trees in drainage channels.

8.1.5 Start planting in June when the soil is wet to depth. Cease planting by the end of the second week in August.

8.1.6 Seedling specifications: plants in jiffy pots or paper pots, at least 5-30 cm in height with a minimum of 2-4 pairs of leaves. Pots and soil mix sterile. Exposed roots to be trimmed before planting.

8.2 Before planting all pits will be inspected by the CALM. Parts of pits which are deemed by CALM to be inadequately prepared, may not be planted until they are adequately prepared.

8.3 Access for planting crews must be pre-planned and specified so as to minimise traffic through unmined forest to minimise disease spread; and across the prepared pit to minimise erosion.

8.4 The CALM district manager must make ensure a detailed record of species planted and treatments given at the completion of the job.

8.5 Selection of Tree Species for Planting: Criteria for selection of tree species is:

i. Tolerance to dieback
ii. Fire resistance
iii. Capacity for roots to penetrate the compacted kaolin layer
iv. Useful timber
v. Proven species longevity, and growth to maturity in the minepit environment
vi. Visual compatibility with indigenous forest
vii. Useful nectar source

Currently there is no tree species with proven capacity to satisfy all these criteria. Pending continuing studies into a wide variety of species in pits and arboreta (and new aboreta establishment), the following species will be planted as random mixtures

8.5.1 Freely draining sites with depth of ore greater than 3.5m

Seedlings

E.maculata	25%
E.muellerana	50%
E.resinifera	10%
E.calophylla	15%

Broadcast Eucalypt seed

E.wandoo	500	viable	seeds/ha	
E.calophylla	2000	"	"	"
E.marginata	2000	"	"	"
E.laeliae	500	"	"	"
E.accedens	500	"	"	"

8.5.2 Less freely draining sites ie. shallow ore (less than 3.5 m) and low slope

Seedlings

E. resinifera
or 50%
E. maculata

E. calophylla
or 25%
E. patens

E. saligna
or 25%
E.diversicolor

Broadcast Eucalypt seed as in 8.5.1 except exclude E. marginata seed if in short supply.

8.5.3 Sumps

Seedlings

E. patens	40%
E.megacarpa	40%
E.diversicolor	20%

Broadcast Eucalypt seed.

E. patens	2000 viable seeds/ha
E. megacarpa	2000 " " "
E. wandoo	2000 " " "

8.6 Seed Sources for Seedlings

Species Native to W.A:
Seed to come from at least 10 provenances, (locations to be specified by CALM rehabilitation research); each represented by at least 10 mother trees.

Eastern States Species

All seed for non-W.A. species is to be obtained from trees in the Eastern States.
Each species shall be represented by seed from at least 10 provenances (locations to be specified by CALM rehabilitation Research).
Equal proportions of seed from each provenance shall be sown separately in the nursery.
Before transportation into field, species shall be mixed together in trays (in the appropriate planting mixture).
During species mixing, tray of provenances shall be alternated. (i.e. use of tray only of one provenance in the mix; when it is exhausted, select a tray from the next provenance ... etc).
The nursery must inform CALM rehabilitation research personnel of any provenances performing badly.

8.7 Fertilizer - Apply 200 grams of Monammonium phosphate per plant.

Fertilizer to be placed approximately 15 cms from the base of the plant, in a spear hole or stamped depression.

8.8 Success Criterion for Planting/Fertilizer Operation - 80% survival of planted species at 9 months after planting.

Areas of 0.5 ha and above which fail to meet this criterion, to be rescheduled for replanting the next winter.

9. UNDERSTOREY ESTABLISHMENT

9.1 The aim of understorey establishment is to generate a diverse and vigorous understorey which will rapidly contribute to soil stabilization, erosion control and the build-up of soil nitrogen and organic matter. At the same time, development of fuels and fire risks should be kept to tolerable levels.

9.2 Base species for the seed mix will include the major northern jarrah forest legume species i.e. Acacia pulchella, A. celastrifolia, A. extensa, A. lateriticola, A. drummondii, A. urophylla, Kennedia coccinea and K. prostrata. These species should make up about 75% of the mixture and be in equal proportions by viable seed number. A large diversity of minor jarrah forest species should make up the balance, including other nitrogen fixing species (Allocasuarina and Macrozamia spp.).

9.3 Specific species and specific mixes should be applied to particular sites e.g. waterlogging tolerant species for sumps, wildflower species for roadsides and recreation areas (See section 4.2), and species of low flammability and height for special fire management zones.

9.4 As a general rule, non-indigenous and high Phytophthora cinnamomi susceptible species should not be used.

9.5 Understorey seed mixes will be determined in advance and specified in the rehabilitation plan for each pit and for specific sites within pits.

9.6 Fertilizer - Areas to be seeded will be broadcast fertilized with 500 kg/ha of superphosphate number 1.

9.7 Application Rate - Mixed understorey seed will be sown at the rate of 1-2 kg/ha with the major legume seed mix no more than 1.0 kg/ha.

Seeding is to be done after ripping by ground application and to be completed by 1st June each year.

9.8 Success Criterion - 1 plant established per square metre, 9 months after sowing, as determined by stocked quadrat survey of each pit.

Areas of 0.5 ha or greater not stocked at this rate to be reseeded the following Autumn. Light scarification may be necessary to promote seed germination in areas reseeded in Year 2.

10. ROADS

10.1 The road network which remains after rehabilitation must conform to a predetermined plan. The basic planning principle is to aim for the minimum number of well surfaced, low profile roads, consistent with provision for public access and fire protection.

10.2 This plan will be drawn-up from approved 5 year mining plans, and will cater for:

i. access for mining
ii. access for rehabilitation
iii. access for future forest and catchment management

10.3 Unwanted roads will be rehabilitated by a combination or all of the following -

i. if possible and economical recovery of gravel for reuse elsewhere
ii. blasting of caprock
iii. overburden and top soil return
iv. ripping and erosion control
v. seeding and planting in harmony with surrounding forest

11. PRESCRIPTION REVIEW

Next date for review of this prescription : May, 1986