"REHAB. 89"

PRESCRIPTION FOR REHABILITATION OF BAUXITE MINES IN THE WESTERN JARRAH FOREST

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 Department of Conservation and Land Management (C.A.L.M.) in consultation with Alcoa.

1.4 Following a period of implementation and further research and analysis by Alcoa and C.A.L.M., previous prescriptions were withdrawn and replaced by this prescription after joint review.

Rehab. 89 is the current document describing techniques to be used in bauxite mine rehabilitation in the higher rainfall zone of 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 C.A.L.M. 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 C.A.L.M. 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

Bauxite mine rehabilitation is to be consistent with the Regional Management Plan. The overall objective of bauxite mine rehabilitation in the Jarrah forest is to maximise the forest's potential by:

Establishing a stable, self regenerating 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 C.A.L.M. regional and district 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 encourage the development of floral, faunal and soil characteristics of the indigenous jarrah forest ecosystem.

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 mine site 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 management
- aesthetic and landscaping considerations
- fire protection planning
- integration of mining into land use plans so as to minimise 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 mine pit should be prepared before rehabilitation. Each proposal should be jointly prepared by C.A.L.M., mining company staff and the Water Authority in water catchment areas and should consider the following specific factors:-

- pit identity
- dieback management, 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 top soil 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 long term management strategy for the rehabilitated area as planned by C.A.L.M.

The conceptual rehabilitation plans will be endorsed by the C.A.L.M. District Manager following discussions with other government agencies where appropriate.

Contentious or unusual areas will be referred to the Regional Manager or 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 the 1st of December. 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 C.A.L.M. District Manager and the Company and interested Government departments.

4.3 Fire Protection Provisions

These are outlined in detail in Fire Protection Plans produced for each mine site. When conceptual plans are submitted to C.A.L.M., the District Manager should ensure they comply with the Fire Protection Plan for the relevant mine site.

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 management is essential.

The two key management aims are:

i) to minimise the spread of infection into dieback-free forest and mine sites.

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

Dieback management practices are specified in detail in other prescriptions dealing with drilling, timber salvage and clearing. i.e., operations not dealt with in this prescription.

Dieback management practices following clearing are to be in accordance with the following:

5.1 Disease boundaries established during clearing are to be maintained and demarcated in the field with pegs. Pegs are to be painted green on one side, yellow on the other. The yellow side of the peg-line will indicate the infected area.

5.2 Stripping operations will segregate infected and uninfected soil. Stripping equipment should not access uninfected areas across unstripped infected areas.

5.3 Infected top soil and overburden should either be stockpiled in situ or transferred only to an immediately adjacent infected rehabilitation site. It should not be transported across uninfected areas.

5.4 Uninfected topsoil and overburden may be transferred to remote locations. Such material should be replaced with due consideration to the quality of native forest downslope of the mining area and the potential for restoration of jarrah within the rehabilitated mine pit.

5.5 Topsoil and overburden handling operations for uninfected material should be scheduled for dry soil conditions.

A categorisation process will be undertaken by C.A.L.M. District Managers and the mine sites within their jurisdiction, which will identify those areas of high quality forest where pre-mining operations should occur under dry soil conditions.

6. PREPARATION OF PITS FOR PLANTING

6.1 When mining is completed, the following earthworks will be carried out.

6.1.1 Deep ripping of compacted pit floors which may be covered with more than 0.5 metres of fill.

6.1.2 Landscaping.

6.1.3 Replacement of overburden, then top soil.

6.1.4 Deep or shallow ripping, or scarification as required. (See 6.6)

6.1.4 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 top soil 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) No transfer of infected material to dieback free sites which are above significant areas of dieback free vegetation.

ii) Endeavour to move soil under moisture conditions appropriate to its dieback status in accordance with arrangements agreed with the District Manager.

6.4 Unmined areas

Islands or inliers of low grade ore often occur within a pit. Clearing of these areas should be kept to an absolute minimum. However, there will be occasions when they are both cleared and stripped. When this need occurs, it will be justified to the satisfaction of the District Manager.

When this occurs, either the area will be completely landscaped or the unmined caprock will be 'popped' with explosives to provide planting sites and minimise surface runoff. The exception to this will be those areas, identified on conceptual plans as being within a noise restriction zone or inside safe blasting distance from private property. Blasted craters will be graded level before respreading overburden and top soil. Overburden/top soil should be at least 30 cm. deep and scarified, on contour as an aid to erosion control. Deep ripping in these areas should normally be avoided in order to reduce the appearance of surface rocks.

Vegetation establishment and growth on unmined areas have tended to be less successful than that of the adjacent rehabilitated mine pits.

In addition to the routine planting and/or seeding of these sites a supplementary seeding mix will be applied.

This mix will contain drought tolerant tree and understorey species. Seed of E. drummondii, E. sideroxylon and E. microcarpa will be applied to achieve a stocking rate of 625 trees per hectare. The understorey seed will be spread at 1 kilogram per hectare and contain only species endemic to the Darling Range.

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 and plants are not damaged.

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 top soil; and to control the overland flow of water. Joint inspection by C.A.L.M. and Alcoa of pits prior to ripping will be carried out where appropriate to determine specific requirements.

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) Where soil erosion control provisions will not be compromised, the ground surface should be levelled wherever possible during or after deep ripping. Any alternative techniques which ensure erosion control while producing a smoother surface are to be encouraged.

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 a minimum of top soil erosion within pits,

- on proclaimed catchments, the system must meet standards of stream turbidity, salinity and biological purity defined 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; or

ii) discharge water.

A combination of retention and discharge techniques may be used. A recurrence interval of once in twenty years will be used as the rainfall design period.

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.

Where used, contour intercepter banks will be constructed at up to 10 metre vertical intervals. Such banks may not exceed 1 metre 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-erodible spillways. Construction of these devices must be completed before the first Autumn rains.

Grade discharge banks will connect to a stabilised waterway.

Well drained sites may require no engineered drainage structures.

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 and 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 with a maximum 10 metre vertical interval. 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 top soil.

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 with the requirements 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 at agreed locations.

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 as appropriate and as agreed to by Alcoa/C.A.L.M. officers.

8. PLANTING

8.1 Planting Layout and Design

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

In order to fulfil the widest range of rehabilitation objectives, the emphasis will be on species indigenous to the Darling Range.

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

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 Stocking rate should be sufficient to yield good tree form. A minimum stocking of about 625 planted trees per hectare must be used. An increase in stocking to 1,250 stems per hectare is favoured to be achieved by the most economic and appropriate method, either broadcast seeding or planting. Where seeding is selected, objective stocking rate should be 2,500 s.p.h..

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 true 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 C.A.L.M. officers. Parts of pits which are deemed by C.A.L.M. 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 C.A.L.M. District Manager must ensure a detailed record of species planted and treatments applied is made at the completion of the job.

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

i) Compatible with land use objectives specified in Regional Management plan
ii) Site suitability index
iii) Tolerance to dieback
iv) Fire resistance
v) Capacity for roots to penetrate the compacted kaolin layer
vi) Useful timber
vii) Proven species longevity, growth to maturity and regeneration in the mine pit environment

vii) Visual compatibility with indigenous forest
viii) Useful food and nectar sources for fauna

Following are the species to be used in bauxite mine rehabilitation in the western, high rainfall area:

Eucalyptus marginata
Eucalyptus calophylla
Eucalyptus patens
Eucalyptus megacarpa

The criteria for determining the distribution of the different species will be determined by position in the landscape and the risk and hazard of dieback disease. Risk and hazard will be determined by agreed procedures which are currently under development.

Alcoa staff and the C.A.L.M. District Manager will agree on a site by site application of the matrix when preparing conceptual plans.

Definitions of Risk and Hazard

Risk is an external force or agent that would bring Phytophthora cinnamomi (P.c.) to a site. Hazard is the degree to which conditions within the site favour the proliferation of the P.c. fungus once it has been introduced. The ability of plants to resist an infection is included as part of hazard rating.

8.5.1 Species Distribution Criteria

8.5.1.1 Assessing levels of dieback risk -

High - soil returned from moderate or high impact dieback area.

Moderate -

i) soil returned from low impact dieback area or high risk of dieback introduction.

ii) soil returned from non-dieback area, but little or no hygiene during soil handling.

Low - soil returned from non-dieback area and a high level of hygiene during soil handling.

8.5.1.2 Assessing levels of dieback hazard -

The dieback hazard of pits will be assessed by Alcoa and agreed with the C.A.L.M. District Manager. Hazard assessment will be according to a procedure to be agreed; based on ore depth, slope, aspect, soil type, pit location on the slope, position within the pit, ripping type, distance from the stream zone, etc., as appropriate. The system will be reviewed as required based on field experience.

8.5.1.3 Species Mix - Mine Pits (%)

Risk of P.c. Introduction	Dieback Hazard								
	Low			Moderate			High		
	Jarrah	Marri	Blackbutt	Jarrah	Marri	Blackbutt	Jarrah	Marri	Blackbutt
Low	80	20	0	60	20	20	20	20	60
Moderate	40	20	40	20	20	60	0	20	80
High	20	20	60	0	20	80	0	20	80

8.5.1.4 Species Mix - Significant Moisture Gaining Sites (e.g., stream crossings, pit sumps, pits with RL at level of adjacent Bullich zone).

Blackbutt - 50%
Bullich - 50%

8.6 Seed Sources for Seedlings

All seed to come from a range of provenances (locations to be approved by C.A.L.M.).

8.7 Fertilizer

Apply 200 grams of Diammonium 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 hectares 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 nutrients 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, comprising about 75% of the mixture, will include the major northern jarrah forest legume species. Jarrah seed is to be applied to all sites. The final mixture will be determined by agreement between Alcoa and the C.A.L.M. District Managers.

It will take into account such factors as seed availability and where the mixture will be used. A large diversity of minor jarrah forest species should make up the balance, including other nitrogen fixing species (Allocasuarina and Macrozamia spp.). Macrozamia seeds to be sown separately and pressed into the soil at a rate of 2 kilograms of seed per hectare.

9.3 Specific species and specific mixes should be applied to particular sites e.g., water logging tolerant species for sumps, wild flower 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. However, use of a low level of D.B. susceptible species (about 10 - 20 seeds) will provide for future dieback monitoring.

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 450 kilograms per hectare of superphosphate.

9.7 Application Rate

Mixed understorey seed will be sown at the rate of 1 - 2 kilograms per hectare with the major legume seed mix no more than 1.0 kilograms per hectare.

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

9.8 Success Criterion

2 native plants established per square metre, 9 months after sowing, as determined by stocked quadrat survey of each pit.

Areas of 0.5 hectares or greater not stocked at this rate to be reseeded the following Autumn. Light scarification and control of insect predation 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 roads low in the landscape 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 including fire protection.

10.3 Unwanted roads will be rehabilitated by:

i) if possible and economical recovery of gravel for reuse elsewhere

ii) blasting of caprock and/or breakup of all compacted material

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 : July, 1989.