"REHAB 83"

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 western 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 of this nature in this field was titled "Rehab 80". It was produced by the Forests Department, 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1.4 Following a period of implementation and further research and analysis, previous prescriptions are to be withdrawn and replaced by this prescription.

Rehab 83 now represents the best current "State of the Art" describing techniques to be used in bauxite mine rehabilitation in the western jarrah forest.

1.5 New techniques (ie. departures from this prescription) may be introduced as research projects, so long as

the location and timing is approved by the Forests Department; and

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

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1.6 The prescription will be reviewed at 12 monthly intervals, at which time new strategies or techniques may be considered for incorporation.

Input for this review will be considered from the various bodies interested or involved in the rehabilitation operation and the review will be co-ordinated by the Forests Department. Any changes to objectives, strategies or operational techniques will be subject to comment and acceptance by the appropriate government authorities, and mining company.

2. THE OBJECTIVE

An objective is a broad statement of what it is expected to achieve within known constraints.

The overall objective for rehabilitation of bauxite mines in the western jarrah forest is:-

"To regenerate 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 eventual 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 Forests Department regional and divisional recreation plans.

2.4 Protection: to conserve the residual soils; to control dieback spread, and to ensure that unacceptable fire hazards do not accumulate.

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

2.6 Conservation: to recreate, in the long-term, floral and faunal characteristics compatible with the jarrah forest.

In seeking to meet goals for the rehabilitation of mined areas, it is important to remember that the desired end-result is a multiple-use forest in which rehabilitated and remnant stands are fully integrated.

3. REHABILITATION STRATEGIES

Strategies are the measures to be adopted in order to achieve the objective. 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 The conduct of research programmes into means of improving rehabilitation procedures.

3.3 The monitoring of the regenerated areas for 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 being achieved.

4. REHABILITATION PLANNING

Rehabilitation planning occurs at two levels:

The first is broadscale regional minesite planning on a 5-year time-scale. The second is the detailed operational annual planning on a pit-by-pit basis.

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4.1 Broadscale Regional Planning

The mining company is required to produce each year an updated 5-year Mining and Management Plan for approval by Government. In the preparation of these plans, the following aspects of rehabilitation are to be considered:-

- The sequence of mining and rehabilitation.
- Access for mining and future management.
- Location of mine facilities.
- Dieback Hygiene
- Landscape considerations
- Water management systems and water course protection.
- Land use priorities.
- Buffer zones for fire protection.

This prescription deals with Mining Operations only within Water Production M.P.A.s and Recreation M.P.A.s.
At this stage no mining is proposed for other M.P.A.s.

4.2 Special Preliminary Planning in Recreation M.P.A.s

Where mining is proposed in areas designated as Recreation M.P.A.s, preliminary survey and site analysis is required. Part of this work is the responsibility of the mining company and part is that of the forest officer-in-charge. However, best results will occur if a team approach is used.

Responsibility of the Company:

(i) Inventory natural and cultural (ie. man-made) landscape attractions and recreational features within the mining envelope. The purpose of the inventory stage is to identify those attractions or features such as water bodies, large rock outcrops, prominent view points, historical sites and existing recreation development which are considered important to the existing or potential recreational use of the area. Such attractions can be classified on the basis of various criteria such as uniqueness and opportunity for relocation elsewhere (in the case of man-made attractions).

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(ii) Record vegetation types which will be cleared as a result of mining and identify any special elements worthy of special protection. Information on vegetation will be used in selecting species mixes for scrub re-seeding following mining.

Responsibility of the Forest Officer:

(i) Assess the mining envelope in terms of its existing and potential significance for recreation at a regional and local level. The assessment should identify the opportunities which exist for land and water-based recreation activities, taking into account both the likely demand for such activities and the capability of the area to service those demands.

(ii) Through reference to regional and divisional land use management plans, determine the areas suitability for post mining recreation development and use (the term suitability refers to capability as modified by other land use requirements and constraints). Proposed recreation development is to be specified in terms of location, type and extent of facilities required.

(iii) Decide on post mining access requirements for recreation development and use of the area and design the mine road network to fit these requirements wherever practicable.

(iv) Examine proposed mining plans with respect to the location, extent and timing of operations in order to identify what impact these operations will have on landscape values and recreational features as determined in the inventory stage. Where practicable, operations will be planned so as to minimise visual impacts on the landscape resulting from mining. In this regard, attention should be paid to considerations such as the size and configuration of mining pods as they relate to the character of the surrounding landscape.

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4.3 Annual Operational Planning

Detailed proposals for each minepit are prepared roughly 12 months in advance of rehabilitation. (Note: when better information on proposed dates of mining for specific areas becomes available, an 18 months lead time should be aimed at).

Each detailed proposal is prepared jointly by Forests Department and mine company staff, and is to deal with the following factors:-

- Pit identity - nominated by F.D.
- Dieback hygiene, drainage, erosion control and water management - specify measures to be adopted from initial drilling through to completed rehabilitation.
- Management of "islands" of unmined forests;
- Species to be used;
- Any special features to be incorporated or retained (e.g. pit walls) as part of the rehabilitated landscape;
- Access, and location of mining facilities/structures.
- Scheduling in sensitive areas.

A conceptual rehabilitation proposal will be prepared for each area, and must be initialled as "Agreed To" by the local Forests Department officer in charge.

Contentious or unusual areas should be referred to the Mining Operations Group. This group contains representatives of the Forests, Mines and Public Works and Agriculture Departments and the Met. Water Authority.

Departures from the agreed conceptual plans are sometimes desirable. This should only happen after detailed field consultation between Forests Department and company staff.

4.4 Special Fire Protection Provision

When rehabilitation is scheduled within the boundaries of

the Jarrahdale or Dwellingup Townsite Protection Plans, refer to these plans for details of tree and shrub species permitted and access required.

5. DIEBACK MANAGEMENT

Because bauxite mining and rehabilitation involves massive soil and vehicular movement under all weather conditions, together with substantial modification to natural drainage patterns in the forest, close attention to dieback hygiene is essential.

The two key management aims are:-

(i) to minimise the spread of infection into diebackfree forests and minesites.

(ii) to manage access and drainage so as not to expand areas which favour the survival and pathogenicity 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 as they arise.

6. PREPARATION OF PITS FOR PLANTING

6.1 When mining is completed, pit walls will be battered and smoothed. In Recreation M.P.A.s, occasional retention of pit walls may be prescribed, subject to an approved plan and attention to the potential safety problems of perched boulders, and long-term stability of the cliff wall.

6.2 Overburden and topsoil will then be evenly respread over all areas to be regenerated. The distribution of this material from pit to pit will be in accordance with the following dieback hygiene requirements:

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(i) no infected material to be carried to diebackfree areas.

(ii) minimise the movement of topsoil

(iii) clean plant and machinery before entry to diebackfree areas where required.

(iv) move soil mainly in dry conditions.

All soil movement must be agreed to by the Forests Department.

6.3 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 the unmined caprock will be "popped" with explosives to provide planting sites and ameliorate run-off. Blasted craters will be graded level prior to respreading overburden and topsoil.

6.4 Throughout the pit preparation work, care must be taken not to import, or bring to the surface, large boulders - i.e., those whose size and density renders the future forest floor untrafficable.

Special measures may be necessary to deal with this problem.

6.5 Ripping

Ripping is required to fracture the compacted pit floor so as to facilitate root penetration and drainage, and to provide an "anchor" for the returned topsoil.

In general: All compacted pit floors will be ripped along the contour.

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Battered banks and pit edges need not be deep ripped, but must be scarified to control erosion and prepare a seed bed.

The distance between parallel riplines is to be determined by the need to ensure a continuous fracture of the compacted subsoil.

Whever possible, ripping should be done when the soil is dry so as to maximise subsoil breakup and minimise compaction of the topsoil and overburden.

In areas where public access is to be encouraged, the ground surface will be levelled during and/or following the deep ripping operation.

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 particular catchment or storage facility involved.

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;
- the system must meet standards of stream turbidity, salinity and biological purity prescribed by the appropriate water supply authority;
- there must be no long term ponds of water lying either within or below pits or roads;
- the need for long term maintenace must be minimal.
- peak flood levels (as prescribed by the water authorities) must not emanate from mined over catchments.

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

7.4 Water Management Systems

Pits can be designed/constructed so as to (i) Retain and infiltrate water, (ii) discharge water or (iii) some conbination of retention and discharge.

7.5 In catchments where water retention and infiltration is prescribed, this 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 mid-slope 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.

Each sump must have the capacity to cope with the runoff from a 10 day 15 year storm event as calculated from meteorological records and mine pit characteristics This design will be based on an accepted hydrological model with an appropriate safety factor of 2.

Where contour interceptor banks are constructed these should be established at up to 10m vertical intervals. Such banks may not exceed 1m in height nor have steep sides which will 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.

Where grade discharge banks are used, these will comprise stabilized waterways which direct water to detention sumps within the pit. Sump and drain locations will be indicated

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on the conceptual rehabilitation plans.

Note: It is recognized that the use of a water retention system may give rise to prolonged pools or saturated zones within or just below pits, and this does not conform with one of the success criteria for water management.

7.6 In catchments where the discharge of water is prescribed, water management will be achieved by:

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

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

Each slow release detention pond or filter system must have the capacity to handle the run-off from a 15 year storm event, as calculated from meteorological records and minepit characteristics. Stable overflow sections are to be provided so that more extreme run-off events will not cause severe erosion or damage.

This requires the installation of adequate grade banks approximately along each 10m vertical contour within each pit, and the construction of a discharge system at the bottom of the pit. This discharge system must adequately filter the water and must be so constructed to avoid saturation or erosion of jarrah forest downslope of the pit.

7.7 Drainage from mine access roads, haul roads or from pits must not flow into unmined jarrah forest, but must be channelled (via ponds or filters) directly into water courses.

7.8 All erosion control earth works must be completed and effective before the first Autumn rains (ie. generally before 30th April each year).

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Standards will be monitored and remedial action specified using an Inspection and Action Checklist (APPENDIX II).

8. PLANTING

8.1 Planting Layout and Design

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

In every mixture, favour species indegneous to the Darling Range and with roughly similar growth rates. Species mixes will be determined in advance and specified in the rehabilitation plan by the Forests Department.

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, some 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 600 planted trees/ha.

8.1.4 Do not plant trees on overflow channels.

8.1.5 Commence planting when the soil is wet to depth after about 10 June. Cease planting by 1 August.

8.1.6 Seedling specifications: plants in jiffy pots or paper pots, approximately 12cm in height with a minimum of 2-4 pairs of leaves. Pots and soil mix sterile. Jiffy pots to be broken open before planting.

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8.2 Before planting commences, all pits will be inspected by the Forests Department. Pits which are deemed by the Forests Department to be inadequately prepared, will not be planted, but carried over for improved preparation and planting the following year.

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

8.4 The forest officer in charge of each area must ensure a detailed record of species planted and treatments given is made at the completion of the job.

8.5 Selection of Tree Species for Planting

Criteria for selection of tree species to be used are:-

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

There are currently 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 arboreta establishment), the following species will be planted:

High in the original landscape (ie. the original jarrah forest uplands, or relatively free-draining sites):-

E. wandoo
E. laeliae
E. accedens
E. resinifera
E. maculata

Low in the original landscape (ie. water-gaining sites):-

E. patens
E. saligna
E. calophylla

Swamps and pit sumps:-

E. patens
E. megacarpa
E. rudis

Other species which may be included as minor components on pit banks and edges where there is a reasonable soil depth:-

E. muellerana
E. microcorys
E. diversicolor

Jarrah (E. marginata) will be sown onto the upland sites at a rate of 0.25kg pure seed per ha. Blackbutt (E. patens) may be sown at a similar rate into the lowlying regions.

8.6 Seed Sources

E. marginata and E. patens seed to come from specifically designated stands and trees. Seed provenances for other tree species to be laid down by Forests Department.

8.7 Fertilizer

Apply 100 gms of Monommonium phosphate per plant at about 3 weeks and again at about 9 weeks after planting.

Fertilizer to be placed within 15cms of 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, as

determined by a 10% systematic sample of rows.

Areas of 0.5ha 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 assist with erosion control and general site rehabilitation. Species to be used will be reviewed for each site each year. Criteria for species selection will be dieback tolerance, appearance and nutritional value.

9.2 Base species to be used will be selected from: Acacia pulchella, A. lateriticola, A. drummondii, Kennedya coccinea and K. prostrata. Where other species are included in the seed mix, Forests Department approval must be obtained.

9.3 Specific species should be added for particular sites - eg. ti-tree and sedges for sumps and swamps, wildflowers such as hovea, kangaroo paws, Hardenbergia etc., for road-sides and recreation sites, and other species endemic to the site if the rehabilitated pit is dieback-free.

Species of low flammability and height growth, or no understorey at all may be prescribed for special fire management zones.

9.4 Species not to be used are non-indigenous species, Proteacaea or large woody and inflammable species such as Albizzia.

9.5 Scrub 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 kg/ha of superphosphate before sowing.

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9.7 Application Rate: mixed seed will be sown at the rate of 1 kg/ha.

Seeding is to be done by ground application and must be completed by 1 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 0.5ha or greater not stocked at this rate to be reseeded the following autumn. Light scarification may be necessary to promote seed germination in areas re-seeded in Year 2.

10 ROADS

10.1 The road network which remains after rehabilitation must conform to a predetermined plan.

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 management.

10.3 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.

10.4 Unwanted roads will be rehabilitated by:-

(i) recovery of gravel for re-use elsewhere
(ii) ripping and erosion control
(iii) seeding and planting in harmony with surrounding forest.

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12. PRESCRIPTION REVIEW

Next date for review of this prescription: May 1983.

R.J. UNDERWOOD
SUPERINTENDENT

11th November, 1982

RJU:DH