1986 WORKING ARRANGEMENT FOR ALCOA'S

BAUXITE MINING OPERATIONS

IN STATE FOREST

ENDORSED

EXECUTIVE DIRECTOR
DEPARTMENT OF CONSERVATION AND
LAND MANAGEMENT

MANAGING DIRECTOR OF ALCOA

REVIEWED NOVEMBER, 1985

N. Capon
G Butcher fyi

for E.P. Library. Could provide useful guidelines for other Companies.
Jr 17/4

23/4.

Frank,

This is the revised Alcoa/CALM Working Arrangements, following Alcoa's comments.

It has a new index, where Part 2 is broken into 2 groups ie.

* Prescriptions

* Summary Studies. ie. programmes still in the developmental stage, such as Post-rehab. management, Hygiene mining.

This latter group has been withdrawn. I am going to re-write them consistent with their developmental status. I don't think Alcoa was prepared to sign these chapters until this was recognized.

What you have are procedures which have been tested operationally, and are agreed to by both parties.

I will forward the re-typed manual to the ED for signing by CALM, and then Alcoa.

Regards,

Drew Haswell

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PART 1

1. Introduction

This booklet is a summary of essential information for control of Alcoa's field operations in State Forest at Jarrahdale, Huntly, Del Park and Wagerup. The booklet has three parts: a brief description of mining; a definition of Alcoa and CALM responsibilities in State forest and the main part, prescription for implementing these responsibilities. The first two parts are likely to remain unchanged unless new mining methods develop or Alcoa enters new agreements with the State. Prescription, on the other hand, should be updated when new research information has been produced and verified.

A co-ordinated approach between Alcoa and CALM is required for updating and implementing prescriptions. This is important so that better use is made of information in both organisations and prescriptions represent mutually agreed, practical, and technically sound working arrangements. Working groups including representatives from alcoa and CALM have been nominated with responsibility for developing (where necessary) and updating prescriptions.

It is not sufficient for prescriptions to contain only technical specifications. For works programming it is important to record requirements such as timing or season when the work must be done and the resources required, men, materials and plant. Responsibility for finance must be shown where not already specified in an agreement.

2. Field Operations in Bauxite Mining

Bauxite mining follows a sequence of exploration, mining and rehabilitation. This includes a number of discrete operations:

* Exploration drilling at a spacing of 120m grid,
* Ore development drilling at spacing of 60m grid,
* Removal of marketable timber,
* Stacking and burning forest residues,
* Removal and stock piling overburden,
* Drilling and blasting caprock,
* Loading and transporting bauxite to crusher,
* Crushing and transport to refinery,
* Rehabilitation of mined pits,
* On-going management of rehabilitated areas.

Bauxite mining is located within jarrah forest that has been treated to improve its resistance, or rehabilitate it from dieback disease.

Within the list of mining operations above, working arrangements or prescriptions are required in every case where forest values are affected, particularly spread of dieback disease. Most of these prescriptions are already operational and require only updating. ~~A new prescription has been developed for the mining operation itself i.e. loading and transporting bauxite to the crusher.~~ Arrangements are in hand for trial hygienic mining in Urbrae Block to develop and test this prescription.

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3. Organizational Responsibilities

3.1 Department of Conservation and Land Management

Under the provisions of the CALM Act 1985 the Department of Conservation and Land Management is charged with the responsibility for management of State forest included in the Alcoa lease area.

In fulfilling this responsibility the CALM aims to ensure that forest resources are managed for maximum long term social and economic benefit. To this end, the CALM has adopted a multiple use management system therein seeking to minimise conflict with other land uses whilst having regard to overall balanced development including economic considerations. Mining is recognised as being compatible with Water Production and is permitted in Recreation, Catchment Protection, Scientific and Timber Production M.P.A.'s. However, mining is not considered compatible in Conservation and Landscape M.P.A.s.

Mining is a transient land use and the CALM is charged with ensuring it takes place with minimum deleterious effects on the forest environment and that rehabilitation is consistent with the land use needs.

3.2 Alcoa

Alcoa's responsibilities in State forest are defined in Alumina Refinery Agreement Acts (Kwinana, Pinjarra, Wagerup) and under the Wagerup ERMP.

3.2.1 Alcoa's Rights and Obligations under Refinery Acts. (Forest requirements only).

* Alcoa may remove overburden and forest produce for its own operations.

* Alcoa will give the Executive Director 6 mths notice of such intentions.

* Executive Director will remove millable timber from areas to be mined.

* Alcoa will dispose of overburden and forest waste so as not to damage adjacent forest.

* Alcoa will leave areas clean and tidy after mining but not necessarily on original contour.

* Alcoa will pay compensation for areas of State forest cleared for mining.

* The District Manager may prohibit use of CALM roads and give Alcoa directions on roads that can be used. This does not apply to roads built by the Company, Main Roads Department, or organizations other than CALM.

* Damage to CALM roads from Alcoa's operations will be repaired at the company's expense.

* Alcoa will restore and reafforest areas destroyed by mining.

* Alcoa will comply with Bushfires Act and take precautions to prevent the spread of fire in its lease area and in adjacent areas, as directed by the District Manager.

3.2.2 Alcoa's Undertakings Under Wagerup ERMP

Although developed as part of the Wagerup ERMP these undertakings are being applied to other minesites ie. Jarrahdale, Del Park and Huntly.

* Alcoa submits mining and management programme which specifies areas for mining and methods for mining and rehabilitation. Five year mining plans are submitted for Jarrahdale and Huntly and Del Park and 10 year mining plans for Willowdale. These are revised annually and form the basis for clearing applications for areas to be mined. Annual clearing applications are checked by District Managers and the mining operation group (see handbook) before approval is recommended to the Executive Director.

* Exploration drilling is subject to stringent dieback hygiene specified by the CALM.

* Rehabilitation proposals are developed to best suit land use and include the following stages:

  Reshaping mined areas to control drainage,

  Return of topsoil,

  Contour or grade ripping,

  Establishing ground vegetation and trees with the aid of fertilizer,

  Controlling drainage and water discharge from pits,

  Providing access for future forest management.

* Alcoa has undertaken to rehabilitate dieback infected forest next to its mining areas.
  Prescriptions have been developed and CALM work programme is funded by Alcoa through FIRS (Forest Improvement and Rehabilitation Scheme).

* Alcoa will dismantle its facilities on termination of mining and will carry out rehabilitation measures.

PART 2

Prescriptions

The table below lists prescriptions which are necessary for Alcoa's operations in State forest. Working groups have been nominated with responsibility for developing (where necessary) and updating these prescriptions. A basis for most of these prescriptions lies in the "mining operations handbook". Many prescriptions have already been developed and in operation for a number of years. These require only updating.

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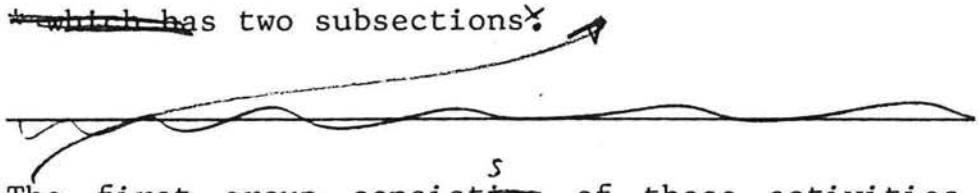
PART 2

Comprises

~~which has~~ two subsections.



The first group consisting of those activities ~~a fairly~~ detailed prescriptions written for t activities are (i) exploration and development (ii) logging clearing and burning, (iii) rehabilitation pits and (iv) FIRS. The second group consist of t vities for which prescriptions are still being Such activities are (i) Dieback Hygiene in mining rehab management of pits. For this latter group uments incorporated in the 'Working arrangement fo Bauxite Mining Operations in State Forest' are t illustrate the latest 'thinking' on the subject ar mary of the 'current procedure' being utilised. goes on in the light of experience and research detailed prescriptions will be able to be agreed to.

1. GROUP 1 PRESCRIPTIONS

Detailed working prescriptions which detail obj strategy, technical specifications, works programme ments in terms of timing and resources and funding.

Title	Objective	Working Group
Exploration and Development Drilling	Ensure dieback hygiene & minimize damage to vegetation	Convenor: D/M Jarrahdale Members: Alcoa Rep. Reg. For. Prot. North For. Mining Dwellingup For. Mining Harvey
Logging, clearing and burning	Ensure dieback hygiene, sale of MFP and proper fire control	Convenor: R/L Ops. North Members: Alcoa Rep. Snr For. Prot. North Snr For. Prot. Central
Dieback hygiene in mining	Develop hygiene mining at Urbrae	Convenor: Alcoa Rep. Members: D/M Dwellingup S/M Dwellingup Research Supt. North
Rehabilitation of mined pits	Update "rehab" prescriptions	Convenor: D/M Dwellingup Members: Alcoa Rep. D/M Jarrahdale D/M Harvey S/M Dwellingup Research Landscape Expert
Post "rehab" management of Pits	specifications for silviculture, access fire control and recreation	Convenor: R/L Planning North Members: Alcoa Rep. R/L Planning Central S/M Dwellingup Research I & P Rep. Snr For. Prot. North Information Branch
FIRS	Update Specifications	Convenor: Insp Admin. North Members: Alcoa Rep. S/M Dwellingup Research D/M Dwellingup D/M Harvey D/M Jarrahdale

Prescriptions should include:

- Objective
- Strategy
- Technical specifications
- Works Programme Requirement
  - Timing
  - Resources

Funding

2. ← GROUP 2 SUMMARY OF STATUS

Details that are given for activities in this group consist of information on:

1. latest 'thinking' on the subject

2. Current procedures being used.

Title	Objective	Working Group.
Dieback ~~[illegible]~~ management and monitoring programme	Test dieback management procedures.	Convenor Alcoa Rep. R/C Planning, North. S/O Dwellingup Research ISAT, Kelmscott D/O Dwellingup Alcoa Reps
Test rehab — management programmes.	Specifications for silvicultural areas, protection & recreation.	Convenor: R/C Planning (North) Members: Alcoa Rep. R/C Planning (Central) S/O Dwellingup Research ISAT, Kelmscott Sen. For. Prot. North Info. Branch.

EXPLORATION AND DEVELOPMENT OF BAUXITE

1.0 THE ORE DEVELOPMENT PROCESS

The general sequence of ore development in an area is as follows:

1. Geological mapping and aerial photography interpretation to delineate prospective areas.

2. Broad-spaced exploration drilling of lateritic areas. Drill holes located off local bench marks are surveyed in drill grids ranging from 60m to 240m.

3. Geological mapping of caprock grade and textures based on a surveyed 60m x 60m grid. This determines targets within potential ore zones for close-spaced control drilling.

4. Close-spaced drilling to provie proven ore reserves. This delineates lateral and vertical limits of the ore body, and provides information for grade control in the mining process.

2.0 PLANNING FOR DRILLING OPERATIONS

2.1 Five Year Drilling Plan:

Each July Alcoa will submit a 5 year drilling plant (1:25000 scale) to the local office of the Department of Conservation and Land Management.

This plan should show the broad direction of drilling over each of the ensuring 5 years. This will assist in the co-ordination of drilling and associated operations with other forest activities, particularly F.I.R.S. and prescribed burning. Without such a plan there may be:

- destruction of dieback symptoms and the creation of false symptoms resulting in greater difficulty in disease interpretation.

- exposure of the soil (by burning) causes hygiene difficulties under moist soil conditions.

- disturbance of pegs which have been accurately surveyed.

In addition, this plan permits commencement of CALM hygiene planning well in advance of the operations.

2.2 Annual Drilling Plans

By the first week of July each year Alcoa will submit proposals for the next 12 months drilling operations to the local office of CALM. These should include:

(i) Broadscale plans showing areas and type of drilling at 1:25,000 scale.

(ii) A programme indicating Alcoa's priority for operations.

(iii) Forest Officers will examine the dieback status and other forest values of the proposed drilling areas. From these considerations a hygiene strategy will be developed (Guidelines in section 3.2).

All dieback forest will be preferentially scheduled for moist soil operations.

The remaining area of forest programmed for drilling will be scheduled for dry and moist soil operations. The general priority for dry soil conditions will be:

ONE: Drilling areas within large continuous areas of dieback-free forest.

- where, due to soil conditions, maintaining clean vehicles under moist soil conditions will be difficult.

- forest types which are likely to suffer high impact if infected with Phytophthora.

TWO: Forest types which are likely to suffer low impact if infected with Phytophthora.

- Small areas of dieback-free forest which are likely to be vulnerable to the natural spread of the disease.

It is recognised that some areas of dieback-free forest will have to be scheduled for moist soil operation subject to the appropriate hygiene (section 4).

(iv) The programme for drilling operations is resolved from an amalgamation of Alcoa's priorities and the hygiene strategy. This will be returned to Alcoa within 2 weeks of the arrival of the programme if a five year drilling plan is available and four weeks if not.

2.3 Changes and additions to drilling operations are possible through-out the year, provided adequate notice for dieback demarcation is given.

3.0 SCHEDULE OF OPERATIONS

3.1 Dieback Interpretation and Demarcation is a CALM responsibility and should occur in advance of all field operations to ensure that hygiene conditions are consistently applied to those operations.

3.2 Dieback Location Maps (1:25,000) and hygiene conditions (including access) should be forwarded to the minesite geologist for areas of operation in the ensuing drill season. Early notification is assisted by 5 year drilling plans.

3.3 Dieback Mapping and Hygiene Conditions: Prior to drilling two copies of the layout will be sent to the local office of CALM. Officers there will mark the dieback management lines, access routes and points for vehicle clean down on the layout and forward one copy to the appropriate Alcoa personnel.

3.4 Notification: Survey crew and drill rig locations are to be available at all times from the minesite security office.

4.0 ENVIRONMENTAL CONTROLS:

4.1 Dieback Hygiene:

(i) Objective:

To carry out field operations in such a manner that the risk of spreading dieback disease into dieback-free forest is minimised.

(ii) Hygiene Strategy:

Dieback Categories

Areas of forest in which field operations are to take place will be categories into:

Dieback
Suspect
Dieback-free

In the forest these categories will be separated by Management Lines of yellow painted blazes on trees and will be demarcated by Forest Officers. Old management lines will be painted over.

Access

Access to each category will be designated and checked by Forest Officer.

Field Operations will be confined separately to each category. Transfer from one category to another requires specific hygiene conditions.

Cleanliness

Vehicle and plant cleanliness is the basis for controlling dieback spread in the field operation. This can be achieved by:

Washdown with fungicide - treated water from a high pressure/low volume pump.

Airhose to either suck or blow by use of vacuum pump or compressor.

Brushing down.

Exploration and Ore Development Operations will be permitted in:

Dieback forest under all seasonal conditions.

Suspect and Dieback-free forest only under dry soil conditions. In the event of dry season rainfall, operations may continue provided soil is not picked up by vehicles; however, support vehicles must be left outside the dieback-free boundary.

Grade Control Operations (drilling, surveying/mapping) will be permitted in:

- Dieback forest under all conditions.

- Suspect and Dieback-free forest under dry soil conditions with normal field hygiene; and during moist soil conditions with the following limitations:

  - conventional support vehicles remain outside the dieback-free boundary or on nominated hard surfaced roads.

  - drill rigs do not pick up and transfer soil while operating in the drill area or travelling on access roads.

(iii) Field Hygiene

Dieback-Free Forest

- Every vehicle is to be inspected prior to entry into the area to ensure that no soil has been picked up in transit. A cleandown is required at the dieback boundary or nominated cleandown point, if the vehicle is not clean.

- Each vehicle traversing an area must be continually checked to ensure that soil is not being picked up. If soil conditions deteriorate the operation must transfer to dieback forest via an approved access road.

- After drilling each hole and prior to departure for the next hole, the drill rig must be inspected for cleanliness. If the rig is not clean of soil, cleandown is required.

- Cleandown must take place at least once per day as a safety measure.

Suspect Forest

- Conditions applying to field operations in suspect forest will be the same as those for dieback-free forest.

- Prior to leaving suspect forest and entering dieback-free forest, vehicles are to be free of soil.

Dieback Forest

- Cleandown between holes is not necessary.

- Do not cross moist low-lying flats or creeks.

- Prior to leaving dieback forest, vehicles are to be free of soil.

(iv) General

Training

Vehicle operators must be trained in hygiene principals, techniques of inspection for vehicle cleanliness and vehicle cleandown.

Prior to departure from the base depot all vehicles must be in a clean condition.

4.2 Rubbish

No refuse is to be left behind after any field operation.

4.3 Forest Disturbance

All field operations must minimise damage and disturbance to forest vegetation.

5.0 REVIEW

Prescription to be reviewed July 1986.

LOGGING, CLEARING AND BURNING OF MINESITES

1.0 Sequence of Events

1.1 Five year mining plan Northern Forest Region (10 year Willowdale) revised annually by Alcoa and available to Executive Director September - October.

1.2 Inspection and consideration by Districts, and M.O.G. Comments and recommendations from Executive Director to M.M.P. Group.
Note: CALM is represented on the M.M.P. Group.

1.3 The above plans are submitted to the Minister for approval about December.

1.4 Alcoa submits two year clearing plan in March. Six months notice is required but under agreement this is extended to two years to facilitate proper planning and implementation of dieback hygiene.

1.5 The two year clearing plan is assessed by Districts and M.O.G. and Region recommends to Executive Director.
(See Appendix 1.5)

1.6 Executive Director approves two year clearing plan about June.

1.7 In July Alcoa submits to Districts a clearing schedule for next twelve months.

1.8 Agreed proposals are surveyed and demarcated in the field by Alcoa.

1.9 Districts check area for dieback and demarcate categories in the field. A dieback plan is given to Alcoa.

1.10 Districts arrange salvage of sawlogs and minor forest produce.

1.11 Alcoa heaps and burns unsaleable debris.

1.12 The area is ready for mining.

2.0 Objectives

To carry out the sequence of events with maximum efficency having due regard for:

2.1 Timber salvage and clearing being confined to areas which are to be mined.

2.2 Minimising the spread of dieback disease into dieback free forest.

2.3 Minimising fire damage to surrounding forest.

3.0 Hygiene Strategy

3.1 CALM will categorise all forest either dieback, uninterpretable, dieback-free including secure Dieback free. Each of the categories will be indicated in the field and on 1:10,000 scale plans given to Alcoa. In the rare cases where uninterpretable dieback occurs, special local arrangements should be made for marking as it should be regarded as dieback-free for entry of vehicles but dieback for exit.

3.2 Field operations will be confined to a single disease category. Transfer from one to another requires specific hygiene conditions.

3.3 Access will be defined in advance by CALM as shown on plan 3.1

3.4 In field operations the strategy to prevent infected soil movement into uninterpretable or dieback-free forest is based on vehicle and plant cleanliness. It can be achieved by:

- Wash-down using a high pressure low volume pump.
- Airhose to either suck or blow by use of vacuum pump or compressor. (dry soil)
- Brushing down. (dry soil)

3.5 Soil Conditions

(i) Dry Soil

Timber salvage, clearing and burning will be possible in all dieback categories during dry soil conditions when the probability of spread is lowest.

All plant must be clean on entry to "uninterpretable" or "dieback-free" areas and on leaving dieback or uninterpretable to travel through dieback-free forest.

(ii) Wet Soil

Similar operations in "dieback" are permitted providing plant is cleaned down before leaving. In "uninterpretable" and "dieback-free" operations should be avoided if possible but are permitted providing plant is clean on entry but support vehicles must remain outside the disease category boundary or enter on nominated hard surface roads.

(iii) Hygiene requirements above apply equally to all operations by all parties involved in timber salvage and clearing of mine-sites.

4.0 Planning for Timber Salvage and Clearing

4.1 The sequence of planning and operational events are 1.0 - 1.12.

4.2 1:10,000 scale plans are used at all stages.

4.3 Changes to the plan are possible provided adequate notice is given to allow for dieback demarcation, timber salvage, clearing and burning.

5.0 Field Operations

5.1 General hygiene requirements

(i) Training - Vehicles and plant operators must be trained in the techniques of inspection for vehicle cleanliness, cleandown and hygiene principles.

CALM will train Alcoa staff when required, Alcoa staff will train their own operators.

(ii) Prior to departure from the base depot all vehicles must be in clean condition.

(iii) Access is to be confined to routes approved by CALM. This is important during wet and moist soil conditions.

(iv) Dieback-free Forest

Prior to entry into the above, every vehicle is to be inspected by the operator to ensure no soil has been picked up in transit. Such inspection should be monitored from time to time by both Alcoa and CALM staff. Cleandown is required at the dieback boundary or nonimated cleandown point if the vehicle is not clean.

(v) Uninterpretable Forest

As for "dieback-free Forest" except prior to leaving uninterpretable forest, vehicles and plant are to be free of soil.

(vi) Dieback Forest

Prior to leaving dieback forest, vehicles are to be free of soil.

5.2 Clearing Boundary Definition

(i) Boundaries of proposed clearing area are marked in the field by Alcoa using yellow plastic tape attached to trees or stumps.

(ii) Following inspection and approval of proposed clearing boundaries by local CALM staff, Alcoa overmarks the yellow plastic tape with white paint prior to the commencement of clearing operations.

(iii) When necessary, Alcoa will prepare site drainage plans for approval by M.O.G. prior to commencement of clearing.

5.3 Dieback/Dieback-free Forest Boundary Definition

(i) The CALM will reinspect dieback boundaries established for surveying and drilling operations prior to commencement of clearing operations.

(ii) Dieback boundaries are established by means of yellow painted blazes on trees along the boundary. The yellow blazes face into the dieback infected forest and act as a warning to all machine operators that should they pass through the line they may infect dieback-free forest.

(iii) Dieback boundary markings removed during timber salvage will be replaced by CALM. Any removed during clearing will be replaced by Alcoa using yellow painted pegs. Within the pit they will also use yellow painted pegs. If there is doubt re which side is dieback Alcoa will overpaint these pegs as per 'traffic lights'.

(iv) In a largely dieback area secure dieback free areas will be separated for hygiene.

5.4 Forest Produce Removal

(i) Salvage of merchantable timber on S.F. is performed by licensed private contractors under the direction of CALM.

(ii) Identical hygiene conditions apply to timber removal operations as these described for clearing operations 3.1 to 3.5.

(iii) CALM is responsible for ensuring that operators are cleaned down when required.

(iv) CALM is responsible for clear definition of dieback boundaries during the forest produce removal phase.

5.5 Clearing Methods

(i) A forest officer will inspect each clearing area prior to the commencement of clearing operations to ensure all merchantable timber has been removed.

(ii) Any non-merchantable timber remaining within the cleared areas is pushed by bulldozer, heaped and burnt by Alcoa. CALM will direct Alcoa concerning fire protection requirements.

(iii) Concurrent with bulldozing operations cleared areas are raked to remove large surface rocks and tree roots. Depending upon quantity of rocks the raked material may be heaped and burnt or separately removed by loader and truck to a site approved by CALM using approved access.

(iv) The dieback boundary definition is to be maintained by Alcoa during clearing operations.

(v) All clearing machinery coming on site ie. entering State Forest, must be cleaned and this will be monitored by Alcoa and CALM.

(vi) Any machine which is to clear dieback-free forest must be clean upon entry. Low loaders are to use CALM nominated access and to be clean on entry to dieback-free roads and forest.

(vii) Where an approved mining area contains dieback and dieback-free forest the dieback-free forest should be cleared first.

(viii) Drainage and runoff from washdown points is to be provided to the satisfaction of CALM.

Temporary drainage control is to be established during clearing on all slopes eg. a strip at the bottom is cleared first and a small windrow of overburden built up to prevent run-off from the cleared area.

Runoff from dieback infected sections of an area to be cleared must be contained and not allowed to enter the dieback-free sections.

5.6 Burning Debris

(i) The burning operations must comply with the provisions of the Bushfires Act 1954 and are subject to a permit issued by the Shire.

(ii) On State Forest CALM is responsible for prescribing the conditions, and retaining power of veto. On private property the same conditions apply as on any other private property burning. The local CALM office must be advised on the day of the burn.

(iii) All burning is banned during the prohibited period as prescribed by the Bushfires Act 1954. eg. Normally December 15 until March 15, CALM will arrange necessary extensions where burning cannot be completed during the prescribed period.

(iv) Heaps are to be located so that retained surrounding forest is not damaged when the heaps are burnt.

(v) Heaps may be burnt at any time during the unrestricted burning period.

(vi) Hygiene during pushing up of burning heaps is to be as outlined above for the clearing operations.

APPENDIX TO PARAGRAPH 1.5

Areas of no ore or marginal ore will be identified by Alcoa at the time of submission of the two year mining plan.

At that time, areas for which there is no predetermined mining operational requirement (access, overburden storage etc) and which will not be cleared, will also be identified. Those areas of non ore or marginal ore within the clearing boundary, for which there is an operational need for clearing, will be discussed between the CALM District Manager and Alcoa representative. The justification for clearing will be demonstrated and the appropriate management strategy agreed upon as a joint submission to the M.O.G.

In the event of disagreement between the District Manager and Alcoa the specific issue will be referred back to the prescription Working Group.

When considering the retention or clearing of small unmined islands or long unmined salients of natural forest the following should be born in mind:

1. Advantages

1.1 Tall trees attract a range of birdlife not found in regrowth.

1.2 Recruitment for small animals and plants. Seed sown in rehab. has limited range.

1.3 Hollow trees and logs for shelter.

Note: Value increases with distance from natural forest. Areas less than 1 ha may be of limited value.

1.4 Avoids waste of natural forest and growth below utilisable size. The quality of forest concerned is an important consideration.

2. Disadvantages

2.1 Management problems ÷ protection, treatment, harvesting.

2.2 Islands less than 1 ha may be of limited ecological value.

2.3 Cost of battering perimeter is high and it is waste area.

2.4 High points in high places attract lightning (Bureau of Meteorology). Islands should ideally be burned frequently but this is a risk in itself and high hazards may accumulate.

2.5 Risk of dieback infection is increased within a mine pit due to the activity.

2.6 Cleared unmined islands or salients are useful areas for depositing overburden and topsoil. If possible have future areas available. Both parties prefer cleared unmined perimeter intrusions.

2.7 Shape is critical. For minimum perimeter a perfect circle gives greatest area.

Checklist for Decision Making

Area (ha)
Shape - perimeter for area gained.
Batter - will bare ground be excessive for area gained?
Quality of forest.
Value for overburden etc. - alternative haul distance.
Ecological value - consider distance from natural forest and inherent value of island vegetation.
Dieback - it is infected or likely to be?
Lightning risk - prominance in landscape.

"REHAB 86"

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 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" doucment 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.

I.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
- acess 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. Occasionaly 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 ripplines 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. These general aims may be modified to meet particular objectives over limited areas. Fire buffers will require lower fuel accummulation rates and species of low height and/or suitability for control burning. Recreation sites or town surrounds may require understorey consisting only of low herb, agricultural pasture, or wildflower species. Swamps and drains will require species tolerant of water logging.

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. prostata. These species will 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 Particular species or mixtures to be applied to particular sites are:

- fire buffer zones : all species likely to form a persistent tall (1 to 3m) shrub layer will be excluded.

Prostrate, low growing (< 0.75m) or understorey tree form species will be included. The major components of the mix will include Kennedia prostrata, Acacia lateriticola, A. drummondii (low species, 0.5kg/ha) and A. melanoxylon, A. elata, A decurrens, A. saligna (tree acacias to give final population of approximately 400 stems /ha). A large diversity of small stature, slow growing or understorey tree (Allocasuarina fraserana) jarrah forest species should make up the balance (0.5kg/ha) of the seed mix.

- Town influence or recreation zones : understorey for these zones may simply be enriched in wildflower species. If also required for reduced fuel or fire risk and suitability for low intensity spring control burning, then agricultural pasture may be prescribed as a ground layer. Pasture establishment will require some modification to other practices as follows :-

(i) the rapid ground covering capacity of pasture will allow a smoother surface finish which could be achieved by grading or cultivation after ripping.

(ii) pasture seed planting should be carried out dry (before opening rains) in late March or early April. It need only consist of the annual Trifolium subterranean (clover) varieties Karridale (50%) and Woogenellup (50%). Seed must be innoculated and lime pelletted just prior to sowing and sown at 40 kg/ha. Only high purity Government tested seed should be used. It can be broadcast by fertilizer spreader mixed evenly with 500 kg/ha plain superphosphate.

If planting is delayed until after opening rains it should be sown with a disc drill to 15mm depth with the same fertilizer application.

(iii) tree seedlings will need to be planted after herbicide application (Roundup 1 : 40) to each planting station. This should aim to remove clover competition from an area of $1m^2$ around each seedling. Tree planting should occur in June after the soil is well wetted.

(iv) tree species should include 30% tree acacia component (i.e. A. melanoxylon, A. elata, A. decurrens) to provide for long-term nitrogen input to the system. Tree planting density can be reduced to favour persistence of the clover cover (e.g. Parkland formation)..

(v) pastured areas should have the normal fertilizer regime in addition to that applied with the pasture seed i.e. tree seedling fertilization and aerial broadcast superphosphate No 1 mix should be carried out at the standard times.

- sumps and drains : the minor component of the seed mix shall include jarrah forest species considered to be tolerant of water logging.

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

FOREST IMPROVEMENT AND REHABILITATION SCHEME (FIRS)

PRESCRIPTION 86

1. INTRODUCTION

In the Wagerup ERMP Alcoa gave a commitment to finance the rehabilitation of dieback affected State Forests adjoining bauxite mines. This led to the initiation of the Forest Improvement and Rehabilitation Scheme (FIRS) in 1978.

The scheme is funded by Alcoa. Work is prescribed and implemented by the Department of Conservation and Land Management.

FIRS work is breaking new ground in the integration of site, land use and disease variables. Each annual prescription is therefore regarded as interim.

This prescription sets out objectives and guidelines for FIRS based on the best information available in February 1985.

2. OBJECTIVES

The Forest Improvement and Rehabilitation Scheme is applied to unmined forest within the bauxite mining envelope. The objectives are:-

. To treat the forest so as to render it less susceptible to dieback disease impact.

. To rehabilitate forest in which the overstorey has been extensively destroyed by disease.

. To prevent erosion which contributed to stream turbidity.

. To apply improvement treatment, such as thinning, to healthy unmined forest.

The overall objective of FIRS is to maintain or improve the capacity of the unmined forest to produce water, timber, recreation, conservation and/or other forest values. Emphasis will vary according to the management priority for each area.

3. TREATMENT SELECTION

. There are four basic F.I.R.S. treatments:-

. Stream Zone Protection.

. Dieback Protection via Understorey Manipulation.

. Rehabilitation of Dieback Graveyards.

. Improvement Treatment of Healthy Forest.

When planning the F.I.R.S. treatment for a particular compartment of forest the stream zones are selected first. The remainder of the unmined forest is to be given either the Dieback Protection treatment, (2), or the Graveyard Rehabilitation treatment, (3), or a variation of these two treatments. Improvement treatments of Healthy Forest, (4), are to be applied after mining and rehabilitation to some of the protected areas.

The choice between the Dieback Protection and the Graveyard Rehabilitation treatments depends on current dieback impact and on the likely consequences of treatment on dieback impact. Four situations are described below to illustrate how the choice might be made:-

. The most simple situation is where the forest is dieback free with a dense population of B.grandis, and where infection from mining is likely. The Dieback Protection treatment, (2), is then applied.

. The other simple situation is where the dieback impact is very high, with well over half the jarrah overstorey killed by dieback. The Graveyard Rehabilitation treatment, (3), is then applied.

. Where disease impact is low (understorey only affected) the Dieback Protection treatment, (2), should be chosen but will need to be modified to suit the situation.

. Where the overstorey is affected by dieback, but not more than half of it has been killed there is a risk that applying the Graveyard Rehabilitation treatment will further increase the disease impact. A conservative combination of the Dieback Protection and Graveyard Rehabilitation treatments is recommended. B.grandis numbers should be reduced, if applicable, and then understorey seed and seed of resistant eucalypts introduced. The disturbance to soil and to existing vegetation should be minimal.

The process of choosing the appropriate treatment is depicted in figure 1. A treatment where little or nothing is done may be most appropriate in some areas where the disease is flourishing.

4. IMPLEMENTATION

Annual FIRS works programmes will be drawn up each year in accordance with approved mining plans and available finance. The "FIRS Year" is regarded as running from the end of one planting season to the end of the next. Each annual plan will be subject to endorsement by Alcoa.

As soon as the areas to be treated are defined, each DFO must ensure that:-

. The appropriate prescription is chosen or written.

. A detailed plan of proposals is prepared.

. A works programme covering manpower, machinery and season is drawn up and priorities assigned.

. Staff responsibilities are made clear.

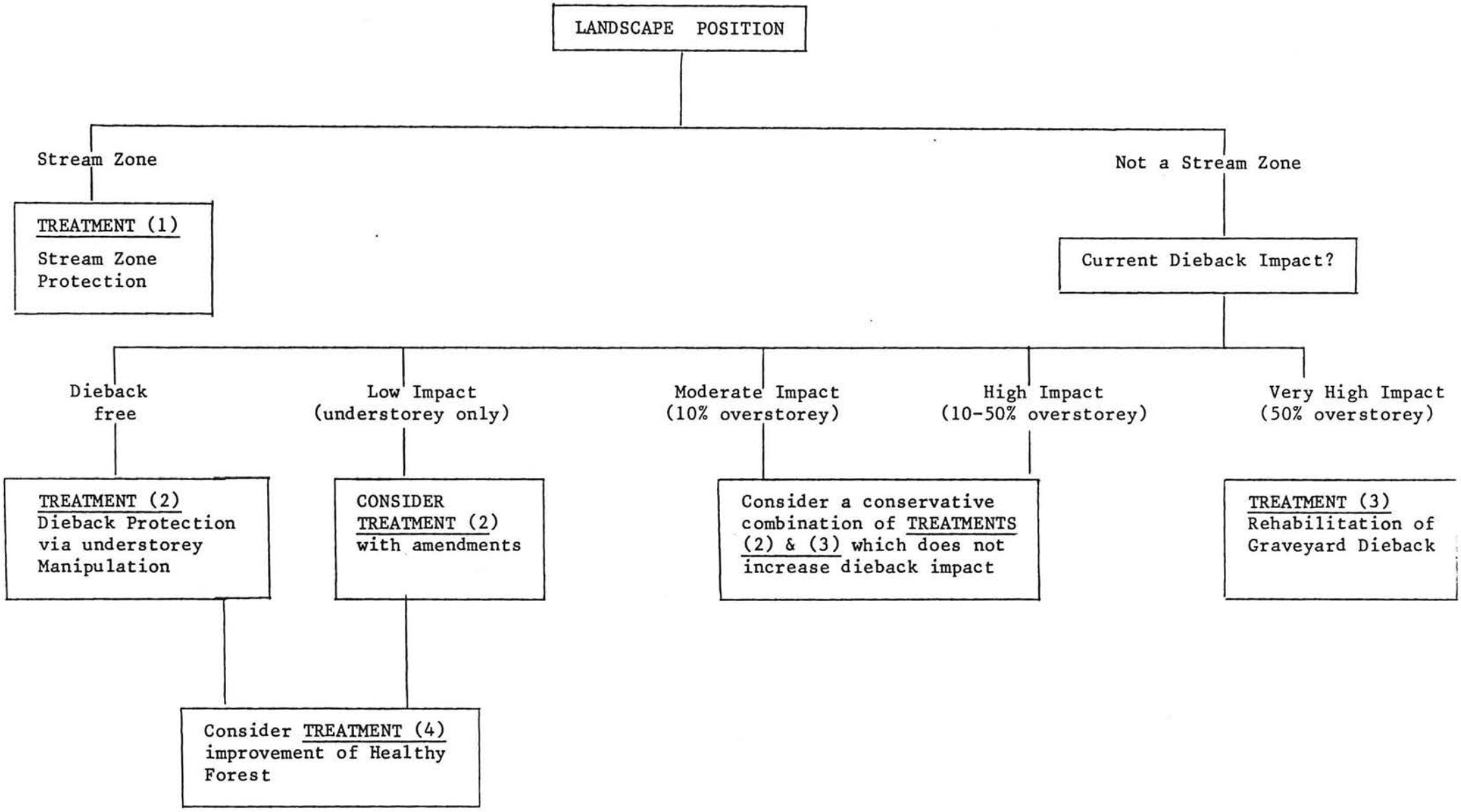


FIGURE 1: Selecting the appropriate FIRS treatment.

The following priorities apply:-

. Carry-over areas from previous year.

. Banksia control, autumn burn and drainage improvements in DB Free or lightly affected stands.

. Rehabilitation of advanced dieback in pipehead catchments.

The Regional Leader will review progress monthly through the year in each Division to ensure that programmes are completed according to prescription and budgets not overspent.

The Regional Leader will prepare a report for Alcoa at the completion of each financial year which will describe: areas treated, costs and treatments used.

Completed work is to be recorded on the HOCS (1:10,000. - system C). The amended plans and Register are to be forwarded to Inventory and Planning in June each year.

Divisional staff will maintain fortnightly records of costs and works progress and forward these to the R/L at Como.

A joint Alcoa/CALM inspection of works programmes will be made each quarter and written comments exchanged.

5. REVIEW AND CONTROL

This prescription will be reviewed in July each year and updated as necessary, on the basis of:-

. changes in emphasis.

. new research findings.

. the need to correct inadequacies in the existing prescription.

6. FIRS PRESCRIPTIONS

Treatment (1) - Stream Zone Protection

Stream Zones are to be selected so as to prevent turbid water from roads and bauxite pits entering streams. They need to be more extensive and secure in harnessed catchments than elsewhere.

Gravel pits, roads, earth dumps etc., which may contribute to stream turbidity should be treated to prevent erosion. Treatment may include closure or relocation if appropriate, earthworks if necessary, and stabilizing soil with vegetation.

The existing vegetation in the stream zone should be protected so that it can filter sediment. If adjacent treatment areas are to be burnt it may be necessary to protect the stream zone by either a burnt edge or a fuel reduction burn in cool conditions. Machine graded firelines are to be avoided if possible.

Where necessary, and particularly in catchment areas, bare areas within stream zones may be seeded with understorey to enhance their ability to filter out sediment.

Where there is a recreation facility within or adjacent to a stream zone it may be necessary to:-

. fall dead or dangerous overhanging trees.

. control erosion from car parks and access roads.

. do limited hazard reduction burning to prevent a dangerous hazard adjacent to picnic areas.

Record treatments on FIRS Register.

Treatment (2) Dieback Protection via Understorey Manipulation

Dieback research has shown that Banksia grandis is highly susceptible to Phytophthora cinnamomi as it is a host tissue from which the dieback fungus can readily sporulate and spread. Dieback research has also indicated that a legume understorey should disfavour the survival and spread of P.cinnamomi. The aim of the treatment, therefore, is to reduce the population of B.grandis and increase the density of legumes in the understorey, thus tipping the balance in favour of the forest rather than the fungus. It is recognized that there are other factors, such as a highly susceptible site or increased drainage from roads and pits, which increase the likelihood of severe disease expression. However, B.grandis will be replaced by legumes unless it is clear that these other factors over-ride the likely benefits from the FIRS treatment.

B.grandis populations are to be reduced using a combination of machines, herbicide and fire. Once populations are reduced by FIRS they should be kept low by a suitable prescribed burning regime before regrowth reaches 4 cm DBHOB. To date tractors, chainsaws and herbidice have been used to kill the larger B.grandis, with coppice and smaller B.grandis being killed by burning the dead tops. This method, strategy A, will continue to be used. Another method, strategy B, is to use fire first and then follow up with manual methods to kill survivors. When perfected it should be cheaper than Strategy A and therefore preferable. Strategy B can only be used where fuels (12-14 tonnes per hectare) are sufficient and will be experimental at this stage. A prescription is provided for both strategies.

To be most effective the Dieback Protection Treatment should be done in advance of mining. The priority areas for treatment are those to be mined several years hence and these should be done before the backlog is tackled in any years FIRS programme. For instance, in the summer 1985/86 treatment should first be applied to those areas where mining will commence in 1989, then those that will be mined in 1988, 1987 etc. The following summer areas to be mined in 1990 are to be done first, then tackle the backlog.

Two manual methods of killing mature B.grandis have proven to be successful. Stems which are uprooted with a tractor rarely survive, and in dense stands this method is cost effective. Cutting B.grandis stems off near to ground level also successfully removes the dominant B.grandis trees, though with this method the smaller stems frequently coppice. Following either push-down or cutting of stems 2m tall the tops are burnt in dry soil conditions to kill small plants, coppice and new seedlings. Any subsequent vigorous coppice, particularly from small cut stems, can be controlled by poisoning with herbicide. The choice between tractors or cutting for the initial knockdown will depend on cost and the risks of spreading dieback.

The aim of this treatment is not eliminate B.grandis. This would be expensive even if it were desirable. The aim is to kill mature B.grandis and vigorous coppice and thereby reduce the likelihood of dieback spread and impact.

The burns prescribed in either strategy A or B will regenerate legumes if seed is present. As a guideline presume legume seed to be deficient unless there is at least one plant every 20m of Acacia pulchella, A.europhylla, A.lateriticola or Bossiae aquifolium. If legume seed is not present it can be added after the burn. The following is a guide to species which should be added to different sites, though it is probably best to have a basic mixture of local legumes and to add the following in greater proportions for the specific sites.

SITE	SPECIES
Moisture gaining	Acacia extensa, A.alata
Havel T & Q	A. europhylla, Bossiaea aquifolium, Kennedia coccineae
Havel P & S	A.pulchella, A.lateriticola

Burning under dry soil conditions should also increase the kill of B.grandis lignotubers and coppice.

Jarrah regeneration should be encouraged in areas poorly stocked with future crop trees. Burning is to conincide with seed fall if possible, and if not jarrah seed added after the burn. If pushdown of the B.grandis can be used it will increase the number of disturbed sites for seed germination. Legume seeding is to be held back for several years until jarrah is established.

Detailed prescriptions follow for the two strategies:-

Strategy A: Manual kill of Banksia, follow-up Burn

Select a coupe which will receive a uniform treatment and will be burnt as one unit. This coupe becomes the basis for recording treatments, as they are done, using the HOCS (1:10,000 scale-system C). Both the HOCS plans and the FIRS Register are to be forwarded to Inventory and Planning in June each year for update of their records.

Identify and mark on a 1:10,000 scale compartment plan:-

. dieback categories

. areas where B.grandis population is to be reduced.

. sites highly susceptible to dieback introduction and/or impact.

. areas deficient in legume seed.

. areas deficient in jarrah lignotubers.

Plan dieback hygiene.

Are monitoring plots to be established? If yes, establish them and mark their location on the HOCS plan. Procedures for plot establishment will be provided separately.

Ensure adjacent areas are sufficiently prepared for the type of burns planned.

Carry out erosion control works as required and close unwanted roads. Avoid draining water into dieback free or lightly affected forest.

Using a rubber tired machine or chainsaw push or cut down all B.grandis more than 2m tall.

(*) Burn at least one year after the above when Banksia cones are dry and seeds have germinated. Burn in summer - autumn using the following guidelines.

- . Fire Danger Index (FDI) 30-35.
- . Tower Winds 10-20 kph.
- . Soil dryness index/200+.
- . Surface moisture content 10-12%.
- . Ignite about 1 hour after the peak of the day.
- . Light fires sufficient distance apart so that they meet towards dusk.
- . Record the following details about the burn on the FIRS Register: Date of burn, SMC, RH%, FDI, SDI, time of ignition, winds and temperature during the burn, Rate of Spread.

(**). After the first winter rains apply legume seed if necessary at 0.25kg/ha. If there are insufficient jarrah lignotubers delay legume seeding for several winters and ensure jarrah seedling establishment either from seed in the overstorey or seed applied. Seeding of either legumes or jarrah to be done by hand with a preference for disturbed sites and ashbeds.

- . Remeasure monitoring plots if necessary.
- . During late spring-summer following the burn poison vigorous coppice from cut stumps or lignotubers if necessary. Do not poison weak coppice except in high risk areas where complete B.grandis control is desirable.
- . Final measurement of monitoring plots to determine the effectiveness of treatment should be done at least 18 months after the burn and 12 months after seeding or poisoning.
- . Subsequent prescribed burning should aim to maintain the treatment by killing B.grandis regeneration before it reaches 4cm DBHOB. Exact prescription is not possible yet as no subsequent burns have been done, but the burn should:-
  - reduce fuel.
  - kill B.grandis regeneration to ground level.
  - regenerate legumes.
- . Records of all stages of the treatment are to be kept using the FIRS Register.

Strategy B: Banksia Reduction Burn, Follow-up kill by Manual Methods

Select a coupe which will receive a uniform treatment and will be burnt as one unit. This coupe becomes the basis for recording treatments, as they are done, using the HOCS (1:10,000 scale system C). Both the HOCS plans and the FIRS Register are to be forwarded to Inventory and Planning in June each year for update of their records.

Identify and mark on a 1:10,000 scale compartment plan:-

. dieback categories.

. areas where B.grandis population is to be reduced.

. sites highly susceptible to dieback introduction and/or sites impact.

. areas deficient in legume seed.

. areas deficient in jarrah lignotubers.

Plan dieback hygiene.

Are monitoring plots to be established? If yes, establish them and mark their location on the HOCS plan. Procedures for plot establishment will be provided separately.

As this strategy requires the accumulation of fuels beyond a level which would normally be permitted aswell as involving burning under dry conditions special attention must be paid to protection planning when selecting areas for this treatment and in the lead-up to the burn. Initially the prescription is to be applied to small (<50ha)well protected areas.

Carry out erosion control works as required and close unwanted roads. Avoid draining water onto dieback free or lightly affect forest.

Crop trees within the burn area are to be protected by removing any dead logs that will ignite during the burn to least one metre from the crop tree.

Burn in summer-autumn using the following guidelines:-

. Soil Dryness Index 1200+.

. Fuel and water conditions at the peak of the day:

- minimum SMC = 8%
- minimum PMC = 9-10%
- maximum temp. = 28-30%
- minimum RH = 35%
- FDI (jarrah) = 47-52

. Ignite approximately 1½-2hrs before sunset ie. 1-2hours after the peak of the day. Fuel and weather conditions at ignition time:

- temperature fallen by 1.5-2°/hr since peak of day ie 25°C and falling.
- relative humidity risen by 7%/hr since peak of day ie. 50% and rising.
- SMC and PMC 9-10% and rising.
- 15-20kph and steady. Not> 20kph.
- FDI 46 and falling.

. Spacing of fires 100m x 200m.

. On flat ground fires should be slow to start but accelerate after 1 hour. Rate of spread should be variable, about 40-200m/hr. In B.grandis litter rate of spread should be 70-140m/hr. Some spots may flare up to 300m/hr. In dry creeks, flats and swamps expect rates of spread up to 600m/hr.

. Flames in jarrah leaf litter fuels should be 1-3m with some isolated crowning. Flames in B.grandis should be 1-4.5m.

. Where slopes are 4^{o} it is advisable to burn under correspondingly cooler, moister conditions. As a guide: for 4-6^{o} slope SMC 12-14% etc.

Record all the following details about the burn on the FIRS Register: Date of Burn, FDI, SDI, time of ignition, winds, temperature and relative humidity during the burn, Rates of spread, flame heights.

Not all of the B.grandis will be killed as fire intensity will be variable across the burn area. These first burns will be monitored to determine the rate of kill. Jarrah scorch will approach total but stem damage should be restricted to trees less than 20cm DBHOB. Damage will increase as DBHOB decreases. Again, these first burns will be used to show how much jarrah damage results.

Subsequent treatment will depend on how successful the burn is in eradicating B.grandis. If manual methods to kill remaining B.grandis produce sufficient dead tops that another burn is necessary then follow strategy A from (*)onwards. If a second burn is not necessary then kill remaining B.grandis > 2m tall and follow strategy A from (**) onwards.

Treatment (3) - Rehabilitation of Dieback Graveyards

Rehabilitation on advanced dieback areas should not be expected to grow fast, as the underlying causes of dieback disease also lead to less than ideal conditions for tree growth. Rehabilitaion should aim to increase the potential for recreation and fauna conservation, without compromising the primarly land use of water production where applicable. Rehabilitation should also aim to improve the timber production potential, but the amount of effort should be appropritate to the expected tree growth. In most areas intensive effort to establish fast growing trees is inappropriate. Small areas which can support faster growing trees appear to exist at the heads and flanks of some gullies, particularly where the Yarrigil complex is least developed.

Planting of eucalypts is suitable only on those advanced dieback sites where tree growth is expected to be good. On most sites planting and fertilizing will encourage shoot growth at the expense of root development. Root development is considered the priority for survival and growth on infertile upland sites and to facilitate root development trees should be grown from seed on site. It is hoped that trees will develop their above ground parts only when they are capable of supporting that shoot growth.

Tree species for rehabilitation need to be selected to suit the particular advanced dieback sites so that long term growth is maximised. The success of different species beyond the establishment phase needs to be rigorously evaluated on different sites. Local species such as wandoo, marri, yarri and bullich should form the basis for rehabilitation, with the latter two species being more suited to lower parts of the landscape. Of the fast growing trees planted to date E.maculata appears to survive and maintain good form on low nutrient sites. Slower growing eucalypts which can grow useful timber on infertile upland sites can be tried as faster growing trees such as E.saligna, E.microcorys, E.globulus and E.resinifera have been planted with limited success on these sites.

The amount and type of site preparation will need to vary with site, though the appropriate preparation for each site is not known. The creation of ashbeds at 12m centres from all non-marketable wood is not necessary. At this stage it is thought necessary to disturb the mineral soil to get effective seed germination and establishment. On sites where planting is used shallow ripping may serve to prepare the ground aswell as enable the seedlings to be relocated for a second fertilizing.

Where natural regeneration is occurring treatment should aim to encourage that regeneration and supplement it if necessary.

Experience suggests that legumes can be established on most sites. The long term survival of these species and the invasion by other species will probably depend on the success of site amelioration by the original legumes and eventually the trees. Seeding rate at present should be 0.5kg/ha bulked with 450kg/ha of superphosphate. Seed of some leafy acacias which grow to around 3m should be included in the seed mix to provide ground shading.

Areas of advanced dieback upslope of dieback free or less affected forest will be treated conservatively so as not to increase the risks to downslope forest.

Falling of stags should only be done in amenity areas or for fire control purposes.

The application of fertilizer should not result in the introduction of weeds and ideally should not increase susceptibility to Phytophthora cinnamomi.

Prescription

Select a coupe which will receive a rehabilitation treatment over one season. This coupe becomes the basis for recording treatments, as they are done, using the HOCS (1:10,000 scale, system C). Both the HOCS plans and the FIRS register are to be forwarded to Inventory and Planning after planting and seeding each year.

Identify and mark on a 1:10,000 scale compartment plan:-

. advanced dieback boundary.

. site types.

. areas of good natural regeneration.

. areas upslope of dieback free or lightly affected forest.

. areas where more than 30% of the original jarrah canopy remains.

On a 1:10,000 scale compartment plan mark the treatment areas.

Put in monitoring plots if necessary. Mark their location on the HOCS.

Carry out erosion control works as required and close unwanted roads. Avoid draining water into dieback free or lightly affected forest.

Prepare the site for seeding and/or planting as necessary.

Carry out any felling necessary for aesthetic improvement or fire control.

Burn if necessary to reduce the hazard for young rehabilitation.

Seed, plant and fertilize as planned following the onset of winter rains.

The following autumn survey the rehabilitation to identify any areas needing replanting or reseeding. Also survey for weed introduction.

Prepare a summary of the previous year's graveyard treatment including an assessment of the techniques used and any changes planned.

Remeasure monitoring plots as necessary.

Records of all stages of the treatment are to be kept using the FIRS register.

Experiments will be conducted to determine the proper prescription which should be applied to each site. The following areas of research will be given priority in the next two years:-

. appropriate tree species to be seeded or planted on different sites, including an evaluation of slower growing species which grow in soils of low fertility.

. techniques for direct seeding of eucalypts and site preparation, including burning and scarifying.

. minimum site preparation, seeding and fertilizing rate for establishing legumes on a range of sites.

. effect of ripping on tree root development.

. the effects of understorey competition on tree growth.

. methods for enhancing the growth of natural regeneration.

Treatment (4) - Improvement Treatment of Healthy Forest

Three years after a particular area has been mined and rehabilitated the remaining healthy forest should be surveyed to identify areas for improvement treatment.