FORESTS DEPARTMENT

GENERAL WORKING PLAN No. 86 OF 1977

PART I

GENERAL WORKING PLAN

NO. 86

This Plan represents a milestone in the history of forestry in Western Australia.

For the first time the whole range of forest land use objectives, together with the policies and management strategies designed to achieve them are stated in one document and are to be made public.

The foresters who preceded us would have welcomed the recent awakening of public interest in forestry. They strove with little support and in the face of considerable opposition to set aside and protect the forest estate now available to the people of Western Australia.

It is to be hoped that people who have an interest in forests and forestry find the time to read this document before passing judgement on any aspects of forest management.

This Working Plan is not intended as a textbook on forestry. Anyone interested in pursuing or seeking explanation of any of the proposals contained in the Plan will be welcomed by officers of our Department.

By adopting the expanded policy proposals and passing of recent amendments to the Forests Act, Government has provided the machinery to meet the changing needs of management and protection of our forests. Those involved in the preparation of this document will feel well rewarded if it receives favourable public acceptance or, at the very least, becomes recognised as a bridge of understanding where frequently little has been seen to exist.

B.J. BEGGS

CONSERVATOR OF FORESTS

GENERAL WORKING PLAN NO. 86

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INTRODUCTION AND SUMMARY

Introduction

Protection of the forest estate and its associated values has been the objective of the Forests Department for many years. As a result of dedication of State forests the Department is holding a substantial area of forests under secure tenure for the benefit of the public.

However, public awareness of, and demand for, forest benefits have now reached the stage where scarcity imparts special values to each resource. Recognising this, Government requested an appraisal of the forestry situation in October 1974 and subsequently reaffirmed the concept of multiple use management adopted by the Department. This concept was then expanded and embodied in the Statement on Forest Policy of April 1976. Amendments to the Forests Act, necessary to permit implementation of this policy, were enacted in September 1976.

Overall Management Objective

The management objective of the Forests Department for land under its control is conservation through the planned use and management of forest land and associated resources, for the greatest long term social and economic benefit. This Working Plan, required under Section 31 of the Forests Act, outlines a land management system which has been developed to cater for the diverse range of forest values and land uses occurring in the forest, and for the protection of these values from damaging agencies.

Multiple Use Management

The demand for each forest value can only be met by managing in such a way that each area of forest land is used for a number of purposes. Use priorities are to be determined for each area, according to the inherent characteristics of the land and current social values. In the longer term, however, it must be recognised that the structure of land use priorities may alter with successional, socio-economic and technological changes.

Forest Values

The values recognised in the Working Plan are water, timber, wildlife, recreation, scientific study and minor products. Management for these values will be under a system of management priority areas. Particular attention is given to water production and special provision will be made for the protection of wildlife, for scientific study and for recreation using the concept of "forest parks".

The need for some flexibility in both time and space must however be appreciated as changes due to disease, natural catastrophe or over-use may impair these values to the extent that they are no longer capable of providing the benefit originally intended.

Resource Management Objectives

Catchment Management: To manage State forest catchments which are needed for existing or future water supplies, in accordance with the requirements of water supply authorities, to maintain or enhance water quantity or quality.

Timber Production: To ensure in the short term that present levels of supply are maintained and that by early next century, the estimated local demand for sawn timber can be met from local supplies. At the same time, the cut from indigenous forest will be regulated according to the long term productive capacities of the respective species, having due regard for regional stability of the timber industry and employment.

Recreation and Tourism: To provide for the planned development of recreation on State forests having regard for anticipated social needs and compatibility with environmental protection.

Flora and Fauna: To conserve areas representing the full range of natural habitats within State forests, to ensure the perpetuation of the many communities and their component species.

Science and Education: To manage specific areas of State forests for the purpose of education, reference and scientific study as the need is foreseen.

Mining (Mining Act Minerals): To guide mining operations onto areas where there will be least conflict with other land uses, to minimise environmental damage and to rehabilitate areas affected by mining to best suit future land use.

Mining (Gravel, Stone and Sand): To provide gravel, stone and sand for Government and semi-government authorities where there is no reasonable alternative supply and where the supply will not result in spread of dieback or prejudice amenity values.

Public Utilities: To limit further development of public utilities which result in loss of forest values, to those considered essential by Government, and for which there is no reasonable alternative location. Where this is so, any such development will be planned to ensure that it results in least environmental damage and minimum land use conflict.

Sandalwood Production: To make available supplies of roots, stems and branches of sandalwood at a practical level of production and current standards of utilisation, where this does not damage regrowth, alter the distribution of the species, or conflict with major land use objectives.

Honey Production: To sustain the present level of beekeeping with due regard to location of apiary sites at intervals to avoid transference of disease and conflict with major land use objectives.

Wildflower Production: To provide seeds, plants and plant parts from State forests according to the demand, where this does not conflict with the distribution and perpetuation of the species or major land use objectives, to the requirements of the Wildlife Conservation Act.

Dedication of Land for Forestry Purposes: To increase the area of State forest where possible to meet foreseeable public demand for each forest use, taking into account land vested in other authorities which complement forestry.

Fire Protection: To provide a fire control system capable of protecting recognised forest values from serious damage. This system is to be compatible with the dominant land use in any area, with the cost of protection not exceeding the value of the loss prevented.

Jarrah Dieback Disease: To limit the spread of infections and to rehabilitate dieback-infected areas to suit the future land use.

Conservation of the Physical Environment: To minimise the deleterious effects of land use and management on the soil, air and water components of the forest environment.

Timber Production

Whilst recognising the importance of other forest values, the role of timber production in multiple use management must not be overlooked. Timber production is essential to supply the community's needs for a basic raw material and makes an important contribution to the social stability of the South West.

The time spans involved in timber production make it necessary to ensure continuity of future supplies at least two decades before the demand arises.

It is predicted that sawlogs will continue to be the major wood product needed and a substantial reduction in the cut of hardwood sawlogs will be required to obtain a better long term balance between sawlog increment and removals. However, the gross productive potential of the hardwood forests for sawlogs and other produce, considerably exceeds the present level of hardwood cut.

There can be no simple equation between gross forest increment and annual cut as envisaged in the classical concept of sustained yield, until the forest contains a complete range of age classes in units of equal area or productivity. Desirably markets for the full range of produce coming forward annually should also be available. These conditions do not apply in Western Australia because of the intensity and distribution of previous cutting as well as other factors affecting the growth rates in the hardwood forest and because the plantation estate is still being developed.

Allowable Cut

The allowable cut is determined on management rather than on silvicultural criteria. The main factors which must be taken into account are existing levels of demand, types of produce required and the period required to accumulate future forest capital in the most desirable range of size classes. This latter process will take at least a century in the hardwood forest and not less than six decades in the plantations.

During the period of this Plan increasing quantities of pine sawlogs will become available to help offset the effects of reducing hardwood sawlog cut. It will be necessary to rely on imported timbers to make good any shortfall in local sawlog availability during periods of peak demand.

As the first steps of a longer term reduction in the hardwood cut the annual intake of hardwood sawlogs will be reduced over the next 5 years by some 137 000 m^3 a year. Over this same period 82 000 m^3 of pine sawlogs will become available annually. The details of these proposals are contained in Part II of this Working Plan which will remain confidential to protect the rights and interests of forest-based industries.

In order to achieve a reasonable level of local self-sufficiency, it is estimated that the plantation programme should be increased to some 3 000 hectares a year to meet predicted local sawlog demands by the turn of the century.

The wood residue-using industries are of particular significance to forest operations in fostering regeneration, which is the key to future hardwood productivity. They also allow flexibility of management options by providing effective outlets for intermediate thinnings.

Regulation of the Cut

The present system of regulating the cut from State forest under sawmilling permits or sawmilling licenses, each with a predetermined permissible log intake, will continue but with two significant modifications.

Firstly, log intakes are to be nominated for each of the major species so that the specified reductions in the jarrah and karri cut are effectively controlled.

Secondly, permits, which give the holder sole rights to a particular class of produce over a specified area, will be gradually replaced with licenses, which confer rights to nominated quantities of material only. This is designed to provide greater flexibility in management.

Private Forestry

The private plantation programme is expected to make a useful contribution to overall future production, but cannot be relied upon fully due to scattered distribution in relation to future markets and to uncertainty on the part of the growers as to cultural methods and production objectives. It is therefore proposed to improve and expand information and advisory services for the benefit of private growers.

Mining and Public Utilities

These land uses frequently result in changes to the original forest and depending on their nature, may preclude the eventual re-establishment of a similar forest type. Nonetheless they are essential to the general wellbeing of the community. Where possible they will be accommodated in localities where there is least conflict with other land uses. Appropriate provision will be made for effective rehabilitation, especially to meet the needs of water supply.

Research

The Department's multiple use management proposals require a vigorous and continuing programme of research and development. Departmental research activities are primarily directed towards developing or adaping management techniques to meet the special nature of our climate, species and soils.

Active participation in the several joint inter-departmental research projects dealing with the broader aspects of land use will be continued. Commonwealth and academic institutions will be encouraged to increase their participation in fundamental forestry research. The Department will continue

to assist other land management organisations by providing the advice where required.

Operational and rehabilitation techniques in relation to dieback and disease control including manipulation of the fire regime, are projects of major priority.

There is a need for expansion of current ecological studies into wildlife protection to provide the basis for ongoing management and the selection of additional areas required for this purpose.

Further evaluation of recreational potential and use is also seen as important. There is a real need for expanded examination of some of the broader economic and social aspects of forestry, particularly the appraisal of the values placed on the forest resource by the public. Desirably this type of investigation should be conducted by bodies outside the Department.

Other important topics requiring investigation include improvement of hardwood growth data and development of new inventory procedures for timber and other forest values at operational level.

Extension

The increasing public awareness of forestry has highlighted the need for a higher standard of general public information in forestry matters as a means of stimulating more informed and more constructive feedback from responsible individuals and organisations.

Existing extension activities will be continued and expanded, by providing better facilities for field study centres at secondary level, by preparing environmental and other reviews of major proposed development projects and by improving communications with the various bodies interested in land management.

An improved advisory service to private forestry growers and extension of existing activities to include the more remote areas such as in the Kimberley and Pilbara is planned.

Organisational Services and Financial Requirements

In the decade ending 1975 total Departmental staff numbers increased at a rate of only 0.2% per year. It should be noted that the annual increase of 2.8% in salaried staff was almost directly offset by an annual reduction of 1.5% in the number of wages employees, which is now below the accepted level needed to provide adequate fire protection in the event of multiple fires on days of severe summer hazard or above.

Financial and staff restraints could affect the achievement of objectives outlined in this Plan. Maximum use will be made of the resources available by continuing with internal reorganisation, increased attention to personnel selection, training and management and continuation of the Department's successful industrial safety programme.

Working Plan Control and Review

This Plan will remain in operation for a period of 5 years from the date of approval from the Governor in Executive Council. Annual reviews of progress will be undertaken at all management levels and formal recommendations for amendments will be submitted in the interim as found necessary in the light of new and improved information.

Action to formalise the "forest park" concept will be initiated early in the Plan period.

1. BACKGROUND TO THE WORKING PLAN

The Forests Act requires that working plans be prepared for a period not exceeding ten years to guide and control management of State forests and timber reserves. These plans are to be approved by the Governor in Executive Council and may only be altered on the recommendation of the Conservator. Since 1918 a total of 58 working plans have been produced by the Department. Only six of these have been general working plans for the hardwood forests, the remainder being for specific forest areas or pine plantations.

No. 40 1927 General Working Plan for Karri

No. 60 1929 General Working Plan for Jarrah

No. 66 1945 General Working Plan for Sleepers and Sawmilling

No. 67 1945 General Working Plan for Jarrah, Karri and Wandoo

No. 79 1956 General Working Plan for Jarrah, Karri and Wandoo

No. 85 1972 General Working Plan for Hardwood Forests

1.1 PREVIOUS GENERAL WORKING PLANS

1.1.1 General Working Plans of 1927 and 1929

Sawmilling started soon after settlement with the first exports of timber being recorded in 1836. However, it was not until the passing of the Forests Act in 1918 that the present system of control by sawmilling permits or licenses, each with a prescribed maximum monthly log intake, was established. The Karri and Jarrah Working Plans of 1927 and 1929 respectively attempted to co-ordinate and regulate timber-getting on a Statewide basis. At that time the total cut was determined mainly by the number and size of the sawmills operating on Crown land and amounted to about 990 000 m^3 per year. This was thought to be about 130 000 m^3 per year above the permissible annual cut and the industry was offered, and voluntarily accepted, a 5-year period in which to make the necessary reductions.

The adjustments were made without serious hardship between 1928 and 1933, a period which coincided with a slump in the industry due to the world depression.

1.1.2 General Working Plans of 1945

The General Working Plan for Jarrah, Karri and Wandoo of 1945 prescribed for the control of all general purpose sawmills, but separate plans were prepared to govern the operations of sleeper and case sawmills. Additional sleeper sawmills were established at that time to cut timber made available from Crown land alienated under the Government's policy of developing new areas in the agricultural zone. These plans prescribed a total annual cut of just under 990 000 m^3 which was not actually achieved until the boom year of 1954, despite the issue of permits for a total intake of 1 416 000 m^3 per year.

1.1.3 Royal Commission Report of 1951

In 1951, the Royal Commission recommended a total cut of 1 133 000 m^3 per year based upon the first attempt to arrive at the total volume of the marketable growing stock.

1.1.4 Working Plan No. 79 of 1956

Working Plan No. 79 of 1956 included all forms of sawmilling, including sleeper and case milling formerly covered by separate working plans, and prescribed a total cut from Crown land of 1 294 000 m^3 per year.

However, in the period 1956 to 1960 the average log intake from State forests and Crown lands of all types was 1 120 000 m^3 per year under permits issued which allowed for cutting up to a total of 1 345 000 m^3 per year.

1.1.5 Working Plan No. 85 of 1972

Working Plan No. 85 was written following the definition of the total area available for forestry purposes and the completion of a comprehensive inventory of the forest

resource. The Plan prescribed a total cut of sawlogs from Crown land of 1 062 000 m^3. In addition the long term yield of sawlogs from State forests and timber reserves was estimated to be between 801 000 m^3 and 1 056 000 m^3 per annum, excluding salvage logs unsuitable for general purpose mills. Exhaustion of timber on Crown land in process of alienation led to the closure of 55 sawmills in the period 1956 to 1971. Timber production from freehold land had continued to decline from 25.3 per cent to 12.3 per cent of total production over the previous decade.

The Plan rationalised and reorganised permit boundaries and intakes to the lower level of long term yield. It provided for a degree of overcutting until softwood from plantations came into the market in sufficient quantities and stressed the real need for an accelerated softwood programme and intensive forestry on high production areas. The aim was for self-sufficiency in sawlog timber by the year 2000.

The importance of jarrah dieback and the necessity for hygiene in forest practices was recognised. A concentrated cut was favoured to reduce dieback spread. Intensive silviculture was directed to high quality hardwood forests and the need to rehabilitate some affected areas was noted.

Provision was made for the Uniform System of cutting and regeneration in the karri forest as the most efficient way to obtain fully stocked, even-aged stands and reduce the total area under regeneration requiring intensive fire protection. This system, with the pending inception of the wood chip project, allowed for effective management of the karri-marri stands.

The need for recutting in selection stands with the consequence of a lower volume yield per hectare and an increase in proportion of smaller-sized logs was also recognised.

The Working Plan of 1972 was the first to stress the need for selected forest reserves and to focus attention on flora and fauna conservation, catchment management, amenity values, recreation and mining.

1.2 MAJOR CHANGES SINCE 1972

1.2.1 Policy and Legislative Changes

The Government sought a statement on the position of forestry in this State in 1974, and following consideration of Departmental submissions, gave approval to the following:

a) hardwood forest management be continued under the provisions of Working Plan No. 85, with the overall industry position under continual review;

b) a pine afforestation programme of 4 000 ha per annum subject to availability of finance, with a minimum programme of 2 400 ha per annum to meet contractual requirements;

c) calling of tenders for private involvement in pine sawmilling with a continuation of the Department's involvement;

d) the Forests Department continuing its role in multiple use forest management and a major review of the Forests Act to be proceeded with as soon as practicable.

As a consequence the Government stated its forest policy in April 1976. It embodied the following forest management objectives:

Water Supplies: To protect, control and rehabilitate where necessary, those forest areas that contribute to the water supply requirements of the State.

Timber Production: To regulate the removal of produce from the native forests to a level that can be sustained by the forest growth.

Other Forest Products: Within the management guidelines for the forests, to ensure the future livelihood of those persons involved in "less important" forest industries.

Recreation and Tourism: To extend access to the forests wherever this is possible and to provide additional facilities for people to enjoy the many forest values that are available to them.

Flora and Fauna: To conserve areas that provide the habitats for the many species of flora and fauna that exist in the forests of Western Australia.

Special Scientific Values: To set aside specific areas of forests for the purposes of education, reference, and scientific study.

Mining: To rehabilitate and stabilise those forest areas upon which the original vegetation has been destroyed in the course of mining operations.

Forest Protection: To maintain and add to the areas of permanently reserved forests; to protect these forests from fire, insects and other harmful agencies; to maintain and improve the health and vigour of the forest area.

Private Forestry: To encourage and assist private owners to establish and manage commercial forests and to provide land-holders with advice for planting trees for their shelter and protective values in the rural areas.

The objectives as stated above were made available to the interested public through the Forests Department publication "Forest Focus". Objectives quoted in this Plan are aligned with the above Government Policy.

The added responsibilities of the Forests Department required amendments to the Forests Act. In 1976 Parliament approved a number of changes to the Act which strengthened the formal authority of the Department to implement the policy of Government. Among amendments made were those applicable to Departmental financial arrangements, preparation of working plans and employment of professional officers who are qualified in disciplines other than forestry.

1.2.2 Multiple Use Management

There has been growing recognition that with limited forest area and increasing demand being placed on the forest resource, management must cater for the maximum range of uses in any particular location. The principles of applying multiple use management to West Australian State forests have been elaborated in the Departmental brochure "A Perspective for Multiple Use Planning in the Northern Jarrah Forest" (in Press).

1.2.3 Forest Diseases

Following identification in 1965 of Phytophthora cinnamomi as the cause of the disease known as jarrah dieback, hygiene measures were implemented to prevent movement of infected soil on vehicles travelling from diseased areas. A major review of the disease situation was completed in 1974. From this it was realised that the mode of disease development, which could exceed 2 years between time of infection and appearance of visible symptoms, was such that hygiene measures alone would not be adequate. To overcome this problem it was necessary to exclude all vehicular traffic from an area until all infections were located. The power to quarantine sections of forest was conferred on the Department with the passing of the Forests Act Amendment Act 1974 and initial implementation was effected in January 1976.

1.2.4 Environmental Awareness

There has been a worldwide movement drawing attention to the impact of man on the environment and the need to plan for environmental protection. Classical forestry theory has for centuries been aimed towards protection and perpetuation of the forest with its associated flora and fauna. This was achieved by developing an understanding of the natural mechanisms of succession and applying this knowledge in regeneration and tending practices so that the yield of various forest resources would be enhanced. Since preparation of the last working plan, objectives and management practices have been reviewed to ensure comprehensive planning to protect the environment.

1.2.5 Integration of Hardwood and Softwood Yields

There are sound economic and social reasons why a high degree of self-sufficiency should be maintained for wood products. Because of previous overestimations of hardwood volumes acceptable to the market, the allocation of areas containing merchantable timber for non-wood production purposes, the impact of dieback disease and inherent slow growth of hardwoods, it is necessary to reduce the hardwood sawlog cut. It is planned to increase the rate of harvesting and planting of softwoods at a rate which will balance the reduction in hardwood availability by the turn of the century. This will maintain adequate supplies of wood on the market from local sources, and continue stability of the timber industry and associated employment.

1.2.6 Removal of Timber Reservation Conditions on Conditional Purchase Land

In past decades timber harvested from land in the process of alienation on which timber rights had been reserved to the Crown, contributed significantly to the annual sawlog cut. This resource was largely exhausted by 1972 and it was foreshadowed in General Working Plan No. 85 that Timber Reservation conditions would be relevant no longer. These conditions were accordingly lifted by Government in January 1972. Current procedure ensures the removal of timber prior to alienation.

1.2.7 Introduction of Functional Management

Until recent years the primary field activities of the Department were associated with fire protection, regulation and control of forest harvesting and tending for wood production. The organisation, built around thirteen major land units, each under the control of a professional forester, had been designed and refined over many years to administer these activities. Recently there have been rapid advances in technology and increased availability of results from research in a number of forestry aspects. At the same time, the management base has been broadened to meet demands for recreation, catchment regulation, protection of fauna and flora and disease control, and it has become necessary to have

professional officers engaged at greater depth in more specific areas of responsibility. Staff structure has therefore been reorganised on a functional basis. Divisions have been grouped for ease of administration into three regions directed from Manjimup, Bunbury and Perth.

2. THE FOREST AREA

2.1 AREA COVERED BY CURRENT PLAN

This Working Plan covers State forest, timber reserves (Forests Act) and freehold land held in the name of the Conservator of Forests. State forests and timber reserves are listed in Appendix I. Outside these areas the Forests Department is also responsible for control and management of forest produce on all other Crown land and has established 58 arboreta in the wheatbelt, two experimental plots in the North Kimberley, and maintains an advisory interest in the Pilbara.

2.2 FOREST AREA AND OWNERSHIP

Land under the control of the Forests Department in the South West is shown on Plan 1 as are the boundaries of the 13 Forests Department administrative divisions in this region. As at 1.12.76 the area under the control of the Forests Department in the South West, is classified as follows:

Tenure	Area (hectares)
State Forest	1 832 783
Forest Act Timber Reserves	84 763
Freehold land held in the name of the Conservator of Forests	25 598
Land under control of the Forests Department	1 943 144

Note: A further 120 494 hectares of land are awaiting dedication as State forest.

The area under Forests Department control may be classified into the following broad forest types:

Type*	Area (hectares)
Jarrah	1 440 000
Karri	140 000
Wandoo	104 000
Mallet	10 000
Tuart	3 000
Pinus radiata	17 000
Pinus pinaster	22 000
Very open areas	207 000
	1 943 000 hectares

In addition to the area under Forests Department control in the South West, 781 ha of State forest and 32 243 ha of Forests Act timber reserves occur in the Eastern Goldfields, making a total estate of 1 976 168 hectares.

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* Jarrah type includes

pure jarrah
mixture of jarrah with marri, blackbutt, wandoo, karri and sheoak as minor species
stands dominated by marri with jarrah as the minor species
stands dominated by blackbutt with jarrah or marri as the minor species
stands dominated by bullich with jarrah or marri as the minor species

Karri type includes

pure karri
mixtures of karri with marri as the major or minor species
mixtures of karri with jarrah or the tingles as minor species
stands dominated by the tingles

Wandoo type includes

pure wandoo
pure powderbark wandoo
mixtures of these with jarrah, marri and mallet as minor species

Mallet type includes

8 300 hectares of plantation mallet
mixtures of mallet with wandoo as the minor species

Very open areas includes

swampy and rocky areas
areas with sparse tree canopy
areas cleared for mining, powerlines and dams

2.3 AREAS AWAITING DEDICATION AS STATE FOREST

Submissions have been made for dedication of 120 494 hectares as permanent forests, and these additions would bring the total land under Forests Department control to 2 096 662 hectares (Plan 1).

The forest estate might further be increased in the future by

a) purchase of private property suitable for Pinus radiata and hardwood production, as funds become available. Such areas are likely to be small in relation to the total forest estate, but their value for intensive wood production is significant;

b) dedication of areas of vacant Crown land in the South West suitable for forestry purposes;

c) dedication of vacant Crown land on the Eastern Goldfields, Pilbara and Kimberley where land use classification indicates forestry potential. In the light of the Department's multiple use policy, such a classification should take account of all forest values.

2.4 PRIVATE PROPERTY AND PRIVATE PLANTATIONS

Hardwood log supplies from freehold land have fallen from 278 000 m^3 in 1965 to 87 000 m^3 in 1975. As a proportion of total log production, this represents a drop from 19.1% to 7.3%.

Hardwood supplies from private property are expected to continue to decline and little future can be seen for sawmills which have drawn their log supplies exclusively from private property.

While forested private property is not expected to make a major contribution to hardwood timber supplies, it can be most important in maintaining water purity, especially in areas having less than 1025 mm annual rainfall.

The area of private pine plantations was approximately 7 600 hectares in March 1976, compared with 39 300 hectares of Forests Department plantations.

3. CONTEXT OF PRESENT WORKING PLAN

The Forests Department was established in 1919 to implement the Forests Act of 1918.

Over the years, Departmental responsibility has increased. It now directly implements four Acts, and has part responsibility for a number of others. Many more impinge upon forest management and administration.

In addition the Department has set out to co-ordinate its planning with those statutory bodies having interests in the management of the public forests.

Many private organisations use the forest for various activities. The identities and needs of these groups have been established so that their activities can be regulated to avoid land use conflict and undue environmental effects.

The growth characteristics of the forest, together with past management practices are also major factors influencing future planning.

3.1 LEGISLATION AND ORGANISATIONS

3.1.1 Acts Implemented by the Forests Department

Forests Act, 1918-1976
Sandalwood Act, 1929 - 1934
Timber Industries Regulation Act, 1926 - 1969
Native Flora Protection Act, 1935 - 1938
(This Act will be incorporated in the Wildlife Conservation Act during 1977, and control will then be exercised by the Department of Fisheries & Wildlife)

3.1.2 Acts under which the Conservator or the Forests Department are nominated as having specific responsibilities

Alumina Refinery Agreement Act, 1961 - 1974
Alumina Refinery (Pinjarra) Agreement Act, 1969 - 1972
Alumina Refinery (Muchea) Agreement Act, 1972

Alumina Refinery (Worsley) Agreement Act, 1973
Bush Fires Act, 1954 - 1973
National Parks Authority Act, 1976
Wesply (Dardanup) Agreement Authorization Act, 1975
Wildlife Conservation Act, 1950 - 1975
Wood Chipping Industry Agreement Act, 1969 - 1973
Wundowie Charcoal Iron Industry Sale Agreement Act, 1974

3.1.3 Acts Affecting Forest Land Management

Aerial Spraying Control Act, 1966 - 1973
Agriculture & Related Resources Protection Act, 1976
Agriculture Protection Board Act, 1950 - 1976
Country Areas Water Supply Act, 1947 - 1976
Environmental Protection Act, 1971 - 1975
Land Act, 1933 - 1972
Local Government Act, 1960 - 1975
Main Roads Act, 1930 - 1976
Metropolitan Water Supply Sewerage & Drainage Act, 1909 - 1975
Mining Act, 1904 - 1973
Soil Conservation Act, 1945 - 1974
State Energy Commission Act, 1945 - 1975
Acts Amendment (State Energy Commission) Act, 1975

3.1.4 Associated Statutory Authorities

Commonwealth Authorities

C.S.I.R.O.
Department of Defence
Department of Health
Department of Primary Industry
Telecom Australia

State Government Authorities

Agricultural Protection Board
Bush Fires Board
Community Recreation Council
Department of Agriculture
Department of Conservation and Environment
Department of Corrections
Department of Fisheries and Wildlife

Department of Industrial Development
Education Department
Lands and Surveys Department
Department of Local Government
Main Roads Department
Metropolitan Water Supply, Sewerage & Drainage Board
Mines Department
National Parks Authority of Western Australia
Public Works Department
Swan River Conservation Board
Department of Tourism
Westrail
State Energy Commission

Local Government

All shire councils adjacent to State forests and timber reserves.

3.1.5 Organisations with which Contact has been Established

The following list is an example of the range of organisations which use the forest and have had contact with the Forests Department.

Darling Range Conservation Authority
Tree Society of W.A. Inc.
Western Australian Naturalists Club Inc.
The West Australian Wildflower Society Inc.
The Kings Park and Swan River Society
Western Australian Speleological Group
Vasse Conservation Committee
The West Australian Association of Lapidary Gem and Rock Hunting Club
Lions International
Speleological Research Group of Western Australia
Ongerup Conservation Organisation
Perth Bushwalkers Club
The Amateur Canoe Association of Western Australia
Australian Institute of Landscape Architects

Leeuwin Conservation Group
The West Australian Trout and Freshwater Angling Association Inc.
Western Australian Gould League
Canning River Conservation Association
Institute of Engineers (Environmental and Hydrology Branches)
Institute of Foresters of Australia (Inc.) (W.A. Division)
Royal Society of Western Australia
Campaign to Save Native Forests
Save Our South West Campaign
South West Forests Defence Foundation
Historical Society of Western Australia
Royal Historical Society
The Environment Centre
University of Western Australia
Murdoch University
Australian National University
Western Australian Institute of Technology
Youth Hostels Association
Western Walking Club
Orienteering Association
Equestrian Federation
Confederation of Australian Motor Sports
Western Australian Motor Cycling Association
Minibike Association
Recreation Vehicles Association
Forest Products Association
Boy Scouts Association
Farmers Union - Beekeepers Section
Local Tourist Bureaux in the South West and Goldfields
Private plantation companies
Sawmilling companies

3.2 SILVICULTURE

The forest is a biological or living entity and as such follows a natural succession. At each stage the composition and structure of vegetation vary.

The forest is composed of a wide variety of plants but it is the trees which provide its vital characteristic. Man has placed values on the total forest system and on its components which include benefits such as aesthetics and wood production.

For centuries cultural procedures have been practised throughout the world to enhance forest values. These practices and others developed during management of local forests provide the basis for future management. A summary of these techniques follows in relation to each of the major local tree species.

Silvicultural treatments such as thinning and fertilising are prescribed during the development of the tree stands according to size, growth potential and management objectives.

3.2.1 Jarrah (Eucalyptus marginata)

The total area of jarrah forest under Forests Department control is approximately 1.44 million hectares. Although occurring mainly as a pure stand or as the dominant species in mixture with marri (E. calophylla), it is also found with wandoo (E. wandoo) and karri (E. diversicolor). Jarrah dominates on lateritic uplands in the high rainfall belt but is also present on a range of other soil types, mainly red earths and sands.

Early treatment

Where cutting took place in the jarrah forest prior to the establishment of the Forests Department, it resulted in removal of virtually all the merchantable timber. Following introduction of treemarking in the 1920's, there was a shift towards periodic light selective cutting, aimed at regeneration in small areas progressively enlarged by subsequent cutting.

This mode of cutting persisted until 1965 when the causal agent of jarrah dieback, Phytophthora cinnamomi, was

identified and a relationship shown between dieback spread and mechanised activity. From then on there was a return to heavy uniform cutting to restrict the area traversed by logging and road-making equipment. Forests cut under this uniform prescription will largely be even-aged, compared with the stepped, uneven-aged forest created by the Selection System.

Regeneration

The flowering cycle for jarrah is irregular but generally follows a cycle of once every 5 - 7 years. The ensuing seedlings form a rootstock known as a lignotuber, which supports a multi-stemmed bush known as advance growth. This advance growth may persist in a semi-dormant condition on the forest floor under the upper canopy for several decades. Opening up the canopy by felling stimulates the formation of a sapling.

Advance growth usually existing on the forest floor has been the main source of jarrah crop replacement. Where it is lacking, seed trees are left during felling operations and the logging debris is burnt to create ash beds and stimulate seed fall.

3.2.2 Karri (E. diversicolor)

The area under Forests Department control in which karri is a significant species is approximately 140 000 hectares. Less than 20% of this area is pure karri, the remainder being a mixture of karri with marri, and in some areas, karri with jarrah or tingle.

Early treatment

Early sawlog operations in the karri forest were conducted under a system of clear felling which resulted in the high quality, even-aged stands of Boranup, Big Brook and Treen Brook. After the late 1930's the clear felling system was gradually superseded by the Group Selection System, which was primarily aimed at recovering the greatest quantity of damaged

timber from the widest possible areas of State forest. However, in these areas, regeneration after cutting was not satisfactory, due to competition from retained trees which themselves showed marked deterioration. Regeneration which became established following the first cut was inevitably damaged by subsequent selective cutting and associated regeneration burning.

Following utilisation trials in 1965, the Uniform System was reintroduced in the karri forest in 1967. It is the most efficient and practical means of securing fully stocked, even-aged regrowth which is free to develop without the suppressing effect of trees from the original crop.

Regeneration

To regenerate strongly, karri requires open sunlight, a mineral soil seed bed and absence of competition. It shows a dramatic growth response to natural ashbeds. Burning is the most economic means of achieving these conditions.

While regeneration with seed trees has been the common practice until now, the fact that karri seeds at irregular intervals of 3 to 5 years means that with this practice a substantial area of cut-over forest must remain unburnt until the seed trees carry mature seed. This can lead to a substantial fire hazard and considerable difficulty in later fuel reduction burning.

In order to provide for a more regular regeneration programme, and to minimise the period between cutting and regeneration, it is now proposed that areas cut over will be regenerated each year by means of seed trees during the seed year and by direct seeding and planting in the intervening years. Techniques have already been developed and research is continuing.

3.2.3 Pine (Pinus spp.)

To date the Forests Department has established some 39 000 hectares of Pinus radiata and Pinus pinaster plantations.

Early treatment

Early treatment of pine plantations was associated with thinning operations designed to enhance future log quality and size. In recent years progressive thinning schedules have been designed to maximise sawlog yield over short rotations while maintaining health and vigour.

Establishment

Seedlings produced from superior stock are raised in nurseries and planted at predetermined spacings to provide sufficient stocking in order to select for sawlog quality during later thinning and tending programmes.

3.2.4 Marri (E. calophylla)

Marri occurs throughout the hardwood forest, mainly in mixture with jarrah and karri. Only rarely does it occur as a pure stand.

Early treatment

Mature or overmature marri trees are usually unsuitable for sawlog production. Where jarrah was commercially harvested, marri stems remained and competed with regeneration. In karri forests, marri was culled to increase regeneration and growth. The establishment of a chipwood industry based on marri provided a valuable contribution to the economics of forest regeneration.

Regeneration

Trials and observation have shown that marri regenerates successfully under both Selection and Uniform Systems and it can be managed in the same way as the species which dominate the stands in which it occurs. Removal of parent trees and regeneration burning can be manipulated to favour either marri or the associated species. Its capacity to regenerate from seed or lignotuberous rootstock is such that it is not possible to exclude it even if deemed desirable.

3.2.5 Other Tree Species

The Wandoos

Wandoo (Eucalyptus wandoo syn. Eucalyptus redunca var. elata) occurs as a major species over approximately 100 000 hectares of State forest. It occurs more commonly in mixed stands with jarrah and marri, although pure stands do exist. Its best development on State forest is in the broad gullies and slopes of the plateau from east of Gingin to east of Collie. There are isolated occurrences along the western scarp and the coastal plain.

Wandoo has similar seeding and regeneration habits to jarrah but is resistant to Phytophthora cinnamomi.

Past cutting has been mainly controlled by size class restrictions and adequate regeneration has been generally achieved with standard prescribed burning techniques.

Powderbark wandoo (E. accedens) has characteristics similar to E. wandoo, occurs in association with it, and over a similar geographic range.

The Tingles

The three tingles, red tingle (E. jacksonii), yellow tingle (E. guilfoylei), Rate's tingle (E. brevistylis), all occur in the vicinity of the Deep, Frankland and Bow rivers near Walpole. Pure stands rarely occur, mixtures with karri, marri, jarrah and each other being far more common.

Regeneration requirements of these species are similar to karri but they are more shade tolerant.

Blackbutt (E patens)

W.A. blackbutt occurs in small patches in gullies and pockets of alluvial soils throughout the prime jarrah forest region. It is also associated with jarrah and karri in some parts of the southern forest region. It is similar to jarrah in that it regenerates well after heavy cutting but it is resistant to Phytophthora cinnamomi.

Tuart (E. gomphocephala)

Tuart occurs extensively on the Coastal Plain on soils derived from limestone. The tuart forest is particularly susceptible to attack from insects.

Regeneration characteristics of this species are similar to karri.

Brown Mallet (E. astringens)

Mallet occurs over some 10 000 hectares of land near Dryandra. Most of this area (some 8 300 hectares) has been established as a plantation. In the past it was used for tannin and wood production.

Mallet regenerates prolifically after fire and forms dense groups of regrowth.

4. LAND MANAGEMENT CONSIDERATIONS

4.1 RESOURCE VALUES TO BE CONSIDERED

The major forest values currently recognised in forest management are those associated with water, timber, recreation, flora, fauna, scientific study, education and minor forest products such as sandalwood, honey and wildflowers. Implicit in the management of all these forest resources is regulation of use and protection from damaging agencies for which there are a number of prerequisites -

security of tenure

management for perpetuation of forest resources including

maintaining soil quality
minimising adverse effects of fire and disease.

Special provision must also be made for service functions such as roads, dams, transmission lines and pipelines as well as for mining of minerals defined under the Mining Act and gravel, stone and sand, defined as forest produce under the Forests Act. Each must be considered as an integral part of total land use planning.

4.2 THE CONCEPT OF MULTIPLE USE OF LAND MANAGEMENT

There has been growing recognition that with limited forest area and increasing demand for each forest value, management must cater for the maximum range of uses in any particular location. The Department has studied means of achieving this.

In its simplest form, multiple use of land means the use of a tract of land for several different purposes. Some land uses cannot be practised concurrently while others may be partially or fully compatible. Assigning priorities leads to different interpretations of the concept, the most significant being:

a) Division of a given area into smaller units, each having one exclusive use. In this case, multiple use is practised over the whole area by a combination of the parts. This is common in current agricultural practice but is rare in forest management.

b) Optimum combination of uses on each area to maximise net social benefit. This requires a considerable amount of detailed data on social demand and site potential which are currently not available. This approach assumes no constraints to management.

c) The selection of a priority or dominant use for an area with the practice of secondary uses which in some circumstances may not significantly interfere with the primary aim, but in others may impose a restriction on output from each competing use. This necessitates a social ranking of use priorities which can usually be done satisfactorily with limited data and experienced value judgement. The Forests Department has adopted this approach for the future management of State forests and timber reserves.

Multiple use has temporal as well as spatial overtones. In the long term the structure of use priorities may alter with socio-economic, technological and successional changes. Such changes could be brought about by a number of influences such as dieback spread, mining, increased water supply requirements or altered demand for wood.

4.3 ALLOCATION OF MULTIPLE USE MANAGEMENT PRIORITIES

The whole forest will be divided into areas in which the dominant and secondary uses will be specified and their priority ranking nominated. Each unit known as a Management Priority Area will be described according to its dominant use. Where aspects of prescribed management for two or more land uses are in conflict, the priority use will be favoured. This is necessary to reconcile the differences in compatibility between the various land uses. The process of delineating management priority areas involves a number of steps:

a) Assessment of site potential for each resource value. For example, the lateritic gravels of the plateau are unsuitable for intensive softwood production whereas the reverse is true for the loams of the Blackwood Valley.

b) Estimation of the level of demand for the various resource values in relation to locality.

c) Identification of the legislative and economic constraints on the area, for example, gazetted catchments, mining agreements and timber supply commitments.

d) Identification of constraints imposed by the nature of each land use itself. For instance, it is generally accepted that water is the resource most likely to become the limiting factor to the State's development, and therefore in cases of acute conflict, water supply should be given precedence over competing forms of land use. However there are some instances where these rules could probably be relaxed or even reversed. The most obvious example is the damming of valleys north of the Preston River which has already resulted in major reduction of some associated site-vegetation types. The remaining as yet unaffected valleys are approaching a rarity value which transcends economic values. Similar situations will also occur with respect to other vegetation types of the western high rainfall zone of the northern jarrah forest. Through a combination of dieback and bauxite mining, these types have been reduced to the point where remnants should be preserved. Such conflicts between land use are unusual. More frequently incompatibility can be reduced by foregoing some benefits from competing land uses.

The allocation of multiple use priorities will represent a concession between the level of demand and supply for each forest value, subject to the constraints imposed. Ultimately the pattern of forest land use will consist of a mosaic of areas, each being managed according to its inherent environmental capabilities. Some areas will provide few resource values whereas others will allow a multiplicity of uses.

Although the formulation of areas managed primarily for conservation of flora and fauna has been in progress for some time, it has been recently accelerated through the establishment of the Conservation Through Reserves Committee (C.T.R.C.). In prescribing management for a number of these areas the concept of a "forest park" envisaged by the C.T.R.C. and defined in the Environmental Protection Authority recommendations will be adopted. Definition of areas with priority of

management for wood, water and other major land uses will be continued during the period of this Working Plan.

Finally, since demand and constraints are subject to change, periodic reappraisal of the priorities is essential. Some changes, such as the need for harnessing catchments in southern forests are generally predictable. Others, such as the demand for extensive recreation, are not so predictable. Management of southern forests for water production will require greater attention to prevention of biological pollution, salinity and turbidity. The introduction of a new disease could produce unpredictable constraints on future management. So far as it is possible, planning must take into account the management requirements for present priorities without eliminating the options for change in land use.

4.4 PROTECTION IMPLICATIONS FOR MULTIPLE USE MANAGEMENT

Protection of the various forest values is necessary if the objectives of management are to be achieved. For instance, if jarrah dieback was allowed to infect forests on the salt-sensitive areas of the catchment, stream salinity would increase.

Forest values usually have differing protection requirements. The system of protection applied to each must be compatible with the priority use and all secondary uses must be viewed in relation to their compatibility with the protection needs of the primary use. Where inconsistencies are found, concessions must be made between the needs of the various land uses, or by modification to the protection system, provided the primary management objective is not unduly prejudiced.

This can be illustrated by considering an area managed primarily for timber production, with flora and fauna conservation and a roadside amenity strip as secondary uses. Prescribed burning of the entire area is the most effective means of protecting timber quality against wildfire. However a burning prescription can be adopted which provides for leaving a mosaic of burnt and unburnt areas which achieves effective protection from wildfire whilst catering to the fauna needs of habitat diversity and havens for animals during burning operations. Roadside amenity is taken care of by burning the road verge outside the wildflower display period and in sections rather than as a whole.

The sequence of events in superimposing protective measures on to land management can be summarised as follows:

a) Establish land use priorities according to site potential, demand and existing constraints.

b) Examine the protection requirements of the dominant land use.

c) Examine how the protection needs of the secondary land uses might interact with those of the dominant land use.

d) Adjust the protection needs of the various land uses or modify the protection system such that the primary management objective is not unduly prejudiced.

4.5 ZONING AS THE BASIS FOR INTEGRATED RESOURCE MANAGEMENT

The allocation of land use priorities to State forest will result in a mosaic of management priority areas. For effective land management and administration these areas will need to be grouped.

4.5.1 Management Grouping

A natural zoning results from land classification using geomorphology and climate. These criteria are closely related to site potential for various land uses. Such a grouping of priority areas will enhance practical land management by:

a) Rationalising the many land management categories that might be defined.

b) Ensuring uniform application of management prescriptions across administrative boundaries.

c) Avoiding loss of perspective where a number of land management categories occur.

The majority of State forest has not yet been delineated into management priority areas. However, the principle of management grouping can be illustrated with reference to the northern jarrah forest where there has been a detailed study of geomorphology, climate, soils and vegetation. This is elaborated in the Forests Department

brochure "A Perspective for Multiple Use Planning in the Northern Jarrah Forest" (at press). Here, marked west to east geomorphological and climatic gradients are described over the forest.

Ten management zones are recognised (Plan 2) and defined as follows:

High Rainfall Areas (greater than 1150 mm/annum)

1. Major valleys and escarpments.
2. Lateritic uplands.

Low Rainfall Areas (less than 1025 mm/annum)

3. Major river valleys.
4. Lateritic uplands.
5. Broad valleys and depressions.
6. Monadnocks.

Intermediate Rainfall Areas (1150-1025 mm/annum)

7. Major river valleys.
8. Lateritic uplands.
9. Broad valleys and depressions.
10. Monadnocks.

It is not yet possible to define a clear cut boundary between high and low rainfall groups as the change is gradual. To overcome this deficiency an intermediate zone has been created which is seen as transitional. Increased research may eliminate the need for this zone, but in the meantime, because of potentially high salinity risks in the zone, it is advisable to manage it on the same basis as low rainfall areas.

A summary of the site characteristics for each zone, its current and proposed land use in order of priority, is illustrated in Table 1.

4.5.2 Land Use Grouping

For the purposes of allocating available expertise, manpower, finance and material resources within the Department it is desirable to aggregate management groups according to the predominant land use.

TABLE 1

NORTHERN PLATEAU MANAGEMENT ZONES

ZONE		WESTERN HIGH RAINFALL (More than 1 150 mm p.a.)	
LANDFORMS		Scarp and Major Valleys	Lateritic Plateau
STYLISED LANDFORM SHAPE			
SURFACES	Name	"Helena, Darkin"	"Lateritic uplands"
	Type	Erosional	Stable
SOILS		Red earths	Laterites
VEGETATION	Dominants	Jarrah Marri Wandoo Blackbutt	Jarrah Marri
	Height	30 metres plus	30 metres plus
DIEBACK -	Occurrence	moderate	high
	Susceptibility	mod. - low	moderate
	Protection from Natural Spread	non protectable	protectable
WATER YIELD		high	moderate
SALT STORAGE		low	low - moderate
CURRENT MAJOR USES		Agriculture Hardwoods National Parks Pine Plantations Quarrying Recreation Water Storage	Bauxite Mining Hardwoods Recreation
PROPOSED MAJOR USES (Within State forest)		Water Supply Water Storage Recreation Hardwoods Flora/Fauna Pine Plantations	Water Supply Bauxite Mining Hardwoods Flora/Fauna Recreation

TABLE 1 (Continued)

CENTRAL, INTERMEDIATE RAINFALL
(1 025 to 1 150 mm p.a.)

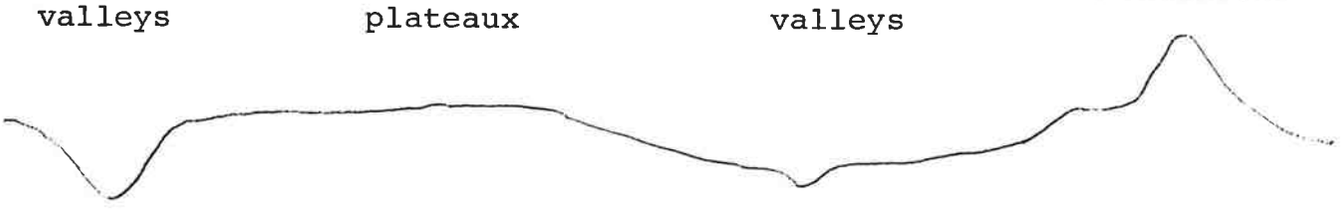
Major valleys	Lateritic plateaux	Broad valleys	Monadnocks
			
"Darkin"	"Lateritic uplands"	"Beraking Goonaping"	"Residuals, Cooke"
Erosional	Stable	Depositional	Erosional
Red earths	Laterites	Sands and clays	Rock, shallow earths
Blackbutt Marri Jarrah	Jarrah Marri	Jarrah Marri	Jarrah Marri Rock Sheoak
30 metres	25 - 30 metres	25 - 30 metres	25 metres
moderate	mod. - low	mod. - high	low
low	moderate	high	moderate
non protectable	protectable	non protectable	protectable
high	mod. - low	low	high
low - mod.	mod. - high	low	low
Agriculture Hardwoods Pine plantations Recreation Water storage	Hardwoods	Agriculture Coal mining Hardwoods	Hardwoods Recreation
Water supply Flora/Fauna Hardwoods Recreation Pine plantations	Water supply Hardwoods Flora/Fauna	Flora/Fauna Hardwoods Coal mining) Pine plantations) (In the Collie Basin)	Flora/Fauna Recreation

TABLE 1 (Continued)

EASTERN, LOW RAINFALL
(Less than 1 025 mm p.a.)

Major valleys	Lateritic plateaux	Broad valleys	Monadnocks
			
"Darkin"	"Lateritic uplands, Nockine"	"Beraking, Goonaping"	"Residuals, Cooke"
Erosional	Stable	Depositional	Erosional
Red earths	Laterites	Sands & clays	Rock, shallow earths
Wandoo Jarrah	Jarrah Wandoo Powder Bark	Jarrah (sands) Wandoo (clays)	Jarrah Marri Rock Sheoak
25 metres	25 metres	20-25 metres	25 metres
low	low	low	low
low	mod.-low	high	moderate
non protectable	protectable	non protectable	protectable
moderate	low	low	high
mod.-high	high	low (sands) high (clays)	low
Agriculture Hardwoods Pine plantations Recreation	Hardwoods	Agriculture Coal mining Hardwoods	Hardwoods Recreation
Water supply Conservation Hardwoods Recreation	Hardwoods Flora/Fauna	Flora/Fauna Hardwoods Coal mining) Pine plantations) (In the Collie Basin)	Flora/Fauna Recreation

With few exceptions, each land use will have priority for management on a proportion of the area in each region. Site potential, demand and constraints on the various land uses differ between these regions. Management policies will have varying priorities in each region and some will not be applicable at all. The predominant land use is that which is given management priority over the greatest area.

State forests and Forests Act timber reserves have been divided into the following broad administrative regions (Plan 3).

a) The Coastal Plain is that area west of the Darling Scarp between Cape Naturaliste and Moore River, characterised by a moderate rainfall, mild topography and infertile sandy soils. Most of this area is underlain by underground water resources, some of which are being partially utilised.

A high proportion of the State forest in this region has been utilised for softwood plantations and to date this is the predominant land use. There are important areas on which conservation of tuart forest, conservation of banksia woodland and recreation are the management priorities.

b) The Northern Plateau is the area north of and including the Preston catchment and east of the Darling Scarp, excluding Dryandra. It is characterised by infertile lateritic soils on undulating uplands and more fertile loams in the valleys. The area has suitable topography for water storage and a good rainfall with a marked west-east gradient. It provides the bulk of the surface water resources which are currently utilised in the metropolitan area and this is the predominant land use. It is subject to open cut mining for bauxite, and is covered by a hardwood forest of low to moderate productivity. Some areas are also used for recreation and for conservation of flora and fauna. Parts of the area are traversed by major roads, arterial power lines, pipe lines and bauxite conveyor belts.

c) The Blackwood Valley is the area of the Blackwood catchment east of the Darling Fault. It is characterised by a moderate rainfall, a high degree of dissection, and a high proportion of fertile, but shallow loamy soils. The predominant use is wood production with emphasis on softwood using

valley soils which are capable of supporting fast growth of Pinus radiata. It has surface water resources and recreational value. Some areas are allocated for conservation of flora and fauna.

d) The Donnybrook Sunkland is the area south of the Coastal Plain between the Darling and Dunsborough Faults. It is characterised by a moderate to good rainfall, mild topography, a high proportion of seasonal swamps and moist, but infertile soils. The predominant land use is timber production and it is capable of supporting satisfactory growth of pines given proper site amelioration. There is a large, though unused underground water resource. Some areas have been used for recreation and others for protecting flora and fauna.

e) The Southern Forest region is the area of catchments east of the Darling Fault, the rivers of which flow into the Southern Ocean. It is characterised by a good rainfall, moderate dissection and a large proportion of loamy soils. The predominant land use is timber production from the karri and southern jarrah forests. The water resources are as yet largely unused. Many areas are managed for protection of flora and fauna and others have considerable recreation use.

f) The Leeuwin - Naturaliste Horst is the area west of the Dunsborough Fault and south of the Coastal Plain. It is characterised by undulating topography and moderate rainfall with sands and sandy-loam soils. The predominant land use is timber production. Some areas are used for recreation whilst others cater for the protection of flora and fauna.

g) Inland forests are those to the east of the main forest belt and comprise Dryandra and parts of the Eastern Goldfields. These areas are characterised by an undulating topography, low rainfall, and open woodland. The area has little potential for water supply but is well suited to flora and fauna management which is the predominant land use. Recreation, sandalwood production and honey production are practised in many areas.

4.6 OTHER RELEVANT LAND USES

The management of State forest cannot be considered in isolation to the management of surrounding areas even though under differing ownership and land use. Forest management may sometimes influence adjacent land uses and vice versa.

Comprehensive land use planning must accommodate the interactions between different land ownership and adjacent land uses. The planning function must identify the practical limits of a land use system and not stop at artificial boundaries such as a change in tenure.

The major land uses adjacent to State forest and currently interacting with forest management include agriculture, National Parks and private forestry. Adjoining land tenures include private property, vested and vacant Crown land.

4.6.1 Agriculture

Agricultural practices may influence land use on State forest. For example, a major effect of clearing in low rainfall areas is higher stream salinity. Greater emphasis must then be placed on maintaining low salt levels in streams draining the State forest portion of the catchment so that the overall salt content is maintained at an acceptable level. Salinity problems are generally confined to catchments east of the 1150 mm isohyet. The Forests Department is currently investigating tree planting and agro-forestry techniques in these areas.

4.6.2 National Parks

A number of National Parks occur within or near State forest. They cater mainly for conservation of flora and fauna but also provide for passive recreation on a restricted basis. Their presence influences the allocation of management priorities in adjacent State forests. At the same time, State forest can provide a buffer which will extend the effective area of a National Park within, or adjacent, to it.

4.6.3 Private Forestry

4.6.3.1 Hardwood

Only a few areas owned by timber companies, and presumably to be managed for timber production, can be expected to contribute significantly to future log supplies. In relation to State needs this is expected to be of minor importance.

Some of these areas occur on the perimeter of State forest and where they occur in the salt-sensitive areas, the maintenance of a forest cover will assist in the protection of good water quality. As with National Parks, they can provide a buffer which effectively extends the forested area.

4.6.3.2 Softwood

Since about 1955 some 7 600 hectares of private plantations have been established. Private consulting and contracting services are available to assist growers and investors. A Departmental information service is also available for many aspects of establishment, maintenance and utilisation.

Departmental forecasts of timber demand suggest a shortfall in future local supplies. Private investment in forestry is therefore favoured. At present there is no consolidated management of private plantations. Nevertheless it must be recognised that in future this resource should provide a significant part of the State's timber supply.

The type of fire management on private plantations will markedly influence the protection system applied to adjoining State forest and other land tenures.

4.6.4 Vacant Crown Land

There are large areas of vacant Crown land which receive only limited management, namely fire protection. These areas can influence adjoining State forest in several ways:

a) they provide suitable habitats for flora and fauna;

b) they provide a few areas which closely approximate wilderness areas;

c) they provide an alternate area to ease the pressures on State forest for certain land uses such as recreation and harvesting of some forest products;

d) they may assist or hinder protection planning.

5. RESOURCE MANAGEMENT

Part I of the Working Plan has been prepared in the light of the multiple use management policy recently approved by Government and is the basis of land use planning in State forests.

Planning is concerned with the setting and achievement of goals. As forest management involves a large range of goals and recognises many ways of achieving them, it is necessary for practical purposes to segregate each aim from what and how, action will be taken. To this end the following planning terminology has been adopted:

Objectives of management: These are the purposes or goals of forestry in Western Australia. They are broad statements of what the Department expects to achieve within known legal, economic and social constraints now operating or expected to operate in the future. Multiple objectives are necessary to provide for all land uses and their protection. Logical decision making is possible only when priorities are assigned to objectives. This is catered for in the approach to multiple use adopted by the Department, whereby the forest is managed as a series of areas within which major and secondary land uses will be specified. Each unit is known as a Management Priority Area.

Policy: This is the course of action to be taken to achieve defined objectives and specifies broadly what will be done by the Forests Department. Such policies direct decision-making and form the basis for the objectives of each level of management.

Management strategy: This explains how the course of action, specified as policy, is intended to be achieved.

In this section each forest value and service function has been dealt with as if being managed for maximum productivity. However, there will be circumstances in which each land use is allocated a secondary priority resulting in some conflict with other land uses. Even where managed as the dominant use, this situation will frequently apply. Examples of the types and range of conflict that might be expected are outlined under each topic. In formulating regional management plans, officers must interpret the policies and strategies in relation to the conflicting land uses.

Management of the various forest values for long term social and economic benefit must recognise the need for education and scientific study. As this infers a land use allocation for these purposes, management requirements have been dealt with as one part of this section.

5.1 WATER

5.1.1 Regional and State Significance

Harnessed catchments on the Northern Plateau produce a large and reliable resource of potable water (Plan 4). Their convenient location to most of the population and many agricultural centres has accentuated the reliance placed upon them for the provision of good quality water for domestic, irrigation and many industrial purposes. Unharnessed surface water resources occur in southern forests and major underground sources exist in the Swan Coastal Plain and the Donnybrook Sunkland.

Water production involves catchment management, water collection and distribution to consumers. The Forests Department's responsibility is limited to the management of those catchment areas which occur on State forest, in accordance with the requirements of water supply authorities.

On the Northern Plateau, a high proportion of incoming rainfall is taken up by trees and transpired back to the atmosphere. Where rainfall is below 1025mm/annum, there are generally large accumulations of salt in the subsoil. Removal of the perennial deep-rooted vegetation is associated with a major reduction in transpiration, thus increasing the amount of water passing through the soil. Here this results in the salt held in the subsoil moving into the streams. Any increase in salt level reduces the capacity of the stream to blend with other sources to produce an acceptable water supply, and therefore represents a financial loss and reduction in the total water resource of the South West.

The value of water can be seen in relation to the opportunity cost, that is, the cost of the next best alternative to present supplies. For the metropolitan area, from figures presented by Sadler and Fields (1975), the opportunity cost of replacing forest water resources by desalination of sea water based on 1973 costs, was computed to be in excess of $40 million/annum.

Catchment management and research is aimed at maintaining and improving, where possible, the quality and quantity of water from State forest. These activities generate a significant amount of employment.

5.1.2 Water Demand

Water supply is the province of the Metropolitan Water Supply, Sewerage & Drainage Board (M.W.S.S.D.B.) and the Public Works Department (P.W.D.). The management of State forests is the Forests Department's responsibility. Where State forests and catchments coincide, management requirements are determined by the demand for water in terms of both quantity and quality.

5.1.2.1 Past trends

The 1975 Annual Report of the M.W.S.S.D.B. shows that demand for water in the metropolitan area supplied by this authority has increased from 156.8 million m^3 in 1972/73 to 181.2 million m^3 in 1974/75. Demand increases since the turn of the century have necessitated progressive harnessing of the major catchments on the Northern Plateau. The first major construction to store water on the plateau was Mundaring Weir, opened in 1902 to supply the Goldfields. The latest was the South Dandalup Dam, completed in 1972.

5.1.2.2 Future trends

Consumption is expected to increase with increasing living standards and industrial development. In the long term the rate of increase can be expected to decelerate with rising supply costs reflecting the scarcity of the resource. The current and future demand for water supply have been summarised by Sadler & Fields (1975). Taking the years 1972 and 2002 as reference points the components of the demand in millions of m^3/annum were given as follows:

	1972 $m^3 \times 10^6$	2002 $m^3 \times 10^6$
Metropolitan (M.W.S.S.D.B. and private bores)	232	738
Country (drawing from catchments on the Northern Plateau and bores on the Coastal Plain)	238	556
	470	1 294

Most of the remaining fresh water catchments in the South West occur mainly on State forests, as do a large proportion of known underground resources. Apart from harnessing additional catchments, water production can be increased by manipulation of the forest vegetation. The maintenance of vegetative cover is essential to keep stream salinity levels to a minimum in salt-sensitive areas. In areas where salt is not a potential problem, the maintenance of an open forest situation increases the yield of good quality water.

5.1.3 Catchment Area

5.1.3.1 Present area

The majority of water is supplied from the Northern Plateau where most of the major streams have been dammed, the most notable exception being the Murray River (Plan 4). The Northern Plateau is closest to the major population centres and the topography is suitable for water storage. Water yield is highest to the west where greater dissection of the landscape coincides with higher rainfall. The major proportion of these catchments occur on State forests.

The following is a break-up of the catchments in relation to the area they serve:

a) Most of the metropolitan requirements are met from 2 103 square kilometres of catchment on the Northern Plateau, the most significant being the Canning, Serpentine and South Dandalup.

b) The Goldfields and much of the central agricultural area is supplied from the Helena catchment with an area of 1 583 square kilometres.

c) Irrigation needs on the coastal plain are provided from catchments between Waroona and Donnybrook, the most significant being those of the Harvey and Collie Rivers.

d) The Collie River catchment also supplies water for the Great Southern Towns Water Supply Scheme.

e) Other small catchments provide water for townships scattered throughout State forest.

f) The intake area for much of the underground water being supplied to the metropolitan area is within State forest. The major resource in use is the Gnangara Mound, a large body of water within a high dune system.

5.1.3.2 Future areas

Most of State forests can be considered a potential source of water (Plan 4) and where this is so the following options are open to the water authorities:

a) Harness the remaining catchments on the Northern Plateau. Means of overcoming the high salinity of the Murray River are currently being studied.

b) Further develop the underground resources on the Swan Coastal Plain. In addition to those north of Perth, underground resources are known for the Myalup-McLarty area near Harvey.

c) Tap surface resources on the catchments south of Collie. In these areas cost increases will reflect the greater transport distances.

d) Tap the large underground resource of the Donnybrook Sunkland.

The supply of water by other methods such as re-cycling or the desalination of seawater is a decision for the relevant water authorities. Given the current level of tech-nology the cost of this form of supply is markedly greater than that of collecting and transporting water from southern catchments to the metropolitan area (Sadler and Fields, 1975).

5.1.4 Objective of Catchment Management

The objective is to manage State forest catchments which are needed for existing or future water supply, in accordance with the requirements of water supply authorities, to maintain or enhance water quantity or quality.

5.1.5 Catchment Management Policy

1. Protect existing healthy forested catchment areas from agents which might lead to deterioration of water quality.

2. Rehabilitate degraded areas where necessary to ensure that water quality is maintained or restored.

3. Regulate all other uses of forested catchments when they compete with water production objectives.

4. Monitor streams where changes in land use are involved.

5. Investigate techniques of land management aimed at maximising water production without detriment to quality.

6. Liaise with water supply authorities on all matters affecting water supply.

5.1.6 Management Strategy

1. Direct forest management on salt-sensitive areas towards maintenance of a deep-rooted perennial crop. Restore vegetation cover as quickly as possible where it is removed by dieback or other causes.

2. Design harvesting and silvicultural practices to maximise water production whilst protecting water quality.

3. Keep road construction and maintenance to the level necessary for catchment protection.

4. On salt-sensitive areas, fire suppression strategy must give priority to minimising the risk of dieback spread.

5. Provide for prescribed burning to be continued on catchments. Burning on each major catchment will be spread over several years to regulate runoff, and to minimise the potential danger from turbidity, ash pollution, and salinity, during the hazard reduction programme or in the event of wildfire.

6. Manage existing land uses on catchments so as to minimise the risks of siltation, turbidity, salinity and biological pollution.

7. Avoid land use changes where they prejudice water values or potential storage sites.

5.1.7 Interaction with other Land Uses

On catchments managed for metropolitan domestic supplies, water production conflicts with land uses involving either a high level of human activity, or a reduction of vegetational cover in salt sensitive areas. The former, typified by recreation, create a biological pollution hazard, and the latter, of which mining, agriculture and dieback are examples, present a salinity risk. On the other hand, management for the conservation of flora and fauna is generally compatible with catchment protection.

On catchments managed for irrigation supplies to the Coastal Plain and Eastern Agricultural Areas the maintenance of low salinity levels is still important, but the same restrictions to human activity do not apply. Potential land use conflicts can also be anticipated for those State forest catchments not yet harnessed.

Metropolitan surface water supplies are augmented from underground sources on the Swan Coastal Plain near Gnangara where the dominant land use is softwood silviculture. Productivity of these stands, conservation of flora and fauna on adjacent forest areas and local recreational opportunity can be affected by a lowered water table following pumping from bores. These effects are currently being monitored by an interdepartmental study group.

5.2 WOOD PRODUCTION

5.2.1 Regional and State Significance of Wood Production

Since settlement began in Western Australia, wood production industries have had considerable social and economic significance to communities throughout the South West area.

The timber industry, based on the sawing of local hardwoods, began in the earliest days of settlement, developed rapidly in the 1890's, and reached peak production in 1913. Historically the effect on South West development was fivefold:

a) the railway system was built to serve the timber industry and has been maintained largely by its freight;

b) both Bunbury harbour and Busselton jetty were developed as the major timber exporting outlets;

c) the development of agriculture was greatly assisted by the employment which forestry and wood production industries provided for many farmers in periods of economic downturn;

d) the industry resulted in township development in many parts of the South West and resulted in a basic infrastructure which assisted the development of other industries;

e) the timber industry provided the basic access for other land uses, as well as for forest management and protection.

Until recently, sawn scantling, sleepers and other large sections were the principal output from this industry. Other produce included piles, poles and bridge timbers, fence posts and rails, strainers, sawdust and firewood. These products have been augmented by pine plantation wood resources for manufacture of plywood and particle board.

More recently a wood chip industry has commenced operations using forest residues that were formerly burned as waste. It is evident that the industries based on wood chips and particle board production are having a significant stabilising effect on work forces in the South West, particularly at Bunbury and Manjimup.

The work force employed on the growing, harvesting and processing of timber is very large and is spread throughout the South West. Prior to 1960, the industry directly employed more than 6 000 men. Despite increased mechanisation, it still employs approximately 4 000 men. An additional 1 000 are employed in forest management. Many thousands are employed throughout the State in wood processing and construction industries, together with the various support and other necessary services which have developed mainly as a result of forest utilisation.

It is estimated that the annual value of sawn production is currently of the order of $53 million (made up of $51 million hardwood and $2 million of local pine). Historically, sawmilling has been a labour-intensive industry and hence a major proportion of this production value represents personal income which is a direct input to the regional economy.

5.2.2 Demand

The demand for timber in Western Australia is affected by factors such as quantity, types of timber products, exports, imports and substitutes.

Quantity: The demand for wood as a raw material is derived from the demand for its various end products. The main components of demand are, population, real per capita income, technology, taste, price and the opportunity to replace wood with other materials.

In the foreseeable future, housing is expected to remain the single largest market for sawn timber. However, the housing industry is currently undergoing significant changes, namely:

a) substitute materials such as steel, aluminium and plastic products are challenging the traditional roles of timber in housing;

b) rising construction costs are resulting in more efficient use of available resources. This is evident, for example, in the increasing use of engineered timber products such as laminated beams, nailed plate roof trusses and pre-fabricated wall framing;

c) the average size of houses being constructed is gradually decreasing.

In the light of these considerations, the per capita consumption of wood will probably fall, although through population increase the level of demand for timber products is expected to continue rising.

The local demand for sawn timber has been estimated to be 943 000 m^3 in 1980 and 1 222 000 m^3 by 2010. These predictions for sawn timber demand in Western Australia were based on the 1975 Borrie Report projections of population and on per capita demand figures calculated from a regression relating demand to economic factors. The estimated population of the Pilbara and Kimberley regions was deducted from the State prediction as these areas cannot be supplied from South West forests any more easily than Perth can be supplied from eastern Australia. The estimates do not include interstate or overseas demand for local timber.

Types of timber products: Increasing competition for the limited wood resource will result in changes in the size and type of product supplied, for example, in the decreasing supply of large sleepers for export. In the long term a similar trend is expected with large section structural timber except that there will be increasing scope for laminated members instead of solid beams.

The market for local sawn timber will tend to stabilise around small-section scantling and joinery. Initially the market will continue to be dominated by jarrah and karri but hardwood availability will decline while softwood supplies increase.

It is likely that lower quality logs will be utilised as demand for the limited resource rises. The average size of log available will continue to decrease and this will bring about change in present processing techniques and a high degree of remanufacture.

Plywood and particle board demand are also closely tied to the construction industry and consumption is expected to rise steadily over the next five years. However, the demand for local products would be affected if there were changes in tariff protection policy.

There will be growing economic pressure to increase the use of wood residues. In the short term the production of charcoal and wood chips is likely to increase, and eventually pulp production can be expected. The present annual demand of 35 000 poles for State Energy Commission transmission and distribution lines is expected to continue.

Substitutes: Over the next five years the trend of replacing traditional timber products with steel, aluminium, concrete and certain plastics, will continue. The effects on timber usage will be subject to relative cost structure, technological advances and consumer taste.

Imports: In the year ending June 1975, sawn timber imports totalled some 31 000 m^3, together with 9.1 million m^2 of veneer, wood laminates and reconstituted wood products. Wood manufactures, mainly as furniture, are imported in considerable quantities. Volumes are not available for the import of timber in log form. These imports are generally for specialised end uses and this level of demand should continue.

Overseas exports: Significant quantities of large section railway sleepers and crossings have been exported in the past. The demand for this type of product is expected to decline as production costs increase, resulting in preference for concrete sleepers. A fall in exports of sawn timber is forecast as this timber finds its way into local end uses such as joinery and scantling.

Interstate exports: Interstate markets require mainly small section timber for specific uses such as roof trusses, flooring and decorative purposes. There is a moderate demand which is expected to continue because local hardwoods offer qualities specifically suited to these end uses.

Interstate trade is governed by the Australian Constitution and there is no barrier to trade between States.

5.2.3 Supply*

It is necessary to take into account present and future availability of local wood resources on Crown land and private property, imports, exports and substitutes.

5.2.3.1 Present availability

Crown land resources: Current estimates of sawlog resource are 23.57 million m^3 of hardwood and 0.35 million m^3 of softwood. The total assessed volume of hardwood is 133.97 million m^3, and of softwood is 2.0 million m^3 (Table 2).

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* All volumes quoted in this section refer to bolewood of living trees. Hardwood resource estimates are derived from measurements made on more than 10 000 plots in the period 1965 to 1975. Softwood estimates are based on measurements made on more than 4 000 plots.

For hardwoods, sawlog volume relates to underbark volume in trees over 50 cm d.b.h.o.b. (diameter breast height over bark). Non-sawlog volume relates to underbark volume in trees over 10 cm d.b.h.o.b. which do not include material available for sawlogs. Sawlog volumes apply as at June 1975 and relate to 1975 standards of utilisation.

For softwood, sawlog volumes are underbark volume and for P. pinaster is 50% of volume over 20 cm d.o.b. (diameter over bark) in stands over 20 years of age. For P. radiata the volume includes total volume in trees over 20 cm in stands over 20 years of age, and 50% of volume in thinned stands between 16 and 20 years of age.

Table 2 : Estimated Crown Land Timber Resources

(A) Hardwood

	Suitable for wood production $m^3 \times 10^6$	Not available for wood production* $m^3 \times 10^6$	Total $m^3 \times 10^6$
Sawlogs volume			
Jarrah	16.3	3.6	19.9
Karri	7.0	3.1	10.1
Wandoo	.08	.02	.1
Blackbutt	.19	.05	.24
Total	23.57	6.77	30.34
Other wood volume			
Jarrah	56.5	12.6	69.1
Karri	6.6	2.86	9.46
Marri	44.7	14.9	59.6
Wandoo	1.4	.36	1.76
Blackbutt	1.2	.35	1.55
Total	110.4	31.07	141.47
Total volume			
Jarrah	72.8	16.2	89.0
Karri	13.6	5.96	19.56
Marri	44.7	14.9	59.6
Wandoo	1.48	.38	1.86
Blackbutt	1.39	.40	1.79
Total	133.97	37.84	171.81

(B) Softwood

	P. radiata $m^3 \times 10^6$	P. pinaster $m^3 \times 10^6$	Total $m^3 \times 10^6$
Sawlog volume	0.31	0.04	0.35
Other wood volume over 8 cm d.b.h.o.b.	1.09	0.56	1.65
Total	1.4	0.6	2.0

* Volumes on areas where management objectives do not include timber production.

The estimate of non-sawlog volume includes a small proportion which represents the future sawlog crop, and a further small proportion suitable for poles, piles and other roundwood products. The remaining large volume is suitable only for industries producing such material as wood chips, charcoal and particle board.

The primary hardwood sawlog species are jarrah and karri. Hardwood residues include jarrah, karri, marri, wandoo and blackbutt. Softwood plantations are almost exclusively P. radiata and P. pinaster. Figures in Table 2 do not include tree remnants resulting from sawlog preparation, groundwood or standing dead trees.

The tingles and tuart have been excluded from the commercial timber resource because of the very limited availability of all four species. They will be managed primarily for their perpetuation by appropriate regeneration treatments aimed at maintaining a full range of age classes.

Within areas where management priorities do not include timber production, there are 6.77 million m^3 of sawlog quality volume and 37.84 million m^3 of total assessed volume.

Private forest resources: Hardwood areas on private property have been extensively cut over in recent decades, and in 1975 only contributed 7.3% of the annual log intake.

As at March 1976, the softwood plantation areas amounted to some 7 600 hectares but are not yet of an age to contribute significantly to State wood resources.

Substitutes: Steel, aluminium, concrete and certain plastics are currently in plentiful supply, and prices are competitive.

Imports: The major supply areas for imported wood products are currently eastern Australia and South East Asia.

Exports: The current demand for local timbers cannot be met from local supplies.

5.2.3.2 Future trends

Crown land resources: As well as producing timber, the present area of State forest must meet the demand for uses such as water catchment, open cut mining, public utilities and large scale allocation for recreation and conservation of flora and fauna.

Therefore, some areas previously allocated for timber production are now excluded.

a) Forests managed for wood production

The forests do not have a uniform growth rate. In considering future timber supplies it is necessary to categorise the growth potential and its contribution to utilisable resources. The three major categories are, original forest, hardwood regrowth forest and plantation forest.

Original forest includes uncut forest plus remnants of the original stand in areas which have been cut selectively over the past 100 years. Uncut forest is a static resource and growth is relatively slow on old trees remaining in the logged stands. The future supply of timber from this source will be determined by variations in demand and the need to maintain the stability of the timber industry. It must be emphasised that the rate at which this type of forest is cut will determine the rate at which the faster growing second crop is regenerated.

The majority of hardwood regrowth forest is not subject to regular tending and therefore bole diameter growth on individual trees is slow. It is likely to continue to yield limited quantities of poles and fencing material, but is not expected to contribute to the sawlog resource until well into the next century.

Plantation forests are primarily softwoods but include small areas of hardwoods. The management programme is aimed at rapid production of sawlog sizes and may involve cultivation, fertilising and regular thinning. It is planned to increase the plantation resource and in the long term it should become the primary source of supply of wood to industry.

For the year 2010 the total sawlog supply could be as follows if the current softwood planting rates are maintained:

Table 3 : Predicted Sawlog Supply in 2010

Hardwood	315 000 m^3
Softwood	687 000 m^3
Total	1 002 000 m^3

The total sawlog demand for the year 2010 is expected to be 1 222 000 m^3. Therefore unless planting rates are increased, a shortfall of 220 000 m^3 can be expected. This imbalance is further discussed in Section 5.2.5.

b) Forests managed for other purposes

It can be expected that some forests managed for purposes other than hardwood production will still yield roundwood supplies, including sawlogs, as a by-product of tending and regeneration. As yet, the rate at which they will yield such products cannot be predicted accurately. Supplies from this source have therefore been excluded from wood production planning in this Working Plan (refer Section 5.5.3 for management of "forest parks").

Private forest resources: The rate at which supplies of timber from private plantations become available will depend on the rate of planting and the silvicultural regime adopted. Although a significant contribution is anticipated, it is not possible to predict accurately the time at which it will be made available, the amount or the quality of such timber.

The rate at which private hardwood supplies will come on to the market is expected to decrease, and in the future will not be significant in relation to State timber requirements.

Substitutes: It is expected that substitute materials will continue to be in plentiful supply. The future price will depend on the increasing costs of conventional energy supplies.

Imports: With increasing world demand there will be greater competition for imported wood products which is likely to restrict availability for the relatively small Western Australian market. Present indications suggest a continuing availability from countries presently supplying wood material to this State for as long as two decades. However, there could be unpredictable changes to both availability and price. In the long term it is unlikely that regular supplies of imported general purpose timber could be assured.

Exports: Supplies of small section local timber for some interstate and overseas markets are expected to continue. Large section timber such as rail sleepers and crossings will become increasingly scarce in the future. This will be reflected by higher prices.

5.2.3.3 Implications of reliance on imports or substitutes

Several significant economic consequences are likely if Western Australia relies on imported timber supplies or substitute materials.

a) Perth is one of the most geographically isolated cities in the world. Costs of transporting materials into Perth are high and can be expected to increase in the future.

b) Growing wood for timber production is a long term project. Present availability is subject to gross fluctuation in price due to world market changes. Although imports might be available for the next one or two decades, predictions of supply beyond then are virtually impossible. Control of production policies in other States or the foreign policies of other countries are of course not possible.

c) Shipping and other transport systems are beyond local control.

d) Many wood substitutes require significantly higher energy inputs for their manufacture as the following table indicates:

Product	Manufacturing energy requirements (megajoules/kgm)
Aluminium	250
Copper	60
Glass	20
Bricks & Tiles	4
Concrete	1
Wood	0.5

Source: C.S.I.R.O. (1975) - Saving Energy at Home. Ecos. 6.

With the predicted shortage of conventional energy supplies, it is reasonable to assume a changing cost structure reflecting higher prices for those materials requiring a high energy input.

Considering these factors, responsible economic policies should provide for the supply of a high proportion of locally grown timber. In the light of long term supply uncertainty from sources outside this State, it would be desirable to achieve net self-sufficiency of timber products.

5.2.4 Objective of Management

The objective is to ensure in the short term, that present levels of supply are maintained, and that, by early next century, the estimated local demand for sawn timber can be met from local supplies. At the same time, the cut from indigenous forest will be regulated according to the long term productive capacities of the respective species, having due regard for regional stability of the timber industry and employment.

5.2.5 Background to Policy Formation

5.2.5.1 Maintenance of wood supplies

Based on present projections of demand and estimates of supply from hardwood and softwood forests, it is desirable to increase the rate of pine planting by the Forests Department from 2 400 hectares to an estimated 3 000 hectares/annum, in order to be reasonably self-sufficient in timber supplies after the year 2000. This presumes a contribution of 500 hectares per annum from private plantings. To provide a stable supply of wood until the year 2000 it will be necessary to increase the rate of harvesting from plantations. It is expected that any short term deficit will be made up from imports.

5.2.5.2 Regulation of the cut

Regulation of the cut from State forests consists of two phases:

a) determination of the allowable cut,

b) determination and control of each permissible intake under sawmilling permit or license within the overall limit of the allowable cut.

Determination of the allowable cut: Broadly, this involves estimating the total productive capacity of an area; deciding how much of this shall be removed; determining whether reinvestment in wood capital is required or whether any excess wood capital shall be removed; finally deciding what portion of the growing stock shall be cut.

Under ideal circumstances, the allowable cut should equal the total annual growth of the forest and a constant level of forest capital should be maintained after the cut. For this situation to apply, it is essential to have

a) a secure and stable forest estate;

b) stable long term markets, completely aligned with the types and quantities of produce becoming available each year;

c) roughly equal quantities of the various types of forest produce coming forward each year;

d) a forest made up of a complete range of age classes in units of either equal area or of uniform productivity.

Clearly, this classic concept of sustained yield cannot apply in cases where the distribution of age classes is grossly unbalanced as a result of long past cutting, where markets have been restricted to a limited range of products, i.e. hardwood sawlogs, or where a plantation estate is being built up as in Western Australia.

In order to work towards a greater balance between growth and yield, especially in sawlog sizes, it is necessary

to reduce the hardwood cut. This level of cut, when supplemented by additional softwoods will meet current demands as far as possible and at the same time allow the sawlog capital of the forests to accumulate. For present purposes, determination of the level of cutting, i.e. "the allowable cut", must be based on management decisions, rather than on silvicultural criteria. The allowable cut relates only to major sawmilling permits and licenses issued over State forests for logs of general purpose sawmilling quality. Short term local licenses are however issued for salvage material not generally up to these standards to promote maximum recovery of sawn material from the resource.

Control of mill intake: The allowable sawlog cut will continue to be regulated under the current system of sawmilling permits or licenses. The former may be renewed for periods of up to 10 years while the latter are issued annually. Under this system, each sawmill operating on State forests is entitled to a monthly "permissible log intake". The permissible intakes for most permits or licenses were set in the 1960's or earlier. They were based on estimates of resource availability and economics of sawmill operation applying at that time. Until the early 1960's the actual log intake fell far short of the allowable cut and as a result it was common practice to set the permissible cut above this level. It is now necessary to equate these two figures.

In administrative terms, a permit holder has sole and exclusive rights to all sawlog material over an area specified in the permit, whereas a licensee is merely entitled to a specified quantity of sawlog material.

Although the security of tenure conferred by the permit system may have been necessary in the past, it is now becoming evident that greater flexibility is required for the more effective distribution of the available resource. This is becoming increasingly necessary because of anomalies in the location of sawmills in relation to their sources of log supply, because of the imbalance of species distribution on permit areas and because of the wider range in size and quality of produce now being sought for various end uses.

Consideration of the progressive replacement of major sawmilling permits by licenses is therefore required in the interests of flexibility of access to raw material and improved utilisation of the available resource for a wider range of end uses.

5.2.5.3 Sawlog production

Hardwood: Determination of the level of sawlog production is an extremely difficult task which depends on accurate assessment of present marketable volume, appraisal of potential growing stock and appraisal of growth rates for individual forest types.

Estimation of total standing volume, that is, the volume of every tree in the stand including those of marketable size and those which have the potential to become marketable logs in future, depends on statistical sampling, stratification of the forest into uniform productivity classes and accurate determination of the area of each of these classes.

Having estimated total sawlog volumes, it is an equally difficult task to determine the proportion of that volume which is acceptable to industry for general purpose sawmilling at any particular time. Determination of this acceptable proportion of the total standing volume depends on accurate appraisal of inherent (and whilst the tree is still standing, largely invisible) defect in relation to current milling technology and marketing economics. The latter are subject to rapid unpredictable changes.

Estimation of growth rates for individual trees, is the most difficult task of all. Because of the fire regime in Western Australia, change in underbark volume over time is the only acceptable criterion.

Because of relatively slow growth rates, changes in bark thickness in jarrah due to its stringy nature, and in karri due to decortication, are such as to completely mask the effects of underbark growth over short periods, unless the most precise mensuration techniques are applied. Even then, there are difficulties in estimating such factors as taper to convert surface measurements to underbark volume for each tree. There is further difficulty in selecting individual tree statistics which are representative of broad areas of a forest type. Multiplier effects can obscure the determination of underbark growth within an acceptable range of statistical variation. This problem is not unique to Western Australia, but applies wherever relatively slow-growing trees with variable bark characteristics occur.

Since 1928 various estimates of the hardwood sawlog resource on State forest have been made, based on differing premises and degrees of reliability of information. These estimates were:

a) 1951 - estimated roughly by the Royal Commission to be 73 000 000 m^3 on 1 620 000 ha of State forests and timber reserves.

b) 1955 - estimated at 98 000 000 m^3 on 2 753 000 ha of State forests, potential State forests, timber reserves, Crown lands and private property with timber reserved to the Crown.

c) 1971 - estimated at 57 000 000 m^3 on 1 883 000 ha of State forests and timber reserves (Forests Act).

Each of these estimates refer to the proportion of total standing volume considered to be "marketable". This volume has two components:

a) Logs of a size and quality suitable for sawmilling at the time of assessment.

b) Logs which are potentially suitable at some time in the future.

Though always recognised as optimistic, it provided an upper limit to the estimate of resource available to the sawlog industry and has been used for long-term planning purposes in the past.

The most up-to-date estimate of "marketable" volume is that assessed in 1971. Assessments are currently in progress to establish the proportion of this volume suitable for sawmilling today. Though incomplete, the interim figures have been adopted for the purposes of planning the sawlog cut during the next five years. They indicate that the volume now assessed as suitable for sawmilling falls well short of the "marketable" volume assessed in 1971.

After allowing for removals over the past five years present estimates of volume in trees over 50 cm d.b.h.o.b.

suitable for general purpose sawmills operating under permit or license are:

Jarrah	19 900 000 m^3
Karri	10 100 000 m^3
Total	30 000 000 m^3

Jarrah dieback has a significant effect on sawlog resources. To date some 183 000 hectares of forest are known to be diseased, and rate of spread measurements indicate that the infected area has recently been increasing at about 20 000 hectares per year. Dieback causes depressed growth rates before death and loss of volume in individual trees which cannot be recovered economically. At the same time dieback has significantly reduced the extent of jarrah regrowth stands which would otherwise have been available for future timber production.

Furthermore, there can be no simple equation between the volume of mature trees of sawlog size removed annually, and the volume of annual growth. For this there are two main reasons: First, as a result of past selective cutting the hardwood forest does not consist of a regular gradation of age classes; second, sufficient time has yet to elapse before established regeneration reaches the minimum marketable size required to meet existing standards of sawmill technology. For this reason it must be borne in mind that regrowth stands resulting from current felling will not provide any substantial quantities of sawlogs of economic size until well into the next century.

Only part of the volume stated as suitable for sawmilling is available to that industry. To meet demands for flora and fauna conservation, scientific study, recreation, stream protection and aesthetics, large areas, and therefore large volumes, have been withdrawn from the resource previously allocated for commercial timber production. For the purposes of this Plan, the commercially acceptable volume available to the general purpose sawmilling industry is therefore as follows:

Jarrah	16 300 000 m^3
Karri	7 000 000 m^3
Total	23 300 000 m^3

Consequently, the total available hardwood sawlog resource is likely to be exhausted within 25 years at the

present rate of cutting. As was foreshadowed in General Working Plan No. 85 of 1972, the hardwood cut must be reduced. Given implementation of this proposal, it is forecast that the hardwood cut could be reduced to an annual level of between 150 000 m^3 and 200 000 m^3 within 50 years. This is within the capacity of the present hardwood sawlog resource. In doing so, it is essential to minimise disruption of timber supplies and employment in the industry by introduction of softwood at a rate which will allow orderly reduction of the hardwood cut and to achieve the reduction in such a way as to maintain the relative marketing capabilities of the various companies.

After reviewing the overall productivity of State forest, it is evident that the karri forest can make the greatest contribution to future sawlog production so long as the present marketable volume (excluding that withheld in priority areas for conservation of flora and fauna and scientific study) can be released over sufficient time to allow existing regrowth stands to reach marketable size. Therefore, there should be a proportionately greater short term reduction in karri sawlog intake so as to ensure future continuity of hardwood sawlog supplies at a significant level.

Softwood: Introduction of softwood into West Australian markets on a long term basis involves consideration of the need to maintain a stable industry, the availability of land for pine planting and the contribution of softwood from private sources.

a) Maintaining the production level: The area of plantations established by the Forests Department to 1975 is approximately 39 000 ha, made up of some 17 000 ha, of P. radiata and some 22 000 ha of P. pinaster. P. radiata will be used to a greater degree in future plantings because of its greater productivity and management flexibility. Less than 17 000 ha of the plantations are over 10 years old and the current yield of sawlogs is relatively small. State Government plantations are being managed for the production of high quality sawlogs, using such silvicultural measures as non-merchantable thinning, low stocking rates and high pruning of crop trees. Softwood will be introduced to the market at a rate which will allow orderly reduction of the hardwood cut. For the period of this Plan a planting programme of 3 000 ha per year

has been adopted. If in future it becomes apparent that the actual production will catch up with or exceed the demand, the planting rate can be readily adjusted. Unfortunately it is impossible to remedy the opposite situation of "too little too late".

b) Land available for pine planting: Replanting uneconomic farmland is a desirable method of afforestation. The Forests Department has actively pursued a policy of land acquisition for this purpose and between 1955 and 1976 purchased some 14 000 ha of farmland, mainly in the Blackwood Valley between Nannup and Bridgetown. Subject to available finance, this policy should be continued as suitable land is offered for sale in acceptable localities.

A considerable area of sandy soils in the Donnybrook Sunkland is suitable for conversion to P. radiata plantation given appropriate fertiliser treatment. The area carries fire damaged jarrah forest largely infected by dieback disease and for most purposes would be considered of relatively low productivity. The diseased sections are unproductive and in need of rehabilitation. A high proportion of the forest as yet unaffected cannot be protected from dieback because of adverse drainage patterns and high water table. Environmental aspects of a proposal to convert some of this land to pine plantation have received careful study. This proposal is described in detail in a document entitled "Afforestation with Pines in the Donnybrook Sunkland - Statement of Intent". The Sunkland is situated in close proximity to the Blackwood Valley where a major area has already been planted with P. radiata. The two locations could provide a concentrated softwood resource capable of supporting a large-scale integrated wood processing industry.

c) Contribution from private plantations: A significant area of pine plantations has been established on private land in the past decade, particularly in the Blackwood Valley. Up to March 1976, approximately 7 600 ha, largely P. radiata, have been planted. In determining the State planting programme, it has been assumed that private planting will contribute 500 ha per annum. Whilst this is less than has been planted in the past few years, it is necessary to adopt a conservative estimate for planning purposes as the area planted each year, its location and future availability, are not programmed in relation to State requirements.

5.2.5.4 Wood residues

Due to small population and isolation from major export markets, Western Australia has not seen the development of large industries using wood residues, until relatively recently. Sawlogs have been the traditional product from the forests of the South West. The original hardwood forests have inherent defects and are not as suitable for sawlogs as species in some other parts of the world. As a result only a small proportion of the total forest volume has quality and size characteristics suitable for economic production of squared timber with the milling technology of today. The figures discussed in relation to availability of this product do not reflect the wood productive capacity (growth) of the forest.

It has been estimated that bole wood now available and suitable for wood production other than sawlogs exceeds 100 million cubic metres. Given this bank of wood and industries able to handle a wide range of size, shape and quality of raw material, total growth potential would meet an annual harvest markedly above the current cut. The yield would be based on thinnings from regrowth stands and removal of original forest trees competing for nutrient and space which is more effectively used by more vigorous young trees.

Without industries utilising residues, it has not been economically feasible to achieve maximum utilisation of the forest. With the development in southern forest of the wood chip industry which is integrated with sawmilling industries, and has concurrent bush operations, maximum resource utilisation is possible. Benefits have been demonstrated in northern softwood plantations where a particle board industry has been utilising residues for some years. Similar benefits will extend into southern plantations with the development of the particle board factory at Dardanup.

Sawlog harvesting and milling results in two main forms of residue, namely, remnant parts of trees following log removal, and offcuts from log conversion. Wood resulting from forest tending and improvement operations, is a further source of raw material for the residue using industries. The economics of managing State forest to meet local sawlog demand are considerably improved by the integration of sawlog and residue industries. The removal of cull trees and debris by these industries is also beneficial with respect to silviculture and fire protection. There is likely to be a gradual change to a greater use of forest residues for the production of particle board and wood pulp.

The major industries now based on residues are hardwood chip production from karri and marri, charcoal production from jarrah and particle board production from softwood. The level at which these industries will be supplied are set under special agreements with the State.

5.2.5.5 Poles, fencing material and other roundwood

The present annual demand for 35 000 poles is expected to continue and is becoming increasingly difficult to obtain from State forest. In the past most of these poles have been supplied from jarrah regrowth stands. There are still adequate supplies of smaller jarrah poles but larger sizes are scarce. In addition the pole-getting operation has ranged widely in the forest increasing the risk of infecting extensive areas with jarrah dieback.

To overcome these problems it is considered necessary to restrict the operation in jarrah forest to summer and in association with sawlogging operations, and to direct the industry to greater use of marri, karri and ultimately, pine poles. It is considered desirable to supplement pole resources by managing specific areas intensely for this purpose. This will include planting up to 100 hectares/annum with a suitable pole species.

Sufficient fencing and other roundwood material will result from forest tending and regeneration operations, and no special planning is necessary to ensure an adequate resource.

5.2.6 Wood Production Policies and Strategies

5.2.6.1 Sawlog production policy

1. Gradually reduce the level of the hardwood sawlog cut to between 150 000 m^3 and 200 000 m^3 over the next 50 years.

2. Increase the level of pine sawlog production to approximately 900 000 m^3 by the year 2010.

3. Control log preparation and allocation to user industries to achieve the most effective resource utilisation.

4. Continue investigations into harvesting techniques designed to avoid environmental damage.

5. Liaise with the timber industry concerning environmental protection, future availability of the resource and utilisation standards.

6. Liaise with private plantation owners to encourage plantation extension, co-ordination of wood resources with the State and advise on plantation management.

5.2.6.2 Sawlog production strategy

1. Set the rate of reduction in the hardwood cut over the next decade at a practical level, programmed to take into account the relative marketing capabilities within the existing industry, local demand, the rate at which pine sawlogs become available, and stability of industry and employment.

In 1974/75 the permissible intake of sawlogs from Crown land was 1 080 000 m^3. By 1980/81 this will be reduced to 795 000 m^3. At the same time the actual cut from Crown land will be reduced by approximately 137 000 m^3 (or 15% of the present cut from permit and license areas). The karri sawlog intake will be reduced by some 67 000 m^3 and the jarrah cut by about 70 000 m^3.

There will be a phased reduction in hardwood intake for the next ten to fifteen years which will involve gradual restructuring of the industry by

a) amalgamation of sawmills into a reduced number of units of economic size;

b) variations of permits and licenses to provide the management flexibility necessary for multiple use forestry;

c) relocation of mills and processing facilities in more socially favoured localities;

d) transferring part of the workforce to remanufacturing activities and into the developing pine processing industry which will be established in the South West, but not necessarily at those centres currently occupied by the hardwood industry.

During the next 5 years this reduction will involve the closure of about 18 sawmills.

The more detailed provisions for the approved cut for each mill are contained in Part II of the Working Plan which is confidential because publication of its contents could adversely affect the trading arrangements of forest based industries.

2. Reduce the jarrah cut proportionately less than the karri during the period of this Working Plan.

3. Give priority to supply of high quality logs to veneer manufacturing industries.

4. Regulate the cut taking into account relative mill efficiencies. Continue control of mill intakes under the existing system of permits or licenses and specify permissible intake by species. Review permit and license conditions to facilitate reduction of the cut and improve utilisation.

5. Introduce modern pine sawmilling techniques into the State on a modest scale. During the period of this Working Plan sawlog production from State Government plantations will be increased to about 82 000 m^3. The Forests Department will progressively adjust its pine milling activities to an experimental basis. This is designed to assist the increasing private industry in product development and acceptance. Pine sawlogs will be made available to the private sector in accordance with the provisions of the Forests Act and Regulations.

6. Plant 3 000 hectares of softwood per annum, favouring P. radiata wherever possible. A high proportion will be concentrated in the Donnybrook Sunkland and repurchased farmland in the Blackwood Valley. The remainder will largely be established on the Coastal Plain and in the Collie Coal Basin.

7. Improve utilisation of the resource by using various directives, incentives and educational programmes.

8. Prevent damage to soil values, and further artificial spread of dieback, by reducing winter logging operations and developing summer stockpiling techniques.

9. Design harvesting programmes to minimise road length and design specification so as to avoid unnecessary environmental damage and loss of forest estate.

10. Investigate means of obtaining compensation for loss of forest values associated with roading.

5.2.6.3 Residue production policy

1. Direct residues from sawmilling and forest tending operations to appropriate industries.

2. Harvesting of residues will be according to priorities set to achieve maximum State benefit and minimum environmental damage.

5.2.6.4 Residue production strategy

1. Generally harvest residues concurrently with sawlog operations. Exceptions to this will only be approved, where residue becomes available from forest tending and regeneration treatments, where drywood is available, and where the removal of these products does not conflict with major land use objectives. Particular attention will be paid to removing residues resulting from plantation clearing.

2. During the period of this Working Plan, supply raw material from State forest for the established residue-using industries, namely,

Company	Agreement	Maximum Amount of Wood per Annum
W.A. Chip & Pulp Co. Pty. Ltd.	Woodchipping Industry Agreement Act 1969-1973	680 000 tonnes
Wesply-Wesbord Industries Pty. Ltd.	Wesply (Dardanup) Agreement Authorization Act 1975	330 000 m^3
Agnew Clough Pty. Ltd.	Wundowie Charcoal Iron Industry Sale Agreement Act 1974	136 000 tonnes

Firewood supplies will be made available where they are not part of the allocated residue resource, where they do not create a disease risk, and where they do not conflict with other land uses.

5.2.6.5 Poles and other roundwood production policy

1. Supply poles from jarrah forest where this does not increase the risk of spreading dieback, or result in conflict with other land uses.

Marri and karri poles will be made available according to market demand. Areas of up to 100 hectares/annum will be planted and managed primarily for pole production.

2. Supply roundwood required for deep mining from areas where it will not conflict with major land use objectives.

3. Make other roundwood available from forest tending and regeneration operations.

5.2.6.6 Poles and other roundwood production strategy

1. Continue liaison with the State Energy Commission to arrive at greater usage of species other than jarrah and minimum standards for each pole quality. Introduce management arrangements which allow extraction of jarrah pole supplies largely during summer.

2. Study the feasibility of more complete integration of pole harvesting with other production operations.

5.2.6.7 Forest management policy

1. Apply appropriate silvicultural treatments to achieve maximum sawlog production consistent with maintaining the forest in a healthy and vigorous condition.

2. Rehabilitate degraded hardwood forests. Preference will usually be given to sawlog producing species.

3. Extend the area of State forest available for timber production purposes whenever suitable land can be obtained.

5.2.6.8 Forest management strategy

1. Taking into account growth and natural succession

characteristics of forest stands, apply silvicultural techniques such as cultivation, fertilisation, thinning and removal of competing vegetation, which will stimulate growth on the remaining crop trees. Forest improvement work will only be implemented where disease and other damaging agencies can be controlled.

2. Degraded sites with high production potential will receive priority for rehabilitation.

3. Suitable areas of available private property will be purchased for intensive wood production as finance permits. Land exchange will be considered where the total growth potential will be increased.

4. Dedication of vacant Crown land as State forest will be requested where it is carrying a production timber crop or has the potential to do so.

5.2.7 Interaction With Other Land Uses

The conflict between timber production and other uses is largely determined by the level and frequency of site disturbance associated with harvesting and tending operations.

In the short term open cut mining is totally incompatible with timber production. In the long term it will affect growth potential on mined sites. Similarly, timber production and damming of river valleys for water storage are in direct conflict.

Silvicultural practices in indigenous forests may limit, but not exclude, conservation of flora and fauna, some forms of agriculture, scientific purposes, recreation and catchment management.

The processes of regeneration, tending and harvesting may affect management for other purposes. For example, the regeneration phase may be less desirable for recreation than the mature phase.

5.3 OTHER FOREST PRODUCE

5.3.1 Regional and State Significance

The Forests Act confers on the Department the exclusive control and management of all forest produce on State forests, timber reserves and other vacant Crown land. Timber is the most significant forest product and has been dealt with separately. Other forest produce, for which markets currently exist, are sandalwood, honey and wildflowers. Minerals and water are not forest produce within the meaning of the Forests Act. Though gravel, stone and sand are defined as forest produce, the removal is a mining operation on a small scale and is considered in Section 5.7.

5.3.1.1 Sandalwood

Sandalwood was first exported in 1845. The trade rapidly built up to some 3 000 - 4 000 tonnes annually. These levels were maintained until well into the present century but declined following extensive clearing for agriculture throughout the wheatbelt where this plant commonly occurred. From 1940 till 1973 exports stabilised around 1 000 tonnes per annum. During this time the bulk of the wood sold was from live stems which had bark and sapwood removed in the field. Since 1973 policy changes have resulted in stems being sold without removal of sapwood and a substantial part of the production being achieved through collection of dead wood and pieces. As a result it has been possible to increase exports to 1 200 tonnes per annum, a level which will be continued. Currently 70 men are employed on sandalwood pulling in the Eastern Goldfields in addition to those involved with transporting and marketing of the product. The export income in 1975 amounted to approximately one million dollars.

5.3.1.2 Honey

The Forests Department is responsible for the registration of apiary sites on State forests, various reserves and other Crown land. Apiarists also locate hives on private property. Currently some 132 apiarists have registered sites and many rely on these to provide a significant proportion of their income. In 1973/74 the gross value of beeswax was $62 000 and that for honey production was $1.28 million.

5.3.1.3 Wildflowers

The wildflower industry is largely seasonal and provides temporary work for many pickers locally. Indirect employment is provided in the marketing and processing industries.

5.3.2 Demand

5.3.2.1 Sandalwood

Some 1 200 tonnes of sandalwood were sold during 1975/76. It is anticipated that this level of demand will continue.

5.3.2.2 Honey

Demand for honey is tied to population and export possibilities. A large proportion of the annual honey crop of 2 500 tonnes comes from Crown lands. The demand for honey and hence for apiary sites is expected to rise steadily in the future.

5.3.2.3 Wildflowers

Approximately 4 000 kilograms of Boronia megastigma blossoms and sprays were collected in the past year. Seeds, dry and fresh material from other species were also collected. Demand for wildflowers is expected to rise steadily in the future.

5.3.3 Supply

5.3.3.1 Sandalwood

Sandalwood pulling is now mainly located in areas to the north and east of Kalgoorlie. The sandalwood resource originally occurred as far west as the present belt of State forests, but conversion to agriculture throughout the wheatbelt has markedly reduced its range. Within the present range the resource has been utilised over extensive areas and young growth is not yet of a size to warrant a second operation.

5.3.3.2 Honey

Apiary sites are placed at not less than three kilometre intervals. There are 1 592 sites now registered with the Forests Department and leases cover much of State forest. The highest density of sites occur in the karri and wandoo forests and the coastal heathlands. Apiary sites are concentrated in vegetation associations dominated by the families Myrtaceae and Proteaceae.

5.3.3.3 Wildflowers

Wildflower supply depends on the species being harvested. Boronia megastigma is the largest single component of this industry and is most prolific in swampy areas of southern forests. Other species, such as hakea, banksia and smokebush commonly used in dried flower arrangements have a more extensive range.

5.3.4 Sandalwood Management Objective, Policy and Strategy

5.3.4.1 Sandalwood production objective

The objective is to make available supplies of roots, stems and branches of sandalwood at a practical level of production and current standards of utilisation, where this does not damage regrowth, alter the distribution of the species, or conflict with major land use objectives.

5.3.4.2 Sandalwood production policy

1. Maintain present supply levels of approximately 1 200 tonnes/annum and provide continued employment for those engaged in the trade.

2. Ensure full utilisation of all woody parts of species made available as dried salvage material or living trees of greater than 400 millimetre stem circumference.

3. Areas allocated to pullers and conditions of utilisation will be specified to ensure perpetuation of the species and minimum conflict with major land use objectives.

4. Continue to investigate the availability of the resource and the growth rate and regeneration requirements of the species.

5.3.4.3 Sandalwood production management strategy

1. The operation will be regulated taking into account the efficiency of utilisation, and will continue to be controlled by the present system of licenses.

2. Salvage of groundwood and trees affected by wildfire will receive priority for sandalwood pulling.

3. Management procedures will be reviewed as further data becomes available from research.

5.3.5 Honey Management Objective, Policy and Strategy

5.3.5.1 Honey production objective

The objective is to sustain the present level of beekeeping with due regard to location of apiary sites at appropriate intervals to avoid transference of disease and conflict with major land use objectives.

5.3.5.2 Honey production policy

1. Locate apiary sites at acceptable intervals taking account of constraints, such as

a) location in relation to private property;

b) risk of stream pollution;

c) proximity of current or proposed activity by the public, the Forests Department or other industry;

d) access with respect to forest disease risk areas or pockets of diseased forest;

e) constraints nominated by other authorities controlling Crown land;

f) Forests Act regulations.

2. Investigate allocation of apiary sites, regularity of use, yield of nectar and the prospects for manipulation of blossom to stabilise the annual flow of nectar.

3. Refer each application for apiary sites on land vested in other authorities to that authority.

5.3.5.3 Honey production management strategy

1. Control apiculture on State forests and other Crown land by the existing system of permits.

2. Advise registered beekeepers of proposed Forests Department activity that could conflict with the location of their hives, or honey production from the site. The Department's prescribed burning programme will be discussed each year with the Government Apiculturist.

3. Continue liaison with other authorities which control Crown land on which apiary sites are located.

5.3.6 Wildflower Management Objective, Policy and Strategy

5.3.6.1 Wildflower production objective

The objective is to provide seeds, plants and plant parts from State forest according to the demand, where this does not conflict with the distribution and perpetuation of the species or major land use objectives, or the requirements of the Wildlife Conservation Act.

5.3.6.2 Wildflower production policy

1. Permit picking on State forest where methods are used which will not conflict with major land management objectives.

2. Collect data on the range of commercial species and their management requirements.

5.3.6.3 Wildflower production management strategy

1. Continue liaison with the Conservator of Wildlife regarding aspects of wildflower distribution and management.

2. Control wildflower production by the present system of licenses in accordance with revised legislation, and results of research into wildflower availability and management requirements.

5.3.7 Interactions With Other Land Uses

5.3.7.1 Sandalwood

Sandalwood is a parasite. Regeneration is difficult and growth rates slow. The collection of sandalwood

occurs on areas where extensive grazing of areas under pastoral leases is the primary land use. Because of the scattered nature of the resource, conflict with this and other land uses, such as conservation of flora, is very slight.

5.3.7.2 Honey

Honey production is affected by interference with the flowering of vegetation associations. Examples of this are the effects of mining, water storage, many public utilities and some forms of agriculture. There is partial incompatibility with land uses involving a high level of human activity, and with catchment protection through the risk of biological pollution. On the other hand apiculture is generally compatible with selective hardwood timber operations and flora conservation. Since honey production is dependent on the flowering cycle of the desired species, many of these land use conflicts are only seasonal. The practice of apiculture involves vehicular access which in some cases increases the risk of dieback infection and therefore may indirectly conflict with other land uses.

5.3.7.3 Wildflowers

If uncontrolled, wildflower picking could conflict with conservation of flora and some passive recreational activities. The collection of some plant material, such as Boronia megastigma blossom, is carried out in wet areas, where it may result in dieback infection, and will produce a conflict with other land uses.

5.4 RECREATION AND TOURISM

5.4.1 Regional and State Significance

Over many years there has been ad hoc development of sites in State forests with particular recreation value. Planning for recreation on a regional basis is a relatively recent facet of forest management in Western Australia.

Recreation and tourism within the forests result in substantial benefits to the State and regional economy. Although the level of direct benefits has not been assessed there has been an obvious financial gain in the business sector in many parts of the South West, with associated increases in job opportunity. The establishment and maintenance of many facilities in State forests have provided an added source of employment.

5.4.2 Demand for Recreation

Preliminary visitor surveys for State forests near the metropolitan area, the Murray Valley and near Pemberton indicate the level of active and passive recreation to be in excess of 500 000 day visits per year. Recreation is also significant in areas such as the major reservoirs, the Blackwood Valley, the karri forest near Margaret River and the tuart forest near Ludlow.

Increasing population, affluence, mobility, urbanisation, education, leisure time and the provision of recreational facilities have largely been responsible for a rapid growth in recreation demand over the last decade. Although only limited definitive work has been carried out locally, it is reasonable to assume that trends observed in other parts of Australia, and in the western world generally, will apply.

An annual increase of 7% is considered conservative for recreational pursuits as a whole and it is probable that this figure can be applied to forest-based leisure activities. Hence, during the period of this Working Plan day visits to State forests can be expected to exceed 700 000 per annum, and by the year 2000 could be about 2.5 million per annum.

A marked increase in tourist activity in the forest can be expected during the next few years because of the recent completion of the new Eyre Highway and the active promotion of the Leeuwin Way as an alternative route from Norseman to Perth.

5.4.3 Supply

5.4.3.1 Current facilities

The Department has developed many facilities for passive recreation from Yanchep to Walpole. With few exceptions, these areas have been developed to meet public demand. In recent years, the provision and maintenance of forest recreation facilities have been partly funded under Treasury grant.

Areas have been made available for many forms of active recreation following liaison with participating organisations, and co-ordinating schemes have been evolved to avoid conflict between active and passive recreation.

A number of forest settlements no longer in use by the Forests Department have been made available under lease to welfare and community organisations. Pimelia, Myalup, Wellington and Lewana settlements have been leased to the Department for Community Welfare and Dryandra settlement to Lions International.

Walking trails of various distances have been developed to cater for those interested in hiking. The shorter trails are usually less than a kilometre, while the Bibbulmun bushwalking track is about 400 kilometres long, beginning near Perth and ending at Northcliffe.

Historical sites and buildings are relatively rare in the forests of Western Australia. Restoration of the few remaining can be expected to receive a high priority in the future. Of those completed the more well known examples in the forest are the Brockman saw pit at Pemberton, One Tree Bridge at Manjimup and original settlers' houses in the Blackwood Valley.

There are numerous buildings and sites of relatively recent origin which will undoubtedly increase in historical worth. Examples of these are fire towers, the most outstanding of which is Gloucester Tree, at Pemberton.

Most of the areas which the Department has developed for recreational purposes are small and localised. However, several larger sections of forest have recently been allocated as recreation management priority areas. Table 3 contains an enumeration and description of these areas but delineation is not yet complete and will proceed during the period of this Working Plan. Areas allocated to date are shown on Plan I.

TABLE 3

Enumeration and Description of Areas in which Recreation is the Management Priority

(as at November, 1976)

DIVISION	MANAGEMENT PRIORITY AREA			OUTSTANDING FEATURES RELEVANT TO RECREATION
	MAP REF.	NAME	AREA (ha.)	
Dwellingup	3.3	Murray Valley	11 159	Major stream suitable for canoeing and fishing.
Nannup	12.4	Blackwood River	18 450	Major stream suitable for canoeing and fishing.
Busselton	1.7	Rapids	2 393	Medium-size perennial stream suitable for fishing, swimming.
Manjimup	6.3	One Tree Bridge *	666	Medium size perennial stream suitable for fishing, historical bridge, outstanding karri trees.
Pemberton	11.3	Brockman *	630	High quality karri forest, perennial streams with cascades suitable for fishing. Gloucester Tree fire tower.
Pemberton	11.5	Muirillup *	209	Virgin karri forest, granitic outcrops, good views.
Walpole	13.6	Mt. Frankland *	1 212	Virgin karri forest, granitic outcrops, good views.

* Management priority areas on which some proportion is likely to be managed as a "forest park" (refer Section 5.5.3).

5.4.3.2 Future trends

There is considerable potential for development of recreational pursuits throughout State forests. Planning must recognise the various activities involved, the site requirement for each, and their effect on the environment. On this basis, the various activities can be classified as follows,

a) Active recreation

Non-motorised - includes rock climbing, cave exploring, canoeing, shooting, orienteering, bushwalking, back-packing, trail horse riding.

Motorised - includes car rallying, trail bike riding, trial riding, use of off-road vehicles.

b) Passive recreation

- includes picnicking, caravanning, nature study, historical study, rock hunting, bird watching, photography, driving for pleasure, tourism.

The potential of the forest to provide for leisure demand may vary. Dieback spread, mining, domestic water supply needs and timber production will each influence change. In some cases these changes will be detrimental to recreational potential, while in others the potential will be enhanced.

5.4.4 Objective of management

The objective is to provide for the planned development of recreation on State forests having regard to anticipated social needs and compatability with environmental protection.

5.4.5 Forest recreation policy

1. Measure the demand for recreation in relation to type and locality.

2. Investigate the capacity of the environment to absorb various types and levels of recreation activities and the means by which the environment may be protected.

3. Provide facilities and sites for recreation pursuits as the demand is foreseen. Locate these facilities and associated services so as to avoid degradation of the environment and protect recreation attributes of the locality.

4. Continue studies for the planned progressive development of recreation facilities on a regional basis.

5. Liaise with State Government and local government in order to integrate forest-based recreation with overall requirements.

5.4.6 Management Strategy

1. Continue surveys designed to sample public demand for forest-based recreation, measure current use and its rate or increase.

2. Investigate techniques by which recreation may be evaluated in relation to other land uses.

3. Liaise with private recreational groups to ensure they are aware of the effect of various forms of recreation on the forest environment.

5.4.7 Interaction With Other Land Uses

The degree of conflict with other land uses depends on the type of recreation activity.

Motorised recreation, when it results in off-road site disturbance, is in direct conflict with the conservation of flora. However, some forms of non-motorised recreation, such as bush walking, are generally compatible with these values.

Where the level of use is high, most forms of recreation affect, but do not exclude, water and wood production. The constraints upon timber production relate mainly to the harvesting phase of the management cycle.

5.5 FLORA AND FAUNA

5.5.1 Regional and State Significance

The conservation of flora and fauna on State forests and timber reserves is the responsibility of the Forests Department subject to the provisions of the Forests Act and the Wildlife Conservation Act. State forests have always been a most important source of land for the preservation of forest ecosystems in the South West.

The value of conservation of indigenous flora and fauna cannot yet be measured realistically in monetary terms. Various measures of public opinion indicate that a high social value is ascribed to State forests as a means of conserving flora and fauna. The contribution from State forest has several significant aspects, namely,

a) State forests have a similar security of tenure to "A Class" Reserves over an extensive area and wide climatic range. This allows perpetuation of a wide range of natural habitats and their component species.

b) Flora and fauna and their related habitats provide the basis for study of biology and ecology.

c) Flora and fauna contribute markedly to recreational experience, and to tourism.

5.5.2 Demand for Flora and Fauna Conservation

Increased importance has been placed on conserving indigenous flora and fauna in recent years. The rising demand has not yet been quantified but is indicated by increase in media reports, public enquiries on this topic, and the number and membership of conservation organisations.

Most land uses have a specific soil, climatic and topographic requirement. Past allocation of land and subsequent management practices have resulted in a selective reduction of some forest site-vegetation types. This has increased the demand for conserving examples of these associations. Examples of selective reduction of forest types include:

a) Land alienation and subsequent clearing for agriculture resulting in a general reduction of forested area. Agricultural pursuits within the State forest belt have been concentrated in valleys.

b) Rising demand for domestic, industrial and irrigation water supplies leading to many of the western valleys in the northern plateau being used for water storage.

c) Jarrah dieback spreading rapidly on lower slopes and poorly drained sites in high rainfall areas.

d) Softwood production being concentrated on high quality soils of the dissected valleys along the escarpment.

State forest is managed primarily for water and timber production, and effectively protects floristic composition. Conservation of floristic composition is prejudiced by those land uses which either threaten the survival of any or all the plant species, or result in the spread of diseases such as jarrah dieback.

The conservation of vegetation structure, however, requires management primarily for this purpose and areas are being retained to represent the large range of vegetational types on State forest.

It is generally accepted that effective conservation of flora will usually meet the needs of fauna conservation. Compatibility with other land uses is largely determined by the impact of disturbance and whether it is desired to conserve vegetational structure, floristic composition, or both.

5.5.3 Area Available for Conservation Purposes

Approximately 90% of State forest is contributing to the conservation of floristic composition. The remainder is affected by jarrah dieback, has been mined, damaged or cleared for public facilities.

There are only limited areas of undisturbed sites on which vegetational structure can be conserved. Exceptions are in the eastern portion of the Northern Plateau where dieback incidence is low, and in Southern Forests where industrial development is recent.

Where undisturbed areas of a particular ecotype cannot be located, sites are selected to approximate the natural state as closely as possible. This problem arises primarily in the northern forests where there has generally been a high degree of disturbance and where there is severe competition between land uses. In this area it has been necessary to use the core-buffer concept well known in research practice when delineating individual management priority areas for conservation of flora and fauna. The core area is envisaged as the central portion in which it is essential to keep disturbance to a minimum. This may include exclusion of vehicles and equipment for protection against spread of dieback or direct damage. The core is surrounded by a buffer in which human activity is permitted, but is managed in a way that will not prejudice the conservation aim of the core.

It is anticipated that fauna, which generally requires a larger living space to maintain adequate populations, will be accommodated both in the core and the buffer, the buffer providing not only additional living space, but also providing partially disturbed (seral) vegetation essential for the survival of some species. Both core and buffer will in turn be mostly included within a larger area of managed forest, which will provide additional living space for fauna as well as connection between individual areas.

In other forest areas where there have been lower levels of disturbance and there is less competition between land uses, the core-buffer concept has not been needed.

On those parts of management priority areas where management involves exclusion of commercial timber production, the concept of a "forest park", envisaged in the Conservation Through Reserves Committee Report and defined in the Environmental Protection Authority recommendations, will be adopted. A "forest park" is defined as "an area of forest which is kept unavailable for the commercial production of timber except in the ordinary course of forest management and to such limited extent as would enable the Conservator for the betterment of the park to cut and remove timber for the purpose of tree regeneration in any areas containing trees which have been damaged or which have deteriorated through age, fire or disease."

Management plans for "forest parks" will take effect as if they were a regulation and so be unalterable except in the manner required in the Interpretation Act for the amendment of regulations made under an Act of Parliament. These plans will include consideration of the implications of future water resource utilisation in full consultation with the Public Works Department.

Sections of forest delineated primarily for conservation of flora and fauna are enumerated in Table 4 and illustrated in Plan 1.

5.5.4 Objective of Management

The objective is to conserve areas representing the full range of natural habitats within State forests to ensure the perpetuation of the many communities and their component species.

5.5.5 Flora and Fauna Management Policy

1. Secure areas of relevant ecological types as reference units for management guidance, scientific study, and maintenance of genetic diversity.

2. Provide examples representing all stages of succession.

3. Monitor flora and fauna populations and study their habitat requirements to develop a sound basis for management.

4. Co-ordinate flora and fauna management priorities in State forests with the requirements of other authorities.

5.5.6 Management Strategy

1. Prepare prescriptions for each area on which conservation of flora and fauna is the management priority and provide for ongoing review.

2. Monitor areas retained for conservation of flora and fauna to ensure:

adequacy in relation to size;
coverage of ecological types;
location of boundaries;
protection needs and legal constraints.

3. Maintain liaison with other authorities responsible for conservation of flora and fauna to ensure that programmes continue to be complementary.

5.5.7 Interaction With Other Land Uses

Areas set aside to conserve ecotypic structure, can be affected by those operations which remove any part of the vegetation components, for example, mining, agriculture, timber production, active recreation and the provision of public utilities. Conservation of flora and fauna is generally compatible with catchment protection, scientific study and some forms of passive recreation.

Where floristic composition is to be conserved, direct conflict occurs with those operations which threaten the survival of any or all of the plant species. Depending on scale and location, examples of such operations are mining, agriculture, water storage, exotic plantations, and the provision of many public services. Conflict with other land uses is relatively minor.

TABLE 4

ENUMERATION AND DESCRIPTION OF AREAS IN WHICH CONSERVATION OF FLORA, FAUNA AND LANDSCAPE ARE THE MANAGEMENT PRIORITY

MAP REF.	NAME	AREA (ha.)	VEGETATION AND LANDSCAPE TYPE REPRESENTED, SPECIAL FEATURES
15.1	Melaleuca *	3 208	Bassendean dune system and associated fauna.
15.2	Ridges	1 260	Spearwood dune system. Supplement and buffer to Yanchep National Park.
15.3	Wabling *	5 030	Transition between Spearwood and Bassendean dune systems. Corridor through plantation. Steep limestone gradients.
15.4	Caraban *	2 966	Spearwood dune system, and transition to Quindalup dune system.
2.1	Julimar	27 798	Northern extension of the jarrah-marri-wandoo forest and associated scrub species. Eucalyptus drummondii and Dryandra polycephala.
2.3	Gunapin *	13 497	Swamp vegetation (and associated fauna), banksia woodland on deep sandy soil typical of Gunapin surface.
2.4	Sullivan *	4 555	Swamps and associated flora and fauna typical of Gunapin surface.
2.5	Russell *	5 702	Virgin wandoo woodland, associated vegetation types, and fauna. Beraking, Nockine surfaces.
2.6	Dale *	6 272	Wide range of landscape and vegetation types, relatively undisturbed. Mainly Beraking surface.
8.1	Eagle Hill *	4 638	Upland virgin jarrah, blackbutt in valleys, Eucalyptus laeliae, Kingia australis. Cooke and Darkin surface.
8.2	Cooke *	4 695	Outstanding E. laeliae. Upland virgin jarrah. Cooke and Randall surfaces.
8.4	Gooralong *	705	Virgin and high quality jarrah-marri, blackbutt in gullies. Darkin and Helena surfaces.

* Management priority areas on which some proportion is likely to be managed as a "forest park".

TABLE 4 (Continued)

MAP REF.	NAME	AREA (ha.)	VEGETATION AND LANDSCAPE TYPE REPRESENTED, SPECIAL FEATURES
8.5	Boyagarring *	1 480	Wandoo, powderbark wandoo and associated fauna. Dissected lateritic slopes
8.6	Windsor *	4 225	Granitic monadnocks, Beraking valley. Lichens, shrublands and swamp vegetation. Upland jarrah forest.
8.7	Serpentine *	1 496	Darkin surface, lateritic uplands. Valley vegetation of marri and blackbutt.
8.8	Lupton *	2 770	Lateritic uplands and dissected slopes. Woodland of wandoo, powderbark wandoo, jarrah and rock sheoak.
3.4	Gyngoorda *	3 453	Eastern lateritic uplands, dissected slopes. Woodlands of wandoo, powderbark wandoo, jarrah, rock sheoak and E. drummondii.
3.5	Duncan *	9 935	Cooke and Randall surface. Virgin wandoo, virgin jarrah in moist sandy valleys. Most extensive and tallest stand of E. drummondii.
3.6	Plavins *	3 495	Darkin, Beraking surfaces and adjacent lateritic uplands. Jarrah-marri forest in high rainfall. River banksia and blackbutt.
3.7	Teesdale *	1 728	Helena surface. Small virgin stand of jarrah-marri. Tall jarrah-marri-blackbutt forest.
3.8	Karnet *	3 688	Darkin-Helena transition. Tall jarrah-marri on uplands. Marri, blackbutt in gullies, E. laeliae around outcrops.
3.10	Wandering *	4 334	Dissected lateritic slopes. Woodland of jarrah, marri powderbark wandoo and wandoo. Low woodland of rock sheoak and jam.
10.6	Surface *	15 125	Lateritic uplands, Beraking and Goonaping surfaces. Largest area of virgin jarrah north of Blackwood.

*Management priority areas on which some proportion is likely to be managed as a "forest park".

TABLE 4 (Continued)

MAP REF.	NAME	AREA (ha.)	VEGETATION AND LANDSCAPE TYPE REPRESENTED, SPECIAL FEATURES
10.7	Nalyerin *	10 375	Lake Nalyerin, Goonaping, Beraking surfaces and lateritic uplands. Vegetation (and fauna) associated with Lake Nalyerin. Open jarrah forest. Treeless sedgeland.
10.8	Stene *	4 487	Undulating land, dissected lateritic slopes, Beraking and Nockine surfaces. Wandoo woodland and jarrah open forest.
10.11	McLarty	727	Spearwood dune system. Tuart. Buffer between highway and pine plantation.
4.1	Trees *	7 837	Lateritic uplands, Goonaping and Beraking surfaces. Virgin open jarrah-marri forest.
4.2	Lennard *	7 562	Lateritic uplands, Darkin and Helena surfaces. Tall open jarrah-marri, blackbutt-marri-jarrah on lower slopes.
10.1	Clifton *	533	Spearwood dune system. Tuart forest with peppermint and jarrah woodland with narrow leaf banksia and woody pear.
10.2	Myalup *	868	Corridor between Myalup Swamp and Yalgorup National Park. Transition between Spearwood and Bassendean dune systems.
10.3	Bell *	2 590	Lateritic uplands and valley resembling Darkin and Nockine surfaces. A range of vegetation types including flooded gum-paperbark, blackbutt, wandoo woodland and upland jarrah forest.
10.4	Federal *	1 412	Lateritic uplands and moderately incised valleys of Darkin surface. High quality vlackbutt, tall jarrah-marri.
10.5	Samson *	1 035	Beraking Valley surface. Lateritic uplands. Best stands of bullich in Darling Range.

* Management priority areas on which some proportion is likely to be managed as a "forest park".

TABLE 4 (Continued)

MAP REF.	NAME	AREA (ha.)	VEGETATION AND LANDSCAPE TYPE REPRESENTED, SPECIAL FEATURES
4.3	Westralia *	2 131	Lateritic uplands, Nockine and Darkin surfaces. Tall and open jarrah-marri forest. Blackbutt-jarrah-marri on lower slopes. Holly leaf banksia and native pear on Collie Basin.
4.4	Dardanup *	1 480	Northern extension of Sunkland. Jarrah-marri: E. haematoxylon on mid and upper slopes.
4.5	Goonac *	5 211	Lateritic uplands. Goonaping and Beraking surfaces. Open jarrah forest, wandoo open woodland, and dense shrub-land on valley floor (Tamar habitat).
4.6	Muja *	3 411	Lake Gnartiminy, lateritic uplands, Beraking and Goon-aping surfaces. Swamp vegetation, including en-dangered Banksia meissneri.
4.7	Bennelaking *	5 635	Lateritic uplands, Nockine and Beraking surfaces. Open jarrah-marri forest, wandoo open woodland, and swamp complex. Remnant of jarrah, wandoo forest, mostly cleared for agriculture.
5.1	Preston *	2 707	Lateritic uplands, Beraking surface. High quality virgin tall open jarrah forest.
5.2	Noggerup *	3 487	Lateritic uplands, Beraking surface. Tall open jarrah-marri forest, swampy woodland of Banksia littoralis.
5.4	Mullalyup *	4 134	Lateritic uplands, valleys resemble Beraking and Darkin surfaces. Heath on granitic outcrops. Tall open jarrah-marri forest, open blackbutt forest in gullies.
5.5	Greenbushes *	1 351	Lateritic uplands, dissected valleys of Blackwood River. Remaining virgin tall open jarrah forests of Blackwood River Valley, open jarrah-marri.

* Management priority areas on which some proportion is likely to be managed as a "forest park".

TABLE 4 (Continued)

MAP REF.	NAME	AREA (ha.)	VEGETATION AND LANDSCAPE TYPE REPRESENTED, SPECIAL FEATURES
5.6	Nollajup *	661	Lateritic uplands, Beraking surface. Open woodland of wandoo, open forest of jarrah-marri; remnant of vegetation mostly cleared for agriculture.
1.2	Mowen *	3 242	Swamps, lateritic uplands, within Sunkland complex: swamp vegetation and bordering open jarrah-marri forest.
1.3	Chester *	489	Only occurrence of karri within Sunkland.
1.4	Paget *	1 427	Typical of wetter southern extremity of Sunklands complex, much of which has been alienated and cleared. Abundant Boronia megastigma.
1.5	Boranup *	3 142	Regrowth karri forest on calcareous soils on Leeuwin-Naturaliste Ridge. Caves. Historically significant.
1.6	Ludlow *	2 880	Spearwood dune system. Tuart at height of its development. Southern extremity of its range.
6.1	Perup	39 000 (approx.)	Mainly Perup soil association. Jarrah-marri open woodland and wandoo open woodland: contains rare endemic faunal populations.
6.5	Dickson *	261	Pemberton and Balbarrup soil associations. Virgin tall open jarrah and marri-jarrah forest.
6.7	Strickland *	1 276	Pemberton and Balbarrup soil associations. Virgin tall open karri, karri-marri and marri-jarrah forest in lower Donnelly River Valley.
11.1	Hawke-Treen *	989	Pemberton soil association. Virgin tall open karri forest 5 y.o., 35 y.o.** Complements Warren National Park in Lower Warren River.

* Management priority areas on which some proportion is likely to be managed as a "forest park".

** Denotes year old.

TABLE 4 (Continued)

MAP REF.	NAME	AREA (ha.)	VEGETATION AND LANDSCAPE TYPE REPRESENTED, SPECIAL FEATURES
11.2	Dombakup *	130	Pemberton soil association. Virgin tall open karri forest.
11.4	Boorara *	587	Pemberton soil association. Virgin tall open karri and marri-karri forest. In Gardner River, East Branch. Rapids.
11.6	Curtin *	1 256	Pemberton and Balbarrup soil associations. Virgin tall open karri forest and jarrah-marri open forest in upper Shannon River.
13.1	Lower Shannon *	8 113	Boorara, Quagering and Chudalup soil associations. Diverse vegetation, forest and flat. Borders Broke Inlet.
13.2	Wattle *	2 898	Pemberton, Quagering soil associations. Virgin tall open karri forest. Entire undisturbed catchment.
13.3	Johnston-O'Donnell *	6 202	Pemberton, Balbarrup, Chudalup and undescribed soil associations. Lithic complex. Tall open karri forest. Jarrah-marri open forest. Jarrah open woodland, banksia and casuarina tall open shrubland. All virgin.
13.4	Mitchell-Crossing *	7 335	Undescribed soil associations. Lithic complexes. Yellow tingle included in diverse vegetation types present. Scenic.
13.5	Soho *	3 236	Undescribed soil associations. Rate's tingle, red flowering gum, included in diverse vegetation types present. Scenic.
7.1	Dryandra * SF 51 SF 53	19 870	Wandoo open woodland, mallet. Remnant of Upper Murray River catchment. Rare endemic fauna.
14.1	Randalls	16 350	A variety of inland forest and shrub types, mainly virgin, in an extensive area of regrowth forest. Scenic, historical interest.

* Management priority areas on which some proportion is likely to be managed as a "forest park".

TABLE 4 (Continued)

MAP REF.	NAME	AREA (ha.)	VEGETATION AND LANDSCAPE TYPE REPRESENTED, SPECIAL FEATURES
14.2	Majestic	2 226	Illustrates the habitat, dimensions and regeneration of salmon gum woodlands.
14.4	Brockway	3 724	Preservation of E. brockwayi and E. dundasii. Scenic, near highway.
14.5	Kangaroo Hills	6 600	Preservation of E. campaspe and E. clelandii. Historical interest and tourist potential.
12.1	Dalgarup *	3 552	Lateritic upland, incised valley of Blackwood River. Most northern occurrence of karri in State forest. Open jarrah-marri forest.
12.2	St. John Brook *	3 194	Incised valley of St. John's Brook in eastern Sunklands. Outstanding development of blackbutt with shrub understorey. Possible rare fauna habitat.
12.3	Milyeannup *	5 665	All variations of Sunklands landscape. Complete range of vegetation types from open jarrah-marri forest to sedgeland and shrubland.
1.1	Whicher *	6 765	Lateritic uplands and incised valleys of the upper Sabina River in Whicher Range. E. haematoxylon. Open jarrah-marri forest, some endemic species.
14.6	Kambalda	3 342	Undisturbed, great ecological diversity. Multiple use potential. Near Kambalda.
14.7	Cocanarup	9 095	Salmon gum and jam. On highway. Potential for recreation, tourism.

* Management priority areas on which some proportion is likely to be managed as a "forest park".

5.6 SCIENCE AND EDUCATION

5.6.1 Regional and State Significance

In the management of State forests for the greatest long term social and economic benefit, the need for scientific study of each forest value and associated environmental factor must be recognised. Such studies provide the basis for education and improvement of management practices.

State forests have a particular value for study and education in the fields of biology, ecology and land use. The forest area is the only large and secure belt of high forest in the South West which contains many associations not represented elsewhere.

5.6.2 Demand for Area

The extent and type of area required for scientific studies depend on research programmes initiated from within the Department, and by other authorities having forest land use interests. For example, these include projects under the direction of the Hunt and Kelsall Committees, C.S.I.R.O., the Education Department and the Forests Department.

The period for which land is required for scientific study and education will depend on the aim of each project. The area required for each project will vary from a few square metres for studies of regeneration, to large areas for water catchment studies.

5.6.3 Availability of Area

A number of areas throughout State forests are currently used for study relating to

impact of forest management on the environment

forest management techniques

alternate land uses

disease, insect attack and wildfire damage and measures of control

forest composition, structure, succession and development

hydrology

Recently many large areas have been delineated for scientific study. Those concerning flora and fauna are included in Table 4, and those for other purposes are listed in Table 5. These areas are illustrated in Plan 1. Delineation of areas managed for scientific study is as yet incomplete. There are numerous areas on which the research being undertaken is compatible with major management objectives and do not warrant delineation as scientific management priority areas.

5.6.4 Objective of Management

The objective is to manage specific areas of State forests for the purpose of education, reference and scientific study as the need is foreseen.

5.6.5 Policy

1. Make areas available for well planned projects.

2. Examine all proposals to ensure they will result in net social and economic benefit.

3. Apply knowledge so gained to improve forests and forest management.

4. Disseminate proven scientific fact to other interested professions and bodies.

5.6.6 Management Strategy

1. Promote the interest of research agencies in study of forestry projects.

2. Maintain liaison with other research organisations to exchange knowledge and avoid duplication of effort.

3. Publish proven data in Departmental bulletins and other brochures.

5.6.7 Interaction With Other Land Uses

The degree of conflict with other land uses depends on the purpose of the study. Areas set aside for the study of recolonisation of mined and dieback sites, for example, will directly conflict with intensive wood production and motorised recreation. On such areas there may be partial constraint on some forms of passive recreation but they would be generally compatible with water production in the high rainfall area.

Long term study of forest growth will require freedom from the type of vegetation disturbance caused by mining, agriculture, provision of public utilities and active recreation, but would be compatible with conservation of flora.

The length of time for which there will be constraint on other land uses will depend on the period required for the study.

TABLE 5

ENUMERATION AND DESCRIPTION OF MAJOR AREAS IN WHICH SCIENTIFIC STUDY IS THE MANAGEMENT PRIORITY

(as at November, 1976)

MANAGEMENT PRIORITY AREA			PURPOSE OF STUDY
MAP REF.	NAME	AREA (ha.)	
2.7	Flynn	1 080	Joint hydrological study (Forests-PWD) of the effect of conversion from hardwood forest to pine plantation.
8.3	Lang	6 502	Long term study of the spread of dieback in absence of human interference.
3.1	Yarragil	7 686	Forests Dept. hydrological study relating yield and quality of water to landscape and forest treatment.
3.2	Amphion	1 005	Forests Dept. study of the effect of fire on jarrah forest ecology.
3.11	Marrinup	173	Joint hydrological study (CSIRO-PWD) of the effect of bauxite mining.
3.12	Saddleback	397	
10.10	Brunswick	410	Study of development of jarrah-marri-blackbutt pole stands of high quality.
4.8	Davis	176	Joint hydrological study (CSIRO-PWD) of the effect of agricultural clearing in high rainfall jarrah-marri forest.
4.9	Leach	964	Joint hydrological study (CSIRO-PWD) of the effect of agricultural clearing in low rainfall jarrah-wandoo woodland.
6.2	Warrup	1 401	Joint hydrological study (Kelsall Committee) of the effect of uniform regeneration in low rainfall jarrah-marri forest on water quality.
6.4	Lewin	269	As above, but in medium rainfall jarrah-karri-marri forest.

Table 5 (continued)

MANAGEMENT PRIORITY AREA			PURPOSE OF STUDY
MAP REF.	NAME	AREA (ha.)	
6.6	Iffley *	385	Long term study of the spread of dieback in relation to landscape.
6.10	Lindasy *	1 080	Scabby Gully catchment protection.
11.7	Sutton	755	Joint hydrological study (Kelsall Committee) of the effect of uniform regeneration in high rainfall karri-marri forest on water quality.

* Management Priority Areas on which some proportion is likely to be managed as a "forest park" (refer Section 5.5.3).

5.7 MINING

5.7.1 Minerals as Defined Under the Mining Act

5.7.1.1 Regional and State significance

Mining of gold, tin, bauxite and mineral sand has interacted with the management of forests in Western Australia. Discovery of gold late in the nineteenth century precipitated rapid population growth and led to extensive exploitation of the timber resources of the State. Gold mining has resulted in the annual consumption of about 350 000 tonnes of wood for mining timbers and firewood and some 3.4 million hectares of woodlands in the semi-arid Kalgoorlie region have been cut over a 70 year period. Since tin mining started at Greenbushes in the early part of the century, there has been permanent loss of much high quality forest. The coal mining industry grew rapidly during the 1950's with bauxite and mineral sands developing during the 1960's.

Currently the major mining being carried out on State forests includes coal mining near Collie, bauxite mining near Dwellingup and Jarrahdale, mineral sands near Capel, and tin at Greenbushes (Plan 3). They provide substantial employment in these areas and immediate financial returns from mining far outweigh those from other forest values. The high capital and maintenance costs generate large support industries as do the further processing and transport of raw materials.

However, these benefits, although substantial, are not without environmental cost. Since open-cut methods are mainly used, most forest values are destroyed on mined areas, at least in the short term. In most cases, companies are required to pay compensation to the Forests Department for loss of forest productivity, and are required to assist in the rehabilitation of mined sites.

5.7.1.2 Demand

Demand for alumina, tin, coal and mineral sands is expected to continue rising at a steady rate.

Mining on State forests affects forest policy in so far as it modifies forest values.

5.7.1.3 Supply

There are substantial reserves of minerals currently mined on State forests. The Collie Coal Basin is known to contain some 280 million tonnes of coal. Significant reserves of bauxite and mineral sands occur elsewhere in the State.

In the case of bauxite three companies have agreements with the Government which give them rights to extensive areas throughout the northern jarrah forest. Each company has access to mineral resources through legislative agreement subject to constraints imposed for environmental protection. Overall, almost half of State forest is subject to current claims and leases (Plan 3).

5.7.1.4 Objective of management

The objective is to guide mining operations on to areas where there will be least conflict with other land uses, to minimise environmental damage and to rehabilitate areas affected by mining to best suit future land use.

5.7.1.5 Background to policy formation

Generally, deep mining need not conflict with other land uses or create serious environmental damage. However, locally the danger of derelict shafts, subsidence and slag heaps must be taken into account in management prescriptions. Because of its extensive and long term effects on soil and forest resources, open cut mining is the primary concern. Associated with all mining activities are roads, buildings, stockpiles and other surface developments which occupy land at the cost of the forest.

Bauxite mining

The area under lease to bauxite mining companies includes the entire northern jarrah forest. The ore bodies are concentrated in ridges and upper slopes of the lateritic plateau. The predominant land use here is water production, although portions of this area are also being managed primarily for timber production, conservation of flora and fauna and recreation.

Mining conflicts with water production where it results in increased turbidity or salinity. Turbidity effects can be minimised by controlling the location of mining activities and by use of various engineering techniques. Salinity effects are not yet understood thoroughly and present more serious problems. Generally salt is known to be concentrated in the soil profiles of forest areas east of the 1025 mm rainfall isohyet. West of the 1150 isohyet, salinity risks are generally not serious.

Between these isohyets data are inadequate to allow prediction of salinity risks. Until more information is available this area will be managed as if having the same salinity risk as eastern forest.

Evidence from research programmes indicates that removal of the deep-rooted perennial forest crop results in increased salinity in areas where salt is present in soil profiles (refer Section 5.1.1). Though the areas mined each year are relatively small, mining results almost inevitably in the spread of jarrah dieback. In the western portion of the forest where salinity risks are not serious, dieback has already infected large areas. Here, mining is not in direct conflict with the primary land use of water production. In the salt-sensitive areas to the east, dieback is so far limited in extent and the effects of mining are likely to be much more serious. Until the risk is identified, forest management must aim to exclude mining from those areas where it may lead to deterioration in the quality of State water supplies.

It must be expected that policies now formed will be subject to alteration in the light of results from extensive research being carried out on hydrology, disease control and rehabilitation of mined and diseased sites.

Other effects of bauxite mining which must be taken into consideration are, short term scarring of the landscape in relation to recreation, interference with areas set aside for conservation of flora and fauna, and loss of timber potential from the established second growth crop.

Coal mining

Coal is now being mined solely in the Collie Coal Basin where the major land uses are timber and water production. Secondary uses are recreation and conservation of flora and fauna. The Basin is extensively infected with dieback and in the main, not protectable from further spread. As a result, land uses will be altered by the effects of this disease to such an extent that the added impact of coal mining will be of minor significance. Forest policy must primarily consider the need for, and type, of rehabilitation necessary.

Tin Mining

The area concerned is that under lease to Vultan Minerals Ltd. and Greenbushes Tin N.L. in the vicinity of Greenbushes. The mineral field was established prior to the passing of the Forests Act. Although many of the leases or claims were granted in the post-war years, the Department has no legislative power to exercise effective land management in these areas.

Mineral sand mining

The area concerned is the Capel-Ludlow area. The major land use has been conservation of flora and fauna, with softwood production and grazing as secondary uses. Mining conflicts directly with conservation of flora and fauna, but is expected to have only short term effects on softwood production and grazing.

5.7.1.6 Policy for mining on State forest

1. Advise Government of the effects of mining lease approvals on forest values.

2. Continue research on techniques aimed to minimise environmental damage and land use conflict.

3. Directly liaise with mining companies to ensure they are aware of the effects of mining on the environment and other land uses and of rehabilitation techniques.

4. Liaise with authorities responsible for administering mining agreements, and with other organisations authorised to study mining effects and rehabilitation techniques.

5. Rehabilitate areas affected by mining to suit the anticipated land use, in accordance with conditions imposed by State Government under the various mining agreements.

6. Investigate rehabilitation techniques.

5.7.1.7 Management strategy

1. Minimise the area of State forests cleared for mining operations.

2. Continue to obtain realistic compensation from companies mining on State forests to cover loss of forest values, and costs of rehabilitation and the ongoing cost of management of areas affected by mining.

3. Establish a full canopy cover of deep-rooted perennials on areas affected by mining in the salt-sensitive areas of catchments which are harnessed, or proposed to be utilised for water supply.

4. Guide bauxite mining operations into areas where the salinity problem is minimised. Seek to direct other mining operations into areas where there will be least conflict with other land uses.

5.7.1.8 Interaction with other land uses

Open cut mining directly conflicts with those values reliant upon the original soil and vegetational characteristics, such as conservation of flora and fauna. Passive recreation and maintenance of water quality in salt-sensitive areas are seriously affected, but not necessarily excluded, except during the mining phase. Timber production will be seriously affected in the long term by those mining operations which remove parts of the soil profile necessary for tree stability and growth. Apart from creating turbidity risks in the short term, mining is fairly compatible with water production in high rainfall areas and mined sites provide a suitable area for some motorised recreation activities such as trail bike riding.

On the other hand deep mining utilises smaller areas and has less conflict with other land uses.

5.7.2 Gravel, Stone and Sand

5.7.2.1 Regional and State significance

Gravel, stone and sand are extracted for engineering purposes. The most common use is for road construction by Government and semi-government bodies.

5.7.2.2 Demand

More than 466 000 m^3 of gravel, stone and sand were removed from State forest during the 1975/76 financial year for engineering developments being undertaken by the various authorities throughout the South West. It is anticipated that the current level of demand will continue.

5.7.2.3 Supply

Gravel, stone and sand supplies exist throughout State forests. Gravel is most prevalent in the central and western portions of the Northern Plateau. It is less plentiful towards the south coast.

There are localised outcrops of limestone which have particular value for road construction, within State forests, on the Coastal Plain. Where quantities are sufficiently large and quality is suitable for industrial use, excavation is generally administered under the Mining Act.

5.7.2.4 Objective of management

The objective is to provide gravel, stone and sand for Government and semi-government authorities where there is no reasonable alternative supply, and where the supply will not result in the spread of dieback or prejudice amenity values.

5.7.2.5 Gravel, stone and sand policy

1. Provide Government and semi-government bodies with gravel, stone and sand only where no reasonable alternatives exist. Supplies will not be made available to private contractors who will be expected to use private sources.

2. Ensure dieback hygiene methods are used in the excavation, transport and spreading phases of the operation.

3. Rehabilitate borrow pits according to the anticipated land use.

4. Locate borrow pits where they will not be in view from public roads.

5.7.2.6 Management strategy

1. Control removal of gravel, stone and sand from State forests and other Crown land by the existing system of licenses and leases. Returns stating amount removed from license or lease areas are required monthly, whether or not royalty is payable.

2. Ensure gravel, stone and sand from dieback infected sites are used only in areas similarly affected.

3. Earthworks associated with rehabilitation of borrow pits will be carried out by or at the expense of the license holder.

4. Minimise the area of State forests cleared for borrow pit sites.

5. Examine license fees and royalty rate to ensure they cover costs incurred and will be set at levels which generally encourage the use of alternative materials or sources of supply.

5.7.2.7 Interaction with other land uses

Gravel, stone and sand are open cut mining operations on a small scale and have been sought over the length and breadth of State forest by road building authorities. In localised areas direct conflict can occur with passive recreation, conservation of flora and timber production. Less serious conflict occurs with water production and motorised recreation, whereas there is general compatibility with the provision of some public services such as power lines. Serious indirect conflict may occur with most land uses because of the propensity of extraction operations to accelerate spread of dieback.

5.8 PUBLIC UTILITIES

5.8.1 Regional and State Significance

A wide array of utilities are located in State forests to service both the forest region and beyond (Plan 5). The major utilities are:

Energy: This utility is provided by the State Energy Commission and uses forest land for generating stations, transmission lines and gas pipelines. Transmission and distribution lines result in considerable dissection of State forest and loss of forested land.

Water: Water is distributed to the metropolitan area by Metropolitan Water Supply Sewerage and Drainage Board (M.W.S.S.D.B.) and to country areas by the Public Works Department. Dams (Plan 4) and associated pipelines are concentrated in the western parts of the Northern Plateau and provide water to the majority of the State's population and for irrigation purposes. Pipelines supplying Goldfields and Wheatbelt areas affect eastern forest on a reduced scale.

Townsites: Many small Forests Department and sawmilling settlements occupy land on State forests. Major townships within the forest belt occupy land vested in the relevant shire, but land use of adjacent State forests is affected by proximity to these townships.

Roads: This utility is provided by Main Roads Department, shires and Forests Department and serves domestic, industrial and leisure needs within, and outside the region. Forest land is used both for the location of the service itself and for the provision of surfacing materials. Shire and Main Road surveys are usually vested in the relevant authority.

Other Communications: Westrail uses forest land for rail transport, Telecom for telephone lines and the Forests Department has provided a number of airstrips.

These utilities are an obvious benefit to the regional and State economy and markedly influence the standard of living.

These benefits are not without environmental cost. Establishment and maintenance of services such as roads and powerlines increase the risk of infecting large areas with dieback and reduce the forest area.

5.8.2 Demand for Area

Over 10 000 hectares of State forests have been cleared to provide public utilities over the last 20 years. The provision of such services is closely tied to the rate of industrial expansion in both the metropolitan area, and in the South West. This trend is expected to continue with associated pressure for use of forest land.

The demand for moderately dissected valleys for water storage is expected to increase and land will be needed for the associated pipelines. The demand for arterial power lines from Collie to areas of industrial expansion can also be expected to increase. In the short term, significant changes in road and rail transport systems are not anticipated. In the long term the demand for land to develop either transport system is likely to depend on the scarcity of conventional energy supplies. The change from telephone lines to microwave links will reduce the area required by Telecom.

5.8.3 Supply of Area

Where utilities are independent of topography the only limit to use of State forests is conflict with major land uses. Loss of forest values and increasing dieback spread result in conflict which is similar to that caused by mining (refer Section 5.7.1.5).

Utilities such as reservoirs and pipelines which have specific topographic requirements are further constrained by available area. As the major valleys are dammed, some particular site vegetation types are becoming scarce. Continued demand for these sites directly conflicts with conservation of flora and fauna. Public utilities located on and adjacent to State forests are illustrated on Plan 5. Water storage areas are shown on Plan 4.

5.8.4 Objective of Management

The objective is to limit further development of public utilities which result in loss of forest values to those considered essential by Government, and for which there is no reasonable alternative location. Where this is so, any such development will be planned to ensure that it results in least environmental damage and minimum land use conflict.

5.8.5 Background to Policy Formation

The same principles apply to public utilities as to mining (refer Section 5.7.1.5).

5.8.6 Policy

1. Ensure that the forest estate and associated forest values are not unnecessarily eroded.

2. Guide the location of public utilities on State forests into areas where land use conflict and environmental damage are minimised.

3. Rehabilitate redundant sites to suit the future land use.

4. Directly liaise with service authorities to ensure their awareness of the effects of their operations on the environment and other land uses.

5. Investigate rehabilitation techniques.

5.8.7 Management Strategy

1. Minimise the area of State forests cleared for public utilities.

2. Liaise with shires to avoid the use of State forests for access to subdivisions for farmlets.

3. Where appropriate, obtain compensation to offset loss of forest estate and associated values.

4. Guide public utilities into areas where the salinity risk and aesthetic impact are minimised. Encourage the use of landscaping.

5. Encourage the use of the same sites for more than one utility.

6. Ensure management practices do not endanger public utilities.

5.8.8 Interaction With Other Land Uses

Clearing of vegetation is usually required for provision of public utilities on State forest and therefore this directly conflicts with conservation of flora and fauna, and timber production. Serious conflict occurs where water quality is threatened.

Although public utilities often conflict with other land uses, some may enhance forest values elsewhere. For example, the provision of public roads may enhance recreation, tourism and timber production on adjacent areas.

Conflict with other land uses is usually greatest during construction. In time, disturbed sites such as road verges and power line clearings, are recolonised with natural ground vegetation which improves soil stability and amenity values. Direct rehabilitation is often necessary and in recent years road building authorities have considerably improved the techniques involved.

5.9 PROTECTING THE FOREST FROM DESTRUCTIVE AGENTS

Protecting the forest from destructive agents is a common denominator of all resource management. In its widest application, forest protection means the maintenance of forest free from external effects contrary to the management objectives. In this State the main protective requirements are,

dedication of land for forestry purposes

use of management procedures designed to conserve all relevant values

minimisation of damage from wildfire and disease

conservation of the physical environment.

5.9.1 Dedication of Land for Forestry Purposes

5.9.1.1 Regional and State significance

Permanent dedication of State forests was a most compelling objective in the early years of the Forests Department. The consent of both Houses of Parliament is required to reverse the process, thus ensuring similar security of tenure to that of an "A Class" Reserve.

With this security of tenure, long term planning and management is possible.

5.9.1.2 Demand placed on State forests and need for additional area

The demands placed on State forests to provide various goods and services is increasing rapidly and the present area is limited in its capacity to meet them. Increased demand will intensify these conflicts and there is an obvious need to increase the area of State forests wherever justifiable.

5.9.1.3 Supply of area for forestry purposes

Some 1.94 million hectares of State forests,

Forests Act timber reserves and freehold land held in the name of the Conservator of Forests, are currently being managed by the Forests Department in the South West. A further 781 ha of State forests and 32 243 hectares of Forests Act timber reserves are managed in the Eastern Goldfields.

Within the South West 120 494 hectares of vacant Crown land are awaiting dedication as State forests. Other vacant Crown land, particularly along the south coast, east of Walpole, has forestry potential. The Forests Department buys suitable private property from time to time, for the extension of high quality hardwood forest (particularly karri) and for softwood plantation establishment. This avenue for increasing the estate, although relatively minor in terms of area is significant in terms of production potential.

Extensive tracts of vacant Crown land still occur on the Eastern Goldfields, Pilbara and Kimberley, but before considering extension of forestry management to these areas, there is need for further knowledge of their forestry potential.

5.9.1.4 Objective of management

The objective is to increase the area of State forest where possible to meet foreseeable public demand for each forest use, taking into account land vested in other authorities which complement forestry.

5.9.1.5 Policy

1. Advise Government on the forestry potential of vacant Crown land.

2. Pursue dedication of vacant Crown land with forestry potential as State forests.

3. Purchase suitable areas of private property as they become available.

4. Exchange land when the total forestry potential will be increased.

5. Oppose alienation of State forests.

6. Recognising the isolation of northern and eastern parts of the State from existing State forests, investigate the need for forest proucts in these areas and their potential for forestry.

5.9.1.6 Management strategy

1. Assess potential of Crown land for multiple use forestry.

2. Enter into land purchase negotiations whenever suitable property has been advertised on the open market.

3. Consolidate State forest boundaries.

5.9.2 Management to Protect the Forest

Dedication needs to be followed by setting out management objectives designed to conserve the forest and protect the environment. The primary function of the General Working Plan is to achieve this purpose.

Management for protection has been discussed (refer Sections 5.1 to 5.8).

5.9.3 Fire Protection

5.9.3.1 Regional and State significance

As a result of summer drought and lightning storms, fire is a natural phenomenon of the local environment. It was also deliberately used by aborigines prior to European settlement. Early agricultural development and timber harvesting caused rapid build-up of debris and devastating fires became more frequent.

A policy of fire exclusion was practiced by the Department for a period of 30 years. During this time fuels built up to levels which posed serious fire suppression problems. In 1954 the policy was changed to fuel reduction by prescribed burning. This was given greater impetus following the large fires of 1961. This policy has proved very successful in reduging wildfire intensity and damage on State forests.

An effective fire protection organisation was built up, and many aspects of fire control, particularly fire behaviour, were investigated. The fire detection system was based on a network of fixed lookouts, but has recently been replaced by more effective aerial surveillance. Mobility and flexibility are provided by an effective radio network.

The fire protection system is designed specifically to protect State forests, but also provides a significant contribution to the protection of community assets in the South West.

Values protected include:

a) Life and Property: The South West contains some 2.5 million hectares of private property and a population of about 77 000. State forests are largely central to this area and abutt the metropolitan area. Indirect protection is afforded to some 800 000 hectares of private property and other Crown lands adjacent to the dedicated forest.

b) Water Catchments: More than 80% of water supplies in the South West come from catchments in State forests.

c) Employment: State forests provide employment for approximately 5 000 people in the Forests Department and the timber industry.

d) Flora and Fauna: State forests provide a habitat for numerous species of native animals, birds and plants.

e) Recreation and Tourism: Current estimates suggest day visits for recreation on State forests are in excess of 500 000 per annum and are still increasing.

5.9.3.2 Demands for a fire protection system

Initially protection was associated with timber values but there is now increasing recognition of other forest values. The demand for fire protection is based on rising value of forest assets, their scarcity and susceptibility to damage. Other factors influencing the need are risks from adjoining land use, fire-prone environment, increasing human activity and increasing property values adjacent to the forest.

The number of fires attended during the period 1971-76 were:

Location	No. of Fires	Area Burnt (ha.)
Indigenous forest	687	25 574
Pine plantations	249	91
Private property/Crown land etc.	393	Not assessed.

There are several factors which will influence the type and complexity of future fire protection. They include:

the need for fire management techniques to be varied to favour each forest value and land use;

accelerated pine establishment;

extended hardwood regeneration programmes;

increased rehabilitation of mined and dieback sites;

added hazards from more extensive pine logging operations;

increased recreational activity;

greater environmental awareness;

rising values of forest and community assets;

increased call for assistance by other authorities;

mutual aid requirements under regional fire control plans for rural and semi-suburban areas.

5.9.3.3 Fire protection capability

Current resources: Since prescribed burning has been implemented on a rotational basis over most State forests, Departmental fire protection resources have proved adequate to meet the majority of fire situations. There have been a few occasions where it has been necessary to hire specialised heavy machinery. Reduction of available manpower has been made

possible by improved fire control organisation, equipment and techniques. Current resources are listed below:

a) Suppression resources

Men and equipment which can be made available for fire suppression are:

329 salaried officers (excluding drafting and clerical) and 481 wages employees

239 VHF radios, 28 R/T sets and 12 HF radios

8 aircraft for fire detection (on hire)
2 aircraft for aerial ignition (on hire)

40 fire lookout towers

192 light transport vehicles

110 fire trucks

58 wheel tractors

13 bulldozers

138 chainsaws

stocks to produce 790 000 litres of fire retardants

Although this is a substantial suppression resource, there have been two occasions in recent years where multiple fire outbreaks proved beyond the immediate control capacity of the Department.

b) Communications staff: Six technicians are permanently employed on communications development and maintenance, and allied problems such as navigational aids for aerial prescribed burning.

c) Fire control plans: Detailed plans for each administrative area specify fire control procedures and resources. They include automatic despatch procedures for high value areas such as pine plantations, procedures for initiation of a special organisation to deal with large fire emergencies, and necessary fire prevention measures to limit risks. Fire plans are updated annually.

d) Research: Considerable research into fire effects and behaviour, together with modernising of management practices has contributed markedly to the efficiency of fire protection resources.

Future resource requirements: Current suppression resources cannot cope with the expected increase in demand unless there are significant advances in technology and management.

There is therefore a need to increase manpower, relocate existing resources, use specially trained and equipped personnel from other organisations, and to purchase more sophisticated equipment.

The research programme will be continued to improve technological, ecological and managerial aspects of fire protection, particularly in respect to changing patterns of land use.

5.9.3.4 Objective of management

The objective is to provide a fire control system capable of protecting recognised forest values from serious damage. This system is to be compatible with the dominant land use in any area, with the cost of protection not exceeding the value of the loss prevented.

5.9.3.5 Background to policy formation

The theory of protection is based on balancing the cost of protection against the losses incurred such that cost plus loss is minimised. This must take into account allocation of funds for the prevention, detection, pre-suppression and suppression phases of fire protection in proportions which achieve the greatest economic efficiency.

A major influence on policy is the inherent environmental and climatic conditions that exist in south Western Australia. The summers are long, hot and dry. The annual build-up of fuel in the forest is substantial and continues for many years. Ignition caused by lightning and man is not amenable to control.

For these reasons fuel reduction, rapid detection and attack are essential for effective protection. Low intensity prescribed burning is the most economic means of fuel reduction. In grassed plantation areas pilot trials are being continued to study the effectiveness of grazing as a means of reducing fire hazard.

Throughout the hardwood forest prescribed burning during spring or autumn is applied on a rotational basis, except where management requirements for regeneration or research favour fire exclusion. In plantations where management is more intense and trees more sensitive to fire damage, prescribed burning in winter is generally used on buffer strips designed to restrict movement of wildfires.

5.9.3.6 Fire protection policy

1. Continue the investigation of fire effects on each major land use to determine losses and benefits in relation to fire intensity, frequency and season, and prescribe the use or exclusion of fire accordingly.

2. Provide for public education, warning and control in relation to fire risk, and ensure liaison with other fire protection organisations.

3. Provide a detection system which will ensure rapid effective attack of all wildfires on State forests.

4. Reduce fuels systematically in the indigenous forest to the level at which wildfire can readily be contained under normal weather conditions.

5. Reduce fuels on buffer strips systematically throughout pine plantations to limit major spread of wildfire.

6. Provide a well-trained and well-equipped suppression organisation capable of suppressing several simultaneous wildfires under severe weather conditions.

7. Assist authorities responsible for fire control on neighbouring land on the basis of mutual aid where this does not conflict with forest protection objectives.

8. Continue research programmes into technological, ecological and managerial aspects of fire protection, particularly in respect of changing patterns of land use.

5.9.3.7 Management strategy

1. Ensure effective liaison with individual neighbours, fire brigades, shires and other organisations with fire protection responsibilities, particularly at a local level.

2. The detection system should provide for:

rapid and accurate determination of fire location

early investigation of fire behaviour

values threatened

factors affecting fire behaviour

monitoring fire development.

3. Carry out prescribed burning of indigenous forest in appropriate seasons at intensities and frequencies which facilitate achievement of the major land use objectives.

4. Carry out fuel reduction programmes in pine plantations on predetermined buffer strips using either low intensity prescribed fire, grazing or mechanical means.

5. Carry out training, preparedness checks, planning and equipment maintenance at appropriate times to ensure efficient suppression of wildfire.

6. Continue research into the fields of:

economics of fire protection

protection of hardwood regeneration

reduction of hazard in pine plantations

fire management for flora and fauna populations

use of fire retardants

aerial photography aids for fire use and suppression

fire weather forecasting

fire suppression systems

system analysis and computer techniques in fire management.

5.9.3.8 Interaction with land uses

Wildfire adversely affects many uses. In some cases the effect can be long term, but in most, only short term interference is experienced.

Wildfire can have long term adverse effects on timber production and conservation of flora and fauna. High fire intensities can kill fire-sensitive tree stands such as pine plantations, or degrade wood quality in the more fire tolerant species such as jarrah and karri. Where wildfire results in alteration of vegetation structure or floristic composition, there is long term effect on conservation of flora and fauna. On the other hand should wildfire result in regeneration of a desired species, there would be long term benefit.

In the short term, wildfire interferes with wildflower display and hence recreation, wildflower collection and honey production. If occurring close to water storage sites, ash pollution can result. Wildfire can also interfere with the use of public utilities such as roads and rail and may also adversely affect air traffic. On the other hand, water yield and in some instances tree growth, may be temporarily increased.

Fire protection techniques are designed to be generally compatible with major land uses. However the techniques found to be most effective in minimising damage from wildfire can have short term effects on the output of some land uses. These techniques include

a) rotational prescribed burning during mild weather conditions;

b) exclusion of fire during mid summer;

c) exclusion of fire from many fire-sensitive plantations;

d) provisions for roadside amenity.

5.9.4 Jarrah Dieback Disease

5.9.4.1 Regional and State significance

The disease known as jarrah dieback is caused by the root rot fungus, Phytophthora cinnamomi. Although the problem was recognised in the 1920's and active research started in 1948 the causal agent was not specifically identified until 1965. The disease spread slowly until after 1945 when heavy equipment such as bulldozers and low loaders were introduced into forestry and logging operations on a large scale. These types of machines favoured the retention of greater quantities

of soil within their track and wheel assemblies. At the same time there was a change to use of contracted plant and machinery, which allowed rapid and frequent movement of these machines and the soil they carried, throughout the forest. The pathogen attacks the feeder roots of a wide range of native plants but is most devastating on poorly drained sites or where proteaceous plants dominate. It has serious effects on most plant communities which occur on lateritic soils in the jarrah forest.

New infections of dieback are caused by transport and dissemination of infected soil. The pathogen will establish itself at new sites where environmental conditions are favourable. Further extension by way of drainage lines is relatively rapid. Natural spread uphill is very slow.

Since its introduction, the disease has become widespread throughout the South West, particularly in high rainfall areas. Its significance results from alteration of the forest environment, the main effects being:

a) loss of forest products and production potential;

b) change of recreation values;

c) deterioration of floristic composition and structure of native vegetation;

d) deterioration in water quality in salt-sensitive areas.

On the other hand reduction of forest density in areas where salinity is not a problem can result in increased water yield.

5.9.4.2 Need for disease control

As at June 1975, 183 000 hectares or about 9% of State forests were known, or suspected, to be infected with jarrah dieback. The major infections occur on the western portion of the Northern Plateau and the Donnybrook Sunkland where soil moisture and temperature favour the pathogen. Broad dieback zones are illustrated in Plan 6. An example of detailed dieback mapping is shown in Plan 7.

A survey of existing infections in relation to drainage patterns has shown a further 270 000 hectares of forest may not be protectable from the disease. Should this

prove to be so, some 470 000 hectares, or 24% of State forests could succumb to the disease, even if further infections could be prevented in protectable forest.

5.9.4.3 Available disease control measures

Techniques such as fungicide application and soil sterilisation will eradicate the disease but are not practical on a forest scale. Procedures developed for field control have therefore been based on preventing new infection. Early attempts to do this entailed stringent controls over vehicle access and cleanliness of vehicles and machines.

Continued research into the mode of action of the pathogen indicated the time between the infection and visible expression of the disease could exceed two years. During this time there could be inadvertent spread even with strict hygiene control through movement over as yet unidentified infections.

To practice effective disease control the location of all infections must first be identified. The most practical means to achieve this, without further inadvertent spread, is by exclusion of vehicular traffic from areas considered to be "at risk" until symptoms can be visually detected. Legislative power to implement this procedure was conferred on the Department with the passing of the Forests Act Amendment Act, 1974. This provided for declaration of Forest Disease Risk Areas, within which vehicular movement could be regulated (refer also Section 1.2.3). In practice this allowed for quarantining of threatened forest areas for sufficient time to allow visible manifestation and subsequent mapping of the diseased area. Given accurate knowledge of disease location and further development of hygiene techniques, a high degree of control is expected.

So far quarantine covers 507 000 hectares of relatively disease-free forest between Mundaring and Nannup (Plan 6). Proposals are in hand to extend the technique to forests south of Nannup and to some areas of the Sunkland. At the same time a campaign has been conducted via the media, Departmental publications and public contacts to explain the approach being taken towards dieback control.

5.9.4.4 Objective of management

To limit the spread of infections and to rehabilitate dieback-infected areas to suit the future land use.

5.9.4.5 Dieback policy

1. Classify State forests according to disease presence, susceptibility of the site and disease resistance of the vegetation to the disease.

2. Continue to use forest quarantine measures to detect and map the disease.

3. Continue to improve and apply hygiene measures.

4. Rehabilitate infected areas with resistant species to suit the anticipated land use.

5. Continue to investigate methods of disease control and rehabilitation techniques.

5.9.4.6 Management strategy

1. Improve remote sensing techniques to prepare accurate maps for subsequent monitoring of diseased areas.

2. Extend the area of forest quarantine giving priority to high value forests with low levels of infection.

3. Continue to apply hygiene restraints into all permits, licenses and contract operations which involve vehicular movement on State forests.

4. Rehabilitate infected areas in the salt-sensitive zone to a full canopy of deep-rooted perennial species in accordance with predetermined management priorities.

5. Extend practical trials of various operational hygiene techniques to test their effectiveness.

6. Continue to disseminate information on dieback and its control to all forest users and to the general public.

7. Liaise with other organisations to foster research on dieback and to avoid duplication of effort.

5.9.4.7 Interaction with land uses

Unlike fire, dieback disease is more permanently devastating to many plant communities.

It adversely affects water quality in areas where salt is a potential problem, jarrah timber production and conservation of susceptible flora and dependent fauna.

The effect of dieback disease on recreation varies. It can adversely affect those forms of recreation which largely rely on healthy forest conditions. Conversely dieback infected areas can provide a venue for such outlets as trail bike riding.

Dieback has little effect on timber production and conservation of non susceptible species. In areas where salt is not present in the soil profile, water production is enhanced because of increased run-off.

Disease control measures will have both short and long term effects on the output of most land uses. Techniques in use are

a) quarantine of areas considered to be at risk. This is likely to result in only short term interruption to land management.

b) Hygiene restrictions. Techniques involved are likely to affect land management permanently in most areas.

5.9.5 Conservation of the Physical Environment

The environmental considerations discussed so far were primarily concerned with the forest as a living entity. However, human activity within the forest can also alter the physical environment (soil, air and water).

Management techniques designed to protect forest resource values from damaging agencies such as fire and disease can influence the environment. For example, prescribed burning will increase the smoke and ash content in the atmosphere over short periods. Though this cannot be avoided, burning can be programmed for meteorological conditions which will minimise the effects on the population. Potential effects of forest management on the physical environment are listed in Table 6.

It is essential that interpretation of management policies and strategies provide for environmental protection and this has been emphasised throughout this Working Plan.

Table 6
Potential Effects of Forest Management on the Physical Environment

Factor	Environmental Component		
	Soil	Air	Water
Physical	Mechanical removal of soil. Alteration of soil structure. Erosion - wind and water. Compaction and loss of aeration.	Reduction of visibility. Temperature change.	Increase in turbidity. Temperature change.
Chemical	Leaching of nutrients. Chemical pollution.	Increase particulate and gaseous content. Increase volatile poison content.	Increase in dissolved salts. Increase pollution. Eutrophication.

5.9.5.1 Objective of management

To minimise the deleterious effects of land use and management on the soil, air and water components of the forest environment.

5.9.5.2 Policy

1. Provide for conservation of the physical environment in all management plans.

2. Monitor the effect of human activity on the physical environment of the forest.

3. Investigate means by which impairment of the physical environment may be avoided or repaired.

5.9.5.3 Management strategy

1. Prepare environmental reviews with respect to proposals for any major land use of management changes.

2. Liaise with other forest-using authorities and organisations to ensure their awareness of environmental effect from their activities.

3. Ensure environmental safeguards form part of all management prescriptions.

4. Continue liaison with the Department of Conservation and Environment, other Government departments and interested bodies.

6. SUPPORT SERVICES AND RESEARCH PROGRAMME

6.1 RESEARCH BRANCH

The Departmental research branch consists of some 12 professional officers and 30 technical and support staff operating from laboratory centres at Wanneroo, Como, Dwellingup and Busselton. The group is managed as an operational service unit oriented to problems with immediate management significance. Wherever possible, basic research problems are directed to external institutions more suited to this type of investigation.

Research is given a larger share of staff and finance than is common in most other Australian forest services. This stems from the special nature of climate, species and soils and, to some extent, geographic isolation. Most management practices need to be specially adapted to local conditions. In particular, fire weather, the jarrah dieback disease, infertile plantation soils and intensive use of the northern jarrah forest create unique problems for management.

It is not expected that research staff will increase to any significant extent within the current planning period. The increasing workload is being met by redirecting staff to new problem areas, greater inter-departmental co-ordination of investigations into land use and by increased activity through Commonwealth and university facilities.

6.1.1 Priorities for Research

Priorities for research over the next five years are estimated to be as follows:

6.1.1.1 Dieback

a) Improved knowledge of the influence of legumes and litter mulches on fungal control.

b) Evaluation of quarantine and hygiene measures and improved delineation of susceptible sites.

c) Tactics and strategies for rehabilitation within specific land use objectives.

6.1.1.2 Fire

a) Burning techniques in young karri stands.

b) Improved techniques for plantation protection including grazing, prescribed burning and fuel reduction by mechanical means.

c) Control of smoke dispersal from prescribed burns.

d) Improvement of systems procedure for planning and control of prevention and suppression activity.

e) Requirements of special habitats.

6.1.1.3 Hardwood silviculture

a) Relationships of coupe size, location and dispersal to the economics of protection.

b) Ecological typing of the Southern Forest region.

c) Tending and intermediate harvesting in karri regrowth.

d) Hardwood nutrition and evaluation of plantation possibilities.

e) Improved harvesting techniques.

6.1.1.4 Softwood silviculture

a) Nutrition of stands in Sunkland sites.

b) Improved harvesting techniques.

c) Integration of grazing with pine production.

d) Yield increase in older stands through fertiliser use.

e) Aesthetic and environmental requirements in plantation development.

6.1.1.5 Hydrology

a) Impact of dieback and mining on salinity of catchments.

b) Possibilities of water management through manipulation of vegetative cover.

c) Monitor the impact of forest operations on water purity.

d) Management implications of ground water resources in forested areas.

e) Rehabilitation procedures for diseased areas, mined sites and other cleared land.

6.1.1.6 Flora and fauna

a) Definition of types in management priority areas.

b) Monitor the impact of human activities covering all facets of forest operations and activities.

c) Extend ecological surveys to the southern forest.

d) Study fire ecology.

e) Study habitat requirements of key species.

6.1.1.7 Recreation

a) Development of a framework plan for recreation in State forests.

b) Inventory of forest resources and user demand.

c) Training in aesthetics and landscaping in management.

6.1.2 External Interests

The integrated, inter-departmental approach to salinity problems associated with bauxite mining and the wood chip industry as promoted through the Hunt and Kelsall

Steering Committees will continue. It is anticipated that this activity will lead to effective research and land use planning on a regional basis.

The Divisions of Land Resource Management and Forest Research (C.S.I.R.O.) have shown interest in increasing their investigations in local forest types. The universities and colleges of advanced education are also showing greater interest in the forest. It is expected that full co-operation will result in more basic research in forest ecosystems.

Research is needed into the social aspects of multiple use management and in particular, the appraisal of the value placed on the forest resource by the public. The nature of such investigations makes it desirable that they be conducted by bodies outside of the Forests Department.

6.2 INVENTORY & PLANNING BRANCH

This branch has a staff of 7 professional officers and 20 support staff operating from centres at Como, Harvey and Manjimup. External support for this function is not available outside the Department. It is anticipated that increasing management complexity will require significant staff increases and re-organisation. Preparation and control of the General Working Plan is becoming more demanding and operational control is more critical. The automatic data processing facilities for fire control, planning and research are managed by the Inventory & Planning Branch at Como.

The major priorities within the current planning period are:

a) Revision of data for updating the Working Plan.

b) Detailed specification of cutting coupes.

c) Improvement and extension of hardwood growth data.

d) Improvement and extension of dieback mapping.

e) Final extension of the hardwood operational control system (H.O.C.S.) to all administrative regions.

f) Implementation of the plantation operational thinning schedule (P.O.T.S.) and monitoring of the plantation operations control system (P.O.C.S.) for conifers.

g) Increased economic analysis for operational evaluation and land use planning.

h) Development and implementation of new inventory procedures for timber and other forest values at operational level.

i) Continue development of automatic data processing facilities for fire control, planning and research.

6.3 EXTENSION BRANCH

Extension encompasses those activities which facilitate communication between the Forests Department and the community.

The Department has been involved in extension work for many years. In the past this service was concerned primarily with answering personal enquiries of a specific, and generally silvicultural, nature.

In recent years there has been greater public environmental awareness which has stimulated a heightened, and often critical, interest in forests and forestry practices. The demand for information has eminated from individuals, companies, societies, institutions and other Government departments. To meet this demand it has been necessary to adopt a more active and educational role in the public arena using all forms of communication. Examples of topics covered recently which have been, and are to be made public, include:

a) Statement of Forest Policy.

b) Environmental Impact Statement for the marri wood chip project.

c) Statement of Intent for pine plantations in the Sunklands.

d) Perspective for Multiple Use Planning in the Northern Jarrah Forest (in press).

e) General Working Plan No. 86, Part I.

f) Forest Focus series.

These releases have aimed at effective public appreciation and participation in major forestry matters.

The overall aim of the Department's extension service is to inform and educate the public on forestry matters; to learn the needs of the community; and to participate in inter-disciplinary forest based activities.

Public education has been concentrated on teacher training. A field study centre at Jarrahdale has been provided for this purpose and a second larger centre is proposed at Hamel.

There are eight staff employed to cover extension requirements in the metropolitan area. The major extension work load is however, carried by Departmental staff as part of their normal duties.

Extension Programme

a) Arrange for public visits to the forest to examine matters of topical interest giving priority to personal contact and discussion with groups.

b) Participate in inter-departmental and inter-disciplinary groups dealing with forest land use, research, planning and management.

c) Communicate with public audiences through lectures, seminars and discussions.

d) Continue Departmental publications such as Forest Focus, Information Sheets and Self Conducting Tour Guides.

e) Continue public education with emphasis on teacher training.

f) Continue co-operation with the Community Recreation Council and service organisations in the educational and recreational use of redundant Forests Department settlements and other facilities.

g) Maintain liaison with shires, schools, clubs, tourist agencies and other interested bodies.

h) Continue displays at agricultural shows and similar venues.

i) Provide improved advisory services to private forest owners.

j) Widen the extension services on general forestry matters to provide better service in more remote areas of the State, such as the Kimberley and Pilbara.

k) Continue to answer specific public enquiries.

7. ORGANISATION, SERVICE AND FINANCE

Achievement of the objectives outlined in this Plan will depend on the availability of finance. The adoption of a three year budgeting programme by Treasury will be of considerable assistance in setting works programmes and priorities.

In recent years the intensity of management required for the range of forest resources has increased markedly, demanding added depth and breadth of knowledge within the Department.

While it has not been possible to balance this with desirable increases in total staff, there has been an increase in both professional and field foresters at the expense of wages staff. Salaried staff numbers have increased by 2.8% per annum over the past eleven years whereas wages staff have decreased by 1.5% per annum during this period.

Limitations on the number of Public Service staff are expected to continue and achievement of objectives will therefore depend primarily on continuing to improve the Department's organisational efficiency.

The principal means by which improved efficiency can be achieved are:

a) Continued training of all staff to gain greater expertise in forestry practice and organisational management. Internal and external training facilities will be utilised to the limit of available finance.

b) Continuation of organisational restructuring within the Department to gain maximum benefits from staff alignment with functions, thereby allowing individual expertise to increase through specialisation. Flexibility will be maintained by fostering maximum interaction between functions.

c) Matching staff and employees to tasks.

d) Selection of new staff and employees with special attributes to meet specific tasks.

e) Continued technological research.

f) Introduction of improved control systems at all levels of management, using computer systems to eliminate manual drudgery and expedite turn-around of management control information.

g) Improvement of qualitative control systems covering each aspect of multiple use management.

Finance, expertise and manpower will be allocated generally in accordance with present priorities, which may be modified in the light of increasing knowledge and changing circumstances.

Emphasis will continue to be placed on staff and employee safety, health and welfare whilst developing additional management techniques designed to further increase levels of employee morale, organisational participation and co-operation with management.

It is aimed to retain the ability to develop new specialised equipment and to provide safe, work-matched plant. Fleet replacement will be determined for each type of vehicle using costs of capital investment, interest, depreciation and maintenance to determine economic life. Contract machinery will be employed where economies can be shown.

Present office accommodation is inadequate and is limiting organisational effectiveness in Head Office as well as in the regional offices at Como, Bunbury and Manjimup. Attention will be given to solving this accommodation problem during the period of this Plan.

Appendix I

List of State Forests and Forests Act Timber Reserves

(as at 1/12/76)

A. State Forests

te Forests No.	Area (hectares)	State Forests No.	Area (hectares)
1	833.5	36	43 746.1
2	2 046.4	37	88 777.2
3	217.7	38	56 537.1
4	18 248.7	39	57 483.5
5	162.7	40	10 897.0
6	2 681.4	41	53 562.6
7	32 055.6	42	3 110.0
8	781.0	43	27 799.0
9	3 473.0	44	1 720.7
10	3 116.9	45	3 066.7
11	3 316.8	46	8 748.1
12	656.4	47	3 803.6
13	101 268.5	48	2 651.1
14	191 101.6	49	1 669.7
15	107 793.1	50	1 174.1
16	8 918.4	51	16 587.9
17	6 194.9	52	2 959.1
18	666.1	53	3 282.2
19	Not declared	54	2 441.0
20	6 197.1	55	72 770.2
21	9 016.8	56	1 802.9
22	126 090.3	57	10 568.2
23	8 165.0	58	48 197.3
24	53 611.5	59	57 572.8
25	25 767.5	60	61.5
26	24 085.6	61	27 708.8
27	16 868.8	62	1 455.5
28	37 551.8	63	26 415.8
29	56 278.3	64	42 110.9
30	4 776.8	65	58 307.8
31	8 579.3	66	1 494.5
32	74 405.8	67	38 258.6
33	56 390.4	68	329.8
34	35 907.4	69	12.3
35	28 595.5	70	659.6
		Total	1 833 563.8

Appendix I (continued)

B. Timber Reserves (Forests Act)

Reserve No.	Area (hectares)	Reserve No.	Area (hectares)	Reserve No.	Area (hectares)
52	3.6	145	651.9	182	117.0
56	64.8	146	13 247.8	183	66.8
60	2 546.7	147	1 934.4	184	299.0
66	919.0	148	5 617.0	185	1 154.2
67	57.5	150	2 082.5	186	47.0
68	1 467.0	151	1 319.3	187	271.2
69	7 836.7	152	44.9	188	357.0
72	1 295.0	153	93.1	189	49.2
84	1 550.0	154	80.1	190	514.6
93	74.5	155	407.5	191	21.0
94	58.3	156	181.3	192	23.3
96	74.9	157	234.7	193	96.4
97	18.1	158	31.6	194	16 350.0*
102	15.0	159	125.9	195	2 226.2*
103	17.4	160	3 222.1	197	3 724.4*
105	80.9	161	496.5	198	6 600.0*
106	484.4	162	1 914.6	199	3 342.5*
107	80.5	163	833.2	200	1 128.0
109	153.8	165	768.9	201	8 963.4
110	194.2	166	200.7	202	819.8
116	247.8	167	30.4	203	688.4
127	291.8	168	790.3	205	171.5
129	1 113.7	170	264.2	206	661.5
130	2 089.0	171	2 428.1	208	108.1
131	66.5	172	1 034.4		
133	40.5	173	403.9		
135	2 208.4	174	184.1		
136	109.1	175	97.9		
138	49.8	176	58.7		
139	1 114.9	177	40.1		
140	4 772.5	178	47.8		
141	60.7	179	312.4		
143	101.2	180	60.3		
144	560.1	181	146.5		
				Total	117 005.9

* Inland (Goldfields) Reserves

Appendix 2

Common and Botanical Names of Species Referred to in this Plan

Common Name	Botanical Name
Jarrah	Eucalyptus marginata Donn. ex Sm.
Karri	" diversicolor F. Muell
Marri	" calophylla R.Br. ex Lindl.
Wandoo	" wandoo syn. E. redunca var. elata
Powder Bark Wandoo	" accedens W.V. Fitzg.
Brown Mallet	" astringens Maiden
Tuart	" gomphocephala
Red Tingle	" jacksonii Maiden
Yellow Tingle	" guilfoylii Maiden
Rates Tingle	" brevistylis M.I.H. Brooker
Bullich	" megacarpa F. Muell
Blackbutt	" patens Benth.
Drummond Gum	" drummondii Benth
Darling Range Ghost Gum	" laeliae Podger & Chippendale
Flooded Gum	" rudis Endl.
Mountain Marri	" haematoxylon Maiden
Fuchsia Mallee	" forrestiana Diels
Dundas Mahogany	" brockwayi C.A. Gardn.
Dundas Blackbutt	" dundasi Maiden
Clelands Blackbutt	" clelandii Maiden
Red Flowering Gum	" ficifolia F. Muell.
	" campaspe S. Moore
Salmon Gum	" salmonophloia F. Muell.
Radiata Pine	Pinus radiata D. Don.
Maritime Pine	Pinus pinaster Ait.
	Dryandra polycephala Benth.
Grass Tree	Kingia australia R. Br.
Rock Sheoak	Casuarina huegelliana Miq.
Sheoak	Casuarina fraserana Miq.
Raspberry Jam	Acacia acuminata Benth.
Peppermint	Agonis flexuosa (Spreng.) Schau.
Narrow Leaf Banksia	Banksia attenuata R.Br.
Woody Pear	Xylomelum occidentale R.Br.
Paperbark	Melaleuca rhaphiophylla Schau.
Holly Leaf Banksia	Banksia ilicifolia R.Br.
	Banksia meissneri Lehm.
Swamp Banksia	Banksia littoralis R.Br.
River Banksia	Banksia littoralis var. seminuda R.Br.
Brown Boronia	Boronia megastigma Nees.
Sandalwood	Santalum spicatum (R.Br.) DC
Mulga	Acacia aneura F. Muell. ex Benth.
Jarrah Dieback	Phytophthora cinnamomi Rands

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13. Various Acts (refer Section 3).

102750/2/77-300 BKS-O/D

PLAN 1

GENERAL WORKING PLAN No. 86
FOREST ESTATE

SCALE 1 : 1000 000

Miles 0 10 20 30 40

Kilometres 0 10 20 30 40 50

LEGEND

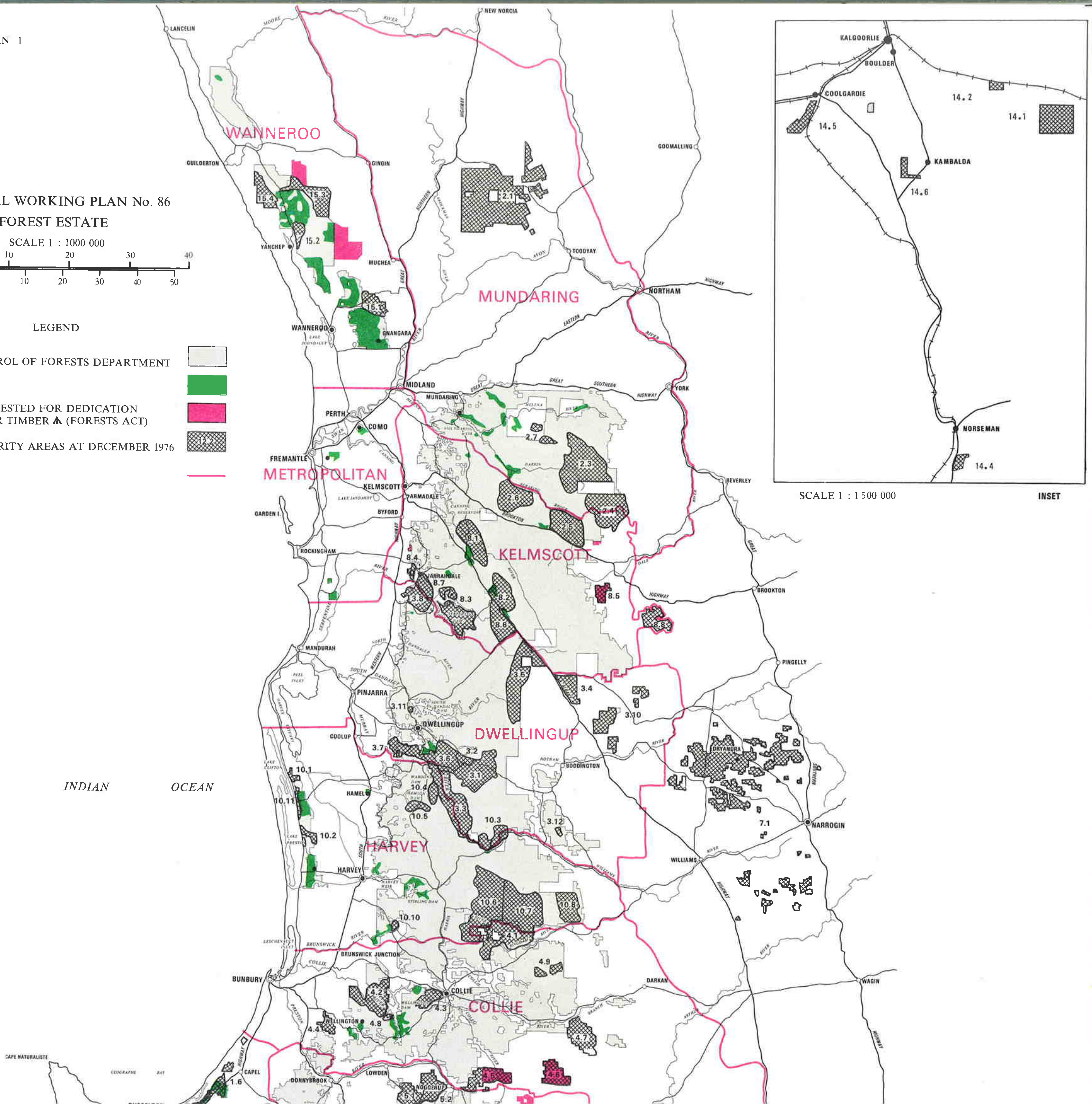
LAND UNDER CONTROL OF FORESTS DEPARTMENT

PINE PLANTATIONS

APPROVED OR REQUESTED FOR DEDICATION AS STATE FOREST OR TIMBER ⩓ (FORESTS ACT)

MANAGEMENT PRIORITY AREAS AT DECEMBER 1976

FOREST DIVISIONS



WANNEROO
MUNDARING
METROPOLITAN
KELMSCOTT
DWELLINGUP
HARVEY
COLLIE
INDIAN OCEAN
LANCELIN
NEW NORCIA
GUILDERTON
GINGIN
GOOMALLING
YANCHEP
MUCHEA
TOODYAY
NORTHAM
WANNEROO
GNANGARA
MIDLAND
MUNDARING
YORK
PERTH
COMO
FREMANTLE
KELMSCOTT
ARMADALE
BYFORD
GARDEN I.
BEVERLEY
ROCKINGHAM
JARRAHDALE
BROOKTON
MANDURAH
PINGELLY
PINJARRA
DWELLINGUP
COOLUP
BODDINGTON
HAMEL
NARROGIN
WILLIAMS
HARVEY
BRUNSWICK JUNCTION
BUNBURY
COLLIE
DARKAN
WAGIN
WELLINGTON
CAPEL
DONNYBROOK
LOWDEN
NOGGERUP
CAPE NATURALISTE
KALGOORLIE
BOULDER
COOLGARDIE
KAMBALDA
NORSEMAN
SCALE 1 : 1 500 000
INSET

INDIAN OCEAN

SOUTHERN OCEAN

DWELLINGUP

HARVEY

COLLIE

BUSSELTON

KIRUP

NANNUP

MANJIMUP

PEMBERTON

WALPOLE

PINJARRA
DWELLINGUP
COOLUP
HAMEL
BODDINGTON
BRYANDRA
NARROGIN
WILLIAMS
HARVEY
BRUNSWICK JUNCTION
BUNBURY
COLLIE
DARKAN
WAGIN
WELLINGTON
CAPE NATURALISTE
CAPEL
DONNYBROOK
LOWDEN
NORGERUP
BUSSELTON
KIRUP
KATANNING
JARRAHWOOD
BALINGUP
GREENBUSHES
BOYUP BROOK
KOJONUP
MARGARET RIVER
NANNUP
BRIDGETOWN
WHEATLEY
KARRIDALE
AUGUSTA
CAPE LEEUWIN
MANJIMUP
NYAMUP
TONE RIVER
QUININUP
PEMBERTON
CRANBROOK
FRANKLAND
ROCKY GULLY
NORTHCLIFFE
MT. BARKER
WALPOLE
DENMARK
ALBANY

PLAN 2

GENERAL WORKING PLAN No. 86
MANAGEMENT ZONES—
NORTHERN PLATEAU

SCALE 1 : 750000

Kilometres 10 0 10 20 30

Miles 10 5 0 5 10 15

LEGEND

LAND UNDER CONTROL OF FORESTS DEPARTMENT

COASTAL LAND PLAIN

NATIONAL PARKS

PINE PLANTATIONS

RAINFALL ZONE

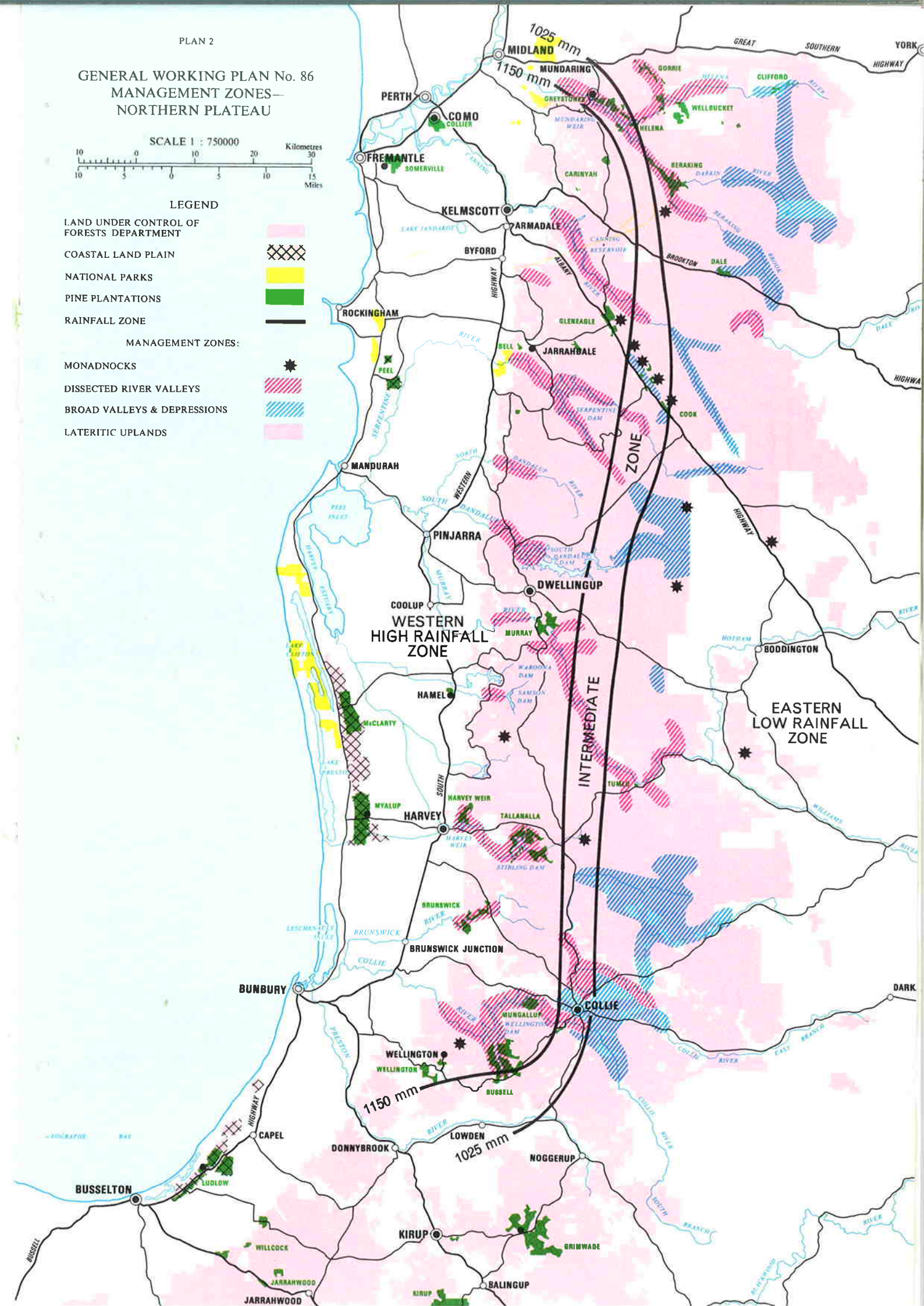
MANAGEMENT ZONES:

MONADNOCKS

DISSECTED RIVER VALLEYS

BROAD VALLEYS & DEPRESSIONS

LATERITIC UPLANDS



PLAN 3

GENERAL WORKING PLAN No. 86

SCALE 1 : 1000 000

0 10 20 30 40 50 Kilometres

0 10 20 30 40 Miles

LEGEND

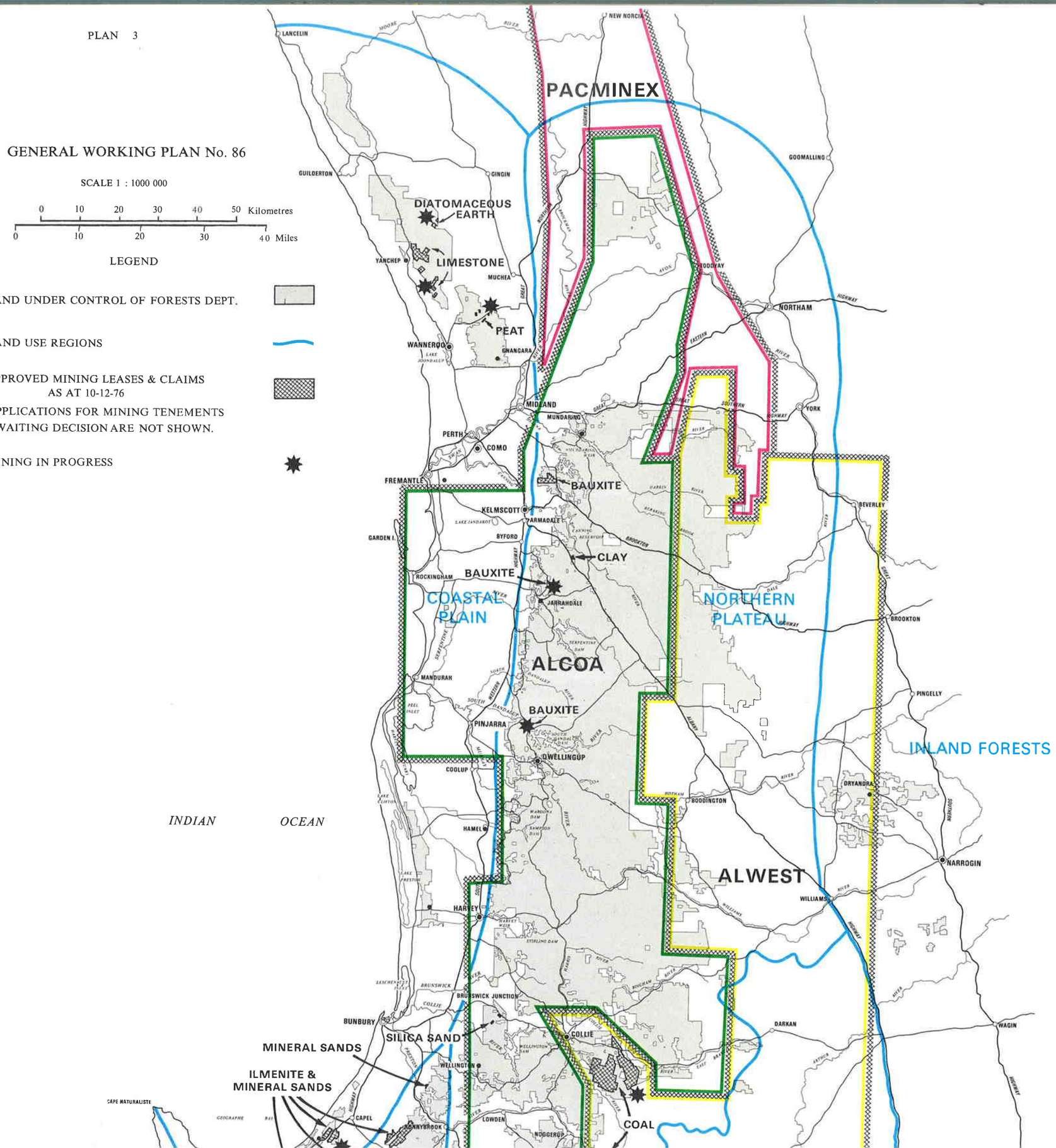
LAND UNDER CONTROL OF FORESTS DEPT.

LAND USE REGIONS

APPROVED MINING LEASES & CLAIMS AS AT 10-12-76

APPLICATIONS FOR MINING TENEMENTS AWAITING DECISION ARE NOT SHOWN.

MINING IN PROGRESS



INDIAN OCEAN

SOUTHERN OCEAN

BAUXITE

PINJARRA

DWELLINGUP

COOLUP

HAMEL

HARVEY

BRUNSWICK JUNCTION

BUNBURY

SILICA SAND

MINERAL SANDS

ILMENITE & MINERAL SANDS

WELLINGTON

COLLIE

COAL

DARKAN

WAGIN

CAPE NATURALISTE

CAPEL

DONNYBROOK

LOWDEN

NOGGERUP

BUSSELTON

MINERAL SANDS

KIRUP

BALINGUP

JARRAHWOOD

GREENBUSHES

TIN

BOYUP BROOK

KOJONUP

KATANNING

LEEUWIN-NATURALISTE HORST

MARGARET RIVER

DONNYBROOK SUNKLANDS

NANNUP

BRIDGETOWN

BLACKWOOD VALLEY

WHEATLEY

KARRIDALE

AUGUSTA

CAPE LEEUWIN

MANJIMUP

NYAMUP

TONE RIVER

PEMBERTON

QUININUP

NORTHCLIFFE

SOUTHERN FORESTS

WALPOLE

DENMARK

ALBANY

CRANBROOK

FRANKLAND

ROCKY GULLY

MT. BARKER

INLAND FORESTS

ALWEST

DRYANDRA

BODDINGTON

NARROGIN

WILLIAMS

PLAN 4

GENERAL WORKING PLAN No. 86
SOUTH WEST CATCHMENTS

SCALE 1 : 1000 000

miles 0 10 20 30 40

Kilometres 0 10 20 30 40 50

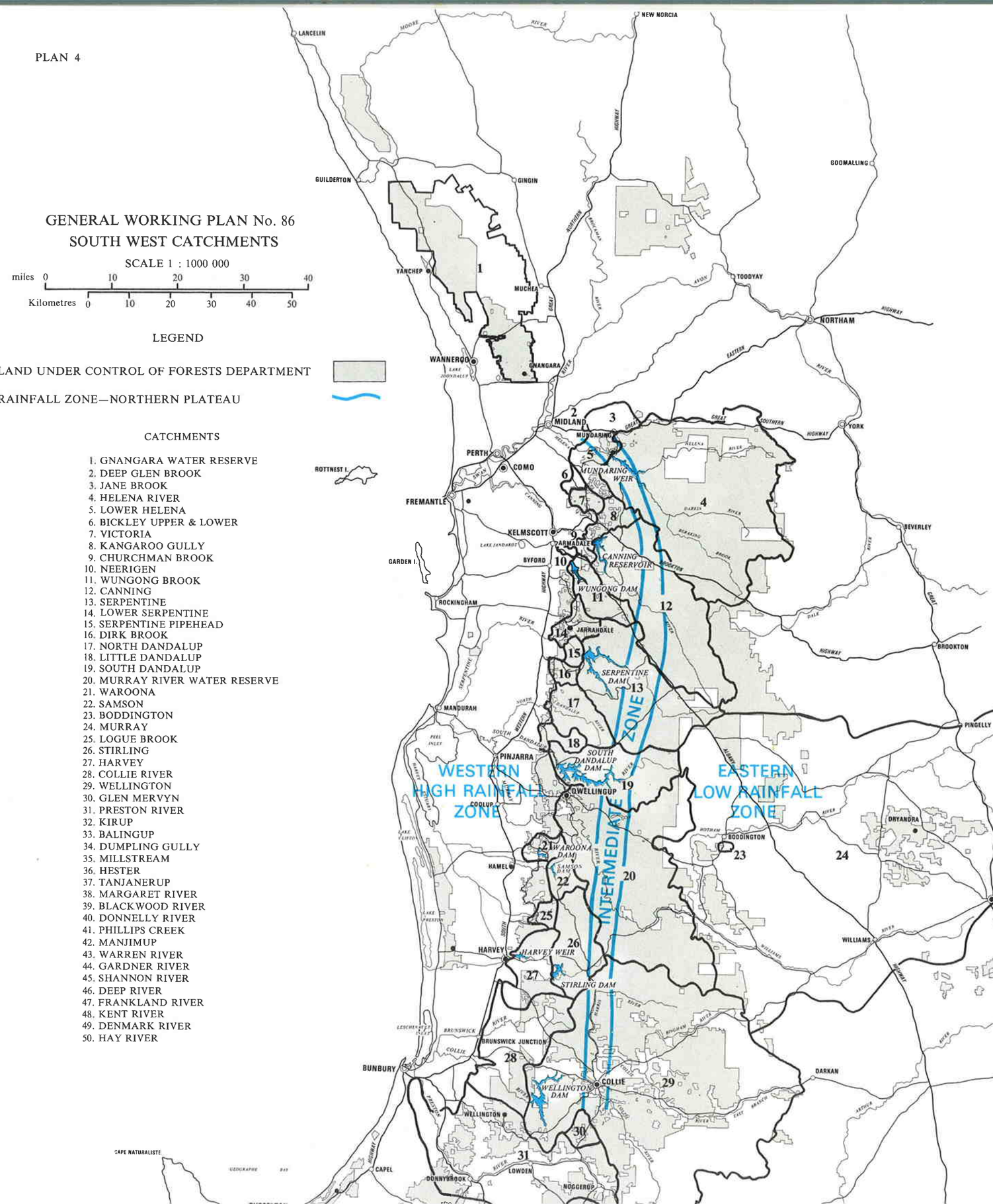
LEGEND

LAND UNDER CONTROL OF FORESTS DEPARTMENT

RAINFALL ZONE—NORTHERN PLATEAU

CATCHMENTS

1. GNANGARA WATER RESERVE
2. DEEP GLEN BROOK
3. JANE BROOK
4. HELENA RIVER
5. LOWER HELENA
6. BICKLEY UPPER & LOWER
7. VICTORIA
8. KANGAROO GULLY
9. CHURCHMAN BROOK
10. NEERIGEN
11. WUNGONG BROOK
12. CANNING
13. SERPENTINE
14. LOWER SERPENTINE
15. SERPENTINE PIPEHEAD
16. DIRK BROOK
17. NORTH DANDALUP
18. LITTLE DANDALUP
19. SOUTH DANDALUP
20. MURRAY RIVER WATER RESERVE
21. WAROONA
22. SAMSON
23. BODDINGTON
24. MURRAY
25. LOGUE BROOK
26. STIRLING
27. HARVEY
28. COLLIE RIVER
29. WELLINGTON
30. GLEN MERVYN
31. PRESTON RIVER
32. KIRUP
33. BALINGUP
34. DUMPLING GULLY
35. MILLSTREAM
36. HESTER
37. TANJANERUP
38. MARGARET RIVER
39. BLACKWOOD RIVER
40. DONNELLY RIVER
41. PHILLIPS CREEK
42. MANJIMUP
43. WARREN RIVER
44. GARDNER RIVER
45. SHANNON RIVER
46. DEEP RIVER
47. FRANKLAND RIVER
48. KENT RIVER
49. DENMARK RIVER
50. HAY RIVER



25. LOGUE BROOK
26. STIRLING
27. HARVEY
28. COLLIE RIVER
29. WELLINGTON
30. GLEN MERVYN
31. PRESTON RIVER
32. KIRUP
33. BALINGUP
34. DUMPLING GULLY
35. MILLSTREAM
36. HESTER
37. TANJANERUP
38. MARGARET RIVER
39. BLACKWOOD RIVER
40. DONNELLY RIVER
41. PHILLIPS CREEK
42. MANJIMUP
43. WARREN RIVER
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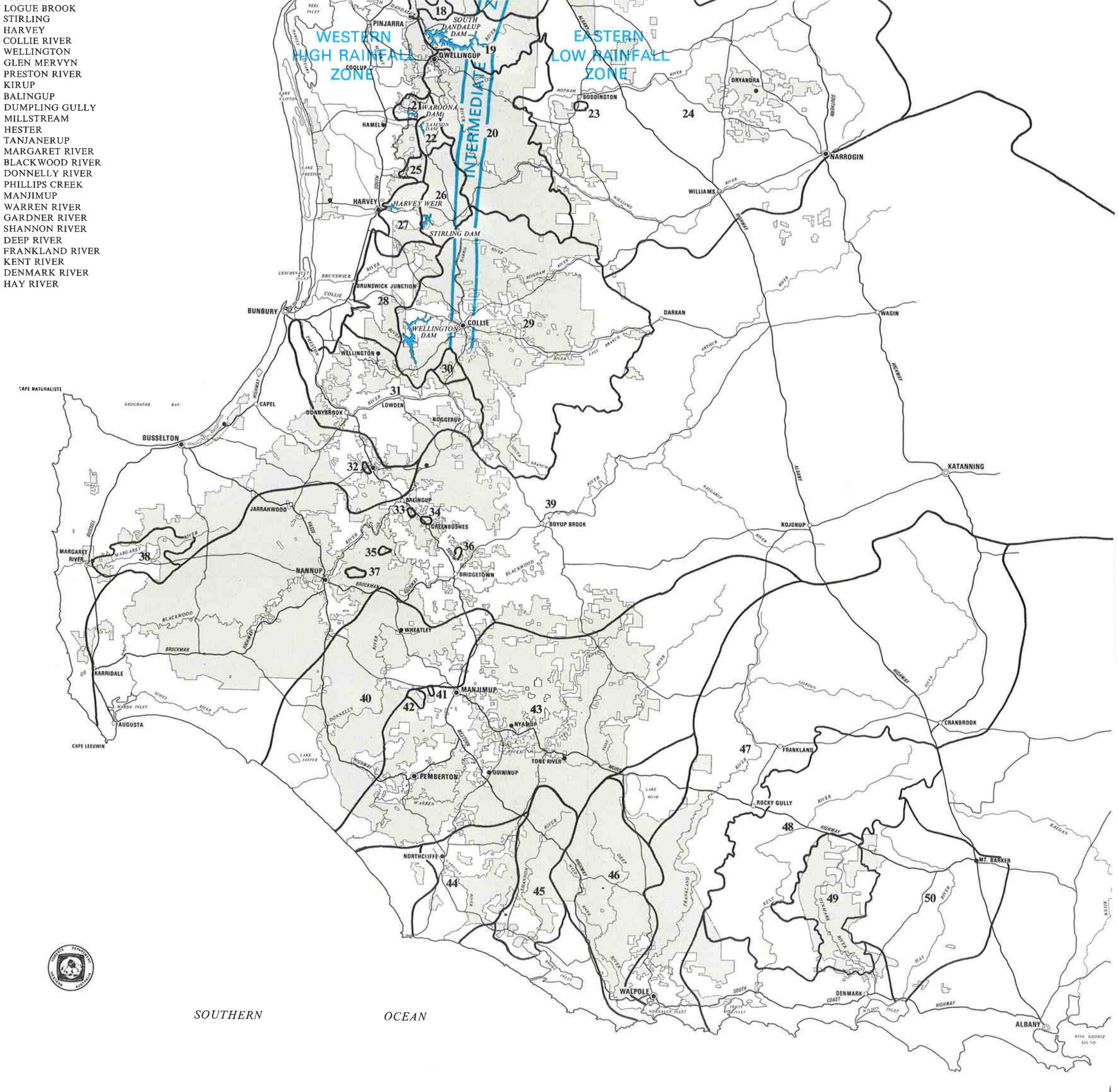
47. FRANKLAND RIVER
48. KENT RIVER
49. DENMARK RIVER
50. HAY RIVER



PLAN 5

GENERAL WORKING PLAN No. 86

PUBLIC UTILITIES

SCALE 1 : 1000 000

0 10 20 30 40 Miles

0 10 20 30 40 50 Kilometres

LEGEND

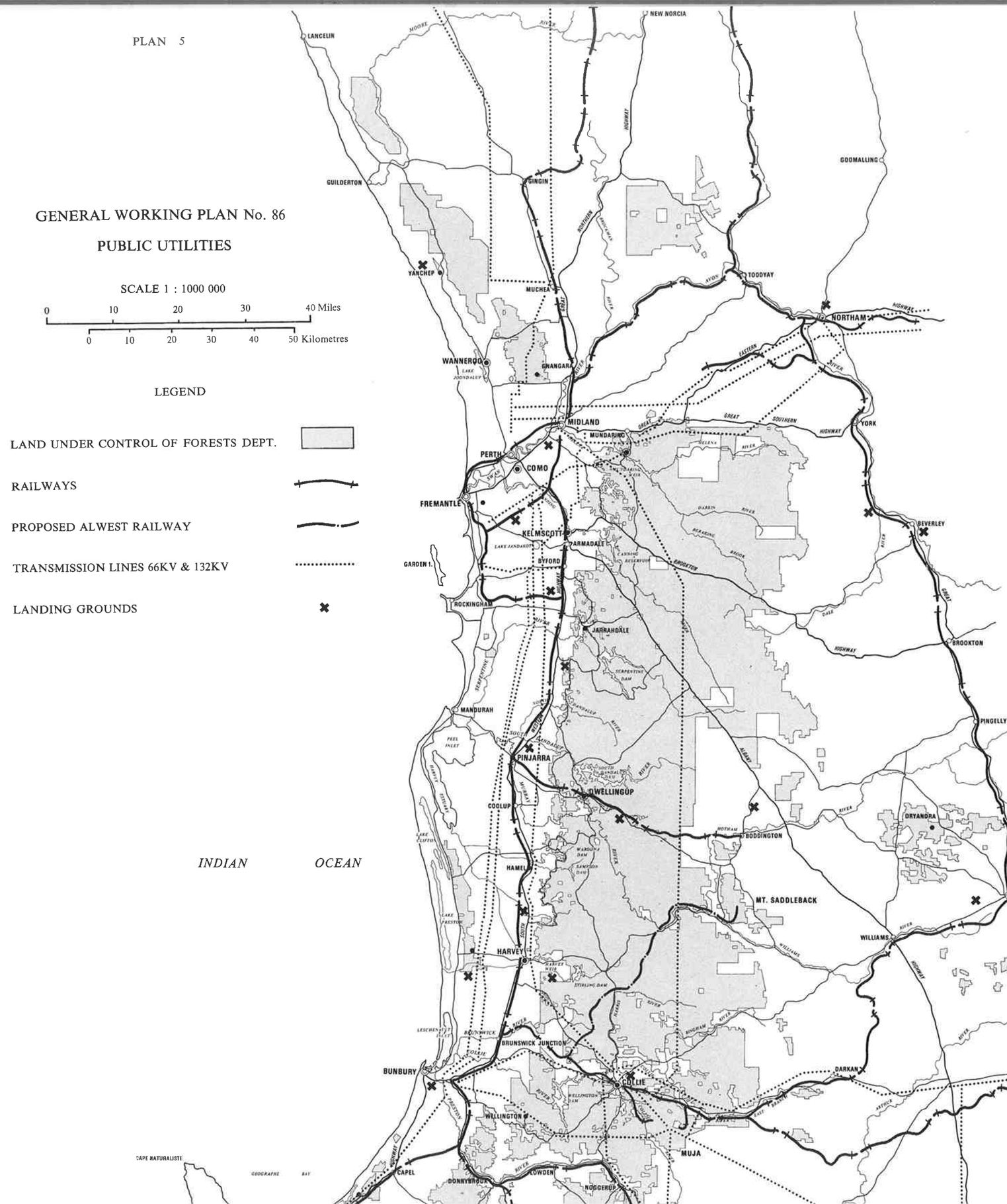
LAND UNDER CONTROL OF FORESTS DEPT.

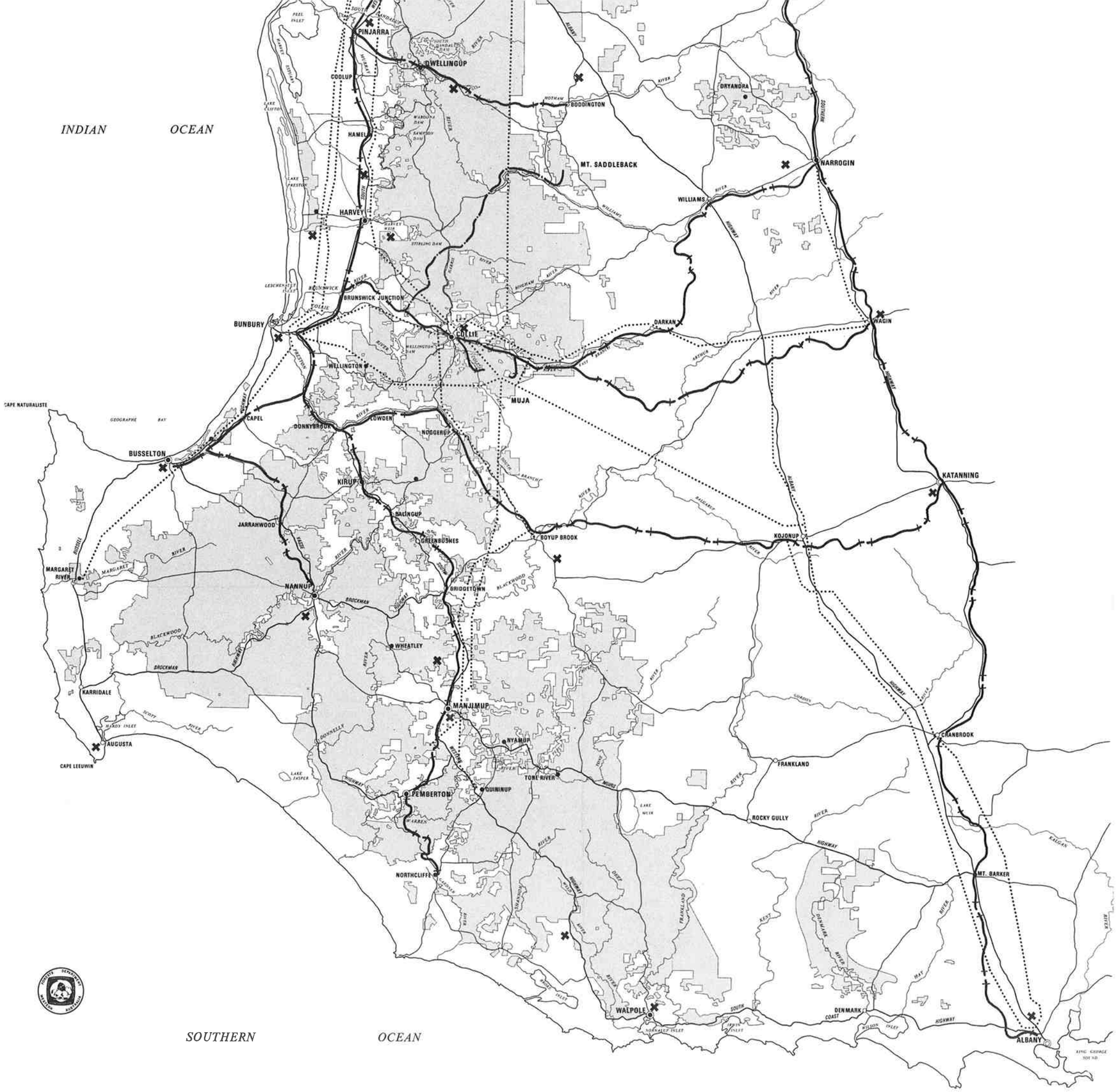
RAILWAYS

PROPOSED ALWEST RAILWAY

TRANSMISSION LINES 66KV & 132KV

LANDING GROUNDS ✖




INDIAN OCEAN
SOUTHERN OCEAN
PINJARRA
DWELLINGUP
COOLUP
HAMEL
HARVEY
BUNBURY
BRUNSWICK JUNCTION
COLLIE
WELLINGTON
CAPE NATURALISTE
CAPEL
DONNYBROOK
BUSSELTON
KIRUP
JARRAHWOOD
NANNUP
MARGARET RIVER
BALINGUP
GREENBUSHES
BRIDGETOWN
WHEATLEY
KARRIDALE
AUGUSTA
CAPE LEEUWIN
MANJIMUP
NYAMUP
TONE RIVER
PEMBERTON
QUININUP
NORTHCLIFFE
WALPOLE
MUJA
NODDERUP
BODDINGTON
DRYANDRA
MT. SADDLEBACK
NARROGIN
WILLIAMS
DARKAN
WAGIN
BOYUP BROOK
KOJONUP
KATANNING
FRANKLAND
ROCKY GULLY
DENMARK
CRANBROOK
MT. BARKER
ALBANY

PLAN 6

GENERAL WORKING PLAN No. 86
JARRAH DIEBACK

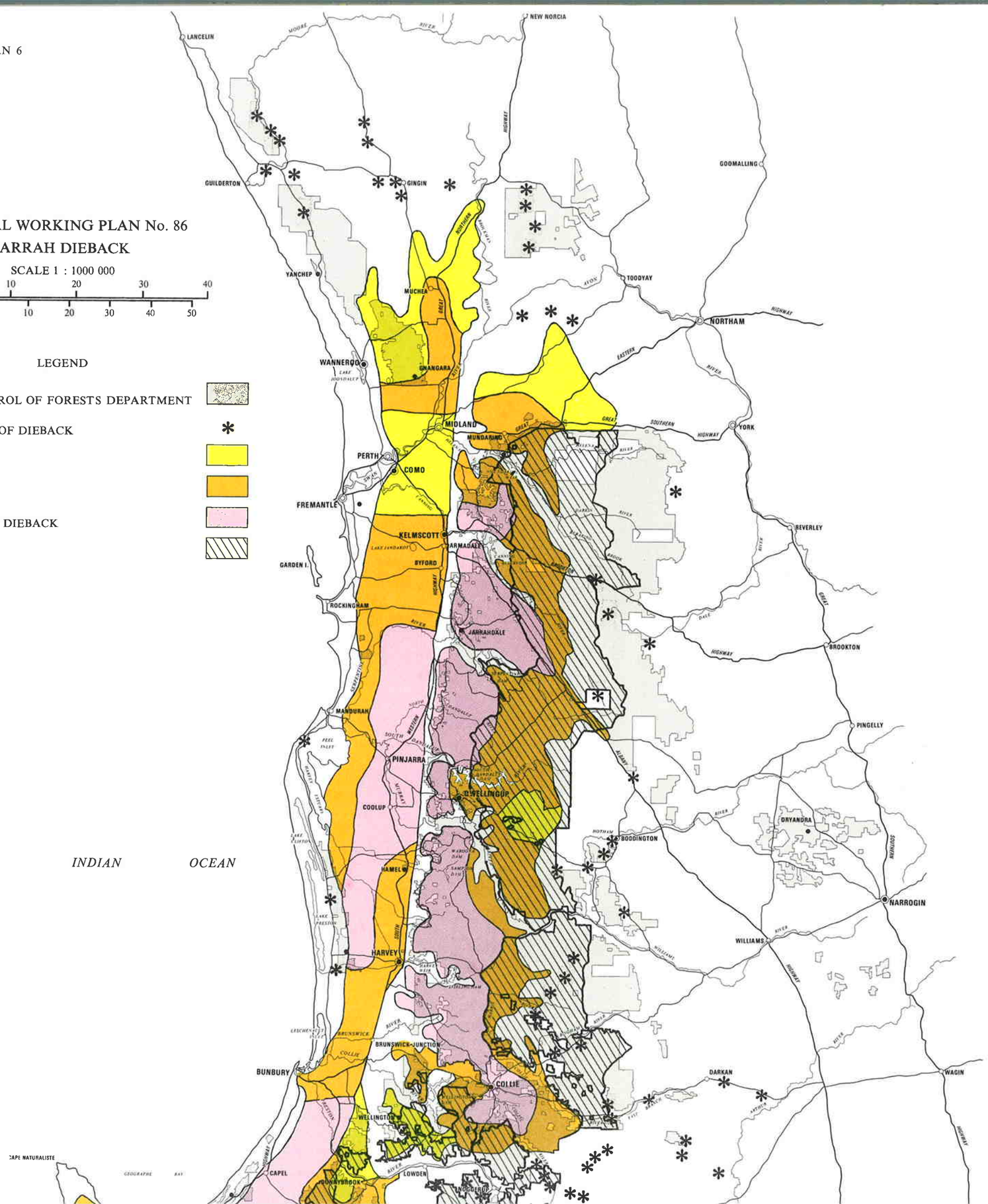
SCALE 1 : 1000 000

Miles 0 10 20 30 40

Kilometres 0 10 20 30 40 50

LEGEND

- LAND UNDER CONTROL OF FORESTS DEPARTMENT
- ISOLATED PATCHES OF DIEBACK
- UP TO 2% DIEBACK
- 2% TO 20% DIEBACK
- GREATER THAN 20% DIEBACK
- QUARANTINE AREA



INDIAN OCEAN

SOUTHERN OCEAN

PINJARRA
DWELLINGUP
COOLUP
NAMEL
HARVEY
BUNBURY
BRUNSWICK JUNCTION
COLLIE
WELLINGTON
CAPE NATURALISTE
CAPEL
BUSSELTON
DONNYBROOK
LOWDEN
KIRUP
BALINGUP
JARRAHWOOD
GREENBUSHES
BOYUP BROOK
MARGARET RIVER
NANNUP
BRIDGETOWN
WHEATLEY
KARRIDALE
MANJIMUP
AUGUSTA
CAPE LEEUWIN
NYAMUP
TONE RIVER
PEMBERTON
QUININUP
NORTHCLIFFE
WALPOLE
BODDINGTON
DRYANDRA
NARROGIN
WILLIAMS
DARKAN
WAGIN
KATANNING
KOJONUP
CRANBROOK
FRANKLAND
ROCKY GULLY
MT BARKER
DENMARK
ALBANY

PLAN 7

GENERAL WORKING PLAN No. 86
EXAMPLE OF DIEBACK MAPPING

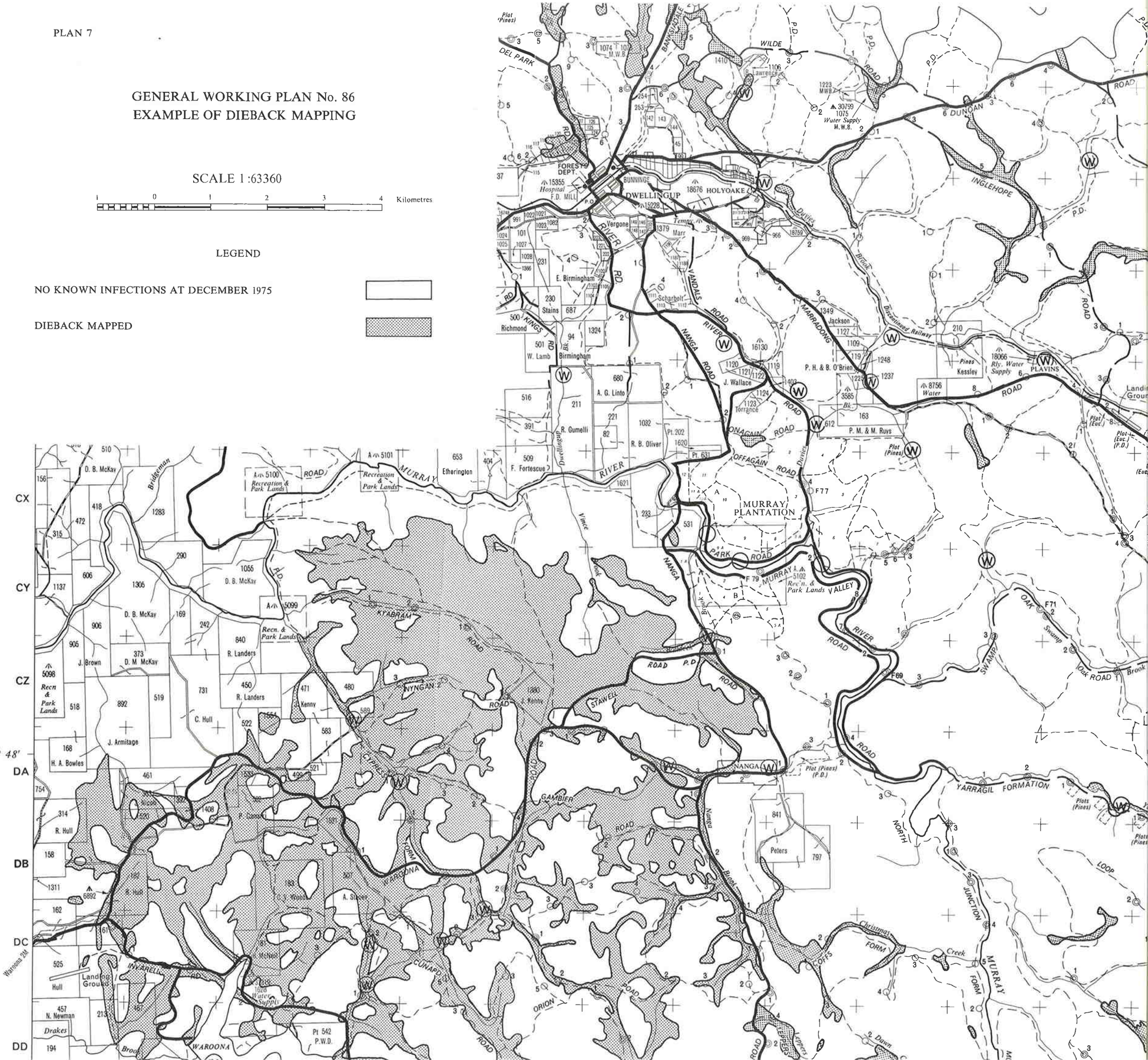
SCALE 1 :63360

1 0 1 2 3 4 Kilometres

LEGEND

NO KNOWN INFECTIONS AT DECEMBER 1975

DIEBACK MAPPED




CZ
DA
DB
DC
DD
DE
DF
DG
DH
DJ
DK
32° 48'
32° 54'
57
58
59
60
61
62
63
64
65
66
67
68
116° 00'
116° 06'
WELLINGTON
NANGA
NANGA ROAD
NYNGAN
CYPRESS
GAMBIER
STAWELL
WAROONA
CUNAPO
ORION ROAD
INVARELL
WAROONA DAM
CHASEDE
SAMSON
SAMSON DAM
SEYMOUR FALLS
BOUNDARY
KONGONI
ARUNDEL FORM
WATEROUS
WILLOWDALE
MT. WILLIAM
DRIVER
BRACKEN ROAD
LOGUE BK RD
MT. KEATS
KEATS
MAYER ROAD
RONSON
MURRAY
JUNCTION FORM
SOUTH JUNCTION
FIRELINE
YARRAGIL FORMATION
NORTH JUNCTION
LOOP
KING JARRAH
Christmas Creek
Down Creek
DRAKESBROOK RESERVOIR
Whisky Brook
Landing Ground
Water Supply
Pt 542 P.W.D.
Recn & Park Lands
Peters
J. Armitage
H. A. Bowles
R. Hull
N. Newman
E. H. McLarty
J. R. McDonald
R. J. Lyons
Norseman Titanium N.L.
A. & M. R. Corvaia
N. McNeill
R. Landers
C. Hull
Kenny
J. Brown
D. M McKay
F. Hill
Collie 33M
Waroona 2M