

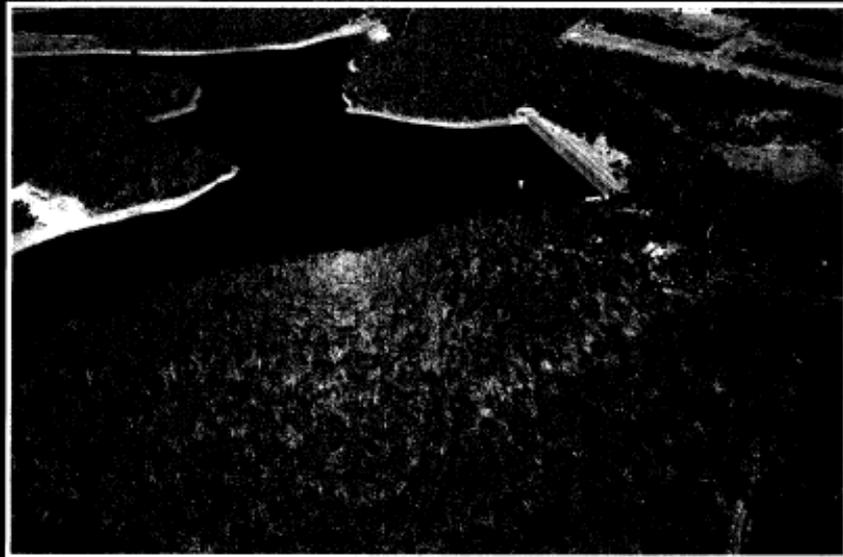
PLANNING BRANCH
DO NOT REMOVE

Waroona

Reservoir and Catchment Area

Management Plan

1990 – 2000



MANAGEMENT PLAN No. 19



Department of Conservation
and Land Management



Water Authority
of Western Australia

WAROONA

RESERVOIR AND CATCHMENT AREA MANAGEMENT PLAN

1990-2000

PROJECT TEAM

Jim Williamson - CALM
Jeff Kite - WATER AUTHORITY
Peter Henderson - CALM
Bowman Bishaw and Associates

DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT

in conjunction with

WATER AUTHORITY OF WESTERN AUSTRALIA

PREFACE

This management plan has been jointly prepared by the Water Authority of Western Australia and the Department of Conservation and Land Management (CALM), in accordance with the planning process established under the CALM Act, 1984.

Preparation of the plan was initiated by the Water Authority following public and local government representations regarding the future of Waroona Dam for irrigation and recreational use. Preliminary, long term planning of future sources for Perth's water supply identifies the alternative of an enlarged dam at Harvey. The supply pipeline from Harvey would pass near Waroona Dam, and it may be feasible to inject potable water, which presently overflows from the Dam into this pipeline. Current Water Authority planning confirms the use of Waroona Dam for irrigation and there is no intention to propose its use for public water supply for at least twenty (20) years. However, as the Water Authority believes it is desirable to keep all options open, it was decided that a catchment management plan should be prepared to provide for sustainable recreational use of the reservoir and its catchment, whilst maintaining water quality in accord with long term objectives.

In the initial stages of this proposal, it was resolved that this plan should be termed an 'Area Management Plan' and be given legal status under the CALM Act, 1984. This formal arrangement arose from two principal factors :

- (i) the majority of the catchment area for the dam is part of a much larger tract of State Forest managed by CALM, and
- (ii) there is no statutory mechanism under existing Water Authority legislation which allows implementation of a management plan on CALM land.

The main emphasis of this plan is management of recreational activities, because recreational use of the dam has increased significantly in recent years and, at present, is not adequately managed. Whilst land is used for other purposes in the catchment area, such as water and wood production, management prescriptions for these uses are adequately addressed in the Regional Management Plan for the Central Forest Region and in the document 'Timber Production in WA' (CALM, 1987 a-d).

The reader should be aware from the outset that, although recreation management is the primary focus of this plan, recreational use is not the priority land use of the catchment. Water and timber production have priority over recreation.

Finally, it is advised that a similar plan has been prepared for the Logue Brook reservoir and catchment. The plans have been prepared concurrently because the two reservoirs are focal points of recreational activity in the district and have similar uses, problems and management prescriptions.

This Management Plan was approved by the Hon. Minister for Conservation and Land Management on 18 December 1989.

TABLE OF CONTENTS

PREFACE	<i>i</i>
TABLE OF CONTENTS	<i>iii</i>
ACKNOWLEDGEMENTS	<i>v</i>
1.0 INTRODUCTION	1
1.1 Recreation on Reservoirs and Catchments in Western Australia	1
1.2 Waroona Reservoir and Catchment	2
1.3 The Need for a Management Plan	2
1.4 Waroona Dam Catchment Management Plan	5
SECTION A: BACKGROUND TO MANAGEMENT	6
2.0 DESCRIPTION OF RESOURCES AND PRESENT LAND USE	6
2.1 Land Tenure	6
2.2 Existing Access	6
2.3 Physical and Biological Resources	10
2.4 Characteristics of Recreational Use	15
2.5 Land Use (Other than Recreation)	18
3.0 EVALUATION OF RECREATIONAL AND ENVIRONMENTAL COMPATIBILITY	20
3.1 Principal Environmental issues	20
3.2 Identification of Environmentally Sensitive Areas in the Catchment	22
SECTION B: MANAGEMENT OBJECTIVES	23
4.1 The CALM Act	23
4.2 Water Production	23
4.3 Wood Production	23
4.4 Recreation	24
SECTION C: RESOLUTION OF ISSUES AND SELECTION OF PREFERRED OPTIONS	25
5.0 SUMMARY OF RECREATIONAL ISSUES AND STRATEGIES	25
5.1 Recreational Settings	25
5.2 Compatibility of Recreational Activities and Settings	26
5.3 Water-based Management Strategies	26
5.4 Land-based Management Strategies	31
6.0 FUTURE ADMINISTRATION	34
7.0 IDENTIFICATION OF THE PREFERRED DEVELOPMENT OPTION	35
SECTION D: FUTURE MANAGEMENT	36
8.0 MANAGEMENT PRESCRIPTIONS	36
8.1 Introduction	36
8.2 Recreation	36
8.3 Information	46
8.4 Resource Management	47
8.5 Forest Resource Protection	51
8.6 Administration	52

8.7	Surveys, Research, Monitoring	53
SECTION E: IMPLEMENTATION AND REVIEW		54
BIBLIOGRAPHY		55
APPENDIX A		59

LIST OF MAPS

Map	1	Regional Context
	2	Land Tenure
	3	Access
	4	Surface Geology
	5	Vegetation
	6	Recreational Facilities 1989
	7	Management Units
	8	Conceptual Strategy Plan

ACKNOWLEDGEMENTS

The contribution to this plan of those who attended the public workshop is gratefully acknowledged, as is the contribution of other members of the public who provided written submissions.

Steering Committee members also provided valuable advice and discussion. The members were Keith Lynch, Chairman (Water Authority), Ian Wood, Jeff Kite (Water Authority), Ron Golding (Shire of Waroona), Charles Lockwood (Shire of Harvey), Dane Smith (Marine and Harbours), Peter Murray (South West Development Authority), and Jim Williamson (CALM). Observers present at Steering Committee meetings included Burt Scott, Ross Doubikin (Water Authority), Bob Chandler, Peter Henderson (CALM), Mike Stoner, Mike Bishaw, Martin Bowman consultant team).

Ian Wood was the main contributor from the Water Authority on the project team until he resigned and his place was filled by Jeff Kite with assistance from Naomi Arrowsmith. Valuable comments were received from several officers in the Water Authority and CALM. Word processing skills were supplied with diligence and cheerfulness by Debbie Bowra.

1.0 INTRODUCTION

1.1 Recreation on Reservoirs and Catchments in Western Australia

1.1.1 Regional Context

In recent years, there has been a significant increase in the demand for recreational use of water supply catchments, particular near to, or on the water storages. Greater demand is partly reflected by the increasing number of requests for special access received by the Water Authority and partly by the pressure on existing facilities.

To put the present situation into a regional perspective, there is an enormous land area on the western edge of the Darling Range which is now affected by restrictions on public access and recreation due to declaration of catchment areas for water production. A total of 7,150 square kilometres is contained within these catchments and there is an additional 1300 square kilometres declared as water reserves to identify the catchments which have potential for future water supply developments.

The existing controls on recreational use of water catchments, therefore, place a significant constraint on large areas of State forest which are otherwise suited to a wide range of recreational activities. However, it should also be recognised that construction of water storages has increased recreational opportunity and must be partially responsible for the existing levels of demand.

1.1.2 Irrigation Water Storages and Catchments

South of Dwellingup, the Water Authority operates a number of reservoirs which store water principally for irrigation purposes. Fewer access restrictions are applied to these reservoirs in recognition of the less stringent water quality requirements in comparison to those for urban/domestic use. The overriding concern is to minimize potential salinity increases. However, as some of these reservoirs may be used for public water supply purposes in the future, other aspects of water quality maintenance are also important. A summary of the present access restrictions is given below:

- Vehicles (including trail bikes and off-road vehicles) are only permitted on public roads, open tracks and designated dam access roads.
- Pedestrian access to all of the catchment and dam wall is permitted. Access to the water area is also permitted, and activities such as marroning, fishing, canoeing and swimming are conducted on some water areas.
- Camping is not permitted outside designated areas.

- Motor boats are permitted on three reservoirs (Waroona, Logue Brook and Glen Mervyn) and water-skiing is a popular pastime.

1.2 Waroona Reservoir and Catchment

1.2.1 Location and Historical Perspective

Waroona reservoir is situated approximately 6 km due east of the township of Waroona, on the edge of the Darling Range. It lies wholly within the Shire of Waroona and is approximately 114 km south of Perth by road.

The catchment for the reservoir was proclaimed as part of the Waroona Irrigation District in 1943, under the provisions of the Rights in Water and Irrigation Act. The reservoir was subsequently formed by damming Drakes Brook during the period 1964-1966. Construction of the dam more than doubled the amount of water previously available to the Waroona Irrigation District, which had been formally established during the 1930's. Map 1 shows the location of the reservoir in relation to Mandurah and Bunbury and also shows the principal area to which irrigation water is supplied.

Prior to construction of the dam, much of the land destined to be flooded was developed as pasture and orchards. Since the official opening in 1966, the reservoir has been made available for water-based recreational activities. It has been named 'Lake Navarino'.

1.3 The Need for a Management Plan

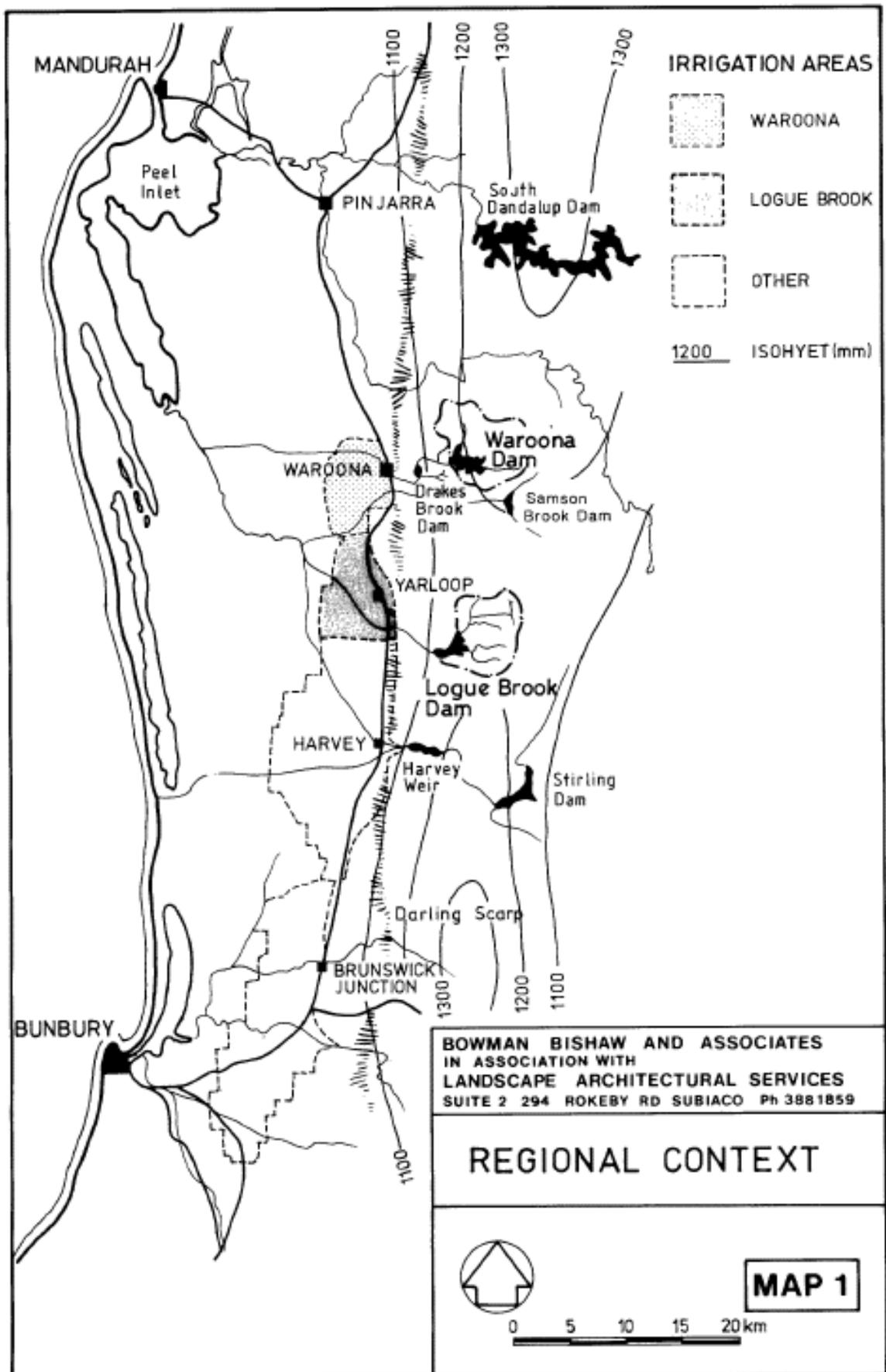
The preparation of this plan was initiated by the Water Authority, largely in response to the increased recreational demand on the reservoir and catchment. As 'people pressure' on the area increase, effective management will be required to ensure that water quality of the reservoir does not deteriorate and that the overall aesthetics of the area are not spoiled. The need for a management plan may be discussed both in terms of broader, regional land use issues and in terms of issues specific to Waroona reservoir.

Some of these issues are briefly summarised below to emphasise the requirement for recreation management.

- i. State forest is to be managed for multiple use. The major uses on the Western Scarp will be for water supplies, sustainable wood production, conservation and recreation. Wood production

and water supply are compatible uses, whereas recreation and conservation are conditional to specific time, area or use constraints.

- ii. Recent land use studies, which have addressed access to catchments and reservoirs, have consistently indicated that there is a need for improved planning and management to enable a gradual lifting of restrictions on recreational activities without compromising priority purposes.
- iii. The Western Australian Water Resources Council has investigated this issue and recommended a number of guidelines to be followed in the planning process if increased recreational use of reservoirs and catchments is to be allowed (WAWRC, 1985). The guidelines include a recommendation that proposals for recreational activities are based on detailed management plans.
- iv. A management plan for Waroona reservoir, based on the WAWRC guidelines, is long overdue as active water-based recreation has been allowed since the dam was constructed.
- v. An effective management plan and associated monitoring programme for this reservoir may be used as a case study with relevance to other reservoirs and catchments, particularly potable water storages.
- vi. A principal requirement of this management plan is to co-ordinate the activities of the various management authorities involved in the area (eg. CALM, Water Authority, Department of Marine and Harbours, Shire of Waroona). Present recreational use traverse the boundaries of responsibility of these authorities.



1.4 Waroona Dam Catchment Management Plan

1.4.1 Scope

The aim of this plan is to formulate management prescriptions for the reservoir, foreshore, the complete catchment area and a small area of Crown land below the dam wall. The management prescriptions focus on recreational use, with due consideration to the priority land uses of water and wood production.

This document is intended to provide guidelines from which an annual works programme can be formulated.

1.4.2 Plan Structure

This document is separated into five sections, as follows:

- Section A presents a summary of the resource information on which the plan is based and evaluates the environmental resources with respect to compatibility of recreational pursuits.
- Section B outlines the overall management objectives for the major land uses in the catchment.
- Section C presents a range of alternative strategies to resolve the recreational issues and outlines the preferred administrative structure for management.
- Section D gives the management prescriptions.
- Section E describes the implementation and review of the plan.

SECTION A: BACKGROUND TO MANAGEMENT

2.0 DESCRIPTION OF RESOURCES AND PRESENT LAND USE

2.1 Land Tenure

The Waroona reservoir has a catchment area of approximately 4020 hectares. Land tenure is shown on Map 2 and it is apparent that the majority of land (about 82%) is State forest, vested in the Lands and Forest Commission and managed by CALM.

Other significant features of the land tenure are as follows:

- three parcels of freehold land in the north-western sector which comprise about 8% of the catchment;
- three distinct classes of land fringing the reservoir, listed in order of decreasing shoreline length,
 - land owned by the Water Authority,
 - State forest managed by CALM,
 - Crown reserve vested in the Water Authority;
- a small parcel of land managed by CALM which is leased to the Shire of Waroona for a caravan park.

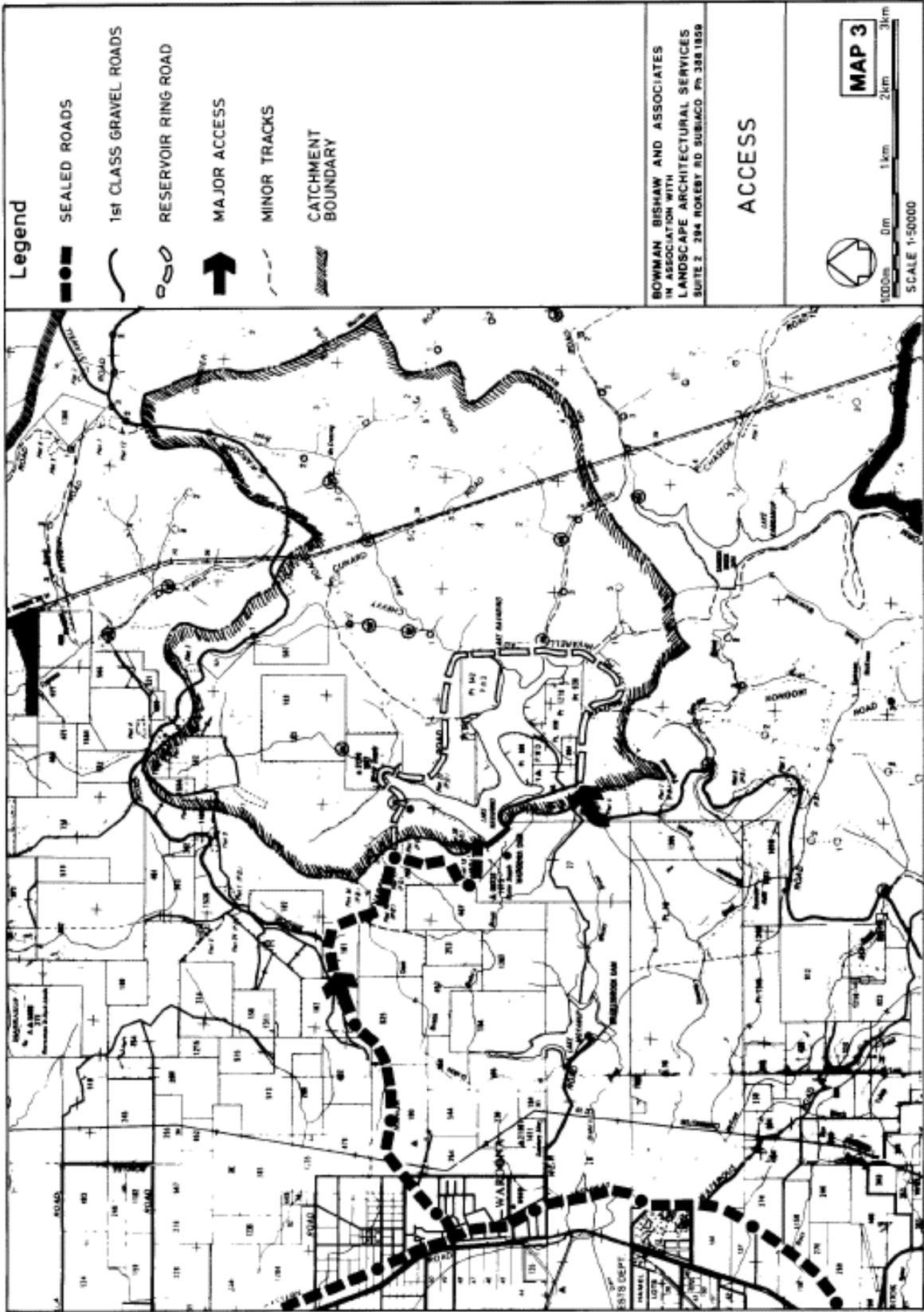
2.2 Existing Access

Map 3 shows the existing access roads to the reservoir and the numerous roads and tracks throughout the catchment. The only sealed access road is off the South-Western Highway at Waroona, via Nanga Brook and Invarell Roads. Invarell Road forms a loop around the reservoir and links the Western Boundary Road which continues in a general southerly direction along the scarp. Although the majority of the loop is unsealed, it provides good access around the reservoir and numerous tracks have been formed from this road to the water's edge.

Other features of the existing access may be summarised as follows:

- the numerous tracks, which are typical of the forest, provide unrestricted access to a large proportion of the catchment;
- access across the catchment boundary is also plentiful and unrestricted;

- soil conditions and surface drainage in the area indicates that most tracks would be accessible throughout the year;
- there are apparent inconsistencies in road nomenclature and sign-posting is generally inadequate.



2.3 Physical and Biological Resources

2.3.1 Climate

The Waroona Dam area has a temperature climate characterised by warm, dry summers and cool, wet winters. Typical features of the climate are summarised as follows:

- The catchment is located in the high rainfall belt of the Darling Scarp, with an annual average rainfall of 1250 mm;
- Approximately 80% of the rainfall falls in the five month period May to September;
- Annual average evaporation (Class A Pan) is about 1 1700mm and generally exceeds rainfall for about seven months of the year.
- A guide to the likely temperature variations may be gained from records at the Dwellingup meteorological station, located approximately 14km NNE. Mean monthly maximum temperatures vary from 29.9°C in January to 14.8°C in July; mean monthly minimum temperatures vary from 14.9°C in February to 5.2°C in August;
- During summer, winds usually blow from the east in the morning and the south-west and south-east in the afternoon. In winter, winds come from the western sector with highest occurrences from the north-west. The strongest winds occur mostly from the western sector.

2.3.2 Geology

The main geological element is the Yilgarn Block and the dominant rock type is a coarse-grained porphyritic granite. Gneissic rock may occur along the western edge of the catchment. Dolerite dykes occur within areas of both granite and gneissic rocks.

A map of the surface geology is given in Map 4. Note that laterite occupies approximately 50% of the land surface, whilst the next most common surficial deposit is pisolitic sandy gravel. This gravel is ferruginous and may be locally re-cemented to form an erosion resistant 'pseudo-caprock'. The gravelly, silty sand is characteristic of the drainage lines.

2.3.3 Landform and Soils

The Waroona dam catchment lies within the broad physiographic unit known as the Darling Plateau, slightly to the east of the steep, rocky slopes which characterise the plateau's western edge (Darling Scarp).

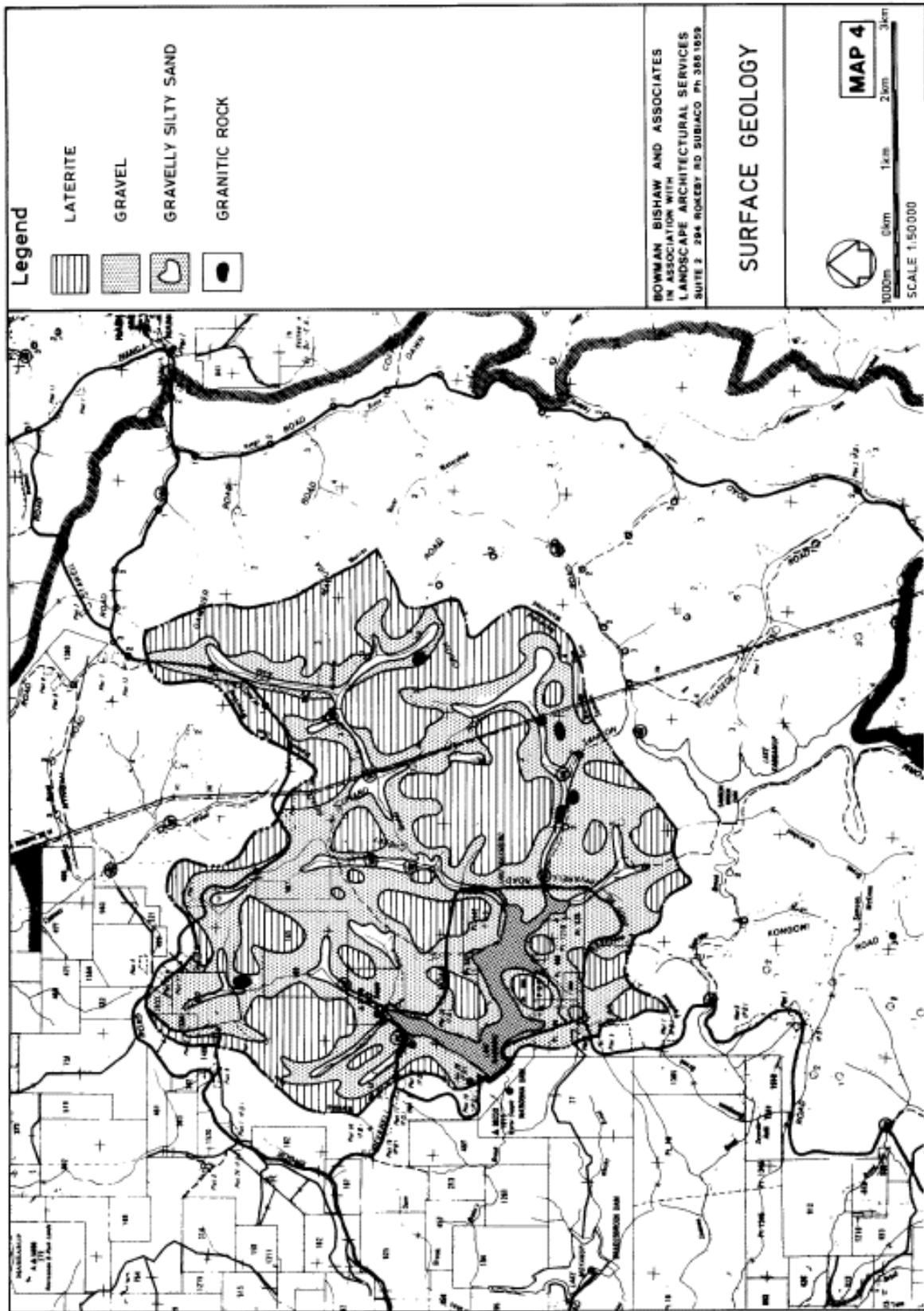
Three landform units are recognised in the area, and these are briefly described below.

- i. **Murray** (22% of the catchment): The reservoir is located in a deeply incised valley typical of the Murray Unit, with slopes between 3% and 15%. Red-brown earths are found on the slopes and gravels together with patchy pseudo-caprock.
- ii. **Yarragil** (36%): The upstream extensions of the major reservoir valley are known as the Yarragil Unit. These upland valleys have more gentle slopes (less than 8%) characterised by sandy gravels, with swampy orange earths in the valley floor.
- iii. **Dwellingup** (42%): The gently undulating, upland areas of the catchment are known as the Dwellingup Unit, which may have a duricrust 'caprock' on the ridges. The shallow depressions are generally sands and gravels.

2.3.4 Hydrology

The reservoir was formed by damming Drakes Brook. The brook and its tributaries flow predominantly in a westerly direction with their headwaters in swampy areas located between the dissected laterite ridges. There are four principal feeder streams which have perennial pools and/or swampy areas.

The average annual runoff of the catchment is 11.5 million cubic metres giving a catchment yield equivalent to 25% of rainfall, though in some years it may be as high as 30%.



2.3.5 Vegetation

Map 5 shows the vegetation of the catchment. This map was reproduced from the original mapping of vegetation complexes by Heddle et. al. (1980).

The vegetation complexes that occur within the catchment relate closely to the landform units described in Section 2.3.3. and are summarised below:

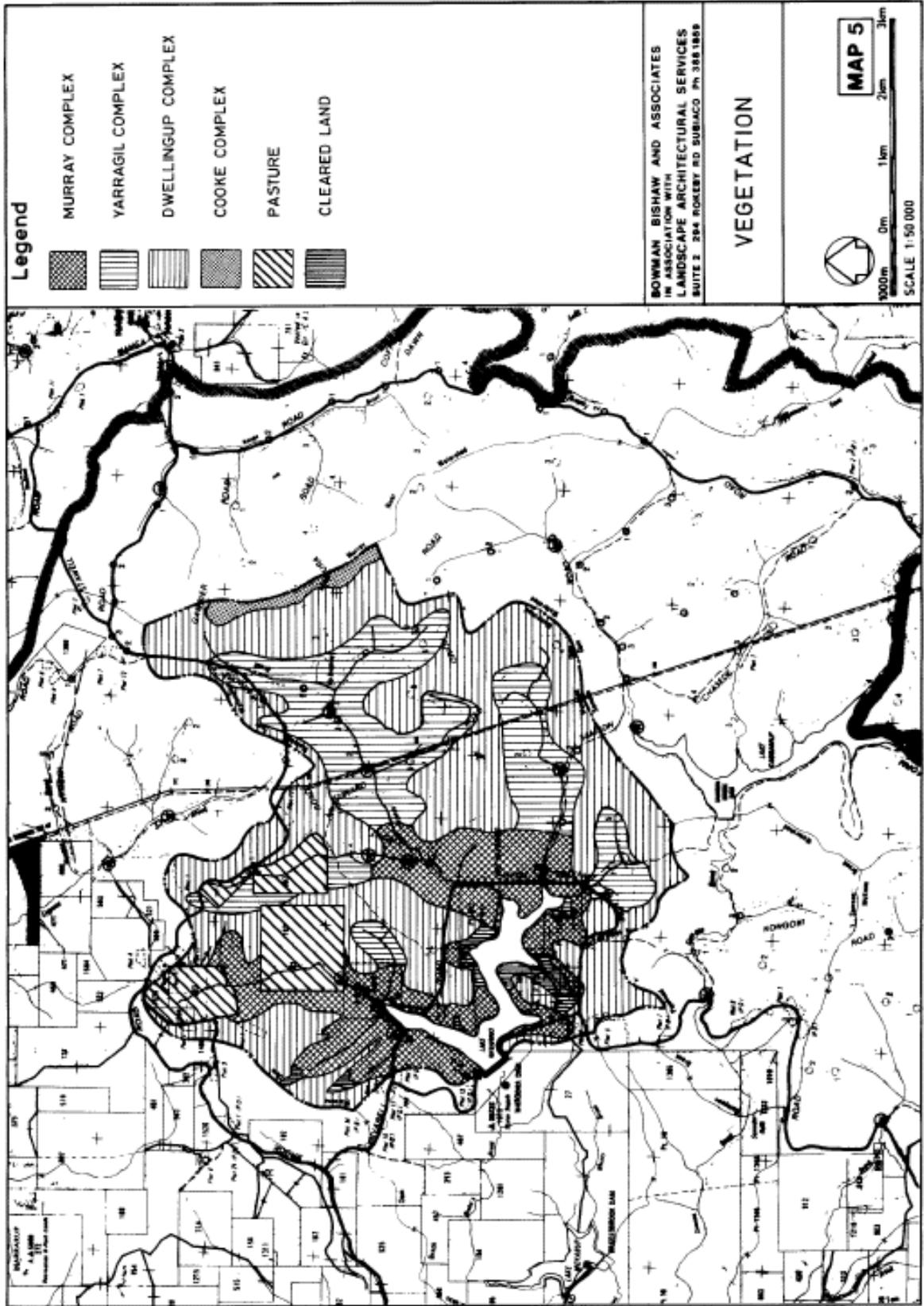
- Dwellingup Complex - comprises primarily jarrah (*Eucalyptus marginata*) and jarrah-marri (*E. calophylla*) open forest, often with an understorey tree layer of sheoak (*Allocasuarina* sp.) and bull banksia (*Banksia grandis*).
- Yarragil Complex - mixed open forest of jarrah-marri with admixtures of yarri (*E. patens*) and bullich (*E. megacarpa*).
- Murray Complex - peripheral vegetation of the reservoirs, mostly jarrah-marri higher on the slopes with occasional yarri on the lower slopes. (Approximately one-third of this complex was removed to form the Waroona reservoir).

In addition, there is a small area of the Cooke complex on the eastern boundary of the catchment. This complex has a range of vegetation from open jarrah-marri forest on deep soils to heath, herbland and lichens on granite soils.

Swampy areas along the feeder streams may have a fringing woodland of paperbark (*Melaleuca preissiana*) and swamp banksia (*A. littoralis*).

2.3.6 Fauna

A reasonably extensive inventory of fauna found in the jarrah forest has been compiled over the years. Surveys have been conducted in nearby areas, such as for the Willowdale bauxite mine (Alcoa, 1978) and the Harris River project (Water Authority, 1984). The reader is referred to these reports and to the resources document for the Lane Poole Reserve (CALM, 1986a) for an indication of the fauna likely to be found in the catchment.



2.3.7 Landscape

The landscape or scenic resources of the Waroona Dam catchment are typical of the Darling Plateau. Overall, there are three principal landscape types which summarise the scenic value and appeal of the area:

- i. Reservoir and foreshore - The expanse of open water with fringing forest is the main attraction. Waroona Dam has two flooded valleys with several minor embayments where 'feeder' streams enter. The fringing forest is a relatively healthy example of the Murray Complex, with dense stands of jarrah in some areas. There are still some large cleared areas on the southern side, formerly utilised for pastoral purposes, which provide open space variation. However, the appeal of this area diminishes in summer, when the pasture dies.
- ii. Open forest - The jarrah-marri association and undulating topography.
- iii. Wetlands - There are numerous streams in the catchment which have quite different vegetation associations.

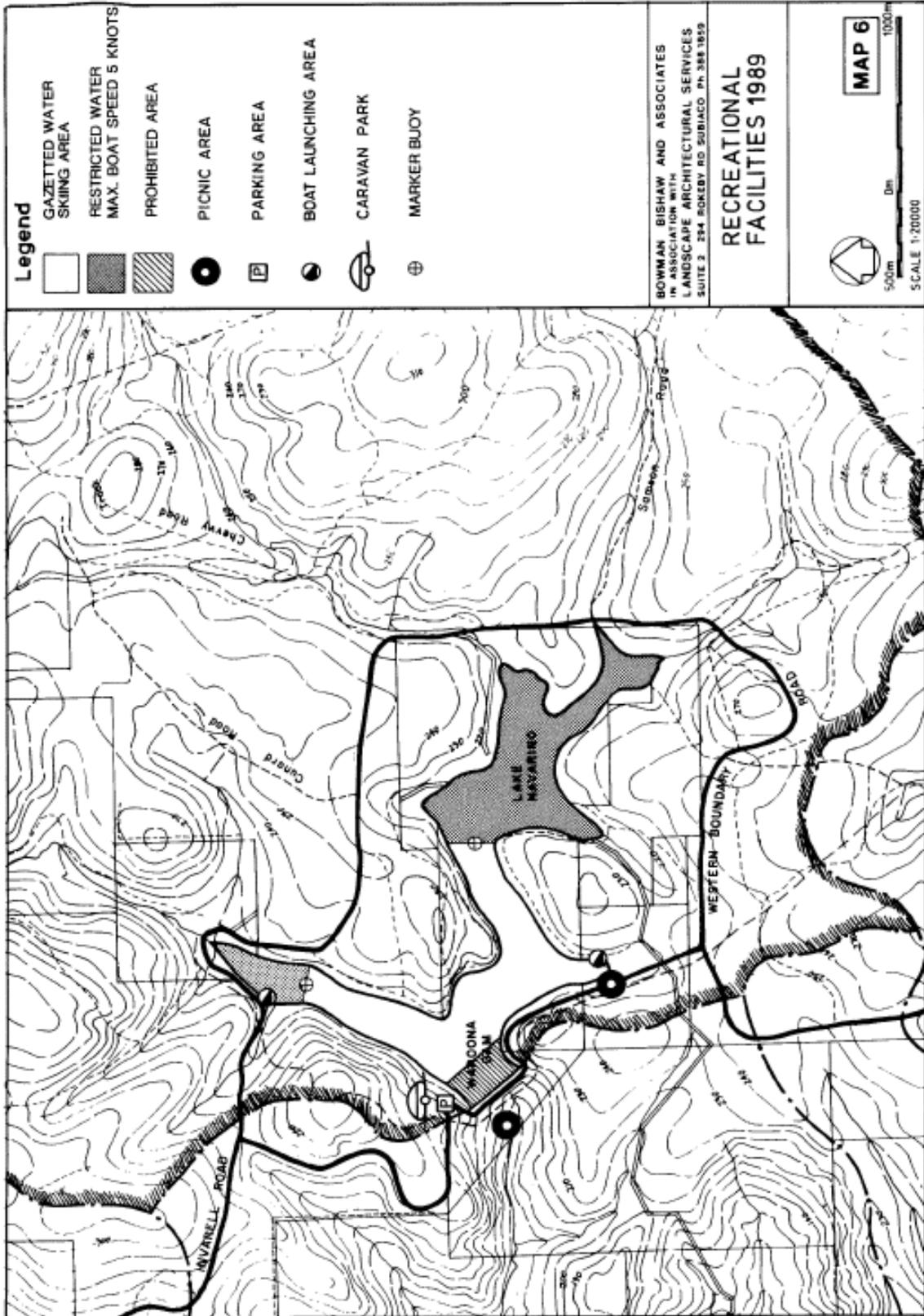
2.4 Characteristics of Recreational Use

2.4.1 Recreational Demand

The System 6 Tourism and Recreational Sub-committee Report (DCE, 1979) predicted a trebling of demand for outdoor recreation in the System 6 area by the year 2000. Given that recreation will generally focus on sites near, or adjacent to a water body, it is reasonable to assume that the recreational capacity of Waroona Dam will eventually be fully utilised. The Western Australian Water Resources Council predicted a similar trend of increasing demand for water based recreation (WAWRC, 1985).

This is supported by a recent assessment of demand trends for the nearby Murray River valley and Lane Poole Reserve, which gave a strong indication that there has been a significant increase in recreational use since the mid 1970's (CALM, 1986, a).

Other factors, such as the area's proximity to Perth and Bunbury, its ready accessibility and recreational attractions and facilities combine to support heavy usage. Local anecdotal evidence collected during the study suggests that the available facilities and recreational opportunities are already used to capacity (and beyond) at certain times of the year.



2.4.2 Water-based Activities

There is no doubt that the reservoir is the focal point of recreational activity in the catchment. Direct contact activities such as water-skiing, canoeing, sailing, windsurfing, swimming, marroning and fishing are popular. Whilst the majority of these activities are pursued throughout the year, there is a definite peak season during the warmer months of the year. (The relative location of existing recreational facilities is illustrated on Map 6).

Waroona Dam is a popular water-skiing location. The configuration of the reservoir (ie. two flooded valleys) is such that at most times an area of water can generally be located which is relatively sheltered from wind disturbance. Although there are restrictions on the areas where water-skiing may occur, there are no time restrictions on this activity. The only activities which may be restricted to particular months of the year are marroning and fishing. The closed season is set by the Fisheries Department and may vary from year to year. In 1987/88 and 1988/89 there was no open season, but in previous years it has been from December 15 to May 1.

The edge of the reservoir is popular for a host of other activities. These do not involve direct contact with water, but stem from the attractive 'natural' forest environment and the enhancement of this by the aesthetic features of the reservoir.

Picnicking and sightseeing are pursued by most visitors to the area. Trail bike riding is commonplace, particularly around the exposed reservoir banks.

'Wild camping' (ie. vehicle-based camping in non-designated areas) also occurs in the catchment but is discouraged by the Shire, particularly near the reservoir. Campers are directed to the caravan park and camping ground.

It is obvious from the incompatible nature of some of the activities described above and the pressure of numbers during peak periods that conflicts will arise between different interest groups. Resolution of these conflicts is addressed in this management plan.

2.4.3 Land-based Activities

Whilst the majority of recreational use is concentrated on the reservoir and forest foreshore, there are a variety of activities conducted in the upper catchment which also require consideration. The majority are represented by the following list:

- sightseeing (usually vehicle-based)
- driving off-road vehicles
- horse-riding

- bushwalking
- picnicking
- camping.

In addition, there may be occasional illegal hunting of feral pigs and kangaroos.

2.5 Land Use (Other than Recreation)

The priority land uses for the catchment are water and wood production, which are recognised as highly compatible activities following the development of effective management prescriptions by CALM. The following section briefly describes these activities. Conservation and agriculture are also discussed, followed by a summary of other more minor land uses.

2.5.1 Water Production and Irrigation Use

The Waroona reservoir has a capacity of 15 million cubic metres when full. On average, about 50% of this volume is released for irrigation purposes on the nearby coastal plain during the summer season. The water storage is replenished each winter when rainfall on the catchment generates runoff. For average conditions, this is estimated to total about 11 million cubic metres.

The economic livelihood of a large number of farmers in the Waroona Irrigation District depends on a reliable supply of good quality water from this reservoir. The current water allocation (ie. maximum volume allowed each season) is 14,000 m³ per rated hectare. An average of about 7 waterings are generally applied during the support summer pasture for beef production and dairying. Land is also irrigated to produce fodder crops, vegetables and fruit.

2.5.2 Wood Production

The catchment has been cut over to supply jarrah sawlogs to local timber mills. The forest in the catchment is now in various stages of regrowth and sawlog production is not likely to occur for another 20-30 years. However, due to the widespread occurrence of dieback and the dynamic nature of this disease, small pockets of dieback affected forest may be logged. Logs may also be harvested to provide charcoal for a proposed silicon industry. This proposal has been subject to an Environmental Review and Management Plan as well as other specific investigations.

2.5.3 Conservation

The System Six Study did not identify any specific area of the catchment that should be set aside as a conservation reserve. However, many of the streamzones are considered to have high conservation

value with respect to maintenance of water quality. It is fortunate that these have generally been protected by catchment management practices. In addition, CALM have developed an overall strategy for conservation, environmental protection and recreation which will be applied to this catchment (CALM, 1987, e).

2.5.4 Agriculture

Within the boundaries of the Waroona Dam catchment several private land holdings exist which are developed for agricultural purposes. Reference is made to Map 2 which shows their location. Not all of the lots have been cleared of native vegetation.

These agricultural land holdings have been in occupation and operation over the past 14 years. Farming practice has generally been development of pasture for beef cattle and more recently for dairying on dryland pastures. Typically, each dairying operation runs approximately 30 head of dairy cattle.

Superphosphate is applied to pasture areas at the traditional rate of about 200 kg per hectare (1 bag per acre). Approximately 30 tonnes per annum is applied over the 150 ha of pasture.

One of the land holdings within the catchment is used for market gardening, utilising moist soils adjacent to drainage lines. A small dam is used for flood irrigation and pesticides and fertilizers are routinely applied. In addition to market gardening, beef cattle are produced for local abattoirs. As these land holdings are within a proclaimed Irrigation District, the Water Authority has considerable control over existing and future developments due to the need for the occupier to obtain approval for any water diverted for private use.

Within farming allotments and areas of the catchment adjacent to agricultural land holdings, nutrients and animal faeces may enter the drainage lines and feeder streams to the reservoir. Research by Loh et al. (1981) indicates that nitrogen concentration in these drainage waters are likely to be significant, whereas excess phosphorous will be taken up by the soil and concentrations are expected to be low.

Some effluent runoff is produced by washing down of animal sheds but would probably be largely absorbed by soil and vegetation. Bacteriological infection could result if animals were to directly defecate into feeder streams.

2.5.5 Other Land Uses

- i. Power Transmission

A high voltage SEC transmission line passes through the catchment to the east of the reservoir. The easement is maintained in a cleared condition to avoid interference with the towers and transmission lines.

ii. Gravel Extraction

Gravel has been extracted from an area located along the eastern bank of the northern reservoir arm. The location of this pit and resultant operations is responsible for some minor erosion along roadways and nearby banks. The pit detracts somewhat from the visual qualities of **the foreshore** environment but the uneven and varying depth of the gravel pit is an attraction for trail bike riders.

3.0 EVALUATION OF RECREATIONAL AND ENVIRONMENTAL COMPATIBILITY

Before management decisions are made, it is important to evaluate the acceptability of the present recreational uses within the catchment. This approach recognises that direct contact recreation has been allowed on-the reservoir since construction some 21 years ago. Therefore, this section gives a brief overview of the principal environmental issues, assesses the impact of recreation on water quality, identifies the environmentally sensitive areas in the catchment and discusses recreational carrying capacity.

3.1 Principal Environmental issues

The principal environmental issues identified during the preparation of the draft management plan were as follows:

- reservoir water quality
- catchment protection and
- public health.

Investigations of these issues provided the following key conclusions:

- i. The present levels of activity do not appear to result in a long term turbidity impact which would affect either irrigation or potable use of the water. The possibility that short term (ie. days or weeks) increases in turbidity could occur requires further investigation.

- ii. There is only a remote possibility of health risk to 'downstream' users while the water is predominantly utilised for irrigation purposes. However, there may be a health risk to recreational users themselves, particularly during peak season when water levels are low. This could not be confirmed without detailed bacteriological monitoring of the water. Supplementary epidemiological investigation of users would possibly also be required. A monitoring program has recently been commenced by the Water Authority but results are not yet conclusive. Should water from the reservoir be used for domestic supply chlorination, at least, would be used to treat bacteriological contaminants.
- iii. Occasional minor fuel spillages do not appear to provide the basis for a constraint to motor boat activity on the reservoir as they do not affect irrigation use of the water.
- iv. Sensible management of sewage disposal in the catchment will minimise the risk of increasing nutrient inputs to the reservoir due to the influx of visitors.
- v. Notwithstanding that the catchment is relatively small, the existing data base indicates that loss of vegetation due to logging, dieback infection and recreation impact has not resulted in sustained stream salinity increases. The high rainfall status of the catchment also tends to mitigate the effect of clearing.

It is estimated that a minimum of 2 years of average rainfall would be required to flush the reservoir. The calculations show that the capacity of the reservoir is relatively small in relation to its catchment yield. This is reflected in the almost annual occurrence of overflow.

3. 1.1 Implications for Management

No major changes to existing recreational use are considered necessary to maintain water quality in the reservoir to the standards required for irrigation purposes. Evaluation of the available data base has identified some areas of uncertainty which need to be addressed before the effect of the recreational activity on the suitability of the water for domestic supply can be determined.

Maintenance of water quality is recognised as the single most important management goal. If the source water to the reservoir is maintained at current quality, then it appears that the existing water-based activities may be permitted to continue without risk of long-term degradation of water quality.

3.2 Identification of Environmentally Sensitive Areas in the Catchment

Uncontrolled and intense pressure from recreational use has the potential to cause permanent degradation to the catchment. Whilst some impact from recreational use must be accepted, this can be minimised through careful planning and management. The primary aim is to maintain a good vegetation cover.

In practical terms, this means that there would be restrictions on access within certain broad zones in the catchment, identified as follows:

- i. stream zone vegetation;
- ii. areas which are protectable from dieback infection;
- iii. areas which have steep slopes or soils with high erosion potential,
- iv. in addition to these zones, the foreshore vegetation should be given special consideration because of the intensity of use in this zone.

3.2.1 Implications for Management

The overview of environmentally sensitive areas presented in the draft management plan may be used to guide the management of recreational use. Wherever possible, stream zones and areas protectable from dieback infection should be managed by keeping these areas closed to all forms of active recreation. Closing of selected access tracks is considered the primary means by which this can be achieved.

SECTION B: MANAGEMENT OBJECTIVES

4.1 The CALM Act

Under the CALM Act, State forest is to be managed to ensure the multiple use and sustained yield of the forest resource for the satisfaction of long term social and economic needs.

The management objectives for this catchment reflect the priority use determined by CALM's northern forest region management plan. For the Waroona Dam catchment area these are for production of water and wood.

4.2 Water Production

Provision of a reliable, good quality water supply to the Waroona Irrigation District is a primary objective of the reservoir and catchment. In determining the water quality standards which should be maintained, it is recommended that the reservoir is managed to provide water to potable standards.

This objective recognises the following factors:

- initial testing indicates that the water is currently suitable for domestic use with simple chlorination as the only treatment required, however further monitoring is required to confirm this;
- there is often an overflow from the dam during the winter, non-irrigation months which is not presently utilized;
- planning for Perth's long term water requirements identifies utilisation of some of this water as a possible cost-effective supplement to the Metropolitan supply scheme.

4.3 Wood Production

Production of wood is another primary objective of the catchment. The majority of the catchment consists of jarrah-marri open forest which is in various stages of regeneration. Management of the forest includes the use of silvicultural techniques where appropriate, to maximise the production of harvestable sawlogs and other forest products.

Provided that existing forest management techniques such as stream zone protection are maintained, wood production is considered compatible with the water production objective.

4.4 Recreation

The recreation objective must recognise the primary land uses within the catchment and be consistent with the previously described objectives. To this end, both CALM and Water Authority have formulated guidelines to assist planning and management of recreational use.

CALM management guidelines may be briefly reiterated as "Provide and allow for the widest range of recreational opportunities consistent with:

- the purpose and vesting for the land;
- the ability of the natural system to sustain the activity without impairment;
- the ability of the Department to supervise the activity where land values may be 'impaired' (CALM, 1987, c)."

In addition, the Water Authority guidelines in relation to tourism and recreation are to:

- ensure that developments are designed to minimise the risks of soil erosion, stream turbidity and bacteriological pollution;
- keep the affected area to the minimum size necessary to achieve the desired recreational goal and ensure that disturbed ground is stabilised;
- direct development away from the vicinity of the dam outlet works;
- prevent continuously disturbing activities such as trail bikes and off road vehicles (Water Authority, 1987).

The overall thrust of these guidelines is that recreational use is endorsed but that the types of activities and level of use should not conflict with the primary land uses. Practical recreational management objectives within the catchment are a blend of the above guidelines.

SECTION C: RESOLUTION OF ISSUES AND SELECTION OF PREFERRED OPTIONS

5.0 SUMMARY OF RECREATIONAL ISSUES AND STRATEGIES

A summary of recreational issues is given below prior to presentation of the alternative recreational management strategies. Recreational issues have been considered from two perspectives:

- characterisation of the reservoir and catchment in terms of different recreational settings followed by a broad assessment of the compatibility of all recreational activities within each particular setting;
- identification of conflicts between different activities and user groups.

The issues identified from the latter perspective are discussed in conjunction with the alternative management strategies for each activity, that are presented in sections 5.3 and 5.4.

5.1 Recreational Settings

To assist in the evaluation of recreational issues, a brief description of recreational settings within the catchment is provided. These arise from the landscape assessment presented in the draft management plan.

5.1.1 Water-based Recreational Settings

Four distinct zones of water-based recreational settings have been identified.

- Open Water:** The expansive open stretches of water in the reservoir are the focal point for all land within the viewshed. From the open water, views of other recreational settings are plainly visible.
- Foreshore and Fingers:** This setting includes the shallow water margins (particularly in the 'fingers' at the entry point of feeder streams), the exposed banks and a narrow band of foreshore supporting a fringe of Murray Complex vegetation. The interface of water and land is the most popular recreational setting.
- Dam Wall Area:** The dam structure and impounded water is an impressive sight and a feature for the initial arrival experience. There are long views of the water body with a forest backdrop

to the east, whilst to the west the outlet stream and the steep valley slopes are the main points of interest.

- iv. **Feeder Streams:** These settings include some of the most interesting and dense vegetation associations. Difficulty of access within the streams results in a low level of use.

5.1.2 Land-based Recreational Settings

The overall forest setting varies with topography and vegetation type. Variation in these factors alter the appeal of the forest. For example, there are lower valley slopes with restricted viewsheds and relatively exposed ridges with occasional long sweeping views. In those areas of forest which do not have a view of the reservoir, the recreational settings and the opportunities provided are essentially no different to forest outside the catchment.

5.2 Compatibility of Recreational Activities and Settings

The impact of each recreational activity on the various settings which were identified in the landscape assessment are described in the draft management plan. It is clear that there are both land-based activities and water-based activities which impinge on the setting in which they take place and even on adjoining settings.

The principal issues which arise are:

- i. Land-based activities: off-road driving, off-trail horseriding and hunting all have the potential to affect the inherent qualities of all others settings.
- ii. Water-based activities: power boating affects the majority of settings near the reservoir by virtue of its noise and has the greatest impact on the most popular setting within the catchment ie. foreshores and fingers.

5.3 Water-based Management Strategies

Recreational development strategies for specific water-based activities are presented in this section. Water-skiing, swimming, canoeing/sailing, fishing and marroning are considered to be the main active recreational pursuits.

5.3.1 Water-Skiing

i. Issues

On a reservoir as small as Waroona Dam, it is inevitable that power boat and water-ski activity will somewhat limit opportunity for concurrent passive recreational pursuits as well as other water-based activities such as fishing, canoeing, sailing and swimming.

Availability of space, safety, noise and wave/wash disturbance are key factors.

Turbulence and wave action generated by the launching and operation of power boats clearly have potential to create shore line erosion and turbidity.

The available evidence suggests that whilst turbid conditions may be induced near the shoreline, particularly during peak periods, this is temporary. Boat wash has not resulted in obvious serious erosional damage to the shoreline.

ii. Alternative Strategies

Three alternative strategies for future management are evident:

- Maintain the' status quo.
- Permit skiing to continue but with new restrictions, routine policing and infringement penalties.
- Prohibit all skiing.

Maintenance of the status quo would effectively mean that water-ski activity would be virtually unrestricted, apart from the minor restrictions imposed by the gazetted water-skiing area. Due to the inherently intrusive nature of this activity on other users, maintenance of the status quo will effectively mean that water-skiing is the priority recreational activity on the reservoir.

The second alternative is to allow water-skiing to continue, but with additional constraints to improve the opportunity for concurrent alternate activities. A list of suggested conditions is given below. it is important to note that past experience has demonstrated that restrictions will be of little value unless they are routinely policed.

a) Time Constraints

- Skiing only permitted between sunrise and sunset ie. no twilight activity.
- Skiing prohibited on nominated weekends (eg. following the start of the trout season).
- Skiing prohibited for longer periods during the year (but in rotation with the nearby Logue Brook Dam).

b) Spatial Conditions

- Total ban on power boats in the vicinity of stream inflow zones and within a set distance of the shoreline in specific areas, except near launching zones.
- Restrictions on the number of boats launching areas.
- Adopt designated take-off and landing areas, remote from boat launching sites.

Prohibition of water-skiing is the third alternative that must be considered. Whilst it is understood that prohibition would receive support from some user groups, it would be a harsh judgement given the lack of alternative inland locations that are suitable and available for this use. The significant demand for inland water-ski areas is demonstrable and well known.

In comparison, whilst the suitability of the reservoir for other activities such as fishing, picnicking, marroning and canoeing may be limited by boating and skiing, there are other reservoirs where these activities can be conducted in the absence of power boat or ski activity.

Further, no firm evidence that power boat activity and skiing is detrimental to water quality has been identified. Therefore, prohibition on the basis of potential for water quality impact would be difficult to justify.

5.3.2 Canoeing and Sailing

i. Issues

Canoeing and sailing are commonly practiced activities on many water supply storages overseas and in the Eastern States. These activities are also frequently allowed on potable supply reservoirs, without apparent adverse effects. Consequently, they are deemed to have high compatibility with this irrigation reservoir.

The reservoir is a relatively sheltered water body and is thus ideally suited to beginners at both canoeing and sailing, and these activities have low compatibility with power boat use. Conflicts obviously arise with power boat operators, particularly in regard to safety.

ii. Alternative Strategies

There is an obvious need for some degree of separation between powered and non-powered craft. At present, the gazetted ski area leaves a reasonable proportion of the reservoir free for other uses.

Enforcement of boat access restrictions may be sufficient to cater for canoeing and sailing. Alternatively, water-skiing could be further restricted to the benefit of non-powered craft. The layout of Waroona Dam in two distinct valleys suggests the option of restricting water-skiing to one flooded valley and allowing only canoeing and sailing on the other.

5.3.3 Swimming

i. Issues

The attraction of such a large body of fresh water for swimming is undeniable and swimming is compatible with water quality requirements for irrigation. However, there are potential safety and public health conflicts which arise from:

- interaction between swimmers and power boats;
- bacteriological contamination affecting both swimmers and water-skiers.

To date, there have been no recorded accidents involving power boats and swimmers, nor is there sufficient information yet on which to assess the health risk.

ii. Alternative Strategies

There are three strategies that are available to manage swimming. These are:

1. Prohibit swimming: This option would be difficult to justify on water quality grounds unless widespread and prolonged bacterial infection was detected and the reservoir was required for potable water.

A prohibition on swimming would also involve the prohibition of water-skiing.

2. Maintain the status quo: this option allows for swimming to occur entirely at the individuals' discretion, anywhere on the reservoir.
3. Tolerate without encouragement: swimming may be conducted in relative safety outside of the gazetted ski areas. Place "swim at own risk" signs in these areas. Also discourage swimming in water-ski zones.

5.3.4 Fishing

i. Issues

Fishing is considered compatible with the water quality objectives. The principal conflict arises from other users of the reservoir, particularly the disruption by power boats in preferred fishing areas.

It is noted that there are about seven other dams within a 50 km radius which have been stocked with trout.

ii. Alternative Strategies

Apart from a total ban on power boats and water-skiing, there is limited scope to resolve the disruption to fishing enthusiasts. Active enforcement of gazetted ski areas is required. Some adjustment of these areas may help to provide a reasonable compromise. There is also the possibility of nominating selected periods during the year for priority fishing, ie. temporary bans on water-skiing. However, enforcement of this proposal would be cumbersome.

Intensive management of the fishery may be required if trout stocks are seriously reduced. The present status of the fishery is not clearly defined. If a consistently high fishing effort were to cause a decline in the fishery then the management alternatives would be to institute a longer closed season or to prohibit boat fishing and fly fishing at night.

The trout management problem at Waroona Dam has been exacerbated by the appearance of redfin perch and the fishery has become largely overrun by this more competitive species. Perhaps management of the trout fishery is not longer an efficient utilisation of funds or effort.

5.3.5 Marroning

i. Issues

Marroning is a popular pastime and is generally considered to be compatible with the irrigation water quality objective. Conflicts which have been identified include:

- occasional anti-social behaviour of some groups, sometimes late at night, creates a disturbance to other users.
- the creation of temporary stone fireplaces which are later inundated as water level rises, represents a hazard to skiers and swimmers.
- rotting animal carcasses and other organic material used as baits are often left in the shallows. These are unsightly and possibly result in bacteriological contamination.

ii. Alternative Strategies

- **Prohibition:** A total ban on marroning would be difficult to justify.

- **Create marron fishing zones:** This option could be introduced if the effects of marroners on other recreationalists becomes a significant issue. The aim of specific zones would be to ensure that water-ski areas are free of makeshift fireplaces and that passive recreational areas are free of unsightly animal flesh baits.
- **Additional controls and policing:** Allow marroning to occur without area restrictions but actively discourage the use of animals flesh baits and makeshift fireplaces. More litter collection activity and/or enforcement of litter removal would be required.

5.4 Land-based Management Strategies

5.4.1 Overnight Accommodation

i. Issues

Camping is one of the principal issues which this management plan needs to address. The Waroona Dam caravan park is the only area where camping is allowed, but this has inadequate capacity and consequently, there is a demand for suitable additional locations. Wild camping - camping outside the caravan park or a designated site - is a common occurrence.

Present policy of the Water Authority and CALM with respect to camping is summarised as follows:

- The Water Authority does not permit camping within any domestic water supply catchments except with specific approval. Within catchments used for irrigation supplies, there is no specific provision precluding camping, however activities associated with camping are controlled through bylaws. Camping is permitted in the Waroona Dam and Logue Brook caravan parks.
- CALM's recreational policy for State forest allows for vehicle-based camping at designated sites, whilst back pack camping is almost totally unrestricted. (There are presently no designated sites within the catchment other than at the caravan park, which is on land leased from CALM). Because the Health Act specifically states that it does not bind the Crown, CALM can provide less sophisticated facilities on land entrusted to it, than would otherwise have been possible. (CALM 1987, e).

'Wild camping' throughout the catchment is generally considered to be incompatible with water quality objectives because of the uncertainty that toilet waste and potentially putrescent litter will be given adequate disposal.

In addition, the constant collection of firewood involves trampling and disturbance to the forest adjacent to camp sites, which may result in permanent degradation to the more intensely utilized areas such as the reservoir foreshore.

It is considered that suitable camping areas could be nominated to allow partial deregulation of camping, consistent with water quality objectives, if the areas are provided with appropriate toilets, such as the sealed vault systems, and with a firewood supply. There is also substantial scope to provide more facilities and accommodation capacity at the existing caravan park site. Sewerage disposal from this site is not an issue in relation to water quality in the reservoir because the leach drain system is located outside of the catchment.

ii. Alternative Strategies

- Retain the caravan park as is and continue regular policing of the catchment to send illegal campers elsewhere (eg. Hoffmans Mill).
- Develop an additional camping site below the dam wall to avoid water quality conflicts. However, there is only limited space available in this area.
- Upgrade or relocate the caravan park to provide more capacity and a range of accommodation types, particularly isolated camping area in natural settings to attract people who would otherwise avoid caravan parks.
- Develop designated camping sites within the catchment in accordance with CALM recreational policy. integrate these sites with the caravan park to prevent conflict with commercial interests.

5.4.2 Barbecue and Picnic Activity

i. Issues

Barbecuing and picnicking activities are compatible with catchment protection, provided the activities are conducted in settings designed to cope with its effects. The demand for this activity routinely exceeds the design capacity of the existing facilities.

Lack of toilet facilities is the main issue of concern. Promiscuous defecation will create health and water contamination risk. Other conflicts relate to the conservation of foreshore vegetation and general litter problems. The need for well designed facilities is especially apparent during summer, when the bushfire risk is a major problem.

ii. Alternative Strategy

Provide adequate facilities at barbecue and picnic sites to allow sustained use, such as:

- suitably designed toilet facilities
- constant supply of firewood or coin operated gas barbecues
- rubbish bins with regular collection, or a centralised bin area
- provision of signs to encourage users to take their rubbish when they leave.

5.4.3 Scenic Driving

i. Issues

Scenic driving on the existing loop road and established forest tracks has no major undesirable effects. The unsealed road mostly reduces vehicle speed, which is desirable, but has some need for upgrading of drainage. Signs are also inadequate and should be upgraded.

ii. Alternative Strategies

- Improved control of drainage through routine earthworks and maintenance is necessary.
- Upgrading of signs should be conducted in accordance with CALM standard designs.

5.4.4 Off-Road Activity

i. Issues

Off-road activities will inevitably cause some damage to vegetation. Widespread and uncontrolled off-road activity obviously conflicts with forest conservation objectives and may indirectly affect water quality due to increased sediment loads to the reservoir.

The noise produced by trail bikes and associated disturbance to passive recreation areas is a key issue. There is also a safety risk which arises from trail bike activity.

ii. Alternative Strategies

- Prohibit and police all off-road vehicle activities.
- Prohibit vehicles only from off-road activity but discourage horse-riding except on trails. Monitor the condition of frequently used areas.

- Allow off-road activities to continue as per present patterns of use.

5.4.5 Bushwalking

i. Issues

Whilst the impact of bushwalking is generally accepted to be low, there are locations within the catchment where some control and monitoring is appropriate, such as areas which are now free of dieback, stream zones and feeder stream inlets.

ii. Alternative Strategies

- Encourage the use of marked trails to reduce the general level of disturbance to vegetation in sensitive areas.
- Discourage bushwalkers from stream zone areas.

6.0 FUTURE ADMINISTRATION

Whilst development of management plans has been the primary concern of investigations, there has also been a need to examine how the implementation of management activity could be best achieved. It is clear from recent management activity that although particular current responsibilities are identifiably assigned to relevant authorities ' there is no formal coordinating structure which enables adequate on-site' management on a day-to-day basis.

Three broad alternative strategies for improving administration were identified and evaluated in the draft management plan. These were:

1. Formalise the existing structure as a Consultative Committee coordinated and chaired by the Water Authority.
2. Allocate administrative responsibility for co-ordination to CALM.
3. Allocate administrative responsibility to the Shire of Waroona.

A fourth consideration was that management responsibilities for specific recreational activities could be delegated to private user groups.

Evaluation has led to the selection of Option 1 as the best approach to future management. CALM will conduct the primary components of day to day management of recreational activity, on priorities agreed by the Consultative Committee, bearing in mind the availability of additional finance.

7.0 IDENTIFICATION OF THE PREFERRED DEVELOPMENT OPTION

The draft management plan evaluated three alternative development philosophies from which the following broad strategy for control of future development was selected. "Maintain and cater for the present demand for recreational and environmental use. Provide recreational and environmental management prescriptions that resolve the identified problem areas".

When considered within the context of the designated priority uses which are of water production and wood production, the investigation concluded that this strategy should be adopted.

On the basis of available data the investigation concluded that the reservoir and catchment environment could sustain the present levels of recreational use provided that:

- i. The existing administrative procedures are coordinated and formalised through a permanent Consultative Committee comprising representatives of the current administrative agencies. The Committee should be chaired by the Water Authority, at least for the duration of this Area Plan, as within this time-frame water production will remain the dominant priority use.
- ii. Recently initiated monitoring of water quality is continued.
- iii. A survey to determine the requirements of recreational users is commenced as soon as possible.
- iv. Management prescriptions to resolve problem areas that have been identified, require institution and policing.
- v. Management prescriptions must be flexible so that adjustments to patterns and type of use can be made if monitoring results indicate such needs exist.

There is also a fall back situation for water quality management that should be noted. If monitoring shows that active recreation on the reservoir is causing unacceptable water quality deterioration, drastic restriction or prohibition would enable recovery to desirable standards within a short time-frame. This is because the annual water yield from the catchment is high relative to the volume of the reservoir, enabling rapid dilution and displacement of contaminated water. Maintenance of the ability of the catchment to provide good quality water is implicit in this suggestion. The protection of stream zone and foreshore vegetation in particular, and forest vegetation and soil stability in general, therefore, has paramount importance.

SECTION D: FUTURE MANAGEMENT

8.0 MANAGEMENT PRESCRIPTIONS

8.1 Introduction

In this section, the prescriptions for each of the activities conducted on the reservoir or within the catchment are presented. Each prescription is preceded by a short statement of the objective of management and the rationale.

Effective management of the resource will depend to a large extent on how effectively people are managed. One effective tool for achieving this is through a zoning mechanism such as the creation of management units. Map 7 shows the management units that should form the basis for future management and provides an overview for the management prescriptions that follow. For example, the land adjacent to the reservoir is intensively used for recreation and has been identified as a restricted land zone. This implies that some activities may be restricted in specific areas, as management must take into account such factors as the high levels of recreational use, the capacity of existing facilities and the ability of an area to sustain particular uses.

8.2 Recreation

It is important to recognise that the development of management prescriptions for recreation has been constrained by two principal factors:

1. Budget limitations and scheduling of the investigation for completion during the winter months restricted the opportunities for the study team to directly observe recreational activity. This is particularly the case for peak use periods which normally occur during summer and at Easter.
2. The available water quality data base for assessment of recreational impacts was limited.

Much of the background data, on which management prescriptions are based, has been pieced together from anecdotal evidence obtained from discussions with recreational users and local administrators. A public workshop held at Waroona during the course of the investigation also provided useful information.

It is therefore recommended that management should be sufficiently flexible so that modifications to permitted recreational practice can be implemented if future monitoring indicates that such needs exist.

Prescriptions for the major recreational issues are listed below in approximate priority order. A conceptual strategy plan for recreational development is presented on Map 8, and this is referred to in the following sections where appropriate.

8.2.1 Power Boats and Water Skiing

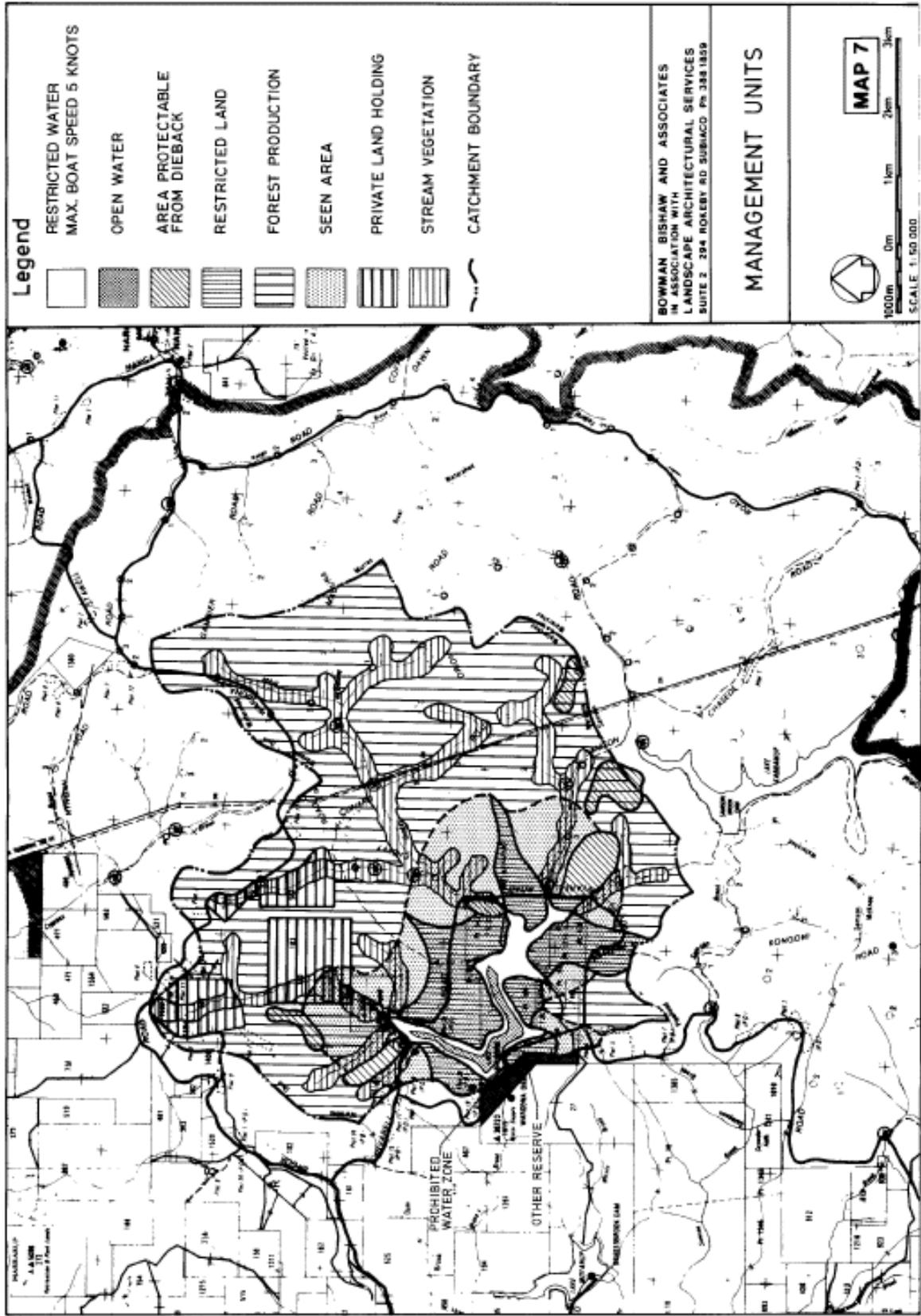
Objective: To ensure that power boat and water ski activity is carried out in a safe manner with due regard to other users of the dam.

Rationale: There is both significant demand and limited resources for inland water-skiing in this region.

Whilst popular passive recreational pursuits are often incompatible with water-skiing, there are a number of alternative venues in the locality where these activities can be pursued in isolation.

Further, there is no evidence to indicate that power boats and skiers have caused deterioration of water quality beyond the limits of its designated use.

Investigation indicates that the intensity of power boat use and skiing is largely self-controlling as capacity is usually evident to users.



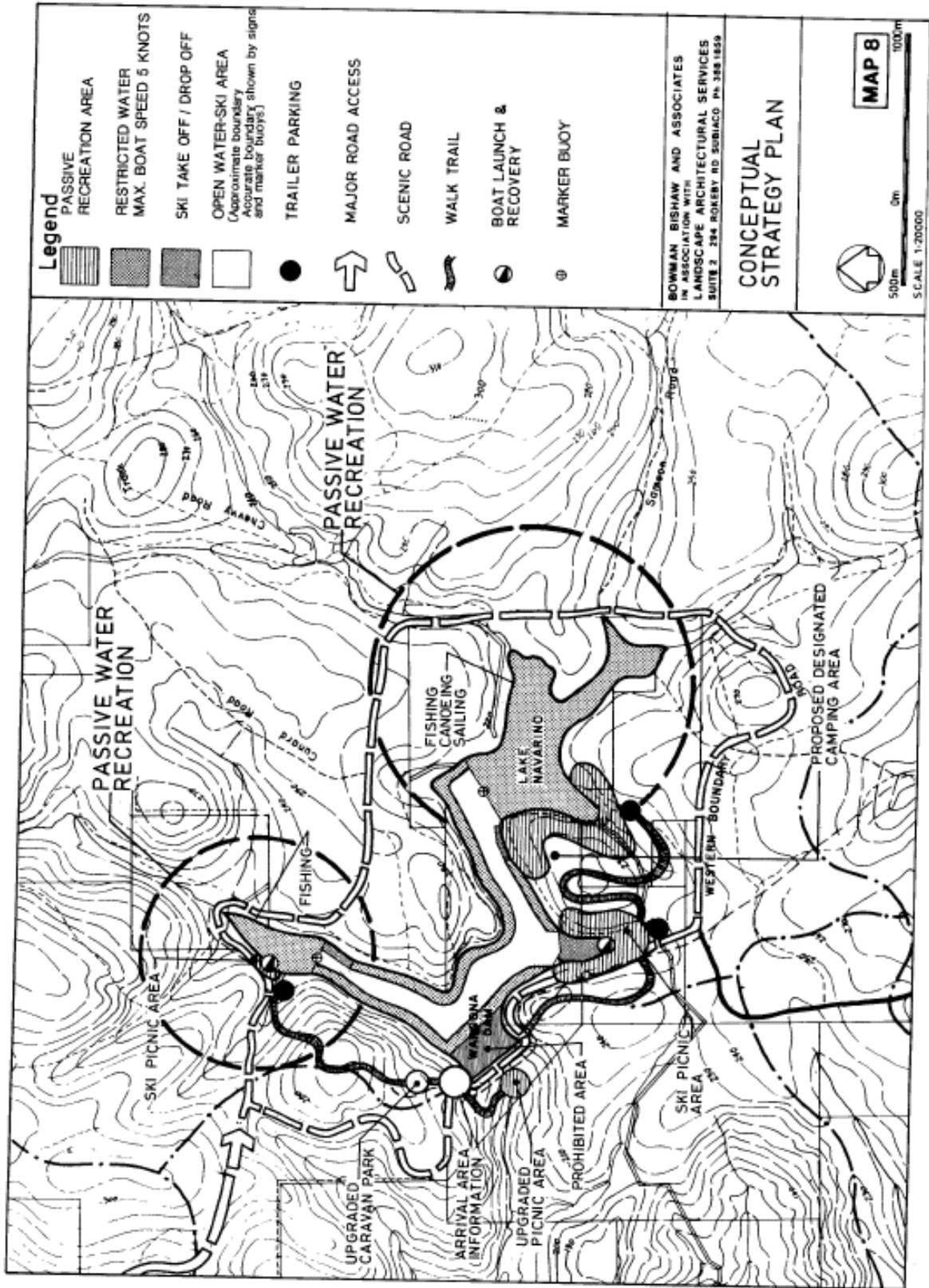
Prescriptions: Water-ski and power boat activity at Waroona Dam should be permitted with the following conditions and changes to current practice.

- A water-ski area as shown on Map 8 will be gazetted. This excludes the dam wall, outlet tower, areas within 45 metres of the shore, and the narrow arms of the reservoir.
- Changes to the gazetted area must first be approved by the Consultative Committee.
- Power boat speed outside the gazetted area will be limited to 5 knots.
- Skiing and boat operation at speeds greater than 5 knots will only be permitted between sunrise and sunset, for safety reasons. This will also improve opportunities for night fishing and marroning.
- When the water level in the dam falls to 199 metres above the Australian height datum, water skiing must stop for safety reasons. Skiing can recommence when the water reaches the 201 metre level.
- Policing will initially be conducted as determined by the Consultative Committee.
- The water skiing fraternity will be encouraged to develop a code of ethics.
- Launching and recovery of boats will only be conducted at the sites shown on Map 8. Public awareness and appropriate instruction signs will be necessary to assist acceptance of this procedure.
- Potential congestion at launching areas between boating, swimming, picnicking and barbecue activities, will be minimized by appropriate location and design of facilities.
- Appropriate toilet facilities and adequate litter bins will be provided at each designated launching site, as funds become available.

8.2.2 Camping and Caravans

Objective: To provide serviced caravan sites at suitable locations. To allow for camping areas at suitable locations.

Rationale: For part of the year there are sufficient facilities at the existing Waroona Dam caravan park. However at peak periods there are not enough facilities and there is a clear demand for more caravan and camp sites, either serviced or within natural settings with minimal facilities.



Many of the facilities at the existing Waroona Dam caravan park are in need of maintenance or replacement. While the existing site could be redeveloped there is at least one other site on the southern side of the reservoir that is worth considering for development.

For economic viability, to develop a good quality caravan park could require 100 or more serviced bays.

As significant demand for serviced bays comes from boat owners, provision of additional bays may result in higher boat and ski activities during peak periods, and a consequential increase in congestion on the reservoir.

The challenge will be to allow for the development of a good quality caravan park that meets a good proportion of the peak demand, is economically viable, and does not result in unacceptable or unsafe congestion on the reservoir.

Prescriptions:

- A good quality caravan park will be developed at Waroona Dam.
- The number of sites allowed will be chosen as the best balance between economic viability and avoiding unacceptable congestion on the reservoir.
- Vehicle based camping will only be permitted in designated areas.
- A designated camping area within a remote natural setting will be developed within the catchment to cater for about twenty camp sites under the direction of the Consultative Committee. A suggested site is shown on Map 8. It is preferable that the site is periodically relocated.
- Development of facilities such as toilets and litter bins will be in accordance with the CALM Recreation Manual.

8.2.3 Effluent Disposal

Objective: To ensure that there is no opportunity for direct entry of sewage to the reservoir.

Rationale: A well-designed leach drain system could operate properly at most times with satisfactory attenuation of contaminants within the clay sub-soils. However, there will always be a risk that peak period use will overload the infiltration capacity of the system with consequent potential for direct entry of sewage to the reservoir.

Prescriptions:

- Septic waste will be disposed to properly designed leach drains with adequate capacity to deal with peak period use.

- Appropriately designed toilet facilities will be installed at each designated barbecue site, designated camping area and boat launching sites, and will be serviced and maintained as required.

8.2.4 Parking and Vehicle Access at the Reservoir's Edge

Objectives: To provide parking that allows views of the reservoir but does not spoil those views or cause erosion.

To provide only essential access to the water's edge so that disturbance is minimised, erosion does not occur, and the scenery is not degraded.

Rationale: Management must balance an obvious demand for the seeking of isolated sites and for parking and recreating near the waters edge, with problems that arise. Factors which support a continuation of the present use include:

- a) With the exception of feeder stream inlet areas, the clay/gravel soils that form the reservoir banks are mostly stable and firm. The banks appear to be resilient to a high level of pedestrian and low speed vehicle access, as no erosional problems of major proportions are evident.
- b) There is no available evidence that indicates vehicle access on the reservoir banks has permanent or significant undesirable effect on water quality.
- c) Utilisation of the banks will tend to reduce activity within the vulnerable forest foreshore zone.

In contrast, unruly vehicle activity poses a clear safety risk for pedestrian access to the water's edge and may result in some erosion and temporary turbidity. Continued, unrestricted access has potential to result in the development of more tracks through the forest foreshore zone and consequent undesirable vegetation disturbance.

Prescriptions:

- The use of exposed bank areas for vehicle circumnavigation and scenic and pleasure driving will be discouraged.
- Movement between foreshore sites around the reservoir will only be allowed via the ring road.
- Parking on the water's edge near access track outlets will be allowed to continue so that further development of parking areas within the forest foreshore area can be minimised.
- Strict vehicle speed control will be introduced for bank areas.
- Unlicensed vehicle activity will continue to be prohibited.
- The existing access tracks will be rationalised so that only those with suitable slope, angle of approach and access to popular locations are retained.

- Unnecessary tracks and those exhibiting any significant erosion or excessive loss of adjacent vegetation will be closed off and revegetated.
- Storm water drains and silt traps will be constructed and properly maintained for the ring road and access track as required.
- Public education will be conducted to assist user adaptation to the new procedures, particularly in relation to use of the banks for vehicle transit between sites.
- Consideration will be given to the establishment of parking facilities outside the forest foreshore zone, near launching sites and picnic/barbecue facilities for trailer parking at times of high water level and during periods of peak demand.
- Any new parking areas will be chosen in consultation with CALM, and will have a minimum level of development.

8.2.5 Picnic and Barbecue Sites

Objective: To provide adequate picnic and barbecue facilities while ensuring minimal impact on catchment values.

Rationale: Picnic and barbecue events are a popular activity, particularly during summer and in association with 'day trip' excursions to the reservoir an catchment.

Facilities are presently inadequate.

Prescriptions:

- Firewood will be provided at existing designated sites to protect the foreshore zone from extensive wood removal.
- More barbecue facilities will be provided at a number of strategic sites around the reservoir.
- Parking areas will be separated from the immediate vicinity of barbecue facilities and pedestrians given easy and well marked access from the ring road.
- Each designated area will be provided with an appropriate toilet.
- Refuse collection procedures will be co-ordinated and formalised and removal will be conducted as often as necessary to prevent excessive accumulation, particularly during peak periods.
- Makeshift fireplaces contrusted on the banks of the reservoir during low water level will be removed at the end of each summer, before the water level rises. In the event that funds to conduct this work are unavailable, construction of fires on the reservoir shores will be prohibited.

8.2.6 Off-road Activity (including vehicles and horses)

Objective: To protect the biological, physical and scenic environment of the catchment by directing potential off-road activity to nominated roads and tracks.

Rationale: Whilst the catchment will have some capacity for sustaining off-road activity, it is not possible to predict with any certainty what this may be. As the priority use of the catchment is for water production, it is important that risk to vegetation coverage is minimised. Therefore, the capacity of the catchment for off-road vehicles of any type should be regarded as minimal.

Prescriptions:

- All vehicle activity outside gazetted roads and existing forestry tracks will be prohibited.
- Horse riding will be restricted to forestry tracks and existing roadways.

8.2.7 Bushwalking

Objective: To provide opportunity for bushwalking consistent with catchment protection objectives.

Rationale: Bushwalking is generally agreed to have minimal unacceptable impact. However, there are some sensitive zones within the catchment where control measures may be required.

Prescriptions:

- Bushwalking will continue to be permitted throughout the catchment.
- Where appropriate, scenic walks will be marked out in the vicinity of picnic and barbecue areas to enhance the recreational facilities.

8.2.8 Non-Powered Water Craft

Objective: To ensure that non-powered water craft activity is carried out in a safe manner with due regard to other users of the dam.

Rationale: For most of the year non-powered water craft, such as sail boats and canoes, could successfully share the water body with skiers and power boats. Protection from boat wash and collision risk would usually be possible outside the gazetted skiing area. At peak periods, capacity for all craft will be limited by space and, therefore, largely self-regulating.

Prescriptions:

- Non-powered water craft should be permitted in all areas of the reservoir, except near the dam wall and outlet tower. Launching and recovery of trailable craft should occur at designated sites.

8.2.9 Swimming

Objective: To allow swimming in designated areas as long as there is no unacceptable degradation of water quality.

Rationale: Swimming has obvious popularity and should be permitted if possible in non water-ski areas, except near the dam wall. However, the lack of bacteriological water quality data, in relation to health risk, limits proper definition of management requirements.

Prescriptions:

- Intensive monitoring of bacteriological water quality at popular swimming areas will be conducted over the duration of a summer peak period week and over at least one year at monthly intervals.
- Swimming will be permitted as long as the results of monitoring are favourable.
- A suitable area will be made available exclusively for swimming.

8.2.10 Fishing

Objectives:

1. To allow fishing for introduced and native aquatic fauna under the provision of the Fisheries Act.
2. To allow stocking for fish species under the control of the Fisheries Department.
3. To minimise potential conflicts between fishing and other recreational areas.

Rationale: The combination of a suitable aquatic environment for introduced and native aquatic fauna, and an attractive landscape has supported the development of a valuable recreational fishery within the catchment. Both Water Authority and CALM management policies allow for encouragement of recreational activities that can co-exist acceptably with the priority use of the reservoir and catchment.

Prescriptions:

- Fishing will be permitted on the reservoir according to the Fisheries regulations.
- During the day all fishing activity will be contained within the restricted water zone except near the dam wall. Night time fishing activity will be permitted in the open water zone (see Map 7).
- Any restocking of fish species will only be permitted according to advice from the Fisheries Department.

8.2.11 Marroning

Objectives: To allow marron fishing under the provisions of the Fisheries Act.

Rationale: In recent years there has been a dramatic increase in marron fishing. The number of inland fishing licences issued has risen from 6862 in 1970/71 to 28765 in 1985/86. Most of these (90%) were issued to marroners. In 1986/87 under the new Recreational Fisherman's Licence, 24,688 licences were issued to marroners.

Although the species has a high reproductive capacity, most marron populations are now being overfished to the point where it is difficult to catch specimens over the legal size.

Prescriptions:

- Marroning will be permitted on Lake Navarino and the waters of the catchment area subject to the Fisheries Regulations.

8.3 Information

Objectives: To provide an information program that incorporates public use, interpretation, resource protection and visitor safety.

Rationale: The protection of resource values and enhancement of the public's care and enjoyment of an area can only occur when both the user and manager are aware of each other's objectives and needs. When this occurs, resource degradation is reduced, visitor satisfaction is increased, visitor safety is improved and management costs are reduced.

There are four categories of information that are important for visitors to the catchment:

1. Public use - descriptive information that provides visitors with an outline of recreational opportunities. This information can also help those planning a visit to the catchment.
2. Interpretation - information that assists visitors to understand the catchment area and the processes influencing it.
3. Resource Protection - information that describes the major resource features of the area and the management guidelines that have been adopted to protect them.
4. Visitor Safety - information that advises visitors of potential hazards, particularly regarding water-skiing.

Careful consideration must be given to the mechanisms used to distribute this information.

Prescriptions:

- Sign requirements will be identified and satisfied.
- Signposting will be undertaken according to the guidelines in the CALM Sign Manual.
- Regular liaison with known user groups and relevant commercial interests will be maintained by personal contact and written material.
- The information program will be linked to other regional and departmental programs to ensure that consistent standards are maintained and the area is not promoted beyond its capacity to cope with visitor use.

8.4 Resource Management

Whilst the primary aim of this plan is to develop effective management of recreational use, it also needs to consider management of other land uses in the area, particularly for the priority uses of water and wood production. Management prescriptions for both the priority land uses and other minor land uses are outlined below. In addition, prescriptions are given for landscape protection in relation to the possible impact that some land uses may have on landscape values.

8.4.1 Water Supply

Objective: To provide a reliable water supply to the Waroona Irrigation District and to prevent adverse long-term deterioration in water quality.

Rationale: For the duration of this ten year plan, water supplied by the reservoir will primarily be used for irrigation purposes. The only other consumptive use will be the continuation of the small scale supply to the caravan park. Therefore, the recommendations detailed in this section only relate to management of the resource for these purposes. However, it should be noted that the overall emphasis of the management plan is on catchment protection and maintenance of water quality to ensure options for domestic supply in the long term are not precluded. Specific prescriptions relating to the use of the resource for large scale domestic supply will be incorporated into subsequent revisions of this plan, if and when required.

Prescriptions:

- Irrigation waters will continue to be supplied to the Waroona irrigation system as required by farmers in accordance with current procedures.

- Water quality monitoring will be conducted, as outlined in Appendix A, to enable greater understanding of the effect of recreation on water quality.
- The supply of water to the Waroona caravan park will be upgraded to incorporate disinfection.

8.4.2 Forest Management

Objective: To enable a level of hardwood production from the area of State forest that is sustainable indefinitely, consistent with requirements such as protection of water catchment, conservation and provision of recreational opportunity.

Rationale: CALM has a suite of management prescriptions which deal specifically with forest management. Most of these are outlined in the Regional Management Plans (CALM, 1987, a). Existing policies cover areas such as harvesting techniques for forest products, dieback management, fire management, mining control, weed control, stream zone protection, feral animal control, forest track maintenance and rehabilitation. These policies deal adequately with the management issues which could arise within the State forest components of the catchment, and which are relevant to this management plan. Catchment management practices may be reviewed to allow for probable demand for residue timber for charcoal, and the water and wood production benefits which may be gained from thinning the forest.

The Noisy Scrub-bird, a gazetted rare species in WA, is now extinct from this area, although it is the type locality for the bird which was discovered in 1842. A recent survey has revealed potential Noisy Scrub-bird habitats are still present along Drakes Brook and its tributaries (A. Danks pers. comm. 1989).

Prescriptions:

- CALM forest management prescriptions will be routinely applied within the catchment area.
- Future logging activity will not visually impair recreational activities.
- Consideration will be given to translocating Noisy Scrub-birds to suitable sites within the catchment.

8.4.3 Landscape Management

Objective: To maintain the visual amenity of the areas of principal recreational activity so that the recreational experience is not adversely affected.

Rationale: Visual quality of the catchment landscape, particularly within the viewsheds available from the reservoir surface, foreshores and scenic drive, is a fundamental component of the recreational resource and, therefore, requires careful management.

Prescriptions:

- Recreation development will be undertaken according to a Recreation Framework Plan to be prepared by CALM in conjunction with the Consultative Committee.
- The visual effects of any works conducted within the catchment area will be evaluated by CALM prior to implementation. Particular attention will be paid to activities within the restricted land management unit (marked on map 7).
- Future forest product harvesting from within the restricted zone will utilize methods that have minimal visual effects on the reservoir viewshed.

8.4.4 Mining

Objective: To minimise the impacts of bauxite mining in the catchment and exclude mining activity from the viewshed of the reservoir.

Rationale: Whilst the catchment area lies outside the current 25 year mining plan an changes to economic circumstances could result in the approach of mining to the close vicinity of the catchment within ten years.

The Consultative Committee will liaise with Alcoa and the Mining Management Programme Liaison Group regarding bauxite mining activity within the catchment.

Prescription:

- Any mining activity within the catchment will be conducted according to CALM management prescriptions and closely supervised. Particular attention will be given to minimisation of turbid runoff from mine areas.

8.4.5 Gravel Extraction

Objective: To minimise the effect of the extraction of gravel on conservation values, landscape values, water quality and rehabilitation potential.

Rationale: Extraction of gravel from the banks of the reservoir is sometimes conducted but is considered to be incompatible with a number of other uses, principally in regard to visual acceptability and bank stability.

Prescription:

- The extraction of gravel will not be allowed within the viewshed from the foreshore or the reservoir surface when the dam is full. Gravel extraction will only be considered from the banks between low water and full water levels in special circumstances under strict conditions approved by the Consultative Committee and by CALM. Strict attention must be paid to timing of the operation, rehabilitation and the prevention of spread of dieback disease.

8.4.6 Beekeeping

Objective: To facilitate beekeeping subject to the need to minimise conflict with other land use objectives of the catchment area.

Rationale: Beekeeping has occurred on the catchment area for many decades; however, with increased recreational use, bees may be a potential hazard to visitors.

Prescription:

- Continue to manage beekeeping as outlined in CALM's regional management plan for the northern forest region (CALM, 1987,a).

8.4.7 Public Utilities

Objective: To limit the development of public utilities to those considered essential by Government and for which there is no reasonable alternative location.

Rationale: Public utilities and landscape recreation values are generally considered compatible.

Prescriptions:

- Liaise with and advise service authorities to ensure their operations are in sympathy with the environment and other land uses.
- Continue to manage public utilities as outlined in CALM's regional management plan for the northern forest region (CALM, 1987 a).

8.4.8 Aboriginal Sites

Objective: To observe and comply with the provisions of the Aboriginal Heritage Act 1972/80.

Rationale: There is a possibility that Aboriginal sites exist along the creeks that flow into Lake Navarino but have never been identified and documented. These sites which are most often evidenced by scatters of stone flakes, are easily damaged.

Prescription:

- Any aboriginal sites that are discovered in the catchment by management authorities will be reported to the WA Museum and will not be disturbed without prior approval.

8.5 Forest Resource Protection

CALM is responsible for the protection of State forest from such causes as fire and disease which may have an adverse effect on the forest ecosystem.

8.5.1 Fire

Objective: To use fire as a management tool to achieve land management objectives in accordance with land use priorities.

Rationale: CALM has a responsibility to protect community and environmental values from damage or destruction by wildfire on land it manages.

Prescription:

- Apply fire management principles consistent with CALM's regional management plan for the northern forest region (CALM, 1987 a), bearing in mind the recreational value of the catchment.

8.5.2 Dieback

Objective: To minimise the damage caused by dieback disease.

Rationale: Although jarrah dieback disease occurs throughout the catchment there are still several areas that are apparently healthy, dieback free and hence protectable.

Prescriptions:

- The apparently healthy, protectable areas in the catchment will be accurately mapped.
- Ensure that activities in the catchment do not spread dieback to these areas.

8.6 Administration

Objective: To develop a workable structure to enable effective administration of this management plan and the successful initiation of management prescriptions as funds become available.

Rationale: Since the reservoir was constructed, recreational use of the area has occurred without a management plan. This recreational activity does not recognise the existing boundaries of responsibility of the various management authorities involved. In addition, there is no formal structure which correctly assigns responsibility for recreational management. Consequently, a number of inadequacies are apparent, particularly in regard to provision of facilities and the policing of regulations on a day-to-day basis and on a 'round the clock' basis as necessary.

Prescriptions:

i. Consultative Committee

- A Consultative Committee will be formed with membership drawn from the Water Authority, CALM, Department of Marine and Harbours, Shire of Waroona, Shire of Harvey and two user group representatives, convened and chaired by the Water Authority. The same Consultative Committee will be responsible for both Waroona and Logue Brook management plan areas.
- It is the responsibility of the Consultative Committee to ensure satisfactory implementation of the management plan.
- Implementation will depend upon ratification by the responsible organisations.
- The Consultative Committee will clarify who is responsible for:
 - i) co-ordinating recreational activity
 - ii) policing regulations on a day to day basis.Their recommendations must be ratified by the responsible organisations.
- The Consultative Committee will investigate the potential for private involvement (eg. club management) to supplement management of specific activities.

ii. Finance

- Funding of the annual works programme will be obtained jointly from the government and local government organisations represented on the Consultative Committee, subject to ratification by the organisations concerned.
- There will be a clear definition of priorities for each annual works programme to ensure more efficient utilisation of funds.
- As the availability of finance is anticipated to restrict implementation of the plan, the user pays principle will be introduced as a means of raising additional funds for management. Consideration will be given to introducing an entrance fee.

- Equitable design of a fee system will include determination of appropriate levels of discount for specific groups of people such as local Shire rate-payers, long-term users of the caravan park, and adjacent land-holders who are regular users.

iii. Staff

- Site inspections by the local Shire ranger and personnel from the Water Authority Depot and CALM District Office will be coordinated whenever possible to maximise the on-site management presence.
- All government and local government personnel who routinely visit the area in the normal course of the duties (eg. Fisheries and Marine and Harbours inspectors) will be familiarised with the management plan to ensure that advice to recreationists is consistent.
- The Consultative Committee will investigate the methods by which rangers from each relevant management authority can be authorised to enforce all appropriate management regulations which are provided to individual management agencies through the relevant statutes.

8.7 Surveys, Research, Monitoring

Objective: To plan and implement an integrated programme of survey, research and monitoring to provide information that will help manage the catchments and, where appropriate, to involve other organisations and volunteers in the programme.

Rationale: Meeting the survey, research and monitoring needs of this plan will require the integration of surveys and research in the catchment, involving specialist and regional or district staff. Where appropriate, other government departments and local groups may become involved, although no work in the catchment will be carried out without approval by CALM.

Prescriptions:

- An integrated programme of survey, research and monitoring will be designed and commenced during the period of the plan. This must be ratified by the relevant responsible organisations.
- Water quality monitoring has the highest priority and a programme will be maintained in accordance with the outline described in Appendix A.

SECTION E: IMPLEMENTATION AND REVIEW

Implementation of this plan should commence immediately. Priority should be given to the prescriptions for recreational management, as long as they remain consistent with the overall management objectives for water supply and wood production.

Three broad phases of work are required to initiate the plan for its first year of operation:

- i. Establish the Consultative Committee and schedule initial meetings. This is the responsibility of the Water Authority.
- ii. The Consultative Committee is to determine plan priorities and draft an annual works programme in accordance with the available budget.
- iii. The Consultative Committee is also to nominate responsibility for specific tasks and establish regular liaison as these are implemented.

The Water Authority has commenced an upgraded water quality monitoring programme. As the water quality data will be a valuable tool for management when the plan is implemented, this action is endorsed.

The duration of this plan is 10 years, however the CALM Act allows for earlier revision if necessary, provided the public participation procedures are followed.

Implementation of the plan will depend upon the availability of finance, staff and the continuing advice of the Consultative Committee.

BIBLIOGRAPHY

- Alcoa of Australia (1978): Wagerup Alumina Project, Environmental Review and Management Programme.
- Advisory Committee for the Purity of Water (1977): A Study of Catchments and Recreation in Western Australia.
- Burton, J.R. (1979): Recreation Use of Water Supply Reservoirs, An Australian Case Study. In **Hydrology and Water Resource Symposium Perth**. pp 184-188.
- Department of Conservation and Environment (1979): System Six Study - Tourism and Recreation Committee Report.
- Department of Conservation and Environment (1980): Atlas of Natural Resources; Darling System, Western Australia.
- Department of Conservation and Land Management (1986, a): Lane Poole Reserve; Draft Management Plan, Volume 1, 11 and 111.
- Department of Conservation and Land Management (1986, b): Shannon Park and D'Entrecasteaux National Park; Draft Management Plan.
- Department of Conservation and Land Management (1986, c): Beating About the Bush.
- Department of Conservation and Land Management (1987, a): Northern Forest Region -Regional Management Plan 1987 - 1997.
- Department of Conservation and Land Management (1987, b): Central Forest Region -Regional Management Plan 1987 - 1997.
- Department of Conservation and Land Management (1987, c): Northern, Central, Southern Forest Regions - Regional Management Plans 1987 - 1997; Supporting Papers.
- Department of Conservation and Land Management (1987, d): Timber Production in Western Australia. A Strategy to take W.A.'s South-west Forests into the 21st Century.

- Department of Conservation and Land Management (1987, e): **Strategies for Conservation and Recreation on CALM Lands in Western Australia - the Conservation, Environmental Protection and Recreation Strategies of W.A.'s Department of Conservation and Land Management.**
- Havel, J.J. (1975, a): **Site-Vegetation Mapping in the Northern Jarrah Forest** (*Darling Range*) - Definition of Site-Vegetation Types. Forest Department, Western Australia Bull. No 86.
- Havel, J.J. (1975, b): **Site-Vegetation Mapping in the Northern Jarrah Forest** (*Darling Range*) - Location and Mapping of Site Vegetation Types. Forest Department, Western Australia Bull. No 87.
- Heddl, E.M., Havel, J.J., and Loneragan, O.W., (1980): Focus on Northern Jarrah Forest Conservation and Recreation Areas. Forest Focus 22.
- Fabos, J and McGregor, A. O (1979): Assessment of Visual/Aesthetic Landscape Qualities: Report to the Australian Heritage Commission.
- Loh, I.C., Gilbert, C.J. and Browne, K.P. (1981): Nutrient Concentrations of Streamflow in the Murray River Basin, Western Australia.
- Longworth & McKensie in Assoc with Kuring-Gai College - Centre for Leisure & Tourism Studies (1986): Survey of Existing & Potential Recreation Use of The Waterboards Catchment & Storage.
- Melbourne Metropolitan Board of Works (1977): First Progress Report North Maroondah; Water Supply Catchment Hydrology Research.
- Melbourne Metropolitan Board of Works (1980): A Case Study of Maroondah Catchment; Water Supply Catchment Hydrology Research.
- Murdoch University (1985): Waroona and Logue Brook Reservoirs, Environment and Recreation Study.
- National Health and Medical Research Council (1987): Guidelines for Drinking Water Quality in Australia.
- Pitts, D.J. and Anderson, D.R. (1985): Lake Wivenhoe - An Example of Comprehensive Water Storage Planning; In **Proceedings of the Workshop on the Recreational Use of Urban Water**

- Storages and Their Environs.** Australian Water Resources Council Conference Series 11. Canberra.
- Polakowski, K.J. (1977): Maribyrnong Valley Metropolitan Park. Master Plan Development; University of Melbourne Centre of Environmental Studies.
- See, R. (1984): Study of Recreational Uses for Graham's Town Dam; Port Stephens Shire Council.
- Shorthouse, D. (1985): Googong Reservoir - A Controlled Experiment for Multipurpose use of a Terminal Water Supply, in **Proceedings of the Workshop on the Recreational Use of Urban Water Storages and Their Environs.** Australian Water Resources Council Conference Series 11. Canberra.
- Soil Conservation Association of Victoria (1985): Eppalock Catchment Project.
- West Australian Silicon Trust (1986): Western Australian Silicon Project; Environmental Review and Management Programme.
- Western Australian Tourism Commission (1986): Tourism Development Plan - South West Region.
- Western Australian Water Authority (1984): Harris River - Environmental Review and Management Programme.
- Western Australian Water Authority (1987): The Impact of Logging on the Water Resources of the Southern Forests, Western Australia; A Report by the Steering Committee for Research on Land Use and Water Supply. Report No. WH41.
- Western Australian Water Authority (Unpub.): Wellington Dam and Collie Gorge - Tourism and Recreational Development. Position Paper - August 1987.
- Western Australian Water Resources Council (1984): Recreation in the Darling Range Catchments; Publications No WRC 2/84.
- Western Australian Water Resources Council (1985): Recreation on Reservoirs and Catchments in Western Australia; Publications No WRC 1/85.
- Willersdorf, B.K. (1985): Planning and Legal Aspects of Recreational Use of Lake Eppalock In **Proceedings of the Workshop on the Recreational Use of Urban Water Storages and Their Environs.** Australian Water Resources Council Conference Series 11, Canberra, pp 189-213.

University of Melbourne. Faculty of Architecture, Building and Town Regional Planning (1979):
Warringine Creek Catchments, Estuary - A Landscape Assessment Study. Melbourne.

APPENDIX A

Water Quality Monitoring Programme

The Water Authority has recently commenced a monitoring programme to assess in detail the impact of recreational activities on the water quality of both the reservoir and the feeder streams. The collection and analysis of water samples has been conducted on a monthly basis to date. However, this frequency may increase over the summer period if results indicate that the water quality is deteriorating. The parameters that are being measured are as follows:

Physical Characteristics

- ❖ Temperature
- ❖ Colour
- ❖ Turbidity
- ❖ Total filterable solids

Chemical Characteristics

(a) *Inorganic ions*

- ❖ Sodium
- ❖ Iron
- ❖ Manganese
- ❖ Sulphate

(b) *Nutrients*

- ❖ Ammonia
- ❖ Phosphate
- ❖ Nitrate

(c) *Organic Chemicals*

- ❖ Hydrocarbons (fuel oil)
- ❖ Chlordane (pesticide)
- ❖ Dieldrin (pesticide)
- ❖ D.D.T. (pesticide)

(d) *Dissolved Gases*

- ❖ Oxygen

- (e) *Acidity*
 - ❖ pH

- (f) *Biological/Bacteriological Characteristics*
 - ❖ Chlorophyll 'a' (microscopic plant matter)
 - ❖ total coliform bacteria
 - ❖ faecal coliform bacteria

The results and extent of monitoring will be reviewed and considered by the Consultative Committee at regular intervals. Where correlations can be recognised between recreational activities and deterioration of water quality, the Consultative Committee will consider and implement appropriate modifications to allowable recreational activity, as defined in the management prescriptions for the reservoir and catchment.

Catchment Management. We're really keen to work with farmers and land managers to reduce risks to drinking water. Collecting wonderful water. A water catchment is an area of land through which water from any form of precipitation (such as rain, melting snow or ice) drains into a body of water (such as a river, lake or reservoir, or even into underground water supplies "groundwater"). Water constantly moves between lakes, rivers, oceans, the atmosphere and the land and every lake, river and reservoir collects water when it rains from a specific geographical area that is known as a catchment. The importance of managing our catchments. Catchments can vary greatly in size and depending upon where they are can include mountains, farmland, cities and towns. Flood and catchment management seeks to reduce the impact of flooding to our towns, cities, key infrastructure and environmentally sensitive areas. It requires a combined consideration of land and water management based upon our river catchments and our coastal areas as the natural, geographical management unit. Solving real world challenges. We seek to achieve solutions which manage flood risk and planning for the needs of future generations. Supporting central and local government agencies and private clients across the world, we formulate policy, deliver national and catchment scale strategies, execute feasibility studies, deliver project appraisals and site-specific flood risk assessments and design solutions. While planning a reservoir, the degree of seriousness and the effect of sedimentation at the proposed location has to be judged from studies, which normally combination consists of: 1. Performance Assessment (Simulation) Studies with varying rate of sedimentation. 2. Likely effects of sedimentation at dam face. In special cases, where the effects of sedimentation on backwater levels are likely to be significant, backwater studies would be useful to understand the size of river water levels. Similarly, special studies to bring out delta formation region changes may be of interest. The steps to