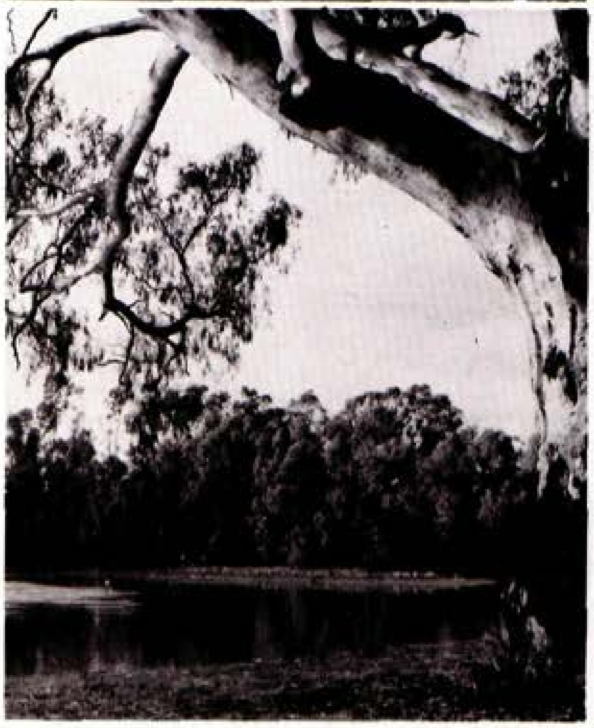
RIVERS AND STREAMS

SPECIAL INVESTIGATION






LCC LAND CONSERVATION COUNCIL

LAND CONSERVATION COUNCIL
Government of Victoria
Fourth Floor, 464 St. Kilda Rd. Melbourne, Victoria 3004
Phone: (03) 267 1311 Fax No. (03) 267 5896

VICTORIA'S RIVERS AND STREAMS SPECIAL INVESTIGATION

SUBMISSIONS

This report allows all who are interested in the various values and uses of Victoria's rivers, streams, and associated public land, the opportunity to comment by making written submissions to the Land Conservation Council.

These submissions will be considered by the Council before proposed recommendations are made on the uses of rivers, streams, and associated public land, and protection of their values. It is suggested that persons wishing to make a confidential submission should first contact the Chairman of the Land Conservation Council.

The report also contains a draft of the Heritage Rivers Program which aims to maintain, in at least their present condition, rivers with special values, and representatives of river types, across the State.

The Council anticipates that submissions will cover many aspects of river and public land use, heritage rivers, and may include general issues as well as specific details of river and land use.

It is apparent that there are some issues that concern many Victorians while others are of greater interest to local communities. The following is simply a listing of questions and issues (see over) without any attempt to establish viewpoints. It does not purport to be complete, but is offered merely to identify what appear to be major points of discussion. Comment on any other related matters is, of course, encouraged and will be welcomed by the Council.

DEADLINE!

The closing date for submissions is Friday 1 December 1989.

WHERE TO SEND YOUR SUBMISSION

Address written submissions to:

The Secretary
Land Conservation Council
4th Floor, 464 St Kilda Road
Melbourne 3004
Fax: (03) 267-5896

For further information contact Mr Don Hough on (03) 267-1311.

RIVERS AND STREAMS SPECIAL INVESTIGATION REPORT

SEPTEMBER 1989

LAND CONSERVATION COUNCIL

4th Floor, 464 St. Kilda Road
Melbourne, Victoria 3004. Phone: (03) 267 1311
Price $15.00

Cover Photographs

Top left

Lake Condah - Darlot Creek (Basin 37):

Significant Aboriginal associations - extensive fish traps and 'stone house' complex constructed from abundant scoria produced by the Mount Eccles lava flows. Wetland habitat value is currently being restored.

Top right

Snowy River (Basin 22):

Major white water recreational resource providing for driving, camping, canoeing, and walking. Many reaches have high scenic value with spectacular gorges and waterfalls. Nature conservation values are high with geological features of national significance found along its course and high naturalness tributary catchments.

Bottom left

River Murray - Barmah Forest (Basin 4):

Wetland of international significance for migratory birds, at a national level for flora and State level for fauna. A mosaic of river red gum forest, wetlands and associated plant communities provide high-value scenery, nature observation, camping, walking and canoeing, as well as timber. Significant cultural features are common.

Bottom right

Victoria River Falls (Basin 1):

Across the State waterfalls are important high-value scenic focal points for recreationists. The upstream reach of Victoria River has riparian vegetation values significant at a State level.

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MAPS

FOREWORD

The Land Conservation Council was established under the *Land Conservation Act* 1970. The function of the Council is to carry out investigations and make recommendations to the Minister with respect to the use of public land in order to provide for the balanced use of public land in Victoria.

This report provides a factual basis for the preparation of submissions to the Council, by describing and assessing the natural, cultural heritage, recreational and scenic values of Victoria's rivers and streams. Its purpose is to ensure that everyone who has an interest in the future use of our waterways and their catchments can obtain and study the basic information that the Council itself will study. The report is an excellent resource document, and has been prepared by Mr S. Ransome, Mr D. Hough and Ms A. Hingston under the direction of Mr I. Miles, and with the assistance of a study group who provided a large body of factual information.

Demands for land in catchments, and for the water they produce, are many and varied. Some land and water uses are compatible with the maintenance or enhancement of the various other values of our rivers and streams, while some are not. It is therefore important that the recommendations made in this investigation are based on the best information available. The Council is aware that numerous community groups and individuals possess specific information about the values and uses of particular rivers and streams in Victoria. The Council is therefore seeking your involvement in expanding the information about rivers and streams, prior to formulating any land use recommendations. In addition, the Council has, in the attachment accompanying this report, put together a list of issues, without any attempt to identify differing views. It does not purport to be complete but is offered merely to provide a focus for discussion on what appear to be the major points. Comment on any other matter relating to public land use is of course encouraged and will be welcomed by the Council.

Submissions are now invited and should be forwarded to the Secretary of the Land Conservation Council by the closing date for submissions, as notified in the **Victoria Government Gazette**, and advertised in State and regional newspapers. The Council will make its recommendations on the uses of rivers and the protection of their identified values only after due consideration of all these submissions.

DAVID SCOTT
Chairman

Land Conservation Council
4th Floor
464 St Kilda Road
Melbourne 3004

EXTRACT

LAND CONSERVATION ACT 1970

Public Land

Section 2:

(1) **'Public land'** means -

(a) land which is not within a city town or borough and is -

(i) unalienated land of the Crown including land permanently or temporarily reserved under section 4 of the *Crown Land (Reserves) Act* 1978 and State forest and parks within the meaning of the *National Parks Act* 1975;

(ii) vested in any public authority (other than a municipality or a sewerage authority within the meaning of the *Sewerage Districts Act* 1958); or

(iii) vested in the Melbourne and Metropolitan Board of Works; and

(b) any other land which the Governor in Council declares under sub-section (2) to be public land for the purposes of this *Act*

'Reserved forest' and **'State forest'** have the same meanings as in section 3 of the *Forests Act* 1958.

(2) The Governor in Council may on the recommendation of the Minister made after consultation with -

(a) any Minister of the Crown in whom any land is vested; or

(b) the Minister responsible for a public authority in which any land is vested -

by proclamation published in the *Government Gazette* declare any such land to be public land for the purposes of this *Act*.

Functions of the Council

Section 5:

(1) The Council shall -

(a) carry out investigations and make recommendations to the Minister with respect to the use of public land in order to provide for the balanced use of land in Victoria;

(b) make recommendations to the Governor in Council as to the constitution and definition of water supply catchment areas under the *Soil Conservation and Land Utilization Act* 1958; and

(c) advise the Soil Conservation Authority concerning policy on the use of land (whether public land or any other land however vested) in any water supply catchment area.

(2) In making any recommendation the Council shall have regard to the present and future needs of the people of Victoria in relation to -

(a) the preservation of areas which are ecologically significant;

(b) the conservation of areas of natural interest beauty or of historical interest;

(c) the creation and preservation of areas of reserved forest;

(d) the creation and preservation of areas for national parks;

(e) the creation and preservation of areas for leisure and recreation, and in particular of areas close to cities and towns for bushland recreation reserves;

(f) the creation and preservation of reserves for the conservation of fish and wildlife;

(g) the preservation of species of native plants; and

(h) land required by government departments and public authorities in order to carry out their functions.

(3) Where the Council recommends the alienation of any land the recommendation shall include the Council's opinion as to the best method of alienating the land to ensure the most satisfactory use and management of the land in the public interest.

(4) Any person or body may make submissions to the Council as to how any public land can be better used to meet the needs of the people of Victoria and the Council shall consider any such submissions before making any recommendation under paragraph (a) of sub-section (1).

Section 8:

(1) Where the Governor in Council is of the opinion that an investigation and recommendation of the Council in relation to any particular district or area of Victoria is necessary or expedient he may require the Council to make such investigation and recommendation within such time as is fixed by the Governor in Council.

(2) The Governor in Council may extend the time fixed under sub-section (1) where in his opinion the investigation could not otherwise be properly carried out.

Investigations, Notices and Reports

Section 9:

(1) The Council shall not make any recommendation under this *Act* in relation to any district or area without a prior investigation of the district or area.

(2) Before commencing any investigation under paragraph (a) of sub-section (1) of section 5 the Council shall publish a notice in the *Government Gazette*, in a newspaper circulating throughout the State and in a newspaper circulating particularly in or in the vicinity of the area or district to be investigated stating that an investigation of that district or area described in the notice is to be carried out for the purposes of this *Act*.

(3) On completing an investigation of a district or area under paragraph (a) of sub-section (1) of section 5 the Council shall -

(a) publish a report of the investigation;

(b) give notice in the *Government Gazette* of the publication of the report, the address where copies of the report may be obtained or inspected and stating that any submissions to the Council in relation to such report will be considered by the Council if they are made within 60 days of such notice; and

(c) publish notice in a newspaper circulating throughout the State and in a newspaper circulating particularly in or in the vicinity of the area or district investigated of the publication of the report, the address where copies of the report may be obtained or inspected and stating that submissions may be made to the Council and the date before which they should be made.

(4) The Council shall consider any submissions in relation to such report made by any person or body within 60 days of notice being given under paragraph (b) of sub-section (3).

Notice to be given to public departments and authorities in certain cases

Section 10:

(1) Not earlier than 60 days after notice being given under paragraph (b) of sub-section (3) of section 9, the Council shall send a copy of its proposed recommendation to -

(a) the Council of any municipality in the municipal district of which any part of the area or district to which the recommendation relates is situated;

(b) any other public authority or government department that in the opinion of the Council has an interest in the area of the proposed recommendation; and

(c) any person or body who made a submission under section 9 -

and shall consider any submissions received within 60 days of the sending of such copy to the council, authority, department, person or body or in the case of a public authority or government department within such longer period as may be agreed upon between the Minister and the Minister administering that department or responsible for that authority.

(2) Where any recommendation is made to the Minister under this *Act* it shall be accompanied by a copy of any submissions received from any person body department authority or council pursuant to the provisions of sub-section (4) of section 9 or sub-section (1) of this section.

(3) Where the Council has made a recommendation to the Minister under paragraph (a) of sub-section (1) of section 5 the Minister may, after he has given not less than fourteen days notice of his intention so to do to the Minister administering a government department or responsible for a public authority recommend to the Governor in Council that notice of the recommendation or that part of the recommendation that affects the government department or public authority be given to the government department or public authority concerned and where notice of that recommendation or part is so given by the Governor in Council it shall be the duty of the government department or public authority to use all diligence and dispatch to give effect to such recommendation so far as it affects any land vested in or controlled by it.

Copy of every recommendation and of proposals to be tabled in Parliament

Section 11:

A copy of every recommendation of the Council made under sub-section (1) of section 5 and of the proposals of the Council submitted to the Minister pursuant to section 7 shall be laid before both Houses of Parliament within fourteen days of the making thereof if Parliament is then sitting and if Parliament is not then sitting within 14 days after the meeting of Parliament.

A copy of the *Land Conservation Act* 1970 can be obtained from the Information Victoria Centre, 318 Little Bourke Street, Melbourne, 3000.

ACKNOWLEDGEMENTS

The Council wishes to gratefully acknowledge the assistance and cooperation of the many individuals and organisations who contributed to this report. Luisa Macmillan's seminal work establishing the catchment naturalness assessment methodology was of particular importance. Dennis Williamson's scenic assessment method for river landscapes was fundamental to this project. Both addressed the Council's seminar held at the start of the investigation, along with Eric Ligtermoet on river recreation, and Peter Helman on New South Wales approaches. Ms Macmillan also served on the Council and study group in the period of this report's development. It is necessary also to specifically acknowledge *the role of the former Director-General of* Water Resources, Dr John Paterson, in the initiation of this Investigation.

Information for chapters and maps was supplied by the Departments of Agriculture and Rural Affairs; Conservation, Forests and Lands; Industry Technology and Resources; Sport and Recreation; and Water Resources; and the Ministry for Planning and Environment, and Rural Water Commission. Key sources include the Department of Water Resources' Environmental Handbook, Water Victoria - A Resource Handbook, studies for the South-West and South-East Water Management Strategies, and the State of the Environment Report 1988 prepared by the Office of the Commissioner for the Environment.

Officers from the above agencies who are or were members of the investigation study group are: A. Arch, T. Cooney, R. Costello, S. Cowling, G. Curtin, P. Daniel, J. Doolan, Z. Helman, P. Jackson, C. Lester, E. Ligtermoet, D. McKinnon, I. Nisbet, J. Oates, M. Parsons, and M. Willis.

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PART I

INTRODUCTION

1. AIMS AND METHODS

Of all resources, clean water is fundamental to society, along with clean air and food. For thousands of years we have sought to control the flow of rivers to our direct advantage. As a result deserts have bloomed, floods have reduced, and industries have developed with the aid of hydro-electricity. Societies are now recognizing, however, that these benefits have not been without their impacts on rivers.

The Rivers and Streams Special Investigation is one step toward addressing such concerns, for rivers across Victoria. This resources report is the first published document in the Land Conservation Council's investigation. The present chapter outlines the terms of reference for the investigation and the procedure to be followed.

Following publication, a 2-month period will allow for community comment on matters raised in the report, on the values and uses of rivers and streams, and in particular on those rivers you feel need recognition or protection for their values and uses.

Rivers are among Victoria's most valuable natural assets; however, many are badly degraded. In response, the government's Conservation Strategy contains policy actions to address concerns about them, including a commitment to complete a Heritage Rivers Program.

The Rivers and Streams Special Investigation is being carried out under section 8 of the *Land Conservation Act* 1970, and will result in recommendations to government on the future uses of public land that relates to rivers. This investigation will enable systematic selection and protection of streams and their catchments with special values on public land.

The Heritage Rivers Program on the other hand is intended to protect outstanding river values, whether on private or public land. Many of the relevant heritage river values are found on public land, and to achieve a co-ordinated approach, it was considered the most effective way would be to link the Program with the Council's investigation, in order to avoid two parallel but closely related simultaneous processes.

Accordingly, the Council was designated 'lead agency' for the preparation of the Program, and Chapter 2 of this report contains an outline of the proposal. The Program will result in advice to the government on which areas have heritage river values and on how best to protect them. Where such rivers occur on public land, the Council's Special Investigation will include recommendations to the government that specified heritage rivers be designated. Figure 1 illustrates the relations between the two concurrent processes.

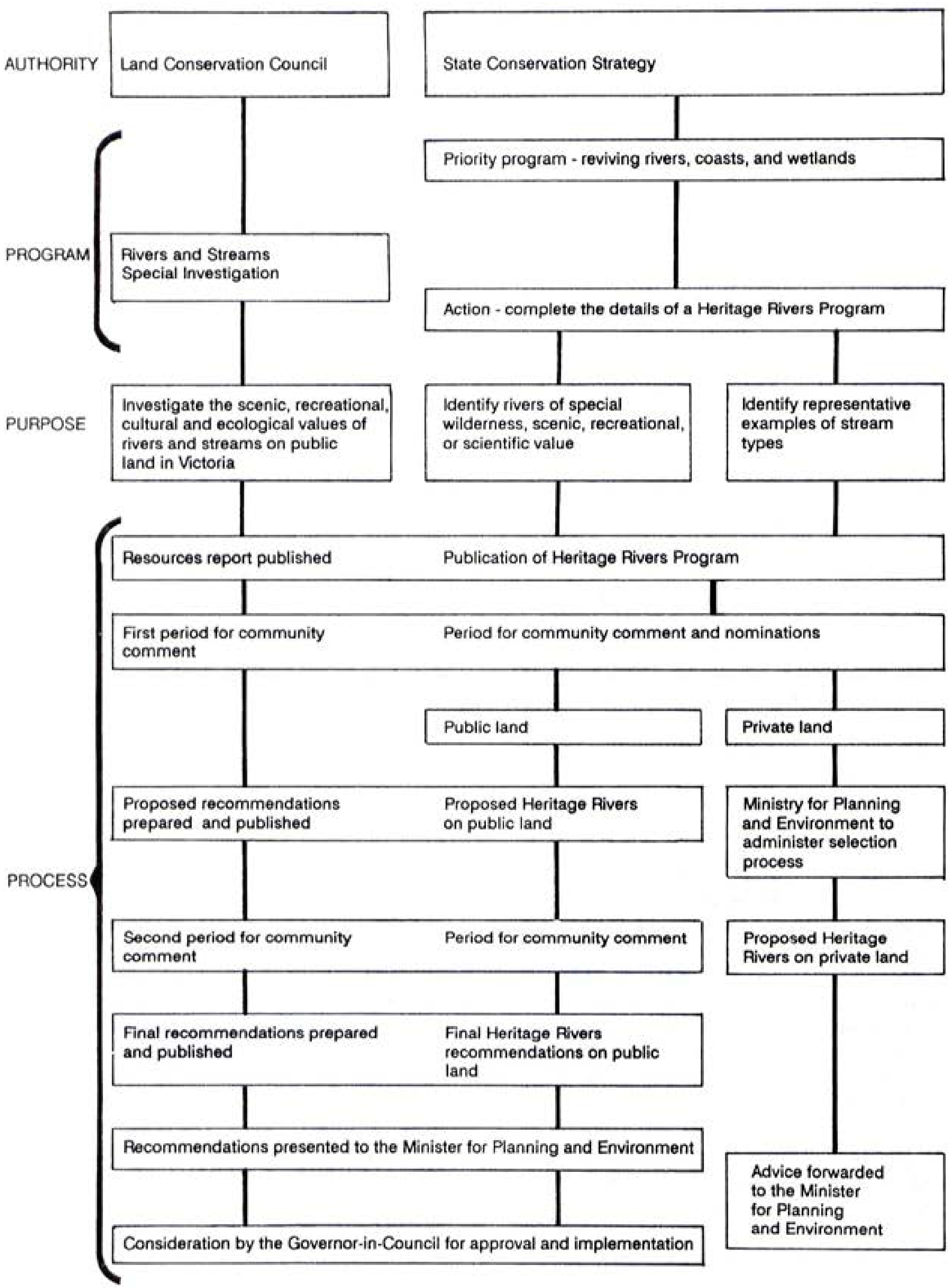
If you wish to nominate a river or creek system for consideration as a heritage river, or wish to comment on the Program, you can include such comments with your submission to the Council. Map 1 shows the rivers and streams, and Appendix I contains a list of all streams across the State.

National and international approaches

In many ways societies across the world have been shaped by the availability and use of water. This century - with the advent of concrete technology, heavy earth-moving equipment, and high-capacity pumps, and the availability of capital - the changes to rivers, wetlands, and underground water tables have taken place at an unprecedented rate.

Despite the benefits, it is now increasingly realised that many of these changes have had or may have long-term impacts. The damming of the Nile has increased the incidence of the disease bilharzia. It has also stopped the flooding that for thousands of years annually brought fertile silts to, and flushed salts from, the agricultural lands along its banks. In the United States, many previously important salmon rivers have been destroyed.

FIGURE 1
RELATIONSHIP BETWEEN THE LAND CONSERVATION COUNCIL SPECIAL INVESTIGATION AND THE HERITAGE RIVERS PROGRAM



Beauchamp Falls, Otway Ranges (Basin 35)

Salmon migration no longer occurs, as a result of either the reduction in flows by water diversion or the blocking of rivers by high dams. Across the world major wetlands, vital habitat for migratory birds, have dried up as a result of drainage or diverted flows. Salt build-up in irrigated soils has also become an international problem. Recent media reports have covered the potential impact of proposed dams in the Amazon Basin, which may result in the dislocation of indigenous people and potential acceleration of the 'greenhouse' climatic change.

Rivers have also been treated as sewers, with additions of toxic and long-lasting chemicals and nutrient-rich domestic waste. Aquatic ecosystems have also been disturbed by nutrient- and soil- rich run-off from the erosion of poorly managed land. It has been said that it is the bread and butter of tomorrow that is being washed away.

Internationally, existing legislation covering the off-stream uses of water, its in-stream use for power generation, or land uses in river catchments is being either amended or supplemented in order to:

* protect scenic, recreation, and cultural heritage values

* maintain riparian, aquatic, and wetland habitats

Legislation and policy vary from country to country; however, two effective models for the protection of wild and scenic rivers have been developed - in the United States of America and in Canada. Table 1 outlines the objects and content of their respective Acts, and Appendix II contains a summary of the land and water management implications of declaration.

Wild and scenic river protection in New Zealand was enabled by a 1981 amendment to the *Water and Soil Conservation Act*. A National Water Conservation Order for the Motu River was signed in 1984, declaring that the river 'be preserved in its natural state' and that 'rights to dam' the river not be granted. Subsequent committees have prepared national inventories of rivers deserving protection in this manner.

Two further rivers and one lake have since been protected by National Water Conservation orders, and six additional water bodies are currently under consideration.

Australian issues

Debates in Australia, over the flooding of Lake Pedder in the 1970s and the proposed flooding of the Lower Gordon and Franklin Rivers in the 1980s, demonstrated the differences in opinion over the appropriate use of water and surrounding land. The debates have emphasised the need to consider all values, be they economic return, flora, fauna, scenery, recreation, or cultural heritage, as well as competing water uses, when determining appropriate water and associated land use.

In both New South Wales and Western Australia, reports have been prepared discussing the concepts, approaches and methodologies involved in identifying wild and scenic rivers. A 1988 report by the Conservation Council of Western Australia reviewed various overseas approaches, and proposed an approach to river protection for the West.

Victorian rivers

While Victoria has enjoyed the benefits of water resource development and resultant economic growth, this growth has not been without adverse impacts on our rivers and streams.

The lower Yarra initially supplied Melbourne with drinking water. By the 1860s the Yarra was so polluted it was dangerous to drink. After more than a hundred years of agricultural and urban development in its catchment, a campaign to 'Give the Yarra a Go' started, the aim of which was to rectify the abuses suffered by the river over the last 150 years.

Construction of the numerous weirs and dams shown on Map 2 substantially changed the flow of many rivers. Rather than reflecting natural processes, river flow increasingly reflects human requirements, and as a result many natural systems have been put at risk. It is ironic that Barmah Forest - a wetland

Table 1

LEGISLATIVE AND POLICY INITIATIVES

United States - *Wild and Scenic Rivers Act* 1968

This federal legislation aims at protecting for future generations rivers and their immediate environments that possess outstanding scenic, recreational, geological, ecological, and cultural features. It was enacted in direct response to the federal program of dam construction and it recognised that some river reaches need to be free from the effects of flooding by water storages and reduced downstream flows.

The Act created a procedure by which river segments across the country could be evaluated and then designated as part of a national wild and scenic river system. This would ensure that the designated segment remained free-flowing.

Designated river segments are classified as 'wild', 'scenic', or 'recreational' on the basis of the amount of development along their banks. 'Wild rivers' are 'vestiges of primitive America'; 'scenic rivers' have 'shorelines or watersheds still largely primitive and shorelines largely undeveloped but accessible in places by roads'; and 'recreational rivers' are 'readily accessible by roads' and 'may have some development along their shorelines'.

By 1985, more than 120 segments were designated under the Act. They ranged in length from 2 to 360 km and total more than 11 500 km. It should be noted that the protection of ecological and other values on a whole-catchment basis is not a feature of this Act.

Many individual States also enacted their own legislation to complement the federal Act. By 1983, 30 states had done so,affording various levels of protection to about 22 000 km of waterways.

The Canadian Heritage Rivers System

This system was instituted in 1984, to give national recognition to the important rivers of Canada and to ensure long-term management that will conserve their natural, historical, and recreational values for the benefit and enjoyment of Canadians now and in the future. It is a one-category system, 'Canadian Heritage River', with no distinct classifications or categories. Selection is based on the values that reflect the aims:

* natural heritage of outstanding Canadian value
* human heritage of outstanding Canadian value
* recreational opportunities of outstanding Canadian value

Public involvement in the nomination process is encouraged, and the system is administered by a board with representatives from relevant government agencies. By March 1988, six river segments with a total length of 920 km had been designated, and ten river segments totalling 1690 km had been nominated, as heritage rivers.

The system relies on co-operation between federal, provincial, and territorial governments. Conservation of values is through the application of a management plan.

The river segment must be of sufficient size, and contain most of the key resources and ecosystem components necessary to demonstrate its heritage value. Also, the quality of water must sustain the processes, features, or activities that make it unique.

Junction of the Latrobe (Basin 26) and Thomson (Basin 25) Rivers in 1880 of international significance - would, as a result of river regulation, become in 1989 the venue for a conference entitled 'Barmah Forest: Dying for a Drink'.

Our rivers have also been adversely affected by the discharge of domestic and industrial effluents, and poor land use practices.

Land degradation has resulted in the addition of massive amounts of sediment to particular streams, the Avon River being one example, and in dryland salting. The salt not only makes an affected area unsuitable for agriculture but also adds to the salt load of the river, decreasing its suitability for irrigation or domestic consumption further downstream.

Collectively, land uses, polluting discharges, and flow regulation have often reduced the scenic, recreational, and other values of rivers.

Recognising the values of rivers and the impacts of past uses, the government's Conservation Strategy (see Chapter 2) outlines its intention to protect river values, to provide for environmental flows, to improve river frontage management, and certain other actions.

THE SPECIAL INVESTIGATION

As part of the development of this process, the Land Conservation Council was directed, on 30 June 1987, to conduct a special investigation of Victoria's rivers and streams,in accordance with the following Order in Council:

> 'Under Section 8 of the *Land Conservation Act* 1970 the Council is required to carry out an investigation of the scenic, recreational, cultural and ecological values of rivers and streams in Victoria, and to make recommendations on the use of these rivers and how their identified values can best be protected.'

Methods

A seminar was conducted at the beginning of the investigation to provide an opportunity for key groups and interested individuals to become involved in its early planning stages.

This report is the first stage in the Council's process, which will assist government decision-making on the future uses of water and the conservation of associated catchment values, particularly ecological, recreational, scenic, and cultural heritage values, in the light of existing uses and commitments.

The report provides a factual basis upon which members of the community may base their submissions to the Council. Submissions are now sought, for a period of 60 days after publication.

After consideration of all submissions received, the Council will prepare proposed recommendations - using information in the descriptive report and any additional information collected in response to the submissions, formal and informal discussions with the community and inspection of relevant areas.

It will then publish the proposed recommendations. Publication will be announced by advertising in major city and country newspapers. A further 60-day submission period will follow, during which organisations and members of the community will have the opportunity to comment on the proposals, make further suggestions, or supply new information.

After considering all the matters raised in the submissions, and other relevant information, Council will prepare its final recommendations. These, and all submissions received, are presented to the Minister for Planning and Environment, and the recommendations are tabled in Parliament.

Scope of investigation

In accordance with the *Land Conservation Act* 1970, this investigation covers 'public land', as defined by that Act. The lower reaches of many streams flow through areas largely cleared for agriculture. However, this investigation potentially covers all rivers and streams across the State, the bed and banks of most water-courses being public land. For reasons of scale, the streams included will be those shown as 'third order' and larger, on the National Mapping 1: 250 000 topographic map series (Chapter 9 explains stream order).

Public land in the vicinity of many rivers and streams has various uses and values, including those mentioned above. Such public land, and that in stream catchments, is included in the study where its scenic, recreational, cultural, or ecological values relate to streams.

This investigation includes on-stream lakes and reservoirs, but is not intended to provide a comprehensive or complete coverage of wetlands, as these require separate detailed study and the Council is to carry out a special investigation of wetlands across the State.

Estuaries are included, and will be treated as an integral part of the river system. However it is not intended that they be comprehensively studied, as they are very complex ecological systems, they often have high levels of use, and require separate study.

For specific on-stream wetlands and estuaries, however, it is expected that this investigation will make recommendations where the land-use issues are relevant to the terms of reference.

Much of Victoria is intensively used, and the luxury of having a wide selection of unaltered, whole river catchments does not exist. The study will therefore concentrate on the values found in particular segments of rivers. In some cases a substantial part of river catchments may be included in the ultimate recommendations.

All the land in whole catchments or sub-catchments will be considered where this is relevant to the values concerned. For example, a high-value scenic landscape may include an entire catchment, or whole sub-catchments may be assessed as having high ecological naturalness, and accordingly be treated as whole units.

The report

This report briefly describes:

* the history of use and administration of water in Victoria
* the geomorphic, hydrologic, and ecological characteristics of catchments and their drainage networks
* special values of rivers and streams for scenery, recreation, and the maintenance of cultural and ecological values
* existing and potential land and water uses

For convenience, key values are summarised by drainage basin (Part V) and many particular values and uses are illustrated in the maps in the pocket. Various other maps showing uses or values are also included in the text or map pocket. Throughout this Report basin boundaries, numbers and names follow the system used by the Australian Water Resources Council.

The report draws on information prepared specifically for this study, particularly on recreational, scenic, ecological, and cultural values. It integrates information from other water-sector studies, which have been completed or are nearing completion, including: the 1988 'State of the Environment Report on Inland Aquatic Environments'; projects carried out for the Department of Water Resources' South-east and South-west Water Management Strategies; and 'Water Victoria: a Resource Handbook' and 'Water Victoria: an Environmental Handbook', both to be published by the Department of Water Resources. Aims of these studies are outlined below.

Information has also been supplied by government departments, public authorities, and interested individuals, and has also been obtained from published reports and other sources.

RELATIONSHIP TO OTHER POLICIES AND WATER-SECTOR STUDIES

Apart from the State Conservation Strategy, several government policies interrelate with the Heritage Rivers Program and hence with this Investigation. These include: the Wetlands Conservation Program, the Rainforests Program, and the Flora and Fauna Guarantee; State Environment Protection Policies (see

Chapter 6); and the Regional Water Strategies prepared or in preparation by the Department of Water Resources.

Other related policies are to implement the 'Better Rivers and Catchments' program; conservation policies to complete the parks and reserves system and declare new wilderness areas, including the Council's current Special Investigation of Wilderness; resource-use policies to upgrade urban and irrigation water-supply systems, and to use the Central Highlands forests as the major supply area for timber; various policies for fish conservation and commercial use; and the outdoor recreation policy.

Some of these involve continuing processes, and the details of each interface between them will need to be carefully developed to ensure they are complementary.

Several studies are currently under way to guide decisions on allocations of environmental flows and design of structures in regulated river systems.

Draft guidelines for planning new water projects to supply environmental water requirements are currently under development by the Department of Water Resources, and a committee with members from several departments.

Various aspects of reservoir design are relevant to such needs - for example, design and provision of appropriate fish ladders, offtake tower design for temperature control of released water, drawdown levels, and destratification equipment.

Detailed policies on these and other aspects will need to be developed.

Department of Water Resources' Studies

Several current studies being carried out by this Department have direct relevance to this investigation. Their aims are briefly outlined below.

Environmental Handbook

Aim: to compile general information on certain environmental variables relating to in-stream and riparian areas of rivers, and their catchments.

Water Resource Handbook

Aim: to document water-supply and waste-water systems, and summarise water quality, quantity, and use across Victoria.

State of the Streams Report

Aim: to assess the physical and environmental condition of streams at 800 sites across the State, primarily regarding river management works and needs.

South-West Region Water Management Strategy

Aim: to prepare a strategy for managing the water resources of the South-West Region (Basins 32-36) for the general benefit of the community. The proposed strategy has been completed and is now the subject of a parliamentary Natural Resources and Environment Committee Inquiry.

Major issues addressed include: future allocations of surface and groundwater for environmental purposes and urban supplies; management of the Otway and Moorabool Catchments; and the operation of the Lake Corangamite drainage scheme.

As part of the development of this strategy, consultants were commissioned to study: recreation values of water bodies; nature conservation value and status; conservation values of lakes and wetlands; and fish populations in specified rivers. Their reports have been used where relevant for the Council's investigation.

South-East Region Water Management Strategy

Aim: to plan future water resource management in the South-East Region (Basins 21-27), particularly in-stream and off-stream water allocation, catchment and river management, water supply, and waste-water management. A draft strategy is now in preparation.

Consultants have carried out studies of nature conservation values of streams, recreation values of streams and water bodies, and conservation values of wetlands.

Office of the Commissioner for the Environment

State of the Environment Report

Aim: to develop indicators of the biological, physical, and chemical condition of rivers, streams, and wetlands, assess water quality in these areas, and recommend appropriate monitoring programs.

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2. HERITAGE RIVERS

The 'heritage rivers' idea has grown out of the 'wild and scenic rivers' concept, first developed in the United States of America. Chapter 1 of this report included a discussion of international and interstate approaches to the protection of *wild rivers*. In Victoria the 'State of the Rivers' interdepartmental task force report - *Better Rivers and Catchments* - identified requirements for protection of the environmental resources of rivers. In particular the Department of Water Resources and the Department of Conservation, Forests and Lands saw the need for a specific study of wild and scenic or heritage rivers. This was reinforced in the State Conservation Strategy, which committed the Government to the development of a Heritage Rivers program.

Government policies relating to rivers and streams

The government's Conservation Strategy 'Protecting the Environment', published in June 1987, forms one of the government's three principal policy frameworks, alongside the Economic Strategy and the Social Justice Strategy.

While the Conservation Strategy primarily focuses on the protection and enhancement of our natural and built environment, it is consistent with and complementary to both the other strategies.

It has five main aims. These are to:

* maintain essential ecological processes and life-support systems
* preserve genetic diversity
* ensure the sustainable use of renewable resources
* ensure the wise use of non-renewable resources
* protect natural areas and ecosystems for the non-material needs of society

These all relate to rivers and streams, but more specifically the Strategy outlines the government's key objects, one of which is *to protect, restore, and enhance rivers to* ensure that ecological processes, native species, and features of scientific, cultural, or scenic interest are maintained, and to provide for present and future recreational and commercial uses.

A government policy statement arising out *of the stated object is to identify those* rivers and streams (or stretches of them) that essentially remain in their natural condition. As these waterways are scarce and irreplaceable, the government will ensure special protection is extended over their entire catchments.

To achieve this, the government committed itself to the completion of details of a 'Heritage Rivers Program'. The Program is a plan of action to implement the policies enunciated by the government, and this chapter contains an edited version of it. A full extract from the Strategy appears in Appendix III.

HERITAGE RIVERS PROGRAM

As indicated in the Strategy, the Heritage Rivers Program will help to:

* protect those rivers and streams that essentially remain in their natural condition

* ensure that rivers and streams of special scenic, recreational, cultural, and conservation value are maintained in at least their present condition

* ensure that representative examples of all stream types in the State are protected

While many streams have at least their headwaters in public land or have a public land frontage reserve, land use practices on the private land parts of stream catchments can have major effects on stream values. Accordingly, the Program has been developed to apply to both public and private land.

The Program was developed by an interdepartmental committee convened by *the Land Conservation Council*, with representatives from the Department of

Water Resources, the Department of Conservation, Forests and Lands, and the Ministry for Planning and Environment.

The key component of the identification of 'Heritage Rivers' is the Council's Rivers and Streams Special Investigation, for which this report is the first stage.

In addition, the Program outlines several options, for consideration by the government, to protect and manage identified values associated with rivers and streams. As these values may occur on either private or public land, methods to co-ordinate relevant aspects of private land use are also included.

Recommendations of the Council's Special Investigation

Past Council studies, conducted on a regional basis, were based on a well-known standard set of public land use categories and an expectation that, where appropriate, some areas would be recommended for allocation to them. In this State-wide Investigation, no established set of categories exists, and so the following framework is merely indicative. Categories will be established only when Council is formulating its proposed recommendations (see Chapter 1).

Table 2 sets out a possible framework for the major recommendation categories in the Council's investigation. It comprises a suite of categories, the first two being Heritage Rivers with National and State status, with a brief description of the values being protected.

The degree of protection provided in each category would reflect its status, with suitable recommended catchment and frontage uses. In the higher-rating categories these would be expected to include minimal or no regulation of stream flow, and strict control of inappropriate uses in catchments and frontages. Some uses may be excluded in the highest-rating categories. For example, free-flowing (unregulated) streams may be essential in National and State Heritage Rivers, and in Natural Rivers, but not in other categories.

In lesser-status categories, according to the values being protected, appropriate levels of water regulation and land use activities would apply, with provision for environmental and/or recreation flows.

Specifications for each category would include a list of appropriate uses. They would also define broad management requirements and the most suitable method of protection (for example, whether legislation, reservation, or management plan).

Government-approved recommendations of Council exist for virtually all public land in the State. The Rivers and Streams Special Investigation recommendations will be framed to reflect these where appropriate or, in some cases, existing recommendations will be modified. In most situations, the object would be to protect river values identified as important, while retaining the intent of the original recommendations where possible.

Where the original recommendations and current management provide adequate protection for stream values, the Investigation's recommendations could specify that the streams have an enhanced status, which could be recognised in management plans.

Mechanisms for protecting identified heritage rivers

The protection of heritage rivers will certainly involve public land and, in some areas, will impinge upon land use activities on private land. Ideally, therefore, any mechanism to protect such rivers should not be restricted by land tenure.

Planning and Environment Act

Protection of values of this nature on eboth public and private land could utilise the existing provisions of the *Planning and Environment Act* 1987. Under this Act, general policies relevant to river protection may be included in the State section of planning schemes, where these policies are of such a general nature that they apply to all or most rivers across Victoria. However, specific controls as to how particular parcels of land can be used or developed would be included in the local section.

Table 2

POSSIBLE OUTLINE OF RECOMMENDATIONS

Categories	Description
Heritage river - National	A river system and catchment with outstanding nature conservation, scenic, recreation, and/or cultural values of national significance
Heritage river - State	A substantial part of a river system and catchment with outstanding nature conservation, scenic, recreation, and/or cultural values of State significance
Heritage river - Regional	An extensive sub-catchment and river or creek system with nature conservation, scenic, recreation, and/or cultural values of regional significance
Natural river	A river sub-catchment with outstanding nature conservation values
Scenic river	A river sub-catchment with outstanding scenic values
Recreation river	A river or creek segment of outstanding value for (specified) recreation
Cultural heritage river	A sub-catchment or river system or segment with outstanding cultural values
Representative river	River or creek systems that represent specific geomorphic/hydrologic stream types

A change in the future use and development of land in a planning scheme requires an amendment initiated by the planning authority, which is usually the local government body.

If any objections to an amendment are raised in submissions, hearings may beconducted by an independent panel.

Although the government might have endorsed the broad policy, detailed controls for inclusion in a scheme to implement that policy still need to be subject to review.

The responsible authority that administers these controls is the local government body. However, the scheme could stipulate sending specified types of application to a referral authority. It is better for the requirements in schemes to be spelt out, so that only the unusual cases need to be referred.

In summary, while the aims of the Act include protection of the types of values of relevance to this Heritage Rivers Policy, in practice it would require numerous individual municipal scheme amendments to include river protection. Implementation would depend on each municipality, and there is a requirement for compensation in cases where protection of river values is viewed as being reservation for a 'public purpose'.

The report 'Application of Land Use Planning Provisions to Improved Catchment and Waterway Management' describes the use of the *Planning and Environment Act* for similar purposes.

This study outlines 'model' planning controls that:

* specify goals relating to stream frontages, nature conservation, land degradation, floodplain management, and water supply

Cudgewa Bluff Falls, Mt Burrowa National Park (Basin 1)

* include land within certain areas requiring protection in specific zones
* introduce relevant special control provisions relating to whole municipalities, such as set-back distances for some developments and vegetation-removal controls
* provide for appropriate agencies to become referral authorities for land subdivision and other development proposals
* involve Catchment Co-ordinating Groups (see below)

It also makes various other recommendations relevant to the protection of river and stream values.

Heritage rivers legislation

Perhaps the most effective way of achieving uniform protection of identified values would be to develop specific legislation that covered both public and private land. Among its benefits, a 'Heritage Rivers Act' would give a firm commitment to protect the free-flowing condition of identified rivers. It would also provide a focal point for protecting rivers so declared, and could specify appropriate land use and management requirements. Provisions relating to private land could be inserted in Shire planning schemes by amendment.

Codes of practice

The *Conservation, Forests and Lands Act* 1985 contains a procedure for establishing codes of practice that can, if required, apply to freehold land. The matters such a code may cover are outlined in Chapter 8. Several of these relate to proper management of freehold land in river catchments, and could assist in implementation of some aspects of the Heritage Rivers Program.

Draft codes, where relevant, are referred to the Land Protection Council, interested Ministers, and affected public authorities, and notice of their preparation must be advertised so that anyone can submit a comment on the draft.

The resulting code of practice may be approved by the Minister for Conservation, Forests and Lands and can be incorporated into a regulation under relevant Acts. Compliance with codes of practice is voluntary unless they are adopted as conditions under a related law, or included in regulations.

Implementation of recommendations

Government-approved recommendations from Council's past studies specify land use and management within broad categories. These commonly include policies for the protection of values, as do other recommendations associated with particular use or management activities. However, the recommendations apply only to public land.

The Special Investigation process has its own institutional arrangements. Section 10(3) of the *Land Conservation Act* 1970 provides that, for government-approved recommendations, an Order-in-Council requires that departments or public authorities use 'all diligence and dispatch to give effect to' the recommendations 'so far as it affects any land vested in or controlled by' such departments and authorities.

In practice, implementation of recommendations by land management agencies may require reservation, preparation of management plans, development of detailed management policies, interdepartmental committees, and in some cases legislation. Programs for implementation must also be fitted into existing budget and staffing priorities.

Management of heritage rivers

Management of areas declared as heritage rivers, and of other areas identified in the recommendations of the Council's study, would be primarily to protect the identified values.

Some guidelines for management would flow from the uses specified in the recommendations outlined above. For example, levels of water-flow regulation, timber-harvesting, agriculture, mining, recreation, and river management activities would need to be managed, ranging from nil to an appropriate level, to suit the heritage river categories decided upon.

The appropriate management agency would need to be decided, but co-

'The Channel', Avon River (Basin 25)

ordination of management would be expected to be important in heritage rivers, in accordance with current moves towards integrated catchment management.

Current land use and management on public land

The broad framework of current land use on public land is provided by previous Land Conservation Council recommendations, where these have been approved by the government (see Map 5). Chapter 7 outlines the categories of most relevance to rivers and streams and Chapter 8 discusses current management.

In many cases, the approved recommendations for land use and management will be compatible with proposals for heritage rivers. In others, some adjustment will be necessary, to accord with the intention of the appropriate Rivers and Streams Special Investigation recommendations.

In the past, where recommendations have been likely to cause impacts on individuals, various actions have been taken (either in the recommendations or as parts of government decisions) to reduce such impacts - for example, by phasing in recommended land use changes.

River management authority programs

River managers now recognise that land and water management are inseparable. Programs should accordingly be developed for whole catchments and be based on preventative maintenance, not on disaster response. The aims should be to achieve both stable catchments (through proper land use and repair of land degradation) and stable rivers (by stopping in-stream erosion, revegetating streams, and properly managing the floodplains).

Establishment of self-maintaining vegetation along the banks is a principal long-term aim; however, it often requires engineering works to provide a stable environment in which vegetation can grow. These include structural bank protection, stream-alignment training, streambed erosion control, and stream-grade control.

Another important aspect of river and catchment management is the recognised need for co-ordination of the works and programs of the various authorities active in river catchments.

Co-ordination of river management and catchment management is discussed in Chapter 8. Three Catchment Co-ordinating Groups have been set up, and, for example, the aims of the Mid-Goulburn Group are as follows:

* to promote land and stream management on a whole-catchment basis

* to promote co-ordinated land and stream management

* to ensure that land and stream management decisions respect the balance of community values

Their wide membership includes water, waterway, and catchment land users - reflecting community, departmental, river management, recreation and conservation interests.

The State Strategy for Integrated Catchment Management provides more focussed direction for co-ordinated management.

Development of the Program

A major part of the Heritage Rivers Program will be put into effect through the Council's Special Investigation. As fmentioned previously and illustrated in Figure 1, comments on the Program and nominations for heritage rivers are now being called for, in conjunction with the community comment period for the Investigation.

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3. THE WATER CYCLE AND PRINCIPLES OF CONSERVATION

The water cycle describes the way water moves above, at, and below Earth's surface (see Figure 2).

As water moves from ocean to atmosphere, to land, and back to ocean, it is stored temporarily in streams, lakes, the soil, or groundwater, and some of it becomes available for use.

In the cycle, energy from the sun evaporates water from the ocean. This water is carried by wind; and over land some is precipitated, when conditions are right, generally as rain, snow, or hail. For Victoria rain is the most important source of water.

Water from rain or melting snow and hail either soaks into the soil or travels overland into streams or lakes as run-off. Water that has soaked into the soil may reach the water table to form part of the groundwater. On its way back to the ocean, water may evaporate from streams, lakes, or swamps or be transpired by plants.

The amount of water falling in an area and the rate at which it evaporates are determined by climate.

Understanding the water cycle is important when thinking about the way natural processes are organised and interact.

As water runs across the land under the effect of gravity, small overland flows meet at watercourses, which join to form creeks; these combine to form rivers, and flow to lakes, wetlands, or the oceans. As water flows, the channel carrying it becomes larger, reflecting the increasing basin or catchment area it drains. Table 3 summarises the overall water balance in Victoria.

FIGURE 2
THE WATER CYCLE

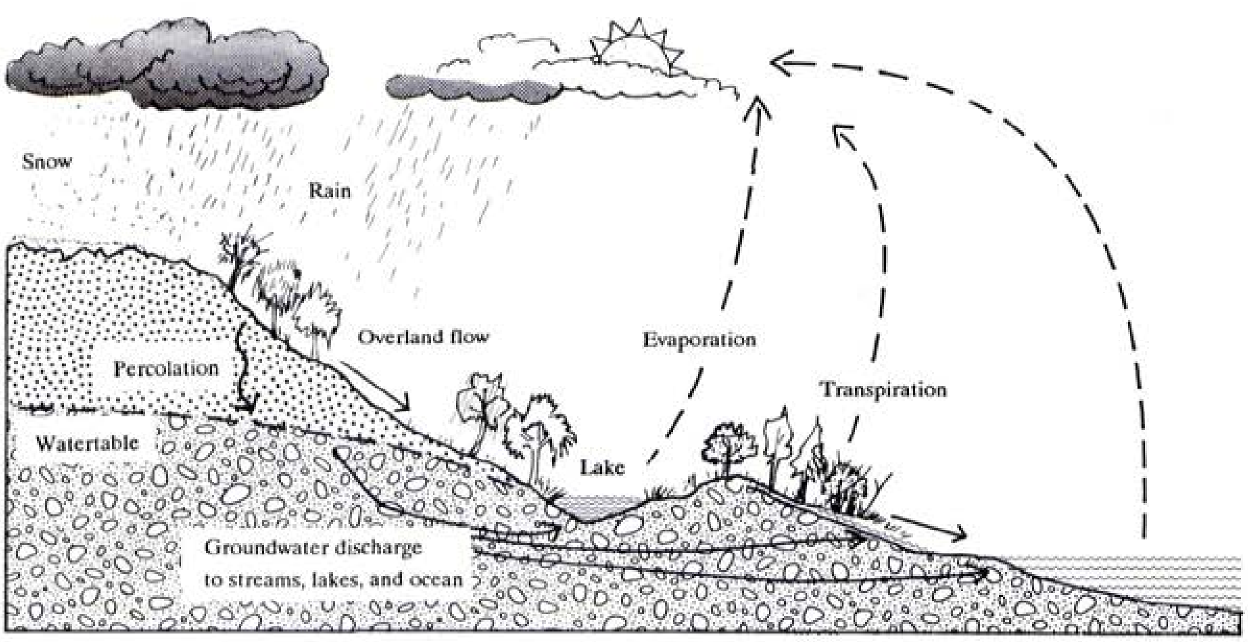

Table 3

ANNUAL WATER BALANCE - VICTORIA

	Million ML
Input	
Rain and snowfall	150
Return	
Evaporation and transpiration	128 (85%)
River flow	21 (14%)
Groundwater recharge	1 (1%)

The creeks and rivers in a basin provide a transport path for the movement of eroded soil, dissolved chemicals, and energy from the higher parts of the basin to the lower basin. The soil may be deposited further downstream to form sand bars and alluvial plains. Nutrients are also transported, and these support the many small and large plants and animals that live in waterways.

Excess accumulation of nutrients in downstream lakes and estuaries may result in nutrient enrichment of slow-moving water. Streams also provide pathways for animals, particularly fish, to migrate. Flowing water has kinetic energy that continuously moves rock and soil material, but can be harnessed by turbines to generate electricity.

Our economic and social system requires a secure supply of water for domestic and other consumption. Consequently, in many areas we have regulated the hydrological cycle to suit our needs. Dams have been built to store water during wet periods for release during summer or prolonged drought. Dams and weirs also assist in the diversion of water to urban and industrial centres and irrigation areas.

Human activities have modified other parts of the water cycle, too. Catchments have been cleared of vegetation, and swamps drained; background levels of dissolved and suspended materials have been greatly increased, and extraneous pollutants added. These changes have had major effects on soil erosion, sedimentation, and flow regimes and on in-stream and riparian ecosystems.

CONSERVATION PRINCIPLES

Conservation is concerned with the interaction between people and the environment. It is often described as the wise or balanced use of resources. Because 'wisdom' and 'balance' are not absolute terms, the principles set out below attempt to explain this concept.

Conservation can be considered as a way to anticipate and resolve conflicts between the individual and society regarding the present and future use of resources, and between competing uses of the same resource. The conservationist is aware of long-term needs and recognises that a community requires areas for recreational, scientific, and aesthetic purposes as well as for the production of food, timber, and minerals, and for urban and industrial use. With improvement in our knowledge about ecosystem dynamics it has become evident that conservation also requires the genetic diversity of entire ecosystems to be maintained. Failure to do so may result in *major impacts - economic as well as* ecological - at a State and in some cases at an international level.

Clean water and clean air and food are vital for the survival of all members of the animal kingdom, including humans. In-stream and off-stream water use is also vital for the maintenance of our economic and social systems, and the ecosystems with which we interact.

Off-stream uses include personal consumption, agriculture (particularly irrigation and stock water), and industrial and domestic uses as a solvent, coolant, energy carrier, or carrier for effluent removal.

In-stream uses include the maintenance of riparian and aquatic ecosystems, recreation, and the production of hydro-electricity.

Resource classification

Natural resources may be classified according to whether they are renewable or non-renewable.

Non-renewable resources

The quantity of these resources does not increase with time, and use consumes them. Last century, the expansion of Victoria's economy was based on the mining of gold - a non-renewable resource. The oil- and gas-fields of Bass Strait provide another example of a non-renewable resource.

The rate of use of these resources can be dynamic in that it responds to a range of factors, including the technology used and commodity prices.

Conservation of such resources requires the best techniques for exploration, recovery, and processing, and the efficient use of the end products. From the viewpoint of their users, they should not be consumed at rates exceeding the ability to develop alternative resources or substitutes. From an ecological viewpoint, often the related effects - at the time of extraction or use - may be of more concern than the rate at which they are used.

Renewable resources

The quantity of a renewable resource may increase or decrease with time. Timber, animal and plant communities and scenic landscape value fall within this category. Abuse of these resources may reduce them either to such a poor condition that the practical opportunity of restoring them to a desired state can be lost, for many generations, or to the point of extinction.

Conservation of renewable resources requires a thorough understanding of ecological principles and development of sound management techniques based on those principles. An ecosystem typically contains many interrelated components, and a change in any one of these will have effects elsewhere in the system. Ecosystems are adapted to naturally occurring sudden changes - such as those caused by fire or disease - and are often able to absorb their impacts. The response of ecosystems to human activities varies greatly.

People are part of the global ecosystem and, like all other organisms, influence and are influenced by the other parts. New technologies have increased our ability to modify the environment. Many new technologies have both advantages and disadvantages. Often the disadvantages are not immediately obvious and only emerge in the long term. The use of insecticides can increase the production of food or fibre dramatically, but may also reduce the population of predatory birds and insects and so encourage the build-up of other pests.

Water can be considered as both a renewable and non-renewable resource. It is renewable in the sense that it continues to cycle from the ocean to the land and back to the ocean. However, in many of its uses, water has the characteristics of a non-renewable resource, such as in the following examples.

* Where water is affected by pollution (such as from domestic and industrial effluents) its uses are reduced and it may even become a hazard to the environment.
* Groundwater may be pumped in excess of its rate of recharge. If the groundwater level falls too low, that remaining may be contaminated by the inflow of adjacent salty groundwater. This is particularly so along the coast.
* Reduction in flows due to diversion may alter the in-stream environment and result in the drying of downstream wetlands, causing permanent ecosystem changes.
* The flooding of valleys by impoundments removes the flooded land from other existing or potential uses, at the same time creating a resource for different purposes.

Relations between resource uses

Many uses of a resource are compatible. They may be supplementary and add to each other (for example, use of irrigation storages for flat-water recreation), or complementary in that one use also benefits from the other (for example, improved irrigation efficiency may benefit salinity mitigation), but they may also be competitive when an increase in one leads to a decrease in the other (for example, allocation of water to environmental flows may leave less for other purposes).

The principles of land use

In the past our society has grown and the economic welfare of the people has been improved through activities such as mining, farming, timber production, and industrial development. These industries have been given prime importance, and the allocation of natural resources for their use has often been decided according to perceived advantages in the short term rather than long. The deleterious effects of this approach to development have been recognised, and increasingly, people prefer development that can be sustained in the long term. Sustained development must not only be economically viable, it requires that the use of renewable resources be limited to a rate that maintains the resource base. For non-renewable resources this necessarily requires efficient use, recovery, and recycling to extend the life of the resource.

Big River (Basin 5)

The concept of balance involves equal consideration of the needs of all sections of society, on both regional and State bases, as well as the needs of the present and future generations.

The intangible values of recreation, aesthetics, and nature conservation must not be ignored. In addition to actively providing land for these purposes, we must also consider the impact of other land uses upon them.

Where several uses are compatible, land should be available for the most beneficial combination of such uses. It may be necessary to define major aims and to determine levels above which secondary uses are unacceptable.

Where land has been committed to a particular use, it should be managed so that its capability for that use is not impaired. Land that is not specifically committed to a use or uses, should be maintained in a condition that will allow the widest possible choice for future uses.

Review and reassessment of land and water use will become necessary as society and technology change.

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4. VICTORIAN RIVERS AND STREAMS

Apart from Antarctica, Australia is the driest continent on Earth. The stream-flow regimes draining Australia are also among the most variable.

Lying in one of the better-watered parts of the country, Victoria has an average annual rainfall ranging from over 1000 mm in the Alps to less than 250 mm in the Mallee. As a result of the concentration of rainfall in the Alps, Otways, and Grampians, and of higher evaporation in the north, stream flow shows major variations across the State, with 80% in the east (see Map 8).

Most of it occurs in July to October, when rainfall and snowmelt tend to be high and loss through evaporation low.

Stream flow and water use are often described by the unit of volume called the megalitre (symbol ML), which is one million litres and is roughly the volume of water in an Olympic-size swimming pool. Table 4 shows the average annual stream flow of the major river systems across Victoria. These volumes differ markedly between wet and dry years.

For water-resource management purposes, Australia is divided into drainage basins based (in general) on the catchment boundaries of the major rivers and their tributaries. As shown in Map 1, 29 basins cover Victoria. They are used frequently through this report and their boundaries are shown on several other maps.

Detailed descriptions of the basins appear in the publications listed in the references below, while a brief outline of major water supply systems in each one is given later in this chapter.

The Victorian basins contain 3800 named watercourses, with a combined length of 56 000 km. Appendix I lists many of these according to the river systems into which they drain, and defines their location by reference to the simple grid squares shown on Map 1.

The hydrological properties of individual basins are outlined in Chapter 10 and their special values, as described in Chapters 15 to 18, are summarised in Part V.

Prior to European colonisation, equilibrium existed between the river basins and the impacts of Aboriginal use of water and associated resources. Droughts and major changes in climate over thousands of years would have had major effects on water availability for direct consumption and for the animals and plants on which Aborigines depended. These changes in water availability would have profoundly affected Aboriginal life and settlement patterns.

Traditional Aboriginal use and management of water included modifying drainage patterns to assist in fish and eel capture, harvesting of wetland and riparian plants and animals, and developing and protecting rock wells, springs and soaks, to assure water supplies. Rivers and streams also had social and mythological significance for Aborigines.

In the last 150 years numerous water storages have been constructed to assure water supply for agricultural, domestic and urban industrial demand. They range in size from small farm dams to major dams.

Currently, 73 storages have a capacity of 1400 ML or more, with a combined total of 15.6 million ML. Four of them - Dartmouth, Hume, Eildon, and Thomson - contain 75% of the State's storage capacity.

On average, some 4.87 million ML of water is used each year, the bulk (77%) of it for irrigation: Table 5 gives the breakdown.

Rivers have been exploited for other resource values as well; these include fish, the extraction of sand, gravel, and soil from the riverbed and floodplain, and alluvial gold. The generation of electricity - another important in-stream use of water - is restricted to the upper reaches

Table 4

ANNUAL AVERAGE STREAMFLOW OF RIVER BASINS

Basin		Area (sq km)	Average Annual Streamflow	
			Megalitres	Megalitres per sq km
1.	Upper Murray River	10,000	3,920,000	390
2.	Kiewa River	1,990	705,000	360
3.	Ovens River	7,780	1,620,000	210
4.	Broken River	7,700	325,000	40
5.	Goulburn River	16,200	3,040,000	190
6.	Campaspe River	4,180	280,000	70
7.	Loddon River	15,300	250,000	20
8.	Avoca River	12,400	85,000	10
14.	Mallee	28,000	0	0
15.	Wimmera-Avon Rivers	24,000	210,000	10
21.	East Gippsland	4,570	770,000	170
22.	Snowy River	6,470	2,490,000	380
23.	Tambo River	4,170	325,000	80
24.	Mitchell River	5,450	960,000	180
25.	Thomson River	5,970	1,220 000	200
26.	Latrobe River	5,210	980,000	190
27.	South Gippsland	6,780	700,000	110
28.	Bunyip River	3,890	355,000	90
29.	Yarra River	4,100	1,100,000	270
30.	Maribynong River	1,420	120,000	80
31.	Werribee River	1,970	95,000	50
32.	Moorabool River	2,170	115,000	50
33.	Barwon River	3,880	300,000	80
34.	Lake Corangamite	4,190	160,000	80
35.	Otway Coast	3,900	765,000	200
36.	Hopkins River	9,680	400,000	40
37.	Portland Coast	4,000	245,000	60
38.	Glenelg River	12,700	725,000	60
39.	Millicent Coast	9,580	4,000	< 1

Table 5

MAJOR WATER USES ('000 ML)
Average Annual Consumption

Irrigated agriculture	3744
Melbourne Metropolitan area	420
Major urban areas outside Melbourne (Mornington Peninsula, Geelong, Ballarat, Otway Region)	132
Wimmera/Mallee stock and domestic supply	145
Latrobe Valley industrial area	52
Other urban, rural, industrial use	374

of rivers in 'run of the river' systems, but is also produced from irrigation water releases from several large storages. It is described in Chapter 20. Parallel to the introduction of exotic animals such as foxes and rabbits onto the surrounding land, exotic fish were introduced into the State's waterways.

Water has many values and uses other than for direct consumption, including the maintenance of aquatic ecosystems. The platypus, for example, is totally dependent on specific aquatic environments.

Recreation, too - ranging from power-boating to peaceful contemplation by a river bank - encompasses the diverse ways we draw pleasure from water bodies. Because water is vital to us and its uses and availability have shaped society, many important cultural features that provide a window to our past are found along waterways.

Consequently, rivers and their catchments contain an essential repository of values that enhance our everyday life, which are described in Part III of this report.

RIVER REGULATION

Many consumptive uses of water - for example, industrial and urban development - require guaranteed water supplies.

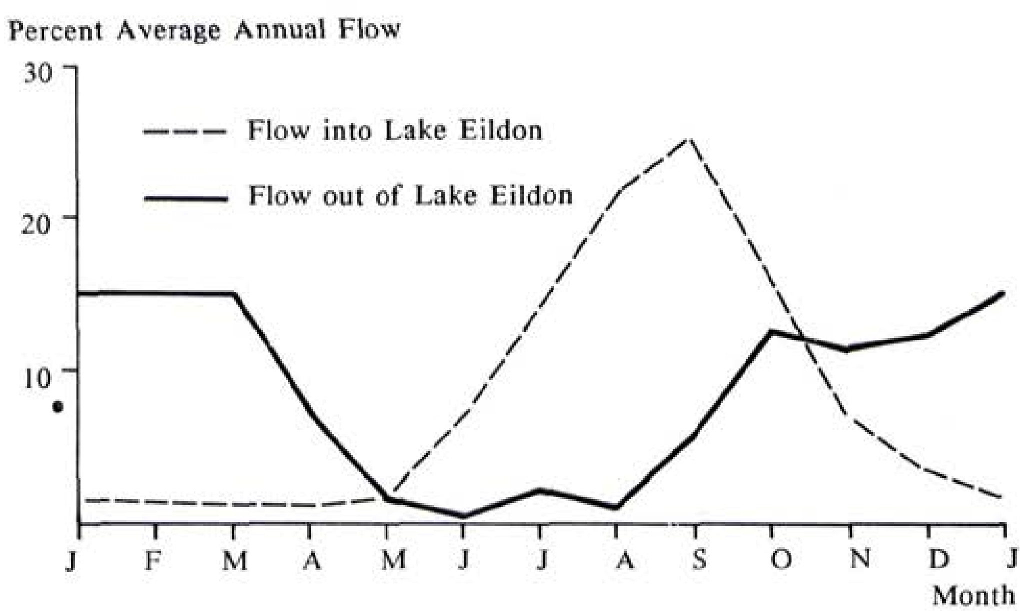
In times when supply is less than certain, restrictions may be introduced to ensure that water is available for the highest-priority uses. When water is insufficient it may be imported from regions where flows exceed demand. Irrigated agriculture makes its greatest water demand during the summer and during prolonged drought, when rainfall and natural river flows are least. Freedom from excess water - flooding - is also required.

River regulation provides a means of improving the certainty of water availability for consumptive uses. It allows the storage of water for controlled future release. It is achieved by constructing dams on rivers - such as Eildon Weir on the Goulburn - or off-stream storage basins such as Lake Mokoan or the Waranga Reservoir. A system of headworks, including diversions, weirs, channels and pipelines, allows movement of water between catchments and river basins - from areas where supply exceeds demand to areas of net demand. The irrigation districts in the north of the State and population and industrial centres are such areas of net demand.

Regulation is achieved by filling the storage during high winter and spring flows or the flood flows that can occur at any time of the year. Using the river flow up-and-down-stream of Lake Eildon, as an example, Figure 3 shows the potential regulatory effect of impoundments.

The storage capacity required to meet a particular use depends on the amount of water required, and on the desired safety margin - calculated to ensure that water

FIGURE 3
EFFECTS OF STREAMFLOW REGULATION



will be available irrespective of the annual statistical variation in rainfall.

The greater the demand, the larger is the storage capacity required. And the more critical uses - for instance, domestic consumption - necessitate a larger safety margin and hence storage capacity. In some instances water storage systems are interconnected to ensure volume and reliability. As water demand increases then storage capacity must increase to maintain the same level of certainty.

Regulation is also used to achieve a variety of other purposes, including the provision of environmental flows, flood mitigation, and maintenance or development of water-based or enhanced recreation.

Environmental flows are those stream flows necessary to maintain the in-stream and the riparian, wetland, and estuarine systems downstream in sustained ecological condition. Regulation gives us the ability to ensure that we can meet adequate low- and medium-flow requirements and generate high flows at appropriate times.

On the Murray River the desired outcome of regulation for irrigation is to ensure maximum water availability in late summer. The red gum wetlands dependent on the Murray are naturally flooded during late winter-spring. Regulation may allow the needs for both wetland maintenance and irrigation to be met.

Flood mitigation structures slow down the flow of water by temporarily storing it, and many large impoundments have a flood-storage capacity as part of their operating regime. Purpose-built flood-retarding basins are most common in urban areas where rainfall runs quickly off impermeable roofs, roads, and car parks and can cause flash flooding.

The regulation of water supply for irrigation, domestic use, and flood mitigation has led to the construction of dams on many major rivers (see Map 2) and the movement of water between drainage basins. In the Murray-Darling System, for example, nearly half of the average annual natural flow is drawn off for irrigation and urban use.

On floodplains in various rural areas, de-snagging, straightening, and channelling of rivers have been extensively carried out to 'improve' flow rates and reduce flooding. River-bank works are widely undertaken to protect structures such as bridges and to reduce channel erosion and erosion of adjacent farmland.

BASIN OUTLINES

Table 6 lists the main river and creek systems in each basin. Basins 1 to 8, 14 and 15 lie to the north of the Great Dividing Range, and flow towards the Murray River. These form part of the catchment and drainage system of the Murray-Darling Basin, the location of which is shown in Map 3.

Basin 1 is the catchment of the Upper Murray and Indi rivers, above Lake Hume. It includes a substantial area in New South Wales, in particular the catchments of the Tooma and Swampy Plain Rivers, but for this investigation only the Victorian part is considered. It contains Lakes Hume and Dartmouth - major storages operated in conjunction with the Murray-Darling Basin Commission.

Basin 2, Kiewa River, contains the State Electricity Commission's hydro-electric scheme on the East Branch of the Kiewa above Mount Beauty. The Ovens River Basin (3) includes moderate-sized storages on the Buffalo and King Rivers, and Lake Mulwala on the Murray. The Broken River and Broken Creek systems in basin 4 are linked, and are regulated by Lakes Nillahcootie and Mokoan. These systems also act as channels for irrigation water to the eastern part of the Goulburn-Murray Irrigation District, along with supplies from Lakes Mulwala and Nagambie.

The Goulburn River system, basin 5, is comprehensively regulated by Lakes Eildon and Nagambie, with diversions to the Goulburn-Murray Irrigation District (partly in this basin) and through the Waranga Reservoir for stock and domestic supplies in the Mallee.

Basin 6, Campaspe River, provides irrigation and domestic water supplies from the Coliban Reservoirs and Lake Eppalock. A similar series of reservoirs

Table 6

RIVERS AND CREEKS IN EACH BASIN

1 : UPPER MURRAY

Big River
Bundarra River
Cobungra River
Dart River
Gibbo River
Indi River
Mitta Mitta River
Murray River
Victoria River

2 : KIEWA RIVER

Kiewa River
Mountain Creek

3 : OVENS RIVER

Buckland River
Buffalo River
Catherine River
King River
Ovens River
Rose River

4 : BROKEN RIVER

Broken River
Broken Creek

5 : GOULBURN RIVER

Acheron River
Big River
Delatite River
Goulburn River
Howqua River
Jamieson River
King Parrot Creek
Little River
Murrindindi River
Torbreck River
Yea River

6 : CAMPASPE RIVER

Campaspe River
Coliban River

7 : LODDON RIVER

Loddon River
Bullock Creek
Tullaroop Creek

8 : AVOCA RIVER

Avoca River

14 : MALLEE

Lindsay River
Murray River
Wallpolla Creek
Hattah Lakes

15 : WIMMERA RIVER

Avon River
Fyans Creek
Golton Creek
Mackenzie River
Mt William Creek
Richardson River
Wimmera River
Yarriambiack Creek
Lake Lonsdale
Lake Hindmarsh
Lake Albacutya

21 : EAST GIPPSLAND

Ada River
Arte River
Bemm River
Benedore River
Betka River
Cann River
Combienbar River
Errinundra River
Genoa River
Goolengook River
McKenzie River
Mueller River
Red River
Thurra River
Wallagaraugh River
Wingan River
Yerung River

22 : SNOWY RIVER

Bendock River
Big River
Bonang River
Brodribb River
Buchan River
Deddick River
Delegate River
Hartland River
Ingeegoodbee River
Little River
Murrindal River
Queensborough River
Rich River
Rocky River
Rodger River
Snowy River
Suggan Buggan River
Yalmy River

23 : TAMBO RIVER

Nicholson River
Tambo River
Timbarra River

24 : MITCHELL RIVER

Crooked River
Dargo River
Dry River
Humffray River
Mitchell River
Moroka River
Wentworth River
Wongungarra River
Wonnangatta River

25 : THOMSON RIVER

Aberfeldy River
Avon River
Barkly River
Caledonia River
Carey River
Freestone Creek
Jordan River
Macalister River
Perry River
Stringer Creek
Thomson River
Valencia Creek
Wellington River

26 : LATROBE RIVER

Ada River
Latrobe River
Moe River
Morwell River
Tanjil River
Toorongo River
Tyers River

27 : SOUTH GIPPSLAND

Agnes River
Albert River
Bass River
Franklin River
Jack River
Merriman Creek
Powlett River
Tarra River
Tarwin River
Tidal River

28 : BUNYIP RIVER

Bunyip River
Lang Lang River
Paterson River
Tarago River

29 : YARRA RIVER

Little Yarra River
Plenty River
Watts River
Yarra River

30 : MARIBYRNONG RIVER

Deep Creek
Emu Creek
Jackson Creek
Maribyrnong River

31 : WERRIBEE RIVER

Kororoit Creek
Lerderderg River
Werribee River

32 : MOORABOOL RIVER

Little River
Moorabool River

33 : BARWON RIVER

Barwon River
Yarrowee River
(Leigh River)

34 : LAKE CORANGAMITE

Woady Yaloak River
Lake Colac
Lake Corangamite

35 : OTWAY COAST

Aire River
Anglesea River
Barham River
Calder River
Cumberland River
Curdies River
Erskine River
Ford River
Gellibrand River
Kennett River
Parker River
St George River
Wye River

36 : HOPKINS RIVER

Hopkins River
Merri River
Mount Emu Creek

37 : PORTLAND COAST

Darlot Creek
Eumeralla River
Fitzroy River
Moyne River
Surrey River

38 : GLENELG RIVER

Chetwynd River
Crawford River
Glenelg River
Stokes River
Wando River
Wannon River

39 : MILLICENT COAST

Mosquito Creek

Note: Basins 2 to 8 also include sections of the Murray River

MURRAY - DARLING RIVER BASIN

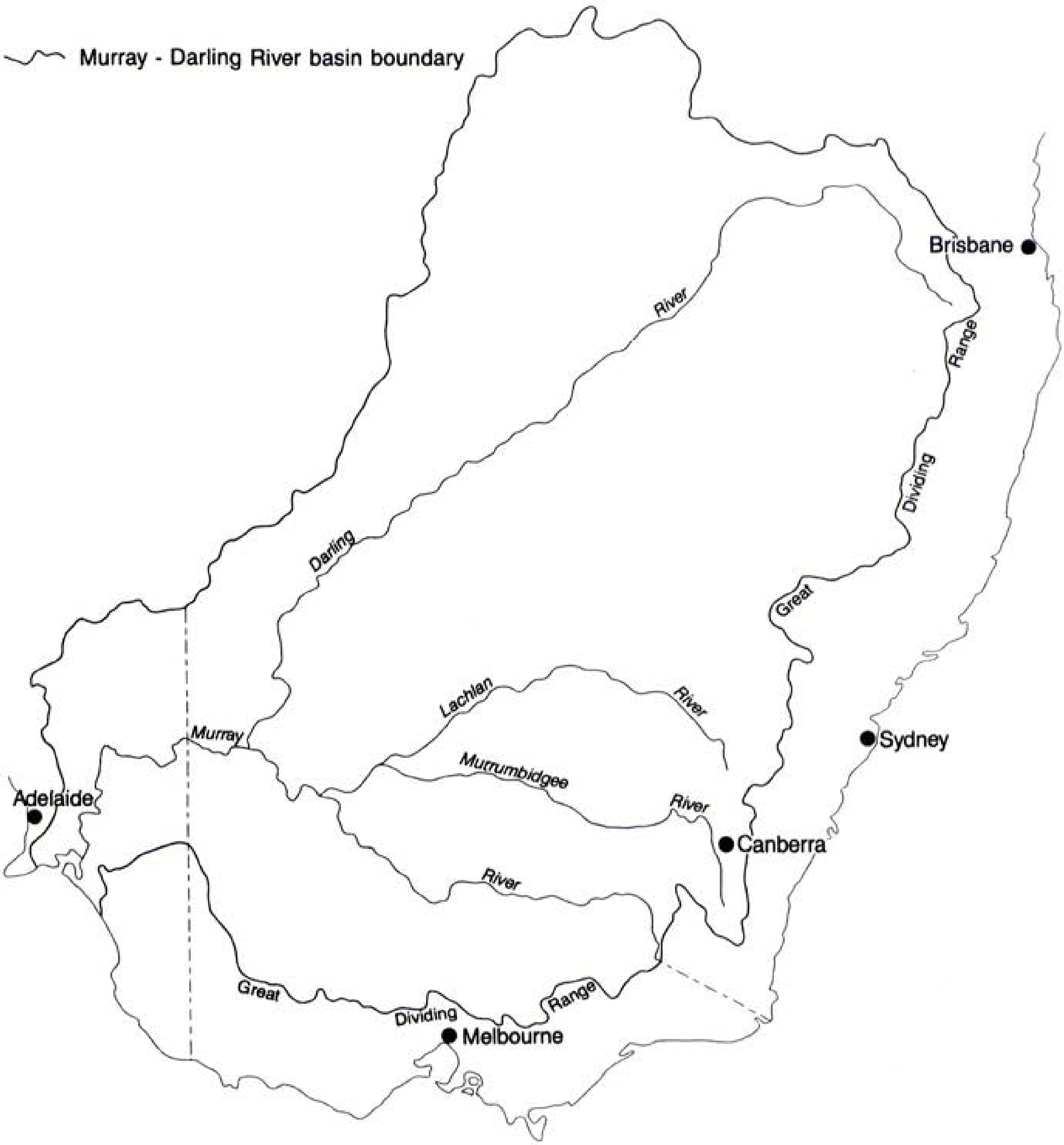
Rivers and Streams Special Investigation

1 : 8 500 000

85 0 170 340

Kilometres

Land Conservation Council Victoria



Cartography by Thematic Mapping Unit
Division of Survey and Mapping
Department of Property and Services

MAP 3

exists in basin 7, Loddon River, with Lake Cairn Curran and Tullaroop and Laanecoorie Reservoirs storing water for irrigation, domestic, and stock supplies. The lower reaches of the Loddon Basin include the western part of the Goulburn-Murray Irrigation District, which uses water from those two Rivers as well as the Loddon.

The Avoca River, basin 8, is substantially unregulated. Under natural conditions its flow ended at the Kerang Lakes, with overflows spreading widely en route to the Murray rather than having an established course. Rivers and creeks west of the Avoca (in basins 8 and 15) flow to terminal lakes rather than reaching the Murray. Their location coincides, for both basins, with the extent of the Mallee Dunefields (see Chapter 9). The lower two-thirds of the Avoca Basin is supplied with water from either the Goulburn or the Wimmera and Glenelg Rivers, in part of the immense Wimmera-Mallee Stock and Domestic Supply system.

Basin 15, Wimmera River, is heavily regulated, with Lakes Bellfield and Wartook and several off-stream reservoirs storing water for diversion to the Wimmera-Mallee system, and for small irrigated areas.

The Mallee Basin (14), generates very little run-off, but consumes substantial amounts delivered by channel or by releases along the Murray River. Uses are for domestic, stock, and irrigation supplies.

Basins 21 to 39 lie south of the Great Dividing Range, and their rivers flow to Bass Strait except for those in basin 34, (Lake Corangamite) and small creeks in part of basin 39 (Millicent Coast), which are internally draining.

East Gippsland, basin 21, has several river systems, including the Cann, Genoa, and Wallagaraugh Rivers whose headwaters lie in New South Wales. None is regulated to any extent. Map 4 shows the location of the interstate parts of river catchments in this basin and the following one.

The Snowy River Basin (22) has some direct tributaries with catchments in Victoria; some such as the Delegate and Bendoc flow across the border before joining the Snowy, while other tributaries lie totally in New South Wales. Large volumes from the headwaters are diverted by the Snowy Mountains Hydro-electric Scheme and flow to the Murray River system. No major regulation takes place in Victoria.

Basins 23, Tambo River, and 24, Mitchell River, are substantially unregulated, and along with the following two basins comprise the catchment for most of the Gippsland Lakes system.

The Thomson and Macalister Rivers in basin 25 are regulated for domestic supply to Melbourne and irrigation (Lake Thomson), and to supply the Macalister Irrigation District (Lake Glenmaggie).

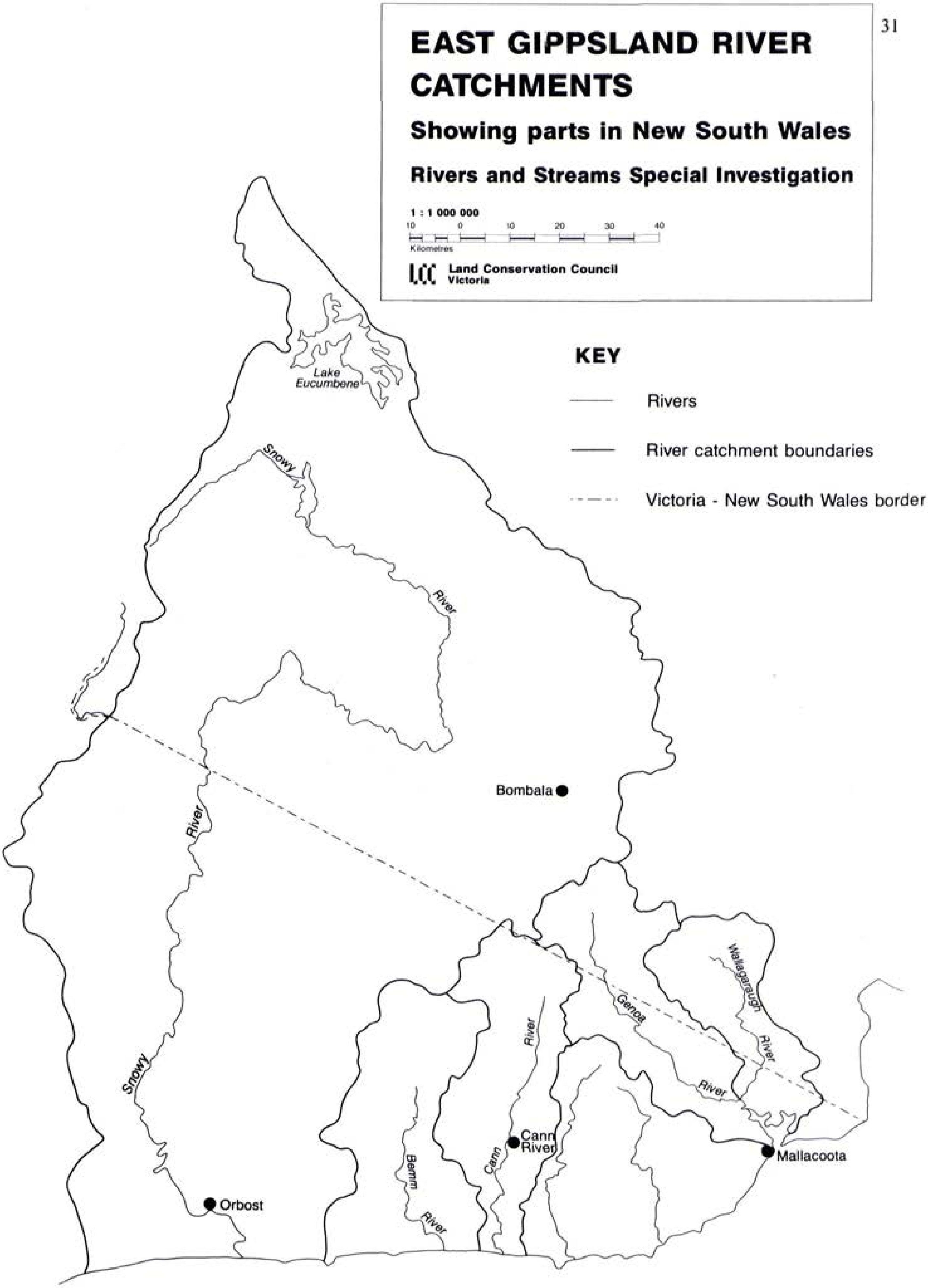
Basin 26, Latrobe River, contains Lake Blue Rock and Moondarra Reservoir on tributaries, which supply major water-users in the Latrobe Valley - for electricity generation, other industrial uses, domestic supplies, and some irrigation.

There is no substantial regulation of flows in basin 27, South Gippsland, for community water supplies, although there are many large farm dams.

The Bunyip River, basin 28, includes Tarago Reservoir, diversions from the Upper Bunyip, and the off-stream storages Cardinia and Devilbend. Much of the basin receives domestic water supply from these sources, through the extensive Mornington Peninsula system.

Basin 29, Yarra River, is heavily regulated for the extensive Melbourne supply system, with the Upper Yarra and Maroondah Reservoirs, the Lower Yarra offtake, and several off-stream and smaller on-stream reservoirs and other diversions. Additional supply is brought from the Thomson Basin, and from upper tributaries of the King Parrot Creek in basin 5.

The Maribyrnong River, basin 30, is substantially unregulated except for Rosslynne Reservoir on Jackson Creek. Storages have been built in basin 31, Werribee River, for irrigation at Bacchus Marsh and Werribee. These are Melton



Cartography by Thematic Mapping Unit
Division of Survey and Mapping
Department of Property and Services

MAP 4

and Pykes Creek Reservoirs and Lake Merrimu.

Basin 32, Moorabool River, contains the Lal Lal and Moorabool Reservoirs, both domestic water storages. The Little River in this basin drains to Port Phillip Bay while the Moorabool River flows into the Barwon River: the remainder of the latter's catchment comprises basin 33. This includes the West Barwon Reservoir and the enlarged lake at Wurdee Boluc, components in the extensive Geelong and Bellarine Peninsula water supply system.

Streams in basin 34 flow to Lake Corangamite and nearby lakes on the Western District basalt plains (see Chapter 9).

Coastal streams, flowing from the Otway Ranges and adjacent plains, comprise basin 35, Otway Coast. This does not contain any storages, but water from it supplies a large area from Princetown and Camperdown to Warrnambool.

Basins 36, Hopkins River, and 37, Portland Coast, similarly contain no major storages, their towns obtaining supplies from headwater offtakes, groundwater, or the adjacent basin 35.

The upper reaches of the Glenelg River, basin 38, are substantially regulated, with diversions from Lake Moora Moora and Rocklands Reservoir to the Wimmera-Mallee system, and from Wannon headwaters tributaries to Lake Bellfield in basin 15.

Basin 39 includes some creeks flowing to the coast near Millicent in South Australia, giving the basin its name, but others in areas from Edenhope to the Big Desert are either internally draining or have little run-off.

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Ferntree waterfall, Middle Creek, Mt Buangor State Park (Basin 26)

5. HISTORY OF USE AND DEVELOPMENT

This chapter briefly outlines key historical changes in the Victorian landscape as they relate to the water cycle, and to the use and administration of water resources: Table 7 lists key events. For further historical information on these changes, see the references at the end of the chapter.

THE FIRST CHANGES

The oral tradition of the Yorta Yorta people tells of the great flood that grew higher and higher until it submerged even the topmost leaves of the trees. The Elders then took their digging sticks and carved a channel through the sandhills and the water escaped. This legend may tell us of the damming of the Murray River when its flow was blocked by earth movements along the Cadell fault near Barmah (see Chapter 9) - only one of the many changes in climate and river features that Aborigines witnessed over the last 40 000 years or so.

Major changes in rainfall and temperature have occurred in association with the expansion and contraction of the ice caps. From 40 000 to 30 000 years ago, approximately, the Mallee was much wetter and contained many lakes, among these being Lake Tyrell (now dry and used for salt production) and the internationally famous Lake Mungo north of Mildura.

As the ice caps expanded and contracted, the sea level fell and rose. When the ice-sheets were large, such as 18-20 000 years ago, sea levels were much lower. Bass Strait and Port Phillip Bay were dry and the Yarra River flowed across Port Phillip Bay, through The Heads, and beyond. With the melting of the ice caps the sea level rose, drowning the river.

Aborigines might have also witnessed some of the volcanic eruptions in western Victoria. Around Lake Condah, the abundant scoria produced by Mount Eccles was subsequently used to construct an extensive system of channels and weirs to control water flows to assist eel-harvesting.

Adaptive changes made by Aborigines to the environment also included the construction of mounds along the floodplain of the Murray and in areas of western Victoria subject to seasonal flooding. Mounds - up to 5 m in height and 30 m in diameter - provided dry living sites.

In addition, the continuous impact of Aboriginal land use might have produced other ecological changes. On the Western District volcanic plains, for example, pollen records from craters such as Lake Wangoom and Lake Terang show that over the last 10 000 years fire-sensitive vegetation types have been replaced by fire-adapted vegetation. It has been argued that this change is a direct result of burning practices.

Fish trap, Lake Condah (Basin 37)

CHANGES SINCE THE 1800s

With the arrival of Europeans the land and its rivers were progressively changed and adapted in accordance with available technology and different social visions.

Pastoralism, agriculture, gold-mining, and urban and industrial developments changed the face of the land. Each created its own demand for water and had its own particular impact on Victoria's rivers and streams. Settlers cleared vegetation, and drained the wetlands they saw as useless swamps or as waterlogged land. Rivers were regulated, and used for the disposal of waste products and to generate electricity. In the late 1800s and early 1900s river use for the transport of goods was also common. Specific administrative controls were introduced to protect water resources and their catchments.

Over the last 150 years the population of Victoria has increased to more than four

Table 7

LANDSCAPE AND SOCIAL CHANGES IN VICTORIA

Year	Changes
+40 000 years ago	Aborigines occupy Victoria and establish a vigorous and complex hunter-gatherer economy.
1830-'40s	Pastoralism leads to conflict with Aboriginal custodians of water sources and associated resources. Major changes to the land commence: vegetation is cleared and cloven-hoofed animals are introduced.
1851	Colony of Victoria is established.
1851	Gold is discovered in Victoria and mining commences; by 1858 more than 5000 puddling machines are in use in Victoria.
1857	Yan Yean Reservoir is built to provide domestic water for Melbourne.
1860	First *Land Act* enacted, stipulating that certain water frontages may not be sold; various subsequent instruments, including the 1881 Proclamation, reserved many frontages.
1860-'70s	Exotic fish are introduced into Victoria. In 1962 European carp is declared a noxious fish.
1882	Royal Commission on water supply established, chaired by Deakin.
1885	First irrigation pump in operation in Victoria, pumps water from the Goulburn River.
1888	Chaffey brothers, using their United States experience, design the irrigation settlement at Mildura.
1905	*Water Act* passed establishing the State Rivers and Water Supply Commission.
1912	Fifty-six bucket dredges operating on Victoria's rivers - most in the Ovens and Bucklands River valleys.
1915	River Murray Agreement reached between the Commonwealth and Victoria, New South Wales and South Australia to establish a network of locks, weirs and dams on the Murray.
1955	Eildon is enlarged, nearly doubling the amount of surface water stored.
1972	Clearing has removed over half of Victoria's natural forest cover.
1979	Dartmouth begins to fill, flooding 5900 ha of forest.
1984	Warnings about mercury contamination of trout in the Upper Goulburn.
1989	Water Bill - to State Parliament.

million. With greater disposable income and access to leisure time, life-styles have also changed. As a result, still more demands have been placed on water for industrial, domestic, and recreational uses.

As described in Chapter 1, this Rivers and Streams Special Investigation is part of the ongoing change. The present chapter summarises the major changes as they relate to the water cycle, water use, and administration of the last 150 years.

Forest clearing

In the 1830s pastoralism, and later land selection, led not only to land clearing but also resulted in the introduction of thousands of sheep and, to a lesser extent cattle. This was the first time animals with hard, cloven-hoofs had trodden Victoria's soils and their compacting effect was substantial. By the 1840s, just 10 years or so after the start of pastoralism, its adverse effects were being noted. In some areas timber was in short supply and colonists were concerned about changes to flora and fauna, land slips, and the occurrence of dust storms.

Similarly, the mining that followed the discovery of gold in 1851 had a major impact on land clearing. Mining operations required large quantities of timber for pit props, shaft linings, poppet heads, and the like. Miners also required it for firewood and buildings.

Whereas pastoralism altered the fertile plains and foothills around Melbourne, the volcanic plains from Colac to Hamilton, and the alluvial plains along the Goulburn River and the Murray River from Echuca to Wangaratta, mining changed the land use in the extensive goldfields at Bendigo, Castlemaine, Ballarat, and Beechworth regions.

With the best agricultural land being taken, settlement and clearing of the Wimmera occurred in the 1860s and 1870s and settlement of the Mallee started in the 1880s.

In the east, clearing began on the river flats of the Mitchell, Avon, Thomson, and Macalister Rivers in the 1850s, around the Dandenongs during the 1860s, and on the Strzelecki Ranges in the 1880s.

The removal of forest cover continued this century. One major change in the 1920s was associated with the development of the Latrobe Valley and its brown coal deposits. Since the 1830s well over half of Victoria's forest cover has been lost, with a further 231 000 ha cleared in the last 15 years.

Water regulation

The most conspicuous evidence of water regulation is the construction of storages. In Victoria they vary in size from the Hume, which covers 200 sq km, to dams, covering a few hectares or less, which are estimated in the thousands. Construction of the latter started with squatting and has continued to the present. In some regions the number of farm dams has increased rapidly during the last 20 years. Hydrologically, their combined effect in a catchment is considered to be significant. In the Lal Lal Reservoir Catchment, for example, the number of farm dams has increased from 180 in 1970 to more than 530 in 1985, with a combined storage of more than 10 000 ML.

By contrast the construction of larger dams is well documented. Construction required large capital commitment by government, and large work-forces were often housed in specially constructed towns. The tourist destinations of Eildon, and Dartmouth were once such townships. The first major dam constructed was Yan Yean. Completed in 1857 and still in use, its purpose was to supply water for Melbourne.

The progressive expansion of major water storages is illustrated in Figure 4. The main increases in storage capacity occurred in 1936 and 1961 (with the completion and enlargement of Lake Hume), 1955 (with the enlargement of Lake Eildon), and 1979 (with the completion of Lake Dartmouth).

Population growth and changes in water consumption

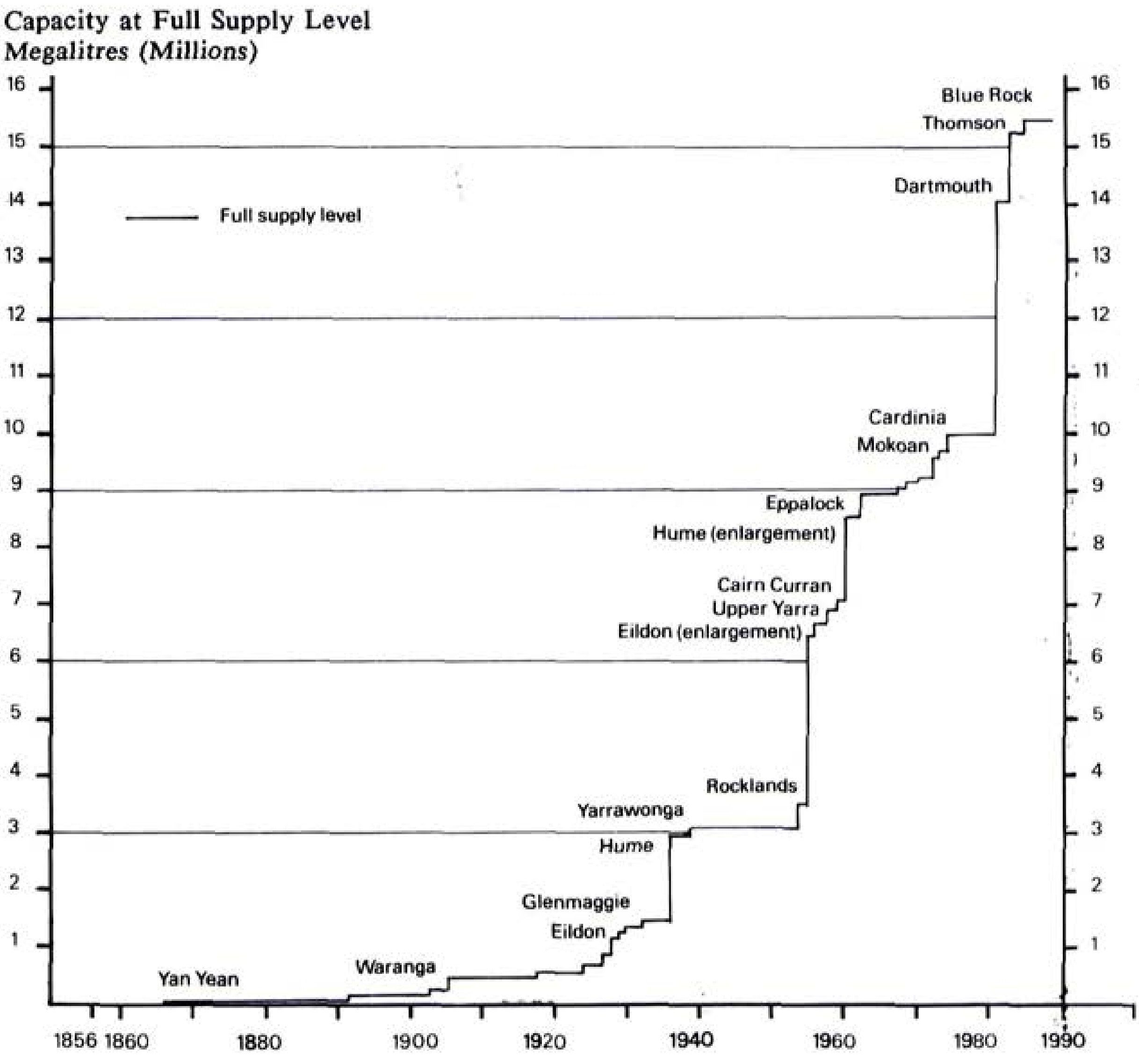
Victoria's population has steadily risen from about one million in the late 1880s to over four million (Figure 5). Over this period, major population growth has been a result of immigration, with the most important increases following the gold rushes in the 1850s and after World War II.

The last 150 years have also seen major increases in the demand for water. These result from the immediate human requirements of a growing population for drinking and other domestic uses, but also from the growth of water-intensive industries such as irrigated agriculture, paper manufacture, and water-cooling systems for coal-fired power stations.

Although domestic use is a small component of total water use in Victoria, the need to guarantee both the quality and quantity of supply make it of particular significance. *Per capita* domestic consumption has progressively increased as changes in life-style have created new demands. Flush toilets, replaced sanitary cans, automatic washing machines were introduced in the late 1950s, and more recently dishwashers and sink disposal units have further increased water consumption. Garden use of water is high in Victoria, accounting for 40% of Melbourne's annual domestic consumption.

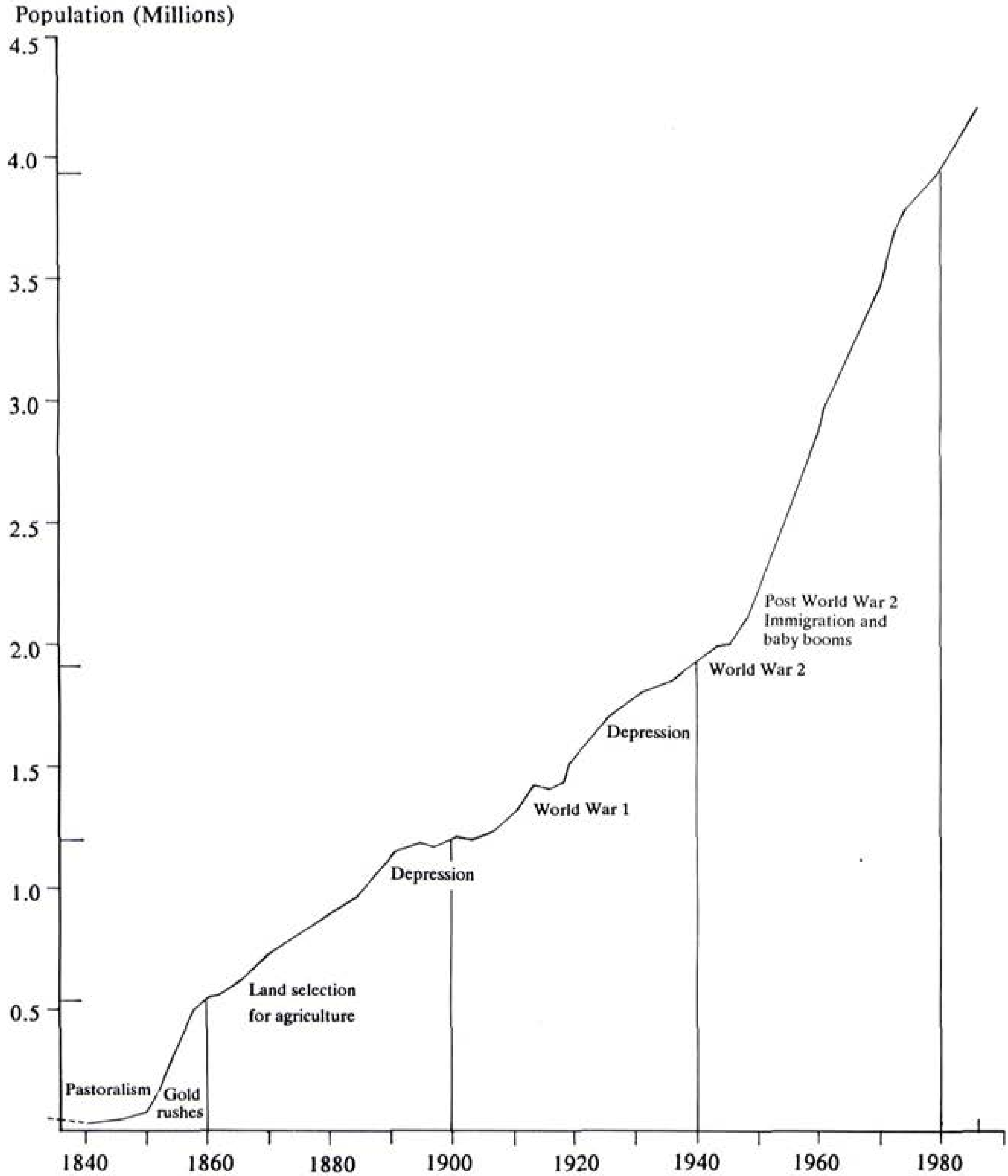
By far the largest consumer of water is irrigated agricultural production. Earliest irrigators were private diverters, who carried, diverted or pumped from streams or groundwaters. While the basic background for the development of

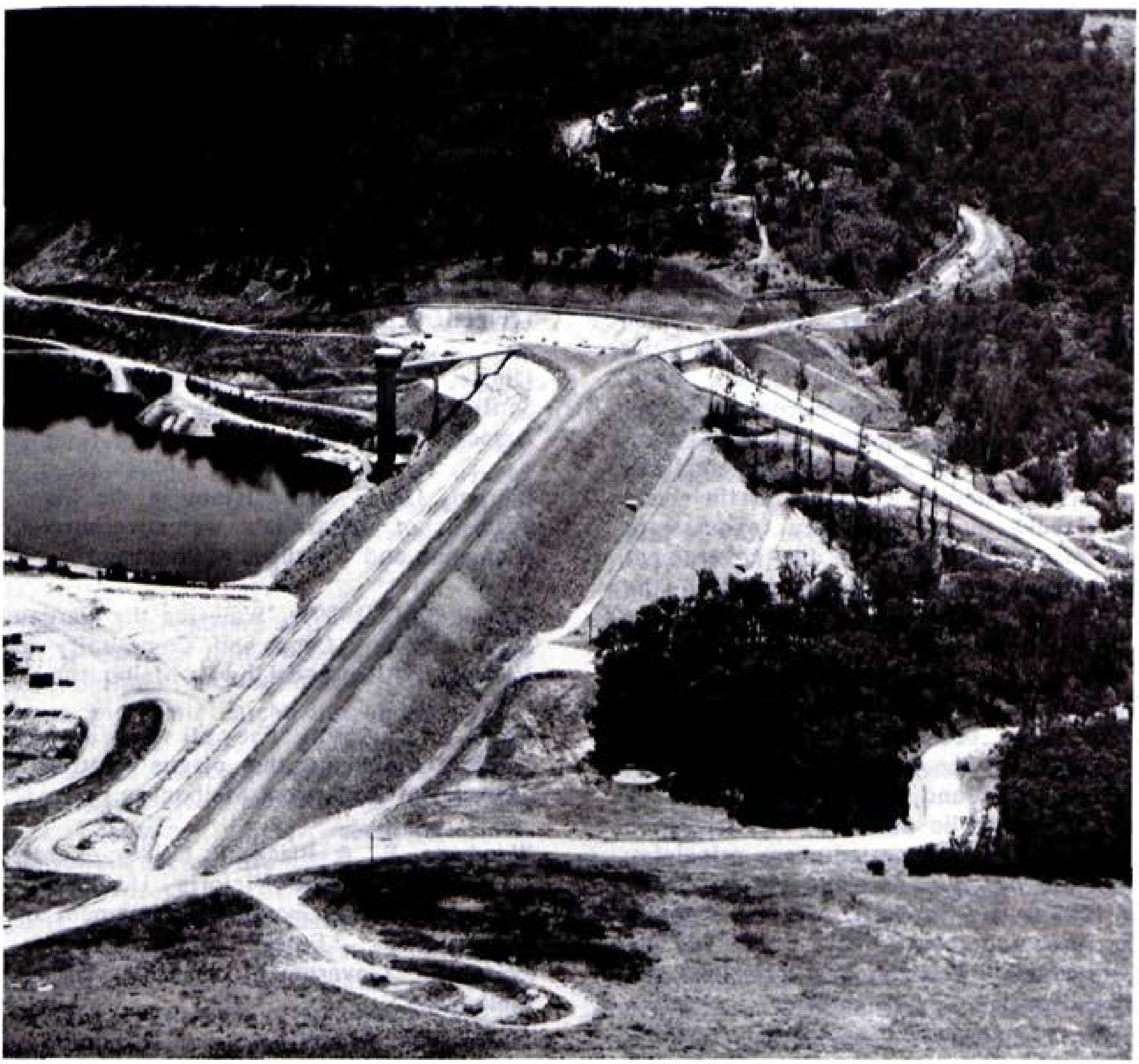
FIGURE 4
GROWTH IN WATER STORAGE CAPACITY



Source: After State Rivers and Water Supply Commission 1980

FIGURE 5
GROWTH IN VICTORIA'S POPULATION
1840-1986





Blue Rock Dam, Tanjil River (Basin 26)

irrigation schemes was established between 1880 and 1920, in terms of size the most significant developments have occurred since the 1930s and parallel the increased availability of water as a result of storage growth (Figure 4).

Demand for water for industrial processing increased rapidly with the discovery of gold in Victoria in 1851. Water was required to process both the gravels from surface extraction and the crushed ore. Streams were diverted and races constructed over considerable distances to bring water to gold-production areas. Initially the waste-water and the crushed rock, treatment waste, and sediment it contained were dumped into the rivers. This form of disposal caused such great problems that specific government legislation was introduced to deal with gold-mining waste or 'sludge', as it was known.

Continued growth and development of Victoria's industrial sector in the late 1800s and early this century led to a progressive increase in water demand.

The rise of public ownership

In many countries and in other Australian States, rivers, their banks, and the water that flows past them are privately owned. One legacy of British colonial administration was the partial retention by the Crown of sections of river frontages. Crown ownership of river banks had many advantages. It ensured public access to rivers for the watering of stock and the collection of domestic water. In navigable streams, it facilitated the development of wharves and slipways. It also provided public access to punts and to the bridges that often replaced them.

To this end in 1838, land within 400 m of rivers along the Port Phillip-Yass Road was retained by the Crown. In 1860 Victoria's first *Land Act* was enacted, which stipulated that certain water frontages were not to be sold. In 1873 the government withheld all Crown lands within 30 m of the entire courses of the Murray, Goulburn, Mitta Mitta, Loddon and Avoca Rivers and all permanent lakes in north-western Victoria. Certain rivers and creeks in the Wimmera region were also withheld. In 1881 the government reserved a substantial number of the remaining river, creek, and lake frontages not yet alienated.

The Victorian government also took the view that, because of the competing demands for the limited available water, its ownership and management should be within the public domain. The *Irrigation Act* of 1886 incorporated these principles. Both the *Irrigation Act* and the *Water Act* of 1905 vested in the Crown the right to the use and control of water in any watercourse. The complex legislative and administrative arrangements covering water management were recently reviewed, resulting in the Water Bill which is discussed in Chapter 6.

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6. STATUTORY CONTROL OF STREAMS AND CATCHMENTS

Each river or stream receives water from its catchment, and all land in the State is in the catchment to a river or stream. The ownership or the control of the use of land, and the activities that occur on it, are relevant to this Investigation, and accordingly all law that has a bearing on these matters is also relevant.

Each river or stream is subject to an immense range of law, much of which applies generally to any land. Some of it is applicable to rivers, streams, and catchments in particular.

This chapter outlines this range of laws, and is divided into two main parts: the first outlines all legislation relevant to rivers and their catchments (both public and private land), and the second summarises selected Acts of particular relevance to rivers and streams. The first part contains three sections: law controlling present use and management of land; law providing for existing and future plans; and law that applies in contingencies. The first section is further divided according to whether land is 'owned' or whether management controls are imposed on the owner by other statutes. Figure 6 illustrates the range of legislation, and the structure of the first part of this chapter.

RELEVANT LEGISLATION

Law controlling present land use and activities

Catchments include private landholdings and land held or controlled for public purposes by various public authorities, which manage it under statutes.

A large area of public land forms the bed, banks, and land adjoining rivers and streams, and much catchment land is also public land. On any given area private interests may hold leases, licences, or licences to take commodities (such as water) from public land. Mining tenements are located from place to place.

Under statutes, some authorities have power to control much of the use and many of the activities conducted on private land (listed in Figure 6 as management controls).

Owned private land, and public land

This group of laws covers both land held for private use and public land held by authorities.

Land may be held for private use:

* under title grants and transfers (*Transfer of Land Act* 1958)
* under transfers by transport agencies (*Transport Act* 1983) eg. in cities
* on lease or licence from the State (*Land Act* 1958)
* as a mining tenement (*Mines Act* 1958)

Various authorities hold and manage public land under the legislation listed below.

* The Department of Conservation, Forests and Lands holds and manages some 38% of Victoria's land, under the *Land Act* 1958, *Forests Act* 1958, *National Parks Act* 1975, and the *Conservation, Forests and Lands Act* 1987.

* The Ministry for Transport holds land for the provision of roads and railways, under the *Transport Act* 1983 (and Railways Board Legislation).

* Local-government authorities manage and control certain lands that have importance for rivers and streams, under the *Local Government Act* 1958 and *Crown Land (Reserves) Act* 1978.

* Water authorities manage or control some streambeds, banks, adjoining lands, and other lands for water harvesting, treatment, and distribution under the *Water Act* 1958. The relevant agencies, some

of which have their own legislation, are the Department of Water Resources, the Rural Water Commission, Melbourne and Metropolitan Board of Works, Dandenong Valley Authority, Geelong and District Water Board, Latrobe Valley Water and Sewerage Board, and various water, sewerage, and river management authorities.

Management controls required by Statute

This group of Acts and associated regulations determine the nature and type of powers that may be exercised in rivers, streams and catchment lands.

* The Department of Conservation, Forests and Lands' powers and functions relate to both public and private land. Relevant Acts administered include the *Conservation, Forests and Lands Act* 1987, *Lands Act* 1958, *National Parks Act* 1975, *Soil Conservation and Land Utilization Act* 1958, *Vermin and Noxious Weeds Act* 1958, *Forests Act* 1958, *Fisheries Act* 1968, *Wildlife Act* 1975, *References Areas Act* 1978, *Flora and Fauna Guarantee Act* 1988, and *Crown Land (Reserves) Act* 1978. Types of Control applied include proclamation and determination of land use in water supply catchments, vermin and noxious weeds eradication powers, national parks, fisheries and wildlife administration, protection of fauna and flora, and forest management and production.

* The Ministry for Transport's powers affect 'transport' land, under the *Transport Act* 1983. Types of control applied cover aspects of road provision, maintenance, bridges, culverts, road reserves, and drainage.

* Local-government authorities hold powers affecting all land, under the *Local Government Act* 1958. They carry out comprehensive administration of land in municipalities.

* The Department of Water Resources' powers can cover private land, rivers and streams, and public land water frontages. Acts administered by the Department and water agencies are the *Water Act* 1958 and various Acts for specific authorities such as the Melbourne and Metropolitan Board of Works. They apply controls over water diversion, storage, treatment, and distribution; erosion, water quality and quantity; and waterway management, flooding, and frontages.

* The Environment Protection Authority has powers affecting all land under the *Environment Protection Act* 1970, including the control of discharge of pollutants to water.

* Operating under the *Health Act* 1958, the Department of Health can control aspects of water quality administration for rivers and streams.

* The Department of Agriculture and Rural Affairs, principally for private land and acting under the *Aerial Spraying Control Act* 1966 and *Agricultural Chemicals Act* 1958, administers some aspects of control over run-off from agricultural land, and land use practices.

* Under the *Mines Act* 1958, the Department of Industry, Technology and Resources, for almost any land, can control many aspects of mining and mineral exploration.

Existing and future plans affecting rivers and streams

Planning schemes, at local, regional, or State-wide level, apply principally to private land across Victoria, under the *Planning and Environment Act* 1987.

Government-approved Land Conservation Council recommendations under the *Land Conservation Act* 1970 apply to public land (under that Act).

Broad-scale plans are prepared by various authorities to be adhered to by themselves or other authorities and private interests. They include: State Environment Protection Policies for water, prepared by

FIGURE 6

CURRENT AND PROPOSED LEGISLATION AFFECTING RIVERS AND CATCHMENTS

		Legislation	Types of control
Laws controlling the present land use and activities			
Private or public land owned or controlled	Land privately owned or controlled	Transfer of Land Act	Crown Grants, title transfers
		Land Act	Licences
		Mines Act	Mining and exploration licences, leases
	Public land	Transport Land Act	Road and railway alignments
		Conservation, Forests and Lands Act	Crown land
		National Parks Act, Forests Act	Scheduled National Parks, Reserved Forests
		Lands Bill	Proposed land categories
		Local Government Act	Land for municipal purposes
		Local Government Bill	Land for municipal purposes
		Water sector acts	Land for water supply and distribution
		Water Bill	Land for water supply and distribution
Management controls required by statute	Private land	Local Government Act	Various land use and building controls
		Local Government Bill	Various land use and building controls
		Environment Protection Act	Discharge licensing
		Agricultural acts	Controls on chemical use, waste disposal
		Water sector acts	Water supply, sewerage, drainage, river management
		Health Act	Controls on health risks
		Mines Act	Controls on extraction, safety, reclamation
		Conservation, Forests and Lands Act	Land management co-operative agreements, Codes of Practice
		Fisheries Act	Recreation and commercial fishing controls
		Wildlife Act	Native wildlife protection and hunting controls
		Flora and Fauna Guarantee Act	Flora and fauna orders
		Soil Conservation and Land Utilization Act	Land use advice, land use determinations, declared river flats
		Land Protection Bill	Proposed land protection orders
		Vermin and Noxious Weeds Act	Regulatory powers for pest plant and animal control
	Public land	Land Act	Licence conditions, regulations
		Lands Bill	Management Plans
		National Parks Act	Restrictions on hunting, pets, certain activities
		Transport Act	Access and use limits
Existing and future plans			
Existing and future plans	Private land	Planning and Environment Act	Planning schemes - State, regional and local
		Environment Protection Act	State Environment Protection Policies
		Environment Effects Act	Assessment of environment effects statements
		Codes of Practice	eg. forestry code - harvesting controls, prescriptions
	Public land	Land Conservation Act	Public land use recommendations
Laws that apply in contingencies			
		Conservation, Forests and Lands Act	Fire protection in State forests and National Parks
		Country Fire Authority Act	Fire prevention and suppression outside the above areas

the Environment Protection Authority; various Department of Conservation, Forests and Lands instruments such as codes of practice, including the intended legislated forestry code; land management co-operative agreements; and management plans. They are to apply to all relevant land.

Under the *Environment Effects Act* 1978, administered by the Department of Planning and Environment, plans for major proposals are submitted for widespread comment by private interests and authorities.

Laws that apply in contingencies

Legislation to promote the prevention and combating of fire, such as Conservation, Forests and Lands and Country Fire Authority legislation, applies in emergencies and can override the above laws.

LEGISLATION OF PARTICULAR RELEVANCE TO RIVERS AND STREAMS

Water Bill

The Water Bill is the result of a comprehensive revision of water legislation. The second reading was moved in Parliament on 26 May, 1989, and before it was introduced it went through a process of consultation and review. The following description covers those sections seen as relevant to this investigation. References to 'the Minister' mean the Minister for Water Resources.

This Bill has several express purposes, which include to:

* provide for the integrated management of all elements of the terrestrial phase of the water cycle
* provide formal means for protection of the environmental qualities of waterways
* provide for the protection of catchment conditions

Part 2 of the Bill covers 'rights in water', particularly the Crown rights to the use, flow, and control of all water and individual rights. The Bill replaces all existing riparian rights - that is, free use of water by owners of properties abutting streams, for domestic use - and lists the ways rights to water can be obtained. Authorisation of any activity or change in land use that may affect the existing drainage regime may be conditional 'to ensure the conservation of waterways, wetlands and aquifers'.

In Part 3 the Minister is charged with ensuring the ongoing assessment of water resources. Within declared water supply protection areas, a management plan can prescribe the maximum amount of surface or bore water to be taken, its rate of use, and the maximum size and numbers of dams built. In times of water shortage, entitlements to water can be reduced or suspended. The Minister may issue a licence to construct works on a waterway, after having regard to any effects the proposal may exert on in-stream uses among other things. Directions to prevent pollution, to alter works, to comply with conditions, or for other purposes can also be given by the Minister.

Part 4 describes the allocation of water. An authority, which includes the Ministers for Planning and Environment and Conservation, Forests and Lands, may apply for a bulk entitlement of water. When considering such applications, the Minister must have regard to:

* the existing and projected availability of water in the area
* any water to which the applicant is already entitled
* government policies concerning the preferred allocation of water resources
* the needs of other potential applicants

as well as matters similar to those listed above relating to conditions on licences.

Also, licences to take and use water can be issued subject to conditions relating to the following matters:

* protection of a waterway or aquifer

* the purposes for which water may be used

* the maximum amounts of water that may be taken in particular circumstances

* protection of the environment, including the riverine and riparian environment

* implementation of the conservation policy of the government, including the State Conservation Strategy

* the efficient use of water resources

* proper management of the waterway and its surrounds or of the aquifer

* the drainage regime

* compensation of existing users who may be adversely affected

* protection or control of in-stream uses

* installation and use of measuring devices or pumps.

Part 6 introduces various water supply, sewerage, irrigation, drainage, and flood-plain management authorities, including a provision that authority-controlled land may be declared, by Order, to be a recreational or environmental area, for the authority to administer.

Part 8 outlines the powers of water supply authorities which include 'to develop and implement programs for the conservation and efficient use of water'. Further, 'an Authority must perform its functions in an environmentally sound way'.

Waterway management (commonly known as 'river improvement' or 'river management') is the subject of Part 10. The functions of waterway management authorities are flexible and may be wide-ranging, covering land and waterway use and protection and floodplain management. Authorities may declare waterway verges, in which consent is required for works likely to interfere with the quality, quantity, or flow of water. The Minister may also declare drainage courses, as under existing legislation.

Public bodies intending to undertake certain works in the above areas must notify the authority and take into account any comments it makes. Waterway management authorities are specifically encouraged to participate in catchment co-ordinating groups.

Certain authorities may declare flood levels, zones, and building lines, and the Minister may declare areas to be liable to flooding.

The Minister can appoint authorities to prepare waterway management schemes, involving assessment and investigations of water resources, preparation of schemes for improved waterway management for drainage and floodplains, and public education.

The Bill's coverage of irrigation (Part 11) includes provisions for temporary transfer of water rights, (up to 5-year renewable transfers) and a tendering system for new allocation of water.

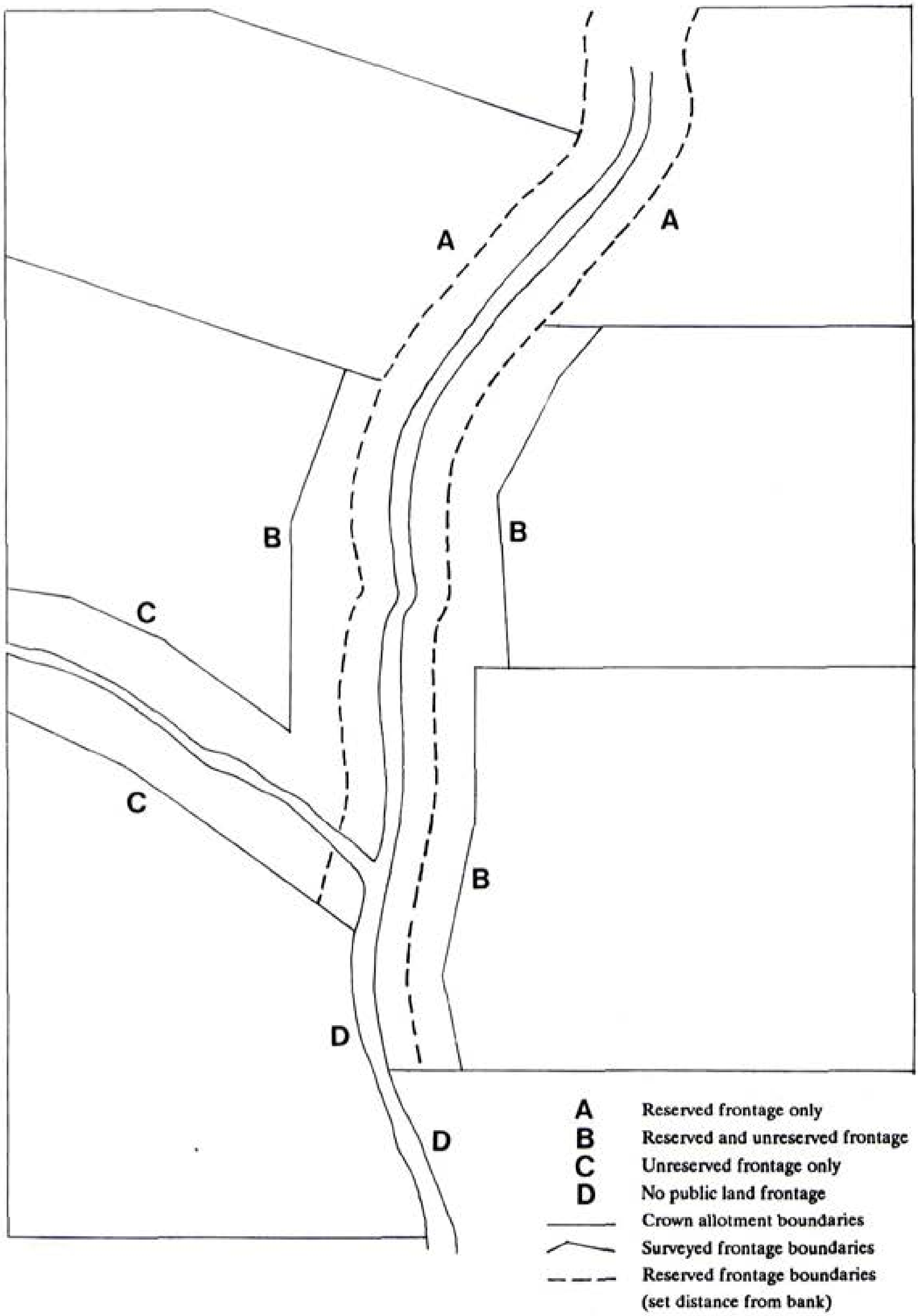
Also, a related amendment transfers a clause from the *Water Act* 1958 to the *Land Act* 1958. This confirms that the beds and banks of all watercourses that form the boundary of a landholding remain the property of the Crown.

Land Act

Several sections of the *Land Act* 1958 have particular relevance to the use of land associated with rivers and streams. Freehold land in the catchments was allocated and granted under the provisions of earlier Land Acts, Crown land is used in accordance with the Act, and reserves can be established under the Act for specific uses, including public purposes, as watershed for water supply purposes, for watering purposes, and various others.

The water frontage reserves are particularly important as a resource for many purposes. Several instruments under Land Acts, most notably the 1881 Proclamation (see Chapter 5), effected the reservation for public purposes of many of these river frontage strips. There remains a mixture of frontage types, some with a fully reserved frontage, some with all unreserved Crown land frontage, others with a mixture.

FIGURE 7
TENURE OF PUBLIC LAND RIVER AND STREAM FRONTAGES



The unreserved frontages are those where a strip along a stream has been withheld from sale and allotment boundaries surveyed. Such strips provide tenure difficulties if the stream changes its course. Four different types of public land water frontage are illustrated in Figure 7.

Lands Bill

To facilitate the management and reservation of public lands, the government prepared (in 1988) a draft Lands Bill to replace a number of Acts that relate to public land management, including the *Land Act* 1958, the *Crown Land (Reserves) Act* 1978, the *Reference Areas Act* 1978, and the *Forests Act* 1958. This draft Bill will be revised prior to being presented to Parliament.

Major differences of the Lands Bill proposals from existing legislation include the following:

* classification of Crown land into 'public land' or 'government land' (Public land under the Lands Bill is not identical to public land under the *Land Conservation Act* 1970, although they cover very largely the same land)

* procedures for reclassification of land into either class for public land

* categorisation into about 16 new categories

* provisions for preparation of management plans

for government land

* provisions for title registration, dealings, and property management

In addition, the Bill includes provisions for committees of management, leasing, licensing, produce, and fire protection, and incorporates clauses for the protection and use of reference areas.

Public land - to be managed by the Department of Conservation, Forests and Lands - is defined by the Bill as land that has conservation, historical, recreational, tourism, natural resource, social, or cultural significance (including special significance for the Aboriginal community), or has special strategic value for present and future generations. The benefits of this land being public land outweigh any benefits of it not being so.

Government land is defined as land that does not meet the above criteria, which is to be managed by the Department of Property and Services and may be treated as a tradeable asset.

Reclassification from government land to public land would require an investigation by the Land Conservation Council.

In the reverse process, reclassification of public land to government land would depend on the category. For land in most categories, reclassification requires a Council investigation, followed by an Act of Parliament. However, land in forest plantations, and public utility reserves or uncategorised land could be reclassified by Order in Council.

Categorisation and recategorisation following Council investigations are proposed to replace reservation as the means of protecting public land values. While their number (16) is smaller than the total range of categories used by the Council in past studies (48), the categories contain groupings of use or value types where the aims of management are similar.

For the first group of recommendations relating to rivers and streams listed in Table 9 (see Chapter 7), the new categories, their broad objects, and their equivalent in the existing system are shown in Table 8.

Catchment land use law

The following Acts are grouped because they regulate various aspects of river catchment land use.

Planning and Environment Act

The *Planning and Environment Act* 1987 concerns planning the use, development, and protection of land in the present and long-term interests of all Victorians. A planning scheme is intended to encourage and control development. Where appropriate, a planning permit may

Table 8

LANDS BILL AND LAND CONSERVATION COUNCIL RECOMMENDATION CATEGORIES

Lands Bill		LCC recommendation categories
Proposed categories and and description	Management objects	
Natural features reserve		Public land water frontage reserve; streamside reserve; River Murray reserve; wildlife reserve; lake reserve
An area of land containing important elements of the natural environment, landscape, and/or geological or geomorphological features that are of scenic or conservation significance	protection and maintenance of the identified landscape and/or other values; recreation and education where appropriate and where compatible with the above; controlled low-intensity exploitation of natural resources compatible with both the above	
Water production reserve		Water production
An area of land in the catchment of or adjacent to a water supply storage or offtake	protection of the water supply and the operation of the water supply system; restriction of access to protect water quality; conservation of the natural environment, landscape, and features of cultural significance where compatible with the first object	

restrict or control the way in which land can be used or developed.

A number of the goals of this Act are of direct relevance to protection of rivers and their catchments. Under section 4 of the Act, the aims of planning in Victoria include:

'(a) to provide for the fair, orderly, economic and sustainable use, and development of land;

(b) to provide for the protection of natural and man-made resources and the maintenance of ecological processes and genetic diversity;

(c) to secure a pleasant, efficient and safe working, living and recreational environment for all Victorians and visitors to Victoria;

(d) to conserve and enhance those buildings, areas or other places which are of scientific, aesthetic, architectural or historical interest, or otherwise of special cultural value.'

Under the Act, a single planning scheme for each municipality sets out 'objectives, policies and controls for use, development and protection of land'. All schemes have a State and a local section, and a regional section if there is a prescribed Planning region for the area.

A planning authority can prepare scheme amendments having considered the Minister's directions and environmental, social, and economic effects. A responsible authority administers and enforces the scheme, and is the municipal council unless the scheme says otherwise.

Conditions for development may be specified in schemes or on permits, and may require things to be done to the satisfaction of the responsible authority, or of a referral authority - that is, an agency to which applications are referred. A planning scheme cannot require something to be done, except as a condition of allowing something else to be done that requires a permit.

Soil Conservation and Land Utilization Act

Control of land degradation by soil erosion is the main focus of the *Soil Conservation and Land Utilization Act* 1958. While erosion control in river and stream catchments across the State is important for this study, two divisions in the 'Land Utilization' part of the Act are of particular importance.

The first provides land use controls in water supply catchments. A three-stage process provides: the means for proclamation; determination of land use; and imposition of conditions on land use, for water supply catchment areas. In practical terms these are:

* catchment definition leading to improved public awareness

* detailed investigation leading to a land use determination, with co-operative implementation

* statutory enforcement of these measures on private land

Proclamation alone confers no particular constraint on land use, but leads to increased consultation and assessment of major development proposals or changes in land use. Potential hazards can then be identified.

Proclamation is often followed by determination of land use which provides the basis for statutory control. This has occurred for 41 of the 108 catchments that have been proclaimed. A determination of land use specifies preferred land uses and appropriate land management, based on an assessment of the hazards to water supply values. Particular attention is given to protecting the waterway system, its environs, and ephemeral streams.

The legislation has generally been applied in water catchments that provide urban, domestic, or irrigation supplies. It may be more widely applicable - for example, where water catchment values need protection to maintain in-stream habitat, stock and domestic water quality, or streambed and bank stability.

Big Bend, Wimmera River, in the Little Desert National Park (Basin 15)

The second division of this part of the Act relates to river flats, which can be declared, so that land use activities such as soil or gravel extraction are strictly controlled. It has been little used in the past, although the powers it contains are very relevant.

Environment Protection Act

A State Environment Protection Policy (SEPP) is a declaration by the government, under the *Environment Protection Act* 1970, of the nature and level of protection to be given to certain environmental features.

Such policies have three major purposes: defining beneficial uses; setting goals for environmental quality; and detailing the attainment program.

Defining beneficial uses

The surface waters of the State are divided into five broad segments, based on land use and water quality. They are:

* aquatic reserves (inside parks and reserves)
* parks and forests (within State forest or listed high-conservation areas)
* estuarine
* coastal
* general surface waters (all other waters)

The policy then identifies the 'beneficial uses' to be protected in each segment. These are the ways people get use or enjoyment from the environment. They include drinking, swimming, irrigation, or protection of aquatic habitats. To maintain these uses, waters may need protection from waste discharges and other polluting activities.

Setting environmental quality goals

Particular beneficial uses determine the level of environmental quality that must be maintained. For example, waters that are used for domestic consumption need to be of better quality than waters intended for stock drinking.

Environmental water quality is measured by the levels of various indicator substances present. Acceptable indicator levels generally are chosen on the basis of the use requiring the best water quality (usually protection of aquatic ecosystems and/or public health).

Detailing the attainment program

Once the water quality goals are decided, a policy outlines a management program that will ensure that the necessary environmental quality is maintained. Such policies aim at providing the highest practicable level of protection.

These policies are implemented by the Environment Protection Authority, State and local government bodies whose activities may influence water quality, and those with roles in land-use planning and management. Those who discharge waste to Victorian waters must follow the policy guidelines. SEPPs also include guidelines for land-use planning and urge greater consideration of waste generation and water quality issues in planning decisions.

Approved State Environment Protection Policies

A broad framework for Victoria is provided in the Waters of Victoria Policy, which applies to all surface waters, including the coastal segment but not groundwater. Requirements for specific catchments are attached as schedules to the main policy. Schedules to the SEPP take into account local issues and challenging environmental problems. New schedules can be added as necessary.

Earlier approved or draft SEPPs apply to the waters of the Western Metropolitan Region, the Yarra River and tributaries, the Maribyrnong River and tributaries, the Wimmera River, Lake Colac and catchment, Lake Burrumbeet and catchment, and the Dandenong Valley. In addition, the Waters of Victoria SEPP includes specific provision for the Werribee River, Little River and Gippsland Lakes catchments.

7. PUBLIC LAND ASSOCIATED WITH STREAMS AND CATCHMENTS

Consideration of the public land associated with rivers and streams for the purposes of the present investigation involves most of the Council's existing categories of public land use. This chapter outlines the current policies and land uses applying to the most relevant categories as recommended by the Council and approved by the government. These provide a framework of existing recommendations for rivers and streams, to which this investigation can be applied. The investigation is not, however, limited to these recommendations: rather, it outlines them to give an indication of the existing situation. Map 5 shows Council's past recommendations, and demonstrates some limits of this investigation, in that the ability of public land use modifications to influence the condition of rivers and streams is constrained by the extent of private land. This reinforces the need for the Heritage Rivers Program, outlined in Chapter 2.

The categories can be grouped into three: those directly affecting water resources, watercourses, or stream banks; those relating to river catchment land use; and those relating to the values central to this investigation - nature conservation, recreation, landscape, and cultural heritage. They are listed in Table 9.

The first group includes recommendations for: the protection of quality and quantity of water production (for domestic and other uses); the protection of water quality, values, and uses of stream- and lake-frontage land; conservation and recreation on certain wetlands and lakes; and hydro-electricity production. The total area involved is 6100 sq.km, being 7.0% of public land.

Larger recommendation categories for various catchment land uses fall into the second group. Many of the individual recommendations contain provisions protecting specific river and stream values, and, for example, those in State forest are outlined. These categories total 71 000 sq.km, or 78% of public land.

The third group comprises special-purpose recommendations for particular values. These total 3300 sq.km, or 4% of public land.

For locations of individual recommendations, descriptions, and detailed recommendation wording, you should refer to the Land Conservation Council's published final recommendations, with their associated 1:250 000 maps. Appendix IV lists the wording for each of the recommendation categories listed below.

RELEVANT CATEGORIES

The following categories directly affect water resources, watercourses or river- and stream-frontage land.

Water production, supply, regulation, and drainage

These recommendations apply to a range of small sites associated with the use, control, or disposal of water.

Council's policies cover investigation of all domestic water supply catchments, and proclamation of domestic, industrial, or irrigation catchments with a multiplicity of uses. Catchments should be managed for a range of uses consistent with water resource protection, and, where appropriate, there should be controlled recreational use of storages.

The optimum combination of land uses will vary between catchments, and full consideration must be given to the effects of land use changes. The Department of Conservation, Forests and Lands and other public land managers should consult, co-operate, and reach agreement with water supply authorities over management in catchments. While it is appropriate for water supply authorities to manage buffer zones around water storages and offtakes (as specified in land use determinations), it is not considered necessary for them to manage all land in their catchments.

Table 9

LAND CONSERVATION COUNCIL CATEGORIES RELATING TO RIVERS AND STREAMS

Categories directly affecting water resources, watercourses, or river- and stream-frontage land

- Water production
- Water supply, regulation, and drainage
- Public land water-frontage reserve
- Streamside reserve
- River Murray reserve
- Lake reserve
- Gippsland Lakes reserve
- Wildlife reserve
- Hydro-electricity production
- *Rivers within*:
  - National and State parks
  - State forest[1]

Categories relating to catchment land use[2]

- Reference area
- National park
- State park
- Wilderness area
- Roadside conservation
- Hardwood (timber) production
- State forest[1]
- Softwood production
- Agriculture
- Uncommitted land

Categories relating to particular river and stream values in catchments and/or water-frontage locations

- *Scenic values*
  - Natural features and scenic reserve
  - Bushland reserve
  - Scenic reserve

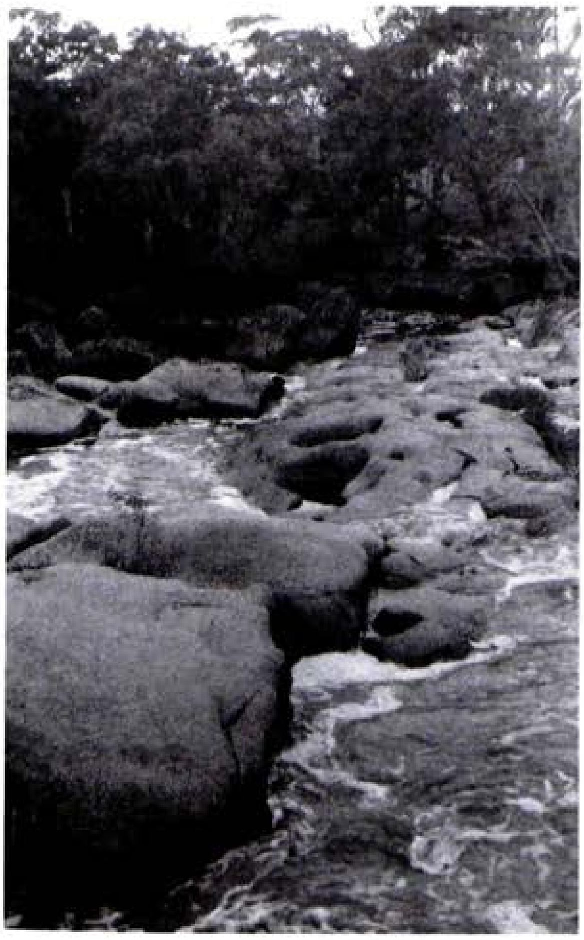
- *Recreational values*
  - Recreation reserve

- *Cultural heritage values*
  - Historic area
  - Historic reserve

- *Nature conservation values*
  - Flora reserve
  - Flora and fauna reserve

Notes:
1. In State forest various recommendations have been made that protect particular river and catchment values.
2. Only those categories covering more than 1% of public land are listed.

Water production category - Mt Cole Reservoir, Ararat water supply (Basin 15)



Public land water frontage reserves -
The Cascades, Coliban River (Basin 6)

Macalister River near Licola (Basin 25)

Many water authorities will probably need to disinfect water supplied from their storages. When public land recommendations in catchments are being implemented, there are recognised needs to protect not only the quantity and timing of yield, but sensitive areas and water quality. The effects of new storages and water releases on fish and wildlife habitat should be fully investigated.

In the stock and domestic supply areas, the importance of lakes and watercourses for nature conservation and recreation should be recognised in management. Areas used for saline drainage should, as far as is possible, also be used for nature conservation and recreation. New schemes for such drainage should not include disposal into natural wetlands or onto river floodplains. Various techniques including replanting of trees should be applied to alleviate the effects of dryland salting.

Public land water-frontage reserves

Narrow strips of reserved public land border many rivers and streams across Victoria, in areas of generally private land. Their locations are shown in diagrammatic form on Map 5, as continuous orange strips, labelled K.

Council's policies cover the value of frontages for access and low-intensity forms of recreation. Access to frontages may need regulation; access should be facilitated from roads and other public land, but not through freehold land. Frontages are of particular value for erosion prevention; for landscape appreciation; and for nature conservation, as corridors and remnants.

Streamside reserves

These small reserves (average area 60 ha) are usually located where a road crosses or abuts a stream at a site with a wide river-frontage reserve. They are not shown on Map 5. They have value for nature conservation, recreation, and public access. Council recognises the need to conserve trees and encourage regeneration on them.

River Murray reserve

This reserve includes the existing 60-metre-wide public purposes reserve along the Victorian bank of the Murray, and in some locations additional areas of adjacent public land, from Biggara near Corryong to the South Australian border.

Council's policies cover the significant scenic, recreation, historical, and conservation values of the Murray River, and its importance for a wide range of recreational activities, for its historical sites associated with the riverboat era, for the many Aboriginal archaeological sites, and for the river red gum forests. The reserve should have (specified) management aims and zoning. Public access to licensed areas should be facilitated, and guidelines for licensed pump and regulator sites are proposed. It would be desirable for the New South Wales bank to have similar management.

Lake reserves

Lakes with this status have a wide range of uses, but are not primarily set aside for recreation and nature conservation, as is the case with wildlife reserves. Council's policies acknowledge the lack of recognition of lake values despite 'public purposes' reservations. Where wildlife conservation is not the prime use, lake reserves are to have secure tenure with management flexibility.

Gippsland Lakes reserve

This recommendation concerns those parts of the public land around the Gippsland Lakes not included in the Lakes National Park or the Gippsland Lakes Coastal Park.

Because of the importance of the Gippsland Lakes and surrounds for recreation, conservation, and fishing, a unified approach should apply to their management, and zoning of the reserve should take account of the particular values of specific areas.

Wildlife reserves

These are in most cases wetlands and watercourses that provide specialised habitat for large flocks of birds, and fish, crustaceans, and some mammals. They average 380 ha in size.

Council's policies cover the need for conservation of habitat areas sufficiently

The Snowy River National Park from McKillops Bridge (Basin 22)

Streamside reserve - Wimmera River near Horsham (Basin 15) large and diverse to support genetically viable populations of species. The Department of Conservation, Forests and Lands should ensure that the formulation of management plans makes provision for the conservation of wildlife, particularly for animals that are closely restricted to a particular habitat for breeding and feeding. Specific principles relating to fauna conservation should be adopted for land uses affecting wildlife values. Further research is necessary to determine the effects of various land management practices, particularly timber production, forest grazing, and intensive recreation. A balance must be achieved between irrigation and drainage and the enhancement of wildlife values. Policies should be developed to ensure adequate allocations of water to the environment.

Hydro-electricity production

These recommendations apply to the Kiewa Scheme in the Alpine Area.

Council appreciates that extension of existing or additional facilities may be necessary, but specific provision cannot be made until definite proposals are put forward. The environmental effects of such proposals should be assessed.

National and State parks

Recommended national and State parks now cover nearly 29% of public land. They contain important reaches of many Victorian rivers and, particularly in the Alpine National Park, the headwaters. In East Gippsland a system of parks exists along much of the Snowy River, including the catchments to the Roger River and Mountain Creek. Management of these parks would in general accord with the protection of many river and stream values.

The intent of the Council's park system is to represent many of the State's land types in these conservation reserves. They are set aside primarily to provide public enjoyment, education, and inspiration in natural environments, while the conservation of native flora, fauna, and other natural features is an essential part of park management.

State forest

This is the largest of Council's categories at present, covering some 40% of all public land. State forest is of great importance for rivers and streams, containing substantial lengths of watercourses and their catchments. However, of more specific relevance are the many recommendations made by Council to protect particular river-related values within State forest. These include rainforest protection, natural features zones, water-supply catchment-protection guidelines, principles for protecting nature conservation, landscape, recreation, and cultural heritage values, forest management guidelines, and many site-specific values.

Various specific sites in State forest along rivers and streams have been identified in past recommendations by Council, and these are listed in Appendix IV. Also included are streams with specific *recommendations for rainforest protection* and natural features zones.

For rainforests, Council's policies incorporate the definition and guidelines for their indentification, including delineation of buffers.

Council's policies for natural features zones cover the importance of (specified) streamside areas in State forest that warrant protection of their special natural features. Some of these areas have scope for sympathetic development of recreational facilities and interpretative aids. The zones should include both the visual corridor and the environmental sequence from dry foothill slope through the species-rich intermediate zone to the riverine section.

Existing recommendations

Many individual recommendations, and several categories of recommendations in Council's past investigations, provided either generally or broadly for protection of river and stream values. Other recommendations specify land uses for river and stream environs, which Council considered appropriate in the context of past region-wide investigations.

The approved recommendations shown on Map 5 illustrate the range of uses, and in conjunction with Map 1, the variation in extent of public land in each of the major river basins, and the different categories of use that predominate in each basin.

River catchments have a wide range of existing uses, and these are committed to varying extents. However, the recommendations as they apply to rivers and streams for many areas are very general, leaving substantial scope to address public land use and management in detail.

The present investigation will address the needs to:

* review public land uses on the basis of natural units such as river catchments rather than arbitrary regions

* consider river and stream uses and values on a systematic basis across the State

Further reading

More information on each of the categories and areas mentioned can be obtained from the published final recommendations of the Land Conservation Council to government, for these areas :

. Alpine Special Investigation (1983)
. Ballarat (1982)
. Corangamite (1978)
. East Gippsland Review (1986)
. Gippsland Lakes Hinterland (1983)
. Mallee Review (1989)
. Melbourne (1977)
. Melbourne District 1 Review (1987)
. Murray Valley (1985)
. North Central (1981)
. North-eastern (Benalla-Upper Murray) Review (1986)
. North-eastern, Districts 3,4 and 5 (1977)
. South Gippsland, District 1 (1973)
. South Gippsland, District 2 (1982)
. South-western, District 1 Review (1983)
. South-western, District 2 (1982)
. Wimmera (1986)

8. MANAGEMENT OF RIVERS AND FRONTAGES

This chapter outlines current management arrangements for the water sector, the management of public land along river frontages in generally private-land areas, and public land in river catchments, including the Code of Forest Practice and Integrated Catchment Management.

WATER SECTOR

Victoria's water sector comprises some 180 agencies that distribute about five million megalitres of water each year, and provide sewerage, drainage, floodplain, and river management services. On average, most of the water (about 77%, or 3.75 million ML each year) is used for irrigated agriculture; 16% (or 0.8 million ML) supplies urban consumers and industry, while 7% (or 0.3 million ML) is used for rural stock and domestic purposes. Water is provided through highly developed systems comprising dams, pipelines, and channels, and this chapter gives an outline of the many agencies that constructed and manage this system, and outlines approaches to decisions on future water-resource development.

The water sector is co-ordinated through the Department of Water Resources, the functions of which are:

* to provide advice on the management, development, and use of Victoria's water resources, and the provision of water services

* to review and develop policy options, plans, and programs for the water sector, to co-ordinate policy development, and to advise on industry plans, programs, and institutional arrangements

* to develop a data-base for the Victorian water sector relating to water resources and water-related matters, and apply it to water policies, plans, and programs

* to develop guidelines to assist water agencies to develop plans and programs

Other functions involve financial programs, performance review, and technical support for water agencies, and public education. The Department's various current programs, strategies, and role in co-ordination are outlined below.

Of the 180 water sector agencies, 147 provide urban water services (water supply, sewerage, and drainage) and 29 are responsible for drainage, floodplain management, and river protection. Urban reticulation systems provide water for the Melbourne metropolitan area and for 345 country towns. Virtually all of Melbourne is now sewered and in country Victoria sewerage facilities exist in 159 towns and urban centres.

The Rural Water Commission supplies water for irrigated agriculture. It is responsible for bulk storage and bulk supply as well as the retailing of water to individual irrigators.

The water storage and distribution network includes two major integrated systems: the Goulburn-Murray system of northern Victoria and the Yarra-Thomson system in south-central Victoria. Other significant regional systems include the Wimmera-Mallee stock and domestic system and the Barwon-Gellibrand system in south-western Victoria.

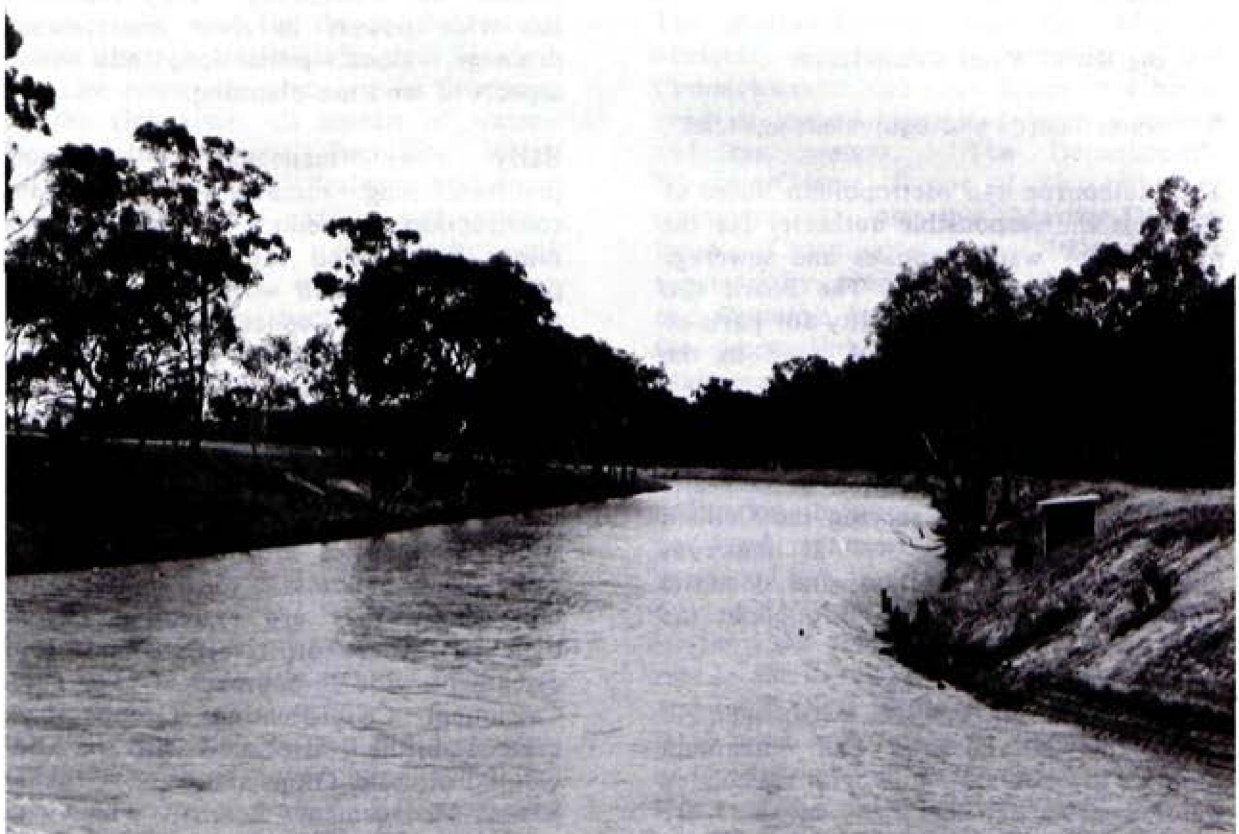
Water resources management

The Rural Water Commission is responsible for providing irrigation and other services in rural areas throughout Victoria and for managing water and associated land. The Commission also undertakes planning, resource assessment, and investigations pursuant to the effective and efficient management, protection, operation, and maintenance of irrigation and related services.

Irrigation

Irrigation is by far the greatest use of water in Victoria. The Commission controls most of the irrigation areas in the State, contained in ten Irrigation Districts,

Goulburn Weir (above) diverts water from Lake Nagambie to the Stuart Murray Canal en route to Waranga Reservoir (below) (Basin 5)



which are shown on Map 17. A separate agency, the First Mildura Irrigation Trust, provides water for irrigation purposes to an area of some 8000 ha, comprising mainly vineyards and orchards. In addition, private schemes irrigate a further 80 000 ha. Most of these are operated by individual land-owners, who pump water directly from watercourses under licence or permit issued by the Water Commission.

The total volume of water diverted at river offtakes during the 1987/88 irrigation season by all the above users was 4 092 000 ML.

Domestic and stock supplies

A number of systems throughout the State provide water to rural properties for domestic and stock-watering purposes. The largest of these is the Wimmera-Mallee domestic and stock supply system, operated by the Rural Water Commission.

Urban water supplies

Public water supplies to urban communities are under the control of:

* the Melbourne and Metropolitan Board of Works
* the Rural Water Commission
* water boards and equivalent agencies

The Melbourne and Metropolitan Board of Works is the responsible authority for the provision of water supplies and sewerage for the Melbourne area. The Board also has management responsibility for parts of its water supply catchment areas in the Yarra Basin.

The Rural Water Commission is responsible for the operation of domestic water supply schemes serving the Coliban and Otway Regions as well as numerous townships within irrigation, and domestic and stock supply districts throughout the State.

Water boards have been established to construct, administer, and maintain supplies to most townships with reticulated water systems. While many of these are small organisations supplying a few towns, some have substantial supply areas - for example, the Mornington Peninsula and District Water Board, Geelong and District Water Board, Latrobe Valley Water and Sewerage Board, and Ballarat Water Board. Their supply areas are shown on Map 17.

Drainage, flooding, and river management

Some flood-mitigation schemes are currently managed by municipalities and *river management authorities*, and floodplain management is effected by some municipalities through planning processes. The Rural Water Commission has a co-ordinating role by undertaking detailed flood studies of identified problem areas, providing flood information to relevant planning authorities, and assisting with the implementation of flood-mitigation strategies.

Four drainage authorities have been established to administer schemes draining land for agricultural use. These are the Strathdownie and Yatchaw schemes in the south-west, Lough Calvert east of Lake Colac, and Longwarry in West Gippsland.

Covering the catchments of the Dandenong, Cardinia, Deep and Toomuc Creeks, the Dandenong Valley Authority has wide powers in river management, drainage, flood protection, and some aspects of land use planning.

Early river management operations involved snag removal and floodway construction, to reduce the incidence of minor floods, and to speed flood-water passage. Some such works led causatively to the next stage, concentrating on river-bed and bank stability. Recognition that the factors leading to bed and bank erosion can arise in the catchment to the river has resulted in the current moves towards integrated catchment management.

Some 29 agencies are involved in river management across the State, and increasingly they are extending beyond their past focus on river channels to a catchment-wide approach. Three Catchment Co-ordinating Groups have been established, associated with the Mid-Goulburn, Mid-Gippsland, and Mitchell River Management Boards, with wide representation of not only catchment and water organisations involved in management and use but also the community.

Planning water-resource use

The processes used to decide between water-resource development options have in the past been inconsistent. In some cases parliamentary committees have been involved, and since the mid 1970s environment effects statements have been prepared for large reservoirs such as Dartmouth, Thomson, Blue Rock, and the Lower Yarra proposal. However, relatively small storages, such as a water board's reservoir, can also have impacts on in-stream values. These are dealt with under the environment effects legislation where they could have a significant effect on the environment.

The Water Bill, outlined in Chapter 6, contains various provisions to ensure that full consideration is given to all uses and alternatives in planning water-resource development.

To assist in this process, the Department of Water Resources is preparing several strategy plans for various parts of the State.

The approach used for the South-Western Region Strategy was a major step forward in water-resources planning in Victoria. For the first time, all aspects of water-resource management, including water allocation, catchments, drainage and river management, water supply and waste-water management, and institutional arrangements were examined together from a regional perspective. The major issues addressed were:

* future water allocations for specified city water supplies, and for environmental purposes

* management of major river catchments

* operation and management of two major drainage schemes

Following publication, the draft strategy was the subject of public hearings as part of a parliamentary Natural Resources and Environment Committee's inquiry.

The South-East Region is being studied in a similar comprehensive manner, considering water allocations, catchment and waterway management, protection of high-value rivers and wetlands, and problems in rivers that have parts of their catchments in New South Wales. It is intended that the strategy will guide water-management decisions for the next 30 years.

Other Department of Water Resources regional studies in progress include the State Water Resources Plan, which focuses on the 'core region' (basins 3, 4, 5, 6, 28, 29, and 31) and the Western Port Rivers management study.

Several State-wide water-resource programs are also in progress, to develop guidelines for environmental flow requirements in rivers, to upgrade drinking-water quality, to review drought emergency planning, and to draw together drainage, floodplain, and river management with an integrated catchment and waterway management planning approach. The Department is also a major contributor to the development and implementation of the State Salinity Strategy.

The Murray-Darling Basin (see Map 3) obviously requires the co-operation of the Commonwealth and four States to achieve progress toward integrated basin planning and management. The Department's Director-General is one of Victoria's two representatives on the Murray-Darling Basin Commission; the Department substantially prepared the draft Salinity and Drainage Strategy and is involved in the preparation of the Natural Resource Management Strategy for this basin.

Critical factors in water-resources planning and management are the co-ordination between various departments and land managers and consultation with users and others. The Department carries out wide consultation in its various studies, and this has played a significant role in the development of the South-West and South-East Strategies. Co-ordination is of great importance in managing rivers and water supply catchments. Various levels of discussion are required, and the present structure is outlined below.

* The Rural Affairs, Conservation and Environment Committee of Cabinet comprises relevant Ministers, and has a wide-ranging role including co-ordination of priorities and budget approaches for catchment and waterway activities, in particular for salinity programs.

* The Rural Affairs, Conservation and Environment Standing Committee assists the cabinet committee to co-ordinate environmental policies, and consists of departmental heads or their nominees.

* The Standing Committee on Rivers and Catchments assists in the co-ordination of river and catchment matters, and has senior departmental officers and representatives from river management, farming, conservation, and recreation interests.

* Catchment co-ordination groups comprise community, farmer, and field-officer representatives from departments. These groups have an advisory but very important role in co-ordinating works and activities within their catchments.

MANAGEMENT OF CROWN LAND IN RIVER CATCHMENTS AND ON FRONTAGES

Management of Crown land is primarily the responsibility of the Department of Conservation, Forests and Lands. All river basins contain Crown land, some of them substantial amounts.

In river catchments, many uses, land management operations, and events such as fires can have a major impact on their short- and long-term condition. In the immediate environs of rivers, either those flowing through large areas of public land or where a public land frontage exists adjacent to private land, land use and management decisions are of even more importance.

Much of the 25 000 km or so of reserved public land frontage adjoins private land, with the reserves covering about 99 000 ha; another 10 000 km of the frontage to major streams is in private ownership, while 28 000 km of minor streams are included in private land. The use and management of these areas is now considered.

Remnant trees in a cleared landscape - Wimmera River frontages near Dadswells Bridge

Unfenced, grazed, degraded frontage - Wimmera River near Eversley (Basin 15)

Water-frontage reserves, in otherwise cleared areas, have many uses. A major present use is for grazing, usually under licences held by adjoining land-owners. However, they also provide: refuges and movement corridors for wildlife; scientific reference material, remnant vegetation, and local genetic stock; seed sources for local plants; food sources for native birds and animals; riparian buffers or filter strips to protect the stream and in-stream habitat; scenic landscapes; public recreation; and gravel extraction.

However, by their very nature and linear shape, they are vulnerable to 'edge effects', and have significant management problems such as: infestation and modification by pests and weeds, rubbish-dumping, illegal clearing, overgrazing, cropping, streambank erosion, pollution, difficult access, and 'traditional' private occupation and use.

Because of this range of uses, it is sometimes difficult for the land managers to protect the various nature conservation, landscape, geological, historical, and cultural values also found along rivers, and to ensure accessibility for recreation uses.

The Department of Conservation, Forests and Lands has been assessing the extent of these difficulties, by means of two record systems:

* Land Information Management System (LIMS), a parcel-based computerised land-asset register designed to collect and record physical and scientific details as a base for future management

* 'Verification of Occupation Program', to review existing occupation of Crown land and to legalise or remove unauthorised uses

The latter program established that about 40% of stream frontage occupations were unauthorised. Licensed grazing takes place on some 50 000 ha, and supports over 144 000 dry sheep equivalents. The

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9000 licences provide income of more than $500 000 each year.

Aims of frontage management

To improve the levels of use and management, the Department of Conservation, Forests and Lands has adopted the general goal to protect, restore and enhance Victoria's rivers and catchments to conditions that maintain the resource and ensure sustainable levels of use. Aims for linear reserves, including stream frontages, are:

* to provide recreational opportunities for a wide range of active and passive recreation uses while minimising effects on the environment

* to conserve and protect flora and fauna, natural features, and land systems, and to make the public more aware of their values

* to review occupations and establish conditions to:
  - eliminate cultivation on immediate floodplains
  - set stocking limits on frontages to minimise degradation
  - encourage revegetation and fencing of frontages
  - allow stock management and prevent erosion

The following particular guidelines for management are being implemented at the time of licence issue or renewal.

* The level of private usage should be set so as to not endanger the natural features and values of the Crown estate.

* Revegetation of stream frontages to stabilise banks should be encouraged by:
  - fencing out frontages to allow revegetation (preferably with indigenous species)
  - limiting uncontrolled access to streams
  - the establishment of co-operative arrangements with land occupiers
  - education programs

* Vermin and weed control on licensed water frontages is the responsibility of the licensee.

* Use of agistment grazing - at specified times of the year for fuel reduction and weed control under controlled conditions - is preferred rather than year-round grazing and stock camping, as these are major causes of erosion and revegetation failure.

* Occupiers of water frontages are encouraged to fence out frontages along their boundaries. In addition, 'management' fencing is encouraged, particularly where the boundary between the private land and the water frontage is an unsuitable fence alignment or where the river has changed course and the exact location of the boundary is difficult to determine.

* The public must have reasonable rights of access and use at all reasonable times.

Other guidelines cover rental charges, reforestation of frontages, and prohibition of camping on licensed frontages or within 20 m of streams.

River migration

One major problem in frontage management results from the difficulties in determining the exact boundary between Crown and freehold land. Many of the original reservations occurred in the 1880s and the frontage strips designated on the parish plans were delineated according to the course of the river existing at that time. In many instances a river's course has since changed and therefore it cannot be assumed that a water-frontage reservation exists along the present course. In other cases the frontage width has been narrowed by bank erosion and subsequent river widening.

The precise situation depends on whether a change occurred imperceptibly over time or in a sudden break-away, and whether the reserve boundary was 'metes and bounds' (surveyed) or a gazetted description (see Figure 7).

Catchment management

As mentioned above, most public land in river catchments is managed by the Department of Conservation, Forests and Lands. However additional powers may apply in domestic water supply catchments, as outlined in Chapter 6.

Code of Forest Practices

The single most extensive catchment land use category on public land across Victoria is State forest, much of which is available for timber production, although only a small area is harvested each year. The *Code of Forest Practices* has been prepared to apply to all timber-production activities on both public and private land, although at present it has been approved only for application to public land. Private land is being considered separately.

The Code states principles and guidelines for the control of timber-production activities, rather than specific requirements and conditions. These principles and guidelines are intended to form the basis of detailed plans and prescriptions for the management of State forests, and the basis of the planning schemes that set the conditions for issuing permits for timber-production activities on private land. The Code does not, however, apply to private-land clearing operations.

The following environmental care principles in the Code are specific to the protection of stream and catchment values.

* Water quality should be protected by measures that prevent the direct disturbance of streams, springs, soaks, swampy ground, and standing water bodies and protect their physical, chemical, or biological quality.

* Stream flow in water catchment areas should be maintained by the careful planning of operations.

* Soil stability should be protected by measures that regulate site disturbance.

* Soil, water catchment, and landscape values should be protected by the careful location, construction, and maintenance of timber-extraction roads and the regulation of their use.

The Code therefore requires that consideration be given to all aspects of catchment stability, water quality, and stream flow. The actual measures that must be taken will vary widely depending on the location of proposed activities, soil and catchment characteristics, and land and water uses. In native forests, for example, more-erodible soils may require a lower slope limit; in a proclaimed water supply catchment it may be necessary to prohibit operations during the winter months.

Landscape values must also be protected but the Code does not refer specifically to those associated with rivers and streams. In practice, landscape values associated with main roads, major tourist routes, walking tracks, look-outs, and similar vantage points are considered. Rivers and streams used extensively for recreation purposes could therefore be readily included.

For State forests the Code is being implemented through an integrated planning approach, which requires preparation of a management plan and wood-utilisation plan for each of 15 defined areas across the State and a coupe plan for each operation.

Integrated catchment management

The philosophy of a co-ordinated approach to combating river degradation has been mentioned earlier and is central to the principles of Integrated Catchment Management, which 'is taken to mean the identification and marshalling of all available land, water, human and biological resources within a catchment to optimise the value of sustainable beneficial uses of the physical environment' (Australian Water Resources Council).

The catchment and the stream should be considered as a single system, rather than as two interacting systems. This is also consistent with the State Conservation Strategy, which emphasises the 'whole-catchment' approach to resource management. The critical relationship between land use activities in a catchment and the resultant condition of the associated river system needs to be recognised and managed. To do this, the interactions of land and water, as well as the management of vegetation and habitat within waterways and their environs, need to be integrated.

River Management Authorities' roles and functions, and related effects, are wider than just in-stream activities, and the integrated approach should ensure that greater concern for stream protection and management is incorporated in works plans and programs.

In developing programs for better waterways it is important to identify requirements for better management of both publicly and privately owned frontage lands.

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PART II

NATURE OF RIVERS AND STREAMS

9. RIVER AND STREAM GEOMORPHOLOGY

The shape of the Earth's surface is determined by the combined operation of geological and geomorphological processes. Water is an important geomorphic agent. Its direct impact as rain on bare ground causes erosion, its expansion when it freezes to form ice can cause rocks to break apart; combined with acids, water over time will dissolve rocks; and the energy it gathers as it runs down hill will cause erosion and transport of solid material.

Knowledge of these roles of water is essential for many aspects of this investigation. Catchment and river management activities such as clearing land, constructing dams, straightening rivers, and removing gravel and sand from their beds have effects that can be predicted and understood using such knowledge. For example, the economic return from a dam may not be obtained if the reservoir fills with silt.

This understanding will also assist in explaining natural variations in aquatic ecosystems. For example, particular plants and animals will only live in streams with beds consisting of cobbles, and may cease to exist if the cobbles become covered with a layer of fine sediment, or are totally removed by dredging.

The geomorphic processes described in this chapter have left their mark on the landscape, and many of the sites of geomorphic significance (discussed in Chapter 15) reflect these.

Recreational activities utilise geomorphic differences to provide their necessary requirements. In the East Victorian Uplands, white water in mountain tract systems provides canoeing opportunities, while the steeply dissected slopes provide habitat for the deer that hunters seek. Each of the other activities described in Chapter 16 is similarly associated with particular geomorphology.

It is perhaps self-evident that major flooding occurs on the present floodplain geomorphic units in the Murray Basin Plains and South Victorian Riverine Plains regions (see Table 10), and on other smaller floodplains, as discussed in Chapter 22.

This chapter briefly describes key concepts and terms used to define the geomorphology of streams and variations in stream-bed composition. In order to provide a basis for recognising different river types, the major geomorphic regions of Victoria are outlined. These are used, in conjunction with the hydrologic regionalisation described in Chapter 10, to develop the river type classification discussed in Chapter 13. The use of geomorphic regions in recognising scenic landscape character is also introduced.

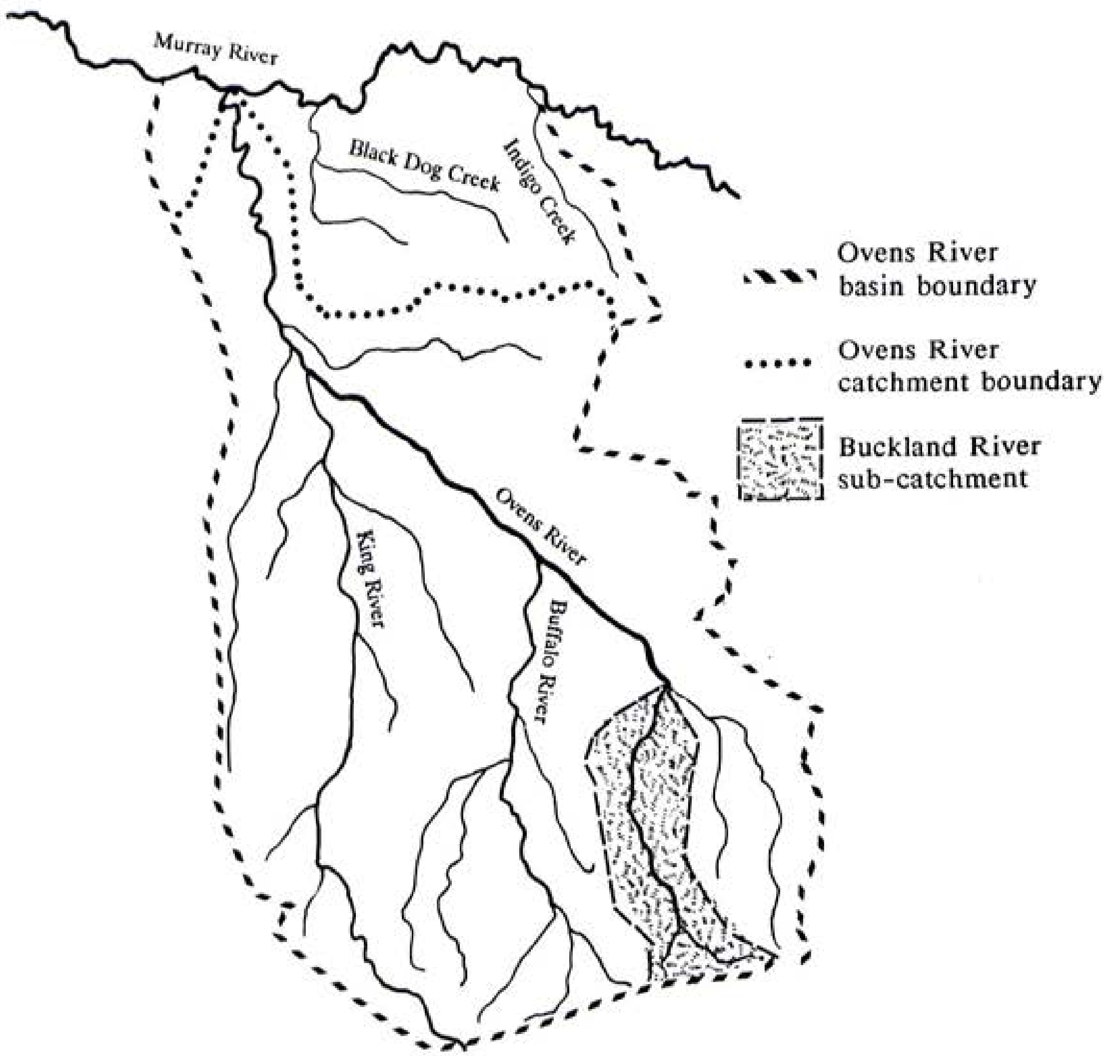
THE CATCHMENT AND STREAM ORDER

A basic unit in water management is the catchment. It integrates both the land and the drainage network within it. Catchments are often oval or pear-shaped in plan and have a number of characteristics. For example, catchments to coastal rivers:

* have a single outflow point at the lowest point in the catchment
* shed surface water which flows out of the catchment at one point (assuming flow is not diverted); its path to the sea is then uniquely determined
* are surrounded by the catchment boundary - the high areas or divides around their edges, which separate them from adjacent catchments
* produce stream flow that may or may not combine with flows from adjacent catchments before reaching the sea

As streams flowing from separate catchments progressively join, the area drained and the volume of the stream channel increase until entire river basins are formed. As outlined in Chapter 4, Victoria is divided into 29 major river basins. The highest points in these basins

FIGURE 8
THE OVENS RIVER BASIN AND ITS SUBCATCHMENTS



are found around the basin margins and are usually known as the stream headwaters. Apart from those ending at inland lakes, river basins south of the Divide have the sea as the lowest point, while basins north of the Divide outfall to the Murray River.

Naming streams serves to identify both the stream and its catchment. When streams join the name of the bigger stream is usually maintained to describe the downstream section. For example, in the Ovens Basin, the Ovens River is progressively joined by the Buckland, Buffalo, and King Rivers.

The Ovens catchment includes all the land and streams above the confluence of the Ovens and Murray Rivers that drain into the Ovens. By contrast, the Buckland River catchment is only that area that drains directly into the Buckland River, which is said to be a sub-catchment of the Ovens. Figure 8 describes this concept.

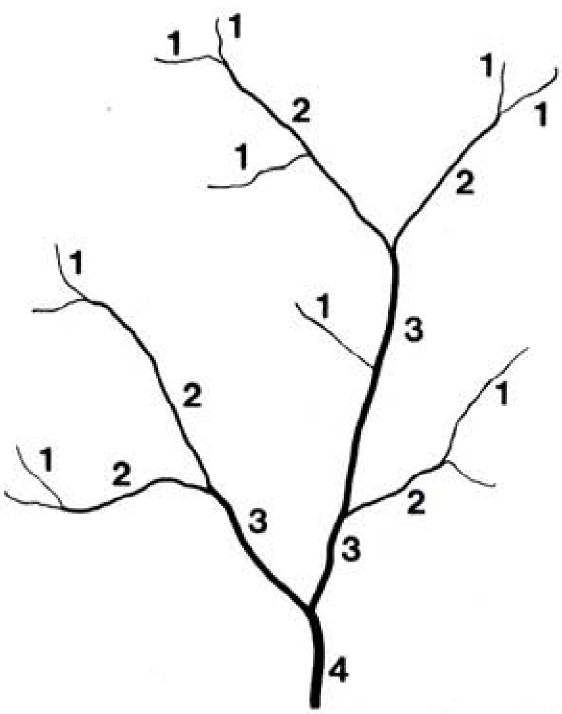
Except for the common creek names like Boggy, Reedy, Sandy, and Scrubby, stream names only provide a convenient label to identify a stream's location. They tell us little of its flow characteristics. Naming or numbering streams according to their order allows ready geomorphic and ecological comparisons to be made between streams.

There are several methods of doing this: in the Strahler system, stream order starts in the headwaters and increases in units of one in the downstream direction. First-order streams are the smallest unbranched channels in the headwaters of a catchment.

When two of these streams meet, they become a second-order stream. Third-order streams form when two second-order streams meet, and so on (see Figure 9). On maps, however, the size of the smallest streams shown depends on the scale. For this report stream order was based on the stream network shown on the National Mapping topographic map series covering Victoria at the scale of 1:250 000.

A project being carried out for the Department of Water Resources will result in each stream in the State being given a unique number. These are organised in order, according to the 29 basins, rivers, and their tributaries. The project, titled Stream and Catchment References for Environmental Data, is numbering every stream shown on the 1:100 000 topographic map series.

FIGURE 9
STREAM ORDER DIAGRAM



RIVER CHARACTERISTICS

Drainage pattern and drainage density

Two important features of drainage systems as seen from the air or on a map are their drainage patterns and their drainage densities or amount of drainage network in a given area.

Drainage patterns are often developed in response to the underlying local geology. Figure 10 shows different sorts of drainage patterns such as dendritic, trellis, rectangular, and radial.

Dendritic patterns develop in regions composed of rocks with uniform resistance to erosion. The resulting pattern is like the branching of a tree and is the most common drainage pattern in Victoria. Trellis patterns develop in regions where alternate dipping layers of soft and hard rock occur. The streams run dominantly in the direction of the easily eroded material and then turn sharply, cutting through the harder rocks. Radial patterns develop on domes of rocks uniformly resistant to erosion or on volcanic cones. Here the streams cut their channels as they run off from a central high point. Rectangular patterns develop where the underlying rock has major joints meeting at 90 degrees, which create weaknesses in the rock which erode more easily. Examples occur on resistant but jointed granite, such as at Mounts Buffalo and Baw Baw.

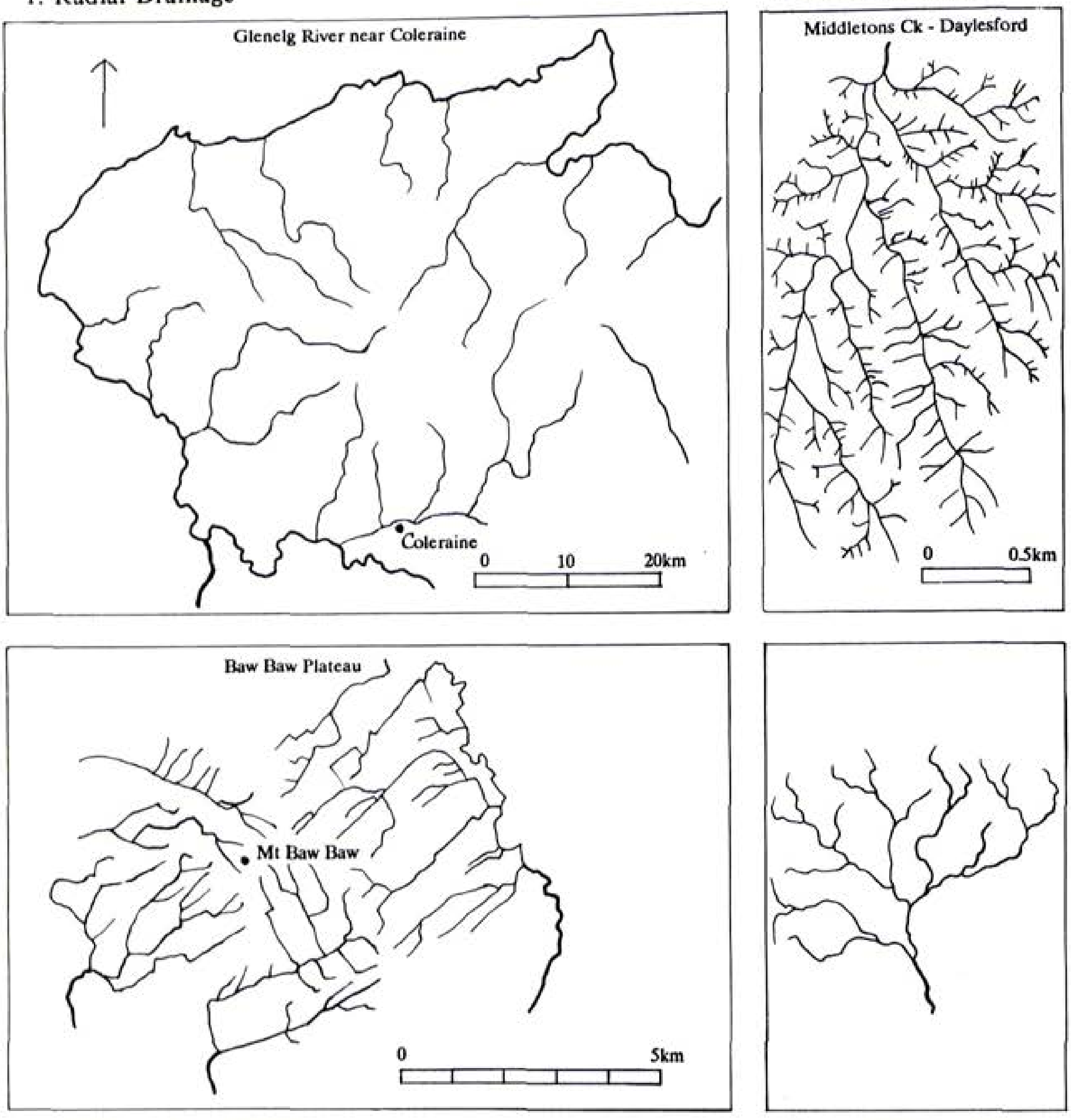
Over geological time, drainage networks may change as a result of earthquakes, lava flows, landslides, and river-capture processes. Victorian examples of these changes include capture of the headwaters of the Broken River above Nillahcootie by the Goulburn, and changes in the course of the Murray River at Barmah Lakes. The rise of the Cadell fault block near Echuca, about 20 000 years ago, impeded the flow of both the Murray, diverting it north and south, and blocked Cornella Creek, forming Lake Cooper. Yorta Yorta oral tradition recalls these events (see Chapter 5).

The drainage density of a catchment refers to the number of channels for a given area. The amount of channel development reflects the rainfall and the properties of the underlying rock. As a result of low annual rainfall (less than 200 mm), the far north-western corner of the State has a comparatively very low drainage density. Where the underlying rock is highly permeable being either strongly fractured or consisting of loose sand or scoria, or containing large connected caverns, much of the water will drain directly to the underlying groundwater table.

FIGURE 10
STREAM DRAINAGE PATTERNS

1. Radial Drainage

2. Trellis Drainage



3. Rectangular Drainage

4. Dendritic Drainage

This is particularly the case for limestone areas, which, as a result of the ease with which limestone dissolves, are often dotted with sinkholes and connected cave systems. Examples occur near Nelson, Warrnambool, and Buchan.

Stream profile

As water flows from the highest to the lowest point in a catchment the loss of gravitational energy results in a change from areas dominated by the transport of eroded material to areas of active deposition. The downstream change in height above sea level is known as the stream's longitudinal profile. The profile tends to be concave, with the steepest sections in the headwaters section of the basin (see Figure 11). This profile provides an indication of the amount of energy in the water, and whether the stream is likely to erode or deposit sediment. Rivers can erode or deposit material at any point along their course, but will generally erode material where the profile is steeper and deposit it at points along the flatter part of the profile.

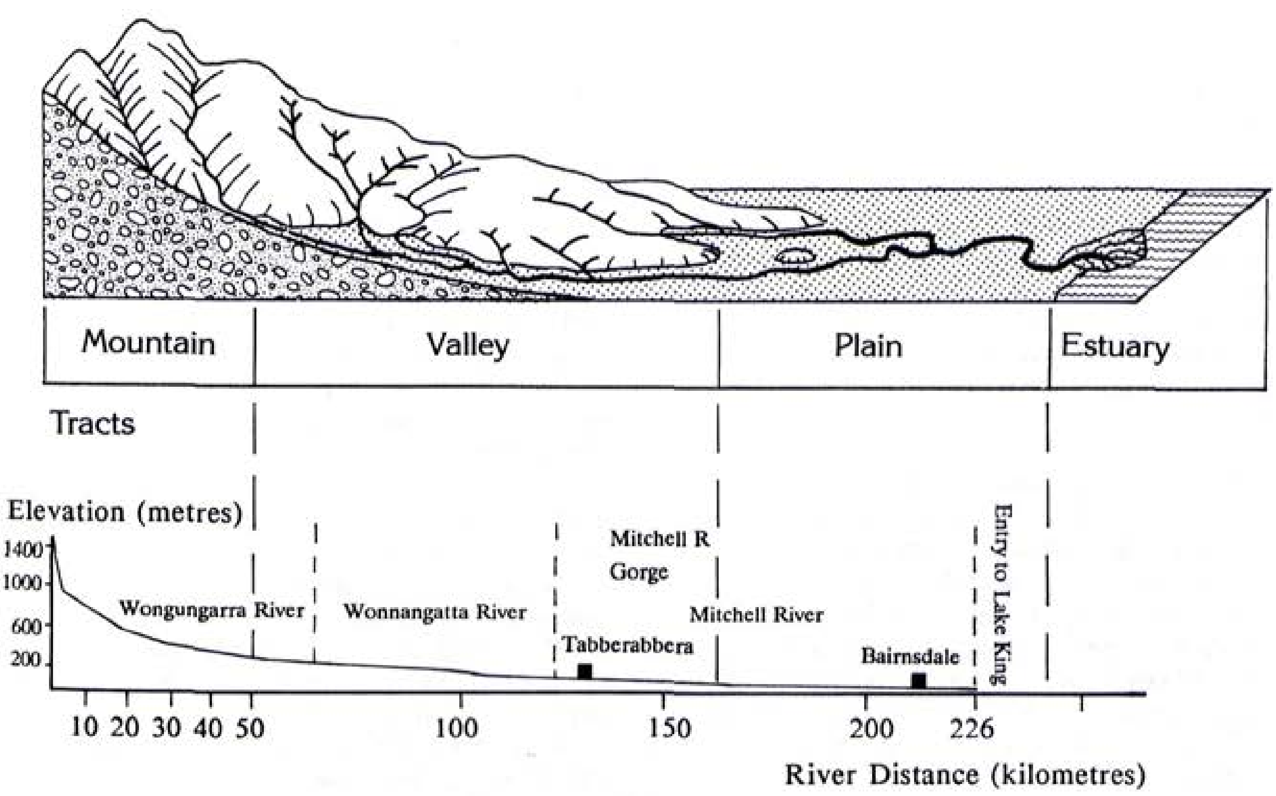
Important features of a profile are the base levels, which set the lower limits for erosion. For streams flowing into the sea, sea level is the base and streams rarely erode below this depth. Consequently the major rises and falls in sea level that have occurred over the last 120 000 years have fundamentally affected stream profiles and the distribution of erosion and deposition along them. The increase in sea level that started 18-20 000 years ago and resulted in the sea being about its present level would have drowned many former river valleys, forming the estuaries now found along the Victorian coast.

Local base levels are also important in stream profile development and are often formed where the river crosses hard rocks that are resistant to erosion. Waterfalls often occur on the downstream side of such base levels or knick points in the profile. Lakes, whether they are natural or formed behind artificial barriers, also act as a local base level for streams flowing into them. Any sediment carried by the stream is then deposited in the lake, progressively filling it.

As Victorian rivers and streams have catchments of differing areas, climates, and rock types and geological histories, each river and stream has developed its own unique longitudinal profile. Figure 11 shows the profile of the Wongungarra, Wonnangatta and Mitchell Rivers, a curve which is close to the 'ideal' shape.

The Little River, at Wulgulmerang in East Gippsland, drops 600 m into a gorge as it flows from the basalt of the Wulgulmerang Tablelands onto the more easily eroded Snowy River Volcanics. The basalt, which is more resistant to erosion, represents a temporary base level in the river's profile,

FIGURE 11
GEOMORPHIC TRACTS OF A RIVER



Stream Profile - Wongungarra, Wonnangatta and Mitchell Rivers (Basin 24) and the gorge would appear as a steeper section in the Little River's profile.

Lava flows of different ages have created several temporary base levels in the profile of the Hopkins River in the Western District. Similarly, a lava flow has blocked the course of Morass Creek near Benambra in Victoria's alpine region. Morass Creek has deposited sediment behind this lava flow, creating a large swamp. As it flows out of this swamp it cuts a spectacular gorge into the softer rock before joining the Mitta Mitta River.

Erosion and transportation processes

Erosion by rivers can occur by three different processes - hydraulic action, abrasion, and corrosion.

Hydraulic action refers to the wearing away of particles solely by the action of running water. The velocity of the river determines the size of the particles eroded.

Abrasion occurs when particles are eroded through the action of other particles already being transported by the river. Common features produced by abrasion are pot-holes in the river-bed. Here, turbulent flow armed with abrasive material including small rocks grinds a rounded hole into the rock exposed on the stream-bed.

Corrosion refers to chemical action of weak acids in eroding particles. In this way, rivers and streams in limestone areas may form caves, underground rivers, or dolines (large sinkholes). Many of these landforms are evident around Buchan in East Gippsland and in coastal areas of south-western Victoria.

Rivers transport both dissolved and solid material. As dissolved material is invisible, the amount transported and its importance is often only noted when it begins to cause problems. High levels of dissolved plant nutrients such as phosphorus and nitrogen may stimulate algal blooms, while a high concentration of common salt may lead to salinity problems.

The ability of a stream to transport the particles it has eroded depends on its velocity and on the size of the particles. The 'competency' of a river is measured by the heaviest particle it can transport. Particle sizes (and their mass) are described in reducing order as follows: boulder, gravel, coarse sand, fine sand, silt, and clay. Deposition of these particles, or sediment, occurs whenever the velocity of the river falls to the extent that it can no longer transport some of its sediment. Smaller particles can be transported by slower water, so some sorting by particle size occurs, according to velocity.

Because rivers and streams will either deposit or erode sediment at different points along the length of their course, they will develop a sequence of tracts from their source to their mouth. Each tract will display its own geomorphic characteristics.

River tracts

Systematic changes in the size of stream-bed sediment, stream pattern, valley cross-section, and depositional landform allow the longitudinal profile to be divided into four types of tract (Figure 11).

With decreasing altitude, these tracts are: the mountain, valley, plain, and (for coastal streams) the estuary tracts.

Mountain tract

Rivers and streams in the mountain tract generally have a high energy state, and are actively incising or cutting into the land, so valley walls tend to be relatively deep and steep-sided. Most of the river landforms here will be produced by erosion, with the substrate or bed of the stream generally consisting of boulders and gravel.

Where a river or stream flows from a steep range directly onto a flat plain, its competency will fall abruptly, depositing almost all of its sediment load at the foot of the steep range. This results in the formation of fan-shaped sedimentary deposit, which gradually extends onto the surrounding plain and, to a lesser extent, vertically up the edge of the range. This has occurred in the Bacchus Marsh area (at the foot of the Brisbane Ranges), and some alluvial fans have developed under a

Mountain tract - Tingaringy Creek headwaters (Basin 22)

Valley tract - Mitta Mitta River (Basin 1)

Plain tract - Thomson River (Basin 25)

Estuary tract - Red River (Basin 21)

similar process from streams flowing off the Cathedral Range near Buxton.

Valley tract

Further downstream, the volume of the stream increases as it is joined by its tributaries, the gradient of the stream decreases, and both the channel of the stream and the valley through which it flows widen. Landforms produced by both erosion and deposition are evident.

The floor of the valley comprises alluvial deposits and, over a period of thousands of years, the river will change its course many times across these alluvial river flats. In doing so, it will form billabongs (backwaters and swamps occupying an abandoned river-bed), and may undercut hill slopes on either side of the valley floor, causing sharpened spurs and related landforms to develop. Rivers such as this may have stretches of alluvial floodplain, punctuated by one or both banks having rocky or hilly sides. Victorian examples of these include the Goulburn River between Eildon and Trawool, the Murray between Corryong and the Hume Weir, and the Ovens between Harrietville and Myrtleford.

Plain tract

In this tract the river has a low gradient and the floodplain is covered by an extensive alluvial deposit. Should the river overtop its banks, extensive flooding of the surrounding country will occur. Victorian examples are the Goulburn downstream of Nagambie, the Loddon downstream of Bridgewater, and the Murray downstream of Wodonga.

The meandering of these rivers is pronounced, as they do not flow across beds of resistant rock that obstruct the development of bends. The winding habit of rivers in their plain tract appears to be inherent in flowing water. As a river moves around a bend, its water will have greater velocity near the outside of the bend because of the greater distance it must travel. Here, erosional processes take place, with the river eroding the outside bank and deepening. Depositional processes occur on the inside of the river bend, and many sandy beaches have developed on such points. Thus, the course of the rivers is continually changing over time, and these processes are active in many Victorian rivers at the present.

Another feature in the plain tract is the development of low linear mounds parallel to the river - called levee banks - caused by the deposition of sediment during flood or near-flood conditions.

If these levee banks are breached during high flow, water flowing from the river may scour a new course for some distance - known as a breakaway or anabranch - before rejoining its original watercourse further downstream. Extensive examples of such river behaviour are found between Echuca and Swan Hill, with Gunbower Creek, Barr Creek, and Pyramid Creek taking off from the Murray River and rejoining it via the Loddon River. Some such channels known as effluents do not rejoin the parent stream. The Yarriambiack Creek is such an effluent of the Wimmera River, forming its own course.

Where rivers with high flows also have high sediment loads, they may form numerous small branching and reuniting shallow channels. These rivers are said to be 'braided'. The lower reaches of the Avoca River displays this condition, and here the division reduces the flow in each channel to a level insufficient to reach the Murray. In normal years the river courses fill terminal lakes near Kerang.

Because of geological events, some rivers in their plain tracts incise their meanders into a narrow valley or gorge within the surrounding plain. Many rivers in south-western Victoria - such as the Moorabool, Maribyrnong, and Yarrowee Rivers - have incised meanders within the basaltic plains.

Some rivers do not have the volume of discharge to sustain them across their plain tracts. This is particularly so for the semi-arid environments of north-western Victoria, where rivers flow to terminal inland lakes. The Wimmera River, Yarriambiack Creek, and Tyrrell Creek provide examples. Usually, the Wimmera River ends at Lake Hindmarsh. However, in wetter than average years, Outlet Creek may carry water from Lake Hindmarsh to

Lakes Albacutya, Brambruk, and Agnes and eventually to the Wirrengren Plain, west of Patchewollock, the ultimate terminal lake of the Wimmera River system.

Outlet Creek has not flowed to Wirrengren Plain since 1917. This may be due in part to increased removal of water from the river for agricultural use in the Wimmera and Mallee regions of the State and, if permanent, may threaten the viability of riverine vegetation around these terminal lakes.

Estuary tract

The estuary tract usually develops in a coastal river at its mouth. Such tracts are characterised by very low gradient, and deposition of fine-textured sediment as alluvial, swamp, and lagoonal deposits is common. Tidal effects are also evident in this tract.

Where the river empties into a low-energy environment such as a coastal lake or estuary, rather than into the sea, it often develops a delta. Where wave action is minor and therefore does not disperse the river's sediment load widely, the delta can extend for some distance.

In Victoria, the Gippsland Lakes environment facilitates development of deltas. The LaTrobe, Nicholson, and Tambo Rivers have all produced deltaic landforms extending some distance into the lakes, but the most dramatic local delta is that of the Mitchell River.

Here the river has deposited silt progressively along both banks from its junction with Lake King out to a distance of 5 km into the lake. This delta, consisting of two parallel 'silt jetties' as they are commonly known, is one of the finest examples of this landform in the world.

Unfortunately, the artificial ocean entrance to the Gippsland Lakes, completed in 1889, has resulted in increasing salinity in Lake King, which has killed off the reed beds that once protected the Mitchell delta from wave action. So the silt jetties are now unstable and eroding in places.

GEOMORPHIC CLASSIFICATIONS

Geomorphic units

Jenkins and Rowan have characterised the geomorphology of the State into six main regions, which include 29 distinct geomorphic units (see Table 10). Map 10 shows the geographic distribution of these regions and geomorphic units and Chapter 13 discusses their use as one of the two main components of the river catchment classification system. The six regions are described below; the numbers refer to the first digit in the two-part code identifying each unit.

1,2. Central Victorian Uplands

The Uplands separate the catchments of the north-flowing streams, which join the Murray River, from the south-flowing streams that drain to the Victorian coast. Generally, the Uplands trend east--west across the State, their width and elevation decreasing to the west until they reach their extremity west of the Grampians.

Two major divisions are recognised, the West Victorian Uplands and the East Victorian Uplands, separated by an area of relatively low elevation at the Kilmore Gap. In total, the Central Uplands contain seven geomorphic units.

3. South Victorian Uplands

Several isolated upland regions exist in the south of the State. The main areas are the Otway Ranges and the ranges of South Gippsland, both composed of beds of siltstone and sandstone. Other areas include the Mornington Peninsula, the granite mountains of Wilsons Promontory, and the Barrabool Hills near Geelong.

4,5,6. Murray Basin Plains

Bounded, in Victoria, by the highlands to the south and the Murray River to the north, the Murray Basin Plains can be divided into three major divisions, the Riverine Plains, Mallee Dunefields and Wimmera Plains. The Riverine Plains comprise alluvial material, most of which was deposited by river systems more ancient than those that flow through the region today. In places the alluvium is covered by a red-brown sandy clay,

Table 10

GEOMORPHIC UNITS OF VICTORIA

Region		Geomorphic unit	
Central Victorian Uplands	1. East Victorian Uplands	1.1	Dissected uplands
		1.2	Dissected plateau (Wellington uplands)
		1.3	High plains (Dargo, Bogong, etc.)
	2. West Victorian Uplands	2.1	Dissected uplands (Midlands, etc.)
		2.2	Prominent ridges (Grampians)
		2.3	Dissected tableland (Dundas Tableland)
		2.4	Dissected tableland (Merino Tableland)
3. South Victorian Uplands		3.1	Dissected fault blocks (Otway Ranges)
		3.2	Moderately dissected block (Barrabool Hills)
		3.3	Moderately dissected ridge (Mornington Peninsula)
		3.4	Dissected fault blocks (S. Gippsland Ranges)
		3.5	Dissected outlier (Wilsons Promontory)
Murray Basin Plains	4. Riverine Plain	4.1	Present floodplain (Murray Valley)
		4.2	Older alluvial plain (Shepparton)
	5. Mallee Dunefield	5.1	Low calcareous dunes (Ouyen)
		5.2	High siliceous dunes (Big Desert/Sunset)
	6. Wimmera Plain	6.1	Clay plains (Nhill)
		6.2	Ridges and flats (Goroke)
		6.3	Low siliceous dunes (Little Desert)
7. West Victorian Volcanic Plains		7.1	Undulating plain (Western District)
		7.2	Stony undulating plain (Western District)
8. South Victorian Coastal Plains		8.1	Ridges and flats (Follett)
		8.2	Dissected plain (Port Campbell)
		8.3	Sand and clay plain (Moorabbin)
		8.4	Fans and terraces (Western Port)
		8.5	Barrier complexes (Discovery Bay/Gippsland Lakes)
9. South Victorian Riverine Plains		9.1	Present floodplains (Gippsland)
		9.2	Intermediate terraces (Gippsland)
		9.3	High terraces and fans (Gippsland)

originating from fall-out from dust-laden winds. The Mallee Dunefields consist of east--west trending sand and clay dunes formed between 15 000 and 40 000 years ago, and parabolic sandy dunes, which generally display greater relief. The Wimmera Plains are characterised by dark grey calcareous clayey soils. Rivers here give rise to anabranches and effluent streams, while, towards the south, chains of swamps and small lakes are aligned between closely spaced ridges.

7. West Victorian Volcanic Plains

Generally occupying a broad area between Melbourne in the east and Hamilton in the west, the plains were formed by lava flows from numerous volcanic eruption points, which were active between 6000 and 6 million years ago. Volcanic hills and craters, *some filled with* lakes, punctuate the landscape. The lava flows filled existing river valleys, diverting some rivers in the area and causing others to cut deeply into the basalt plain.

8. South Victorian Coastal Plains

These areas are composed of marine sediments, and range from the limestones of the Port Campbell and Lower Glenelg areas, through the sand plains around Port Phillip and Western Port Bays, to the coastal barrier complexes of the Gippsland Lakes and Discovery Bay.

9. South Victorian Riverine Plains

Found only in Gippsland, the plains were formed by the deposition of sediment from the rivers draining south from the Uplands, and include the Latrobe, Thomson, Mitchell and Snowy Rivers.

Landscape Character Types

The geomorphic regions have characteristic components, which with land-use and vegetation patterns provide a basis for dividing Victoria into visually similar landscapes.

Nine main landscape character types have been identified and mapped for Victoria. Each reflects broad-scale areas of land with common distinguishing landforms, vegetation patterns, and waterforms. The basis for differentiation is the shape of the landscape in different regions, which is derived from the same basic features as the geomorphic regions, and there are necessarily strong similarities between the two classifications. This is illustrated in Maps 10 (black lines and labels) and 14.

Chapter 17 discusses the use of the landscape character types in assessing the scenic quality of Victoria's rivers and streams.

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10. HYDROLOGICAL CHARACTERISTICS

CLIMATE OF VICTORIA

The major topographical determinant of Victoria's climate is the Great Dividing Range, which runs west--east across the State, then turns northwards and rises to nearly 2000 m in the eastern half. The Divide acts as a barrier to the moist south-east to south-west winds and, together with its proximity to the coast, causes the area south of it to receive more rain than the area to the north.

With the exception of Tasmania and its islands, no land lies to the south of Victoria for 3000 km. This vast area of ocean has a moderating influence on Victoria's winter climate. Snow is a common winter occurrence at similar latitudes on the eastern seaboard of the great land masses of the Northern Hemisphere, but is rare in Victoria below elevations of 600 m and only endures above 1200 m. To the north of Victoria, however, the land mass of Australia becomes very hot in the summer, and on several days at this time of the year the temperature within the State may rise to between 35°C and 40°C, often with a strong northerly wind.

Rainfall

Across Victoria, the average annual rainfall varies from more than 1400 mm in the Alps and the Otway Ranges to around 250 mm in parts of the Mallee (Map 6), and for, half of the State remains below 650 mm.

The Great Dividing Range is the main physiographic feature affecting distribution of this precipitation. The higher average altitude of the Divide in the east causes the major proportion of it to occur in the eastern half of the State. Northwards, the precipitation decreases rapidly with increasing distance from the Divide. To the south, it is higher and more reliable because of the highland areas' proximity to the coast and the effect of prevailing west and south-westerly winds. Moist air streams crossing the Southern Ocean from the west also cause pockets of high rainfall in the Otway Ranges and on Wilsons Promontory.

Rain 'shadows' occur on the downwind sides of those parts of the terrain high enough to cause precipitation on the windward slope. This phenomenon is most notable in the hinterland of the Gippsland Lakes, which is substantially shadowed in several localized areas by the Great Dividing Range, and the Werribee Plains, which are shadowed by the Otway Ranges. Rain shadows are also evident on the eastern sides of the Grampians, Pyrenees, and Strzelecki Ranges (Map 6).

The other principal influence that shapes the seasonal pattern of Victoria's weather is a general movement of high-pressure atmospheric cells from west to east. The low-pressure troughs between these cells usually bear rain. Seasonal variation in the path of the westerlies extends their influence further north during winter. Most of Victoria receives higher average monthly rainfall in winter than in summer, although this is more evident in the west and north of the State than elsewhere. Further, its the seasonal distribution is more even across the south-central and south-eastern regions than in the west and north.

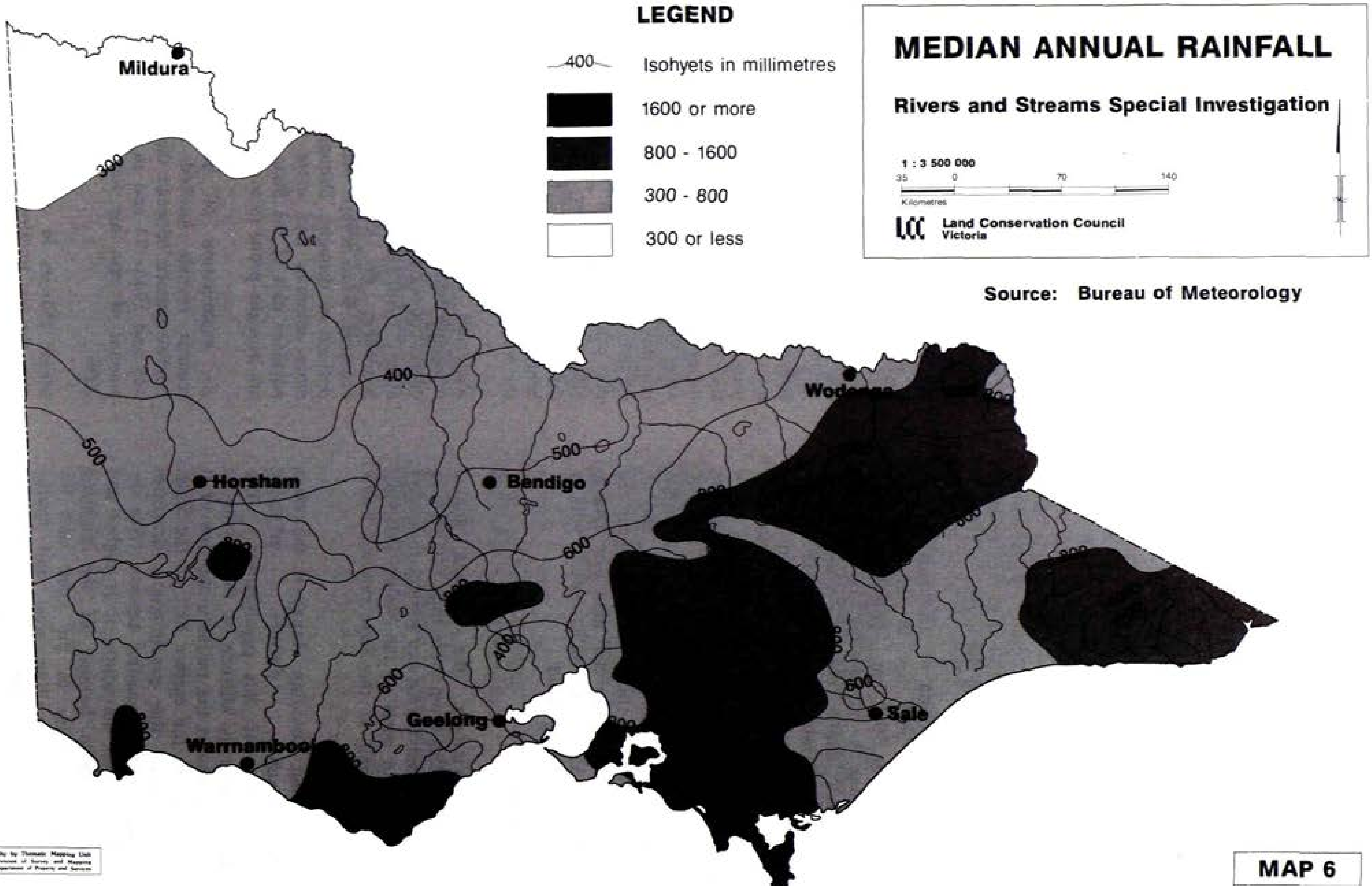
Victoria's annual rainfall varies quite markedly from year to year, although the degree of variability is less than in the other Australian mainland States. Sequences of low-rainfall years are common. When severe, these sequences are defined as drought. Drought tends to be more common and more severe in the northern part of the State, but most parts are drought-prone to some degree.

An examination of historical rainfall records reveals marked differences in rainfall pattern between the periods 1913--45 and 1946--74 and in some areas the amount of rain has increased by up to 20%.

Major changes in climate have occurred over the last hundred thousand years as a

MEDIAN ANNUAL RAINFALL

Rivers and Streams Special Investigation



Source: Bureau of Meteorology

MAP 6

Cartography by Thematic Mapping Unit, Division of Survey and Mapping, Department of Property and Services

AVERAGE ANNUAL PAN EVAPORATION

Rivers and Streams Special Investigation

1 : 3 500 000

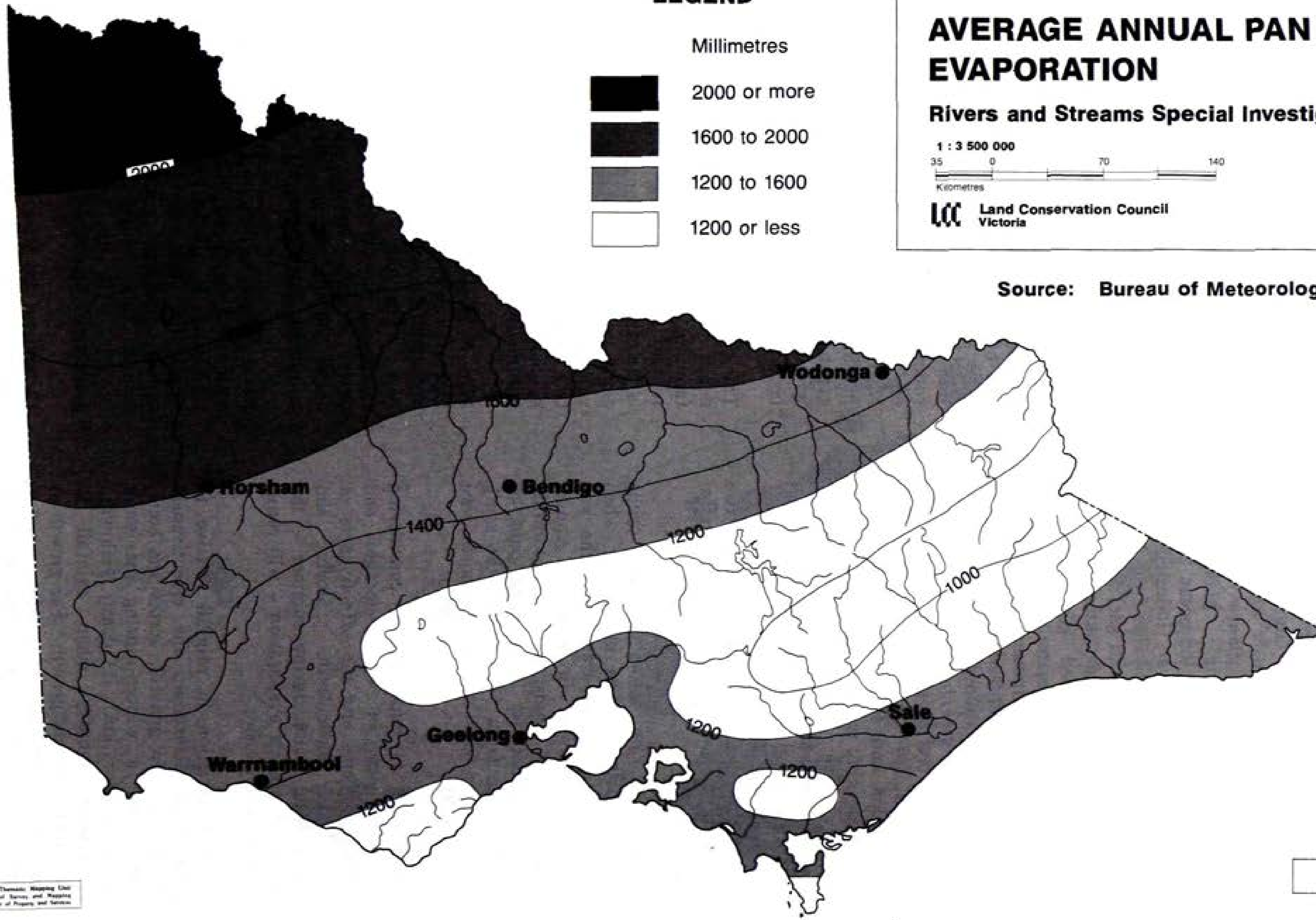
Land Conservation Council Victoria

LEGEND

Millimetres

- 2000 or more
- 1600 to 2000
- 1200 to 1600
- 1200 or less

Source: Bureau of Meteorology



MAP 7

direct effect of natural heating and cooling of Earth's surface.

World-wide, for centuries, sources of carbon dioxide - combustion and respiration (from animals and plants) - remained in dynamic balance with uptake by photosynthesizing plants and phytoplankton and by the ocean floor and other 'sinks'. However, industrialization has produced carbon dioxide from burning fossil fuels (oil, coal, and gas) at a greatly increased rate, while extensive forest clearing has reduced the mass of photosynthesizing material. Other industrial gases compound this, resulting in increased concentrations of the gases that insulate the atmosphere, reducing heat escape. This 'greenhouse effect' is likely to promote warming of our Earth, with changes in, for example, rainfall amount, distribution and seasonality and ice-cap-melting leading to sea-level rises.

Water loss to the atmosphere -
evaporation and transpiration

Evaporation and transpiration are two important components of the hydrological cycle.

Evaporation rate shows strongly cyclic variation being highest in summer when the air is dry and warm and the sun strong, and lowest in winter. Annual figures for atmospheric evaporation potential (measured using open pans of water) range from 1400 mm in the south to more than 2000 mm in the north-west (see Map 7).

Evaporation is important in considering the efficiency of open storages and channel systems and the effectiveness of rainfall for agriculture. Storing and transporting water during summer - the period of highest evaporation - will result in large water losses.

Seasonal variation in rainfall relative to evaporation determines the effectiveness of rainfall. In general, across the State, rainfall has a winter--spring maximum when evaporation is least, allowing consecutive months when rainfall is sufficient for plant growth. For growth to continue in the summer months, when a water deficit applies for shallow-rooted plants, additional water supplied by irrigation is required.

SURFACE WATER RUN-OFF
QUANTITY AND VARIABILITY

Surface water run-off reflects the combined effect of the various components of the water cycle: rainfall, evaporation and transpiration, infiltration, and groundwater inflow.

On average, 150 000 000 ML of rain and snow falls across the State each year. Only a small proportion of this precipitation subsequently becomes surface run-off, as 84% of the amount reaching the ground either evaporates or is transpired by vegetation. (This may be compared with an evapotranspiration loss of approximately 60% in Europe and North America.) Another 1% of the total infiltrates the soil to depths saturated by groundwater storage and becomes 'groundwater'. The remaining 15% becomes stream flow.

The concept of measuring rainfall by its depth - that is, in millimetres - is familiar. In order to compare rainfall and run-off from particular areas, however, it is helpful to also convert run-off to a depth unit, by dividing a stream's run-off volume by the area of catchment it drains. One megalitre of stream flow per square kilometre of catchment is equal to one millimetre of run-off.

Map 8 shows that the areas with the highest run-off in millimetres are the high-rainfall and snowfall areas of the Alps. The only other areas generating substantial run-off are the Grampians and Otway Ranges. . In the north-west, with under 500 mm .of rain, there is virtually no reliable surface run-off.

River flows in Victoria have marked seasonal variations and substantial variability in discharge between years. Across the State, about 60% of average annual discharge occurs in the four months July, August, September, and October. (In the western streams this proportion approaches 75%.)

Throughout the State, river flows decrease during the summer and autumn months.

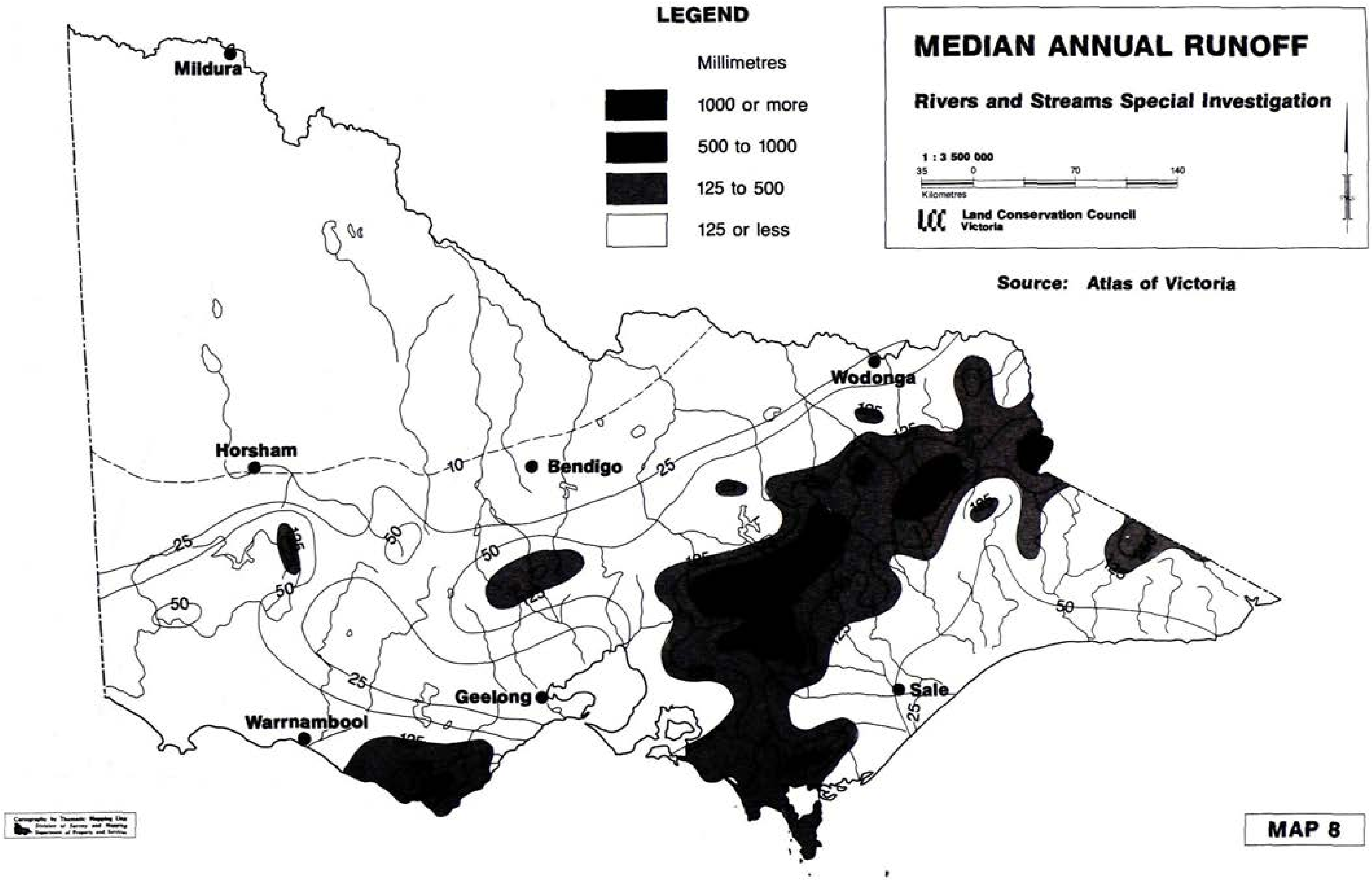
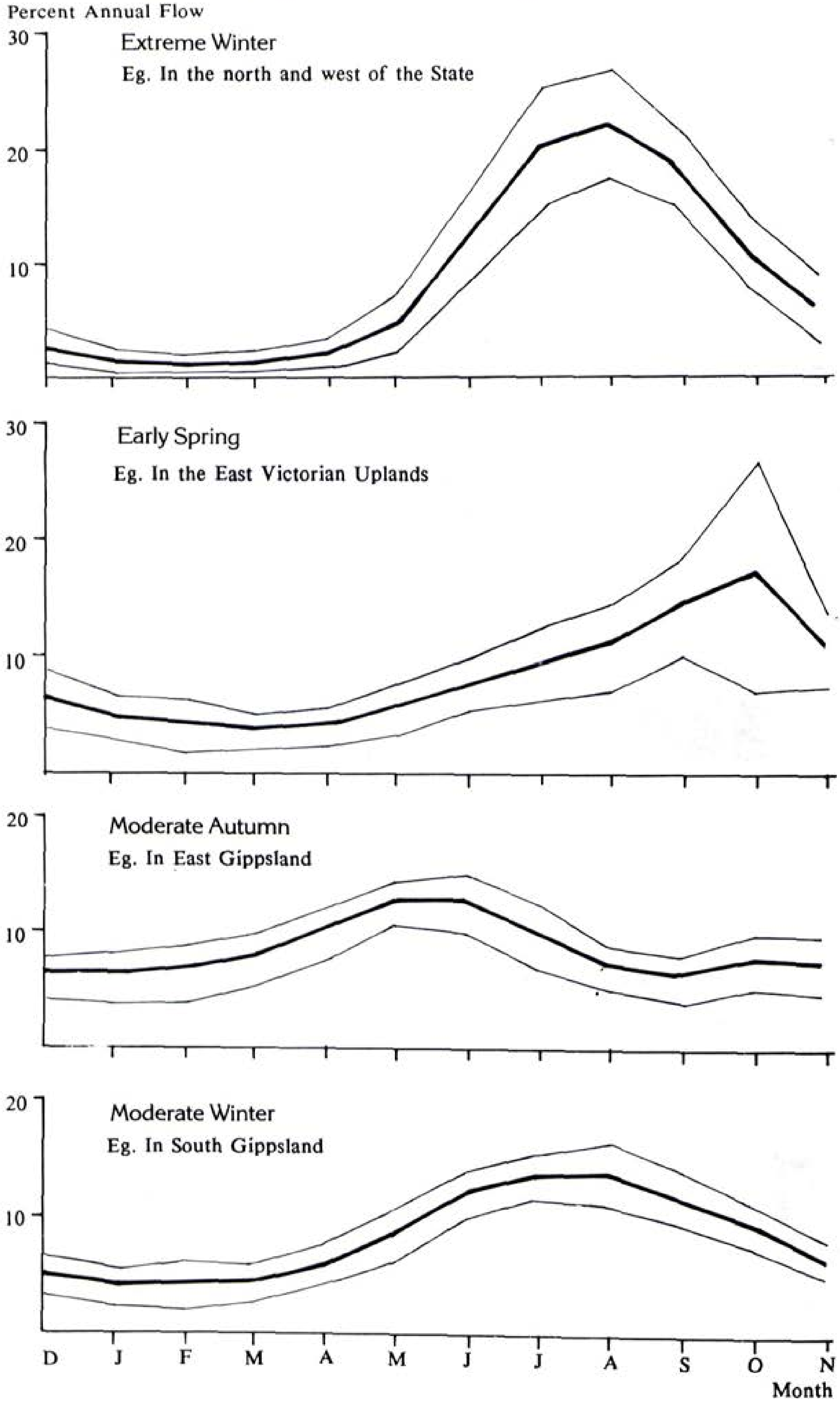

MEDIAN ANNUAL RUNOFF
Rivers and Streams Special Investigation
1 : 3 500 000
35 0 70 140
Kilometres
LCC Land Conservation Council Victoria
LEGEND
Millimetres
1000 or more
500 to 1000
125 to 500
125 or less
Source: Atlas of Victoria
Mildura
Horsham
Bendigo
Wodonga
Geelong
Warrnambool
Sale
10
25
50
125
MAP 8

FIGURE 12
RIVER REGIMES OCCURRING IN VICTORIA



In general those basins with headwaters in the upland areas of eastern Victoria have more reliable flows, while those in the west exhibit a greater degree of variability.

Dry years and wet years occur almost at random, however lengthy runs of dry or wet years can and do occur. Victorian streams, like Australian streams generally, exhibit a higher degree of variation in annual flows than streams in North America and Europe, although they have somewhat lower variations in flow than those in most other Australian States. The variability of stream flow is as important a consideration as its mean volume in the planning and management of water resources.

HYDROLOGICAL REGIONS OF THE STATE

A major aim of the Rivers and Streams Special Investigation is to systematically select representative examples of all stream types in the State. A major input to this process is the identification of river types that differ hydrologically.

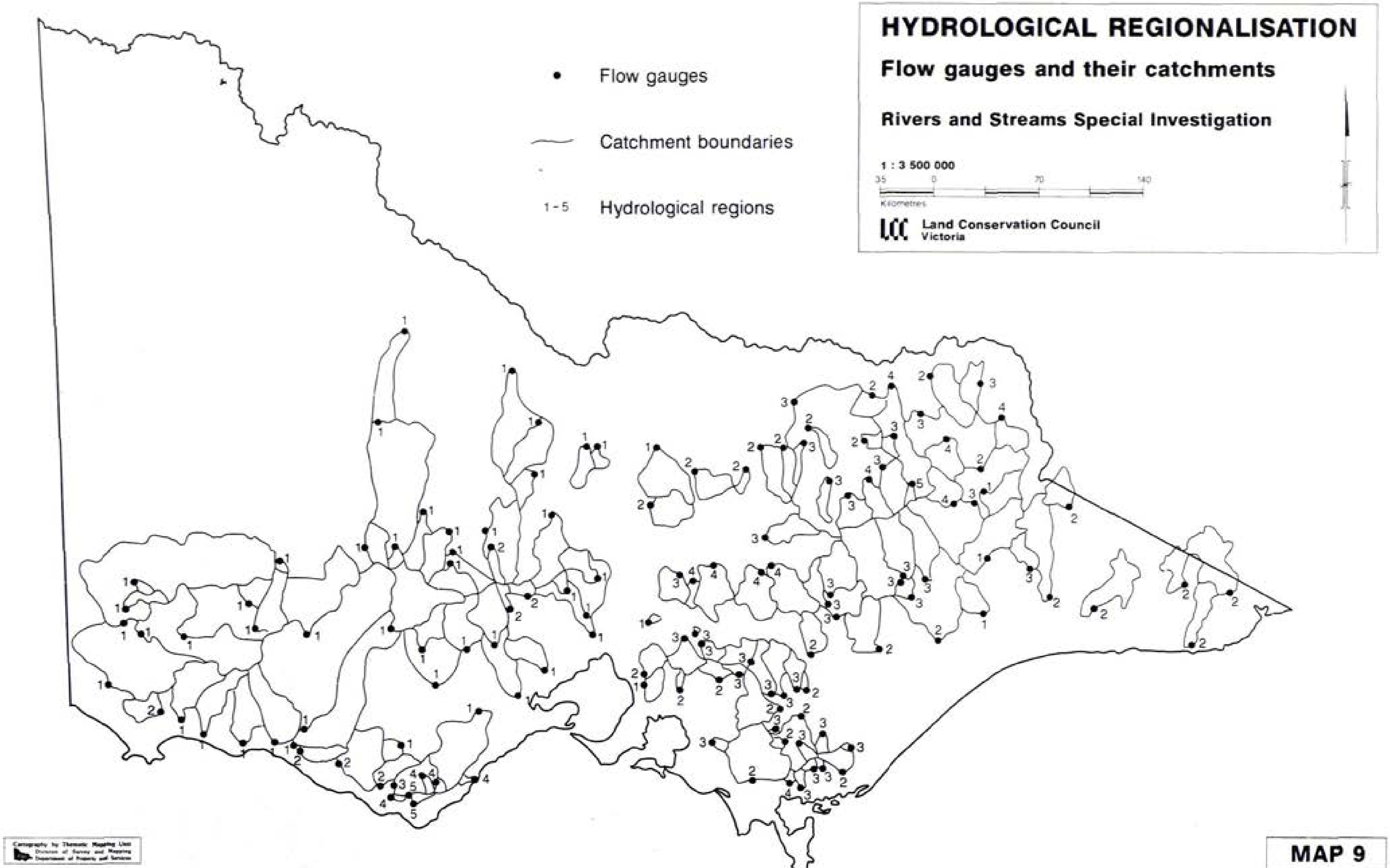
Several attempts have been made to characterize the hydrological behaviour of Victorian and Australian rivers. Compared with streams across the world, Australia's are known to have the highest variability of total annual run-off, having a coefficient of variation of 0.70 compared with a world mean of 0.43. Peak discharges from Australian streams

Flow gauge - Stokes River (Basin 38)

HYDROLOGICAL REGIONALISATION

Flow gauges and their catchments

Rivers and Streams Special Investigation



MAP 9

also vary substantially more than the world average.

Using a global data set, Finlayson and McMahon have identified 15 seasonal river regime classes. They found 10 of these in Australia, from their analysis of records from 156 river flow gauges, and four - extreme winter, early spring, moderate winter, and moderate autumn (see Figure 12) - in Victoria, with the first two dominant.

A more detailed Victorian study by Hughes and James has identified a system of five hydrological regions based on data from 138 Rural Water Commission flow gauges. This analysed a minimum of 15 years' data since 1950, using only streams without major impoundments or diversions. Data on annual flows, monthly flows, peak (daily) discharges and low flows were used to calculate 13 variables, which were then statistically analysed for all stations to identify regional patterns, which led to the five-region system. The stations, spread widely across the State, included most areas except the Mallee, lower Wimmera, Murray floodplain, Moorabbin Plain, and Gippsland intermediate-level terraces and floodplains.

Map 9 shows the distribution of gauges used, their catchments, and the five regions. One of the 13 variables - mean annual run-off - ranges in average values *from 73 mm (Group 1) to 1103 mm* (Group 5). The five regional groups can be generally characterized in order of 'wetness', from Group 1 (dry) to Group 2, Group 3, Group 4, and Group 5 (wet).

Comparisons between Map 6 (median annual rainfall), Map 8 (median annual run-off) and Map 10 (hydrological regions) make it clear that the regions strongly reflect rainfall and run-off.

Key hydrological characteristics of the groups are listed in Table 11. These indicate that, as well as distinct ranges of mean annual run-off, the groups display the following trends.

* Annual and monthly flow variability ranges from Group 1 (high) to Group 5 (low).
* Mean annual maximum flows also vary from Group 1 (low) to Group 5 (high).
* Mean annual minimum flows tend to be low in Group 1 with the other groups having moderate minimum flows.
* Mean low-flow spell duration trends from Group 1 (long) to Group 5 (short).

The regionalization generally indicates that low-run-off, high-variability, drier streams, which are less prone to high peak flows, occur predominantly in the west of the State, and that streams with relatively high run-off, low variability, high mean maximum flows, and moderate mean minimum flows occur in localized areas along both sides of the Great Divide, mainly in the east of the State.

As well as mean annual run-off, 12 other standard annual flow, monthly flow, peak flow, and low flow parameters have been related, to differing degrees, to the five regions. Accordingly, the regions give a very useful way of characterizing Victoria's rivers and streams on the basis of their hydrological regime. It is recognised that the regions necessarily reflect, to some extent, land use differences in the flow gauge catchments.

In terms of stream-flow regulation, the regions give a general guide to differences *that are important when considering in-*stream works. High variability and long low-flow spells influence decisions on the water volume that must be stored to ensure supply for consumptive uses. Knowledge of mean maximum and specific peak flows is important in dam spillway size, flood detention and prediction, and river management works. This regionalisation is, however, insufficiently detailed for design of works at particular sites.

With regard to the other values of rivers, the hydrological regions can be of use in various ways. Hughes and James suggest three of these.

* Rivers with high coefficients of variation of annual flows (for example, Group 1) would be expected by stream ecologists to

Table 11

CHARACTERISTICS OF HYDROLOGICAL REGIONS
(after Hughes and James, 1989)

Hydrological regions[1]	Mean annual runoff (mm)	Coefficients of variation: Annual flows	Coefficients of variation: Mean monthly flows	Coefficients of variation: Annual minimum flows	Specific mean annual maximum flows ($m^3/s/sq.km^2$)	Specific mean annual minimum flows (L/s/sq.km)	Mean low flow spell duration
Group 1 (n=49)							
x	73	0.81	1.01	1.61	0.07	0.049	29
s	32	0.19	0.17	1.29	0.04	0.095	18
Range	10-137	0.43-1.32	0.58-1.23	0-6.08	0.004-0.14	0-0.55	4-88
Group 2 (n=35)							
x	204	0.60	0.76	1.06	0.14	0.43	17
s	35	0.17	0.21	0.81	0.07	0.37	11
Range	143-264	0.27-0.97	0.39-1.17	0.28-5.0	0.05-0.37	0.002-1.5	0-52
Group 3 (n=37)							
x	342	0.48	0.67	0.92	0.14	1.3	11
s	55	0.11	0.20	0.99	0.083	1.3	9
Range	274-464	0.25-0.64	0.3-1.03	0.27-5.1	0.05-0.40	0.0002-5.4	0-40
Group 4 (n=14)							
x	553	0.45	0.68	0.55	0.21	2.1	11
s	56	0.07	0.13	0.18	0.14	1.5	5
Range	497-693	0.34-0.5	0.37-0.90	0.36-0.94	0.088-0.51	0.85-6.5	0-18
Group 5 (n=3)							
x	1103	0.33	0.65	0.45	0.37	3.8	8
s	261	0.05	0.02	0.03	0.06	1.5	6
Range	913-1400	0.29-0.39	0.64-0.68	0.42-0.47	0.30-0.43	2.5-5.5	2-14

Notes:
1. n - number of flow gauges; x - mean value; s - standard deviation.
2. Seven other parameter were used in the regionalisation as well as the six above.
3. Regions 1 and 2 were labelled in the Hughes and James study as 2 and 1 respectively.

have a higher level of in-stream disturbance and be less predictable than streams that are not so variable (Groups 4 and 5).

* Low monthly flow variability, as shown by Group 5 streams, indicates greater seasonal constancy, an important influence on limiting changes in aquatic macrophyte cover. Streams with high monthly variability (Group 1) may have irregular and unpredictable changes in macrophytes.

* Rivers with high variability in peak flows, such as those in Group 5, may have lower species diversity and abundance than streams with less variable peak flows.

For in-stream recreation uses such as white-water canoeing, the hydrological regionalization gives an indication of flow regimes with respect to annual and monthly variability, peaks, and low flows for different parts of the State. These parameters could assist flow-level prediction in river reaches suitable for canoeing, and recreation planners when assessing management alternatives.

Fish populations and breeding cycles may also be related to the different flow regimes separated by the five hydrological regions.

In Chapter 13 these regions are used, in combination with the broad geomorphic units of Victoria identified by Jenkin and Rowan and described in Chapter 9, to establish a river-type classification system.

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11. WATER QUALITY

Water varies widely in its quality - from crystal clear (with no potentially toxic salts, chemicals, or bacteria) to murky and/or toxic to most plants and animals.

Under natural conditions, water changes in composition as it moves through the water cycle. During its fall through the atmosphere, rain dissolves gases and picks up dust particles. Then water flowing across and through the soil continues this process, dissolving more salts and picking up fine soil and organic particles, until it either reaches the sea or evaporates.

In general, its composition changes progressively as it flows through the various river tracts to the sea. In the mountain tracts stream water is well oxygenated and contains little dissolved material. As it flows through the valley and plain tracts its salt load increases and the amount of oxygen decreases. Its temperature also varies, equilibrating with the temperature of the surrounding air as this changes from season to season. The flow of the river keeps the water temperature reasonably constant throughout its depth. Over many hundreds of years the plants and animals found in wetlands, and in and alongside rivers, reached a state of dynamic equilibrium with the quality of the river on which they depended.

Particular land uses and industrial processes may cause major changes beyond the natural variations in water composition. These changes can happen in a variety of ways.

Atmospheric discharges, be they products from the consumption of fossil fuels or other industrial waste gases, may have a major impact on rainfall composition. 'Acid rain' is the best-known example: in the Northern Hemisphere it has resulted in tree death, fish kills, and other major changes to aquatic ecosystems over extensive areas.

Changing land use is also an important consideration. Clearing of deep-rooted native vegetation, as has occurred over more than 50% of the State since 1869, has caused substantial changes to various elements of the water cycle in these areas - in general, less water is transpired, more runs off the surface, and more infiltrates the soil. The increased run-off may cause soil erosion, introducing silt into the stream. Run-off from intensively used agricultural areas may also introduce phosphorus and nitrogen (from fertilizers) and various pesticides and herbicides into rivers. Salty discharges from areas with high saline water tables may also increase the salt content of rivers above what would be naturally expected.

Discharges and leaching from present and past mining operations can introduce a range of chemicals that would not normally be present in stream water or stream sediment. These discharges and leachates may also raise concentrations above the natural level.

Industrial and domestic discharges from urban areas are potentially major point sources for a diverse range of solid and dissolved materials. Some of these materials may stimulate plant growth, causing de-oxygenation, while others may be cumulative toxins.

Impoundment of water behind dam walls is another action likely to result in changes in water composition. In particular seasons, the deep still waters behind dams may develop layers - the warmest at the top and the coldest and most oxygen-deficient at the bottom.

Releases from water intakes at the base of a dam comprise water with very different temperature and other physical and biological properties from those that would have existed prior to dam construction. These properties can have major impacts on in-stream biota. The water has to flow many kilometres before it returns to a condition similar to that occurring naturally.

Changes in water composition may have severe adverse impacts on aquatic ecosystems. Nutrient levels in the

Gippsland Lakes led to an algal bloom and subsequent fish kill in 1987. Apart from the obvious effect on fish populations, the bloom and fish kill had an adverse impact on the tourism industry, which uses the lakes as its main attraction.

The changes may also limit the use to which the affected water may be put without expensive treatment processes, or alternative disposal methods for point-source discharges. Costly land use or land management controls for the reduction of diffuse sources of pollutants may be required, as well.

Water drawn from the Murray to supply drinking water for Mildura and Adelaide requires extensive and complex treatment to make it fit for consumption. Moreover, *the quality of the water is progressively* falling as the salt content of the Murray continues to rise.

Mercury pollution above background levels, resulting from mining operations in the Upper Goulburn catchment, has required restriction on the consumption of trout caught by recreational anglers.

Water-quality guidelines can assist in determining both the level of discharge treatment or appropriate land use and management required to maintain water at a suitable quality. They also assist in determining suitable use for a particular body of water.

WATER QUALITY CRITERIA

Water quality is measured using indicators, which must be chosen with relevance to a particular end use. For instance, water's colour is not important for irrigation, but is relevant if you intend to drink it. Water-quality indicators are of five types:

* Physical indicators often measured include: temperature, light penetration, turbidity, colour, suspended solids, dissolved solids, and settleable solids.

* Chemical indicators include: acid/base level (pH), dissolved oxygen, nutrients (phosphorus and nitrogen), conductivity, toxicants (persistent and/or cumulative chemicals such as DDT and non-persistent ones like chlorine), carcinogens, and genetically active materials (mutagens and teratogens).

* Indicators of pathogens include: total coliform bacteria, E.coli, specific pathogens, and viruses.

* Radioactivity markers test for *alpha* and *beta* radiation.

* Aesthetic indicators include: odour, taste, colour, and floating matter.

In addition, biological monitoring may be carried out: certain species of invertebrates, fish, or plants can be used to indicate, for example, either the toxicity of contaminants in water or the degree of change from the natural condition. Another 'biological' parameter is biochemical oxygen demand, a measure of the amount of organic material present in water.

The level set for a particular indicator depends on the intended water use. Failure to attain the appropriate level usually causes ecosystem degradation, and may result in consequences - consumer health or equipment damage - depending on the extent and duration of failure.

Specific levels for a range of relevant uses are detailed in the publication 'Environment Protection Authority - Recommended Water Quality Criteria'. Appendix V outlines the variation in common indicator levels that are appropriate for different off-stream water uses.

Sign - Reedy Creek (Basin 3)

WATER-QUALITY REPORTING

The discussion of criteria and appropriate water-quality levels uses as an example in-stream use, particularly the maintenance of riverine and wetland habitat values and the extent to which they are met. It summarizes detailed information from the 1988 State of the Environment Report, which assesses the recorded levels for the following physical, chemical, and biological criteria.

* physical criteria - turbidity, suspended solids and conductivity
* chemical criteria - dissolved oxygen, biochemical oxygen demand, pH, phosphorus and nitrogen
* biological criteria - information on macro-invertebrates, (mayflies, caddis flies, etc) fish, and streamside vegetation

The values listed for certain of these criteria in Appendix VI provide broad measurements of water quality, which range from excellent (where levels are within the range that would be expected under natural conditions) to degraded (where ecosystem function is likely to be impaired). It should be noted that of the criteria examined under natural conditions only turbidity, suspended solids, and electrical conductivity show systematic changes from their mountain to plain tracts.

Although persistant toxicants were also considered important, there were insufficient data to allow a State-wide assessment.

For physical, chemical, and biological criteria many of the raw data were discontinuous or otherwise incomplete. The extent to which data were sufficient to allow assessment was as follows:

* physical criteria - 30% of mountain tracts, 55% of valley tracts, and 50% of plain tracts
* chemical and biological criteria - 5% of mountain tracts, 5% of valley tracts, and 15% of plain tracts

Summary of results across the State

Turbidity

In general those rivers draining directly from forested catchments had excellent water quality. The Yarra, Latrobe, Maribyrnong, and Werribee Rivers, the Thomson below the Dam, and the lower reaches of the Goulburn and Wimmera had poor or degraded water quality.

Suspended sediments

The Wimmera, Avoca, Loddon, and Campaspe river basins to the north-west and the Hopkins, Glenelg, Portland, Corangamite, and Barwon basins in the south-west have poor to degraded water quality. Rising water tables and dryland salting associated with low parts of the landscape in areas cleared for agriculture are common in these basins.

Phosphorus

The general condition of the Wimmera, Werribee, Maribyrnong, Yarra and Latrobe Rivers appears to be predominantly poor or degraded for this indicator.

Nitrogen

Available data suggest poor or degraded water quality for many stations on the Latrobe and most river basins north of the Divide (Wimmera, Loddon, Campaspe, Avoca, and lower Goulburn and Broken Rivers) and in most of the south-western basins (Corangamite, Barwon, Moorabool, Werribee, and Maribyrnong).

pH

There appear to be no problems with acidification of Victorian rivers.

Dissolved oxygen

Assessments show that the plain tracts of the Latrobe, Wimmera, Yarra, and Maribyrnong Rivers have poor or degraded water quality.

Although the data do not allow a systematic and detailed station-by-station assessment of water quality across the State, the following pattern emerges for the criteria considered.

Table 12

INDEX OF ENVIRONMENTAL QUALITY
(State of the Environment Report 1988 - Victoria's Inland Waters)

Rating	Physical and chemical indicators	Biological indicators		
		Macroinvertebrates	Fish	Vegetation
Excellent	Water clear, minimal turbidity, natural levels of salinity and nutrient levels, and high oxygen levels Natural levels of toxicants in water column	Natural abundance and diversity of species	Natural abundance and diversity of native fish species No introduced species	Streamside vegetation intact for at minimum 100m width from the bank, with continuous cover essentially unmodified and few exotics. Catchment vegetation substantially uncleared. Less than 10% catchment logged
Good	Water clear, minimal turbidity, natural levels of salinity, low nutrient and high oxygen levels Natural levels of toxicants in water column	Macroinvertebrate communities intact, with all species present, with species abundance reflecting low level input of wastes and minor catchment modifications	Predominantly native fish, with no more than one introduced species present	Existing streamside vegetation communities intact, with cover essentially unmodified for, at minimum, 30m width for over 80% of segment. Infrequent exotics. Largely undisturbed by roading. Limited permanent clearing of catchment vegetation
Moderate	Slight increases in one or more of turbidity, salinity, and nutrient levels. No substantial change in oxygen levels Natural level of toxicants in water column	Minor changes in macroinvertebrate communities including changes in community structure and local loss of some species, corresponding to influence of input of wastes and catchment modifications	Equal numbers of native and exotic fish species or predominance of native species with more than one introduced fish species present	Existing streamside vegetation communities predominanly intact and exotics infrequent. Riparian zone intact for 30m width, at minimum, for over 60% of catchment

Table 12 (continued)

Rating	Physical and chemical indicators	Biological indicators		
		Macroinvertebrates	*Fish*	*Vegetation*
Poor	Marked increases in one or more of turbidity, salinity, or nutrient levels; some change in dissolved oxygen levels; or significant presence of cumulative or non-cumulative toxicants present in water column	Marked changes in macroinvertebrate communities, including changes in structure and local loss of species reflecting significant inputs of wastes, toxicants or other matter	Predominantly introduced species present	Existing streamside vegetation largely fragmented and exotics frequent. Riparian zone of 30m width intact for less than 60% of catchment, and frequently disturbed by roading. Catchment segment largely cleared of native vegetation
Degraded	Major presence of one or more of turbidity, salinity, or nutrient levels, substantial change in oxygen levels Cumulative or non-cumulative toxicants present in substantial levels in water column	Major changes in macroinvertebrate communities, including changes in structure and massive local loss of species	Few introduced and no native species, or no fish found	Little remnant streamside vegetation. Surviving patches fragmented. Exotics frequent. Riparian zone of 30m width intact for less than 25% of catchment, and frequently disturbed by roading, bare or eroded. Catchment segment substantially cleared of native vegetation

* Major river basins such as those in the north-west have water quality sufficiently low to adversely affect aquatic ecosystems dependent on them.

* Rivers with excellent water quality tend to be those draining forested catchments in the Eastern Highlands and Otways region.

* Rivers draining land used for broad-acre agriculture often tend to have elevated salt, nitrogen, and phosphorus levels - and hence low water quality.

Index of environmental quality

The 1988 State of the Environment Report integrates, for each tract in each basin, the physical, chemical, and biological water-quality indicators, to provide a broad view of the current environmental condition of Victorian rivers, in relation to its natural state prior to European settlement. Table 12 lists the indicators and definitions used. As different physical, chemical, and biological criteria are relevant to different consumptive or in-stream uses of water; a broad index is only a general guide.

The environmental quality indices can be grouped according to basins with similar quality. Table 13 lists groups of basins, and the number of times that environmental quality is either 'good' or 'excellent', for each indicator and each basin in a group. The number of environmental quality records with adequate data is also listed.

Table 13

INDICES OF ENVIRONMENTAL QUALITY
NUMBERS OF BASIN RECORDS WITH GOOD OR EXCELLENT QUALITY

River basin group	Indicator	
	Physical/chemical	Biological
North-east: Basins 1-5	7(10)	5(34)
North-west: Basins 6-8, 14 & 15	0(7)	1(22)
Far south-east: Basins 21-25	4(7)	13(21)
Near south-east: Basins 26-29	1(10)	9(30)
South-west: Basins 30-38	1(14)	4(37)

Note:
The first figure is the number of records with 'good' or 'excellent' environmental quality for the basin group, combining mountain, valley and plain tract records. The total number of records for which there is adequate data is shown in brackets.

The table shows that river basins in the north-east (Basins 1 to 5) and far south-east (Basins 21 to 25) have good or excellent physical (and where measured, chemical) quality for over half their records; the north-western basins (6 to 8, 14 and 15) and those in the south-west and near south-east rarely display good or excellent physical and chemical quality.

While the far south-east basins have good or better biological quality for over half their records, the other basin groups show poorer quality, and in decreasing order are

East Gippsland streams - high quality

near south-east, north-east, south-west, then north-west. For Basins 26 to 29, eight of the nine high-scoring indices are from mountain tract streams, while for Basins 1 to 5, all are. In the south-west group, three of the four 'good'-quality records are for native fish in Otways coastal streams.

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12. BIOLOGICAL CHARACTERISTICS

This chapter outlines the habitats that are found near rivers and streams, and the types of animals and plants associated with them.

Access to water is obviously essential for the survival of all animals. The two most conspicuous groups - fish and birds - are discussed in general terms, while invertebrates, the vegetation, and other fauna found in particular habitats are mentioned in the relevant sections.

Council's regional resources reports describe in more detail than can be included here the various vegetation units across the State and the occurrence of fauna, in particular according to habitat types such as wetlands, wet forests, and river red gums. Appendix VII lists the scientific names of the species mentioned.

FISH

Australia has a unique native fresh-water fish fauna. It comprises a relatively small number of species and the boundary between these and 'estuarine' fishes is often indistinct. Indeed, they total only about 190 species, compared with about 2000 in South America and 1400 in Africa.

It is generally accepted that the small number of species and many of the unique characteristics of Australian fishes are associated with the relative isolation of the continent for 50 million years. With few exceptions, Australian species are recent marine invaders, often illustrated by the fact that many of them have marine or estuarine phases in their life cycles. In addition, the dryness of the continent has contributed to the paucity of native fish species present. By international standards Australia has only one large river system, the Murray--Darling.

Victoria contains 43 recognized species of 'fresh-water' fish (listed in Table 14). The taxonomy of the family Gadopsidae is still under review and may contain species additional to the freshwater blackfish and the two-spined blackfish. Similarly there is a possibility that a form ('Galaxias fuscus') of the mountain galaxias may be given individual taxonomic status.

Only 24 species are restricted to fresh water during their entire life cycle and many of these can tolerate high salinities. For example, the Lake Eyre hardyhead can tolerate salinities up to 100 parts per thousand (100 000 mg/L; sea water is about 35 000 mg/L).

In addition to those native fishes that spend all or a major part of their life cycle in fresh water, at least 50 species inhabit or regularly enter estuaries from inshore marine environments. Estuaries are important nursery areas for many species of marine and fresh-water fish.

Of the few 'large' native species, only 17 commonly exceed 15 cm in length. The most important angling species belong to the family Percicythyidae, the fresh-water basses and cods. The best-known of these - Murray cod, trout cod, golden perch, and Macquarie perch - are restricted in their natural range to the Murray--Darling system. The only large native fishes commonly found in fresh waters south of the Dividing Range are the short-finned eel, the long-finned eel, the freshwater blackfish, and the Australian grayling. The remainder are generally small 'forage' species, of which members of the family Galaxiidae are the most diverse and widespread.

Distribution patterns

A number of discernible patterns assist in describing the distribution of Victoria's native fishes (see Table 14). Firstly, only a relatively small number of species have a widespread occurrence throughout the State, both north and south of the Dividing Range. These include: the freshwater blackfish, although some doubt still remains regarding the taxonomic status of the northern and southern varieties; the mountain galaxias, widespread in highland streams where trout are absent; southern pigmy perch

Table 14

NATIVE FISH SPECIES OCCURRING IN VICTORIAN INLAND WATERS

Key: A - Widespread north and south of Dividing Range
B - North of Dividing Range
C - Coastal streams generally
D - Coastal streams generally east of Wilsons Promontory
E - Coastal streams, but distribution not extending to East Gippsland
F - Limited distribution
* Species considered endangered at a national level
** Species considered potentially threatened at a national level
*** Species of uncertain status at a national level
(Conservation Status after Cadwallader *et al* 1984)

SPECIES	DISTRIBUTION
Endangered in Victoria	
* Trout cod	B
Vulnerable in Victoria	
Murray cod	B
Macquarie perch	B
Golden perch	B
Silver perch	B
** Australian grayling	C
Restricted in Victoria	
Broad-finned galaxias	C
Spotted galaxias	E
Freshwater hardyhead	B
Lake Eyre hardyhead	B
Western chanda perch	B
Yarra pigmy perch	E
Southern purple-spotted gudgeon	B
Indeterminate, possibly threatened	
Flat-headed galaxias	B
Pouched-lamprey	E
Bony bream	B
Freshwater catfish	B
Require monitoring	
Freshwater blackfish	A
*** Two-spined blackfish	B
Secure in Victoria	
Short-finned eel	C
Long-finned eel	D
Freshwater herring	D
Common galaxias	C
Mountain galaxias	A
Eastern little galaxias	C
Tasmanian mudfish	F
Australian smelt	A
Crimson-spotted rainbow fish	B
Small-mouthed hardyhead	C
Black bream	C
Estuary perch	C
Australian bass	D
Southern pigmy perch	A
Tupong	C
Yellow-eyed mullet	C
Sea mullet	C
Striped gudgeon	D
Cox's gudgeon	D
Flat-headed gudgeon	A
Western carp gudgeon	B (E)
Bridled goby	C
Tamar River goby	C
Blue-spot goby	C

and Australian smelt, occurring in the backwaters of rivers and in wetlands; and the flat-headed gudgeon, widespread throughout Victoria except at higher altitudes in the north-east.

Secondly, some species are restricted in their natural distribution to the Murray--Darling system. As has already been mentioned, this group includes such important angling species as Murray cod, golden perch, and Macquarie perch. However, it also contains many smaller 'forage' species such as the crimson spotted rainbow fish, which prefers slow-flowing back-waters and wetlands with dense aquatic vegetation, and the western carp gudgeon, which has also been introduced to the Wimmera system. A total of 16 species are restricted in their natural range to the Murray system.

Macquarie perch - restricted to the Murray--Darling system

Eleven species have a generally widespread distribution in coastal streams. Ten of these are either largely estuarine species that do not penetrate far into fresh water (like the estuary perch, yellow-eyed mullet, sea mullet, black bream, and bridled goby) or have estuarine or marine phases in their life cycle (the Australian grayling, the short-finned eel and the common galaxias). The exception is the eastern little galaxias, which is restricted to fresh water.

Five species are restricted to the coastal streams of East Gippsland, not occurring west of Wilsons Promontory. These reach the southern limit of their natural range in Victoria and include the Australian bass and Cox's gudgeon. None is restricted to fresh water.

Three species occur in coastal streams, but their distribution does not extend to East Gippsland. These - the Yarra pigmy perch, pouched-lamprey, and spotted galaxias - have estuarine or marine phases in their life cycle.

Finally, the Tasmanian mudfish has a very restricted distribution in Victoria, having been recorded only in a swamp at Wilsons Promontory and a small stream in the Otway Ranges. Further sampling may yet extend the known range of this species.

Movement

During their life cycles, 25 species of fresh-water fish are known to move considerable distances. In coastal streams, many species migrate between fresh water and estuarine environments, but migrations also occur totally within fresh water. Golden perch, for example, tagged in the Murray River in South Australia, have moved more than 2000 km upstream into tributaries of the Darling River in Queensland. Golden perch have semi-buoyant pelagic eggs and upstream movement of adults compensates for the downstream displacement of eggs and larvae.

A number of species in coastal streams move to estuarine or marine environments to spawn. The short- and long-finned eels, for example, migrate to the Coral Sea, while other species such as the common galaxias migrate to estuaries for this purpose.

A number of galaxiid species, such as the spotted galaxias and the climbing galaxias, spawn in fresh water but the larvae are swept downstream to estuaries where they overwinter before the young fish migrate back upstream. The Australian grayling has a similar life cycle.

Significance of wetlands associated with rivers

Many native species, particularly those occurring in the Murray--Darling system, depend on the inundation of floodplain wetlands for successful breeding. Nutrient-rich water, extensive macrophyte growth, and the ecological succession of invertebrates to provide a food source are vital for the survival and recruitment of larval fish. Furthermore, the timing of inundation of wetlands is important for fish breeding, as some species have specific temperature requirements. Murray cod, for example, spawn in spring--summer when the water temperature reaches about 20^{o} C.

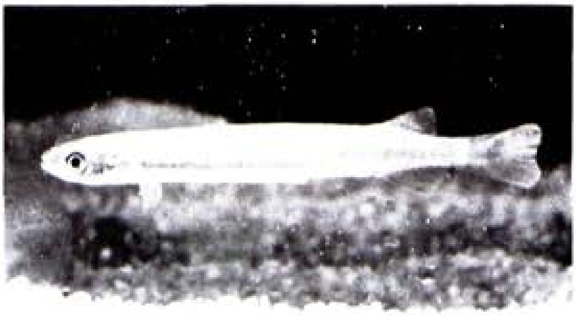
The inundation of wetlands is also important for smaller native species such as the eastern little galaxias. This species spawns in late winter--spring and, in areas such as Victoria Valley in the Grampians Ranges, adults migrate into newly flooded wetlands to spawn among the submerged macrophytes. The larvae remain in these wetlands until the wetlands begin to dry out during the summer and then migrate back to refuge areas.

Conservation status of native fishes

Although it is generally accepted that the distribution and abundance of many native species have declined since European settlement, there is no evidence that any species has become extinct. Table 14 indicates each one's conservation status.

Only one species, the trout cod, is considered endangered in Victoria. It is also considered endangered at a national level, although once widespread in the Murray--Darling system. At present, the only viable population in Victoria occurs in a small section of Seven Creeks near Euroa: it was derived from translocations of fish from the Goulburn River in 1921 and 1922. Reasons for its decline include alterations to the environment caused by impoundments and siltation due to catchment and bank erosion. Competitive interaction with trout may also have been a major factor.

Of the five species considered to be vulnerable in Victoria, four are native to the Murray system. The fifth one, the Australian grayling, occurs in coastal drainage systems and is also considered potentially threatened on a national level. Murray cod, once widespread throughout the Murray--Darling system, can no longer be considered common anywhere in Victoria. The range and abundance of Macquarie perch have been greatly



The vulnerable Australian grayling

reduced over the past 50 years, as has the distribution of golden perch. The Australian grayling has declined rapidly in numbers and distribution since European settlement but remains relatively abundant in some localities in the eastern half of the State. The reasons for the decline in these species are complex and poorly understood, but undoubtedly relate to general habitat degradation as well as over-fishing in some instances.

The eight species considered to have a restricted distribution in Victoria are all small 'forage' species that have been little studied. Another four species are considered to be in the indeterminate possibly threatened category, while the river blackfish and two-spined blackfish are considered to require monitoring, mainly because the taxonomy of the family Gadopsidae is still uncertain. The two-spined blackfish is classified as a species of uncertain status at the national level. The remaining 24 species are considered to be secure in Victoria at present.

BIRDS

Apart from major floodplains associated with rivers such as the Murray, most rivers and streams only provide minor aquatic bird habitat in comparison with wetlands. However, for many visitors, birds are often the most conspicuous part of the fauna of rivers and streams.

It is difficult to make general comments about the association between bird species and rivers, as this varies with the location of the area within the State and the type of vegetation found there. For example, the edge of a rainforest stream in East Gippsland may be home to the brown gerygone, which would not be found in a

Table 15

BIRDS ASSOCIATED WITH RIVERS, AND MAIN HABITATS USED

Key: R - roosting, perching or refuge
N - nesting
F - feeding

Species	Riparian forest	Reedswamp	Muddy shore, banks or shallow water	Stream or river channel	Still open water	Pasture, grassland
Grebes		R,N		F	F	
Australian pelican				F	R, F	
Cormorants (mainly great and little pied)	R, N			F	F	
Herons, egrets, ibis, spoonbills	R, N	R	F			F
Bitterns		R, N, F			F	
Black Swan		N	R, F	F		F
Maned duck	R, N		R, F	R		F
Dabbling ducks (mainly Pacific black duck and grey teal)	R, N	R, N	R, F	R, F	R, F	F
Diving ducks (eg. musk duck)		R, N			F	F
Whistling kite	R, N		F	F		F
White-bellied sea-eagle	R, N			F		
Swamp harrier		R, N, F	F			F
Crakes and rails		R, N, F	F			
Dusky moorhen		R, N	F	F		F
Purple swamphen		R, N, F	F			
Eurasian coot		R, N			F	F
Masked lapwing			F			R, N, F
Other waders (eg. black-fronted plover)			R, N, F			
Gulls and terns			R, F		R, F	
Azure kingfisher	R		R, N	F	F (near edge)	
Swallows, martins and woodswallows (mainly white--breasted)	R, N		R, N	F (over)	F (over)	F (over)
Clamorous reed warbler		R, N, F				
Little grassbird		R, N, F	F			

Source: R. Loyn, Department of Conservation, Forests and Lands

Straw-necked ibis

wet streamside forest further west in Gippsland. Several species, particularly azure kingfishers and insectivorous birds such as swallows, martins, and common sandpipers, often use over-river and riparian areas for feeding. Nevertheless, some birds with strong aquatic affinities are typically found in certain habitats and Table 15 provides a guide to some such associations, with roosting, nesting and feeding habitats shown.

Far more species occur on large lakes and large rivers than on small streams. Some of the species listed in Table 15 use rivers and streams for feeding but not nesting. For example gulls, terns and pelicans usually nest at large wetlands or on sea coasts. The main species associated with small streams in Victoria are little pied cormorant, white-faced heron, Pacific black duck, dusky moorhen, azure kingfisher and clamorous reed warbler.

MAMMALS

Platypus

This animal occupies a habitat varying from upland streams to lowland rivers, provided these have permanent flow, and also occurs around large reservoirs.

The platypus had a very extensive natural occurrence. Although widely hunted for its pelt last century, it is now reasonably common. Piatypus records show a widespread distribution, from far East Gippsland to the South Australian border, mainly in upland but not alpine streams. No recent records have come from the Avoca River or the Mallee Basin.

Platypus food consists of a range of aquatic invertebrates - mussels, insects, crustaceans (shrimps, etc.), and worms.

Water rat

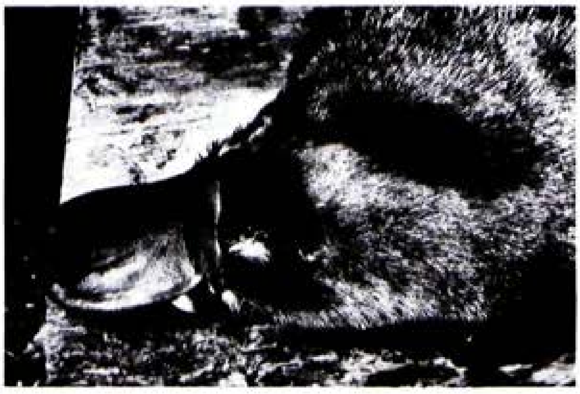
The habitat of the water rat is the banks of rivers and lakes, estuaries, and marine shores. Water rats construct burrows or seek refuge in rock crevices or debris. Their present distribution status is considered to be widespread and common. They are mainly carnivorous, consuming large insects, yabbies, mussels, fish, frogs, tortoises, and small mammals.

INVERTEBRATES

The wide range of life form covered by the collective term invertebrates includes variation from single-celled protozoans to larger and more complex organisms such as the fresh-water crayfish and giant earth-worms.

The majority of the more the 100 000 species of invertebrates in Australia are arthropods, particularly insects, but only about half of this number have been scientifically described. No definitive figures are available for the number of invertebrate species which occur in Victoria. It is estimated that less than five per cent of these have had their basic natural history documented or have their main ecological associations known.

Invertebrates are parts of complex food webs as both prey and predators. They are involved in decomposition processes (e.g. of dead timber, aquatic detritus,



Widespread in streams - the platypus

dung, and carcasses), pollination and regulation of population balances of other species (e.g. seed harvesting, parasitic interactions, and 'biological'), and hence community dynamics.

Most invertebrates have specific ecological requirements, are restricted to particular habitats and are dependent on relatively stable environments. The invertebrate fauna can be particularly vulnerable to disturbance, as a consequence of specialization and low breeding rates. Many ecological changes associated with land-use practices have the potential to affect specialized species.

While the level of information on invertebrates is very limited, Frood and Calder (1987) comment that priority habitats for their conservation include unmodified wet forest areas and aquatic habitats in drier areas of the State. Some invertebrate communities may be endangered by the regulation of river systems.

Aquatic Invertebrates

Many invertebrate species - insects, crustaceans, shellfish and worms - live in inland waters. Their habitat is the bottom of streams and ponds, in the sediment or clinging to rocks and other suitable shelter. Invertebrates occupy a central role in the food chains of rivers and streams. They include herbivores which eat algae and other aquatic plants, detritivores - consumers of dead plant and animal material, and carnivores which eat other invertebrates. In turn, they are eaten by fauna such as fish, platypus and waterfowl.

Macro-invertebrates are those large enough to be seen. They are easily studied as they can readily and quickly be collected in the field with relatively cheap equipment, they are easily preserved, and they occur in a wide range of habitats.

Invertebrates form very diverse assemblages in undisturbed streams, in which 100 to 200 species may be present. Stresses in stream systems are usually reflected in changes in either the total or the relative species composition. The life spans of stream-bottom invertebrates usually vary from a few months to a year, and together with their relative lack of mobility, mean that their populations react to contamination events.

These characteristics make them ideal indicators of the condition of aquatic ecosystems. The 1988 State of the Environment Report discusses the importance of invertebrates for this purpose, and proposes more comprehensive data collection, analysis and interpretation of indicator data. That report also reviews existing data for Victorian rivers and wetlands, and designates five levels of stream quality using macro-invertebrate data.

The following comments apply to three groups of insects associated with rivers or riparian areas, for which there is information on conservation status.

Odonata (Damselflies and Dragonflies)

Many endemic species are localized. One damselfly, *Hemiphlebia mirabilis*, may have recently become extinct through habitat alteration. It was known from flood-plain lagoons, where it was dependant on seasonal flooding of reedbeds.

Plecoptera (Stoneflies)

Several species are very localized and threatened. The Otway Stonefly (*Eusthenia nothofagi*) may have been displaced by changes to stream habitats. *Riekopera darlingtonii* is a wingless species known only from several small temporary streams on Mt Donna Buang, and is vulnerable to habitat alteration. Four species of the wingless stonefly genus *Thaumatoperla* each occur near the summit of one, or very few, mountains, and are considered rare.

Hemiptera (Bugs)

The three species of the archaic Peloridiidae which occur in Victoria are flightless and local (*Hemiodoecus wilsoni*: Beech Forest area; *H. leai*: Lorne area and Tarra Valley, *H. donnae*: Mt Donna Buang). These species live in saturated mosses and liverworts, usually associated with *Nothofagus* trees. Habitat in the Otway Ranges has been considerably reduced through forest clearing.

Other aquatic invertebrate orders found in aquatic environments include Ephemeroptera (mayflies), Trichoptera (caddis flies), Mecoptera (scorpion flies), Coleoptera (beetles), Collembola (springtails), Diptera (flies), and Lepidoptera (moths).

Crayfish and Yabbies

About 11 species of crayfish occur regularly in inland waters in Victoria. They may be divided into two distinct groups: the spiney crayfish, which all belong to the genus *Euastacus*; and the yabbies, which belong to the genus *Cherax*. In addition, 13 species of land yabbies - belonging to the genera *Geocherax* (2 spp.), *Engaeus* (7 spp.), *Pseudengaeus* (2 spp.), and *Austroastacus* (2 spp.) - are found in a wide variety of habitats from swampy lowlands to the tops of hills. Land yabbies are most abundant in the Dandenong Ranges, around Healesville, near Warragul, and in the Otway Ranges.

Spiney crayfish

Nine described species of spiney crayfish presently inhabit inland waters in Victoria (see Table 16). Their biology and distribution are little known but in contrast to yabbies (see below) they generally inhabit the cooler, upland sections of rivers with high dissolved oxygen levels and fast running water. They are very susceptible to habitat deterioration, generally exhibit low growth rates, and are susceptible to fishing pressure.

Table 16

FRESHWATER CRAYFISH SPECIES OCCURRING IN VICTORIA

Species	**Approximate distribution**
Euastacus armatus	Murray River and tributaries
E. crassus	Upper Murray and Mitta Mitta Rivers
E. bidawalus	East Gippsland, east of Snowy River
E. kershawi	Coastal streams from Latrobe River
E. diversus	Restricted population in Snowy River catchment
E. neodiversus	Strzelecki Ranges and Wilsons Promontory
E. woiwuru	Highland streams north-east of Melbourne, north and South of Dividing Range
E. yarraensis	Coastal streams from Otway Ranges to Bunyip River
E. bispinosus	Glenelg and Wannon Rivers

Source: Morgan, G.J. (1986)

The Murray crayfish is probably the best-known. It occurs in the Murray River and its tributaries, where it may grow as large as 2.8 kg. A related species, *Euastacus crassus*, occurs in the upper Murray and in the Mitta Mitta River while another, *E. woiwuru*, occurs both north and south of the Dividing Range, north-east of Melbourne. The remaining species are restricted to coastal streams.

Yabbies

Of the two species of yabby in Victoria, *Cherax destructor* is widespread, whereas *C. albinus* is restricted to the north-west of the State. The biology of the latter is little understood.

Cherax destructor is widespread throughout Australia, with the exception of Western Australia, indicating a wide tolerance to a range of environments. In Victoria these yabbies are found in rivers, creeks, wetlands, irrigation channels, and farm dams, and are capable of leaving the water and walking overland for some distance. Adult specimens can tolerate very low levels of dissolved oxygen, but the eggs and young may be less tolerant.

They also inhabit brackish waters in coastal streams. They are, however, highly susceptible to pesticide poisoning.

MAJOR HABITAT TYPES ASSOCIATED WITH RIVERS

Terrestrial habitats

Rivers and streams flow through a wide range of land types in Victoria (see Chapter 9) and the riparian zone contains plants that differ from the surrounding vegetation. Often the riparian vegetation reflects the environmental sequence from relatively dry foothill country, through the species-rich intermediate zone, to the riverine section. Some major terrestrial habitat types, and the animals associated with them, are outlined below.

River red gum forests

With its thick trunk and heavy twisting branches, the river red gum grows throughout all mainland States and is the most widespread eucalypt in Australia. It is common in the drier parts of Victoria (less than 700 mm average annual rainfall), growing along inland rivers or dry watercourses and on floodplains. In dryland areas, watercourses often have a ribbon of red gum fringed with black box. Periodic flooding is required for the reproduction of this species, and in this respect it has similar requirements to those of many native fish. Both have been adversely affected by the changes in flood frequency, extent, and seasonality that have accompanied water regulation (see Chapter 22).

The trees often have an understorey dominated by grasses and sedges rather than shrubs. Consequently, such areas are often grazed and this can reduce regeneration because stock browse on the seedlings. The more extensive red gum forests, as at Barmah and Gunbower, have a more developed understorey, comprising a complex mosaic of associations.

River red gum forests provide important habitat for many animals, particularly those that depend on hollows in mature trees. Animals that nest in these sites include possums, gliders, parrots,

River red gum woodlands require periodic flooding kingfishers, treecreepers, owls, bats, and carpet snakes.

In the Murray Valley, where river red gums support a high diversity of animals, several rare species that use hollows are found. For example, the mature river red gum and box woodlands that occur adjacent to the Goulburn River, and near its confluence with the Murray River, are important strongholds for the rare squirrel glider. Barking owls also depend on hollows for nesting - not only for themselves but for their prey, which includes squirrel gliders. They are therefore doubly affected by timber and clearing operations that reduce the number of mature trees. Although carpet snakes hunt their prey of small mammals and birds at night, they use tree hollows for shelter during the day.

Whether for breeding, feeding, or sheltering, river red gum hollows are vitally important to the animals that live along our inland rivers.

Reeds and rushes

Reed and rush communities occur around rivers and fresh-water swamps. Bulrushes (cumbungi) and phragmites are often present; and extensive beds of giant rush occur along the Murray River (for example, at Top Island in the Barmah Forest), which may be several metres high.

Along the Murray such areas are favoured breeding sites for many water-birds. Platypus and water rats may also be found and, although they are considered to be common throughout Victoria, both require stable banks for burrows and in-stream snags for cover. They are therefore susceptible to stream modification.

Another less-well-known species occurring in the Murray Valley is the large-footed myotis - a bat that feeds over water. Indeed it is never found far from water and elsewhere occupies quite different habitats - for example, along rainforest streams. It swoops over the water using the sharp claws of its feet to catch the aquatic insects that make up most of its diet. Such water-foraging bats are far more common in other countries than in Australia, probably due to the aridity of our continent and the comparative rarity of areas of permanent fresh water.

Wet and dry sclerophyll forests

In the foothills of the more steeply dissected hills and mountains, sclerophyllous forests reflect the moisture conditions of each site - higher-rainfall areas will tend to have wet forests, while those with lower rainfall will have dry ones. However, in extensive areas in the north-east and south-east of Victoria the two types of forest often occur side by side or in intricate mosaics. Whereas the dry forest generally grows on ridges and exposed north- and west-facing slopes, wet forest occurs in gullies on south- and east-facing slopes at lower altitudes, and across the landscape in higher-altitude or wetter areas. Maps of the vegetation show a distinctive finger-like pattern of wet forest along rivers and streams, with the drier forest surrounding it.

Various eucalypt species occupy these sites; the particular mixture of species in any area reflects the moisture conditions as well as the other preferences of each one. While a full description would be very complex, the map 'Forests of Victoria' (Department of Conservation, Forests and Lands) identifies the nine main broad eucalypt forest types that comprise wet and dry sclerophyll forest, and Table 17 lists these in approximate order of their moisture needs. It also lists the eucalypt species in each forest association that occur in or adjacent to drainage lines and watercourses.

These forests are very rich in animal species, several of which are found in no other habitat types. The long-nosed bandicoot and the dusky antechinus are generally restricted to wet gullies with an understorey of ferns or heath. Other mammals include the tiger quoll, swamp wallaby, and several bat species. The eastern whipbird and satin bowerbird favour the wettest areas and, unlike the many birds that live in both types of habitat, are not found in dry forest.

Of the reptiles, four skinks are restricted to sclerophyll forests and two are dependent on the thick, moist leaf litter that makes up the forest floor.

Table 17

FOREST TYPES OF HILLY AND MOUNTAINOUS AREAS IN VICTORIA

Showing common riparian eucalypt species in wet and dry sclerophyll forest types

Broad types	Conditions	Forest types	Drainage-line species	Occurrences
Dry sclerophyll	drier; low altitude	Box/ironbark	Yellow box, grey box, yellow gum	Maryborough, St Arnaud, Rushworth area
		Silvertop/stringybark	Mountain grey gum, manna gum, river peppermint, narrow-leaf peppermint, blue gum	Southern foothills of the Eastern Uplands - Neerim to Genoa
		Stringybark/box	Narrow-leaf peppermint, yellow box, southern mahogany	Low to moderate hills fringing the Eastern and Western Uplands: Grampians to Yea; Alexandra to Corryong, Licola to Goongerah
		Peppermint/gum	Narrow-leaf peppermint, candlebark, blue gum, manna gum	Dissected hills north and south of the Eastern Uplands; Mansfield to Nariel; Woods Point to Bonang
		Messmate/stringybark	Manna gum, swamp gum, mountain grey gum mountain ash	Grampians, far south-west; Otways
		Messmate/gum	Mountain ash, messmate, candlebark, mountain grey gum, narrow-leaf peppermint, blue gum, manna gum	Steep slopes - Otways, Ballarat - Mt Macedon area, Mt Disappointment to Mt Coopracambra; South Gippsland
		Gum/peppermint	Manna gum, narrow-leaf peppermint, candlebark, blue gum, mountain mountain swamp gum	Widespread in mountains, mainly north of the Great Divide, from Marysville to Tom Groggin
		Mountain ash	Mountain ash, manna gum, mountain grey gum, shining gum	Extensive in mountainous areas in Yarra basin and adjoining forests; Otways, Strzeleckis
Wet sclerophyll	wetter; high altitude	Alpine ash	Alpine ash	Steep upper mountain slopes along the Great Divide and adjacent ridges, from Lake Mountain to Mt Pinnibar

Riparian forests

Floristic vegetation surveys in East Gippsland have identified two types of riparian forests alongside streams and in gullies. Montane riparian forests are restricted to sub-alpine and montane valleys and typically consist of a closed scrub of mountain tea-tree. Riparian forests are found along wet slopes and river-sides of nearly all the major lowland watercourses in the region. The various eucalypts comprising the overstorey include mountain grey gum, manna gum, river peppermint, messmate, and yellow stringybark.

High diversity is a feature of riparian communities, which provide corridors linking a range of habitats, making them important for migratory animals. The bush rat is one of the mammal species frequently found here, in addition to gliders and possums. The areas are also rich in birds, containing more than eight species, while frogs, snakes, and lizards are common.

Rainforests

Being restricted to the wettest parts of the high-rainfall areas of the State, rainforests grow along streamsides and in gullies in East Gippsland, the Otways, the Central and South Gippsland Highlands, and Wilsons Promontory. East Gippsand contains most of the rainforest in Victoria.

Two types occur: cool temperate and warm temperate. The former is generally confined to moist gullies and sheltered slopes between 600 and 1200 metres. The latter is actually a southern extension of the subtropical rainforests of coastal New South Wales and Queensland. In Victoria it is generally restricted to sheltered gullies throughout the lowland and foothill country from sea level to about 700 metres.

Southern sassafras is the dominant species in East Gippsland's cool temperate rainforests, while further west myrtle beech becomes dominant. Lilly pilly is the key species in warm temperate rainforests. Unlike other forests, eucalypts are not common here, but East Gippsland's cool temperate areas often

Warm temperate rainforest (Basin 21)

carry shining gum as an emergent through the rainforest canopy.

Although not a common habitat type, rainforest is very significant as it contains many species of plants and animals that are uncommon or rare in the State. For example, warm temperate rainforest is home to the large-billed scrubwren and the rare great barred frog. It is also a very beautiful environment and therefore has great scenic value and recreation potential.

In-stream habitats

Three broad regions have been identified, on the basis of climate and topography, as having in-stream habitats with some degree of similarity within each. These are briefly described.

Murray Basin rivers

This region includes the floodplain sections of the Murray River and tributaries, but excludes upland streams. It has flat topography and a relatively dry climate. The rivers, although permanent, have marked seasonal flow variations, with maximum flows commonly in late winter, and minimum flows in late summer--autumn. Water temperature in the Murray ranges from about 8^{o} to $25^{o}C$; turbidity is often high and salinity, while in general less than 500 mg/L, can reach 3000 mg/L. In this region streams are generally depositing sediment.

The fish species restricted to the Murray--Darling system have been previously mentioned. Several have breeding seasons that coincide with flooding, so that food is available following inundation of floodplains. Stream-bed fauna consists largely of a few species tolerant to the unstable bottom and variable stream flows, and generally associated with underwater branches and rocks rather than sediments. These rivers receive a large litter input from their fringe of river red gums, allowing dense populations of invertebrates to develop.

An important part of these habitats is the system of billabongs, which act as feeding and refuge areas for waterfowl, fish, and other animals. Billabongs are biologically more diverse than their associated rivers.

Upland rivers and streams

The fast-flowing upland streams occur along both sides of the Great Dividing Range. They have steep stream gradients and continue to erode their beds. In general, the climate is wet and cool and, particularly in the upper reaches, streams are substantially shaded by bank vegetation. Stream flows are permanent, with no pronounced seasonal variations, although flow rates usually reach a peak in spring. Turbidity and salinity are low; water temperatures range from less than $5^{\circ}C$ in winter to about $20^{\circ}C$ in summer.

In-stream fauna is diverse with local variations. The number of streambed species appears to correlate with the size of the stream and its catchment.

Coastal rivers

South of the Great Divide rivers in this third group vary widely in their characteristics, despite some common features. Climate is moderate, being warmer than the second group and wetter than the first. Most rivers are permanent, but some have very low summer flows. They include short, steep coastal streams on the south sides of the Otways and South Gippsland Ranges; moderate-gradient East Gippsland Rivers; and low-gradient rivers crossing the extensive Gippsland riverine plains, western Victorian volcanic plains, and various coastal plains.

Sea access is reflected in the fish fauna differences described earlier. Macro-invertebrate diversity is often high, but reduces in the lower reaches of major systems such as the Latrobe River.

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13. RIVER CLASSIFICATION METHODOLOGY

In past investigations the Council has seen the need to base its recommendations on data describing the characteristics of the land. It has also adopted an ecological approach, integrating single environmental features such as rainfall, geology, topography, soils, and native vegetation into repeating patterns, classifying them into units, and thematically mapping them.

Stream characteristics and stream-flow patterns depend on climate, topography, geology, vegetation, and soil. Further, rivers and streams are active agents in landscape development and the modification of other environmental factors such as habitat. They are fundamental to both the erosion-deposition cycle and the water cycle.

Victoria has a diversity of rivers and streams, reflecting the State's pattern of land types and climatic zones. One of the objects of this investigation is to ensure that representative examples of stream types are maintained in at least their present condition. To achieve this, a State-wide classification is required to identify stream types, and streams occurring in each type.

This objective is similar to the Council's standard policy of ensuring that, as far as practicable, examples of the major land types of the State are represented within the State's system of conservation reserves.

Macmillan (1987) discusses the importance of geomorphic and climatic characteristics, in placing river segments into a regional context. Before the conservation value and status of rivers can properly be evaluated, different river 'types' and their components must be identified and classified.

An ecologically based classification system is necessary to allow comparison of similar types and to understand functions within systems. It can also generate working units of a reasonable size. Without a classification system, an inventory can remain an unorganized list.

River classification systems

Approaches to river classification methods have been reviewed by Macmillan (1987), mainly from the perspective of in-stream biota. Geomorphic divisions within river systems - mountain, valley, plain, and estuarine tracts (see Chapter 9) - have been used in various classifications, and in some cases have been linked to biological differences. Several methods use water-quality characteristics, while others focus on catchment geology. River flow and other climatic parameters form the basis for some studies. The most relevant are the classifications used in the detailed regional studies by Macmillan, and others using related methods, (see the references in Chapter 15 for a list of these).

For the East Gippsland study, rivers were classified according to their size - low-order tributaries or mainstreams. Low-order streams were further divided physiographically into plateau, uplands or lowlands units; then between three rainfall classes; and finally by geology. Main streams were divided by physiography, flow regime, stream gradient, then geology.

The Wimmera catchment required an amended system. Streams were classified first on the basis of whether they were permanent or ephemeral; then into tributaries, main streams, effluent streams, or lakes; then by physiography, by run-off, and finally by geology.

Related studies for the Department of Water Resources, Dandenong Valley Authority, and Land Conservation Council used similar frameworks to classify rivers.

In conclusion, various systems use geomorphic criteria to classify rivers, some use climatic, and some a combination.

The climatic variable selected should as far as possible integrate most aspects of the water cycle, so that it is of some value in understanding river systems, and in classifying streams of very variable behaviour. The single parameter that approaches this aim is stream flow, and the flow regionalization mentioned in Chapter 10 and discussed below is just one of many possible groupings or divisions of rivers. However, other groupings will be similar in many respects, and the regionalization is considered sufficiently well established to be used for this investigation.

The particular geomorphological and climatic criteria discussed below have led to the development of a combined river classification system.

Geomorphology

As a necessary and important component of a river classification system, geomorphology embraces surface topography and underlying rock types, and concerns landscape formation. Rivers have carved the present Victorian landscape into many different patterns, in response to the geological parent material and the gross topography produced by upwarping, other earth movements, and volcanic activity.

Steeply dissected valleys in the East Victorian Uplands are quite distinct from the more gentle slopes of the West Victorian Uplands; streams draining the extensive West Victorian volcanic plains are unlike those in the Murray Basin or South Victorian riverine plains, or the coastal plains.

The various river processes described in Chapter 9 respond to, or are influenced by, the geology and topography of the areas the rivers drain. Accordingly, a broad geomorphic characterization of the State is one of the two main factors in the descriptive river classification system being used in this investigation.

The geomorphic basis is the 29-unit system developed by Jenkin and Rowan, and published at 1:500 000 scale in the Land Conservation Council's Statewide Assessment of Public Land Use report (see Chapter 9). Describing Victoria in so few units requires combination of somewhat different areas on the basis of their broad similarities. This method has the benefit of already being subdivided into land systems - smaller units with repeating patterns of geology, topography, climate, soil, and vegetation. A more detailed characterization of river catchments can therefore be taken from the land system information, but there are too many of these - more than 700 across the State - for a river classification.

Primarily, the geomorphic units characterize river catchments in plan view - that is, from the air. Another geomorphic feature of a river is its longitudinal profile - that is, a view in elevation from the head-waters to the Murray or coastal outfall. River profiles and their division into tracts have been introduced in Chapter 9.

Identification of tracts is important in detailed studies of rivers where it is necessary to divide rivers into consistent segments. Many uses and values of rivers are associated only with particular tracts. A map at 1:1 000 000 scale showing approximate mountain, valley, and plains tracts across Victoria is included with the 1988 State of the Environment Report.

While for individual systems it is useful to divide rivers into their tracts, on a broad scale they do not provide as effective a characterization of the State as the 29 geomorphic units. Stream tract differences do not separate the major differences between various areas of uplands (eastern or western Victoria, Otways) or plains (riverine, volcanic, coastal), which are, however, identified by the broad geomorphic units. More detailed studies of particular regions may require further division of the broad units, particularly on the basis of geology.

Climate

The other major factor in classifying rivers should be derived from climate. Geomorphology and climate are closely linked - as indicated for example, by the coincidence of higher-rainfall locations with high-elevation areas. However, because of the great variability of values for climatic parameters across the State, consideration of climate is also of central importance in any attempt to characterize and classify rivers.

Climate incorporates several elements of the water cycle (see Chapter 3). Stream flow comprises surface run-off and groundwater inflow. It is primarily a response to precipitation and is moderated by evapotranspiration - both key climatic parameters.

Patterns of stream flow - from month to month and from year to year - are of critical importance for understanding stream systems, and when considering both consumptive use of water and its use for in-stream conservation, recreation, and other uses. The hydrological behaviour of Victorian rivers is highly variable; however, as discussed in Chapter 10, a study has identified five regions that distinguish broad hydrological regimes by statistical analysis of stream-flow records. Broadly, these are in order of decreasing run-off per unit of catchment area, from region 5 (wet), through 4, 3 and 2 to region 1 (dry). 'Wet' and 'dry' are used here as shorthand references to the set of hydrological values displayed by each of the regions, as Chapter 10 explains.

The hydrological regionalization relates to a selection of those sites on rivers and streams with flow gauges and with adequate records. That is, it uses information from specific points, not areas of land. This causes some difficulties in extending the regionalization to geographic areas, then to the whole State, which is necessary as, for a State-wide classification, complete coverage is preferable. The stream flow at a flow gauge reflects its catchment, and in effect integrates the geomorphic and climatic variables that combine to determine run-off at that point. Application of the hydrological region to a flow gauge catchment therefore amounts to averaging the run-off behaviour of all parts of the catchment.

Except in areas with very consistent topography and run-off, the region may change with progression down the catchment. The head-waters of rivers are commonly categorized into a wetter region. This is illustrated by the Hughes and James study (see Chapter 10) where it uses more than one flow gauge in a single river catchment. For example, the catchment to the Mitta Mitta River near Benambra (region 3) includes the wet tributary Big River (region 4), which drains the east slopes of Mount Bogong. Drier tributaries such as Morass Creek (region 1) then join the Mitta Mitta River, resulting in its being classed in region 2 at its junction with the Gibbo River below Benambra. Wet tributaries such as the Snowy Creek (region 4) and Dart River then join the Mitta Mitta, and (from stream-flow records prior to completion of Dartmouth Reservoir) these cause the river to be classed in region 3 at Tallandoon (see Map 10).

While this illustrates that large whole-basin systems can seldom be categorized into one hydrological region, it would be unreasonable to expect that they could. For smaller catchments the hydrological regionalization is a very effective tool to characterize run-off behaviour into similar groups.

The 138 flow gauges used in the regionalization are spread widely, and in many cases their catchments abut along drainage divides. Accordingly, the regionalization includes a large proportion of the upland areas across the State, within the limitations mentioned above. Map 9 shows all flow gauges used.

Geomorphic/hydrological classification

For the purposes of this investigation, a combination of geomorphic units and hydrological regions has been selected as a basis for identification of river types. In order to extend the hydrological regionalization to areas not included in the statistical analysis, using existing information, it is necessary to consider the individual hydrological parameters used (see Chapter 10). The most suitable for this purpose is mean annual run-off. This variable has a range of values in each region, but no overlap between regions. The regionalization shown on Map 10 has been extended further across the State by careful use of such data from selected additional flow gauges, to clarify the boundaries between regions. The additional sites allow the identification of areas that are consistent with adjacent regions and rainfall records.

The descriptive classification resulting from a combination of the geomorphic and hydrological information (Table 18) was produced by overlying 1:500 000 maps of the 29 geomorphic units onto maps at the same scale showing the catchments to the regionalized flow gauges (see Map 10). The resulting river catchment types are combinations of the hydrological region and the geomorphic unit. Of the 37 river catchment types identified, 12 occur almost entirely on one geomorphic unit; the remainder combine more than one geomorphic unit, but have distinctive character. Catchments were grouped into one or other of the 37 types according to similar percentages of their area in specified geomorphic units. Appendix VIII lists these percentages.

Catchments in river catchment types '1/2.1, 7.1' and '1/7.1, 2.1' have the same hydrological region and contain the same geomorphic units, but in strongly different proportions. For example, the catchment to flow gauge 407220 (Bet Bet Creek) is type '1/2.1, 7.1'. It contains geomorphic unit 2.1 (West Victorian uplands) in 75% of its catchment area, and unit 7.1 (West Victorian volcanic plains) in 25%. The catchment to flow gauge 236203 (Mt Emu Creek) is type '1/7.1, 2.1'. It contains the same geomorphic units but in reversed proportions. The dominance of one of these - say the hilly, dissected uplands unit - over the other - the flat, volcanic plains unit with sparse, incised streams - gives these river systems clearly different characters.

Mt Emu Creek (Basin 36) - type 1/7.2,2.1

West Arkins Creek (Basin 35) - type 5/3.1

In addition to the above criteria, rivers entirely in the East Victorian Uplands unit (1.1), and those with some high plains unit (1.3) also, were separated according to their drainage to the Murray or to the coast. This uplands unit is very extensive, covering a range of geological parent materials that differ north and south of the Divide.

Accordingly, north- and south-draining streams in the uplands are considered to differ. Further, they have distinct fish assemblages and other biological habitat characteristics, as outlined in Chapter 12.

Several of the river catchment types effectively defined themselves by the geographic location and limited extent of some geomorphic units - for example, units 2.2 Grampians, 3.1 Otway Ranges, and 3.4 South Gippsland Ranges. As such areas are striking and individual geomorphic features, it follows that their river types should class them distinctly.

Another aspect of this classification is that some rivers do not fall clearly into one or other geomorphic/hydrological type, but are mixtures of different types. The Glenelg River above Dartmoor, for example, has its headwaters in the Grampians (unit 2.2), flows through the Dundas Tableland (2.3) and south-western

Table 18

GEOMORPHIC/HYDROLOGICAL RIVER CATCHMENT TYPES

Number of Hydrological Region Catchments in Each Type

Geomorphic unit groups	Description	Hydrological region 1	2	3	4	5
3.1	Otway Ranges					2
1.1, 1.3	East Vic. uplands, high plains (north-draining)		1	1	3	1
3.1, 8.2	Otways, adj. coastal plain			1	4	
3.4	Sth Gippsland Ranges			8	1	
1.1	East Vic. uplands (north-draining)		7	5	6	
1.1, 1.2, 1.3	Dissected East Vic. uplands, plateaux, high plains		2	5		
1.2, 1.1, 1.3	Dissected East Vic. plateaux, uplands, high plains		1	4		
1.1, 1.3	East Vic. uplands, high plains (south-draining)	2	2	4		
1.1	East Vic. uplands (south-draining)	2	7	7		
1.1, 9.3	Dissected East Vic. uplands, Gipps. river terraces		2			
1.1, 4.2	East Vic. uplands, old Murray plains	3				
3.4, 9.3	Sth Gipps. Ranges, river terraces		4			
7.1, 8.1	Volcanic plains, south-west coastal plains		1			
8.2, 7.1, 7.2	Pt Campbell coastal plains, volcanics		3			
2.1, 7.1	West Vic. uplands, volcanic plains volcanic plains	6	3			
2.1	West Vic. uplands	4				
2.1, 4.2	West Vic. uplands, old Murray plains	3				
2.2	Grampians	1				
2.3, 2.4	Dissected Dundas, Merino Tablelands	2				
7.1, 2.1	Volcanic plains, West Vic. uplands	9				
7.1, 7.2, 2.1	Volcanic plains, stony rises, west uplands	2				
7.1, 7.2, 8.1, 8.2	Volcanic and stony plains, coastal plains	3				
8.2, 7.2	Pt Campbell coastal plains, stony rises	1				
3.3	Mornington Peninsula Uplands	1				

Notes:

1. The figures in the five columns on the right-hand side of this table represent numbers of the 138 flow gauges regionalized by Hughes and James.
2. The groups of geomorphic units in the left-hand column are listed in decreasing order of abundance of each unit.
3. Each entry in one of the five right hand columns represents a 'river catchment type' drawn from the geomorphic and hydrologic data.

coastal plains (8.1), and includes the Wannon River (its own catchment a mixture of Grampians and Dundas Tableland with volcanic plains (7.1), Merino Tablelands (2.4), and West Victorian Uplands (2.1) components). The Glenelg is therefore not one member of a type, but rather a unique river.

In broad, lowland reaches of large river systems, it becomes harder and less relevant to simply characterize river catchments using stream flow as a criterion, as the headwaters, which generate most of the flow, are more and more remote. In these areas mixtures of river catchment types occur more frequently. Of the catchments used in the hydrological regionalization, apparent mixtures of river types occur in the catchments to the Ovens River above Wangaratta, Mitchell River above Iguana Creek, Barwon River above Winchelsea, and Moe River above Moe, as well as the Glenelg and Wannon Rivers. These either have very large catchments containing a range of geology and topography, or flow through two or more geomorphic types and have tributaries in each. Rather than treat these all as distinct types, it is considered preferable to treat them as mixtures: that is, their sub-catchments - each of a different type - are treated separately.

While in parts of the State the geomorphic units and hydrological regions do not vary completely independently, the combination of both is particularly effective as a classification technique in two large areas. In the western half of the State, geomorphic units distinguish between the many river catchments in the same hydrological region; and in the East Victorian Uplands, hydrological region distinguishes between many rivers in the same geomorphic unit.

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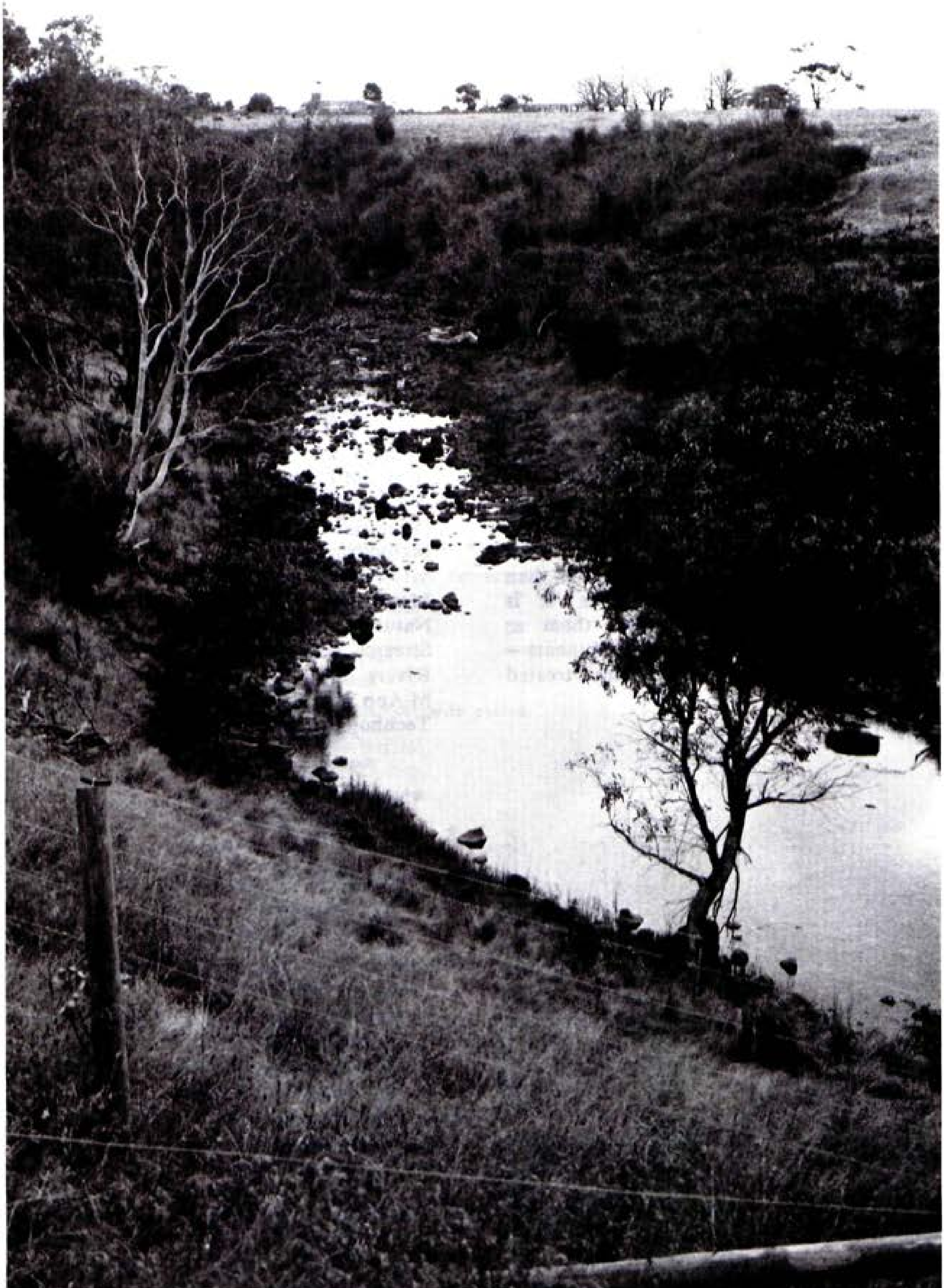


A basalt plains stream - Hopkins River near Framlingham (Basin 26)

PART III

SPECIAL VALUES OF RIVERS AND STREAMS

14. INTRODUCTION

Part III of this report outlines the special values that are the subject of this investigation. Part I introduced the diverse range of uses and values of rivers and their catchments, and gave a historical view of the uses. It also outlined the current legislative framework, uses of public land in their catchments, and the present management of rivers and adjacent land.

Part II described aspects of the physical and biological features of rivers and their catchments that assist our understanding, and that determine or limit the range of values they contain or uses to which they can be put. Figure 13 illustrates some of the physical features of streams in their various tracts.

The following chapters describe the special values of rivers and streams and their catchments. These values have in the past been taken for granted, or else authorities have not provided sufficient resources for systematic management. The special values relate to our needs as people and to the broader view of the human race being one part of a global ecosystem.

Each chapter in Part III discusses one of the following special values.

* Nature conservation - Chapter 15 describes a range of ecological and geological/geomorphological values of rivers and their catchments
* Recreation values - Chapter 16 introduces and describes this

FIGURE 13
GEOMORPHIC CHARACTERISTICS OF RIVER TRACTS

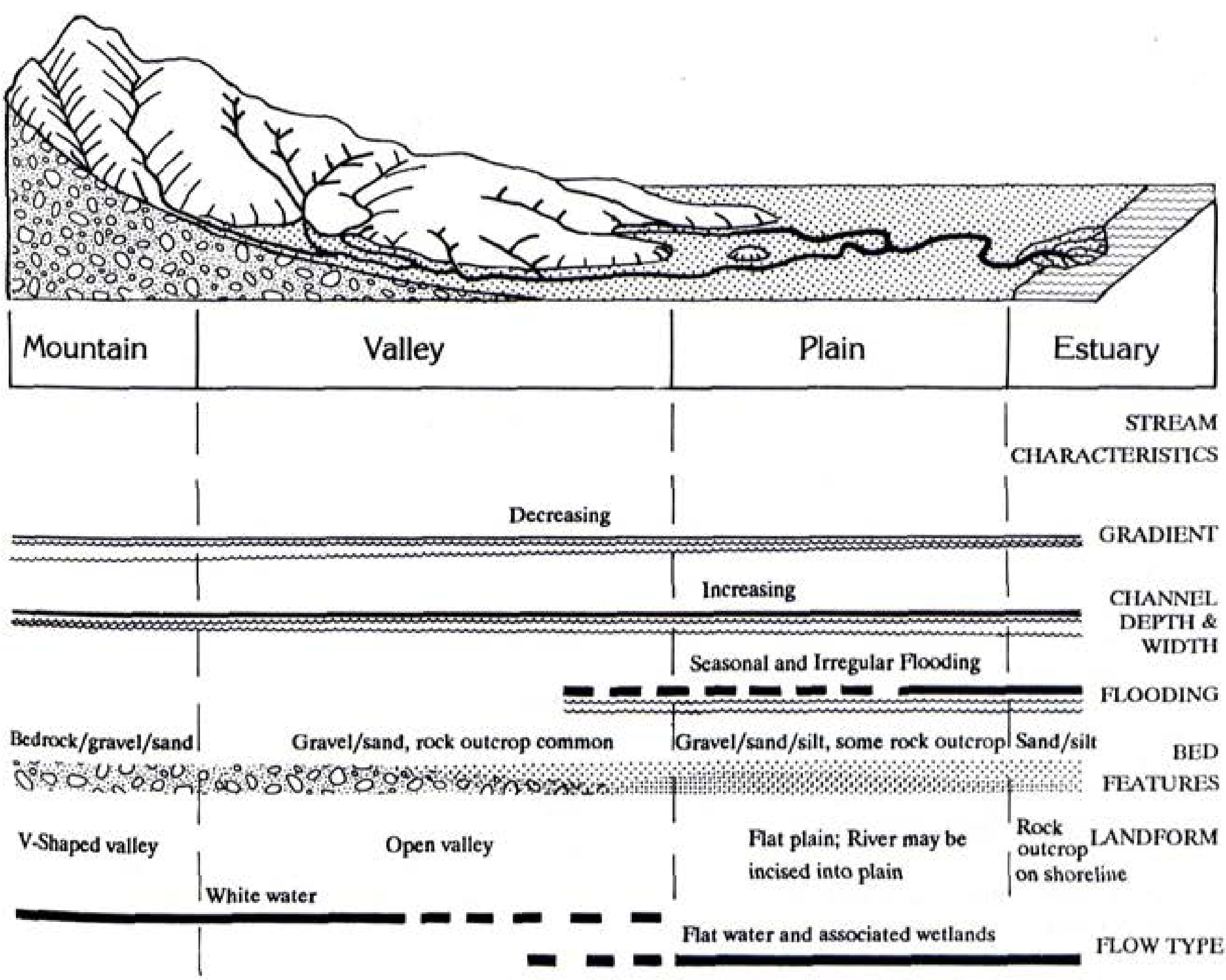
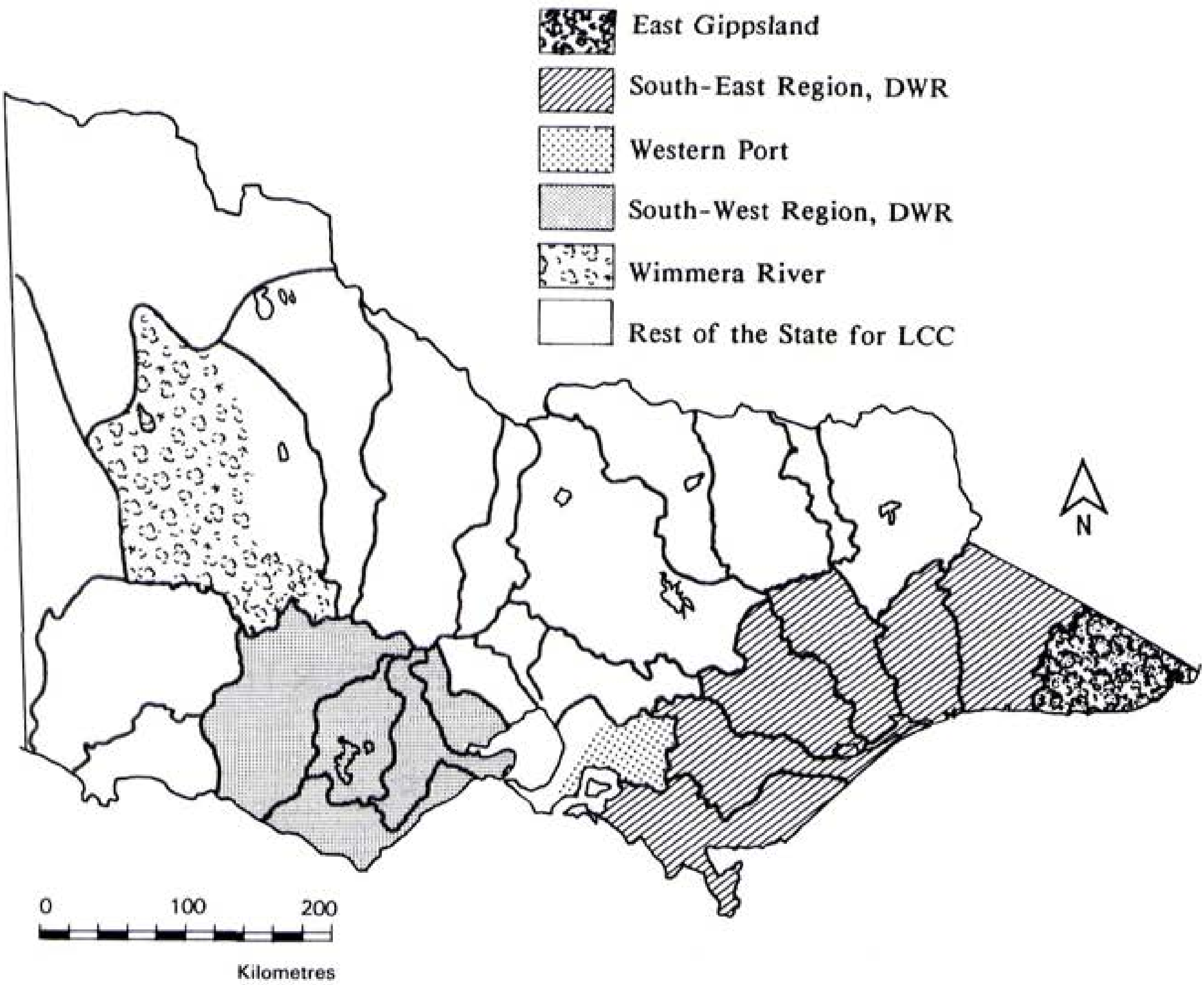


FIGURE 14
NATURE CONSERVATION VALUES OF RIVERS AND STREAMS.
Location of Study Areas



important and varied component of our interaction with water bodies

* Landscape values - Chapter 17 specifically describes many of the scenic values of rivers and their catchments
* Cultural associations - Chapter 18 thematically describes the various ways we have related to river and other water bodies

Information on high-value or significant river and stream reaches or catchment areas was obtained from a range of studies. Where existing sources of information were incomplete, additional complementary studies were commissioned as part of this Investigation.

Stream reaches and catchments with high nature conservation, recreation, and scenic values are shown on Maps 11, 12, and 13 and are described in the basin summaries given in Part V of this report. The cultural associations are illustrated by Map 16 - Aboriginal Archeological Sites and Appendix IX - A Listing of Historic Places.

The principal documentary sources are referenced in the relevant chapters, and are summarized below.

Nature conservation values

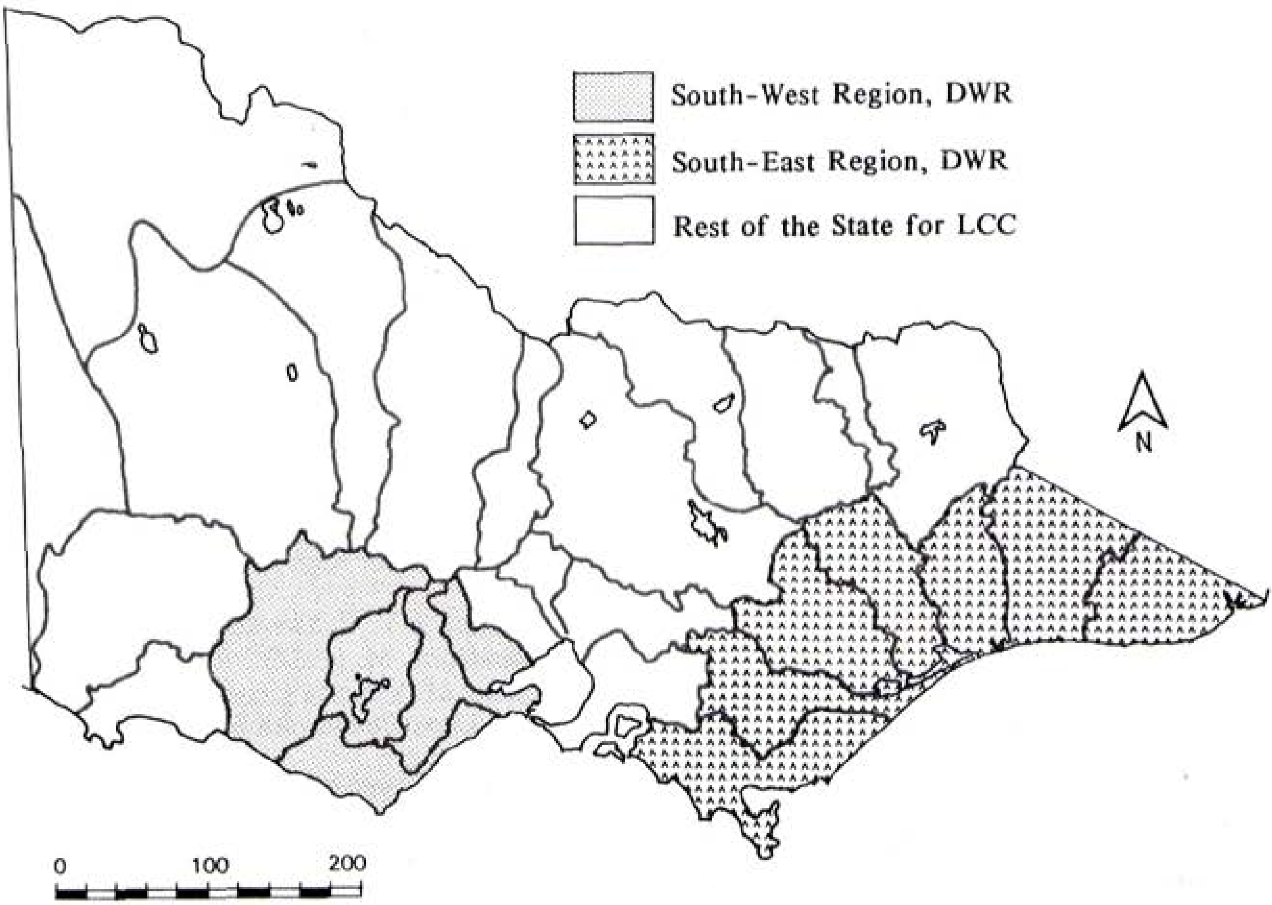
The authors of the following reports used and adapted where necessary an approach developed by Macmillan to assess nature conservation values.

* Macmillan, L., (1987). 'Assessing the Nature Conservation Values of Rivers and Streams with Particular Reference to the Rivers of East Gippsland,

FIGURE 15

RECREATION VALUES AND USES OF RIVERS AND STREAMS

Location of Study Areas



Victoria.' M.App.Sci. Master thesis. (Chisholm Institute of Technology: Melbourne.)

* Macmillan, L., Kunert, C., and Blakers, M. (1987). 'Nature Conservation Values and Status of Rivers in the South-western Region, Victoria.' (Report to the Department of Water Resources.)

* Kunert, C., and Macmillan, L. (1988). 'Conservation Value and Status of Victorian Rivers - Part III: the Wimmera River and its Catchment.' (Royal Melbourne Institute of Technology: Melbourne.)

* BIOSIS Research Pty Ltd (1989). 'An Assessment of the Nature Conservation Values of the Rivers and Catchments of the South-east Region.' (Report to the Department of Water Resources.)

* BIOSIS Research Pty Ltd and Ecological Horticulture Pty Ltd (1988). 'Report on the Ecological Values of Victorian Rivers and Streams'. (Report to the Land Conservation Council). This report covers the rest of the State not covered by the other studies.

* Seymour, B.S. (1987). 'Assessment of the conservation values of the rivers and streams in the Western Port Region.' Dandenong Valley Authority *Technical Report* No 31.

Figure 14 shows the areas covered by each of these studies.

Recreation values

Using the criteria inherent in published methods, consultants have carried out the following three regional studies to assess the recreational uses and values of Victoria's inland waters.

* Farmar-Bowers, Q. (1987). Recreational values associated with water bodies in the South-western Region - Victoria. (Report to the Department of Water Resources.)

* Farmar-Bowers, Q. (1988). Assessment of recreational values of rivers and streams in part of Victoria. (Report to the Land Conservation Council).

* Ligtermoet, E. (1989). Recreational value and use of the inland waters of Gippsland. (Report to the Department of Water Resources.)

The studies covered the areas shown in Figure 15, and drew on the following information:

* existing survey data

* questionnaires completed by office-holders of local, regional, and State recreation clubs

* interviews and completed questionnaires from local-government officers and land managers

* staff of outdoor recreation companies

The authors of these studies recognize the following limitations.

* Some recreational activities such as non-competitive swimming, are not organized around clubs.

  Where clubs do exist for a particular recreation, club membership is traditionally low, often being less than 20% of participants. Consequently the office-holders may not be representative of all participants involved in a particular activity.

* The assessment is based on the perceptions of current users, so the value of water bodies that are comparatively unknown and rarely used is likely to be understated.

* It is difficult to determine the extent to which Victorians seek recreational opportunities outside Victoria or the use of Victoria's resources by interstate and international visitors.

Landscape values

Using a methodology developed by Scenic Spectrums Pty Ltd and applied to the Werribee River in 1986, this study adapts the method, lists specific visual elements that enhance scenic quality, and identifies stream reaches of high scenic value.

* Anson, Y., Sweatman, C., and Sandford, M. (1987). A scenic assessment of Victoria's rivers. (Report to the Land Conservation Council.)

Cultural associations

A consultant's study thematically describes the cultural associations with water over the last 150 years, and lists some 500 sites of national, State, and regional significance that illustrate these themes. Using ethnographic and archaeological evidence, the Victoria Archaeological Survey (N. van Waarden) provided a report on the Aboriginal use of water-related resources and the features that result.

* Clark, I. (1989). Themes related to the past 150 years of Victoria's rivers, streams and water systems. (Report to the Land Conservation Council.)

15. NATURE CONSERVATION

Most of Victoria's river catchments have been extensively modified by logging and by clearing for agriculture, roads, and impoundments. Those remaining in an essentially unmodified condition are considered to have high conservation value. This chapter describes the development of a methodology for assessing the nature conservation value of river catchments and its subsequent application to all parts of Victoria.

Sites of high value tend to be restricted to the eastern part of the State and they are discussed below, as are the State-wide distribution of sites important for native fish and riparian vegetation and the sources used to determine their significance. More detailed information and maps showing the sites are provided in Part V of this report.

ASSESSING NATURALNESS

No inventory of ecologically important water bodies has been conducted in Australia, except for the regional studies using the method for assessing the nature conservation values of rivers and streams developed by Macmillan (1987). The need for such information was recognized by the Australian Heritage Commission, which funded Macmillan's study of East Gippsland rivers and streams.

Ideally, such studies would be based on detailed investigation and extensive field work. Instead, this method uses existing material such as maps, aerial photographs, and information held by government agencies, because detailed studies have not been widely carried out. It is based on the view that the condition of a stream can be determined by examining the condition of its catchment. Information on catchment land use forms the basis of the evaluation. Where detailed chemical or biological studies of streams have been carried out - for example, in the Mitta Mitta, Thomson, and Latrobe Rivers - they reinforce the land use impacts on river condition, assessed by Macmillan's method.

Although information on the biological condition of streams is very limited, it is used as an additional source when available. It includes assessments of the naturalness and rarity of fish populations, and the presence of sites of biological, geological, and geomorphological significance. Invertebrate species diversity and abundance are also good indicators of naturalness.

As the method was established in East Gippsland, the approach used there is now outlined. The first stage was the classification of rivers and streams into groups with similar physical components. This is important because the subsequent evaluation of conservation significance depends on the comparison of streams that are ecologically similar.

Streams were initially divided into low-order tributaries and headwaters (Order 1,2, and 3) and main-stream segments (Order 4 and above) on 1:100 000 maps. The low-order streams of East Gippsland fell into three physiographic groups - plateau, upland, and lowland. Rainfall and geology were then used to further divide the streams into separate categories. For example, White Monkey Creek was classed as an upland stream of volcanic origin with rainfall of 900--1400 mm. The method for classifying main-stream segments was similar although gradient was also considered.

Once a stream was classified, it was allocated to one of five categories depending on how much its catchment had been modified. Only the top two categories, 'A' and 'B', were considered to have significant naturalness value. However, the remaining streams may still have had specific features of high conservation value (for example, an endangered fish species) even though the catchment had been significantly degraded. The definitions of 'A' and 'B' follow.

A. An 'essentially unmodified' river or stream is one that has had negligible modification to its catchment and riverine environment. Fluvial and hydrological processes remain intact and the riparian environment is in a virtually pristine state. The entire catchment system represents an unmodified ecosystem suitable as a baseline reference.

B. A 'slightly modified' river or stream is one in which catchment processes are largely intact and where the flow regime has been modified to no more than a minor extent. It contains no barriers to movement of in-stream biota and the only possible pollution input is in the form of sediment resulting in minor modification to the stream substrate. The riparian environment remains largely unmodified.

The lower groups are 'moderately modified', 'heavily modified', and 'severely degraded'.

A filter process was used to allocate streams to the catchment modification categories. Firstly, low-order streams were excluded if they had major impoundments, major stream engineering works, major pollution sources, or significant past mining, or if the catchment contained more than 10% non-native vegetation. Where the impact of mining was not substantial however, a 'C' rating was given. A stream that contained a minor weir, had a road along much of its length, had some non-native vegetation in its catchment, or had more than 10% of its catchment logged received a 'B' rating. A catchment with none or less than 10% logged, was given an 'A' rating. Table 19 lists these differences.

The process was similar for the main-stream segments. Entire river segments were rated according to the level of modification of the low-order streams and main-stream segments. For example, a river system obtained an 'A'rating if all the low-order streams and main-stream segments within it were A-rated.

In addition to the assessment of catchment condition, streams were separately rated for fish naturalness (presence of exotic species), fish rarity (endangered species), and sites of geologic and geomorphic significance. Although the results of these separate assessments were not added to the naturalness scores, an 'A' stream with very high fish naturalness and rarity ratings obviously has more importance than an 'A' stream without them.

Other related studies

Macmillan's method has been used to assess the conservation value of rivers and streams throughout Victoria.

Studies of the Western Port Region and the Department of Water Resources' South-West region were completed in 1987. The Wimmera River catchment (1988) and the Department of Water Resources' South-East region (1989) have also been assessed, and the Council commissioned a study of the remainder of the State for this report. Figure 14 indicates the study area boundaries.

Although the Macmillan method was used in each case, modifications were made when necessary (see Table 20 for details). However, the first-stage classification of streams remained the same. Major differences are discussed below.

Western Port

This study incorporated additional information from the Dandenong Valley Authority's Stream Condition and Assessment Program (SCAP). Not normally available for the assessment of stream naturalness, this detailed information allows streams with more modified values to be classified. Without it, only the very few high-value streams in the area could be assessed. Significantly, SCAP records include riparian vegetation values - an important, but frequently unavailable, measure of catchment naturalness. Rapid assessments were also made of fish, invertebrate, water-plant, and noxious weed populations.

South-West

Modifications of the method for assessing naturalness took account of when logging occurred. Logging carried out before 1945 was not counted, largely because records before then are incomplete. Macmillan's assessment of East Gippsland did not make such a distinction, although it was included for Western Port.

Table 19

A SUMMARY OF THE DIFFERENCES BETWEEN ESSENTIALLY UNMODIFIED AND SLIGHTLY MODIFIED AREAS

Feature	Naturalness	
	A - essentially unmodified	B - slightly modified
Catchment cleared (%)	Nil	10%
Catchment logged (%)	10%	Any amount
Road crossings	No more than 1 per 5 km	Any number
Parallel roads	None	Of slight impact
Reservoirs	None	None
Water abstraction	None	For a given month should not exceed 10% of minimum flow
Intensive agriculture	None	None
Extractive industries	None	None
Mining with associated toxic discharge	None	None
River engineering	None	None
Urbanization	None	None

Source: Macmillan (1987)

Wimmera

The Wimmera is a highly modified region with large areas affected by agriculture and settlement. Although in general the Macmillan method was used, the Wimmera River northern plains, lakes, Outlet Creek, and effluent segments were placed in categories based on assessments of bed and bank stability, stream flow, and water quality. These are described as being equivalent to catchment naturalness categories.

South-East

Several modifications were made to Macmillan's method in this study. In the most significant one, any catchment that had been logged at all received a 'B' rating (assuming it passed all the earlier filters such as the absence of impoundments), whereas other studies included areas with less than 10% logging in the 'A' class. The presence of a minor weir or parallel road in an otherwise natural catchment did not result in its demotion from the 'A' to 'B' class.

Rest of the State

In order to cover such a large area, Macmillan's method was simplified in parts and information was generally collected in less detail. For example, catchments were classed as either completely unlogged or not, whereas Macmillan divided them into more or less than 10% logged. Areas with any logging were given a B rating and in this respect the method followed that used in the South-East. The report included significantly more data on biological significance than the other studies.

Highly natural catchments in Victoria

While the various studies differ in the points of detail outlined above, they all identify upper catchments that are highly natural; however, these are only found in the eastern part of Victoria. The boundary is an imaginary line drawn from

Table 20

COMPARISON OF CATCHMENT NATURALNESS STUDIES CARRIED OUT IN VICTORIA

	East Gippsland (Macmillan 1987)	Western Port (Seymour 1987)	South-West (Macmillan et al. 1987)	Wimmera (Kunert and Macmillan 1988)	South-East (BIOSIS 1989)	Rest of the State (BIOSIS 1988)
Catchment naturalness (see note 1)	No distinction between pre and post 1945 logging >10% logged is B <10% logged is A Categories used: A, A^-, B, B^-	Incorporated additional information from SCAP Logging pre-1945 excluded >10% logged is B <10% logged is A Categories used: A^+, A, A^-, B^+, B, B^-	Logging pre-1945 excluded >10% logged is B <10% logged is A Categories used: A^+, A, A^-, B^+, B, B^-	Modified Macmillan method for Wimmera River northern plains, lakes, Outlet Creek, and effluents segments Remainder (tributaries) evaluated using Macmillan's (1987) filter method: categories used - slightly modified (B), moderately modified (C)	Modified Macmillan's method by only assessing whether the impact was substantial: used presence of a minor weir or parallel road to distinguish between categories A and A^- rather than B and B^-; added procedure for assessing degraded mainstreams> 10% logged is B^- < 10% logged is B Categories used: A, A^-, B, B^-	Simplified Macmillan's method to cover such a large area Low-order streams - only consider whether catchment is wholly covered by native vegetation whereas Macmillan divided it into more or less than 90%: catchment classed as logged or not; if logged at any time is B, unlogged is A. Mainstream - if more than minor logging is C; if no minor) logging but has weir or parallel road is B; if no logging and no weir etc. is A
Fish naturalness and rarity	Developed categories for naturalness	Macmillan method; used Koehn's (1986) fish survey, part of Western Port Rivers Management Study	Macmillan method; used Tunbridge and Glenane (1982) and others:. limited abundance data (Jackson and Williams 1980) used to modify rarity ratings	Macmillan method; used Tunbridge and Glenane (1982) and others	Macmillan method; used data from the Natural Resources Inventory in addition to obtaining information from experts	Macmillan's method for assessing fish naturalness and slight modification for rarity Used Tunbridge and Glenane (1982) and other sources
Sites of geological and geomorphic significance	Used the 'sites of significance' series - e g., McRae-Williams et al. 1981, Joyce and King 1980)	Used Rosengren's (1979) ranking of sites at national, State, regional and local levels of significance	Used Department of Industry, Technology and Resources files and Rosengren's (1984 and pers comm) ranking of sites at international, State, regional, and local significance	Sites identified as significant by King (1985), Bowler and Magee (1978) and the Australian Heritage Commission	Used Rosengren (1984); Rosengren, McRae, Williams and Kraemers (1981) and Geology Society of Victoria (1980)	Used a variety of sources (Rosengren 1986; Rosengren et al. 1981 and 1983; King 1985 and Geology Society of Victoria 1980)

	Four categories: National, State, regional and local significance					
Riparian vegetation	Developed guidelines for naturalness of riparian vegetation (see Macmillan 1986) but these but these were not used or discussed in the East Gippsland study	Used Macmillan's (1986) guidelines and SCAP data; also used Herbarium survey of of sites of botanical significance at national, state, regional and local levels of significance	Listed sites of significance: limited information	Used Macmillan's (1986) guidelines plus aerial photos; data from Carr (1984) and others used to make assessment of rarity	Assessed the extent of clearing of riparian vegetation Listed sites of floral significance obtained from Forbes et al. (1981) and Gullan et al. (1984)	Applied national, State, local categories to other authors' data - based on six criteria
Birds (see note 2)	Not assessed	Used Andrew et al's (1984) study of sites of zoological significance.	Used RAOU (1982), Lane (in press) and Naarding's (1983) assessments of sites of significance for species dependent on wetlands - waterfowl and Lathan's snipe	Sites containing rare and endangered bird species identified		(Sites of faunal significance (given a significance rating (using criteria developed by (BIOSIS for wetlands ((Species and sites assessed (at four levels of signific-(ance - national, State, (regional and local
Other flora and fauna			Known sites of significance collated; no comparative assessment	Sites of platypus, water rats and long-necked tortoises are noted (National Parks and Wildlife Division data)		

Note: 1. Under catchment naturalness, the 'categories used' (A^+, A, A^- etc.) have minor differences, some of which are explained in the text. For more detailed explanation, see the references.

2. See the original reports for references used.

Essentially unmodified catchment - the Rodger River (Basin 22)

Corryong on the New South Wales border, past Mount Buffalo to Lake Eildon then Warburton and finishing south of Leongatha. Only those catchments to third-order streams that received 'A' ratings are mapped on the basin map sheets (Maps 11 to 13) and discussed here.

Many East Gippsland catchments just miss out on the highest rating because of timber-harvesting activities. The pockets of high-value streams tend to be in areas that did not contain desirable timber species, were too steep or expensive to log, or have not yet been scheduled for harvesting.

Two very interesting groups are located in East Gippsland. A sequence of four small coastal streams occurs - Benedore, Red and Little (Easby) Rivers, and Shipwreck Creek - along with four internal lake systems (Dock Inlet and Lakes Barracoota, Elusive, and Wau Wauka). The coastal streams are particularly significant, as the only other high-value ones in the State are found on Wilsons Promontory. The remainder of the high-value catchments in East Gippsland are fairly scattered, the only cluster being the tributaries of the Snowy River draining from the east side. Of these, Mountain Creek stands out because it is the largest high-value stream in the region.

The Snowy River separates the East Gippsland region from the areas to the west where high-value catchments tend to be restricted to the mountainous headwaters. Many of the high-value catchments in East Gippsland are in good condition for much of their length. Further west parts of the upper Avon River and Valencia Creek, and several western tributaries of the Macalister River (for example Serpentine and Mt Useful Creeks) are of high value.

Very few sites are found in South Gippsland, apart from those on Wilsons Promontory. The Promontory is one of only three areas in the State containing entirely forested catchments - from headwaters to the sea - East Gippsland and the Otways Coast being the other two. The one high-value catchment in the Otways was not included in this investigation because of its small size (second order).

In the upper reaches of the Yarra, the O'Shannassy River has two high-rated sections and these significant areas are the closest to Melbourne.

Towards Eildon, the upper reaches of the Goulburn River and its tributaries the Black and Big Rivers have several high-value sub-catchments. Between Eildon and Mount Buffalo, the Catherine and Dandongadale Rivers and Yarrarabula and Devils Creeks, which are in the headwaters of the Ovens River, all have high value.

The only remaining river system of note for naturalness in the State is the Mitta Mitta. The high-value catchments are all above Lake Dartmouth and include the Bundara and Cobungra Rivers.

OTHER BIOLOGICAL VALUES

As indicated above the assessment of biological values was an adjunct to the rating of streams for naturalness. In general, each of the reports attempted to provide information on fish naturalness and rarity, and sites of geological and geomorphological significance, while some also detailed the flora and other fauna.

For the purposes of this study, fish, flora, and geological/ geomorphological data were extracted from the reports, along with additional information where necesary. The particular data used are described below, with a discussion of the conclusions reached.

Fish

The basin maps in this report include an indication of areas with high value for native fish. The source was a report

Murray cod

Mitchell River digitate delta (Basin 24) - international significance

produced by the Department of WaterResources - the most recent compilation of fresh-water fish records, done for the whole of the State.

Sites of significance for fish have diversity or rarity value, or both. However, this distinction is not marked on the maps. Diversity was defined here as the presence of four or more native fish species, and rarity value was assigned when at least one endangered or vulnerable species had been recorded. The only fish endangered in Victoria is the trout cod and the Australian grayling, Murray cod, Macquarie perch, and golden perch are considered vulnerable species. (An endangered species is considered to be one in immediate danger of extinction and a vulnerable species may soon become endangered if the factors causing its demise continue to operate.)

Another indication of the naturalness of a stream is the absence of exotic or non-native fish. However, this was not used as a measure of high fish value on Maps 11 to 13 because only two areas of the State are essentially free of exotics - East Gippsland (east of the Bemm River) and Wilsons Promontory.

Other fauna

Few surveys have been conducted of the fauna associated with rivers and streams in Victoria, and the available data are incomplete. Although the 'Rest of the State' report listed sites of faunal significance and limited information was provided in some of the other reports, no sites are marked on Maps 11 to 13. The major deficiency in our knowledge relates to the invertebrates. These insects play a vitally important part in stream life and provide the food supply for other fauna such as fish.

Riparian vegetation

The strip along the river is particularly important in areas of predominantly freehold land, as it may be all that separates a stream from cropland or pasture. Significant sites throughout Victoria have been marked on the basin maps. The sources used and the categories that have been combined to mark these sites are described below, and each site shown is briefly described in Appendix X. No distinction is made on the basin maps between the categories - the sites are simply marked as having high value for riparian vegetation, according to the criteria outlined.

While the 'Rest of the State' area (see Figure 14) is predominantly freehold, it includes many sites of significance for riparian vegetation. Those sites of national and State significance are shown on the maps, and also those regional sites that represent excellent examples in terms of size, lack of disturbance, diversity, botanical 'intactness', or presence of significant species. The initial classification of sites was carried out by Ecological Horticulture Pty Ltd using published sources.

Riparian vegetation classed as extremely rare, endangered, or vulnerable in the Wimmera region, or of national and State significance in Western Port, has been marked as 'high value'. Aerial photography with field verification formed the basis of the original Wimmera ratings, and surveys by the Victorian Herbarium were combined with a stream condition and assessment program in Western Port.

Although important sites were noted in the South-West study, the information provided was insufficient for mapping purposes.

Only those sites of botanical significance identified by regional surveys in 1981 and 1984 are shown on the basin maps for the South-East and East Gippsland. In cases where whole areas were listed as significant, such as the Baw Baw Plateau, only streams of third order and larger were marked.

Sites of geological and geomorphological significance

The study of geology and geomorphology provides an insight into the evolution of the Earth and the shape of its surface. Protection of sites is important for many reasons, including the prediction of economic minerals and understanding of wise land use practice. Many features also often have important scenic qualities such as waterfalls and gorges.

Rivers and streams, through erosion processes, can strip away weathered rock and expose good sections illustrating events through geological time. With deposition in the floodplains, through terrace formation, evidence of the human occupation of Australia over tens of thousands of years, is preserved. In order to demonstrate processes, as a record of past events, and as an educational display, it is sensible to protect such sites.

The size of features of importance varies from a few centimetres for a layer of fossils to many square kilometres for important features of river development.

Some parts of the State have yet to be systematically assessed for significant geological and geomorphic sites. Other sites will be found with the on-going survey and improvement in our understanding of existing survey areas.

The data used in this study are drawn from a number of regional studies, as listed in the references. Sites rated as having international, national, and State significance have been marked on the river basin maps.

Biologically important catchments in Victoria

Fish

Wilsons Promontory, East Gippsland, and the Otways have the highest concentration of streams considered to be of high value for native fish. In the case of the last two, these tend to be the coastal streams or coastal sections of larger streams. The significance of all three areas is not surprising as they are relatively undisturbed forest areas in which the streams have not been substantially altered by clearing or dam construction. Wilsons Promontory and far East Gippsland also benefit from an absence of exotic species. Although the evidence is far from clear, it appears that some exotic species compete with native fish for food and breeding sites (see Chapter 22). Their presence is also generally acknowledged as an indication of a modified stream environment.

Streams north of the Great Dividing Range have special value in terms of the number of rare fish species that live in their warmer waters. Of the five endangered and vulnerable species in Victoria, four are restricted to this area, which probably reflects the greater modification of the streams and the consequent loss of fish habitat and disruption of breeding patterns north of the Divide. See Chapter 12 for a description of rare fish species and Chapter 22 for an outline of the impacts of translocation.

The most significant region in the northern part of the State is the North-East. The Ovens River south of Wangaratta and the nearby Buffalo River contain sections with high diversity of native fish as well as several rare species.

Towards Shepparton, in the Lake Mokoan area, the upper reaches of the Broken River are significant, particularly along Ryans Creek, which has a long stretch containing rare species.

Goulburn River and Seven Creeks, located between Lake Eildon and Echuca, contain numerous stretches with a high diversity of native fish. This is accompanied by high rarity value - in fact the Seven Creeks catchment is the last remaining stronghold of Victoria's only endangered fish - the trout cod.

Flora

The relatively unmodified condition of parts of East Gippsland may suggest that the region would contain a large number of sites of floral or botanical significance. However, relatively few sites are shown on our maps. This is because the source used for this study examined all vegetation types within Gippsland and assessed their rarity within the region. The study of the 'Rest of the State' on the other hand concentrated on riparian vegetation (outside the large areas of public land) and, more importantly, was done on a State-wide basis. It therefore contains relatively more sites of significance than the others, reflecting the predominantly cleared nature of the land, and accordingly the relative importance of remnants. The following brief section provides a guide to where significant riparian vegetation occurs in Victoria.

In general, from Sale to Lake Tyers, native riparian vegetation is not found along the lower reaches of rivers and streams. Banks below an altitude of about 200 m have been largely cleared, and in the case of the Tambo and Dargo Rivers clearing has been even more extensive. For the Gippsland and East Gippsland regions, Maps 11 to 13 only show those areas that have been defined as sites of significance. However, the authors of the South-East study concluded that all the remaining native weed-free riparian vegetation had the highest significance. They argued that rivers and riversides tend to be the most disturbed ecosystems in an area and therefore all remaining riparian vegetation is important.

In the rest of the State the following areas stand out because they contain clusters of significant sites: an area south of the Dartmouth Dam including the Gibbo, Mitta Mitta, and Bundarra Rivers and creeks such as Morass and Benambra; the upper reaches of the Kiewa River; the Ovens River; parts of the Goulburn River and Broken Creek; a long stretch of the Loddon River from the Murray River to Hope Creek; the Murray River, particularly near Tallangatta and near

Echuca; Lake Hindmarsh and Outlet Creek near the Wimmera River; the Glenelg River in the far south-west of the State; and finally, the Yarra, Werribee, and Plenty Rivers near Melbourne.

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16. RECREATION

Recreation is defined as any activity relating to pleasure, relaxation, or sport done on a voluntary basis.

Of the outdoor recreational activities the most commonly pursued, particularly in the warmer summer months, are those enhanced by or based on water.

While beaches, coasts, and bays play a major role in providing opportunities for recreation, inland waters, rivers, lakes, and estuaries are vital recreational resources for most Australians. The maintenance and wise use of these resources are particularly important in a country as dry as Australia and for a State as populous as Victoria.

Recreational activities range from those as simple as a swim at a local waterhole to duck-shooting, which requires special equipment (a gun, waders, a boat, etc.) licences, and for city-based people a long car trip.

Many recreational activities, such as hunting, angling, or gold-fossicking have evolved from former necessities of life. Others use devices such as sail-boards and plastic kayaks that have resulted from changes in technology or, like picnicking and relaxing by running water, are as old as human existence.

Social and economic benefits of recreation

Recreation is an intrinsic feature of our way of life. Its social benefits are widely based and include:

* the opportunity to 'have a break' and recoup vital energies necessary in an increasingly pressured society
* development of self-awareness through challenge, achievement, and commitment to freely chosen activities
* entertainment and social interaction
* development of each individual's 'personal identity'
* a direct appreciation of environmental systems and issues
* contribution to individual and general societal fitness

Participation in recreation also accrues economic benefits through:

* transport and overnight accommodation (for some towns, such as Mallacoota, this is an important component of the local economy)
* development of domestic recreation facilities that lead to an improvement of the quality and diversity of tourist opportunities for intrastate, interstate, and international visitors (these facilities will also be of use to schools or clubs providing recreational activities)
* development of private entrepreneurial activity based on specific recreational resources, such as commercial white- water rafting

Recreation: challenge and achievement

* purchase and hire of equipment (boats etc.) and the purchase of consumable items such as fish bait

* publication of numerous magazines based on outdoor recreation

Decisions on the use and management of a water body should consider both the social and economic consequences.

In its 1987 report 'Access to Victoria's Parks', the Parliamentary Natural Resources and Environment Committee made recommendations on recreational use of public land, based on these beliefs.

* Economic and social factors should not arbitrarily limit the access of Victorians to our recreational resources.

* The extent of Victoria's recreational resource and the range of recreational opportunities available should be publicized.

* The recreational experience should be enhanced through the publication of interpretive material.

Water and recreation

Water-related recreation may be divided into two categories:

* water-based (the activity is impossible without suitable water - for example, canoeing or fishing)

* water-enhanced (it is more pleasurable if it takes place on or near water - for example, picnicking)

Often a number of recreational activities of both categories are undertaken together, such as car-based camping, swimming, and angling when on holiday. Most of the Victorian water bodies used for community recreation are on public land - along stream and lake frontages, or on water, which is a public resource.

ASSESSMENT OF THE RECREATIONAL RESOURCE

For activities such as angling, which has been practised for thousands of years, the minimum requirements for the activity are well known. The equipment, such as a hook, line, and sinker, is enduring although it has become increasingly specialized. However, the motivation has changed. Whereas once fish were caught and eaten as a necessity of life, now anglers are more likely to go fishing to relax in the outdoors.

By comparison, some recreational activities have become possible only as a result of technological and manufacturing changes over the last 20 years. Commercial river-rafting is possible only with the recent manufacture of large inflatable rafts. Windsurfers, 'indestructible' plastic kayaks, jet skis, and eductor dredges are also recent recreational items. They result from new technologies and materials. Each item has either extended or made its own new demands for water resources. Consequently the potential use that could be made of a water body may evolve with changing technology.

The extent to which a particular water body will be used for recreation depends on a number of factors that, for simplicity, are grouped as follows:

* physical, biological, and aesthetic requirements
* socio-economic conditions
* land use and management decisions

Physical, biological, and aesthetic requirements

Before an activity may take place, a number of physical, biological, and aesthetic requirements must be met, including:

* physical requirements - size and depth of water body, water speed and turbulence, exposure to wind

* biological requirements - habitat, water quality

* aesthetic requirements - scenery, clean air, quietness

Some recreational activities may still take place without these being completely met. However, the quality of the experience will be reduced. The requirements for specific activities are described later.

Recreational resources associated with rivers are unevenly distributed across Victoria, being least in the north-west of the State where rivers are few. Where water bodies are present, the quality of the resource is likely to vary with the season and from year to year with changes in annual rainfall, and, in the case of a regulated water body, will depend on the way that water body is managed.

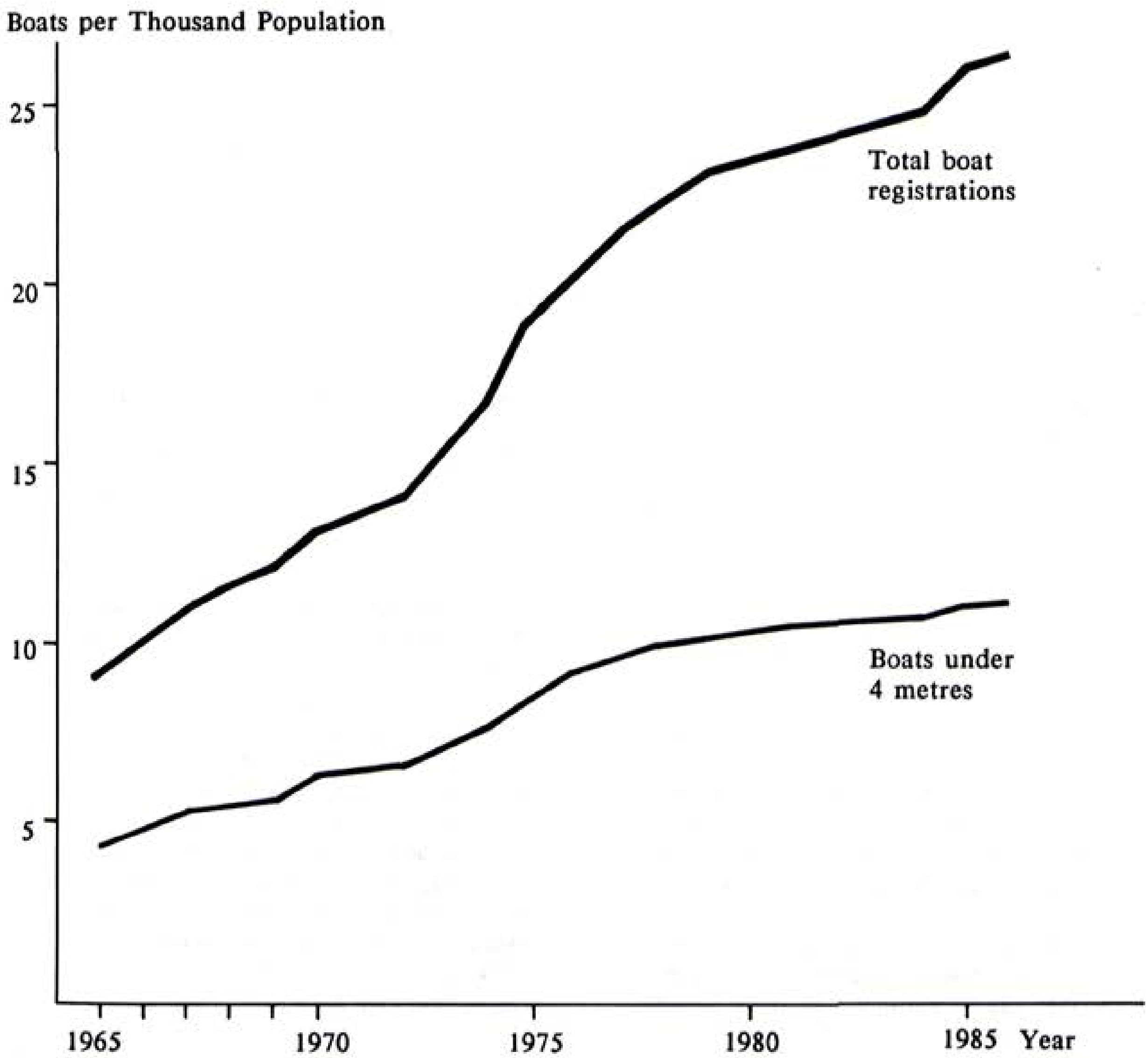
These variations in place and time determine the range of recreational activities that may be developed and the time of year they can be pursued, as the following examples illustrate.

The character of water bodies varies markedly with the physiography. Mountain areas characteristically have steep incised rivers that are suited to angling, white-water rafting, and canoeing. However, activities such as water-skiing cannot be undertaken. By contrast, the western plains have numerous lakes suited to sailing or power-boating, which also often have habitat suited to duck-hunting.

Major changes in rainfall and evaporation rate occur throughout the year and from year to year. Unregulated streams and lakes are at their highest during periods of

FIGURE 16

REGISTERED BOATS PER HEAD OF POPULATION



Source: Road Transport Authority, Victoria Year Book high rainfall and low evaporation, which in Victoria commonly occur in winter and spring. As a consequence, many rivers and lakes are at their lowest level during the drier and warmer months when the demand for many recreational activities is greatest. Stream-flow and lake levels also drop or may dry up completely during prolonged drought.

Longer-term natural variations in annual rainfall over decades and changes that may result from the greenhouse effect will also affect water availability.

An understanding of the physical distribution and seasonal variation in resource quality assists long-term planning by defining Victoria's competitive advantage in recreational resources.

Socio-economic conditions

Participation in outdoor recreation has increased rapidly since the 1950s and in most instances is growing faster than the increase in population. Small boats provide an example: as Figure 16 shows, the growth in boat registrations has outstripped population growth. This increase in outdoor recreation can be attributed to the following.

* Choice of activities has widened. As described earlier, changes in technology and manufacturing have led to new recreational activities. The advent of convenient, lightweight outdoor equipment has also encouraged more participants.

* The public has an improved knowledge of the extent of the recreational resource and the range of recreational activities available. This has occurred through the promotion of the outdoors in general, conservation of the environment, and the development of outdoor recreation programs in schools.

* Ability to participate in recreation has increased. Decreasing and more flexible working hours have increased public access to leisure time. Participation has also been encouraged by the near-static fuel costs. These factors, combined with improved road conditions, have led to an increase in the range of resources that can be used during weekends and holidays.

* Commercial provision of outdoor recreational activities has grown rapidly.

Land use and management decisions

The rapid increase in recreational participation and the demand for resources has required land use and land management agencies to ensure the diversity and quality of recreational experiences are developed and maintained, while minimizing the impact on the sensitive areas.

Land use and management decisions may enhance or adversely affect recreational activities. The construction of a water storage may have both positive and negative features. The former may include: the creation of an alternative resource through the artificial stocking of the reservoir; provision of power-boat and ski facilities; and specifically regulated discharge to provide for downstream white-water canoeing. Negative features may include flooding of a white-water-canoe or angling resource, and a reduction of the downstream flows necessary to maintain suitable conditions for some activities such as angling, or duck-hunting habitats. The impacts of recreation are discussed more fully in Chapter 22.

Decisions to improve road access or publicize the resource will also have a major impact on resource use. In general, the better the road and the greater the publicity, the greater will be the use of the resource. Changes in road access and publicity may also attract different types of users seeking different experiences.
In recognition of the recreational importance of public land and the potential impact of land use and management decisions, the past recommendations of the Land Conservation Council have led to the establishment of a State-wide network of areas broadly suitable for a wide range of recreation (see Chapter 7).

As a result of an increasing population, improvement and extension of the road network, and river regulation, options for future planning are becoming increasingly limited. This is particularly so for those recreational activities requiring only minimal development, such as extended four-wheel-drive trips, long-distance and remote bushwalking, or canoeing, where the options are fewer than they were in the 1960s.

Within a particular recreational activity, some people will seek isolation and remoteness, while others will seek the companionship of large numbers of people and developed facilities. Most people will probably prefer their river and stream activities to occur in an area with reasonable but not overdeveloped access and facilities.

One way to provide quality recreation opportunities for the whole community is to plan for diversity. Such planning implies setting aside sections of rivers to provide different types of recreational opportunities and experiences. A gradation is required between areas and river tracts where major developments can occur without unacceptable environmental damage and those where development is minimal and the number of people low.

This approach is reflected in the 'recreational opportunity spectrum', now the basis of land use planning for recreation on Victoria's public land. The five recreation settings in this spectrum are defined in Appendix XI.

INLAND WATERS: THEIR RECREATIONAL VALUE AND USE

It is important to know the value of the recreational resource when decisions are being made about water and land, use and management. The term 'value' describes the extent to which a water body meets the physical, biological, and aesthetic requirements of a particular recreation activity. In duck-hunting, for example, the value will vary from nil where ducks are not normally present to very high where ducks are commonly present in large numbers in most years.

Value is in-dependent of use, as use is more likely to reflect management-related factors such as ease of access or the promotion of a particular area as a destination. The in-formation necessary to rate water bodies in Victoria according to their value for different recreational activities is far from complete.

By comparison, recreation use can be more readily estimated than value. Use is often described as the total number of people using the resource. Data on use are gathered by surveying clubs, and from State-wide polls. The most reliable method is to count the number of participants using the resource. This is relatively easy for areas with limited access, such as developed picnic areas or boat-launching ramps, where use can be easily gauged by using automatic vehicle-counters. However, few recreational activities are carried out at locations where use may readily be measured. Anglers, canoeists, and car-based campers are often dispersed over tens of kilometres of water and frontage, making use measurements very difficult.

High use should be considered in terms of the managed carrying capacity of the resource. Developed camping areas, for example, range in physical capacity from less than 100 to several thousand. The smaller sites tend to be in remote areas such as at Wingan Inlet, whereas the large sites, such as the foreshore camping area at Mallacoota, will be adjacent to towns. During summer both large and small areas will reach their capacity and have the maximum visitor numbers. Yet the numbers of people present may vary greatly.

The variations in use of a particular resource that can occur are illustrated by the number of visitors to Fraser National Park at Lake Eildon. Seasonal use varies with coincidence of warmer weather and school holidays, and peaks occur during key public holidays and long weekends (see Figure 17).

RECREATIONAL ACTIVITIES

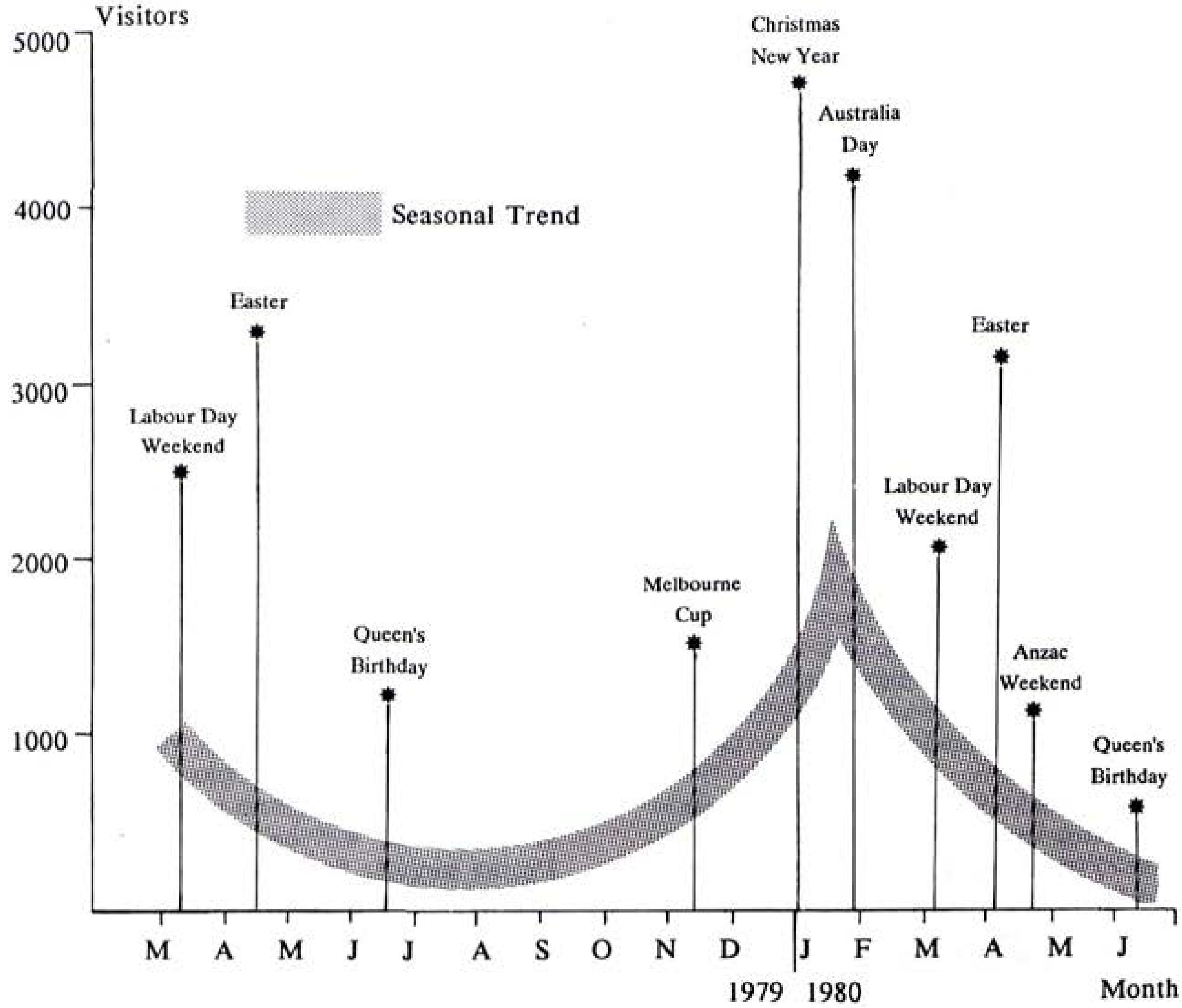
As stated earlier, recreation can be divided into water-based and water-enhanced activities. Water-based activities include sailing, power-boating, swimming, rowing and sprint canoeing, canoeing and rafting, and fishing from boat or bank or by wading.

Water-enhanced activities include hunting, walking and lightweight camping, horse and bicycle-riding, car-based camping,

FIGURE 17

DAY VISITORS PER WEEK AND PEAK WEEKENDS

Fraser National Park - Lake Eildon



Source: Department of Conservation, Forests and Lands

picnicking, pleasure driving, and nature observation.

The activities and the physical, biological, and aesthetic conditions that are required to sustain or to enhance them are set out below. In addition, Table 21 schematically describes the river tracts and impoundments where these resource requirements are likely to be met.

Sailing

Wind-driven craft vary from trailer sailers and keelcraft to sail-boards. On inland waters the largest craft are usually less than 8 m in length. The bigger the craft is, the larger and deeper the water body it requires.

Sailboarding on Waranga Res. (Basin 5)

Expanses of open water are necessary - preferably larger than 100 ha and longer than 1 km, with gentle or minimal flow conditions and at least 1.5 m depth. Wind is a prerequisite. The water must be free of obstacles such as trees, weeds, and reeds. The posts and wire of fences may be particularly hazardous during low water conditions. Launching areas must be free of mud, rocks, overhanging trees, and power lines.

Larger craft call for onshore facilities such as car and trailer parking, while additional facilities may include boathouses and club rooms. Regattas are an important adjunct.

The above resource requirements are often met by estuaries, coastal lakes, and the lower reaches of rivers that feed them, and by larger impoundments and inland lakes.

Power-boating

Power boats vary in size, speed, and capability. They range from boats capable of towing a skier or racing at speed to houseboats, cruisers and hovercraft, jet skis, and jet boats. They also include sailing boats that use motors for auxiliary power and small dinghies that may be used for angling.

As boat speeds greater than 40 k.p.h for skiing and 80 k.p.h for racing are common, the water body should be several kilometres in length, wider than 30 m, and free of obstacles such as submerged or standing dead trees that may damage the boat or injure a skier. The water must also be free of weed, which can choke the engine cooling system. Racing and water skiing usually take place from spring to autumn.

Good access to the water's edge, concrete launching ramps, and adjacent car and trailer parking facilities are required, while picnic and spectator viewing facilities are desirable. These may be developed in conjunction with boat and club houses.

The above resource requirements are often met by large open water bodies such as estuaries, coastal lakes, and impoundments, and by the plain tracts of larger rivers.

Launching at Lake Dartmouth (Basin 1)

The resource requirements for houseboats and cruisers are generally only met in Victoria by large impoundments, rivers and estuaries. These usually provide weed- and snag-free water of a depth greater than 1 - 1.5 m and of sufficient size to allow for overnight stops at sheltered locations with secure anchorages. Long-term mooring and launching facilities are also necessary.

By virtue of their low weight, shallow draft, and low speed, dinghies have modest requirements compared with water skiing, racing, houseboats, and cruisers. Often they can navigate weed and snag-free water less than a metre deep. Although launching facilities and car and trailer parking are important in high-use areas, dinghies can often be manually launched from gently sloping banks.

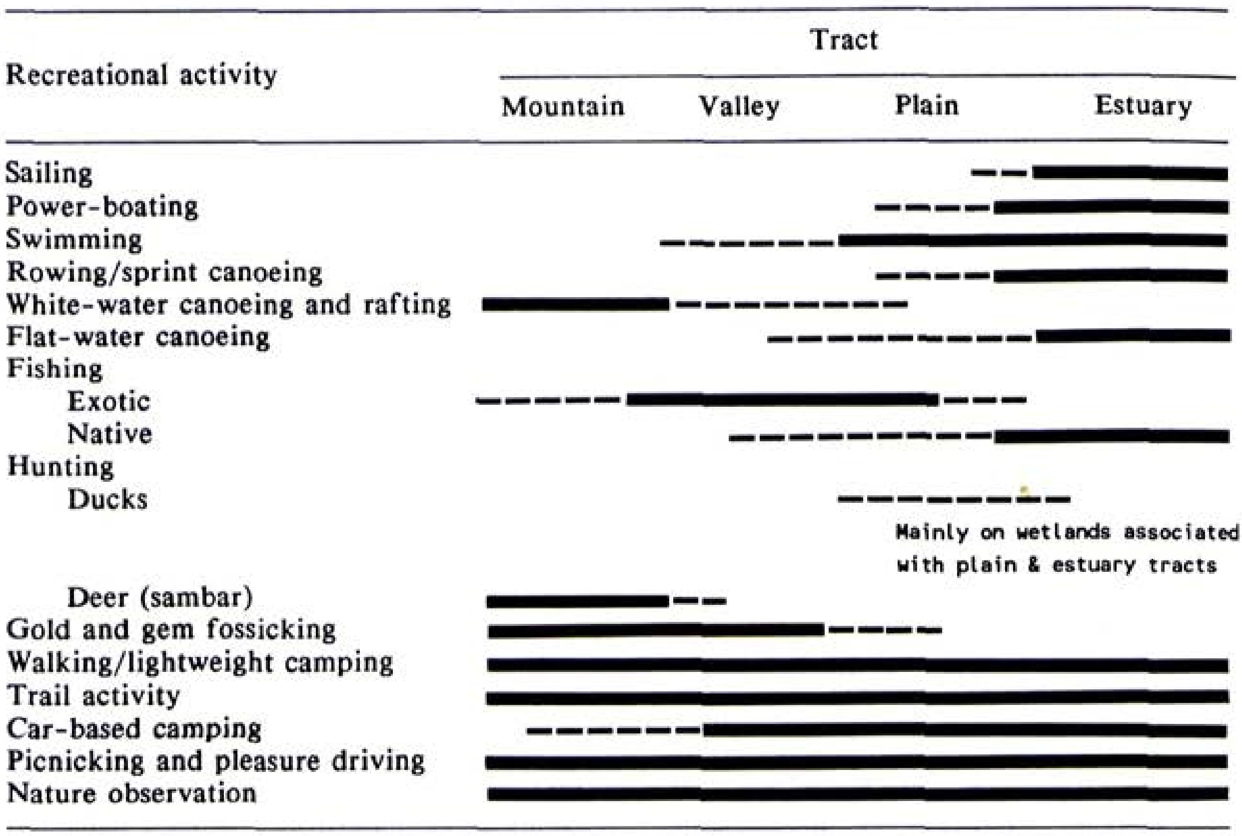
Swimming

Swimming is carried out wherever water occurs and usually in the warmer months.

The best conditions occur when the water is free of chemical pollution, and the streambed and banks are firm and free of objects likely to cause injury, such as glass, rusting cans, and snags. Overhanging trees may enhance the resource, by providing shade, scenery, and attachment points for rope swings. Swimming often takes place in association with other activities, such as picnicking, canoeing, and walking.

Table 21

SCHEMATIC DISTRIBUTION OF RECREATION RESOURCES WITH RIVER TRACT



In recent years, competitive swimming on inland waters has increased as part of triathlons. These require vehicle and spectator access at start and finish points and a stretch of water free of obstacles.

Although the resource requirements can be met by most water bodies, they are optimal in the plain and estuary tracts. Deep impoundments, and water released from them, may be too cold.

Rowing and sprint canoeing

These competitive club-based activities, involve year-round training, so facilities must be close to population centres. Courses require sheltered, calm or slow-flowing waters at least 50 m wide, over 1.5 m deep and longer than 2000 m. They must be free of obstacles and the water preferably free of pollution and are usually developed in conjunction with club facilities, such as change-rooms and boat-houses for storing craft. Gently sloping banks are required for the manual launching of craft to 18 m in length. Car and trailer access and parking are required for competitors at regattas, along with picnic and bank-viewing facilities for spectators.

Optimal conditions are met by the plain tracts of rivers and small open water bodies.

Canoeing and rafting

Canoeing takes a number of forms and for convenience is divided into white-water and flat-water activities. It may take place over a few hours or several days and cover distances from less than a kilometre to several hundred kilometres. Some activities - such as slalom, down-river racing (flat or white water), and marathons - are competitive.

Flat-water canoeing takes place on the low-gradient reaches of rivers, and in estuaries and inland lakes. Less than a metre depth of water is sufficient, but some water bodies are subject to wind-produced waves, which may make

Flatwater canoeing, Goulburn R. (Basin 5)

canoeing hazardous. It is desirable that the water be free of pollution, and the surrounds picturesque.

White-water canoeing and rafting require fast-flowing water and are usually carried out on the upper reaches of rivers. These reaches are often characterized by waves and eddies, caused by steep river grades, drops in the riverbed, or narrowing of the channel. The water body must be deep enough to allow free passage and wide enough to navigate. Suitable high-flow conditions may only occur seasonally and for short periods.

Road access to put-in and take-out points are important for both flat- and white-water activities. Overnight trips require camping spots and access to fresh water.

The resource requirements for white-water rafting and canoeing are usually met by the mountain and valley river tracts, while the plain and estuary tracts and impoundments often provide suitable flat-water conditions.

Whitewater kayaking on the Goulburn

Angling: boat, bank, and wading

Any accessible water containing desired fish species has potential for fishing. Preservation of fish habitat is as important as stocking to maintain or extend fish populations. Consequently, land use or management activities that lead to water pollution or changes in habitat, such as de-snagging or the removal of streamside vegetation, cause concern. Flow regulation that leads to low flows or inappropriate temperature regimes, or dredging (which may increase turbidity), can also diminish the value of streams for recreational fishing.

The most sought-after species of native and exotic fish in inland waters are:

* native species - Murray cod, golden perch, and freshwater blackfish

* exotic species - brown and rainbow trout, English perch, and salmon

Facilities required on adjacent land vary from ease of access for wading or bank fishing (this may need attention where the bank is surrounded by private land) to launching facilities for lightweight boats.

Surveys of anglers suggest that being 'outdoors', and 'able to unwind and relax' are important aspects of fishing. Consequently, peaceful, scenic surrounds and facilities for bush camping and picnicking enhance the sport.

Estuary and the plain tracts of larger rivers often meet the resource requirements of anglers seeking native fish, whereas the mountain, valley, and plain tracts attract those seeking exotic fish. Artificially stocked reservoirs and rivers are important resources.

Hunting: ducks and deer

Duck-hunting occurs during open season on open waters. As ducks are migratory, the quality of a particular area for hunting is seasonal and depends on rainfall, flooding, and habitat condition.

Hunting takes place on both rivers and flat water, but shallow lakes and wetlands in undulating country are preferred because they provide better duck habitat.

Duck-hunting will be addressed in detail in the Land Conservation Council's forthcoming Special Investigation of Wetlands.

Deer-hunting takes place mainly in the cooler months of the year with sambar deer being found in areas extending from the coast to the alpine tree line and hog deer mainly on the plains.

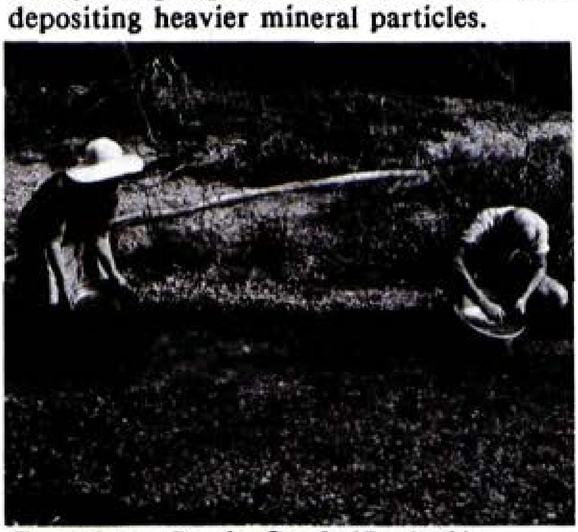
For sambar deer, forested mountain valleys - particularly in the Eastern Victorian Uplands - are ideal habitat. The forest provides suitable forage and cover for refuge. Watercourses are an important part of the deer range providing watering points, dense cover, and ideal locations to establish territorial markings - such as mud wallows, and rub trees.

As a result of the shy nature of sambar quiet surrounds are important to the success of hunting involving stalking. Accordingly, much of the present hunting effort occurs adjacent to rivers and on the lower mountain slopes in the more remote areas.

Gold and gem fossicking

Fossicking occurs anywhere people hope to find gold and gems. It usually takes place when water flow is low and during the warmer months.

Gold is the most sought after of several precious and semi- precious minerals present in watercourses. Their presence results from the natural concentrating effect of running water in selectively transporting lighter rock materials while depositing heavier mineral particles.



Fossicking, Reedy Creek (Basin 3)

Conventionally, a similar process is used when fossicking. In its simplest form, it involves sieving and panning for gems and gold, which is done by hand and usually in conjunction with other activities such as picnicking.

Another method of fossicking, mainly for gold, is eductor dredging. The dredge floats on the water and operates in a similar way to a vacuum cleaner, in the sense that it sucks up sand and gravel from the streambed, and separates gold through a riffle box. In accordance with government policy, the use of eductor dredges is being phased out, ceasing by the end of 1990.

The resource requirements of fossicking are usually found in the mountain and valley tracts and to a much lesser extent the plain tracts.

Walking and lightweight camping

Walking ranges from trips that occupy less than an hour to those that take days and require overnight camping. Shorter walks are often combined with other recreational activities such as car-based camping, picnicking, car touring, and nature study.

Water bodies are sought for their scenic, flora, and fauna values and can vary from open lakes such as those at Hattah to deep incised creeks and waterfalls, as are found in the Otways.
For overnight trips, unpolluted water for drinking and cooking is important. Camp-sites are often sought in clearings along stream edges.

The river setting (Table 22) must be of sufficient length to allow lightweight campers the experience they are seeking. To provide for wilderness-users, development in the river area must be minimal.

The above resource requirements may be met by a variety of water bodies.

Trail activity: horse- and cycle-riding

Open, treed, well-drained camping areas and an adjacent source of drinking water are desirable. A defined trail or open route is required. Approaches to river crossings should be free of overhanging branches and blackberries. The banks

Trail riding in Gippsland

should be gentle enough and the river shallow enough to negotiate. For horse-riding the stream water should be of sufficient quality for the horse to drink, and the streambed preferably of firm sand or gravel.

The requirements for these activities are often met by the mountain, valley, and to a lesser extent the plain tracts.

Car-based camping

This involves camping adjacent to the car, either in a tent or caravan. The banks of rivers and lakes are popular destinations because of their scenic value and also for opportunities for fishing, swimming, boating, or water-skiing, particularly in the summer. The water body must be accessible (two- or four-wheel-drive) and have reasonable-quality water. The camping area should ideally be well drained and grassy and have shade trees.

On the Wimmera R. at Horsham (Basin 15)

Camping experiences vary widely, from those of rough bush camping at sites with no facilities to those provided by developed sites managed by local or private authorities, which often have ablution blocks, laundries, and kiosks.

Picnicking and pleasure driving

Rivers, lakes and dams, and particularly waterfalls often have positive scenic values, and roads and picnic spots along them are well utilized. Picnicking and pleasure driving are complementary activities undertaken in fine weather. They can be conducted from home or a holiday base or as part of the holiday itself. Repeated surveys show that pleasure driving is one of the most popular recreational activities in Australia.

As pleasure driving takes place in a range of vehicle types - two-wheel drive, four-wheel drive, and trail-bikes - and participants will be seeking a range of experiences, different road standards and facilities are desirable. They could vary from a rough bush track, where route-finding, driving, or trail-riding are part of the challenge and no picnic facilities are provided, to sealed roads leading to developed picnic sites with shelter sheds, toilet blocks, and facilities for large groups. These may incorporate areas for games, short walks, and swimming. Larger developed picnic sites are usually close to population centres or in areas with high tourist pressure where the development can be justified.

The above resource requirements may be met by a variety of water bodies.

Nature observation

Often undertaken in conjunction with other recreational activities (such as walking, canoeing, and boating), nature observation involves the appreciation and understanding of flora and fauna and participants vary in both capacities. Some only have a casual involvement while others with extensive and detailed knowledge undertake flora and fauna surveys as a recreational activity.

Good habitat is the key to nature observation - the exact requirements will vary, depending on whether plants, small mammals, or birds interest the participant. Good habitat is often characterized by tranquillity, beauty, and natural surroundings. In some instances, particularly for birdlife, excellent observing conditions may be found in wetlands surrounded by altered environments - for example, Werribee Sewerage Treatment Farm.

The above resource requirements may be met by a variety of water bodies.

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17. SCENIC LANDSCAPES

The character of Victorian landscape has changed markedly in the last 150 years. Forests and woodlands have been cleared; the countryside has been crossed by roads, railways, and powerlines; towns and cities have developed; and regions have been quarried and mined. Pre-contact landscapes have contracted, some modified landscapes are of low scenic value, and modifications are still occurring.

As part of these wider processes, riverine landscapes have also experienced major changes: removal of riparian vegetation, erosion of streambeds and banks, and muddying of the water by soil material. Structures have been built, rivers channelled, meanders straightened and wetlands drained. At some water bodies the air has been fouled by rotting algae, a result of enhanced nutrient levels. One consequence is that the appearance of riverine landscapes has come to be regarded as a indicator of the ecological health of the land. Rivers illustrate ecosystem interactions and imbalances, and the impact of land management.

It is recognized that both natural processes and human intervention can have positive or negative effects on the river environment. While such changes do not always lead to protection of scenic values, many are important in the creation of features with high scenic quality. Dynamic processes forming waterfalls, V-shaped valleys, alluvial plains, estuaries, and deltas enhance the landscape quality. Certain human interventions have also had the effect of 'enhancing' river environments.

Artists, notably the Heidelberg School, have used river motifs. Waterfalls, rivers, gorges, and wetlands figure prominently in the work of writers, designers, and film-makers. 'Coffee table' books, posters, calendars, and documentaries emphasize the continuing importance of water as a source of inspiration and regeneration, and to evoke a variety of responses from our predominantly urban society.

As described in Chapter 18, rivers are central to a sense of place. Their origin was the subject of Aboriginal myth, and they have played an important part in the development of various more recent responses to the Australian landscape. Poets and novelists have often evoked rivers in their works. Henry Kendall, for example, ended his poem Bellbirds:

> 'So I might keep in the city and alleys
> The beauty and strength of the deep mountain valleys:
> Charming to slumber the pain of my losses
> With glimpses of creeks and a vision of mosses.'

Riverine landscapes have long provided a focus for active recreation. Walking tracks along rivers to waterfalls around Zumsteins in the Grampians, to Kalimna Falls at Lorne, and at Mount Buffalo have been popular with travellers and tourists for many decades. Within cities and towns, fountains, ornamental lakes, and wetlands are often used as key features in parks and gardens. The community wishes to enjoy not only pleasant surrounds and scenic views but also the sounds, smells, and hourly changes associated with riverine locations.

Consequently land use and management activities that may lead to a decrease in scenic quality generally and in that of water bodies in particular are now being carefully considered. Landscape values are now more commonly assessed for inclusion in planning for such activities.

MANAGEMENT AND ASSESSMENT OF SCENIC LANDSCAPES

Land use and management activities have visual elements that may have positive or negative effects on the landscape. For example, wildfire has a major effect on a forest, changing it from a dense mosaic of colour and texture to a skeleton of blackened trees; with regeneration this impact is rapidly reduced and the forest returns to a scenic character comparable to its previous condition. By contrast, other

FIGURE 18

LANDSCAPE ASSESSMENT METHOD FLOWCHART

Phases **Steps**

CLASSIFICATION

Use the nine *landscape character types* (Map 14, Table 16)

Use the six *river-setting categories* (Table 17)

Identify reaches, each having one of the 54 *river/landscape settings* (combinations of landscape character types and river-setting categories)

ASSESSMENT

Develop, for each *river/landscape setting*, a set of positive and negative features that contribute to or detract from the scenic value (see Table 18)

From aerial photographs determine the presence of and degree of occurrence of positive and negative features (for fourth-order and greater streams in the west and sixth-order and greater in the east)

EVALUATION

Compare the number of positive and negative scenic features for reaches with the same *river/landscape setting*

List rivers with high scenic value (Map 15, Table 20) visual alterations may have longer-lasting effects, for example, construction of power-lines and communication towers. In these instances the scenic change is long-lasting, but its impact may be minimized by integration with the visual character of the landscape.

The Land Conservation Council has recognized that landscape is a valuable resource and has made a number of recommendations to conserve or enhance landscape values. These are outlined in Chapter 7.

Before land use decisions can be made and riverine landscapes managed in order to better protect their scenic qualities, we need a systematic method to assess the quality of the visual resource. The methods currently available recognize that, while the appreciation of high scenic quality is personal and based on an individual's preferences and knowledge of the world, consistent preferences can be determined.

Perception studies identify the scenic elements that individuals find enhance or detract from a particular landscape. One way of conducting such studies is to list responses to photographs that have different combinations of landscape elements such as: landform, vegetation, waterform, land use, and other cultural features. Photograph-based perception studies:

* confirm the visual importance of water
* show that people find a wide variety of landform, vegetation, and waterform types pleasing
* show that although natural-looking landscapes are often considered attractive, some highly modified land-scapes such as those in which rivers run through gardens and parks may also be
* identify specific physical, biological, cultural and wildlife features considered to enhance or detract from scenic value

Perception study methods are subject to review and on-going development.

In order to make comparisons between visual landscapes, likes must be compared. This is important if landscapes are to be assessed in terms of their scenic quality. For example, a sunset over the river red gums on the Murray has very different visual components from a rising mist in the gorge country of the Snowy River. Although the scenes differ markedly, neither would necessarily be rated as better than the other in terms of scenic value.

To allow the identification of reaches with high scenic value, the following systematic procedure based on qualitative descriptive criteria has been used.

A METHODOLOGY FOR SCENIC ASSESSMENT

The methodology used to assess the scenic quality of Victoria's rivers and streams involves a three-phase process: classification, assessment, and evaluation. Each phase and the steps involved are described in the flow chart in Figure 18 and are detailed below.

Phase 1 - classification

Classification of river reaches that have a similar range of visual elements is necessary to enable scenic assessment and comparison of rivers across the State. In any reach, that range of visual elements likely to be present is determined by the 'landscape character type' and the 'river-setting category'.

Victoria has been divided into nine areas, each with its own distinctive landscape character. The nine types are broad-scale landscape units with similar landform, vegetation, waterform, and land use. Their geographic distribution is shown in Map 14, and Appendix XII summarizes their key visual features.

River-setting categories describe the decreasing degree of natural appearance and increasing associated development intensity of a river setting. From least to most altered, these categories are: natural, semi-natural, farm--forest, agricultural, small town--suburban, and urban--industrial. Table 22 describes their visual features.

Combining nine landscape character types and six river-setting categories creates the

LANDSCAPE CHARACTER TYPES OF VICTORIA

Rivers and Streams Special Investigation

1 : 3 500 000

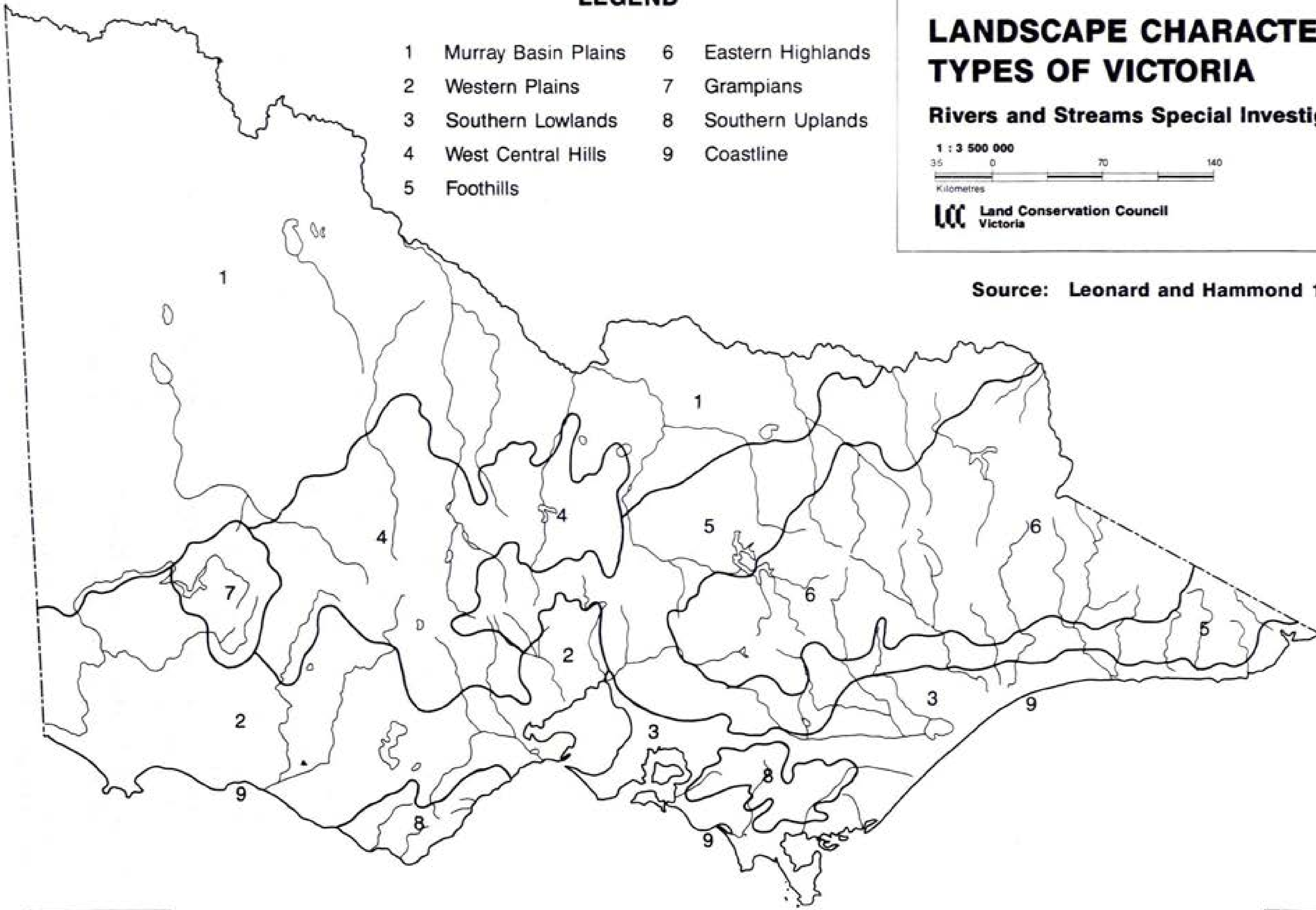
35 0 70 140

Kilometres

LCC Land Conservation Council Victoria

LEGEND

1 Murray Basin Plains
2 Western Plains
3 Southern Lowlands
4 West Central Hills
5 Foothills
6 Eastern Highlands
7 Grampians
8 Southern Uplands
9 Coastline



Source: Leonard and Hammond 1984

potential to classify reaches into one of 54 different river/landscape settings, each with a distinctive set of visual characteristics. A river or stream 'reach' in this context is a section with a consistent river/landscape setting.

Phase 2 - assessment

The assessment of scenic quality of a reach is based on determining the presence of positive and negative scenic features. Appendix XIII details positive features for each river/landscape setting.

Natural river setting - Avon R. (Basin 25)

Table 22

RIVER-SETTING CATEGORIES

Natural

Cultural changes are not visually apparent. The river has not been modified and the area can usually only be reached on foot.

Semi-natural

Cultural changes may be visually apparent but do not dominate. These changes may include isolated structures such as dam walls and diversions. Road and rail access may exist, but is not along the river banks.

Farm--forest

Visually dominant changes are scattered through more natural areas, such as occurs where natural vegetation is mixed with areas used for agriculture. River works may occur and small farm dams are common. Vehicle tracks to and along the river are common, but are screened by surrounding vegetation.

Agricultural

Major clearing for agricultural uses has occurred. Patches of natural vegetation may remain, but are usually restricted to stream-sides and along fences or roads. Changes to the river may be common. Small and large dams are very common as are farm buildings and structures. Vehicle access to and along the river is likely to be well established and clearly visible.

Small town--suburban

Suburban housing dominates visually. Rivers may be substantially modified by flood-mitigation works. Rivers may flow through parks or undeveloped areas. Vehicle access to and along the river is likely to be well established.

Urban--industrial

High-density urban, commercial or industrial uses dominate. High-use parklands are likely to occur. The river is likely to be highly regulated and modified, and crossed by bridges and powerlines.

Semi-natural setting - Thomson River (Basin 25)

Negative features are those that reduce the scenic quality of an area, and context is important in determining the extent to which they will do so. For example, a powerline and associated clearing is likely to have a negative impact on many natural settings, yet it could be an integral part of an area used for heavy industry. Subject to differences between river/landscape settings, other features that may reduce the visual quality of a landscape include: buildings and other structures; exotic vegetation; vegetation-clearing and plantations; and river modifications such as dams, dredging, and channelling. Features that usually reduce scenic value irrespective of context include: eroding earthworks and quarries; weed infestations; and polluted and littered water bodies.

The *choice of rivers* assessed for their scenic quality was based on practical considerations related to the number and total length (over 50 000 km) of rivers and creeks in Victoria. The range of river settings, the size of rivers, and the method by which data on scenic features were gathered were key aspects of river selection. The assessment:

* examined only those reaches with the following river settings: natural, semi-natural, farm--forest, agricultural, and small town--suburban
* examined only those reaches whose order was larger than fourth-order in the west and sixth-order in the east (as determined from the 1:250 000 map series)
* collected information on the presence of positive and negative scenic features from black and white or colour aerial photographs (generally at 1:25 000 scale) held by the Victoria Information Centre

Phase 3 - evaluation

Scenic quality was evaluated by comparing the numbers of positive and negative scenic features between reaches with the same river/landscape setting. Reaches with the greatest number of positive and least number of negative features have the highest scenic value under this system.

RESULTS

The 619 separate reaches assessed for scenic value ranged in length from 2 to 220 km (see Map 15). Table 23 gives the number of reaches and their median length for each landscape character type and river-setting category. This table shows that the 'natural' river setting was not present in the Murray Basin Plains, Western Plains, Southern Lowlands, West Central Hills, and Grampians landscape character types.

Table 24 lists and Map 15 shows those rivers in which reaches of high scenic value were identified. Rivers and creeks that have high scenic value for more than 50% of their length include: the Murray, Genoa, Cann, Big (Goulburn tributary), Rodger, Suggan Buggan, Snowy, Dargo, Buchan, Goulburn, Wingan, Gellibrand, Cumberland, Erskine, Aire, Franklin, Yea, and Lerderderg Rivers, and Dwyers, Barry, and Pyrites Creeks.

These results highlight:

* the number of rivers that have reaches with low scenic quality - particularly in western and central Victoria, where erosion (associated with the lack of stabilizing vegetation) and various past land use practices have reduced the scenic quality
* the extensive modification of some landscape character types such that they retain few or no natural river-settings with consequent reduction in the potential range of scenic resources

Table 23

NUMBER AND LENGTH OF REACHES ASSESSED

River-setting	Landscape character type								
	Murray Basin Plains	Western Plains	Southern Lowlands	West Central Hills	Foothills	Eastern Highlands	Grampians	Southern Uplands	Coastline
Natural	-		-	-	12 (7)	31 (18)	-	3 (5)	2 (4)
Semi-natural	6 (43)	5 (8)	9 (4)	4 (4)	26 (16)	35 (13)	5 (20)	10 (7)	9 (7)
Farm--forest	18 (44)	6 (5)	3 (19)	6 (10)	16 (6)	21 (10)	3 (12)	4 (15)	-
Agricultural	60 (38)	51 (34)	31 (15)	40 (20)	38 (21)	17 (18)	5 (15)	9 (13)	17 (5)
Small town--suburban	35 (3)	19 (3)	10 (2)	15 (2)	14 (2)	9 (2)	-	-	15 (2)

Total number of reaches examined: 619
Total length of reaches examined: 10 900 km
Note: Median length (km) of reaches is in brackets

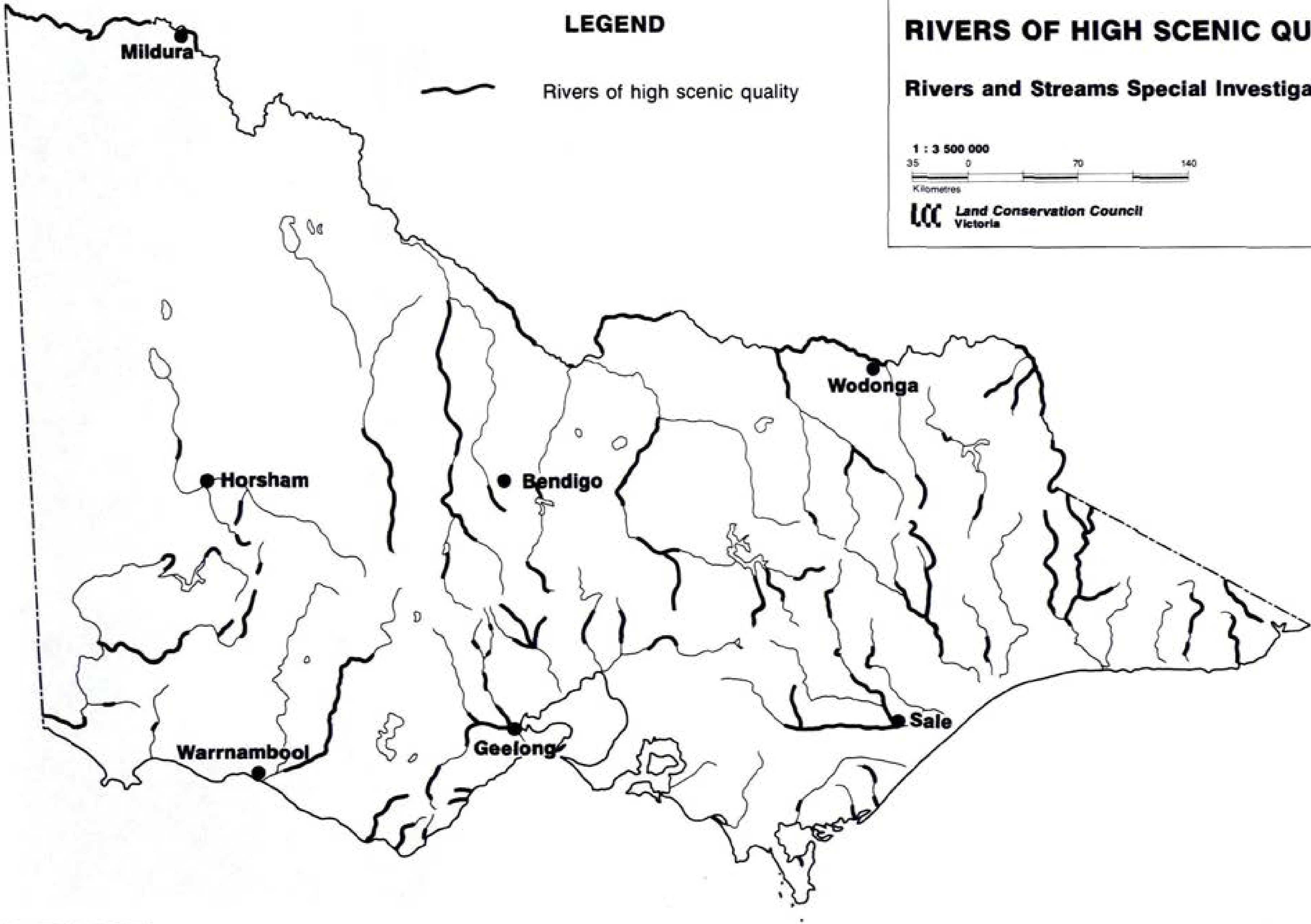
Farm--forest river setting - Macalister River (Basin 25)

Table 24

RIVERS WITH REACHES OF HIGH SCENIC VALUE

Murray Basin Plains*	Western Plains	Southern Lowlands	West Central Hills	Foothills	Eastern Highlands	Grampians	Southern Uplands	Coastline
Natural river-setting								
				*Lerderderg R *Snowy R *Genoa R Mitchell R Avon R	*Murray R, *Rodger R *Suggan Buggan R *Dargo R, *Buchan R *Snowy R		*Cumberland R	*Barry Ck
Semi-natural river-setting								
*Murray R	Crawford R	*Cann R *Wingan R *Genoa R	Moorabool R	*Lerderderg R *Pyrites Ck *Wingan R *Genoa R Macalister R Tyers R Thomson R Nicholson R Werribee R	*Big R *Dargo R Jamieson R, King R Macalister R Kiewa R	Mackenzie R Golton Ck Wannon R	*Erskine R *Aire R	*Wingan R Glenelg R Bruthen Ck
Farm--forest river-setting								
*Murray R Ovens R	Moorabool R Darlot Ck		Moorabool R - east branch	*Genoa R Yarra R Nicholson R *Cann R	*Goulburn R *Dargo R Wonnangatta R Mitta Mitta R	Glenelg R	*Gellibrand R *Franklin R	
Agricultural river-setting								
*Murray R *Goulburn R Loddon R	*Lerderderg R Deep Ck Mt Emu Ck Leigh R Wannon R Hopkins R Barwon R Werribee R Moorabool R	*Genoa R Macalister R Latrobe R Thomson R	Woady Yaloak Ck Bullock Ck Tullaroop Ck Loddon R Avoca R Campaspe R Werribee R Hopkins R	*Murray R *Yea R *Goulburn R Mitta Mitta R Plenty R *Cann R	*Murray R Buffalo R Cudgewa Ck Corryong Ck Ovens R	*Dwyers Ck Glenelg R	*Franklin R Barham R	*Franklin R *Gellibrand R Tarra R Aire R
Small town--suburban river-setting								
*Murray R Ovens R Yarriambiack Ck Loddon R	Grange Burn Ck Darlot Ck Glenelg R Leigh R	*Snowy R Thomson R Macalister R	Werribee R Creswick Ck	*Lerderderg R Yea R *Cann R	Ovens R, Kiewa R Little Yarra R			*Genoa R Merriman Ck Barwon R Moyne R Glenelg R

* Rivers with more than 50% of their length assessed as having high scenic value



RIVERS OF HIGH SCENIC QUALITY

Rivers and Streams Special Investigation

1 : 3 500 000

35 0 70 140

Kilometres

LCC *Land Conservation Council* Victoria

MAP 15

Agricultural river setting - Wannon River (Basin 28)

Small town--suburban setting - Benalla on the Broken River (Basin 4)

- reaches with perceived high scenic value, within the criteria assessed for each river/landscape setting.

DISCUSSION

The methodology used in this scenic assessment has produced a detailed and structured analysis of the scenic quality of many Victorian rivers. The use of aerial photographs provided a 'first-cut' assessment of the State's high-value scenic river assets. Aerial photographs are one means of identifying scenic elements, while other approaches provide different opportunities. Assessment of scenic values using on-river observations, for example, would be complementary, providing information:

- where the tree canopy is closed and the features of the water-course can not be assessed from aerial photographs

- at a level of detail not present on aerial photos

Consequently, the number of positive small-scale features identified would probably increase.

It is expected that field inspection and information provided in public submissions will result in additions to the list of high-value scenic rivers.

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18. CULTURAL ASSOCIATIONS

Our cultural heritage provides a 'window to the past' and helps explain present-day Australia to us.

It is often, although not always, illustrated by tangible objects that are considered representative or explanatory of earlier social, technological, or aesthetic activities, particularly those judged to be significant. More abstractly, cultural heritage also embraces those ideals, ideas and practical needs that conditioned our past interactions with natural systems, but that our material culture only reflects to a limited extent.

An inventory of it is not however, fixed. Our understanding of, and interaction with the past changes as out society and culture change from day to day. In that sense, our cultural heritage is being constantly remade. Any consideration of the cultural heritage of Victoria's rivers and streams will necessarily change over time.

As water is fundamental to life, it is not surprising that human associations with water over the last 40 000 years or more are varied and complex, representing the overlap and interplay of Aboriginal society pre-1788, the contact and post-contact experiences. These involved major differences in cultural values, technology, and social organization, and accordingly have left different imprints on the landscape.

Because of the antiquity of the settlement of Victoria, the amount of information available to describe human associations with water varies. The more recent is the association, generally the more information available. At present fewer than ten sites older than 10 000 years have been found in the State, usually on floodplains or lake edges. By comparison, the number of sites less than 5000 years old is believed to be in the tens of thousands. Despite the immense amount known about our immediate past, the records are variable and far from complete.

Not only does the amount of information change through time, but its nature also varies. Today we have written, oral, visual, and material records such as buildings, items, etc. Yet, with time some of today's evidence will be destroyed. Much will decay and only the more durable fragments will survive.

As a result of such variations, the history of human associations with water is, for the purposes of description divided into three eras:

* pre-contact era - Aboriginal society prior to contact with European society
* cultural contact era - the initial period of contact between Aboriginal and European society
* post-contact era

Themes that can be used to describe the key associations with rivers and streams are outlined below, with illustrative examples. Each one has features or 'heritage indicators' that demonstrate the association. Table 25 presents a preliminary list of themes, sub-themes, and heritage indicators.

In choosing the themes and interpreting the evidence, we have recognized that distinctions between traditional Aboriginal and contemporary perceptions of the environment may be misunderstood.

PRE-CONTACT ERA

Aboriginal associations with rivers and streams can be described by two themes: rivers in the spiritual and social landscape; and the use of rivers as a resource, including adaptions to resource distribution.

The expression of and interaction between these two vary over time and space. Climatic changes during the period of Aboriginal occupation were substantial, and major fresh-water systems and the plant and animal food resources they once supported have gone. Cultural evolution and social divisions would also have led to different expressions of these themes.

Rivers in the spiritual and social landscape

Being major physiographic features, rivers and streams are prominent in tribal histories, traditions, and mythologies, as the following legend illustrates.

> 'In the Dreamtime, Purra the Kangaroo was trying to escape from Doan the Flying Squirrel who was hunting him. In his escape Purra kept hopping along, his tracks forming the bed of the Wimmera River until he reached a place rich in grass. As he was no longer being followed, Purra stopped for a long time and ate the area bare, forming Lake Hindmarsh. Purra then moved on more slowly, forming the overflow from the lake, until he came to a place of quandongs. Here he grazed and formed Lake Albacutya. From this place he hopped northwards at a leisurely rate, forming Outlet Creek. His track disappears in the sand dunes.'

Water bodies were an integral component of social organization. A clan's estate was often centred on particular water sources, with the boundaries between clans and tribes commonly defined by rivers and creeks or their catchment boundaries. Using south-west Victoria as an example, Figure 19 clearly shows the proximity of the centre of clan estates to the major watercourses. In this area the Hopkins River and its tributaries separated the Djab Wurrung, Dhauwurd Wurrung, and Girai Wurrung clans.

Aborigines also identified themselves with features of the surrounding water bodies, being people of the river, lake, or swamp. For example, their neighbours called the clan living at Lake Condah on Darlot Creek the Kerrup gunditj - 'belonging to the lake'.

Rivers as a resource

Victoria currently has some 10 000 recorded Aboriginal sites (Map 16). This is less than 1% of the estimated total. Despite the limitations of such a small sample, the systematic survey of core areas and ethno-historic records have demonstrated the importance of water-associated and water-based resources.

Rivers, creeks, lakes, springs, and soaks were potential sources of drinking water, except where saline, particularly in the north-west of the State. The distribution of such saline water bodies was more extensive in the arid times experienced over the last 40 000 years. Water management involved the use and/or construction of rock wells, the use of animal-hide water-bags in the Wimmera and Mallee regions, and the construction of 'torrongs', bark or wooden vessels raised more than a metre from the ground on forked posts. In summer and in times of drought permanent water sources in rivers increased in significance.

Rivers also formed a focus for a diverse range of habitats and environments. The range of habitats that could be readily exploited for their resources varied according to the position in the river tract and the surrounding land type. Particular areas used often changed with the season and with the availability of food in the surrounding countryside.

The use of these resources has left an imprint on the landscape in general and riverine environment in particular, as discussed on the following pages. It is helpful to separate the use of particular resources, beginning with food resources, to emphasize the complexity of the record.

Fishing and eeling were carried out in a number of ways. In Gippsland, for example, men and women usually fished (from the shore or from canoes) along the coast, estuaries, and lakes in summer, but in winter moved further inland and fished along the rivers. They used nets, fishing lines, and spears.

They wove nets from kangaroo grass, used tea-tree bark for floats and stones for sinkers, and made their fish hooks from bone or shell and their lines from the inner bark of trees. At night, they attracted fish by the light of stringybark torches or by fires they placed on mud or stones on the floor of canoes.

Table 25

THEME AND FEATURE CHECKLIST

PRE-CONTACT ERA

ABORIGINAL ASSOCIATIONS

Rivers in the spiritual and social landscape

- Myths, oral and written histories

Rivers as a resource

- Water (rock wells, springs soaks)
- Food - animal and vegetable (middens, mounds, fish traps)
- Vegetal - barkfibre (scarred trees, oral history)
- Stone (axes, scatters of worked stone, axe-grinding grooves)

Adaptations to resource distribution

- Aboriginal places (mounds, rock shelters, burials, open sites, shelter foundations)

CULTURAL CONTACT ERA

ABORIGINAL--EUROPEAN CONTACT

- Dispossession
- Reservations
- Renaming the landscape (rivers and streams with post-contact significance i.e., named after/by Aborigines)

POST-CONTACT ERA

RIVERS AND COMMUNICATION

Exploration

- Camp-sites, crossing places

Shipping

- Vessels - riverboats
  Infrastructure
  (wharves, warehouses, slips for boat-building, offices, access means, cranes)
- Navigation (markers, channels, pilot-boats, signal points)
- Engineering (canals, diversions, dredging, sandbars, snags, etc.)
- Informal/folk responses (landing points)

Barrier

- Over river (bridges - foot, stock, road, rail, corduroy; flying foxes)
- On river - frontage features (launching sites, toll-gates, barriers, fords)
- On river - river features (punts, pontoons, ferries, others)
- Permanent barrier - rivers, streams, swamps, etc. that have to be avoided (frontage, wetlands, variable flow, arid land)

RIVERS AND WATER SUPPLY (CONSUMPTION)

Urban

- Urban foundations (town siting, formation; flooded towns, huts, etc. from mis-siting, reservoir spread)
- Urban/domestic consumption (rivers, lakes as water supply; infrastructure; storages - reservoirs, dams, floodplains, iron-clad catchments, other storage; related engineering - pipes, aqueducts, spillways, bypasses, valves, locks, etc.; major regional schemes - Coliban, others; diversions, pondages, etc.)

Rural (non-metropolitan, non-urban use)

- Pastoral properties (station siting, run orientation, huts, etc.)
- Depots (Aborigines, surveyors, camp reserves for goldfield commissioners and staff, construction workers, arid land use)
- Regional variations in run siting (arid lands, *Mallee Act* 1883)

Table 25 (continued)

RIVERS AND RAW MATERIAL AND ENERGY

Primary Industry

- Pastoralism
(stock use, frontage use, frontage misuse, Chain of Ponds; stock work, sheep dips)

- Agriculture
(irrigation pre-1880: folk responses; irrigation post-1880s: individual responses - engineering; regional schemes - channels, diversions, engineering; river drainage - channels, levees, pipes; swamp/wetlands drainage - engineering, channels, etc.)

- Mining (gold)
(alluvial - panning: diversions, excavations, dumps; alluvial - hydraulic: sludge, erosion, siltation; alluvial - dredging; deep leads: engineering, processing)

- Mining (other)
(coal - stream removal; sand, gravel extraction; salt extraction; tin-mining)

Secondary industry

- Processing agent
(tanneries, wool-scouring, fellmongering, breweries, cordials, aerated waters, flour, timber, paper, wool, others)
- Energy/power source
(milling, steam, electric, hydro, other)

RIVERS AND WELL-BEING

Active

- Swimming, water-skiing, other sports - access points
- Fishing, hunting - sheds
- Picnicking, camping, hiking
- Frontage activities, facilities
- Boating, canoeing, racing etc. - paving, walkways, fencing, signs, regulations, netting, protective measures

Passive

- Vistas, aspect, popular frontages, preferred landscapes - lakes especially
- Incorporation into public gardens, town plans, civic design etc; botanic gardens, planned and unplanned towns
- Water aesthetics - identifiable sites; cemeteries
- Spiritual and social values

RIVERS AND HAZARDS

Hazards

- Flood controls
(control/abatement measures - levees, locks, dams, diversions, straightening, reservoirs, pondages, bypasses, floodways; engineering specifics - pipes, valves, gates, construction details, errors; engineering controls; drainage measures: highways - culverts, gutters, inlets, downdrains)

Public health

- Waste disposal
(collection and disposal works)
- Waste transportation
(pipes, aqueducts, sewerage works)
- Swamp hazards
(drainage problems, disease, clearance; associated works)
- Events
(drownings, stock losses etc.)

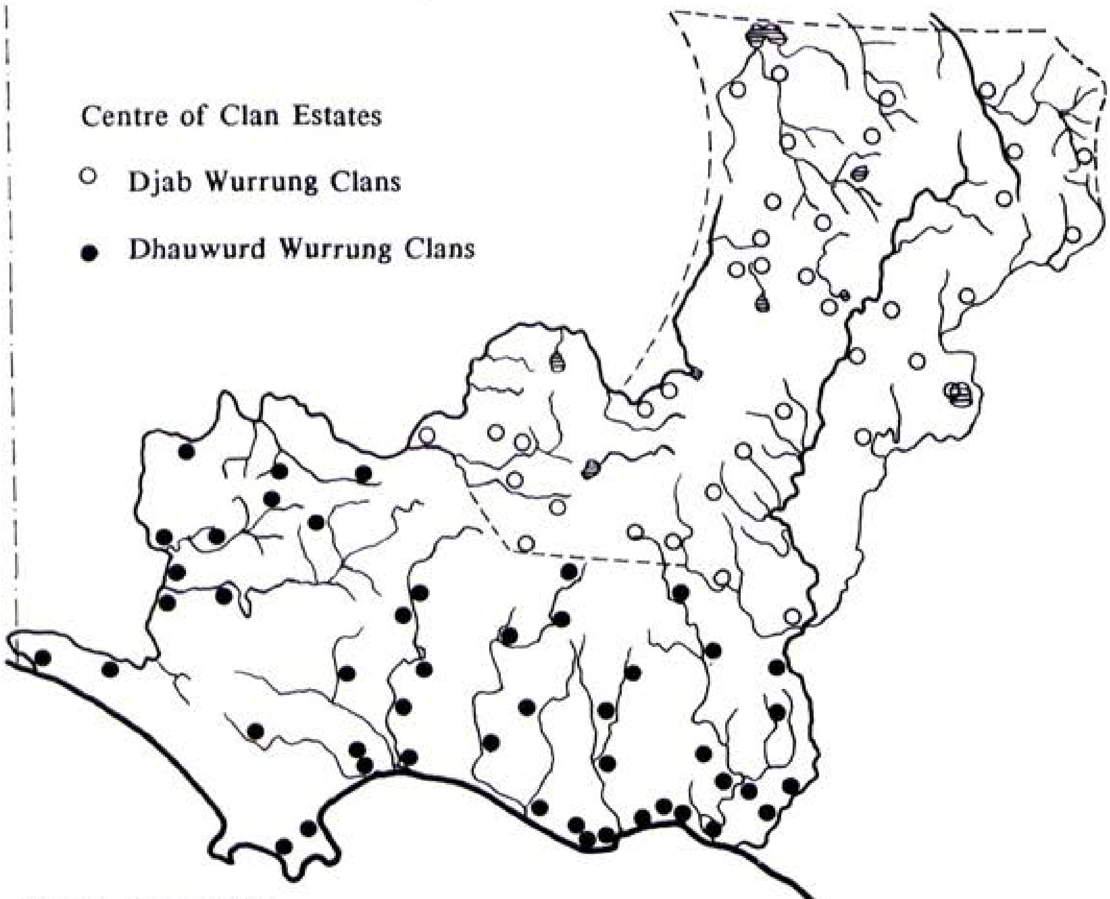
Environmental despoilation

- Salinity - sites
- Erosion - frontage damage, river diversions, variable flows, blockages
- Inundation - vegetation change, destruction, water table change, overland flow change

FIGURE 19

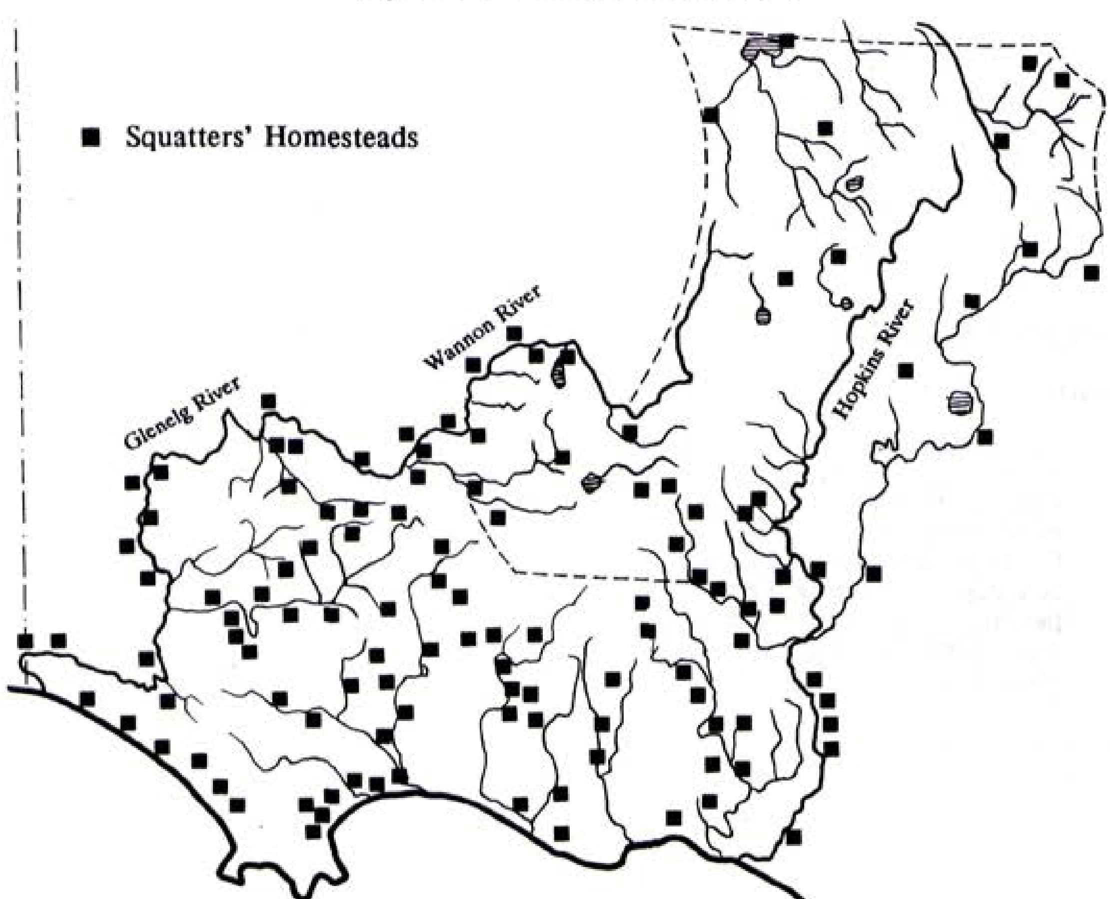
OCCUPATION IN PARTS OF SOUTH-WESTERN VICTORIA

Aboriginal Clan estates at Contact



Source: Clark 1989

Squatters' homesteads in 1851



Source: Powell 1989

Along the Murray, weirs were constructed across dry creek-beds. When the river waters rose, water passed through the weirs into the creeks. The weir openings were then blocked, trapping fish in the creek-beds where they were easily captured. These tribes also used nets, some being hundreds of metres long and 2 m wide, which they made from fibre produced by chewing cumbungi roots.

Eels were available all year round, especially during autumn. Sometimes groups of up to 30 people gathered eels in one location. Such occasions were often important ceremonial and social events and might have involved the exchange of trade items and negotiations over marriage arrangements.

In the Western District, extensive stone or earth structures consisting of weirs and channels were built to divert the swimming eels into large tapering baskets. These structures often covered several hectares or more and are still to be found near Toolondo, to the south of Mt William in the Grampians, and at Lake Condah.

Water-bird trapping incorporated a variety of methods. In Gippsland, water birds were generally caught during the moulting season when the birds were sitting on nests or had just fledged. Sometimes the trappers placed stakes in the water as pedestals to attract cormorants, which they caught by swimming quietly to the stake and knocking them off with a stick or boomerang.

Along the Murray, large nets were placed just above the level of the water to trap ducks. Around Port Phillip Bay water birds became entangled in traps, made from grass and sticks, placed in the water. Large brush fences were built along lake shorelines in the Western District: breaks left in the fence allowed the birds access to the water, where they were easily captured with a noose.

Shellfish collection provided a variety of shellfish, including fresh-water mussels (common along rivers north of the Divide) and estuarine shellfish such as mud arks, oysters, and southern mud whelks. The shell remains of meals - middens - are often preserved in the archaeological record and are common along the Murray River. The oldest known record of shellfish-harvesting in Victoria comes from a 16 000-year-old midden on the banks of the Murray River near Mildura.

Plant foods, of which aquatic and riparian environments were also rich sources, included berries from the lilly pilly tree, water ribbons, common reed, and cumbungi. The underground stem of cumbungi was cooked and chewed for starch and was a staple food for the Murray river tribes. Its young shoots were also eaten. Important medicinal plants, such as 'old man' weed, were common on floodplains, and Aborigines throughout south-eastern Australia still use this plant for internal and external complaints.

Not only did rivers supply food, they provided a variety of resources useful in everyday life.

Bark was an extremely versatile material used to construct huts, make shields and bowls, and build canoes. Not all trees had suitable bark; some of the best came from river red gums. In some ecosystems, such as the extensive grasslands to the west of Melbourne, the only suitable trees were those along the edge of rivers and creeks. Some canoes were just large enough for one person while others could carry up to seven people. A canoe made rivers and lakes accessible and would have extended the range of social contacts that could be made and of resources that could be readily used. Scarred trees are still found along many water bodies. Bumbang Island on the Murray contains more than 500, displaying the importance of bark in traditional Aboriginal society.

Many plants found along rivers were used for a variety of purposes. Cumbungi roots, chewed to produce **fibre**, provided string for containers and nets. Reeds and rushes were woven into baskets and in some areas fashioned into spear shafts and necklaces.

Stone was integral to Aboriginal technology. It was used for axe heads, grinders, knives and spear barbs, and different stone types with particular properties were required. Highly prized stone was often carried and traded over hundreds of kilometres. In certain areas,

Water, an important focus for Aboriginal life - hummocks with occupation deposits - Lake Connewarre (Basin 33)

Rivers as a resource: the result of shellfish collection, a shell midden - Murray River (Basin 14)

Axe grinding grooves - Honeysuckle Creek (Basin 5)

Canoe scar - Wimmera River (Basin 15)

river valleys were the only source of suitable stone. On some basalt plains, for example, stone types suitable for cutting-tools were only found where rivers and creeks had eroded through the basalt to the underlying rocks. As large rivers bring together material from all over their catchments, streams with cobble beds form ideal locations to gather different stone types. In Gippsland suitable water-worn pebbles were regularly used as axe heads. Axe-grinding grooves are also found in or next to watercourses, a constant supply of water being required to remove the grinding waste.

Adaptations to resource distribution

Rivers provided drinking water, food, and other resources. Archaeological remains demonstrate the occupation of open sites, rock shelters, and caves along creeks, rivers, lakes, and estuaries. These often contain detailed evidence of occupation, providing insights into people's daily lives, and into the strategies adopted in the face of major climatic changes. It is possible to identify significant regional variations in riverine camp-site types.

Rock shelters and caves offered protection from the cold, wind, and rain. Notable sites occurred in limestone caves on the Buchan and Snowy Rivers, and were used about 22 000 years ago.

Many riverine environments in the west and north-west of the State were prone to waterlogging or flooding in winter. The construction of large earthen oven mounds provided a well-drained and dry area on which to live. Mounds were common along the Hopkins River and the Murray River floodplain east of Boundary Bend at Nyah, Vinifera, and Barmah Forests. Those along the Murray were up to 50 m in diameter and more than 2 m above their surrounds. They often contain bone and shell remains of various foods such as fish, crayfish, emu eggs, bush rats, and turtles. Mounds were a relatively new phenomenon, being mainly developed in the last 3000 years.

In the stony rises around Lake Condah, hundreds of U-shaped or semi-circular stone structures have been recorded. These structures are about 3 m in diameter and usually less than a metre high and are believed to be the bases of shelters. Roofs were probably constructed of less durable material such as timber, bark, or sod.

Burials were common in river plains and in the dunes bordering lakes. The repeated and exclusive use of a small area for burials only occurred along the River Murray at such places as Lake Wallawalla, Robinvale, and Kow Swamp, where cemeteries were in use 13 000 years ago. An initial assessment suggests that cemeteries were a direct response to the very specific conditions that existed along the middle and lower reaches of the Murray. There, in drought one could walk from a river stocked with fish, invertebrates and food plants to a parched plain in a matter of minutes.

Rivers and other water sources had two other roles - as a focus for ceremonial gatherings, and as preferred pathways - so camp sites often developed along their banks. The large scatters of stone flakes found along Kororoit Creek may result from the use of the creek as a meeting-place of clans and as a path from the coast to the hinterland.

Today, the oral and written records, and archaeological sites, are of particular significance to Aborigines, and for the community at large are tangible evidence of Victoria's long and rich history.

CONTACT ERA

With the arrival of Europeans in the 1800s, river-based activities and interactions changed. Aboriginal resources were stolen, individuals attacked and killed, and diseases spread. The places and images relating to this period are many.

Dispossession

The water sources and water-based resources on which Aboriginal spiritual and social life were based were also those sought by pioneer settlers. Pastoralists centred their runs on the water sources (Figure 19) that often formed the heart of Aboriginal clans. The resulting social dislocation is illustrated by an account of the arrival of Captain Rupert Allen, a Western District squatter. In 1842, after Allen and his party had settled under Mount William Range, the Weeripkwart baluk ordered him to leave. Allen's neighbour reported: 'They told him that he must not stop there, it was their country and the water belonged to them and they could not go to another Blackfellow's country for they would be killed.'

Conflict over the use of water for eeling also arose and continued for some time. In 1863 at Lake Bolac, Aborigines were prevented from catching eels. The only outlet from the Lake had been taken over and was being netted by white settlers from Ararat.

Clashes resulted from different cultural perspectives and needs, and often ended in violence. As rivers and streams were meeting places, they also became the sites of a number of deaths. Many place names recall these times. A graphic example was the massacre in 1839 of 35 to 40 Darnbirr gundidj people at a place now known as 'Murdering Gully', a swampy area adjoining Mt Emu Creek.

The historical and social significance of these sites lies in their capacity to remind us both of the unpredictability of 'frontier' violence and of the intolerance and misunderstanding that propelled New World settlement ambitions. The sites also act as a corrective to the 'romance' now sometimes associated with the squatters. As such they are important features of Aboriginal and white heritage.

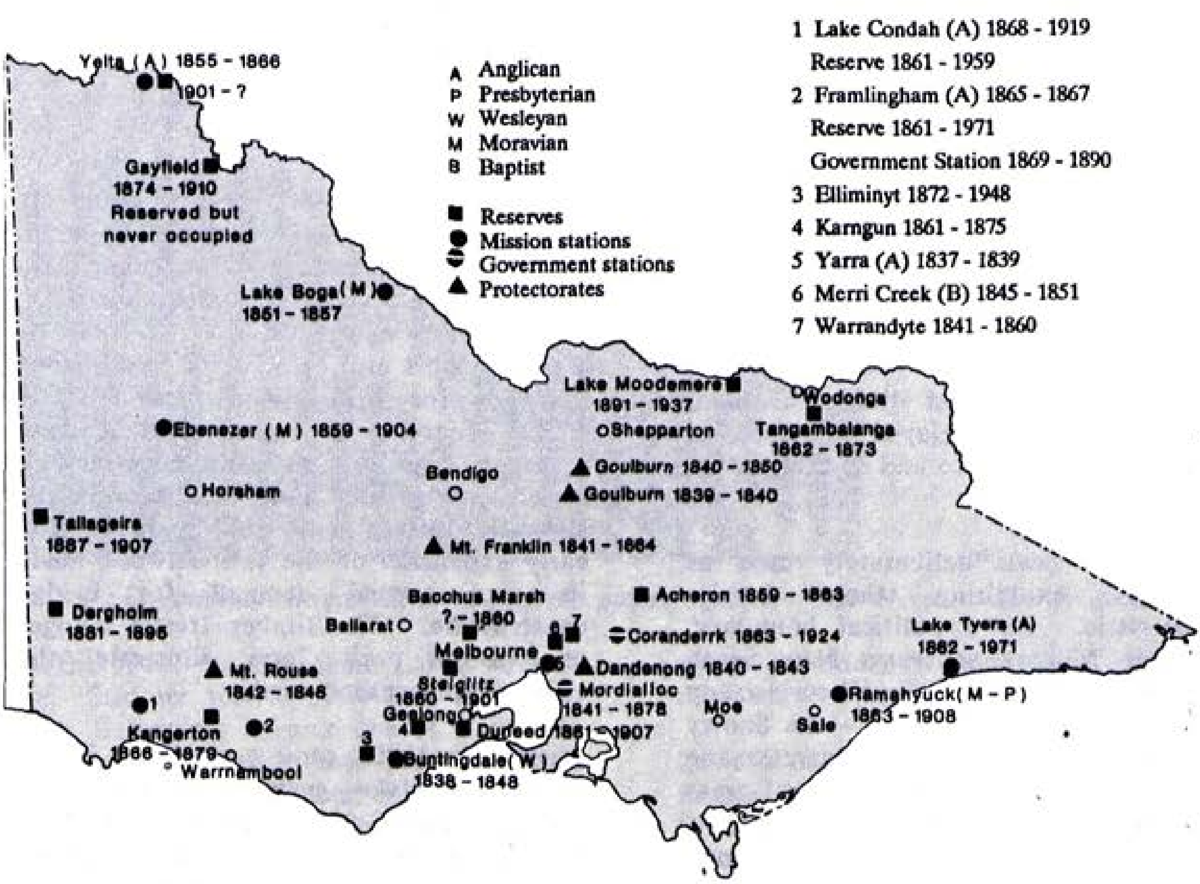
Reservations

As a result of disease, massacre, and social dislocation, Victoria's Aboriginal population substantially declined. The remaining Victorian Aborigines were 'resettled' from the 1840s to 1860s by missionaries and officials on reserves, protectorates, and missions.

The reservation system (Figure 20) aimed at self-sufficiency. The area had to be suitable for hunting and gathering and for eventually supplementing the natural diet through self-sufficient grain and livestock

Cummeragunga Mission - Murray River

FIGURE 20
ABORIGINAL RESERVES AND STATIONS



Source: Atlas of Victoria

production. Consequently all reserves were water- or river-based.

Reserves figure prominently in Aboriginal--white history as examples of various settler philosophies to educate, christianize, assimilate, protect, and 'smooth the pillow' of what was seen as a dying race.

Renaming the landscape

'Explorers' and squatters were often guided by Aborigines. Many early roads followed Aboriginal paths and many Aboriginal river-crossings were also used. The landscape was new and foreign to these explorers and the surveyors that followed, and they set about renaming natural features and naming newly created towns and localities in their own terms. In some instances, Aboriginal names were retained or given to localities. A few examples of such rivers and riverside towns include:

Mitta Mitta - little water or where reeds grow
Yarra - running water
Echuca - meeting of the waters
Wangaratta - nesting place of shags

In Kulin dialects the term 'Yalug/alloc/yallock/yaloak' was used for stream/water/creek. Place and river names: Pirron Yallock, Woori Yallock, Woady Yaloak, and Mordialloc, and Yaloak and Yallock Creeks retain this meaning.

These names are part of our living cultural heritage and are reminders of the sequence of occupation and cultural transformation of the landscape.

POST-CONTACT ERA

Rivers are central to many activities that have shaped the lives of Victorians over the last 150 years. They have:

* been a focus for communication
* supplied water for domestic consumption
* provided raw material and energy
* been important to our social well-being
* posed a hazard to human endeavour

The following description of these five themes often draws on examples from the nineteenth century. Appendix IX list significant places which illustrate these themes.

Rivers and communication

As natural features that divide the land, Victoria's rivers have played an important role as both a barrier to and as a means of communication.

Rivers have been deliberately used as boundaries exploiting their barrier characteristic. As a political boundary, the River Murray separates New South Wales and Victoria. Within Victoria many rivers form shire boundaries - the Snowy River (for the most part) separates the Orbost and Tambo Shires. In rural areas rivers have been traditionally used as a convenient boundary that restricts stock movement and are often left unfenced.

Rivers have commonly been viewed negatively, and a variety of methods have been used to overcome the barrier to communication and trade that they pose. These vary from structures that cross over them (bridges) to those that cross on or through them (such as punts or fords). Although punts, fords, and crude bridges were easy to construct, they were inoperative in flood, isolating those dependent on them. Some structures, built following demands for the provision of more reliable crossings, still survive. For example, the Melbourne--Geelong coach road ford over the Werribee River at Werribee, dating from about 1840, is still usable.

Crude timber bridges were progressively replaced by better-designed wooden bridges, or increasingly from the early twentieth century by reinforced concrete.

Rail transport also created its own special demands for bridge construction. As trains require a relatively constant gradient, high bridges were necessary to cross deep gullies, and these needed the strength to carry heavy rolling stock. The early expansion of the rail network made its own special demand for bridge construction. The timber trestle bridges on various rail lines illustrate the construction method used.

During the 1800s, some coastal and inland rivers and lake systems formed vital communication and transport corridors, stimulating trade and social exchange. Coastal transport played an important role in the development of Victoria from the 1830s to 1870s. Ports were often established on coastal rivers. The township of Genoa on Genoa River is one example, but the lower Genoa River is now considerably silted and the navigation achievement of the coastal traders could not be repeated.

Rivers and communication: trestle bridge - Stony Creek (Basin 23)

Rivers and communication: the wreck of the paddle-steamer 'The Hero' - Murray River

By the 1860s the Gippsland Lakes were in use. Steamer traffic peaked in the 1880s when Bairnsdale became one of Victoria's leading ports. By the 1930s steamer traffic on the Gippsland Lakes and its rivers stopped due to competition from road and rail traffic and the silting of the rivers.

Of the inland rivers, the Murray was used extensively for transport from the 1850s to the 1880s. Consequently, the infrastructure necessary for riverboat trade, from ports to boat-building facilities, was constructed along its banks.

Trade along the Murray commenced in 1853 when the first boat, the 'Mary Ann', reached Echuca. By 1875, trade on the Goulburn had begun, with the snagger 'Bunyip' reaching Seymour in 1878. Murray River trade reached its peak in the 1870s and ports such as Echuca boomed. River trade had many advantages. Large tonnages could be carried, and shallow-drafted vessels could often be unloaded directly onto gently sloping river banks. Ideal river heights occurred in winter and spring when road conditions were at their worst. However, rivers were often low in summer and riverboat time-tables were not reliable. Consequently, as the land transport networks were expanded and improved across south-eastern Australia the use of rivers to transport goods and passengers declined around the turn of this century.

Some of these early port facilities are still intact, and today for example the 'Adelaide', built in 1866 and the third-oldest operating paddle steamer in the world, still ties up at the Port of Echuca.

Rivers and domestic water supply

Rivers are vital in meeting our potable water requirements and consequently access to water is an important factor in the location of settlements and farms.

As described earlier in this chapter, water sources were sought by pastoralists for their domestic and stock requirements. Pastoral stations were often located on rivers, and during the selection era pastoralists often chose strategic blocks on the river, to retain control of larger areas. In the 'survey before selection' period, many blocks were surveyed as elongated rectangles, each with a relatively short river frontage, so that as many as possible could have direct access.

Provision of a town water supply was an issue in the siting and development of every settlement. Before reticulated water systems, town residents relied on a range of means for their domestic water, including rain-water tanks, wells, springs, various pipes and pumps, and water carts, which supplied water from the nearest stream.

The supply of water was often an issue on the goldfields, where watercourses were used for a multitude of purposes as well as providing domestic supply. As water free from contamination was in short supply, water-carriers and hoteliers benefited. In the 1860s, the government developed major schemes to provide water to the Victorian goldfields, the largest being the Coliban regional scheme. This involved the construction of a large storage on the Coliban River at Malmsbury, smaller distribution reservoirs, 100 km of aqueduct, five major tunnels, and a complex series of bridges and channels. In 1874 Castlemaine residents received the first water from the scheme.

Development of a reticulated water supply was often regarded as one of the most important events in the history of a country town: the start of work to bring reticulated water to Stawell, in February 1875, was celebrated by a public holiday and a picnic. Reticulation, however, did not necessarily mean that residents would have water connected to their homes. In Echuca, for example, mains were laid along all the principal streets, and stand pipes erected where residents could collect water daily.

In most districts the first systematic attempts to improve the water supply came with the formation of waterworks trusts. The earliest waterworks often consisted of wells connected to hand pumps, then steam pumping plants were used to pump water from watercourses into storage tanks. Reservoirs were also constructed and the number grew steadily from the 1850s (see Figure 4). The principal work of most trusts included the construction of weirs, channels, 'improvements' to creeks and waterholes, and reticulation. In the event of drought, when rivers ceased flowing, small communities often made efforts to link their systems to the reservoirs of the major towns and cities nearby.

A major drawback of many water-supply schemes was that they drew their supply from streams that had functions other than as a domestic water source. As rivers could be receptacles for sewage, street drainage, and industrial pollutants, as well as sources of recreation, the purity of river water was often a critical issue. Stock use of river frontages added to the bacterial content. In some cases the solution was to relocate the weirs upstream from settlement.

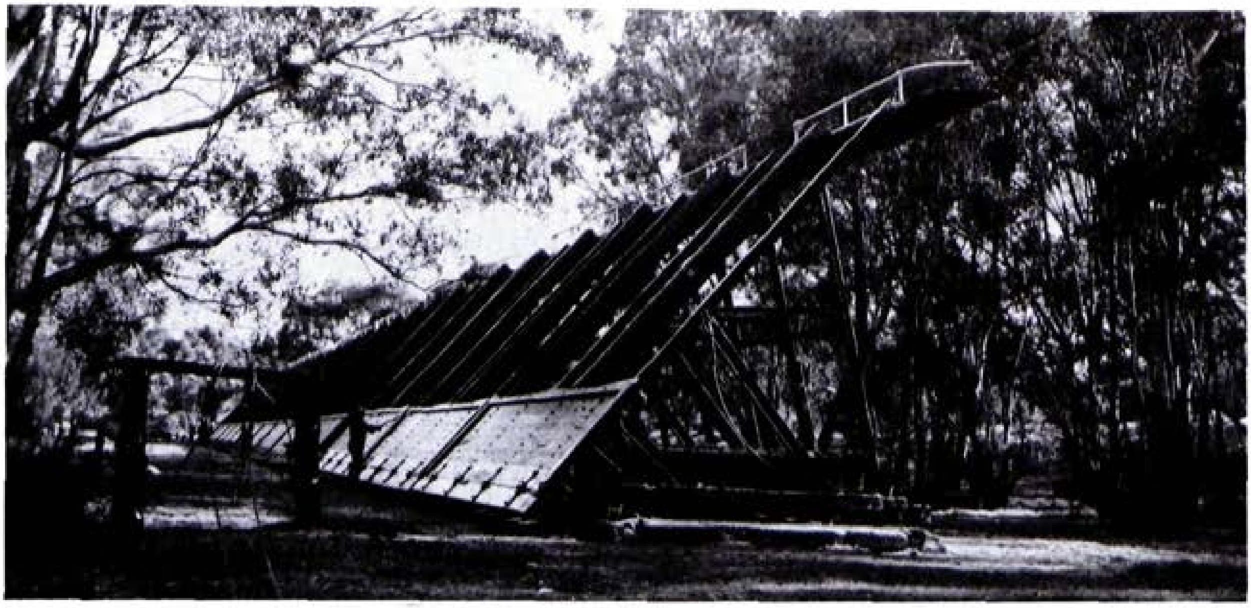
Every non-metropolitan settlement has its own story of the development of its domestic water supply. This story is more than likely a progression from an *ad hoc* utilization of rivers to a deliberate regulation and diversion of the river by some form of impoundment. Population growth increased the pressure for both reticulation and larger storage. In northern Victoria domestic and agricultural demands were often met by the same supply.

The introduction of water restrictions during the summer months and in times of drought reinforce the importance of rivers and streams in the provision of domestic supplies. Regardless of technological improvements in storage and delivery, Victoria's population can still be affected by water shortages. During 1975-76 when restrictions were in effect in Horsham, cars circulated making appeals through loudspeakers for people to turn their taps off in crisis periods; nevertheless, a number of people appeared in court for letting their hoses run at night.

Raw materials and energy

Rivers and streams are important resources in agricultural and industrial production, and contribute in a number of ways.

* Water is needed to sustain agriculture and grazing on fertile floodplains created by fluvial processes.
* It often concentrates or is associated with raw materials such as gold and salt, and is also used in their extraction processes.
* In industrial processing water is used for washing, cooling, heating, dust- and fire-prevention, and as a solvent.
* Flowing water is used as a source of power.



Rivers and raw materials: technical innovations, the trestle weir - Torrumbarry Weir

Reliable supplies of water were sought by early pastoralists. In the Wimmera region, irregular low rainfall made water supply an important issue. As early as 1856 an earthen embankment was built across the Wimmera River to divert water down Yarriambiack and Dunmunkle Creeks. The need to retain as much water as possible in the waterholes led landholders to enlarge and clear them of silt at the end of each summer. An innovation that resulted was the 'muckbilly', a low four-wheeled trolley or dredge that when pulled through a lagoon scraped 'muck' from the bottom.

In the mid nineteenth century creeks were also used for washing sheep, as no machinery was available that could remove dirt and burrs from wool. Clean wool also weighed less, thus reducing freight charges and the costs of overseas shipment. Place names such as 'Sheepwash Paddock' and the eleven 'Sheepwash' Creeks are reminders of this practice.

Not only was water important for livestock industry but was also required for the development of irrigated agriculture. Irrigation commenced modestly and by the 1850s was often used by Chinese market-gardeners. As projects expanded in the 1880s opponents regarded irrigation as 'Chinamen's work' and 'below the white man's dignity' and spoke of 'young men making swamps to grow weeds'. Despite such racial prejudice, irrigation was successfully applied and by the 1890s Victoria led the rest of Australia in the promotion and development of large-scale schemes. These schemes expanded gradually until major development was finished in the 1930s.

The development of irrigation also resulted in technological innovations such as the 'Dethridge direct-measuring water meter' and trestle weir. The trestle weir could be drawn out of the river during floods and had the advantage that it could be painted and repaired when removed from the river. Torrumbarry and Mildura Weirs are notable examples.

The Victorian gold rushes of the 1850s to 1860s saw Victoria's population boom as a result of one of the great migrations of recent times. The gold rushes involved a variety of uses of rivers and valleys; and resulted in another set of heritage values. The effect of early gold-mining on Victoria's rivers is illustrated by Howitt's description of Bendigo Creek in the 1870s:

> 'Little more than a year ago, the whole of this valley on the Bendigo Creek, seven miles long by one and a half wide, was an unbroken wood! It is now perfectly bare of trees, and the whole of it riddled with holes of from 10-80 feet deep - all one huge chaos of clay, gravel, stones, and pipe-clay, thrown up out of the bowels of the earth! So much has been done on this one forest in one year; and not only so much but a dozen other valleys as large...'

Raw materials and energy: hydraulic sluicing for gold - Beechworth (Basin 3)

Following the use of picks and shovels, other methods of obtaining washdirt were introduced. In the north-east at the Cobungra and Mitta Mitta fields, high-speed water jets (hydraulic sluicing) was introduced. This allowed the ground on hillsides and steep stream-banks to be washed loose for processing - in some areas, leaving only rock. By 1898, water pumps were being used to provide water jets around Beechworth and Yackandandah and by 1907 there were 84 pump sluicing plants operating in Victoria.

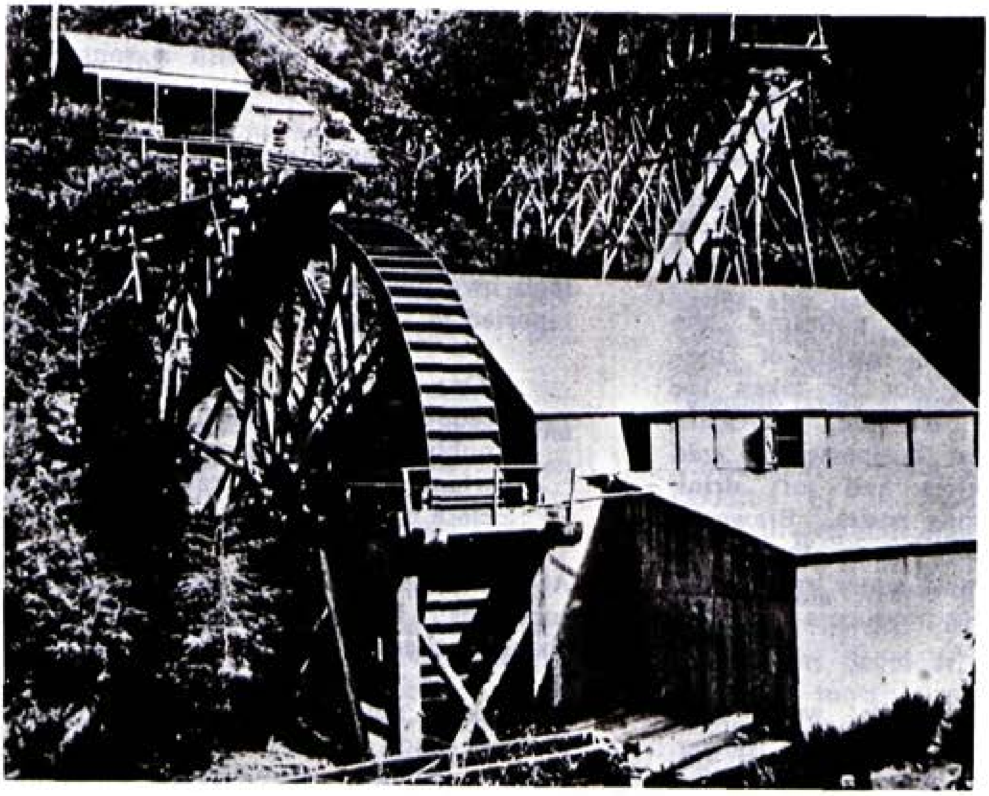
Processing the washdirt required large quantities of water, and hundreds of kilometres of 'tail-races' were constructed. Tail-races were so numerous in the Beechworth Mining District that by 1868 they totalled more than 1500 km, more than double the length of channelling in any other gold-mining district.

Alluvial gold-dredging commenced in 1898, and by 1912, 56 dredges were excavating gold-bearing floodplains across Victoria, many of them working on the Ovens and Buckland Rivers. A bucket dredge that operated on the Reedy Creek (a tributary of the Ovens River) floodplain from 1935 to 1956 can still be found at Eldorado and is a significant reminder of this era. In 1957 a dredge operating on the Avoca River sank, marking the end of large-scale dredging in Victoria.

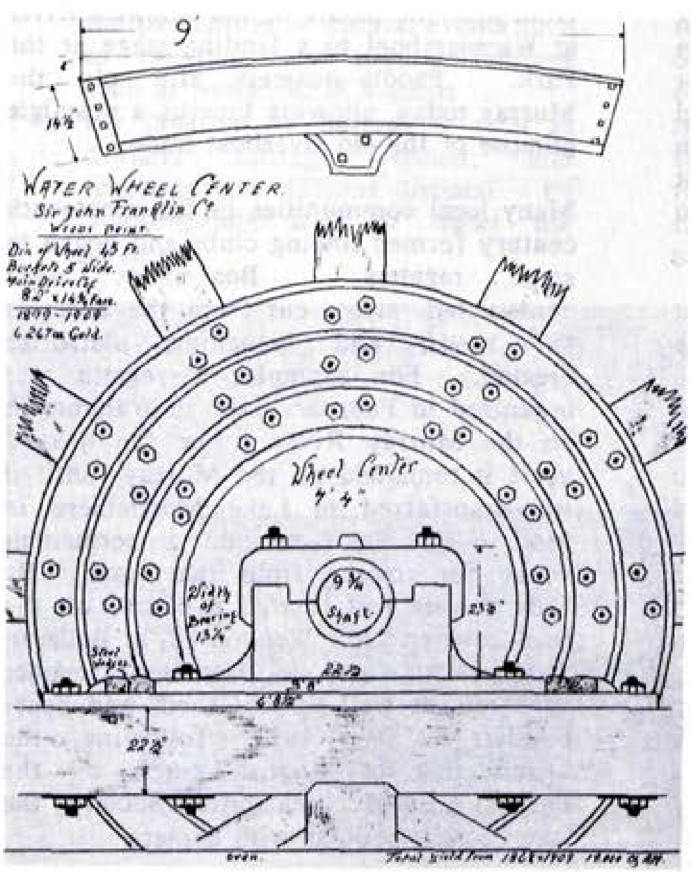
Whereas water is used to concentrate gold mechanically, water's solvent properties, are used along with evaporation to concentrate and purify salt.

About one-third of the State's natural lakes are brackish or saline and some are dry salt pans for much of the year. Most of these salt lakes and pans are situated in the north-west. Salt extraction has occurred in Victoria since the early days of European occupation and by the 1840s squatters were already taking dray loads of salt from small lakes near Lake Bolac. Common salt and gypsum are still extracted from natural lakes, in the Mallee area.

With growth of secondary industry in the nineteenth century, water was required for purposes as diverse as fellmongery and the supply of beverages. Fellmongeries, for



Water and energy: water-wheel St John Franklin Mine - Goulburn River (Basin 5)



Cultural heritage has many forms, only the iron hub of the water-wheel at the mine site now survives example, needed a ready and reliable supply of water and were often located beside lakes and permanent watercourses. After soaking in a 'dock' for at least 24 hours the skins were removed and washed. Later, the final rinsing was carried out in deep water of the lake or river, where rafts with washing crates were moored.

With many activities polluting the waterways, the drinking quality of free-flowing water could not be taken for granted, especially on the goldfields. Some of the earliest businesses in gold towns were breweries and soft drink factories situated along rivers. Breweries serviced bush shanty-towns throughout their districts. Aerated water and cordial factories were able to produce a relatively pure 'preserved water'.

The energy of running water was commonly used as a source of power. Water-wheels were a means of using this energy and were common throughout the nineteenth century. Power generation involved water flowing down a falling race onto the blades of a water-wheel, connected directly to milling machinery, whether it was for wheat-milling or the crushing of gold ore in a gold stamp. At the Sir John Franklin Mine on the Goulburn River south of Woods Point, for example, the remains of a water-wheel and the associated mining structure can still be found. Like others of its type, it took advantage of the renewable energy in running water.

Hydro-electricity is similar, except that the head of water used is greater and the water-wheel is replaced by a turbine connected to a generator.

Victoria's first major hydro-electric scheme was built by the Cassilis Gold Mining Company in 1908 to supply power to a mine at Cassilis. This diverted water from the Victoria River, but closed in 1916 owing to a lack of reliable flows.

These are but a few examples of the early industrial associations with Victoria's rivers.

Rivers and well-being

Rivers provide a sense of place and a range of opportunities that contribute to our physical and spiritual well-being. Rivers and creeks are also a source of contemporary folklore.

Public swimming holes were an important feature of riverside towns, especially as many townspeople in the nineteenth century lacked the luxury of a bath in their own houses. As the Horsham Times reported in 1882:

> 'One of the most indispensable requisites in a warm climate is a public bathing place, especially so where there is a stream of water in close proximity to a town ...'

At many old swimming holes structures such as jetties, diving-boards, and changing sheds remain.

Many local municipalities have developed reserves and parks on river frontages, often to commemorate significant events. Facilities for swimming, camping, angling, picnicking, and boating were often constructed. At Jubilee Park on the Hopkins River, near Allansford, the steam launch 'Lady Loch' operated around the turn of the century, conveying picnickers from near the mouth of the Hopkins River at Warrnambool to a landing stage at the Park. Paddle-steamers still ply the Murray today, allowing tourists a nostalgic glimpse of the old riverboat trade.

Many local communities in the nineteenth century formed rowing clubs and began to stage regattas. Boat-sheds were constructed, moats cut from the river to the sheds, and launching platforms erected. For example, a regatta was organized in February 1860 at Wahgunyah on the Murray River. For the next 2 years it remained on the Murray, until it was transferred to Lake Moodemere in 1863. The lake became a permanent venue for rowing from that time. By 1864 rowers had cleared a course on the reed-covered Lake Wendouree, at Ballarat. Soon yachts and a passenger steamer appeared, as well as boat-sheds and boat-builders. By 1872, following the introduction of English perch by the Ballarat Fish Acclimatization Society, the lake became popular with anglers.

The use of rivers for active and passive recreation has endured and the current diverse range of uses is described in Chapter 16.

Rivers and streams have also been used for religious purposes, particularly for the conduct of baptisms by full immersion. In the nineteenth century this occurred on the Avoca River (at Quambatook), Yarra River (Warrandyte), Campaspe River (Kyneton), Corryong Creek, and Gunbower Creek.

Numerous creeks and particularly the mineral springs along them have been sought for their therapeutic value. Today springs in the Daylesford area are a major attraction.

Waterfalls, rivers, and wetlands have often been sources of spiritual rejuvenation for our largely urban-based society, and of inspiration for writers, photographers, and artists.

Rivers as a hazard

This theme illustrates the dichotomy between human endeavour and nature, expressed in two ways:

* the perception of natural events such as flooding, and natural features such as wetlands, as hazards
* the creation of hazards - such as dryland salting, erosion, and inappropriate effluent disposal - by inappropriate land or water use strategies

Floods have become local folklore. Communities react to floods, and name some, for example, 'The Biggest Known flood of ...' or 'The Great Flood of ...'. The personal inconvenience of flooding rivers is shared by many communities, especially as they deal with damage to their property and possessions. Country towns also have their stories of heroism, when individuals risked their lives to rescue others, and of tragedy, when flooding rivers claimed victims.

Throughout Seymour's history, the flooding of the Goulburn River has demonstrated shortcomings in the siting of this town. A major flood in 1847 began to alter the river's course and this was completed by the 1916 floods. Periodic flooding at Seymour, as at many other riverside towns, reminds us of our historical association with rivers. The original reason for siting adjacent to rivers was for water-supply purposes. Technology such as pumps and pipes makes this requirement no longer necessary.

Floods reinforce the sense of a river as a barrier. In the past floods made punts, ferries, and fords inoperative, and occasionally destroyed bridges and washed out roads across floodplains. With time, transport networks have improved, many flood-prone roads have been relocated or raised, and bridges strengthened and raised, thereby reducing the inconvenience of flooding.

Rivers and well-being: mineral spring - Lerderderg River (Basin 31)

The threat of flood to local communities has resulted in extensive modification of rivers by flood-mitigation works. The following example illustrates the actions of many local councils last century. After the 1891 Walhalla flood a major works program was undertaken, involving realignment of the creek, deepening and widening of the bed, sheeting the bed and banks, and building stone walls to confine the stream, particularly where it cut deep into hillsides. These works may themselves now be considered as heritage features.

For some people, flooding was a source of great excitement. The community of Pella, situated near Lake Albacutya, usually viewed the flooding of the Wimmera River as a cause for celebration. When the Wimmera River is in flood, Lake Hindmarsh overflows into Outlet Creek, which drains into Lake Albacutya. Pella residents would meet the water flowing from Lake Hindmarsh and walk with it on its 45 km journey to Lake Albacutya. At the Lake, residents welcomed the arrival of the water with a picnic.

Although swamp drainage in Victoria has generally been undertaken on grounds of pastoral development and settlement expansion, such as the drainage of Koo-Wee-Rup swamp, some resulted from the swamps being regarded as health hazards. For example, typhoid was attributed to inadequate surface drainage in towns such as Warrnambool, where swampy areas remained in the 1910s.

Following the extensive use of water in domestic and industrial process, the disposal of waste-water often resulted in environmental degradation. This was particularly the case in some nineteenth century gold-mining operations, where waste or sludge was discharged directly into rivers and creeks. In some instances elaborate measures have been taken to transport waste-water across rivers and streams. These measures include channels or races, and sewer aqueducts or pipes. An illustration of this is the concrete truss sewer aqueduct over the Barwon River, constructed in 1915 at the Breakwater.

In the nineteenth century, some anti-irrigationists were opposed to irrigation on the grounds that it artificially extended miasmatic conditions. Proponents argued that well-regulated systems of irrigation necessarily involved improved drainage facilities, the clearing and replacement of the original offensive vegetation, and the more-efficient use of waste-water.

The thematic associations outlined in this chapter document a rich, complex, and long history in which water is of fundamental importance. The places, structures, artefacts, and records demonstrate social, economic, and technical changes and the strategies that have been used to adapt to and manipulate the environment around us. This heritage provides a resource of experiences and ideas, which helps us to develop a sense of our identity.

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PART IV

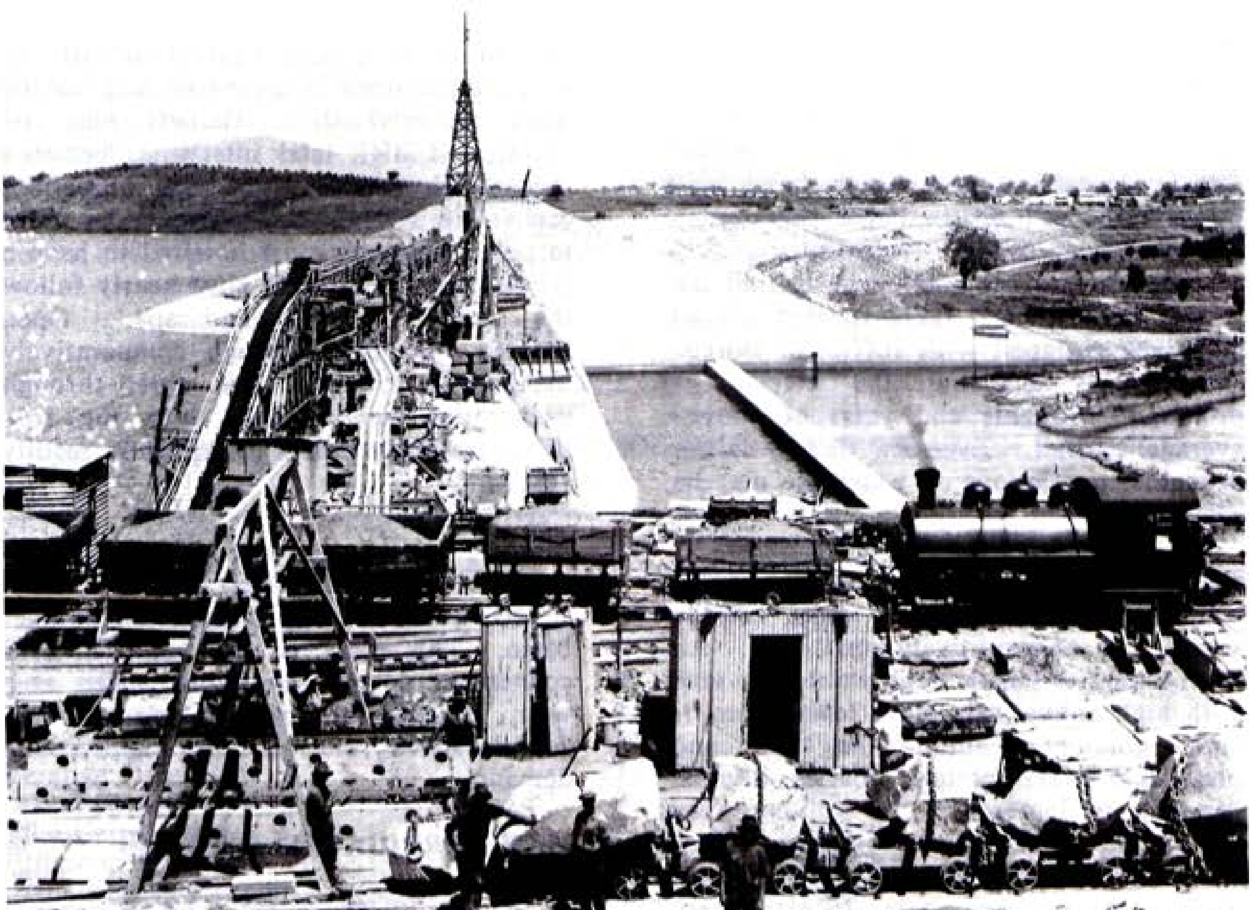
USES OF RIVERS AND STREAMS

19. INTRODUCTION

Part III described the special values that are the subject of this Investigation. Part IV describes water utilization, stream frontage, and other catchment uses and discusses hazards associated with these uses and other river and stream issues. As noted in Chapter 4, rivers and catchments serve a number of other important community functions, including the supply of water for irrigation, stock and domestic requirements, as well as for urban centres, and the production of hydro-electricity. The uses and their associated water storage and distribution systems are described in Chapter 20, which also describes sites that are potentially suitable for the expansion of the hydro-electric supply system.

In addition, watercourses and adjacent lands provide a number of other resources that are in daily demand. These include the provision of high-quality agricultural and grazing land, the supply of alluvial sand, gravel, soil, and gold, and the supply of river red gum timber. Aquatic environments also provide the habitat for various native and exotic fish that support commercial and recreational angling. Chapter 21 summarizes such uses.

Utilization of riverine and catchment resources is not without its hazards. Chapter 22 describes the various associated hazards, and issues raised in the use and development of Victoria's rivers. Flooding, for example, may constrain land use options, or may result in property damage and sometimes loss of life. Chapter 22 also outlines erosion and siltation effects, and the potential impacts of various land use activities on catchment and riverine values in general and on nature conservation, recreation, cultural heritage, and scenic values in particular. The impact of river regulation on these values is also discussed, and the effects of introduced or pest species.



Construction of the Hume Weir c.1930 (Basin 1)

20. WATER UTILIZATION

Agricultural, industrial, and urban development all require assured access to water of suitable volume and quality. As such development progresses, water demand may often outgrow the supply that can be obtained from local surface water. This may require the use of groundwater sources or the importation of surface water from other catchments. Development of the Wimmera and Mallee for cropping and grazing for example, was totally dependent on imported water.

In Victoria, a number of major water supply systems have been developed to meet urban, industrial, and irrigation demands. In many instances these systems have resulted in the movement of water between major river systems, and its transport over hundreds of kilometres.

Water supply systems have two important components - the water-harvesting and storage system, and the water-transport system.

Water-harvesting and storage systems

These consist of dams and weirs that block the stream, storing water and restricting flow. Aqueducts and water races may increase the volume available for storage by diverting water from surrounding catchments into the catchment behind the dam. The artificial lakes formed behind dams are designed with sufficient storage capacity to level-out the effects of prolonged droughts and years of above-average rainfall. Even so, during severe droughts, restrictions on water use may be required.

The best sites for water storage occur where a large volume of water can be stored in a comparatively small area. An ideal dam site has: a large catchment area with high annual rainfall; a low stream or land gradient behind the site and preferably a flat bottom (that is, alluvial deposit), to increase stored volume; very steep adjacent slopes, to minimize surface area; and solid rock abutments with a narrow gap between them, to give dam-wall stability and minimize construction effort per unit of storage volume.

This prescription is often met at the top end of gorge sections in stream mountain or valley tracts. Examples include Lakes Thomson, Eildon, and Dartmouth. The flat nature of plain tracts on the other hand entails long dam walls to hold an appreciable water volume, and the relatively high ratio of surface area to volume also means high losses by evaporation. Lakes Mokoan and Lonsdale and Waranga Reservoir are such plain tracts examples.

A dam in the higher mountain and valley tracts has the added advantage that gravity, rather than pumping, can be used to move water to its point of consumption. Dams for hydro-electric schemes must lie in the higher parts of the landscape to ensure that sufficient head of water exists between the dam and the power station.

Transport system

The transport system usually consists of pipes, or channels that may or may not be lined or covered. Tunnels may be required if high land intervenes between the storage and point of use. Pipelines can follow straight-line routes from point to point; channels must be sited to have a gentle gradient, so they must nearly follow the contour of the landscape. Open unlined channels, although comparatively inexpensive to build, lose water through evaporation and seepage into the soil. Water flowing in them is also more readily polluted.

In some instances, rivers and streams are used to transport water that has been stored upstream or diverted from another basin. This water is then removed at a convenient downstream point, often at a weir. Smaller intermediate storages allow for localized changes in supply and demand.

MAJOR IRRIGATION SYSTEMS

Most agricultural crops depend on water in the surface soil. The extent to which plants can obtain this surface water depends on seasonal variations in rainfall and evaporation. In Victoria, the time with the most sunlight and warmth for plant growth is also the time of lowest rainfall and highest evaporation, leaving insufficient water available in most of the State to sustain plant growth. Moreover, rainfall has substantial natural variations from year to year (see Chapter 10).

In such a climate, augmenting rainfall with irrigation water offers considerable benefits. Perennial pastures can replace annual grasses, tree and annual crops can be grown despite unreliable rainfall, and fodder crops can be grown under irrigation in summer to take advantage of the heat and prolonged daylight hours.

Today 570 000 ha of farmland are under irrigation, 500 000 ha by public schemes and the remaining 70 000 ha by private diversions from regulated schemes. Although this land represents only 4% of the area devoted to farming in Victoria, it produces 24% of the State's agricultural production in average years, worth $630 million at the farm gate. In drought years the figure approaches 30%.

Of the irrigated land, 80% is under pasture for meat and dairy production, while the remainder carries intensive crops with high economic value. These include: fresh, canning, and jam fruits; dried vine fruits; vegetables; tobacco; table and wine grapes; and hops and citrus fruits.

In developing irrigation, Victoria has utilized more of the available water resource than the other States. The current annual consumption of water for irrigation is approximately 3 750 000 ML, 80% of which is used in pasture production.

With the exception of the Werribee, Bacchus Marsh, and Macalister Irrigation Districts, most of the land under irrigation lies north of the Divide (see Map 17).

Goulburn--Murray Irrigation District

This District is the largest in Australia. It extends 270 km from Yarrawonga and Shepparton in the east to Boort and Swan Hill in the west and up to 60 km south from the Murray. On average 440 000 ha are irrigated each year. Most of the land presently under irrigation carries pasture, with dairying and mixed farming the most common agricultural activity. Orchard fruit, vegetables, and grapes are the major horticultural products.

Some 60% of irrigation water is drawn from the Goulburn, Loddon, and Campaspe Rivers, and the rest from the Murray. Water diversion and storages for distribution involve integration of 10 major storages (Table 26 - above). Average use of water totals some 3 744 000 ML. Much of the irrigation system is gravity-fed, the Waranga, East Goulburn Main, and Macorna being the main distribution channels.

Table 26

STORAGES SUPPLYING THE GOULBURN--MURRAY IRRIGATION DISTRICT

Storage	Basin	River
Lake Dartmouth	1	Mitta Mitta
Lake Hume	1	Murray
Lake Nillahcootie	4	Broken
Lake Mokoan	4	(off-river)
Lake Eildon	5	Goulburn
Waranga Reservoir	5	(off-river)
Lake Eppalock	6	Campaspe
Lake Cairn Curran	7	Loddon
Tullaroop Reservoir	7	Loddon
Laanecoorie Reservoir	7	Loddon

Waranga Western-Channel supplying the Goulburn--Murray Irrigation District - (Basin 5)

Macalister Irrigation District

This District covers 54 000 ha and lies on the plains immediately to the north and west of Sale. The Macalister and Thomson Rivers flow through it. On average, it supplies 200 000 ML per year for irrigation, mainly for pasture production. Lake Glenmaggie on the Macalister is the major storage regulating the supply. Some water is also drawn from the Thomson River at Cowwarr Weir.

OTHER MAJOR WATER SUPPLY SYSTEMS

The following sections describe several extensive systems which are shown on Map 17. Many other systems are more localized, but supply communities ranging in size from cities such as Sale to a few hundred people.

Wimmera--Mallee stock and domestic system

Thought to be the largest water supply system of its kind in the world, the Wimmera--Mallee system derives water from the Wimmera River and its tributaries, from the headwaters of the Glenelg River systems that drain the Grampians and through the Waranga channel from the Goulburn. Storages in the Grampians, together with 16 000 km of distribution channels, serve 28 500 sq.km of farmland and a population in excess of 70 900, two-thirds of whom reside in towns. The total volume of water used in the system each year varies, averaging approximately 118 000 ML for domestic and stock use and 27 000 ML for irrigation.

The plains of the Wimmera and Mallee slope away from the Grampians, enabling water to flow by gravity along channels from the storages. Elevated localities and town storage tanks require water to be pumped from holding reservoirs. The channels are 'run' once a year in the cooler months, watering the northern areas first and those nearest the storages last.

When the Grampians storages are low, supply to the northern section of the system may be supplemented from the Waranga Western Main Channel. This channel originates from the Waranga Basin at Rushworth, filled from the Goulburn system.

Seepage and evaporation losses from the open earth distribution channels are high. In 1984/85, for the system as a whole, only 36% of the water released actually reached the point of delivery. For some parts of the Mallee, the proportion delivered dropped to 20%.

In recent years, demand for water within the supply area has been increasing at an annual rate of 1.5 to 2%. It is expected that increasing demand will be met by increased efficiency obtained by piped delivery of water. Pipelining reduces water loss through evaporation and seepage, and eliminates the pollution that currently enters along channel banks. Pipelining will also reduce seepage (thought to be a significant contributor to dryland salting) and save some water, which can be allocated for other purposes.

Melbourne Metropolitan Area

The Melbourne and Metropolitan Board of Works (MMBW) has responsibility for providing water services to Melbourne. The Board currently supplies water to more than 2.5 million people as well as for industrial and commercial uses. In 1985/86 of the 418 000 ML of water used, 68% was used for domestic purposes, 24% for industrial and commercial use, and the remaining 8% for various institutional and community purposes. Water is drawn from reservoirs and diversions in the Yarra, Thomson, and Goulburn Basins.

In the Yarra Basin, the Upper Yarra, O'Shannassy, Maroondah, Yan Yean, and Tourourrong Reservoir catchments are supplemented by diversions from the Armstrong, Cement, McMahon, Starvation, Badger, and Grace Burn Creeks. Water is pumped from the Yarra near Yering Gorge and stored at Sugarloaf Reservoir, one of the Board's off-stream storages along with Silvan, Greenvale, and Cardinia (in the Bunyip Basin) Reservoirs.

Lake Thomson water enters the Board's system through a tunnel to the Upper Yarra catchment. Headworks on the Wallaby, Silver, Hellhole, Mud, and Stoney Creeks in the upper King Parrot Creek Catchment (Goulburn Basin) direct water to Tourourrong Reservoir (see Maps 2 and 17).

Latrobe Valley water supply system

This system is centred on the Latrobe River and its tributaries and supplies water principally for irrigation and industrial use. In 1985/86, 85 000 ML of water were used as follows:

* industry - 51 000 ML: the two principal uses are as a coolant in electricity production, and for paper manufacture
* irrigation - 26 000 ML: provided from private diversions on the Latrobe River and its tributaries
* domestic consumption - 7000 ML: towns supplied include Morwell, Traralgon, and Churchill, plus the Rosedale district

Water for the supply system is drawn from major reservoirs on the Tanjil (Blue Rock Reservoir), Tyers (Moondarra Reservoir) and the Latrobe (Lake Narracan) Rivers (see Maps 2 and 17).

Mornington Peninsula supply system

The system draws most of its water from Tarago Reservoir, on the Tarago River, and diversion works in the Bunyip River Catchment. Water is also supplied by the MMBW from Cardinia Reservoir (18 000 ML in 1985/86). The Peninsula is an important tourist destination, with its population in summer swelling to over 280 000. Annual consumption can exceed 40 000 ML, with 90% being used for domestic purposes.

Geelong and District water supply system

Geelong is Victoria's second-largest urban area and its economy is underpinned by a large heavy-industrial sector. In summer the population of the district exceeds 250 000. Three separate systems bring water over long distances:

* East Moorabool system supplies 20% of the district's requirements from reservoirs on the head-waters of the East Moorabool River

* Barwon River and tributaries system supplies more than 60% of the District's requirements from the West Barwon and Wurdee Boluc Reservoirs

* Lal Lal Reservoir on the Moorabool River (two-thirds of its yield has been allocated for use in the Ballarat Water Supply System

Coliban supply system

This system supplies a population of 74 000 around Bendigo and Castlemaine.

Current annual demand for domestic, commercial, and industrial purposes is about 21 000 ML.

Approximately 2100 annual permit-holders are supplied from an extensive system of irrigation channels located between Malmsbury and Raywood. In an average year, irrigators use 12 000 ML of water, while another 2000 ML are supplied for stock and domestic purposes. Land is irrigated for orchards and market-gardens, and for pasture that supports beef and fat lamb production.

Water is supplied to the system from three reservoirs - the Upper Coliban, Lauriston, and Malmsbury - on the Coliban River, and from a shared allocation from Lake Eppalock on the Campaspe River.

Ballarat supply system

This system supplies Ballarat and surrounding towns with an average 15 000 ML each year of which approximately 50% is used for domestic purposes and a further 35% for industrial and commercial purposes. Its main storages are the Lal Lal and Moorabool Reservoirs, and a system of smaller storages and offtakes including White Swan Reservoir.

Irrigated pasture

Otway supply system

This supplies some 40 000 people in towns in the Otway--Lismore--Warrnambool area, and a further 3000 consumers outside urban centres with water for domestic and stock use. Offtakes at two locations on the Gellibrand River, and on tributaries in the Otways, provide the water, which is supplied to consumers via the Otway Main and South Otway Pipelines.

HYDRO-ELECTRICITY

Hydro-electric schemes extract power from flowing water. They have the advantage over other forms of electricity generation in that they have quick start-up capability. Consequently, when combined with other less flexible plant such as coal-fired power stations, they are ideal for meeting daily peak consumption requirements.

These schemes have other advantages. Water is a renewable resource, and after the generation of electricity, is still available for downstream use. In addition, in contrast to combustion of fossil fuels, hydro-electric schemes do not produce carbon dioxide, which may contribute to the greenhouse effect, or other gases, which may produce acid rain.

Several of the hydro-electric schemes that have been developed supply Victoria (see Map 17). In 1986/87 they provided 6% of the State's power - approximately 2% from Victorian schemes and 4% from the Hume and Snowy schemes.

A recent evaluation by the State Electricity Commission Victoria (SECV) estimated the potentially 'usable' hydro-electric capability of Victoria at 2000 GWh per annum. To date 1100 GWh per annum have been developed. The remaining 850 GWh per annum are made up approximately as follows:

* small hydro-electric schemes on existing storages (1 MW to 20 MW) - 150 GWh/annum
* small hydro-electric schemes at new storages - 100 GWh/annum
* large hydro-electric schemes using new storages (more than 20 MW) - 600 GWh/annum

Small hydro-electric schemes at existing storages

A preliminary SECV assessment of costs, likely output, and availability of water has resulted in the ranking of small schemes on existing storages as follows: more favourable - Upper Yarra Reservoir, Thomson Reservoir, Lake Mulwala, and Lake William Hovell; less favourable - Lake Hume, Lake Nagambie, Lake Glenmaggie, and Lake Buffalo. A scheme has recently been constructed at the Thomson Dam.

Small hydro-electric schemes at new storages

Sites with potential for small hydro-electric developments in the State are common, from an engineering perspective. As schemes on new storages require the construction of major control works and infrastructure, potential sites have not been systematically evaluated. However, the SECV has indicated that, for example, three sites in the Goulburn River Basin could develop about 55 GW per annum.

Large hydro-electric schemes

Five river systems have been identified by the SECV as containing relatively favourable possible future hydro-electric development options:

* Kiewa No. 2 - two options involving construction of a dam adjacent to the McKay Creek power station and a new power station downstream; one option would require diversion of water from the Big and Diamantina Rivers

* Rubicon - this involves the upgrading of existing run-of-the-river schemes; dams would be required on the Royston and Rubicon Rivers and Quartz Creek

* Mitchell River - a dam would be constructed on the Mitchell River approximately 35 km north-west of Bairnsdale

* Mitta Mitta River - a dam would be constructed 1 km below the confluence of the Big and Cobungra Rivers; a power station could be built at the dam base or in the Hinnomunjie area

* Macalister River - a dam would be constructed 25 km upstream of Lake Glenmaggie

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21. OTHER USES OF STREAMS AND ADJACENT LAND

This chapter describes a number of important uses of waterways and the lands associated with them. They include: agricultural uses; the production of mineral and stone; the introduction and production of exotic and native fish for commercial and recreational purposes; and the harvesting of river red gum.

AGRICULTURAL USE OF PUBLIC LAND WATER FRONTAGES

Public reserves along water frontages are highly valued for watering stock and grazing, and for some cultivation and domestic uses. Nearly 50% of Victoria's inland frontages are now licensed and about 20% more are grazed without authorization. Where frontages are not licensed, all public rights of use and access remain and most rights remain in licensed areas. However, few members of the public have any easy way of knowing whether a particular frontage is licensed.

Some 61% of land in Victoria is held in private ownership. Land that was not alienated following settlement tends to be either unsuitable for agriculture or held for specific purposes in various forms of public reserve. Substantial areas of public land are currently used under a range of tenures, including lease, licence or agistment, and occasionally illegal occupation.

Private use of public land can be of considerable value to the individual farmer. For example, public-land grazing can provide summer feed and increase the carrying capacity of a farm. The forage along watercourses is often of better quality than that on adjacent freehold land, and it often provides an adjoining farmer's only access to permanent water. Grazing on irrigated stream frontages takes place in north-eastern Victoria in summer periods and demand for this use is expected to increase. Reduction in risk of stock feed shortage during drought, and improved flexibility in management are thought to be at least as important to many lessees as production increases. In most years the value of the public-land component of agricultural production is not apparent in regional or State economies, but in the long term the improved financial stability may affect the welfare of local communities.

Public-land grazing, if well managed, can provide substantial community benefit through fire-fuel reduction and, sometimes, weed control. Adverse effects of such grazing (usually through poor management) include loss of vegetative cover, soil compaction and erosion, loss of native species by preferential grazing of herbs and destruction of regenerating shrubs and trees, spread or introduction of weeds, deterioration of water quality, and loss of aesthetic enjoyment by some people.

The following comments on agricultural use of public water frontages were established by a Department of Agriculture and Rural Affairs survey conducted in 1986.

In East Gippsland, most grazing on public land is on river flats with only limited grazing on river and stream frontages. Public-land grazing leases in forest areas provide security of feed in droughts and dry cattle runs during floods.

Grazing is carried out in State forests along the Ovens River floodplain downstream from Wangaratta. Substantial use is made of stream frontages for grazing elsewhere in the north-east. Tobacco is cultivated along the Ovens and King Rivers, including some areas within public land frontages.

In the Bendigo area, and around Warrnambool, stream frontages are commonly grazed under licence.

Limited areas of public land are licensed or leased around the lakes and periodically inundated areas north of Colac.

Agricultural use of public land in the Seymour district includes stream-frontage grazing by sheep and cattle, and intensive stream-frontage use, including some cultivation, in limited areas. A few river flats are used for high-value horticultural production. The river flats that have been cleared are highly valued for vineyards, flower-growing, instant lawn, and vegetables. Land used includes parts of the public-land water frontage, in some places.

Public land is used for open-range grazing in the Barmah State forest, and in parts of the Barmah State Park subject to a recommendation of the Barmah Forest Grazing Advisory Committee. Frontages elsewhere along the Murray River are subject to the Council's recommendations for the River Murray Reserve, in which grazing is permitted at the discretion of the land manager, only where it is compatible with the zoning of specific areas.

Other than in the Barmah Forest, minor use is made of public land around Echuca for grazing, mainly on Lower Goulburn River frontage. Much is subject to inundation.

Around Wodonga, much of the stream-frontage reserve is managed for agriculture, particularly grazing, in association with adjacent freehold land. The majority of stream frontages in this area, and many other parts of the State, are unfenced.

In the Lake Buloke bed and overflow areas, agriculture is one of the primary uses. The land is prone to flooding so grazing is more common than cropping. However, in good seasons it can produce excellent crops and the overflow area is important for individual farmers.

Open forests along the Wimmera River support limited grazing of native grasses in the grey box, yellow gum, and river red gum forests in currently licensed areas, but not where 'special measures are necessary' to protect the flora. The surrounds of Lake Hindmarsh, a lake reserve, are botanically important, and are not available for grazing.

The small areas of remaining creek and river frontage in the north-west of the State generally have low agricultural capability, but are extensively used. River Murray Reserve frontages may be grazed subject to three safeguards: that the natural vegetation does not sustain long-term damage; that regeneration of native species is fostered; and that particularly sensitive areas are protected.

Lake Albacutya is in a regional park. When dry, the lake-bed may be grazed at the land manager's discretion.

MINERAL AND STONE PRODUCTION

Under the *Extractive Industries Act* 1966 'stone' is defined as rock, gravel, sand, earth, and soil. Gravel, sand, and soil are discussed below, as are the minerals gold and coal.

Gravel and sand

Many of the rivers and streams throughout the State have been, since European settlement, a considerable and readily available source of sand, gravel, and stone for use in the construction industry, road surfacing, etc. Considerable amounts have been extracted in the past. However, over the last decade the volume of material extracted from the bed, banks, and environs of streams has decreased sharply. The most significant factor contributing to this reduction is the increased awareness of the possible effects extraction can have on in-stream values and stream behaviour. More rigorous assessment of extraction proposals from waterways is now made. Some operations are carried out where extraction is likely to improve the hydraulic characteristics of a stream that is being adversely affected by the accumulation of sediment. Bryans Creek near Coleraine in western Victoria provides an example.

Estimates of the amount of material extracted from the main stream networks within the State are provided in Table 27. In some cases these figures represent the best estimate based on local knowledge where records are incomplete or unavailable. It is thought that greater quantities of material are being extracted than currently indicated in formal returns - for example, in statutory declarations.

Regulation of shallow extraction activities on public land is administered by the Department of Conservation, Forests and

Table 27

ESTIMATED VOLUMES OF MATERIAL EXTRACTED FROM VICTORIAN STREAMS

River basin	River/stream	Volume extracted (cu.m) Public land	Freehold land
Operations administered by Department of Conservation, Forests and Lands.			
Upper Murray	Nariel, Corryong, Thowgla, Mitta Mitta, Tallangatta	15 000	5000
Kiewa	Yackandandah, Kiewa	15 000	5000
Ovens	Buffalo, Buckland, Hurdle, 15 Mile, King, Ovens	30 000	2000
Goulburn	Castle, Hughes, Mollisons, Goulburn	56 000	
Campaspe	Myrtle, Coliban	2000	
Loddon	Bullock	2000	
Wimmera	Various	100	
East Gippsland	Cann	1000	
Tambo	Tambo	3000	
Mitchell	Mitchell	30 000	
Thomson	Avon	70 000	
Otway	Barham	2000	
Hopkins	Salt, Hopkins		
Glenelg	Bryans, Wando, Pigeon-Ponds, Glenelg	37 000	
Extractive Industries Act licences			
Kiewa	Murray River floodplain at Wodonga	700,000	
Mitchell	Mitchell River floodplain at Lindenow	35,000 (in 1984)	

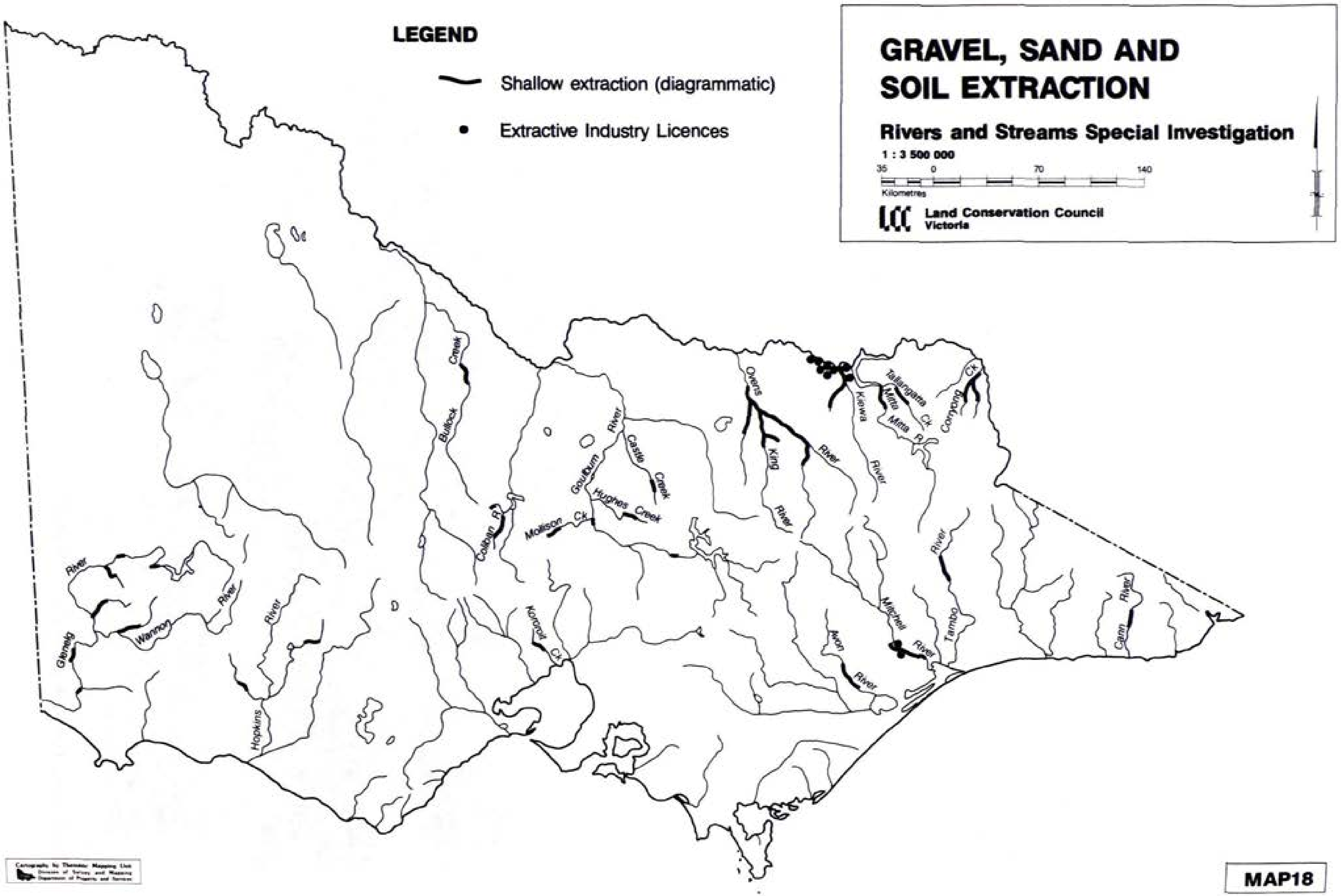
Lands (DCFL) under the Land Act. Activities on private land are also administered by the DCFL under the *Soil Conservation and Land Utilization Act* 1958. If deep extraction (greater than a depth of two metres) is involved - for example, on a floodplain - the operation is administered by the Department of Industry, Technology and Resources (DITR) under the *Extractive Industries Act* 1966. In any event, an application to extract is considered following consultation between DCFL and Rural Water Commission and, if appropriate, the local river (or stream) management authority.

Map 18 indicates the major locations of extraction from rivers and streams, and deep floodplain extraction.

DITR is responsible for issuing licences for operations on flood-plains (as opposed to beds and banks) and nearly all of these are along the floodplains of the Murray River near Albury, although two are on the Mitchell River floodplain in Gippsland. Because of the established move away from in-stream extraction, the amount taken from floodplains is likely to increase substantially in the future, particularly in the extensive plains of the Murray River.

Gravel extraction - Goulburn River (Basin 5)

Sand extraction - Murray River floodplain


LEGEND
Shallow extraction (diagrammatic)
Extractive Industry Licences
GRAVEL, SAND AND SOIL EXTRACTION
Rivers and Streams Special Investigation
1 : 3 500 000
35 0 70 140
Kilometres
Land Conservation Council Victoria
Bullock Creek
Campaspe R
Goulburn River
Mollison Ck
Hughes Creek
Castle Creek
Ovens River
King River
Kiewa River
Tallangatta Ck
Mitta Mitta R
Corryong Ck
Tambo River
Mitchell River
Avon River
Cann River
Glenelg River
Wannon River
Hopkins River
Korkuit Ck
MAP18

Gold

Gold-mining in Victoria can be divided into two distinct groups. Small-scale operations (including individual miners and prospectors, eductor-dredge operators, and metal-detector operators) and larger-scale operations (which usually involve formally constituted companies). Only the second group are required to provide statistical information on mineral production to the DITR so no reliable information on the extent of small-scale operations is available. However, the Council has generally regarded such activities as essentially recreational pursuits that are permitted in most areas so long as they involve minimal disturbance to soil and vegetation.

Eductor dredging has generated some concern in the 10 years since it was first permitted in Victoria. In accordance with government policy, the use of eductor dredges is being phased out, ceasing by the end of 1990.

Gold production by large companies may occur on rivers. In the early 1900s large mechanical dredges capable of excavating to a depth of 40 m were used on floodplains and riverbeds. The Ovens River near Harrietville was one such site, and a proposal to dredge the same area has recently been considered.

An important factor in the level of gold-mining activity is the world price of gold. While this remains high, so will the interest in gold exploration and the reworking of old areas. With improvement in technology and high prices for gold, it is often economic to rework areas that were previously unprofitable due to low yield.

Coal

Although rivers and streams are not sources of coal, deep open-cut mining for coal has meant that minor streams have required diversion. In the future, the course of the Morwell River may require alteration in order to obtain access to some Latrobe Valley coal deposits. Decisions on the need for, and the timing of, a major diversion of the river have not yet been taken.

Soil

Soil is an essential component of any garden. Topsoil is often removed or buried (under layers of rubble) during building operations and many new-home-owners purchase soil in order to overcome such problems. In addition, local councils may need soil in order to build up garden beds in existing parks or to landscape new areas such as disused rubbish tips.

Floodplains are a ready source of the rich topsoil needed for such purposes. Although large amounts of heavy and often rocky subsoil are available from the excavations associated with multi-storey buildings, this is not suitable for landscaping purposes.

High-quality soil is removed from floodplains in areas such as the upper and middle reaches of Kororoit Creek. Extraction of soil is generally shallow, and is managed by the Department of Conservation, Forests and Lands.

INTRODUCED FISH SPECIES

For the purposes of this report, an introduced fish is defined as 'any species or subspecies transferred to an ecosystem outside its natural range'. It includes 'exotic' species that have been 'transplanted' or 'native' fish 'translocated' within this country to areas outside their natural range. Exotic introductions and native translocations are considered separately.

Exotic fish

Twelve species of exotic fish have been introduced into Victorian inland waters (Table 28). Their introductions may be considered in three separate phases. The first commenced last century and fish were selected by the new settlers for those sporting or food qualities thought to be lacking in the native fish fauna. Government agencies worked in co-operation with acclimatization societies to stock species familiar to settlers.

The salmonids: salmon and trout

The most significant of the early introductions were undoubtedly those of brown trout and rainbow trout.

Table 28

EXOTIC FISH IN VICTORIA

Species	Year of introduction	Native range
Brown trout	1864	Europe
Rainbow trout	1894	North America
Chinook salmon	1877 (1936)	North America
Carp	1860 (1960)	Asia Minor
Goldfish	1860s	Eastern Asia
Tench	1870s	Europe and Central Asia
Roach	1870s	Europe
Mosquito fish	1925	North America
English perch	1868	Europe and Asia
Black mangrove cichlid	before 1978	West Africa
Convict cichlid	before 1978	Central America
Oriental weather loach		North-eastern Asia

The introduction of brown trout to Australia is the earliest known introduction of the species beyond its native range in Europe. After four unsuccessful attempts between 1841 and 1862, trout ova were successfully shipped to Tasmania in 1864. Of the 300 brown trout hatched from the ova, 38 were retained at the hatchery and their progeny used to stock the rivers of Tasmania and mainland Australia.

Rainbow trout were introduced as fertilized ova from New Zealand in 1894. The species had been introduced to New Zealand from their native range in North America in 1883.

Many rivers in south-eastern Australia were stocked with brown and rainbow trout very rapidly following these early introductions. '...such was the zeal of early acclimatisationists that trout were introduced into most suitable river catchments before 1900' (Tilzey, 1977).

These introductions have undoubtedly been successful, and self-reproducing populations now inhabit many of Victoria's mountain rivers and streams, particularly at altitudes above about 600 m. Reasons why trout have been successful in the Australian environment are thought to include: the physiochemical and biological similarities between many of south-eastern Australia's highland streams and the trout's ancestral waters; the virtual absence of significant parasites and diseases; an abundant invertebrate food source; and little competitive interaction from native fish.

Brown and rainbow trout are the only salmonids in Victoria to have established self-reproducing populations in the wild; however, a population of chinook salmon exists at Snobs Creek hatchery.

Chinook salmon ova were successfully shipped to Australia, via New Zealand, in 1877. Salmon fry were subsequently released into many coastal rivers in Victoria without success. In 1936 chinook salmon ova were again introduced from New Zealand and released into a number of Victorian lakes. Fisheries developed in Lakes Purrumbete and Bullen Merri, with Bullen Merri being stocked regularly until 1952 and Purrumbete until 1967. In 1967 a ban was placed on the importation of salmonid fish and eggs into Australia to prevent the import of disease. The remaining stock at Snobs Creek hatchery were successfully acclimatized to an entirely fresh-water life cycle and in 1976 had risen to sufficient numbers to allow further release of fish into Lake Purrumbete and in 1978 into Lake Bullen Merri. Stockings have continued in these and a few other waters until the present day.

The cypriniids: tench, roach, carp, and goldfish

Of the four cypriniid fishes occurring in Victoria, probably only tench and roach were introduced to provide additional angling species. Carp and goldfish were probably introduced as ornamental fish species.

Tench were introduced from England, via Tasmania, in the 1870s and were widely distributed by acclimatization societies. They are now widespread both north and south of the Dividing Range, but generally occur in small numbers only. They do not occur in East Gippsland.

Roach were also introduced from Tasmania in the early 1870s but the origin of the Tasmanian stocks is not documented. The species has only a patchy distribution in Victoria, limited mainly to the Yarra and Werribee Rivers although it has been recorded in several other southern rivers and also in the Goulburn River north of the Dividing Range.

The history of carp introductions into Victoria is a complex one and the details of early introductions are not well known. It is apparent that they were first introduced to Australia in the 1860s and that fish from these early introductions survived in some ornamental ponds, including the Botanical Gardens in Melbourne and the Prospect Reservoir in New South Wales.

However, three different strains of carp can be recognized in Australia, one from Prospect Reservoir, one confined largely to the irrigation systems of the Riverina area of New South Wales, and a third strain originating in Victoria. This third strain was introduced into the State from Europe in the early 1960s and from a small farm in Boolarra in Gippsland it was introduced into many farm dams across the State.

In 1962 it was declared a noxious fish and a large number of farm dams were poisoned with rotenone in an attempt at eradication. However, the carp quickly spread into the Latrobe River system and hence the Gippsland Lakes, and from Lake Hamilton near Mildura into the Murray system. They are now also present in the Yarra, Barwon, Wimmera, and Werribee systems.

Goldfish were first introduced in the 1860s and during the 1870s they were widely distributed in Victorian waters by acclimatization societies. They are now common throughout Victoria and are often found in large numbers in backwaters of rivers and in wetlands.

English perch

Redfin or English perch were a very early introduction. In 1868, ten fish from England were released into a reservoir at Ballarat, seven of which were subsequently placed in a swamp at the present site of Lake Wendouree. These fish are the ancestors of the present stocks in south-eastern Australia.

English perch are now widely distributed throughout most of Victoria and are often abundant in the slower-flowing reaches of rivers. Their distribution in south and east Gippsland remains restricted to a few locations, including the Latrobe and Thomson Rivers.

Mosquito fish

The second phase of introduction concerns the establishment of the mosquito fish - introduced to reduce mosquito numbers.

Mosquito fish were introduced into the Sydney region in 1925 and this was followed by large-scale introductions during World War II in an effort to control mosquitos, particularly along the Murray River, to combat encephalitis. They are now widely distributed in lowland areas of Victoria, particularly in still waters with abundant submerged aquatic vegetation.

The cichlids and oriental weather loach

The third and more recent phase concerns the importation of aquarium fish to Victoria. To date, these introductions have not resulted in widespread populations, as the species concerned have specific habitat requirements.
Cichlids are popular aquarium fish and many species have been introduced into Australia. Two of them, the convict cichlid and the black mangrove cichlid, have self-maintaining populations in the cooling pondage for the Hazelwood power

station in the Latrobe Valley. The heated water from the power station provides suitable temperatures for tropical fish. When they were introduced to the pondage is uncertain, but they were first discovered in 1978.

The oriental weather loach appears to have established itself in two localities in Victoria - in a tributary of the Ovens River at Wangaratta, and in the Yarra River near Warrandyte.

Translocations of native fish

Seven species of native fish have been introduced to localities outside their natural range (Table 29). All are Murray-Darling species and, except for trout cod, they have been translocated to rivers south of the Dividing Range.

Translocation of native species has occurred in two phases. The first involved acclimatization societies and angling clubs. The Acclimatization Society of Victoria, at its second meeting in 1863, had already made mention of translocating Murray cod to the Yarra River. Those species included in Table 29 were all introduced into the river systems listed, by the 1930s.

The second phase of translocations comprised releases of hatchery-produced fry by the government's Fisheries agency. These have been limited in nature and have only occurred in cases of special management need. The policy of the current Fisheries Division of the Department of Conservation, Forests and Lands is that waters to be stocked with native species for conservation or recreational purposes must be within the known former natural range of the species, except where special management or research needs arise. Stockings will not be considered where the conservation status of other native species or unique faunal assemblages will be put at risk.

Table 29

TRANSLOCATED NATIVE FISH IN VICTORIA

Species	Native range	Translocation range
Murray cod	Murray system	Yarra River and Wimmera system
Trout cod	Murray system	Seven Creeks and Lake Sambell
Macquarie perch	Murray system	Wannon, Barwon and Yarra Rivers
Golden perch	Murray system	Wimmera system
Silver perch	Murray system	Wimmera system
Freshwater catfish	Murray system	Wimmera system

STOCKING EXOTIC FISH FOR RECREATIONAL AND COMMERCIAL PURPOSES

Early introductions of exotic fish to Victorian waters were undertaken by acclimatization societies. Acclimatization in Victoria began in 1857 when the Zoological Society was formed in Melbourne. Part of its charter was 'to encourage the introduction of foreign animals and domesticate the indigenous mammals and birds of the colony'. In 1861 the Zoological Society became the Acclimatization Society of Victoria.

The Society formed regional specialist fish acclimatization societies to assist with the introduction of fish species, particularly brown and rainbow trout and English perch. The first of these was the Ballarat Fish Acclimatization Society, which was formed in 1870 and was instrumental in distributing trout and English perch through much of Victoria. Its hatcheries still operate to this day and supply fish for private dams as well as some trout ova for public waters.

The second to be formed was the Geelong and Western District Fish Acclimatization Society in 1874. It ceased operation in the 1950s.

The first State government involvement occurred in 1909 when the Fisheries and Game Department erected a hatchery near the Yarra at Studley Park and a government hatching facility was built in the Zoological Gardens. Up until the 1950s the Department encouraged small local hatching operations such as those located at Warburton, Bright, and Kyneton. The Department also purchased young fish from the Ballarat and Geelong Societies. In addition, a number of local hatcheries for trout were conducted by local angling clubs - for example, Castlemaine, Horsham, and Warrnambool.

Since the opening of the government's Snobs Creek Hatchery in 1958, stocking of public waters has been undertaken exclusively from this hatchery and has been limited to brown trout, rainbow trout, and chinook salmon. The establishment of the Snobs Creek facility has greatly increased the production of trout species. During the period 1958 to 1967, it produced a total of 20 million fish for management purposes.

In the early days of acclimatization the emphasis was on stocking as many waters as possible and on distributing fish to new waters wherever this could be achieved. However, the trend in recent years has been to reduce the numbers of waters being stocked. Between 1970 and 1978, about 120 waters were stocked regularly with trout. These have now been reduced to about 80.

The current policy of the Fisheries Division regarding trout species is to limit stocking to those waters with suitable habitat where natural reproduction is considered insufficient to support a fishery. Trout are not stocked in waters where their release may constitute a threat to a population of a species of special concern (such as, Australian grayling) or where a unique faunal assemblage exists. Waters east of the Snowy River Catchment are not stocked because of the highly natural condition of the rivers in this part of the State and the significance of the native fish fauna.

Commercial fishing

There are few commercial fisheries in Victoria's inland waters. Eels, both short- and long-finned, form the basis of a small but important export industry. There are currently 19 licensed eel fisheries, with total annual catches averaging more than 200 tonnes and worth about $1.24m on the export market. The short-finned eel makes up about 95% of the catch. A small number are smoked for local consumption, but the majority are exported to markets in Europe (frozen eels) and South-East Asia (live eels).

One small commercial fishery for native species such as Murray cod, silver perch, and golden perch, and introduced species such as English perch and some carp, is located in the Murray system between Echuca and Mildura. It involves about 15 operators, but most are part-time and the value of the annual catch is small.

A small commercial fishery for carp has existed in recent years, using electrofishing gear and nets. Most of the catch is sold for pet food or crayfish bait. At its peak in 1976/77, this fishery took nearly 550 tonnes, but catches have steadily declined. At present one full-time operator works in the Gippsland area and a small number of part-time licensees in the Kerang area.

Finally, a small fishery for yabbies in the Horsham area currently involves about 40 licensed operators, of whom only about 15 are fishing regularly. It is based largely on Lake Hindmarsh and Lake Albacutya, and fluctuates greatly with the amount of water in these lakes.

RIVER RED GUM TIMBER PRODUCTION

An important habitat type associated with rivers and streams, river red gums produce very hard and durable wood, which resists decay and termites. It is therefore highly sought-after and has been used for housing, railway sleepers, harbour and bridge construction, fence-posts, telegraph and power poles, and furniture. In the past it also provided large quantities of fuel for the paddle-steamers that plied the Murray River, and for irrigation pumps along the river. A small amount of charcoal is produced for specialist industries as a source of carbon or in the production of filters. Some uses of river red gum - for example, sleepers and house stumps - are now declining and substitutes such as concrete are more commonly used. Others are increasing and examples include firewood for mainly urban populations and timbers and chips for landscaping.

The two major production areas in Victoria are the Murray River floodplain and parts of the Grampians. Operations in the Grampians National Park, particularly around the Victoria Valley on the Glenelg River, have now ceased following the declaration of the Park and the associated logging phase-out period. Nearby sites at Woohlpooer in the Grampians State Forest and at Kadnook and Connewirricoo are still harvested for small-dimension timber. The Murray River area is, and always was, a far more productive one.

Most of the timber taken from the floodplain of the Murray and its tributaries comes from the Barmah and Gunbower forests. Smaller occurrences along the river include the stretch between Colignan and Karadoc, and the young stands with high growth potential upstream of Wemen. Lindsay and Wallpolla Islands are also considered to be well suited to timber production. The net productive area of river red gum forest available for timber production across the State totals approximately 50 000 ha.

The harvesting method used depends on the location and characteristics of the particular stand of trees (for example, numbers and age). Although logging may be very selective, only removing individual trees or small patches, up to half of the trees in an area may be felled.

EXCLUSIVE OCCUPANCY

Rivers and their banks are popular sites for recreation, as discussed in Chapter 16. A variety of organizations such as boating and sailing clubs, scout groups, and schools have exclusive occupancies of sections of public-land water frontages, which they use for club houses and equipment storage. In addition, some commercial operations, such as caravan parks, have similar rights.

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22. HAZARDS ASSOCIATED WITH USES

This chapter outlines several major hazards associated with rivers and streams - flooding, erosion and siltation, and inappropriate land use - then discusses the more specific impacts of river regulation and introduced or pest species.

FLOODING

From the perspective of flooding, Victoria's river tracts typically exhibit the following characteristics. In mountain tracts, *floodplains* or river terraces are small or non-existent. Valley tracts have meandering channels with relatively narrow floodplains, and channel capacities will be exceeded about every 2 years on average. Plain tracts have low stream gradients with small channels, extensive floodplains with many anabranches, and channel capacities that are exceeded at least once every year on average.

Mountain and valley tracts commonly occur on geomorphic units 1.1 (East Victorian Uplands) and 2.1 (West Victorian Uplands), and on the dissected fault block units 3.1 (Otways) and 3.4 (South Gippsland Ranges).

Plain tracts occur on the extensive present floodplain (4.1), older alluvial plain (4.2), and Nhill clay plain (6.1) geomorphic units north of the Divide, and on the South Victorian riverine plains units (9.1 to 9.3), and coastal plains units (8.1 to 8.4) south of the Divide.

Areas across Victoria liable to flooding are shown approximately on Map 19A. These are primarily floodplains, along with volcanic plains, estuaries, and some shallow wetland areas, where flooding is a natural and ongoing process. The development of anabranch and effluent systems is a response to high-flow events, and their presence illustrates the continuing likelihood of floods.

The occurrence of flooding in land along any particular stream is very variable, responding to: intense or protracted rainfall; catchment land use, shape, and flood storage capacity; and the flood-conveyance characteristics of the stream.

River regulation, construction of artificial levees, and channel works can reduce the frequency of floods at specific locations.

Map 19A shows that the north-western and north-central streams have the largest of the floodplain areas characterized by extensive alluvial plains and small stream channels.

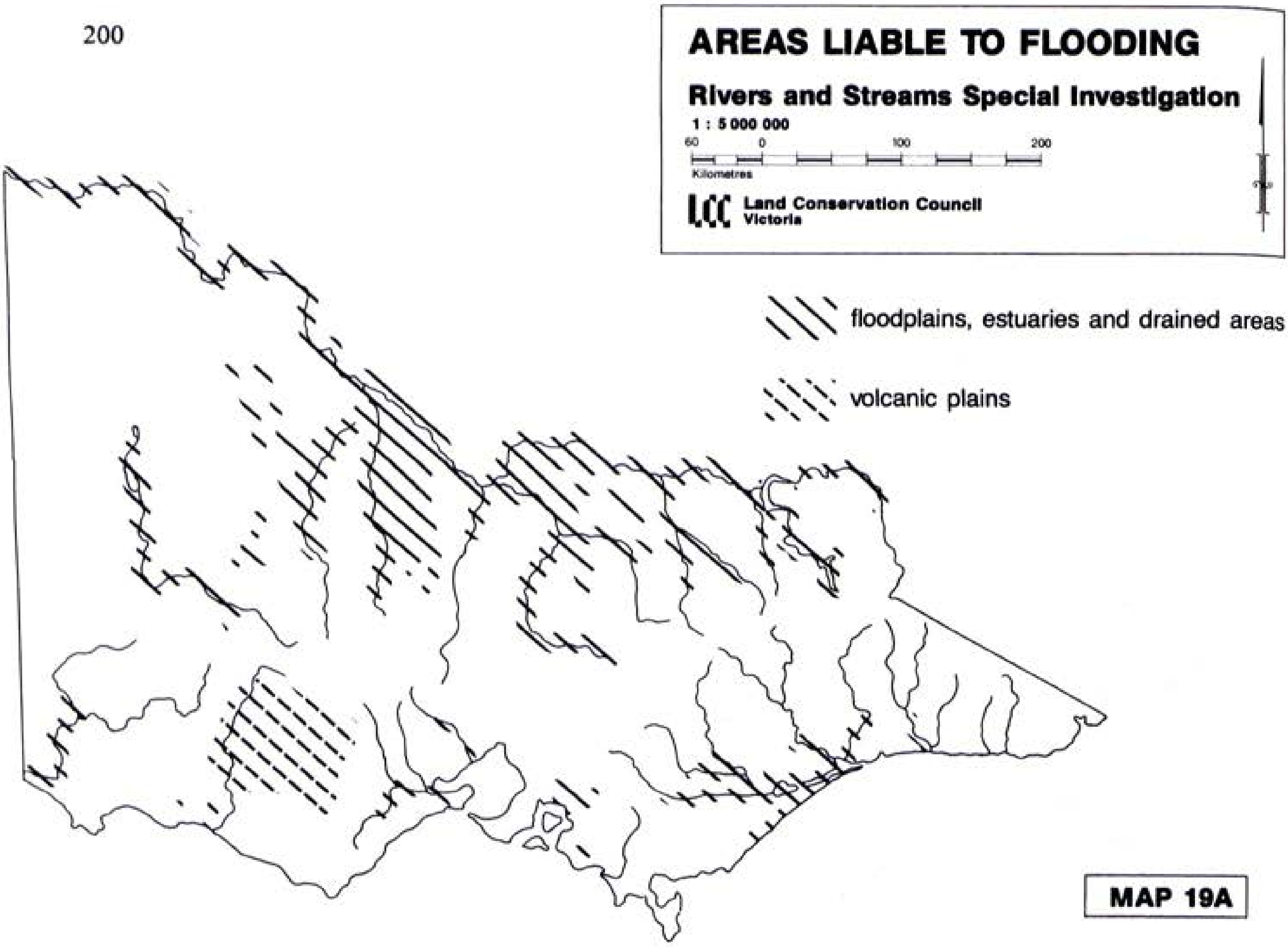
The Western District streams are dominated by basalt plains, in geomorphic units 7.1 and 7.2. Some coastal streams have flooded areas associated with dune lakes, in geomorphic unit 8.5 (barrier complexes). In Gippsland the most notable floodplain areas are on those rivers flowing to the Gippsland Lakes.

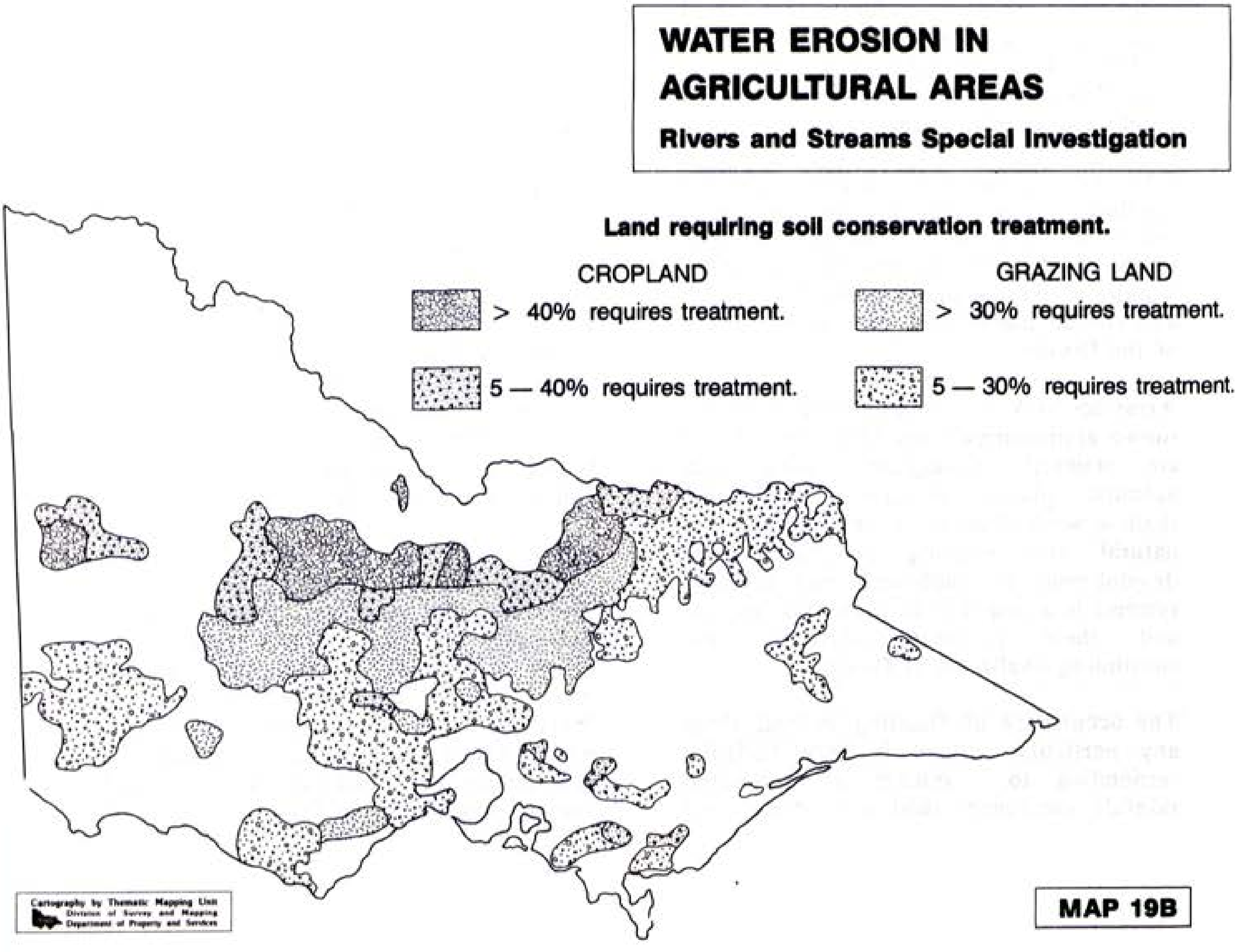
Flooding on major rivers

The following briefly summarizes the flooding characteristics of each of Victoria's major river basins.

The River Murray has a very complex flooding pattern. From the mid reaches above Lake Hume to near Cobram it has a relatively narrow and naturally confined floodplain. Below Cobram, levee systems contain floods up to a 35-year average recurrence interval (ARI). At Barmah, extensive natural flooding in the Barmah/Millewa Forest areas is caused by the Barmah Choke. Between Torrumbarry and Nyah, extensive flood-prone areas include the Gunbower Forest, Pental Island, the Fish Point--Lake Boga area, and the Tyntynder Flats.

The Kiewa River has a narrow floodplain between Mount Beauty and Kiewa township, but further downstream its floodplain widens. On the Ovens River below Porepunkah, the floodplain is quite wide, with anabranch systems at Myrtleford and Markwood. The King River has a well-established floodplain downstream of Whitfield and anabranch systems downstream of Oxley.


AREAS LIABLE TO FLOODING
Rivers and Streams Special Investigation
1 : 5 000 000
60
0
100
200
Kilometres
LCC Land Conservation Council Victoria
floodplains, estuaries and drained areas
volcanic plains
MAP 19A


WATER EROSION IN AGRICULTURAL AREAS
Rivers and Streams Special Investigation
Land requiring soil conservation treatment.
CROPLAND
> 40% requires treatment.
5 — 40% requires treatment.
GRAZING LAND
> 30% requires treatment.
5 — 30% requires treatment.
Cartography by Thematic Mapping Unit Division of Survey and Mapping Department of Property and Services
MAP 19B

Downstream from Benalla the Broken River has an extensive floodplain with several effluent systems. High water levels in the Broken and Boosey Creeks result in the flooding of a wide area in the Tungamah to Nathalia region.

The Goulburn River from Shepparton to the Murray has a very wide floodplain with several anabranch and effluent systems. Of the Goulburn's tributaries, the Seven, Honeysuckle, Wanalta, and Cornella Creek plains are prone to extensive flooding.

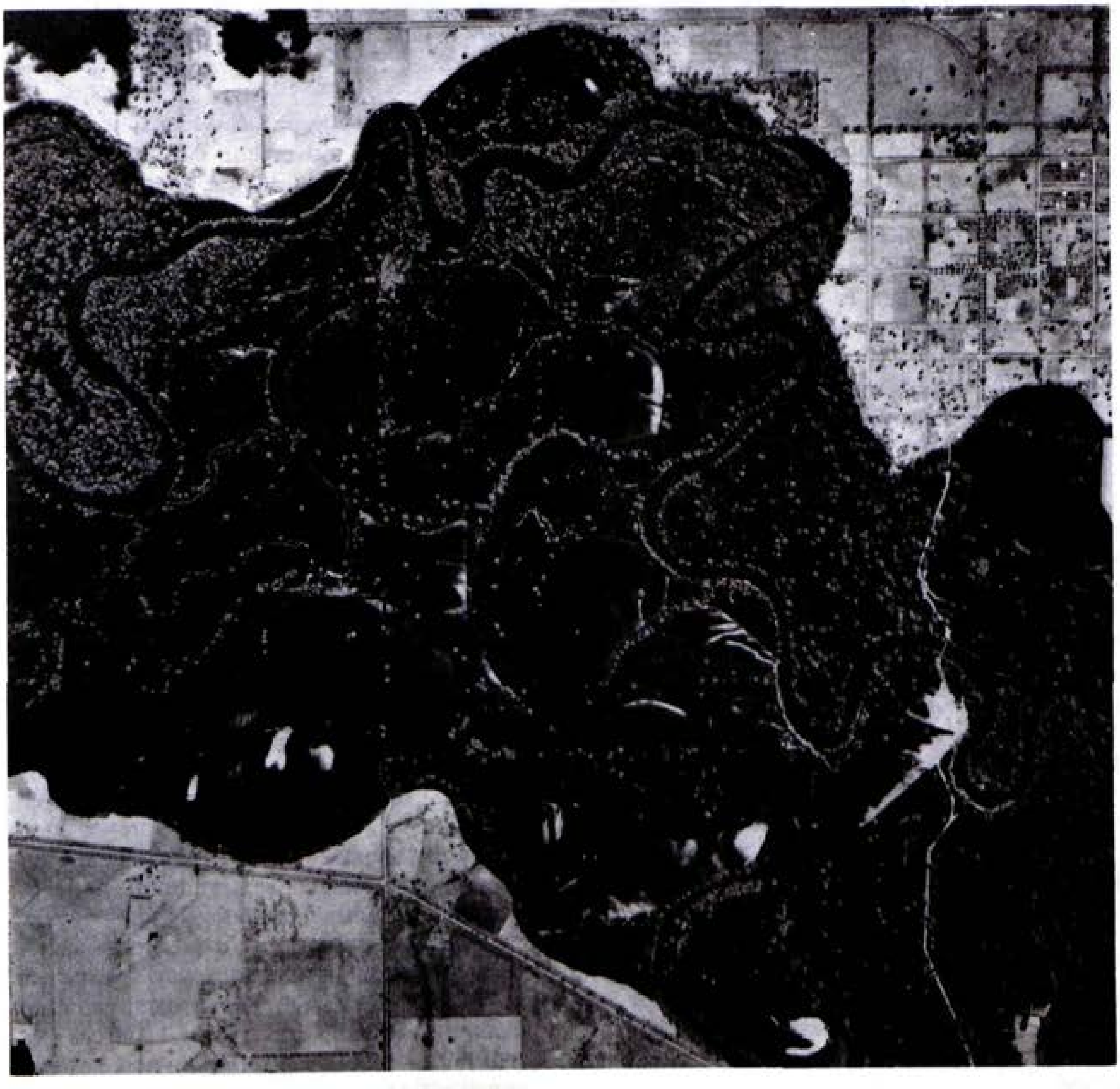
Along the Campaspe downstream of Rochester, extensive areas are prone to flooding as far as Echuca.

The Loddon flows across a vast flat plain with many anabranch and effluent systems below Bridgewater.

Downstream of Charlton the Avoca River has major effluents including the Tyrrell and Lalbert Creeks. Widespread flooding occurs, and during sustained wet periods overflows from the Top Marsh flow to the Little Murray via Lake Boga.

The Wimmera River has widely varying flood characteristics. Swamps occur even in the headwaters, but between Campbells Bridge and Horsham the Wimmera has an extensive floodplain with two effluent streams, the Dunmunkle and Yarriambiack Creeks. Downstream of Horsham the river generally has a relatively narrow well-defined floodplain.

The Snowy River below Bete Bolong has an extensive floodplain, which is lower



Flooding at Wodonga, 1974 - Murray River (Basin 2) than the natural river-bank levees and this creates potential for severe scouring during floods. In Gippsland, the Tambo has a moderately wide floodplain from near Bruthen and the Mitchell River has an extensive floodplain downstream of Glenaladale.

Below Redbank the Avon River channel is substantially higher than the adjacent floodplain, creating potential for the river to break away from its present course. On the Macalister River, vast areas are flood-prone downstream of Lake Glenmaggie. Some artificial levee banking downstream of Maffra is in poor repair and would be ineffective against large floods. Downstream of Cowwarr the Thomson River enters the same plain as the Macalister, and flooding is quite extensive. The Thomson has developed a major anabranch, the Rainbow Creek, between Cowwarr and Heyfield. The Latrobe River has an extensive floodplain from Yallourn Dam to Lake Wellington.

In South Gippsland, the Merrimans Creek, Tarwin River, and Powlett River have floodplain sections in their lower reaches. The Lang Lang and Bunyip Rivers and Cardinia Creek flow through a vast drained swamp that is still inundated in major floods.

Near Werribee township a number of effluents mark the beginning of the Werribee River Delta. A substantial flow can pass along the Werribee West floodway to Port Phillip Bay. The Little River enters a broad alluvial plain downstream of the Melbourne--Geelong Railway, where flooding can be extensive.

The only major floodplain areas along the Barwon River are near Inverleigh and downstream from Geelong. The Yarrowee River, a tributary, can cause flooding problems in the urban area of Ballarat. Almost the entire Corangamite Basin consists of a poorly drained basalt plain, with many lakes and swamps. During abnormally wet periods the area is extensively flooded.

The streams draining the Otway Ranges have no floodplain areas, except for the Gellibrand River. The estuarine sections of coastal streams are, however, flood-prone.

The Hopkins River Basin is marked by extensive basalt plains with poorly developed drainage systems. During wet years substantial areas are flooded. The Portland Coast Basin has several remnant swamps on the basalt plains and dune swamps at the coast. Flooding of these swamps can be extensive during wet periods. The Glenelg River rises in the Grampians, and has some swampy areas in its mid and upper reaches.

EROSION AND SILTATION

Land degradation in river and stream catchments

Catchments in hydrological balance are generally regarded as stable and show no significant signs of accelerated erosion. Undisturbed natural catchments are the best examples of this situation. Erosion risks under this regime are considered negligible.

Natural events such as floods, drought, fire, or mass movement can disturb the balance, as can deliberate events such as clearing of native vegetation, road construction, development for agriculture, or timber harvesting. A return to hydrological balance, or sometimes a new equilibrium, may take decades. Where the catchment has been severely disturbed, stability may only be achieved with active intervention.

The most important processes contributing to land degradation in Victoria are salinization, wind erosion, water erosion, soil deterioration from increasing acidity and from compaction, coastal erosion, and river-bank instability on cleared land. These effects are directly or indirectly the result of the clearing of native vegetation for land or resource development. Most of the land affected is in agricultural use; but uses such as timber harvesting, mining, tourism and recreation, urban development, or transport and communications can produce similar effects on a smaller scale. In the case of transport and communications, the facilities can have a disproportionately large effect on land and water relative to the small total area they occupy. For example, roads are major sources of sediment, both during and after construction.

Gully erosion, Mosquito Creek Catchment (Basin 6)

Dry land salting, Kameruka area (Basin 7)

All forms of land degradation are expressions of catchments in poor hydrological balance. Improved land management and possibly stream management are required for stable conditions to return. Improved management may mean treatment with works (such as erosion-control structures), catchment or frontage revegetation, improved land management practices, or a combination of these.

Within the State the most widespread form of land degradation is erosion by water, the bulk of which can be attributed to sheet and rill erosion and gullying (see Map 19B). It is estimated that sheet and rill erosion affects 13 000 sq.km of land and another 19 000 sq.km is at risk; also some 25 000 km of gully erosion exists.

The most extensive sheet erosion and gullying occurs on land comprising the northern slopes of the Great Dividing Range, from Dimboola--Ararat--St Arnaud in the west through Maryborough and Benalla to Corryong in the north-east. Cropping with grazing is the predominant land use in the lower-rainfall zone; as rainfall increases, grazing predominates. Soils are mainly duplex types with highly dispersible subsoils, making them susceptible to tunnel erosion. Tunnels may give way to gullying following collapse.

The steep to undulating southerly slopes and foothills of the Great Dividing Range have a high incidence of both gully erosion and combined gully and sheet erosion. Grazing is the predominant land use. The areas most affected lie in the Coleraine--Casterton, Sunbury--Whittlesea, Bacchus Marsh, and Omeo districts.

The volcanic plains in western Victoria are relatively stable. Where cropping is undertaken there is a low incidence of sheet erosion and under grazing gullying is not common.

High mountain country and elevated plateaux of the Eastern Highlands are important water-production areas. Clearing native vegetation from this land has induced mass movement on some steep slopes. Land is subject to a high risk of sheet and gully erosion under grazing and a high risk of wind erosion if cultivated. Gully and stream-bank erosion are common.

Stream-bank erosion and siltation

'The State of the Rivers' in Victoria is illustrated by the report of that name. Under natural conditions prior to European settlement, catchments were relatively free from erosion, and delivered relatively sediment-free run-off water. Rivers were deep and ran for long periods.

Rivers responded to catchment land use changes - and (in some areas) to gold-mining by diggers and dredging - by actively eroding their beds and banks, depositing silt and sand in their lower reaches, and occasionally cutting new courses. The courses became eroded and choked with sediment, and stream-flow duration shortened. Despite subsequent improvements in the condition of many river catchments, stream flows from cleared catchments had higher energy, and continued to erode streambeds and banks. Opportunistic species such as willows took root and diverted flows, widening stream courses.

Previously a pleasant, narrow stream, the Avon River is now in places 800 m wide over a 32-km eroded reach near Stratford. Cliffs more than 6 m high flank massive beds of sand and shingle in place of what was previously forested floodplain. The Avon is estimated to have washed away 72 million cu.m of soil, and destroyed some 1500 ha of land.

Many other rivers and streams have similar erosion and siltation problems, although to a lesser degree than in the Avon. While the mixture of past land use practices varies, in common is the observation that streams flowing in cleared land have deeper and wider courses through bed and bank erosion, and their flow regimes have higher, shorter peaks and less perenniality than under natural conditions. Sediment is deposited when stream velocity slows - in lakes, estuaries, and reservoirs.

CATCHMENT AND FLOODPLAIN LAND USE

Impact of land use on ecological values

Streams are inter-connected systems supported by physical, chemical, and biological processes. Changes to the natural condition of catchments, and to stream-bank stability, have the potential to generate pollutants, degrade the stream environment, and have adverse effects on stream biota.

Catchment clearing

In addition to the substantial impacts of catchment clearing on stream-flow regimes, and on erosion and siltation, it also has far-reaching ecological impacts. The obvious loss of natural ecosystems from areas cleared; edge effects and altered microclimates in vegetation remnants; introduction of weeds, vermin, and pollutants; impacts on soils (compaction, erosion, and loss of organic matter); and altered fire regimes - all these have major effects.

Grazing and cropping

Grazing by introduced stock affects stream systems in several ways. Streamside vegetation is reduced and altered in composition; stream-bank soils are compacted. These two factors combine to cause accelerated stream-bank erosion, resulting in changes to the stream channel shape, with the substrate altered and channel widened; and, in the water, temperature, nutrients, suspended sediment, and bacterial levels increase. The extent of the impact is determined by the intensity of grazing, and the sensitivity of the soils, vegetation, and stream banks to grazing impact.

Cropping requires tree-clearing and total removal of ground vegetation by cultivation, obviously involving major disruption of natural habitats.

Timber-harvesting

Increased sediment and nutrient input to streams, and higher water temperatures, may result from logging, along with the stream-flow effects mentioned above arising from clearing. Harvesting requires construction of roads, tracks, and log landings, which are key sources of sediment. Heaping of logging debris and burning may have further impacts on soil structure and organic matter level.

The structure and composition of a forest are severely affected by disturbances, such as timber harvesting or wildfire, which interupt the natural development of the forest community. Provided that species composition and provenances are not affected by the disturbance, the natural development process recommences following disturbance. Some forest types, especially rainforests, only develop to ecological maturity after several hundred years. Frequent disturbance by timber harvesting or wildfire will therefore prevent development to full maturity.

Loss of riparian vegetation, and ecological and scenic values - Mount Emu Creek (Basin 36)

Only a very small proportion of a catchment would ordinarily be affected by timber harvesting in any one year. However, in small headwater catchments, one logging area may represent a significant proportion of the catchment. The hydrological impact is therefore relatively severe, especially where the clearfelling silvicultural system is used.

The Code of Forest Practices for Timber Production (see Chapter 8) contains several requirements intended to lessen hydrological impacts. These include road construction standards, erosion protection measures and retention of stream buffers and steep areas.

River engineering works

These works in general can include de-snagging, widening, deepening, and straightening of stream channels, diversion of flows, and stream bed and bank stabilisation. The purposes are to reduce loss of adjacent land and structures by stream bed and bank erosion, and to facilitate water flow to reduce flooding. Such works may alter channel shape, bed structure, and flow characteristics, decreasing habitat diversity. De-snagging, for example, removes fish cover and reduces spawning sites for some native species. In the last decade revegetation of streams has become a major component of river engineering programs.

Drainage

Wetland drainage, billabong-filling, and by-passing of meanders result in habitat loss, and can lead to dramatic changes in channel form and erosion in adjacent rivers. An obvious loss is waterfowl habitat; however, wetlands are integral parts of a stable river system. Drainage of a morass on the Avon River tributary Freestone Creek contributed to the massive erosion and sedimentation mentioned earlier.

Mining and extractive industries

The impacts on rivers and streams of mining last century were mentioned in Chapter 18. The massive volumes ofmining sludge in rivers at the turn of the century blocked and polluted rivers, exacerbating flooding. The Sludge Abatement Board was established to mitigate these problems.

Enduring ecological changes resulting from that and subsequent mining are evident where mining was most intensive: around Bendigo, Ballarat, St Arnaud, and other western Victorian dissected uplands goldfields; in the Beechworth area, and the Ovens and other river valleys in the north-east; and on various goldfields in the eastern Victorian Uplands. Chapter 18 outlines the impacts of mining in these areas on the rivers.

Chemicals used by mining companies to extract gold from crushed ore were discharged to streams, or have leached from mullock heaps. In these circumstances of pollution and land use changes, catchment, riparian, and in-stream habitats were substantially altered.

Roads

Recognized as among the major contributors to sediment and turbidity in watercourses, roads and tracks can have significant impacts on ecological values. Several variables are involved: road density in an area; design of stream and watercourse crossings; location; the nature of the road surface; discharge points from road drains; and the level of use and extent of maintenance. For example, a road along a watercourse edge has a greater impact on the aquatic environment than one across the catchment. Roading is linked with other uses, as it is required for agricultural and urban development, forestry, mineral exploration, and some recreational activities.

Other activities affecting ecological values

Pollution from insecticides, herbicides, and fertilizers can contaminate water, sediments, and aquatic organisms. Obviously broad-spectrum biocides would have impacts on stream invertebrates and plants, where these chemicals reach stream environs. Fertilizer inputs, particularly to still waters, can stimulate excessive phytoplankton, algae, and macrophyte growth, leading to dissolved-oxygen depletion and in some cases eutrophication, where light and turbidity conditions are not limiting.

Source of siltation - Snowy Creek (Basin 1)

Urbanization is another use with obvious levels of impact on natural habitats. Downstream of urban areas, run-off patterns are modified as a result of extensive hard surfaces, sediment yields initially increase from construction sites and roads (*then may decrease as urbanisation is* established), and water quality deteriorates from the input of industrial and domestic wastes from point and non-point sources.

Impact of land use on cultural heritage values

Catchments and floodplain uses - *particularly those activities involving* clearing, burning, cultivation, or grazing - may affect cultural features in a number of ways. The range of impacts is illustrated by examples involving pre-contact sites. These sites are chosen for their explanatory value and their subtle expression in the landscape, not always being obvious to the novice observer. Nevertheless the potential for damage to post-contact features is equally an issue.

Bank erosion and works may lead to the undercutting of canoe trees, destruction of shell middens through erosion, and disturbance to burial sites. For example, the exposure of burials on the Murray River near Robinvale in the early 1980s was attributed to bank erosion by eddies formed as a result of trees being felled into the river. Artificially high water levels on inland lakes may also result in erosion of heritage sites. At Kow Swamp, for example, high water - combined with the reduction of aquatic vegetation by carp and cattle, which may serve to dampen wave action - has resulted in the *undercutting of former lake edge* sediments and associated oven mounds.

Artificially high sediment loads carried by streams may also result in adverse impacts. Over 130 years ago an extensive system of earthen eel traps was clearly evident at Mt William Swamp. The loss of these traps is attributed to the burial by siltation that *followed the mining of gold in the swamp* catchment.

Recreation may also adversely affect cultural sites, in two ways. First, previous use of a site might have been determined by a number of desirable features, such as protection from the weather, good scenery, or close to a fishing hole. Later generations may similarly seek these values and camp in the same location, unintentionally causing damage to the evidence of the site's prior use. This is a common feature of rivers in the Murray plain.

Second, damage to cultural features may result from places being sought for their curio value. Damage to the integrity of the site may occur through the selective removal of artefacts, and the damage that results from their removal.

Impact of land use on scenic values

Loss of scenic value may occur when elements with high scenic quality are destroyed, when scenic diversity falls or when scenic elements are introduced that are out of context with their surrounds.

In river catchments, extensive land clearing and drainage of wetlands reduces scenic diversity and introduces processes that may lead to erosion, weed infestation, pollution, and littering of waterways. These all change or potentially reduce the scenic value of a catchment.

Maintenance of the scenic quality of a river corridor depends on the retention of a diversity of vegetation, waterform, and small-scale landform features.

The clearing of natural riparian vegetation potentially has a negative impact on scenic quality. In this case trees and shrubs with a diversity in form, structure, and texture may be replaced by grassland to the water's edge. Even the replacement of native vegetation with exotics such as willows may not compensate, due to the uniformity of height and crown characteristics and the narrowness of the vegetation corridor.

River-channel works and sand and gravel extraction may result in the loss of particular waterforms and small-scale landforms. Channels tend to become uniform in cross-section and less sinuous. Irregularities such as small islands, cut-off meanders, and point bars are removed. With the continued loss of these scenic elements, stream channels increasingly take on the visual characteristics of a drain.

Stream-management works may also introduce scenic elements that are out of context. For example, a concrete or rock drop-structure in an area where bed and banks are characterized by silt and sand is clearly out of visual context. Such features may further reduce the scenic value of a stream reach.

Recreation and land use issues

A number of river and catchment activities may have impacts on recreation, and the following activities provide illustrative examples. Clearing and roading of catchments have reduced the options for some recreation activities, particularly those that require unaltered areas or long river segments free from the effects of a modern technological society. These activities need a 'remote' or 'semi-remote' recreation opportunity setting (see Appendix XI). Conversely, the extensive 'roaded natural', 'semi-developed', and 'developed' settings provide suitable areas for those recreation activities requiring them, and meet the needs of different users.

Run-off from agricultural areas or from various other land uses may reduce water quality, making it unfit for drinking or activities involving immersion.

Recreation activities can adversely affect riverine values and conflict can arise between different activities. These impacts can be divided into physical and biological effects and social ones.

Physical and biological impacts

Inappropriate use, or overuse, of particular river areas for camping may lead to soil compaction and trampling of vegetation or its removal for camp fires. This may lead to erosion, especially where river banks are cleared for boat-launching ramps or fossicking, or repeatedly used for vehicle crossings. Bank erosion by the wash from passing boats is also a problem, particularly where channels are confined and banks are steep and lack the protection of energy-absorbing vegetation, such as reeds.

Adverse impacts may also result from hunting or fishing either by the taking of protected or undersize species, or through depletion of stock by over-hunting or fishing. There is also increasing concern over the addition of lead, from shot used in hunting and anglers' sinkers, to aquatic ecosystems.

Water quality may also be affected through the re-suspension of sediment as a result of fossicking, oil and petrol spillage or leakage from power-boats, and the inappropriate disposal of human waste.

Social impacts

Such impacts may arise from mixing of incompatible recreational activities, from

Rubbish, an adverse social impact - Goulburn River (Basin 5)

overcrowding, or from exclusive use of an area by a particular group.

Peace and quiet are requirements of, or enhance, some recreational activities such as relaxing or bird-watching. Other recreational activities - those using engines - produce noise, for example power-boats used for racing or towing water skiers, vehicles with faulty muffler systems, or generators used by car-based campers. The acoustic properties of many valleys and water bodies means that noise may travel considerable distances, particularly at the day's end, and annoy others. Safety issues also arise, particularly where boats and swimmers mix, or where firearms are being used.

Overcrowding may be an increasing source of dissatisfaction, particularly where a sense of isolation or 'getting away from it all' is an important part of the recreational experience.

Access

Competitive activities such as triathlons, rowing, sailing, windsurfing, and power-boat racing require exclusive use of a water body. This ensures that participants are not disadvantaged, as well as the safety of competitors and bystanders. Restrictions on such access usually only apply to part of a water body for a specified period of time, and this is generally accepted by the community.

Access to water bodies and frontages may, however, become an issue where public land adjoins a farm or other landholding, or is used exclusively by a club. It may also be a problem where water bodies have no public frontage or the land tenure of frontage is uncertain. This has particular relevance to anglers and canoeists, especially for waters surrounded by farmland, and is a source of inconvenience to both recreationists and land-owners.

Land use on floodplains

Our perception of flooding as a hazard arises from the community's land use practices along rivers. Floodplains are productive areas for agriculture, so we have cleared and farmed them, presuming 'normal' flows will continue. Towns have been established close to water. When flooding occurs, it disrupts our imposed practices.

Because of the widespread intensive existing uses of floodplains, we are obliged to continue with many uses. Through good planning practice, areas identified as being prone to flooding can be excluded from intensification of use, while appropriate flood-protection measures will continue to be used where necessary.

Gradually communities are recognizing that floods are a natural and necessary part of the function of river systems, that flood control structures in one location can adversely affect other uses, and that informed land use decisions need to be made.

IMPACT OF RIVER REGULATION ON OTHER USES

Fish

The impacts of river and stream regulation on individual fish species and on populations can be substantial. The endangered trout cod, once widespread, owes its decline in part to flow regulation.

Barriers to movement

The migratory behaviour of many Victorian native species makes them very vulnerable to structures that form barriers to movement, such as dams and weirs. A small weir in the lower reaches of a river can totally disrupt the life cycle of a species such as Australian grayling.

Variability of discharge

Coupled with the great variability of Victorian streams are the occurrences of particular high-flow events that appear to act as environmental cues to trigger stages in the life cycles of native fish. For example, rising water levels accompanied by rising water temperatures are important in triggering spawning behaviour in golden perch. Floods also strongly influence the breeding success of Australian bass. Other species such as the Australian grayling require high-flow events to carry larval fish downstream to the estuary. Australian grayling apparently delay spawning during periods of low flow, and flows high enough to disturb bed material may stimulate the hatching of grayling eggs.

River red gum forests

These trees rely on regular flooding, having evolved under a pattern characterized by a regular winter--spring flooding followed by late spring--early summer recession of flood-water. The recession of water in spring provides conditions for prolific seed-set and regeneration. Regulation of the major rivers has altered flood patterns, such that sections of the river red gum forests are now subject to an unnatural flood regime. They are frequently flooded in summer when rivers are maintained at a high level to provide water for irrigation, while the storage of winter and spring flows has reduced the frequency, duration, and extent of normal flooding then.

Flows in the Murray are regulated through releases from Lakes Hume and Dartmouth. Flooding now occurs on the Murray once or more during the summer and autumn. Because of the retention of water by the Eildon Dam, Goulburn Weir, and Waranga Reservoir, flooding now only occurs in the Goulburn River occasionally during very wet seasons. The remaining river with significant river red gum forest, the Ovens, has not been regulated to the same extent as the Murray and Goulburn and flooding patterns have not been substantially altered.

The impacts of the changes in flood regimes in Victoria's major river red gum area - Barmah Forest - include the following.

* Mature trees have died because of the high summer river levels that are maintained for irrigation requirements.
* A blue fungus which restricts sap flow and causes moisture stress has been found in stressed trees in such flooded sites.
* The absence of winter--spring floods has led to more severe outbreaks of a skeletonizer moth that strips the leaves. Moisture-stressed trees are more susceptible to defoliation, which may be fatal.

- Shallow wetlands have been invaded by river red gums, with a consequent loss of the open water and rushland habitat that is important for water-bird breeding.
- Rushlands fail to fill at the appropriate time for water-bird breeding, reducing populations of birds such as ibis. A series of 3 successive dry years is likely to cause the demise of such colonies.
- The conditions required to enable native fish to breed are provided much less frequently.
- The scenic and ecological diversity provided by lakes, billabongs, rushlands, grasslands and box forests, within the stands of river red gum, would consequently be reduced.

Cultural heritage values

Stream-flow regulation may have adverse impacts on cultural features. Flooding by impounded waters may result in the loss of cultural heritage for all time. Internationally a major operation was undertaken to salvage historical features that would have been flooded by the filling of the Aswan Dam on the Nile River. In Tasmania the potential loss of Kutikina Cave, its values, and the information it contained was a consideration in the decision regarding the proposed damming of the Franklin River.

Recreation values

Regulation may have both positive and negative impacts on recreation. For convenience, the impacts of impoundments and in-stream effects are summarised.

Impoundments involve the creation of an expanse of water. These may be large in area, involving the drowning of river valleys, or only involve the construction of low weirs and result in the development of a linear lake confined by the weir and river banks. Benefits may result through the creation of a new recreational resource suitable for activities requiring an expanse of water, such as power-boating, water-skiing, and sailing, and water-enhanced activities such as camping or picnicking. Impoundments may also result in suitable habitat for exotic fish, such as trout and in some instances the enhancement of bird habitat for duck-hunting.

In cases where reservoirs or their catchments are closed to recreation, no such benefits are available from the created resource. Where the reservoir is made available, its value may be reduced as a result of fluctuating water levels. Large draw-downs are most likely in irrigation water storages in summer, the time of peak recreational demand. The exposure of snags and shallow water may make high speed power-boating or water-skiing dangerous. The exposure of muddy

Recreational values lost as a result of river diversion - Goulburn River (Basin 5) lake fringes may also reduce the scenic value of the area.

Reservoirs may also result in the destruction (through flooding) of riverine recreational resources. This is particularly the case when rivers suitable for extended white-water canoe touring or rafting are flooded. Figure 21 illustrates the impact of the Thomson Dam on flows in such a river.

A number of in-stream impacts may result from regulation, depending on whether water is being added to or withdrawn from the river system, and on the timing and declaration of these flow changes.

Reduction in downstream flows may result in the loss of habitat for fish sought by anglers, in reduction in the value of the stream as a canoe resource, and in the exposure of a barren riverbed of little potential for river-enhanced activities. Discharges released from deep in a reservoir may also be much colder than would be seasonally expected, creating a hazard for activities involving immersion.

Drawdown, a reduction in scenic value - Lake Mulwala (Basin 3)

Releases may not be advertised, leading to unpredictable rises and falls in river height. In some instances it may be possible to regulate discharges to a predetermined time-table. This may provide enhanced canoe potential where diversion is not involved, or an amelioration of the impact of reduced flows resulting from diversion.

Scenic values

The impact of impoundments on scenic values depends on their size, and on the scenic elements present in the surrounding area, as determined by the landscape character type and river-setting category (see Chapter 17).

Many towns, such as Benalla, use small impoundments as a scenic focus for the town. The impact of larger impoundments can vary widely, and needs to be assessed on a site by site basis.

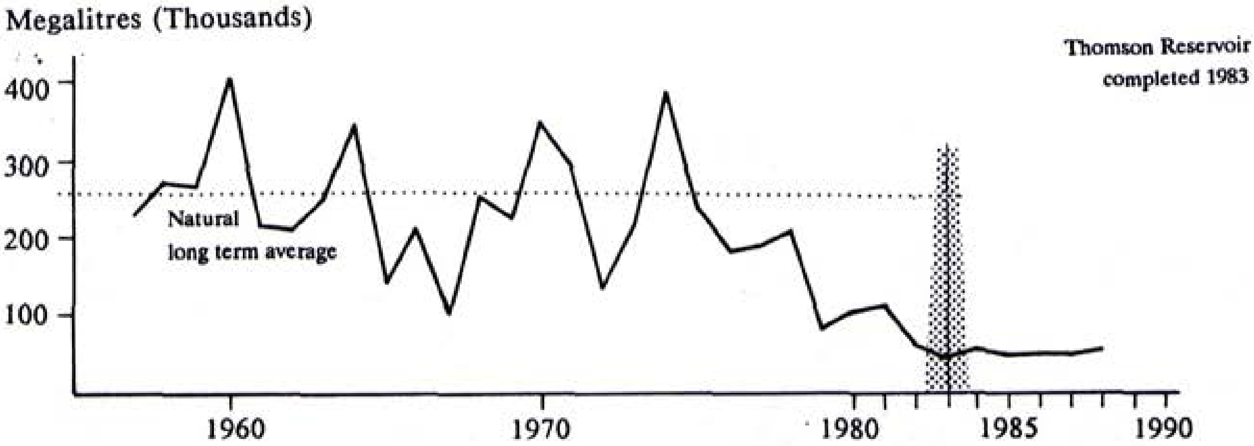
Impoundments introduce two distinct elements into the landscape - the lake itself and the dam-wall area. The lake may replace scenically diverse or outstanding landforms, waterforms, and vegetation with a comparatively uniform waterform - with variation in landform and vegetation truncated at the surface. Lake features likely to reduce scenic quality include groves of dead standing trees, and exposure of eroded and bare banks or mud-flats during drought or draw-down. Nevertheless the scale of the lake may provide a spectacular contrast to the surrounding countryside. Flat water is often seen as a positive scenic element, particularly where it enhances the landscape.

With respect to the dam-wall area, roads, quarries, construction, and maintenance facilities can all have negative impacts on the scenic amenity of a dam site.

INTRODUCED AND PEST SPECIES

The rabbit is probably the best-known of Victoria's non-native wildlife species, but many others are well established throughout the State. Rivers may act as corridors for the spread of introduced species, particularly in areas that are otherwise too dry for their survival. For example, in low-rainfall regions blackberry is confined to moist sites such as creeks and irrigation

FIGURE 21
IMPACT OF REGULATION.
Streamflow below the Thomson Reservoir



Source: Rural Water Commission discharge records

channels. Although some introduced mammals and birds are also associated with wet areas such as rivers and wetlands (for example, wild pigs), only fish are discussed in the following pages.

Noxious weeds

Noxious weeds may occur in both the riparian and aquatic environments. Their establishment along rivers and streams generally results from activities that disturb the stable vegetation or soil surface or reduce ground cover.

The invasion of unwanted plant species along rivers and streams can be accelerated by erosion and deposition of material, clearing of vegetation, cultivation, overgrazing, and works associated with track and road construction and maintenance. All such activities create ideal conditions for weed germination and establishment. The creation of this favourable growing environment is enhanced by a good water supply or available moisture and ready seed spread along the watercourse.

Blackberry is the most widespread noxious weed in Victoria. It was planted along watercourses to prevent erosion and provide berries for human consumption. Its shade tolerance and vigorous growth give blackberry a competitive advantage over the many desirable native or introduced plants equally capable of preventing stream-bank erosion. Its dense prickly thickets also provide habitat for vermin such as rabbits and foxes.

Other noxious weeds colonize where conditions are more environmentally favourable. For example, African feather grass is found along the Glenelg River where soils are sandy; Californian burr, Noogoora burr, and golden dodder grow along the northern river systems.
Control measures used are predominantly spray application of common herbicides. These are applied under conditions that aim at avoiding potentially damaging effects such as stream contamination or erosion of stream banks.

Aquatic weeds such as water hyacinth, salvinia, lagarosiphon, and alligator weed, while not a problem in Victorian rivers, have the potential to become one if not kept in check. Growth that choked the waterways would affect the natural river flow and interfere with boat movement and water supply.

Aquatic weeds have the potential to cause extremely serious problems. For example,

Exotic weeds - Broken River (Basin 4)

a single water hyacinth plant may develop into a mass covering 600 sq.m in the course of one growing season. It was reported in Victoria, but was eradicated. The large number of plants imported for the growing aquarium trade is of concern. Disposal of the remains of failed or unwanted household fish tanks into waterways could lead to the establishment of potentially serious water weeds which could spread from there to other areas.

Introduced fish

The effect of exotic fish species on the indigenous aquatic fauna is difficult to ascertain as their introductions were closely accompanied by other changes to Victorian waters. Comprehensive research to determine the impacts of exotic fish has not been undertaken. However, there are indications that some introductions, such as those of brown and rainbow trout, have had deleterious effects on some native species.

The fragmented distribution of some galaxiid species is thought to be due to the presence of trout. For example, in the Kiewa River galaxiids have been observed to only occupy places inaccessible to trout, such as above waterfalls. Various researchers have since demonstrated the mutually exclusive distributions of trout and mountain galaxias. The relationships with other galaxiid species are much less clear, but some evidence suggests that the distribution of the climbing galaxias has also been affected.

Data are few on the relationships between trout and other native fishes. The freshwater blackfish appears to be able to co-exist with brown trout, although the two species have similar diets, and the short-finned eel also appears able to co-exist. Relationships with native species such as Macquarie perch, Australian grayling, and trout cod are difficult to ascertain because these species are no longer abundant. However, Macquarie perch may not be able to compete successfully with trout for food and the decline in the distribution and abundance of Australian grayling corresponds closely with the introduction of trout. Trout may also have played a key role in the decline in range and abundance of trout cod because of their similarities in diet, habitat requirements, and aspects of their behaviour.

The relationships between other introduced species and the native fauna are less well understood. Some introduced fish such as carp, goldfish, and roach provide a significant food source for some of the larger native species, such as Murray cod and golden perch.

Carp have been reported to modify the environment by their feeding and spawning behaviour, although this has proved difficult to demonstrate. They also appear to have an adverse effect on the distribution and abundance of bony bream. They have been declared a noxious species in Victoria.

It is generally agreed that, because of their predatory nature and high fecundity, English perch (redfin) have had a detrimental effect on native fishes. They complete for habitat and food with Murray cod and golden perch, and appear to have contributed to the decline of Macquarie perch in Lake Eildon and its tributaries.

Smaller native species such as rainbow fish, western carp gudgeon, and pigmy perch may be reduced in abundance as a result of predation by English perch.
The mosquito fish has become the dominant fish species in sections of many Victorian streams and wetland habitats, particularly in urban areas. Its diet includes fish eggs and young fish and it has been declared a noxious species in Victoria.

The black mangrove cichlid and the convict cichlid are unlikely to spread beyond the warm waters of Hazelwood pondage, due to unfavourably cooler temperature regimes. There is potential for the oriental weather loach to spread beyond its present limited distribution.

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PART V

BASIN SUMMARIES

BASIN SUMMARIES

The following tables lists many of the key values for each river basin. The reader is also referred to the 'River Basin Values' Maps which show the location of the high-value features.

North of the Divide: Basins 1-8, 14, 15 - Map 11
South of the Divide - East of Melbourne: Basins 21-29 - Map 12
South of the Divide - West of Melbourne: Basins 30-39 - Map 13

An outline of the symbols and abbreviations used, and layout of the basin data follows.

Discharge characteristics

'Discharge' lists the average annual total surface water discharge from the basin. For many basins stream flow is highly regulated, being either diverted for use within the basin or transferred for consumption in other basins. The 'percent utilized/regulated' is a percentage of the total basin flow.

LANDSCAPE AND RECREATION

All major rivers and streams for each basin are listed. Entries only occur where a high-value features has been identified. Where high-value features occur on a minor tributary stream, (shown indented under the major stream it joins), its values are also listed. It should be noted that not all major streams listed will have high-value features.

Scenic landscapes

The river/landscape setting of each high scenic value reach is listed. The first letters describe the landscape character type. The letter following describes the river-setting category.

Landscape character type	River setting category
MBP - Murray Basin Rivers	N Natural
WP - Western Plains	S Semi-natural
SL - Southern Lowlands	F Farm--forest
WCH - West Central Hills	A Agricultural
FH - Foothills	T Small town--suburban
EH - Eastern Highlands	
G - Grampians	
SU - Southern Uplands	
C - Coastline	

When a basin has more than one high scenic value reach in the same landscape character type, the landscape character type is not repeated. For example, MBP/S,T indicates two reaches both with a Murray Basin Plains landscape character type but one with semi-natural and the other with small town-suburban settling.

Recreation

White-water canoeing - high-value streams are those reaches with white-water rapids graded 2 or higher by the Victorian Amateur Canoe Association. Their presence is shown by 'X'.

Angling - high recreational fishing value streams are those identified by Tunbridge and Glenane, for either exotic fish - 'E' or native fish - 'N'.

Car-based camping - popular camping streams, away from structured campgrounds, are shown by 'X'.

Waterfalls - the approximate locations shown are from several sources, but particularly J. Piesse and P. Larkins.

NATURE CONSERVATION VALUES

High naturalness catchments

Those catchments with 'A' ratings for naturalness (see Chapter 15) are listed and shown on Maps 11, 12, and 13 as solid green areas. A '#' indicates a previously designated high naturalness catchment which has been downgraded as a result of recent inspection. Note - not all catchments listed are shown on the maps.

Native fish rarity or diversity

Those reaches with native fish rarity or diversity values are listed. This information is taken from the Department of Water Resources' Environmental Handbook.

Rarity (R): presence of trout cod, Murray cod, Macquarie perch, golden perch, or Australian grayling.

Diversity (D): presence of at least four native fish species.

Sites of botanical significance

These are listed in Appendix X.

Sites of geological and geomorphological significance

Those features with a significance rated at State level or greater are listed; they are drawn from the references cited in Chapter 15. The feature's location, its level of significance - 'I', 'N' or 'S' (International, National or State respectively) and a description are given.

CULTURAL HERITAGE FEATURES

Aboriginal archaeological sites are shown on Map 16 and Historic Places are listed in Appendix IX.

BASIN 1 : UPPER MURRAY

Area:	10 000 sq km	**Discharge:**	3 920 000 ML[1]
Public land:	69%		
Private land:		Percent utilized/ regulated:	24%[1]
forested	5%		
cleared	26%		

1 - The catchment above Lake Hume lies partly in NSW and Victoria. Natural flows are supplemented by diversions from the headwaters of the Snowy River. The value given describes Victorian inflows and downstream transfers to Victorian basins but does not include substantial transfers to New South Wales and South Australian basins.

Major Storages: Dartmouth Reservoir (4 000 000 ML); Lake Hume (3 040 000 ML)

The basin values summarised below are illustrated on Map 11.

LANDSCAPE AND RECREATION VALUES

Stream name	Scenic landscape	White-water canoeing	Angling[1]	Car-based camping
Big R		X		X
Bundarra R			E	
Cobungra R			E	
Dart R				
Gibbo R		X		
Indi R	EH/N,A	X		X
Mitta Mitta R	EH/F,A	X	N	X
Snowy Ck		X		X
Watchingorra Ck			N	
Victoria R				
Murray R	FH/A,EH/A			
Nariel Ck	EH/A		N	
Cudgewa Ck	EH/A			

1 - Lake Darmouth and Lake Hume have high angling value for exotic fish

NATURE CONSERVATION VALUES

The consultants commented that the Murray River above Tom Groggin, and the Mitta Mitta River and tributaries above Lake Dartmouth, were notable for their general high value.

High naturalness catchments

High naturalness catchment	tributary of:	High naturalness catchment	tributary of:
Upper Cobungra R	Cobungra R	High Plains Ck	Bundarra River
Unnamed	Bundarra River	Unnamed	Middle Ck
Unnamed	Middle Ck	Stony Ck	Morass Ck
Front Ck	Morass Ck	Splitters Ck	Morass Ck
Sassafrass Ck	Gibbo R	Hardies Ck	Gibbo R
Mt Tabor Ck	Mitta Mitta R	Banimboola Ck	Mitta Mitta R
Davies Plain Ck	Buckwong Ck	Serpentine Ck	Indi R
Rough Ck	Indi R	Log Bridge Ck	Cudgewa Ck
Unnamed	Log Bridge Ck		

Native fish rarity or diversity

Stream name	Rarity (R) or Diversity (D)	Stream name	Rarity (R) or Diversity (D)
Lake Hume	R	Murray River (above L. Hume)	R
Mitta Mitta (at Snowy Ck)	R	Lake Dartmouth (3 sites)	R
Livingstone Ck	R	Corryong Ck	R
Cudgewa Ck (2 sites)	R		

Sites of botanical significance (see Appendix X)

Sites of geological and geomorphological significance

No feature of State or greater significance recorded to date.

CULTURAL HERITAGE FEATURES (see Appendix IX and Map 16)

BASIN 2 : KIEWA RIVER

Area:	1990 sq km	**Discharge:**	705 000 ML
Public land:	42%		
Private land:		Percent utilized/ regulated:	14%
forested	33%		
cleared	25%		

Major Storages: Rocky Valley Storage (28 400 ML)

The basin values summarised below are illustrated on Map 11.

LANDSCAPE AND RECREATION VALUES

Stream name	Scenic landscape	White-water canoeing	Angling[1]	Car-based camping
Kiewa R	EH/T[1]	X	E, N	X
East Branch	EH/S			
West Branch	EH/S			
Mountain Ck				X
Murray R	MBP/A			

1 - Mt Beauty

NATURE CONSERVATION VALUES

High naturalness catchments

None identified

Native fish rarity or diversity

Stream name	Rarity (R) or diversity (D)
Kiewa R (above Kiewa)	R

Sites of botanical significance (see Appendix X)

Sites of geological and geomorphological significance

No feature of State or greater significance recorded to date.

CULTURAL HERITAGE FEATURES (see Appendix IX and Map 16)

BASIN 3 : OVENS RIVER

Area:	7 780 sq km	**Discharge:**	1 620 000 ML
Public land:	49%		
Private land:		Percent utilized/ regulated:	21%
forested	3%		
cleared	48%		

Major Storages: Lake Mulwala (118 000 ML); Lake Buffalo (24 000 ML); Lake William Hovell (13 500 ML)

The basin values summarised below are illustrated on Map 11.

LANDSCAPE AND RECREATION VALUES

Stream name	Scenic landscape	White-water canoeing	Angling	Car-based camping
Buckland R		X	E,N	X
Buffalo R	EH/A	X		
Catherine R				
King R	EH/S	X	N	X
Ovens R	MBP/F EH/A,T[1]	X	E,N	
Reedy Ck				X
Rose R		X		X
Murray R	MBP/F,A, T[2]			X

1 - Bright, Wangaratta
2 - Howlong

NATURE CONSERVATION VALUES

High naturalness catchments

High naturalness catchment	tributary of:	High naturalness catchment	tributary of:
Unnamed	Dandongadale R	Catherine R	Buffalo R
Unnamed	Annie R	Yarrarabula Ck	Buffalo R
Buckland R, East Br	Buckland R	Devils Ck	Buckland R
Long Ck	Ovens R, West Br	Washington Ck	Ovens R, East Br

Native fish rarity or diversity

Stream name	Rarity (R) or diversity (D)	Stream name	Rarity (R) or diversity (D)
Ovens R (5 sites below Myrtleford)	R	King R (at Black Range Ck)	R,D
Buffalo R (3 sites)	R	Meadow Ck	R,D
Hodgsons Ck	R		

Sites of botanical significance (see Appendix X)

Sites of geological and geomorphological significance

No feature of State or greater significance recorded to date.

CULTURAL HERITAGE FEATURES (see Appendix IX and Map 16)

BASIN 4 : BROKEN RIVER

Area:	7700 sq km	**Discharge:**	325 000 ML
Public land:	14%		
Private land:		Percent utilized/ regulated:	17%
forested	2%		
cleared	84%		

Major Storages: Lake Nillahcootie (40 000 ML)

The basin values summarised below are illustrated on Map 11.

LANDSCAPE AND RECREATION VALUES

Stream name	Scenic landscape	White-water canoeing	Angling	Car-based camping
Broken R		X		
Samaria Ck				X
Broken Ck				
Murray R	MBP/S,T[1]			X

1 - Cobram, Tocumwal

NATURE CONSERVATION VALUES

The consultants commented that the Barmah Forest was particularly significant for its general high values.

High naturalness catchments

None identified

Native fish rarity or diversity

Stream name	Rarity (R) or diversity (D)	Stream name	Rarity (R) or diversity (D)
Broken R (at Shepparton)	R,D	Broken R (above Shepparton)	R
Broken R (below L. Nillahcootie)	R	Back Ck	R
Holland Ck (2 sites)	R	Ryans Ck (3 sites)	R
Lake Mokoan	R		

Sites of botanical significance (see Appendix X)

Sites of geological and geomorphological significance

No feature of State or greater significance recorded to date.

CULTURAL HERITAGE FEATURES (see Appendix IX and Map 16)

BASIN 5 : GOULBURN RIVER

Area:	16 200 sq km	**Discharge:**	3 040 000 ML
Public land:	30%		
Private land:		Percent utilized/ regulated:	48%
forested	6%		
cleared	64%		

Major Storages: Lake Eildon (3 390 000 ML); Waranga Reservoir (411 000 ML); Goulburn Weir (25 500 ML)

The basin values summarised below are illustrated on Map 11.

LANDSCAPE AND RECREATION VALUES

Stream name	Scenic landscape	White-water canoeing	Angling[2]	Car-based camping
Acheron R		X		
Little R				X
Big R	EH/S	X		X
Delatite R		X		
Goulburn R	MBP/A,FH/A, EH/S,F	X	E	X
King Parrot Ck		X		
Howqua R			E	
Jamieson R	EH/S	X		
Murrindindi R			N	
Torbreck R				
Yea R	FH/A,T[1]	X	N	
Murray R	MBP/S			

1 - Yea
2 - Lake Eildon and Waranga Basin have high angling value for exotic fish

NATURE CONSERVATION VALUES

The consultants commented that the Goulburn River and tributary rivers above Lake Eildon, and the lower reaches of the Goulburn River, were notable for their general high value.

High naturalness catchments

High naturalness catchment	tributary of:	High naturalness catchment	tributary of:
Unnamed	Howqua R	Woods Ck	Big R
Fryer Ck[#]	Big R	Enoch Ck	Big R
Snake Ck[#]	Goulburn R	Moonlight Ck	Gaffneys Ck
Flourbag Ck	Goulburn R	Stony Ck	Goulburn R
Williams Ck	Goulburn R	Black R	Goulburn R
Lazarini Ck[#]	Black R		

Native fish rarity or diversity

Stream name	Rarity (R) or diversity (D)	Stream name	Rarity (R) or diversity (D)
Lower Goulburn R (2 sites)	R	Goulburn R (2 sites below Shepparton)	R,D
Goulburn R (above 7 Cks)	R,D	Goulburn R (below Lake Nagambie)	R
Goulburn R (above Nagambie)	R,D	Goulburn R (above Seymour)	R
King Parrot Ck	R	Yea R	R
Acheron R	R	Delatite R	R
Hughes Ck (2 sites)	R	Lower Seven Cks	R
Seven Cks (above Honeysuckle Ck)	R,D	Seven Cks (below Euroa)	R
Seven Cks (below Strathbogie Ranges)	D	Seven Cks (steep section)	R,D
Seven Cks (near Strathbogie)	R		

Sites of botanical significance (see Appendix X)

Sites of geological and geomorphological significance

Howqua River - N: Devonian fish fossils.

CULTURAL HERITAGE FEATURES (see Appendix IX and Map 16)

BASIN 6 : CAMPASPE RIVER

Area:	4180 sq km	**Discharge:**	280 000 ML
Public land:	8%		
Private land:		Percent utilized/ regulated:	39%
forested	4%		
cleared	88%		

Major Storages: Lake Eppalock Reservoir (312 000 ML); Upper Coliban Reservoir (31 500 ML); Lauriston Reservoir (19 800 ML); Malmsbury (17 800 ML)

The basin values summarised below are illustrated on Map 11.

LANDSCAPE AND RECREATION VALUES

Stream name	Scenic landscape	White-water canoeing	Angling[2]	Car-based camping
Campaspe R	FH/A, WCH/A	X		
Coliban R		X		
Murray R	MBP/T[1]			X

1 - Echuca
2 - Malmsbury and Lauriston Reservoirs have high angling value for exotic fish.

NATURE CONSERVATION VALUES

High naturalness catchments

None identified

Native fish rarity or diversity

Stream name	Rarity (R) or diversity (D)
Campaspe R (2 sites below Rochester)	R

Sites of botanical significance (see Appendix X)

Sites of geological and geomorphological significance

Barfold Gorge - N: Newer Volcanic sequences

CULTURAL HERITAGE FEATURES (see Appendix IX and Map 16)

BASIN 7 : LODDON RIVER

Area:	15 300 sq km	**Discharge:**	250 000 ML
Public land:	12%		
Private land:		**Percent utilized/ regulated:**	52%
forested	2%		
cleared	86%		

Major Storages: Cairn Curran (149 000 ML); Tullaroop Reservoir (74 000 ML); Kow Swamp (51 000 ML); Laanecoorie Reservoir (7700 ML)

The basin values summarised below are illustrated on Map 11.

LANDSCAPE AND RECREATION VALUES

Stream name	Scenic landscape	White-water canoeing	Angling[3]	Car-based camping
Loddon R	MBP/A,T[1] WCH/A	X	E,N	
Bullock Ck	WCH/A			
Tullaroop Ck	WCH/A			
Creswick Ck	WCH/T[2]			
Jim Crow Ck		X	E	
Murray R	MBP/S,A			X

1 - Kerang
2 - Clunes
3 - Cairn Curran, Laanecoorie and Tullaroop Reservoirs have high angling value for exotic fish

NATURE CONSERVATION VALUES

The consultants commented that the Gunbower Forest on the Murray River was notable for its general high value.

High naturalness catchments

None identified

Native fish rarity or diversity

Stream name	Rarity (R) or diversity (D)	Stream name	Rarity (R) or diversity (D)
Little Murray R	R	Loddon R (2 sites)	R
Lake Cairn Curran	R	Wandella Ck (2 sites)	R
Pyramid Ck	R	Kow Swamp	R,D
Gunbower Ck	R		

Sites of botanical significance (see Appendix X)

Sites of geological and geomorphological significance

Kow Swamp - I: Lunettes and Pleistocene occupation.
Kerang Lakes - N: Lunette and lake complex

CULTURAL HERITAGE FEATURES (see Appendix IX and Map 16)

BASIN 8 : AVOCA RIVER

Area:	12 400 sq km	**Discharge:**	85 000 ML
Public land:	4%		
Private land:		Percent utilized/ regulated:	3%
forested	8%		
cleared	88%		

Major Storages: Lead Dam; Bealiba Storage; Redbank Storage; Sugarloaf Reservoir

The basin values summarised below are illustrated on Map 11.

LANDSCAPE AND RECREATION VALUES

Stream name	Scenic landscape	White-water canoeing	Angling	Car-based camping
Avoca R	WCH/A			
Mountain Ck				X
No 2 Ck				X
Murray R				

NATURE CONSERVATION VALUES

High naturalness catchments

None identified

Native fish rarity or diversity

Stream name	Rarity (R) or diversity (D)
Avoca R (2 sites)	R

Sites of botanical significance (see Appendix X)

Sites of geological and geomorphological significance

Lake Tyrell - N: Large salt lake - transverse dunes, Pleistocene occupation.

CULTURAL HERITAGE FEATURES (see Appendix IX and Map 16)

BASIN 14 : MALLEE

Area:	28 000 sq km	**Discharge:**	Nil
Public land:	44%		
Private land:		Percent utilized/ regulated:	-
forested	1%		
cleared	55%		

Major Storages: Nil

The basin values summarised below are illustrated on Map 11.

LANDSCAPE AND RECREATION VALUES

Stream name	Scenic landscape	White-water canoeing	Angling camping	Car-based
Murray R	MBP/S,F,A,T[1]			X
Wallpolla Ck			E, N	
Lindsay R			E, N	
Hattah Lakes				X

1 - Mildura

NATURE CONSERVATION VALUES

The consultants commented that the Hattah Lakes system, and the Murray River downstream from Wentworth were notable for their general high value.

High naturalness catchments

None identified

Native fish rarity or diversity

None identified

Sites of botanical significance (see Appendix X)

Sites of geological and geomorphological significance

Hattah Lakes System - N: Anabranches, lakes, and associated channels.

CULTURAL HERITAGE FEATURES (see Appendix IX and Map 16)

BASIN 15 : WIMMERA

Area:	24 000 sq km	**Discharge:**	210 000 ML
Public land:	11%		
Private land:		Percent utilized/ regulated:	40%
forested	1%		
cleared	88%		

Major Storages: Lake Bellfield (78 500 ML); Lake Lonsdale (65 500 ML); Pine Lake (64 000 ML); Taylor Lake (37 000 ML); Lake Fyans (21 000 ML); Wartook Reservoir (29 400 ML);

The basin values summarised below are illustrated on Map 11.

LANDSCAPE AND RECREATION VALUES

Stream name	*Scenic landscape*	*White-water canoeing*	*Angling*	*Car-based camping*
Avon R				
Mackenzie R	GR/S			
Richardson R				
Wimmera R	MBP/S			
Fyans Ck	GR/S			
Golton Ck	GR/S			
Mt William Ck	GR/S			
Lake Lonsdale				X
Lake Hindmarsh			E	X
Lake Albacutya				X
Yarriambiack Ck	MBP/T[1]			
Pine Lake			E	

1 - Warracknabeal

NATURE CONSERVATION VALUE

As an entire system the Wimmera River is of interest to fluvial geomorphologists, comment Kunert and Macmillan (1988). The terminal lake group - Hindmarsh, Outlet Creek and Albacutya - has high conservation values.

High naturalness catchments

None identified

Native fish rarity or diversity

Stream name	Rarity (R) or diversity (D)	Stream name	Rarity (R) or diversity (D)
Wimmera R (4 sites below Horsham)	R	Dock Lake	R
Taylor Lake	R	Richardson R	R

Sites of botanical significance (see Appendix X)

Sites of geological and geomorphological significance

Lake Hindmarsh - S: Dune and lake system.

CULTURAL HERITAGE FEATURES (see Appendix IX and Map 16)

BASIN 21 : EAST GIPPSLAND

Area:	4570 sq km	**Discharge:**	770 000 ML
Public land:	95%		
Private land:		**Percent utilized/ regulated:**	< 1%
forested	3%		
cleared	2%		

Major Storages: Nil

The basin values summarised below are illustrated on Map 12.

LANDSCAPE AND RECREATION VALUES

Stream name	Scenic landscape	White-water canoeing	Angling	Car-based camping
Arte R				
Bemm R				
Benedore R				
Betka R				
Cann R	FH/F,A,T[1]			X[3]
East Branch		X		
Combienbar R				
Errinundra R				
Ada R				X
Genoa R	FH/N,S,F; SL/S,A; C/T[2]	X		
Goolengook R				
McKenzie R				
Mueller R				
Red R				
Thurra R	C/N			
Wallagaraugh R				X[3]
Wingan R	FH/S,SL/S, C/S			X[3]
Yerung R				

1 - Cann River
2 - Mallacoota
3 - Most camping occurs in the estuary tracts

NATURE CONSERVATION VALUES

High naturalness catchments

High naturalness catchment	tributary of:	High naturalness catchment	tributary of:
Upper Goolengook R	Bemm R	Red R	(Bass Strait)
Errinundra R (East Br)	Bemm R	Benedore R	(Bass Strait)
Back Ck	Cann R	Shipwreck Ck	(Bass Strait)
Beehive Ck	Cann R	Unnamed	Betka R
Winnot Ck	Cann R	Double Ck	(Mallacoota In)
Thurra R (West Br)	Thurra R	Genoa Ck	Genoa R
Unnamed	Thurra R	Unnamed	Genoa R
Lake Elusive	—	Murmuring Ck	Genoa R
Soda Ck	Wingan R	Blackjack Ck	Genoa R
Coolwater Ck	Wingan R	Lake Barracouta	—
Little R	(Bass Strait)	Lake Wau Wauka	—

Native fish rarity or diversity

Stream name	Rarity (R) or diversity (D)	Stream name	Rarity (R) or diversity (D)
Yeerung R	D	Lower Bemm R	D
Bemm R (2 sites)	R	Little R	D
Lower Cann R	D	Cann R	R
Lower Thurra R	R,D	Mueller R	D
Wingan Inlet	D	Wingan R	R,D
Upper Wingan R	D	Little R	D
Red R	D	Benedore R	D
Shipwreck R	D	Betka R	D
Genoa R	D	Wallagaraugh R	D
Mallacoota Inlet	D		

Sites of botanical significance (see Appendix X)

Sites of geological and geomorphological significance

Genoa River Gorge - I: Devonian Genoa River beds - tetrapod trackway.
Dock Inlet - S: Classic example of a freshwater lagoon.
Lake Barracoota - S: Coastal wetland and freshwater lake.
Lake Elusive - S: Deep, dune blocked, freshwater lake.
Sydenham Inlet - S: Estuarine lagoon and extensive swamp land.
Tamboon Inlet - S: Largest relatively unmodified estuary in East Gippsland.
Thurra River and Point Hicks - S: Pleistocene and Holocene dunes over bedrock.
Wingan Inlet - S: Classical estuary.

CULTURAL HERITAGE FEATURES (see Appendix IX and Map 16)

BASIN 22 : SNOWY RIVER

Area:	6470 sq km	**Discharge:**	2 490 000 ML
Public land:	83%		
Private land:		**Percent utilized/ regulated:**	45%
forested	6%		
cleared	11%		

The Snowy River headwaters lie in NSW, and major diversions of water occur in this section. The values given are for the whole basin.

Major Storages: No storages in the Victorian section of the Basin.

The basin values summarised below are illustrated on Map 12.

LANDSCAPE AND RECREATION VALUES

Stream name	Scenic landscape	White-water canoeing	Angling	Car-based camping
Bendock R				
Big R				
Bonang R				
Brodribb R				
Lilly Pilly Ck				X
Buchan R	EH/N	X		
Deddick R		X		
Delegate R				
Hartland R				
Ingeegoodbee R				
Little R				X
Little Yalmy R				
Murrindal R				
Queensborough R			N	
Rich R				
Rocky R				
Rodger R	EH/N			
Snowy R	EH/N, F; FH/N	X		X
Suggan Buggan R				
Yalmy R				

NATURE CONSERVATION VALUES

High naturalness catchments

High naturalness catchment	tributary of:	High naturalness catchment	tributary of:
Hospital Ck	Hospital Ck	Simpson Ck	Simpson Ck
Reedy Ck	Buchan R	Rough Ck	Buchan R
Native Cat Ck	Buchan R	Buchan R	Buchan R
Unnamed	Buchan R	Unnamed	Buchan R
Wibenduck Ck	Snowy R	Unnamed	Snowy R
Loongelaat Ck (S Br)	Snowy R	Loongelaat Ck (N Br)	Snowy R
Upper Raymond Ck	Snowy R	Creamy Ck	Raymond Ck
Cavender Ck	Yalmy R	Serpentine Ck#	Yalmy R
Musk Ck	Yalmy R	Unnamed	Rodger R
Unnamed	Rodger R	Unnamed	Rodger R
Cattle Ck	Rodger R	Upper Rodger R	Rodger R
Mountain Ck	Snowy R	New Country Ck	Mountain Ck
Unnamed	Mountain Ck	Little R	Snowy R
World End Ck	Suggan Buggan R	Buchan Ck	Suggan Buggan R
Bridle Ck#	Suggan Buggan R	Yellow Waterhole Ck#	Suggan Buggan R
Rocky Plains Ck	Suggan Buggan R	Freestone Ck	Suggan Buggan R
Moscow Ck	Suggan Buggan R	Upper Suggan Buggan R	Suggan Buggan R
Ingeegoodbee R	Suggan Buggan R	Jamb Ck	Snowy R
Gattamurh Ck	Snowy R	Menaak Ck	Snowy R
Tomcat Ck	Snowy R	Sandy Ck#	Snowy R
Unnamed Ck	Snowy R	Unnamed Ck	Snowy R
Wallaby Ck	Deddick R	Running Ck	Deddick R
Unnamed	Deddick R	Minchin Ck	Deddick R
Home Ck	Deddick R	Swamp Ck	Deddick R
Bonang R (N Br)	Deddick R	Riddle Ck	Brodribb R
Stony Ck	Brodribb R	Upper Brodribb R	Brodribb R
Nelson Ck	Delegate R	Ellery Ck	Brodribb R
Craigie Bog Ck	Delegate R	Queensborough R	Delegate R

Native fish rarity or diversity

Stream name	Rarity (R) or diversity (D)	Stream name	Rarity (R) or diversity (D)
Buchan R, Murrindal R at junction	R	Lower Snowy R	D
Snowy R at Deddick R	R	Suggan Buggan R	R
Brodribb R	R		

Sites of botanical significance (see Appendix X)

Sites of geological and geomorphological significance

Buchan caves - N: Best cave system in Victoria.

Little River and Boundary Creek gorges - N: Rugged area with exposure of Snowy River volcanics.

New Guinea, Snowy River Gorge - N: Snowy River volcanics and Buchan Limestone outcrops - limestone caves - bat habitat - Pliestocene occupation.

Scrubby Creek area - N: Limestone karst.
The Pyramids area - N: Underground stream drainage and active, decorated cave system.
Tulloch Ard Gorge - N: Gorge through Snowy River Volcanics
Reedy Creek Chasm - S: Diverse range of geological and geomorphological features, unusual vegetation pattern.
Snowy River floodplain - S: Well developed crevasse features.
Tara Creek - S: Best exposed thrust fault in Victoria.
Upper Buchan River - S: Ordovician and Silurian sediments.

CULTURAL HERITAGE FEATURES (see Appendix IX and Map 16)

BASIN 23 : TAMBO RIVER

Area:	4170 sq km	**Discharge:**	325 000 ML
Public land:	73%		
Private land:		Percent utilized/ regulated:	< 1%
forested	6%		
cleared	20%		

Major Storages: Nil

The basin values summarised below are illustrated on Map 12.

LANDSCAPE AND RECREATION VALUES

Stream name	Scenic landscape	White-water canoeing	Angling	Car-based camping
Nicholson R	FH/S, F			X
Tambo R		X		X
Haunted Stream				X
Timbarra R		X	E	X

NATURE CONSERVATION VALUES

High naturalness catchments

High naturalness catchment	tributary of:	High naturalness catchment	tributary of:
Store Ck	Nicholson R	Unnamed	Tambo R
Running Ck	Tambo R	Unnamed	Tambo R
Garron Ck	Tambo R (Sth Br)	Scrubby Ck	Tambo R
Unnamed	Upper Tambo R	Duggan Ck	Upper Tambo R
Unnamed	Upper Tambo R	Mt Elizabeth Ck	Timbarra R
Cutts Ck	Timbarra R	Gap Ck	Timbarra R

Native fish rarity or diversity

Stream name	Rarity (R) or diversity (D)	Stream name	Rarity (R) or diversity (D)
Lower Nicholson R	D	Lower Tambo R	D
Tambo R (Bruthen)	R	Tambo R (Timbarra Jn.)	R
Tambo R (above Timbarra R)	R	Haunted Stream (at Tambo R)	R,D
Haunted Stream (above Tambo R)	R	Boggy R	D

Sites of botanical significance (see Appendix X)

Sites of geological and geomorphological significance

No feature of State or greater significance recorded to date

CULTURAL HERITAGE FEATURES (see Appendix IX and Map 16)

BASIN 24 : MITCHELL RIVER

Area:	5450 sq km	**Discharge:**	960 000 ML
Public land:	73%		
Private land:		**Percent utilized/ regulated:**	< 1%
forested	4%		
cleared	23%		

Major Storages: Nil

The basin values summarised below are illustrated on Map 12.

LANDSCAPE AND RECREATION VALUES

Stream name	Scenic landscape	White-water canoeing	Angling	Car-based camping
Crooked R				X
Dargo R	EH/N,S,F	X		X
Dry R				
Humffray R				
Mitchell R		X		X
Moroka R				
Wentworth R		X		
Wongungarra R				
Wonnangatta R	EH/F	X	N	X

NATURE CONSERVATION VALUES

High naturalness catchments

High naturalness catchment	tributary of:	High naturalness catchment	tributary of:
Unnamed	Wonnangatta R	Black Snake Ck#	Wonnangatta R
Pinnacle Ck, East Br.	Wonnangatta R	Unnamed	Wonnangatta R
Moroka R#	Wonnangatta R	Surveyors Ck#	Carey Ck
Playboy Ck	Moroka R	Unnamed	Moroka R
Unnamed	Wonnangatta R	Conglomerate Ck	Wonnangatta R
Unnamed#	Humffray R	Unnamed	Humffray R
Upper Wongungarra R	Wonnangatta R	Unnamed	Upper Wongungarra R
Blue Rag Ck	Upper Wongungarra R	Two Mile Ck#	Dargo R
Unnamed	Dargo R	Speedwell Ck	Dargo R
Dargo R (headwaters)#	Dargo R	Punchen Ck	Wentworth R
Teapot Ck	Wentworth R	Unnamed#	Wentworth R

Native fish rarity or diversity

Stream name	Rarity (R) or diversity (D)	Stream name	Rarity (R) or diversity (D)
Mitchell R (below Bairnsdale)	D	Mitchell R, Wentworth R at junction	R
Dargo R	R	Wonnangatta R (2 sites)	R,D

Sites of botanical significance (see Appendix X)

Sites of geological and geomorphological significance

Mitchell River Delta - I: Classic form of a digitate delta.
Mitchell River Valley, Lindenow to Bairnsdale - S: Miocene-Pliocene sediments.
Mitchell River Gorge - S: Rugged gorge - sediments of the Upper Avon River Group.
Moroka Gorge - S: High cliffs with exposures of Upper Devonian-Lower Carboniferous sediments.

CULTURAL HERITAGE FEATURES (see Appendix IX and Map 16)

BASIN 25 : THOMSON RIVER

Area:	5970 sq km	**Discharge:**	1 220 000 ML
Public land:	70%		
Private land:		Percent utilized/ regulated:	25%
forested	5%		
cleared	25%		

Major Storages: Thomson Dam (1 130 000 ML); Lake Glenmaggie (190 000 ML)

The basin values summarised below are illustrated on Map 12.

LANDSCAPE AND RECREATION VALUES

Stream name	Scenic landscape	White-water canoeing	Angling	Car-based camping
Aberfeldy R		X		X
Avon R	FH/N	X		X
Freestone Ck		X		X
Valencia Ck		X		X
Barkly R		X	N	X
Caledonia R				
Carey R				
Jordan R				X
Macalister R	EH/S; SL/A, T[1]	X	E	X
Perry R				
Thomson R	FH/S	X		X
Stringer Ck				X
Wellington R		X		X

1 - Maffra, Sale

NATURE CONSERVATION VALUES

High naturalness catchments

High naturalness catchment	tributary of	High naturalness catchment	tributary of:
Matlock Ck	Thomson R	Whitelaw Ck, West Br#	Thomson R
Bell Clear Ck#	Thomson R	Little Boy Ck#	Thomson R
Unnamed	Glenmaggie Ck	Glenmaggie Ck, East Br	Glenmaggie Ck
Glenmaggie Ck West Br	Glenmaggie Ck	Stony Ck	Macalister R
Hickey Ck	Macalister R	Mount Useful Ck#	Macalister R
Serpentine Ck#	Macalister R	Unnamed	Serpentine Ck
Stony Ck	Macalister R	Grimme Ck	Macalister R
Breakfast Ck	Wellington R	Thiele Ck	Dolodrook R
Upper Dolodrook R	Wellington R	Unnamed	Avon R
Ben Cruachan Ck	Avon R	Stockyard Ck	Ben Cruachan Ck
Unnamed	Ben Cruachan Ck	Unnamed	Avon R
McColl Ck	Avon R	Upper Avon R	Avon R
Mt Hump Ck	Avon R	Valencia Ck#	Avon R
Turton R	Avon R	Unnamed	Valencia Ck
New Place Ck#	Valencia Ck		

Native fish rarity or diversity

Stream name	Rarity (R) or diversity (D)	Stream name	Rarity (R) or diversity (D)
Rainbow Ck (Thomson R)	R,D	Avon R (at Stratford)	R
Valencia Ck	D		

Sites of botanical significance (see Appendix X)

Sites of geological and geomorphological significance

Lake Tali Karng - N: Highland lake formed by a landslide.
Dolodrook-Wellington Rivers - S: Fossil-rich Cambrian and Ordovician sediments.
Latrobe River Delta - S: Delta formation determined by reed swamp.

CULTURAL HERITAGE FEATURES (see Appendix IX and Map 16)

BASIN 26 : LATROBE RIVER

Area:	5210 sq km	**Discharge:**	980 000 ML
Public land:	34%		
Private land:		Percent utilized/ regulated:	9%
forested	11%		
cleared	55%		

Major Storages: Blue Rock (200 000 ML); Moondarra Reservoir (34 000 ML); Hazelwood Pondage (31 000 ML); Lake Narracan (80 000 ML);

The basin values summarised below are illustrated on Map 12.

LANDSCAPE AND RECREATION VALUES

Stream name	Scenic landscape	White-water canoeing	Angling	Car-based camping
Ada R				
Latrobe R	SL/A	X		X
Toorongo R				X
Moe R				
Morwell R				X
East Branch			N	
West Branch			N	
Little Morwell R				X
Tanjil R	FH/S	X		
Tyers R				X

NATURE CONSERVATION VALUES

High naturalness catchments

High naturalness catchment	tributary of:	High naturalness catchment	tributary of:
Morwell R, East Br	Morwell R	Red Hill Ck	Moe R
Tyers R, West Br	Tyers R	Unnamed	Latrobe R
Ada R	Latrobe R	Unnamed	Ada R

Native fish rarity or diversity

Stream name	Rarity (R) or diversity (D)	Stream name	Rarity (R) or diversity (D)
Latrobe R (below Morwell R)	R	Tararalgon Ck	D
Morwell R	D		

Sites of botanical significance (see Appendix X)

Sites of geological and geomorphological significance

Eaglehawk Creek - S: Stratigraphic and palaeontologic features in Mesozoic sediments.
Eaglehawk Creek Gully and 'Delta' - S: Recent changes in stream channel morphology.
Rintoul Creek - S: Cretaceous fossil flora.
Traralgon Creek - S: Lower Cretaceous fossil beds.
Tyers River - S: Only outcrop of the Coopers Creek Limestone.
Tyers River Gorge - S: Distinctive gorge and Lower Devonian and Cretaceous sediments.

CULTURAL HERITAGE FEATURES (see Appendix IX and Map 16)

BASIN 27 : SOUTH GIPPSLAND

Area:	6780 sq km	**Discharge:**	700 000 ML
Public land:	19%		
Private land:		Percent utilized/ regulated:	1%
forested	5%		
cleared	76%		

Storages: Candowie Reservoir (2270 ML); Lance Creek Reservoir (1900 ML)

The basin values summarised below are illustrated on Map 12.

LANDSCAPE AND RECREATION VALUES

Stream name	Scenic landscape	White-water canoeing	Angling	Car-based camping
Agnes R				
Albert R				X
Bass R				
Barry Ck	C/N			
Bruthen Ck	SL/F,C/S			
Franklin R	SU/F,A; C/A			
Jack R				X
Merriman Ck	SL/F,C/T[1]			
Powlett R				
Tarra R	C/A			X
Tarwin R		X	N[2]	X
East Branch				X
West Branch		X	N	
Tidal R				

1 - Seaspray
2 - Wilkur, Ruby and Coalition Creeks

NATURE CONSERVATION VALUES

High naturalness catchments

High naturalness catchment	drains to:	High naturalness catchment	drains to:
Barry Ck	Corner Inlet	Lilly Pilly Ck	Sealers Cove
Unnamed	Darby River		

Native fish rarity or diversity

Stream name	Rarity (R) or diversity (D)	Stream name	Rarity (R) or diversity (D)
Lower Tarwin R	D	Tarwin R, West Br	R,D
Tarwin R, East Br	D	Deep Ck	R,D
Agnes R	R,D	Darby R	D
Tidal R	D	Roaring Meg Ck	R
Albert R	R,D	Jack R	D
Lower Tarra R	D	Upper Tarra R	R,D
Merriman Ck	R,D		

Sites of botanical significance (see Appendix X)

Sites of geological and geomorphological significance

Bass River Delta and Floodplain - N: Complex delta.
Agnes River and Falls - S: A major relief feature with exposures of Mesozoic sediments.
Bodman Creek Gully - S: Haunted Hills Gravels.
Merriman Creek - Callignee South - S: Outcrops of Mesozoic sediments.
Tarra Valley National Park - S: Small catchment suitable for benchmark hydrological studies.

CULTURAL HERITAGE FEATURES (see Appendix IX and Map 16)

BASIN 28 : BUNYIP RIVER

Area:	3890 sq km	**Discharge:**	355 000 ML
Public land:	11%		
Private land:		Percent utilized/ regulated:	8%
forested	4%		
cleared	85%		

Major Storages: Cardinia Reservoir (287 000 ML); Tarago Reservoir (37 600 ML); Devilbend Reservoir (14 600 ML)

The basin values summarised below are illustrated on Map 12.

LANDSCAPE AND RECREATION VALUES

Stream name	Scenic landscape	White-water canoeing	Angling	Car-based camping
Bunyip R			N	
Diamond Ck			N	
Lang Lang R			N	
Paterson R				
Tarago R			E,N	
Labertouche Ck			N	

NATURE CONSERVATION VALUES

High naturalness catchments

Several second-order tributaries, and the Bunyip River mainstream, have been identified as being highly natural in the area upstream of the Bunyip Weir (above Diamond Creek).

Native fish rarity or diversity

Stream name	Rarity (R) or diversity (D)	Stream name	Rarity (R) or diversity (D)
Unnamed Ck near Cape Schank	D	Cardinia Ck (2 sites)	D
Cardinia Ck (lower site)	R	Lang Lang R (2 sites)	R,D
Bunyip R	R,D	Tarago R	D

Sites of botanical significance (see Appendix X)

Sites of geological and geomorphological significance

Lang Lang River incision at Heath Hill - N: Rapid geomorphic adjustments.
Yallock Creek - N: Remnant of a once extensive swamp landscape.
Bunyip River Bridge - S: River channel changes since European settlement.
East Creek Dry Valley - S: Features related to coastal development at different sea levels.
Hamilton Creek - S: Underground stream in granite.
Lang Lang River at Athlone - S: Headwater development.

CULTURAL HERITAGE FEATURES (see Appendix IX and Map 16)

BASIN 29 : YARRA RIVER

Area:	*4100 sq km*	**Discharge:**	*1 100 000 ML*
Public land:	33%		
Private land:		Percent utilized/ regulated:	25%
forested	6%		
cleared	61%		

Major Storages: Upper Yarra (200 000 ML); Silvan Reservoir (40 000 ML); Sugarloaf Reservoir (95 000 ML); Yan Yean Reservoir (30 000 ML); Maroondah Reservoir (22 000 ML); O'Shannassy Reservoir (4000 ML);

The basin values summarised below are illustrated on Map 12.

LANDSCAPE AND RECREATION VALUES

Stream name	Scenic landscape	White-water canoeing	Angling	Car-based camping
Little Yarra R			E	
Plenty R	FH/A			
Watts R				
Yarra R	FH/F, EH/T[1]	X	E, N	

1 - Yarra Junction

NATURE CONSERVATION VALUES

The consultants commented that the Upper Yarra River was notable for its general high value.

High naturalness catchments

High naturalness catchment	tributary of:	High naturalness catchment	tributary of:
O'Shannassy R	Yarra R	Smiths Ck	O'Shannassy R

Native fish rarity or diversity

Stream name	Rarity (R) or diversity (D)	Stream name	Rarity (R) or diversity (D)
Yarra R (below Watts R)	R,D	Badger Ck	D
Yan Yean Res.	R		

Sites of botanical significance (see Appendix X)

Sites of geological and geomorphological significance

Crooked Creek - S: River valley development.
Watsons Creek - S: Abandoned high level meander of the Yarra River.

CULTURAL HERITAGE FEATURES (see Appendix IX and Map 16)

BASIN 30 : MARIBYRNONG RIVER

Area:	1420 sq km	**Discharge:**	120 000 ML
Public land:	6%		
Private land:		Percent utilized/ regulated:	3%
forested	8%		
cleared	86%		

Major Storages: Rosslynne Reservoir (24 500 ML)

The basin values summarised below are illustrated on Map 13.

LANDSCAPE AND RECREATION VALUES

Stream name	Scenic landscape	White-water canoeing	Angling	Car-based camping
Maribyrnong R		X	E	
Emu Ck			E	
Deep Ck				
Jackson Ck	WP/A[1]		E	

1 - Deep Creek is the reach of the Maribyrnong above the Jackson Creek confluence.

NATURE CONSERVATION VALUES

High naturalness catchments

None identified

Native fish rarity or diversity

None identified

Sites of botanical significance (see Appendix X)

Sites of geological and geomorphological significance

Maribyrnong River - Dry Creek confluence - N: Valley evolution processes - mega fauna and Pleistocene occupation.
Taylors Creek - N: Silcrete cave.
Emu Creek - S: Distinct valley landscape.
Organ Pipes National Park - S: Silurian sediments and Newer Volcanics - valley incision processes.

CULTURAL HERITAGE FEATURES (see Appendix IX and Map 16)

BASIN 31 : WERRIBEE RIVER

Area:	1970 sq km	**Discharge:**	95 000 ML
Public land:	23%		
Private land:		Percent utilized/ regulated:	30%
forested	5%		
cleared	72%		

Major Storages: Pykes Creek (24 000 ML); Lake Merrimu (35 000 ML); Melton Reservoir (17 000 ML)

The basin values summarised below are illustrated on Map 13.

LANDSCAPE AND RECREATION VALUES

Stream name	Scenic landscape	White-water canoeing	Angling	Car-based camping
Lerderderg R	FH/N,S,T;[1] WP/A	X		N
Werribee R	FH/S,WP/A, WCH/T[2]			
Pyrites Ck	FH/S			
Kororoit Ck		X		

1 - Blackwood
2 - Ballan

NATURE CONSERVATION VALUES

High naturalness catchments

None identified

Native fish rarity or diversity

Stream name	Rarity (R) or diversity (D)
Lower Werribee R	D

Sites of botanical significance (see Appendix X)

Sites of geological and geomorphological significance

Korkuperrimul Creek - I: Permian glacials
Lerderderg River, Morven - I: Permian glacials
Lerderderg River, Darley - N: Permian glacials
Toolern Creek - N: Pillow lavas
Werribee Gorge - N: Deep gorge exposing a long and complex geological record.
Cataract Creek - S: Waterfalls, relief inversion and exposure of the Bullengarook lava flow.
Korjamunip Creek (Pykes Ck Reservoir) - S: Permian glacials
Lerderderg Gorge - S: Stream rejuvenation following faulting, extensive section of Lower Ordovician sediments.
Parwan Valley - S: Active landslide site, scarp retreat.
Werribee River - Myrniong Creek junction, The Island - S: Permian sediments and palaeotopography.
Werribee River Delta - S: Late Quaternary stratigraphy
Yaloak Creek - S: Extensive landslip sequence.

CULTURAL HERITAGE FEATURES (see Appendix IX and Map 16)

BASIN 32 : MOORABOOL RIVER

Area:	2170 sq km	**Discharge:**	115 000 ML
Public land:	10%		
Private land:		Percent utilized/ regulated:	16%
forested	3%		
cleared	87%		

Major Storages: Lal Lal Reservoir (59 500 ML); Bostock Reservoir (7450 ML); Moorabool Reservoir (6700 ML)

The basin values summarised below are illustrated on Map 13.

LANDSCAPE AND RECREATION VALUES

Stream name	Scenic landscape	White-water canoeing	Angling	Car-based camping
Little R				
Moorabool R	WP/F, A			
East Branch	WCH/S, F			
West Branch	WCH/S			

NATURE CONSERVATION VALUES

High naturalness catchments

None identified

Native fish rarity or diversity

Stream name	Rarity (R) or diversity (D)	Stream name	Rarity (R) or diversity (D)
Lower Moorabool R (at Geelong)	R	Moorabool R (2 sites)	D

Sites of botanical significance (see Appendix X)

Sites of geological and geomorphological significance

Hovells Creek - S: Holocene coastal development
Hovells Creek (Lara) - S: Pleistocene macro-fossils
Hovells Creek Estuary (Limeburners Bay) - S: Classical estuary
Moorabool River (Batesford) - S: Tertiary stratigraphy
Moorabool River (Viaduct crossing) - S: Type locality - Moorabool Viaduct Sand

CULTURAL HERITAGE FEATURES (see Appendix IX and Map 16)

BASIN 33 : BARWON RIVER

Area:	3880 sq km	**Discharge:**	300 000 ML
Public land:	10%		
Private land:		Percent utilized/ regulated:	9%
forested	3%		
cleared	87%		

Major Storages: West Barwon Reservoir (21 700 ML); Wurdee Boluc Reservoir (19 100 ML); White Swan Reservoir (14 100 ML)

The basin values summarised below are illustrated on Map 13.

LANDSCAPE AND RECREATION VALUES

Stream name	Scenic landscape	White-water canoeing	Angling	Car-based camping
Barwon R	WP/A	X	N	
Yarrowee R (Leigh R)	WP/A, T[1]			

1 - Inverleigh

NATURE CONSERVATION VALUES

High naturalness catchments

None identified

Native fish rarity or diversity

Stream name	Rarity (R) or diversity (D)	Stream name	Rarity (R) or diversity (D)
Barwon R (above Geelong)	R,D	Barwon R (Lake Connewarre)	D

Sites of botanical significance (see Appendix X)

Sites of geological and geomorphological signficance

Lake Elizabeth - N: Landslide lake on the Barwon River, East Branch

CULTURAL HERITAGE FEATURES (see Appendix IX and Map 16)

BASIN 34 : LAKE CORANGAMITE

Area:	4190 sq km	**Discharge:**	160 000 ML
Public land:	4%		
Private land:		Percent utilized/ regulated:	< 1%
forested	3%		
cleared	93%		

Major Storages: No major storages within the basin. Water supplies are dependent mainly on the import of surface water and the extraction of groundwater.

The basin values summarised below are illustrated on Map 13.

LANDSCAPE AND RECREATION VALUES

Stream name	Scenic landscape	White-water canoeing	Angling[1]	Car-based camping
Woady Yaloak R	WCH/A			X
Lake Colac			E	

1 - Lake Tooliorook has high angling value for exotic fish

NATURE CONSERVATION VALUES

The Woady Yaloak River is the best example of a lowland (volcanic plains) stream in the South-West Region, according to Macmillan, Kunert and Blakers (1987).

High naturalness catchments

None identified

Native fish rarity or diversity

None identified

Sites of botanical significance (see Appendix X)

Sites of geological and geomorphological significance

Smythes Creek Gorge - S: Basalt flows

CULTURAL HERITAGE FEATURES (see Appendix IX and Map 16)

BASIN 35 : OTWAY COAST

Area:	3900 sq km	**Discharge:**	765 000 ML
Public land:	35%		
Private land:		Percent utilized/ *regulated:*	2%
forested	7%		
cleared	58%		

Major Storages: No major storages.

The basin values summarised below are illustrated on Map 13.

LANDSCAPE AND RECREATION VALUES

Stream name	Scenic landscape	White-water canoeing	Angling	Car-based camping
Aire R	SU/S, A			
Anglesea R				
Barham R				
East Branch	SU/A			
Calder R				
Cumberland R	SU/N			
Curdies R				
Lake Purrumbete			E	
Erskine R	SU/N			
Ford R				
Gellibrand R	SU/F, A		N	
Kennett R				
Parker R				
St George R				
Wye R				

NATURE CONSERVATION VALUES

The Otways rivers appear to be biogeographically significant, comment Macmillan, Kunert and Blakers (1987). The Aire River is the least-modified of the larger rivers in the South-West Region, and contains the tributaries Redwater and Clearwater Creeks - two chemically distinct streams on similar geological material.

High naturalness catchments

One second-order stream has been identified as being highly natural in this basin.

Native fish rarity or diversity

Stream name	Rarity (R) or diversity (D)	Stream name	Rarity (R) or diversity (D)
Curdies R (3 sites)	D	Lake Purrumbete	D
Lower Gellibrand R	D	Ford R	D
Parker R	D	Lower Barham R	D
Barham R (East Br)	R,D	Wild Dog Ck	D
Smythes Ck	R,D	Carisbrook R	R,D
Kennett R	R,D	Wye R	R,D
Cumberland R	R,D	Erskine R	R,D
Painkalac Ck	D	Anglesea R	D
Thompson Ck	D		

Sites of botanical significance (see Appendix X)

Sites of geological and geomorphological significance

Aire River - S: Landslip lake.
Aire River - S: Structurally controlled meander.
Aire River Gorge - S: Rugged gorge, structurally controlled watercourse.
Barham River lagoon - S: Largest abandoned tidal meanders in Western Victoria.
Carisbrook Falls - S: Long and high rapid and casade section, structural controls evident.
Carlisle River, headwaters - S: High rainfall, forested, benchmark-catchments.
Chapple Creek - S: Biostratigraphic feature - Otway Group sediments.
Elliot River - S: Stream mouth accordance.
Gellibrand River - S: Fluvial landforms and sediments.
Gellibrand River - S: Physiographic effects of recent fault movement on river evolution.

CULTURAL HERITAGE FEATURES (see Appendix IX and Map 16)

BASIN 36 : HOPKINS RIVER

Area:	9680 sq km	**Discharge:**	400 000 ML
Public land:	2%		
Private land:		Percent utilized/ regulated:	2%
forested	1%		
cleared	97%		

Major Storages: No major storages.

The basin values summarised below are illustrated on Map 13.

LANDSCAPE AND RECREATION VALUES

Stream name	Scenic landscape	White-water canoeing	Angling	Car-based camping
Hopkins R	WP/A, WCH/A	X		
Merri R			E	
Mount Emu Ck	WP/A, WCH/A			

NATURE CONSERVATION VALUES

High naturalness catchments

None identified

Native fish rarity or diversity

Stream name	Rarity (R) or diversity (D)	Stream name	Rarity (R) or diversity (D)
Lower Merri R (2 sites)	D	Lower Hopkins R	D
Hopkins R (above Mt Emu Ck)	R,D	Mt Emu Ck (2 sites)	D

Sites of botanical significance (see Appendix X)

Sites of geological and geomorphological significance

No features of State or greater significance recorded to date

CULTURAL HERITAGE FEATURES (see Appendix IX and Map 16)

BASIN 37 : PORTLAND COAST

Area:	4000 sq km	**Discharge:**	245 000 ML
Public land:	14%		
Private land:		**Percent utilized/ regulated:**	< 1%
forested	3%		
cleared	83%		

Major Storages: Nil

The basin values summarised below are illustrated on Map 13.

LANDSCAPE AND RECREATION VALUES

Stream name	Scenic landscape	White-water canoeing	Angling	Car-based camping
Eumeralla R				
Fitzroy R				
Darlot Ck	WP/F, T[1]		N	
Moyne R	C/T[2]			
Shaw R				
Surrey R				

1 - Port Fairy
2 - Tyrendarra

NATURE CONSERVATION VALUES

High naturalness catchments

None identified

Native fish rarity or diversity

Stream name	Rarity (R) or diversity (D)
Lower Fitzroy R	D

Sites of botanical significance (see Appendix X)

Sites of geological and geomorphological significance

Fitzroy River - N: Long, continuous, parallel ridges on the lava surface.
Condah Swamp, Cloverdale - S: Tumuli (low, cone-shaped mounds on a lava flow surface produced by squeezing up of the liquid lava).
Condah Swamp, Wallacedale - S: Impact of lava flows on stream drainage.
Darlot River Crossover - S: Drainage adjustment to the emplacement of a lava flow.
Swan Lake and Johnstone Creek - S: Dune blocked valley lake.

CULTURAL HERITAGE FEATURES (see Appendix IX and Map 16)

BASIN 38 : GLENELG RIVER

Area:	12 700 sq km	**Discharge:**	725 000 ML
Public land:	26%		
Private land:		Percent utilized/ regulated:	11%
forested	3%		
cleared	71%		

Major Storages: Rocklands Reservoir (348 000 ML); Moora Moora Reservoir (6300 ML)

The basin values summarised below are illustrated on Map 13.

LANDSCAPE AND RECREATION VALUES

Stream name	Scenic landscape	White-water canoeing	Angling[3]	Car-based[3] camping
Chetwynd R				
Crawford R				
Glenelg R	GR/N, GR/A, WP/T, C/S, T[1]		E	X
Stokes R				
Wando R				
Wannon R	GR/S, WP/A	X		X
Grange Burn	WP/T[2]	X		
Dwyer Ck	GR/A			

1 - Nelson
2 - Hamilton
3 - Rocklands Reservoir has high values for exotic fish angling and car-based camping.

NATURE CONSERVATION VALUES

The consultants commented that the Glenelg River Gorge and Lower Glenelg areas were notable for their general high value.

High naturalness catchments (none identified)

Native fish rarity or diversity

Stream name	Rarity (R) or diversity (D)	Stream name	Rarity (R) or diversity (D)
Lower Glenelg R	D	Glenelg R (3 sites above Casterton)	D
Wannon R (near Coleraine)	D	Wannon R (above Wannon)	R

Sites of botanical significance (see Appendix X)

Sites of geological and geomorphological significance

Wannon Falls - I: Vivianite occurrence
Grange Burn and Muddy Creek - N: Late Tertiary exposures
Crawford River - S: River capture of the Crawford River by a tributary of the Glenelg River.
Lower Glenelg karst area - S: Large karst area.

CULTURAL HERITAGE FEATURES (see Appendix IX and Map 16)

BASIN 39 : MILLICENT COAST

Area:	9580 sq km	**Discharge:**	4000 ML
Public land:	28%		
Private land:		**Percent utilized/ regulated:**	9%
forested	1%		
cleared	71%		

Major Storages: Nil

The basin values summarised below are illustrated on Map 13.

LANDSCAPE AND RECREATION VALUES

Stream name	Scenic landscape	White-water canoeing	Angling	Car-based camping
Mosquito Creek				

NATURE CONSERVATION VALUES

High naturalness catchments

None identified

Native fish rarity or diversity

None identified

Sites of botanical significance (see Appendix X)

Sites of geological and geomorphological significance

No features of State or greater significance recorded to date.

CULTURAL HERITAGE FEATURES (see Appendix IX and Map 16)

APPENDICES

Appendix I

VICTORIA'S RIVERS AND STREAMS

Stream name	Grid No.	Tributary of:	Basin
A (ST ARNAUD)	F07	WATTLE CK	15
A1	E10	LIMESTONE CK	36
A10 (BEAUFORT)	E08	FIERY CK	36
A106	K10	BEAR CK	26
A107	K10	HAZEL CK	26
A11 (BEAUFORT)	E08	FIERY CK	36
A110	M09	MACALISTER R	25
A112	M10	THOMSON R	25
A113	M09	THOMSON R	25
A116	L09	JORDAN R	25
A119	L09	ABERFELDY R	25
A12 (MORTLAKE)	E10	BLIND CK	36
A120	M09	GLENMAGGIE CK	25
A121	M09	GLENMAGGIE CK	25
A123	M09	SERPENTINE CK	25
A124	M09	SERPENTINE CK	25
A125	M08	CALEDONIA R	25
A127	M09	AVON R	25
A129	M09	BEN CRUACHAN CK	25
A13 (BALLARAT)	G09	BAILLIE CK	36
A130	M09	BEN CRUACHAN CK	25
A131	M09	AVON R	25
A132	M09	VALENCIA CK	25
A132	M09	AVON R	25
A133	M08	DRY CK	24
A134	M08	RILEY CK	24
A135	M08	HUMFFRAY R	24
A136	M08	HUMFFRAY R	24
A137	M08	HUMFFRAY R	24
A138	M08	HUMFFRAY R	24
A139	M08	HUMFFRAY R	24
A14 (SKIPTON)	F09	BAILLIE CK	36
A140	M08	WONNANGATTA R	24
A141	M08	CAREY CK	24
A142	M08	MOROKA R	24
A146	M08	MT SELWYN CK	24
A148	N08	MT SELWYN CK	24
A149	N08	BLUE RAG CK	24
A15	F10	MOUNT EMU CK	36
A150	N08	WONGUNGARRA R	24
A152	N08	DARGO R	24
A153	N08	DARGO R	24
A154	N08	TWO MILE CK	24
A157	N08	WENTWORTH R	24
A158	N08	WENTWORTH R	24
A159	N08	WILD HORSE CK	24
A16	E10	MOUNT EMU CK	36
A163	O09	CLIFTON CK	24
A166	O07	TAMBO R	23
A167	O07	TAMBO R	23
A168	O07	TAMBO R	23
A169	O07	A168	23
A17	E10	MOUNT EMU CK	36
A170	O07	TAMBO R	23
A171	O08	TAMBO R	23
A174	O08	TAMBO R	23
A176	O09	TIMBARRA R	23
A177	O09	TAMBO R	23
A178	O09	TAMBO R	23
A179	O09	TAMBO R	23
A181	O09	MUNDIE CK	23
A184	P07	SNOWY R	22
A184	P07	BUCHAN R	22
A185	P07	BUCHAN R	22
A189	P07	LITTLE R	22
A19	E10	BLIND CK	36
A190	P07	LITTLE R	22
A191	P07	MOSCOW CK	22
A193	P07	MOSCOW CK	22
A198	P07	GATTAMURH CK	22
A199	P07	GATTAMURH CK	22
A20	E10	HOPKINS R	36
A200	P08	SNOWY R	22
A201	P08	SNOWY R	22
A206	Q08	DELLICKNORA CK	22
A209	Q08	DELLICKNORA CK	22
A211	P08	SNOWY R	22
A212	P08	SNOWY R	22
A213	P08	MOUNTAIN CK	22
A215	P08	RODGER R	22
A216	P08	RODGER R	22
A218	Q08	YALMY R	22
A219	Q09	LAKE CURLIP	22
A22	E10	STONY CK	36
A220	Q08	BRODRIBB R, NTH BR	22
A221	Q08	BRODRIBB R, STH BR	22
A222	Q09	A223	22
A223	Q09	RICH R	22
A225	Q09	JACK R	22
A226	Q09	CABBAGE TREE CK	22
A227	Q09	YEERUNG R	22
A228	Q09	YEERUNG R	22
A23 DRAIN	E10	HOPKINS R	36
A230	Q08	HENSLEIGH CK	21
A231	R08	COMBIENBAR R	21
A232	R08	COMBIENBAR R	21
A235	Q09	PADDY CK	21
A237	Q09	BEMM R	21
A238	R09	LITTLE R	21
A239	Q08	DELEGATE R	21
A24 DRAIN	E10	HOPKINS R	36
A240	Q08	A239	21
A241	Q08	BOG CK	21
A242	Q08	BOG CK	21
A244	Q08	DELEGATE R	21
A249	R08	TONGHI CK	21
A25 (CORANGAMITE)	F09	LAKE LITTLE CORANGAMITE	34
A250	R09	TONGHI CK	21
A251	R09	TONGHI CK	21
A252	R09	TONGHI CK	21
A253	R09	REEDY CK	21
A254	R09	REEDY CK	21
A255	R09	REEDY CK	21
A257	R08	TENNYSON CK	21
A258	R08	LOCK UP CK	21
A260	R08	A263	21
A261	R08	A263	21
A262	R08	A263	21
A263	R08	THURRA R	21
A266	R09	DRUMMER CK	21
A267	R09	THURRA R	21
A268	R09	THURRA R	21
A269	R09	THURRA R	21
A270	R09	THURRA R	21
A271	R09	THURRA R	21
A272	R09	THURRA R	21
A273	R09	MUELLER R	21
A274	R09	MUELLER R	21
A275	R09	WINGAN R	21
A276	R09	WINGAN R	21
A277	R09	WINGAN R	21
A278	R09	SODA CK	21
A279	R09	SURPRISE CK	21
A28 (CORANGAMITE)	F10	LAKE CORANGAMITE	34
A280	S09	HARD TO SEEK CK	21
A284	S09	SHIPWRECK CK	21
A285	S09	BETKA R	21
A286	S09	BETKA R	21
A287	S09	BETKA R	21
A288	S09	TASMAN SEA	21
A289	S09	TASMAN SEA	21
A290	R08	GENOA R	21
A292	R08	GENOA R	21
A293	R08	GENOA R	21
A294	R08	GENOA R	21
A295	S08	BIG FLAT CK	21
A296	S08	GENOA CK	21
A298	S08	GENOA R	21
A299	S08	SANDY WATERHOLE CK	21
A3	E08	HOPKINS R	36
A30	F10	CURDIES R	35
A300	S08	MARAMINGO CK	21
A303	S08		21
A304	S08		21
A31	F10	CURDIES R	35
A32	F10	CURDIES R	35
A33	F10	CURDIES R	35
A35 (MORTLAKE)	E10	CURDIES R	35
A39	F11	COORIEMUNGLE CK	35
A4	E08	HOPKINS R	36
A40	F10	ROSS CK	35
A42	F11		35
A43	F11		35

Appendix I (continued)

Stream name	Grid No.	Tributary of:	Basin
A44	F10		35
A45	F10		35
A46	G10	BARWON R	33
A5	F08	HOPKINS R	36
A53	F10	SPRING VALLEY CK	34
A57	F11	SANDY CK	35
A6	E08	HOPKINS R	36
A60	F11	LATROBE CK	35
A61	F11	A60	35
A62	F11	A60	35
A7 (WILLAURA)	E09	HOPKINS R	36
A72	H09	MOORABOOL R	32
A73	H10	HOVELL CK	32
A75	H09	LITTLE R	32
A76	J10	A77	28
A77	J10	PATTERSON R	28
A79	L11		27
A8 (WILLAURA)	E09	HOPKINS R	36
A80	L11	TARWIN R, EAST BR	27
A81	L11	TARWIN R, EAST BR	27
A82	L10	BERRYS CK	27
A83	K10	TARWIN R, WEST BR	27
A84	L11	DEEP CK	27
A85	L11	FRANKLIN R	27
A86	M11	BODMAN CK	27
A87	M11	CORNER INLET	27
A88	M11	BRUTHEN CK	27
A9 (WILLAURA)	E09	BRUSHY CK	36
A90	K10	LANG LANG R	28
A91	K10	LANG LANG R	28
A93	L10	MORWELL R, WEST BR	26
A94	L10	MORWELL R	26
A95	L10	MORWELL R	26
A96	M10	TRARALGON CK	26
A98	L09	TANJIL R, EAST BR	26
ABERFELDY R	L09	THOMSON R	25
ACCOMMODATION CK	P08	DEDDICK R	22
ACHERON R	K08	GOULBURN R	5
ADA R	Q08	ERRINUNDRA R	21
ADA R	K09	LATROBE R	26
AGNES CK	L11	AGNES R	27
AGNES R	L11	CORNER INLET	27
AIRE R	F11	LAKE HORDERN	35
ALDERMAN CK	K09	YARRA RIVER	29
ALLAN CK	R09	SCUDDER CK	21
ALLSOP CK	K10	BASS R	27
AMBER CK	L11	FISH CK	27
ANDERSON CK	E07	WALLALOO CK	15
ANDERSON CK	L10	LA TROBE R	26
ANDERSON CK	H10	GRASS CK	35
ANDREWS CK	K08	LITTLE R	5
ANGLESEA R	H10	BASS STRAIT	35
ANNIE R	M07	BUFFALO R	3
ARARAT CK	K10	TYNONG DRAIN	28
ARCHIES CK	K11	POWLETT R	27
ARMSTRONG CK	K09	YARRA R	29
ARNOLD CK	L09	BIG R	5
ARRANDOOVONG CK	C09	DARLOT CK	37
ARTE R	Q09	GOOLENGOOK CK	21
ARTHUR CK	L08	TAPONGA CK	5
ARTHURS CK	J09	DIAMOND CK	29
ATKIN CK	G10	BARWON R	33
AULT BEAG CK	K08	MURRINDINDI R	5
AVOCA R	G05	KERANG LAKES	8
AVON CK	F07	AVON R	15
AVON RIVER	E07	RICHARDSON R	15
AXE CK	I07	CAMPASPE R	6
B (RUPANYAP)	E07	STATION CK	15
B.A. CK	Q08	BRODRIBB R	22
BACK CK	N07	LITTLE SNOWY R	1
BACK CK	L07	BROKEN R	4
BACK CK	I08	PRICE CK	5
BACK CK	I07	MAJOR CK	5
BACK CK	I08	PLOWMAN CK	6
BACK CK	G08	TULLAROOP CK	7
BACK CK	R08	QUEENSBOROUGH R	21
BACK CK	R08	CANN R	21
BACK CK	O08	TAMBO R	23
BACK CK	K09	BUNYIP R	28
BACK CK	E09	HOPKINS R	36
BACK CK	D10	MOYNE R	37
BACK CK	C09	WANNON R	38
BACK R	O08	TIMBARRA R	23
BADDAGINNIE CK	K07	BROKEN R	4
BAKER CK	L08	DELATITE R	5
BAKER CK		YARRA R	29
BAKER CK, EAST BR	N08	BLACK SNAKE CK	24
BALACLAVA CK	K08	MURRINDINDI R	5
BALCOMBE CK	I10	PORT PHILLIP BAY	28

Stream name	Grid No.	Tributary of:	Basin
BALD HILLS CK	O08	TAMBO R	23
BALDY CK	L08	DELATITE R	5
BALLIANG CK	H09	LITTLE R	32
BANANGAL CK	C09	DUNDAS R	38
BANIMBOOLA CK	N06	MITTA MITTA R	1
BARBER CK	J09	PLENTY R	29
BARHAM R EAST BR	G11	BARHAM R	35
BARHAM R WEST BR	G11	BARHAM R	35
BARK HUT CK	M09	GLENMAGGIE CK, W BR	25
BARKERS CK		LODDON R	7
BARKLY R	M09	MACALISTER R	25
BARKLY R WEST BR	L08	BARKLY R	25
BARMOUTH CK	O08	NICHOLSON R	23
BARONGAROOK CK	G09	LAKE COLAC	34
BARONGAROOK CK W BR	G09	BARONGAROOK CK	33
BARRY CK	L11	CORNER INLET	27
BARWIDGEE CK	M07	OVENS R	3
BARWON R	G11	BASS STRAIT	33
BARWON R WEST BR	G11	BARWON R	33
BASIN CK	P08	SNOWY R	22
BASS R	K10	WESTERN PORT	27
BAY CK	N07	KIEWA R	2
BAYLISS GULLY CK	M10	MERRIMAN CK	27
BEAR CK	K10	MOE R	26
BEECH CK	K08	MURRINDINDI R	5
BEECH CK	N08	WENTWORTH R	24
BEEHIVE CK	R08	CANN R, EAST BR	21
BELLBIRD CK	Q09	BEMM R	21
BELLBIRD CK	O09	TAMBO R	23
BEN CRUACHAN CK	M09	STOCKYARD CK	25
BEN CRUACHAN CK	M09	MACALISTER R	25
BENAMBRA CK	O07	MORASS CK	1
BENDIGO CK		PICANINNY CK	7
BENDOC R	Q08	SNOWY R	21
BENEDORE R	S09	TASMAN SEA	21
BENNETS CK	L10	LATROBE R	26
BENNISON CK	L11	BASS STRAIT	27
BERREN CK	P08	DEDDICK R	22
BET BET CK	G07	LODDON R	7
BETE BOLONG CK	P09	SNOWY R	22
BETHANGA CK	N06	LAKE HUME	1
BETKA R	S09	TASMAN SEA	21
BEYNON CK	L09	TYERS R, WEST BR	26
BIDWELL CK	Q08	DELEGATE R	21
BIG FLAT CK	S08	GENOA R	21
BIG MURRUM-BIDGEE CK	Q08	DEDDICK R	22
BIG PATS CK	K09	YARRA R	29
BIG R	O07	MITTA MITTA R	1
BIG R	Q08	BRODRIBB R	22
BIG R	L08	LAKE EILDON	5
BIG RUNNING CK	N08	WONGUNGARRA R	24
BILL CK	P09	HOSPITAL CK	22
BILLY CK	L10	MIDDLE CK	26
BILLY CK	M11	ALBERT R	27
BINDI CK	O08	TAMBO R	23
BINGO MUNJIE CK	O07	MITTA MITTA R	1
BIRCH CK	G08	TULLAROOP CK	7
BLACK DOG CK	L06	OVENS R	3
BLACK FELLOWS CK	P08	BUCHAN R	22
BLACK FELLOWS CK	M09	MACALISTER R	25
BLACK GLEN CK	F10	SCOTTS CK	35
BLACK JACK GULLY CK	R08	GENOA R	21
BLACK RANGE CK	L07	KING R	3
BLACK R	L09	U.GOULBURN R	5
BLACK SAND CK	K09	LITTLE YARRA R	29
BLACK SNAKE CK	R08	THURRA R	21
BLACK SNAKE CK	O08	NICHOLSON R	23
BLACK SNAKE CK	N08	WONNANGATTA R	24
BLACK WATCH CK	Q09	GOOLENGOOK CK	21
BLACKWALL WEST CK	L09	ABERFELDY R	25
BLACKWOOD CK	D10	MOYNE R	37
BLANKET CK	N07	OVENS R, EAST BR	3
BLIND CK	K07	BROKEN R	4
BLIND CK	I07	MOUNT PLEASANT CK	6
BLIND CK	E10	MOUNT EMU CK	36
BLIND CK (EXT)	E10	BLIND CK	36
BLIND JOE CK	M10	LATROBE R	26
BLUE GUM CK	K08	CORDUROY CK	5
BLUE JACKET CK	L09	THOMSON R	25
BLUE RAG CK	N08	WONGUNGARRA R	24
BLUE RANGE CK	L07	BROKEN R	4
BLUEY CK	O08	TAMBO R	23
BODMAN CK	M11	TARRA R	27
BOG CK	Q08	DELEGATE R	21
BOG CK	R08	BENDOC R	21
BOGGY CK	L07	KING R	3

Appendix I (continued)

Stream name	Grid No.	Tributary of:	Basin
BOGGY CK	D08	MCKENZIE R	15
BOGGY CK	M10	THOMSON R	25
BOGGY CK	F11	GELLIBRAND R	35
BOGONG CK	N07	KIEWA R	2
BOLINDA CK	I08	EMU CK	30
BONANZA GULLY	Q08	DELLICKNORA CK	22
BOONAWAH CK	D09	LAKE LINLITHGOW	38
BOOSEY CK	K06	BROKEN CK	4
BOSTOCK CK	F10	CURDIES R	35
BOUGHYARD CK	L06	BOOSEY CK	4
BOULDER CK	Q09	BEMM R	21
BOUNDARY CK	*J07*	*HUGHES CK*	*5*
BOUNDARY CK	G10	BARWON R	33
BOX CK	H05	PYRAMID CK	7
BOYD CK	O06	NARIEL CK	1
BOYD CK	L08	BIG R	5
BOYD CK	I09	DEEP CK	30
BRADFORD CK	G07	LODDON R	7
BRANCH CK	D08	DWYER CK	38
BRANDY CK	M07	BUFFALO R	3
BRANKEET CK	K08	LAKE EILDON	5
BREAKFAST CK	M09	MACALISTER R	25
BREAKFAST CK	D10	EUMERALLA R	37
BRENANAH CK	G07	FENTONS CK	8
BRIDGE CK	L07	BROKEN R	4
BRIDGE CK	K11	POWLETT R	27
BRIDLE CK	P07	SUGGAN BUGGAN R	22
BRIGGS CK	D07	WIMMERA R	15
BRIM CK	*E07*	*WIMMERA R*	*15*
BRITANNIA CK	K09	LITTLE YARRA R	29
BRODRIBB R	Q09	LAKE CORRINGLE	22
BRODRIBB R, NTH BR	Q08	BRODRIBB R	22
BRODRIBB R, STH BR	*Q08*	*BRODRIBB R*	*22*
BROKEN CK	F09	MOUNT EMU CK	36
BROKEN CK	I05	MURRAY R	4
BROKEN RIVER	J06	GOULBURN R	4
BROKIL CK	I10	PORT PHILLIP BAY	28
BROOK CK	C08	MATHER CK	38
BROTHER CK	M11	BRUTHEN CK	27
BROWN CK	O07	DART R	1
BRUCES CK	J09	YARRA R	29
BRUCKNELL CK	E10	HOPKINS R	36
BRUSHY CK	E09	HOPKINS R	36
BRUTHEN CK	M11	BASS STRAIT	27
BRYAN CK	C09	WANNON R	38
BUCHAN CK	P08	SUGGAN BUGGAN R	22
BUCHAN R	P09	SNOWY R	22
BUCHEEN CK	N06	TALLANGATTA CK	1
BUCKEYE CK	M07	MORSES CK	3
BUCKLAND CK	J07	HUGHES CK	5
BUCKLAND R	M07	OVENS R	3
BUCKLAND R, E BR	M07	BUCKLAND R	3
BUCKLAND R, W BR	M07	BUCKLAND R	3
BUCKWONG CK	*P07*	*MURRAY R*	*1*
BUDWUID CK	N09	DARGO R	24
BUENBA CK	O07	GIBBO R	1
BUFFALO CK	M07	OVENS R	3
BUFFALO R	M07	OVENS R	3
BUFFALO R, E BR	M07	BUFFALO R	3
BUFFALO R, W BR	M07	BUFFALO R	3
BULDAH CK	R08	CANN R	21
BULGABACK CK	N09	WONNAGATTA R	24
BULL SWAMP CK	K10	MOE R	26
BULLABUL CK	G07	LODDON R	7
BULLER CK	L08	JAMIESON R	5
BULLEY CK	P07	MURRAY R	1
BULLHEAD CK	N06	MITTA MITTA R	1
BULLOCK CK	H05	LODDON R	7
BULLOCK CK	H05	PYRAMID CK	7
BULLOCKY CK	O06	THOWGLA CK	1
BUNDARRA R	N07	MITTA MITTA R	1
BUNGAL CK	H09	MOORABOOL R, E BR	32
BUNGEET CK	L06	BOOSEY CK	4
BUNROY CK	P06	MURRAY R	1
BUNYIP R	*K10*	*WESTERN PORT*	*28*
BURBIBYONG CK		THOWGLA CK	1
BURCHETT CK	E09	MUSTON CK	36
BURGOIGEE CK	M07	OVENS R	3
BURKE CK	I07	FOREST CK	6
BURN BANK CK	G08	BET BET CK	7
BURNETT CK	N09	MERRIJIG CK	24
BURNT CK		LAKE EILDON	5
BURNT CK	G07	BET BET CK	7
BURNT CK	D07	WIMMERA R	15
BURNT HUT CK	D08	DWYER CK	38
BURROWYE CK	O05	MURRAY R	1
BURRUMBEET CK	G09	LAKE BURRUMBEET	36
BUTCHER CK	O08	LIVINGSTONE CK	1
BUTCHERS CK	P08	MURRINDAL R	22
BUTTERCUP CK	L08	BAKER CK	5
BYE CK	M06	BLACK DOG CK	3
C	E07	SHEEPWASH CK	15
CAIRNS CK	B08	CHETWYND R	38
CALDER R	F11	LAKE HORDERN	35
CALEDONIA R E BR	M08	MACALISTER R	25
CALLAHANS CK	G10	BARWON R, EAST BR	33
CAMERON CK	J08	KURKURUC CK	5
CAMERON CK	K08	TAGGERTY R	5
CAMP CK	M07	BUFFALO R	3
CAMP CK	R09	MUELLER R	21
CAMP CK	*Q09*	*BRODRIBB R*	*22*
CAMP CK	L09	TANJIL R, EAST BR	26
CAMP CK	F11	GELLIBRAND R	35
CAMPASPE R	I06	MURRAY R	6
CAMPASPE R	I06	MURRAY R	6
CAMPBELL CK	F07	AVOCA R	8
CAMPBELL CK	P08	BUCHAN R	22
CAMPBELLS CK		BARKERS CK	7
CANN R	R09	TAMBOON INLET	21
CANN R, EAST BR	R08	CANN R	21
CANN R, NORTH BR	R08	CANN R, EAST BR	21
CANN SWAMP CK	R08	LOCK UP CK	21
CARAPOOEE CK	F07	CAMPBELL CK	8
CAREY CK	M08	MOROKA R	24
CAREY R	M09	WELLINGTON R	25
CARGERIE CK	F10	CURDIES R	35
CARMANUEL CK	G07	BET BET CK	7
CARTER CK	*Q08*	*DEDDICK R*	*22*
CARTERS CK	M09	NEWRY CK	25
CASCADE CK	L09	THOMSON R	25
CASEY CK	O09	STONY CK	23
CASTLE CK	*J07*	*GOULBURN R*	*5*
CASTLE CK	D08	U.GLENELG R	38
CASTLEBURN CK	N09	WONNANGATTA R	24
CATHERINE R	M07	BUFFALO R	3
CATTLE CK	Q08	RODGER R	22
CATTLE STATION CK	D08	ROCKLANDS RES	38
CATTLEMAN CK	O07	WHEELER CK	1
CAVENDER CK	P08	YALMY R	22
CEMENT CK	K09	YARRA R	29
CHALLICUM CK	F08	FIERY CK	36
CHANDLERS CK	R08	CANN R, EAST BR	21
CHAPPLE CK	F11	GELLIBRAND R	35
CHARLIE CK	K09	ADA R	26
CHARLIES CK	J07	REEDY CK	5
CHARLIES CK	G11	GELLIBRAND R	35
CHERRY TREE CK	N07	KIEWA R	2
CHERRY TREE CK	G07	AVOCA R	8
CHETWYND R	*B08*	*GLENELG R*	*38*
CHRISTMAS CK	O07	WOMBAT CK	1
CIANCIO CK	F11	AIRE R	35
CLEAR CK	M07	BUCKLAND R	3
CLEAR CK	*L09*	*THOMSON R*	*25*
CLEAR CK	L10	TARWIN R, EAST BR	27
CLEAR CK	K09	YARRA R	29
CLEAR COUNTRY CK	M08	MOROKA R	24
CLIFTON CK	O09	MITCHELL R	24
COALITION CK	K10	TARWIN R	27
COBBANNAH CK	N09	MITCHELL R	24
COBON CK	R08	COMBIENBAR R	21
COBUNGRA R	O07	MITTA MITTA R	1
COCHRANES CK	G07	AVOCA R	8
COCKY CK	O07	BENAMBRA CK	1
COGHILL CK	G08	CRESWICK CK	7
COIMADAI CK	H09	WERRIBEE R	31
COLE CK	*F11*	*GELLIBRAND R*	*35*
COLEMAN CK	M08	MACALISTER R	25
COLIBAN R	H07	LAKE EPPALOCK	6
COMBIENBAR R	Q08	BEMM R	21
COMPTON CK	*I07*	*MAJOR CK*	*5*
CONCONGELLA CK	E07	SHEEPWASH CK	15
CONCORDIA GULLY	Q08	DELLICKNORA CK	22
CONGLOMERATE CK	M08	WONNANGATTA R	24
CONGUPNA CK	*K06*	*BROKEN CK*	*4*
CONNELLY CK	K08	ACHERON R	5
CONNERS CK	N08	DARGO R	24
CONTENTMENT CK	K09	WATTS R	29
COOLWATER CK	R09	WINGAN R	21
CORDUROY CK	K08	LAKE EILDON	5
COREA CK	B09	MACPHERSON CK	38
CORNELLA CK	I07	LAKE COOPER	5
CORRIEMUNGLE CK	F11	COORIEMUNGLE CK	35
CORRYONG CK	O06	MURRAY R	1
COTTONTREE CK	N06	LAKE HUME	1
COX CK	D09	MUDDY CK	38
CRABHOLE CK	Q09	BEMM R	21
CRAWFORD R	*B09*	*GLENELG R*	*38*
CREAMY CK	P08	RAYMOND CK	22

Appendix I (continued)

Stream name	Grid No.	Tributary of:	Basin
CREIGHTON CK	J07	GOULBURN R	5
CREIGHTONS CK	J07	PRANJIP CK	5
CRESWICK CK	G08	TULLAROOP CK	7
CRINOLINE CK	F11	SANDY CK	35
CROOK CK	M09	MT USEFUL CK	25
CROOKED CK	N08	WONGUNGARRA R	24
CROPPER CK	M07	BUFFALO R	3
CROPPERS CK	L06	KING R	3
CRYSTAL CK	K08	GOULBURN R	5
CRYSTAL CK	K10	TARAGO R	28
CUDGEWA CK	O06	MURRAY R	1
CULTIVATION CK	D08	ROCKLANDS RES	38
CUMBERLAND R	G11	BASS STRAIT	35
CUTTS CK	O08	TIMBARRA R	23
D UNNAMED CK	*F08*	*AVOCA R*	*8*
DABYMINGA CK	J08	GOULBURN R	5
DADDAH DADDAH CK	L06	BLACK DOG CK	3
DAIRY CK	J08	GOULBURN R	5
DALE CK	H09	PYKES CK	31
DANDONGADALE CK	M07	DANDONGDALE R	3
DANDONGADALE R	M07	BUFFALO R	3
DAREBIN CK	J09	YARRA R	29
DARLOT CK	C10	FITZROY R	37
DART R	O07	DARTMOUTH DAM	1
DAVIES PLAIN CK	P07	BUCKWONG CK	1
DAY CK	O08	LIVINGSTONE CK	1
DEAD CALF CK	Q08	BRODRIBB R	22
DEAD HORSE CK	P07	LIMESTONE CK	1
DEAD HORSE CK	O09	TAMBO R	23
DEAD HORSE CK	K10	SHADY CK	26
DEAD LOG CK	G07	BULLABUL CK	7
DEADLOCK CR	L10	TARWIN R, WEST BR	27
DEANS CK	G09	LAKE COLAC	34
DEANS MARSH CK	G10	BARWON R	33
DEEP CK	O07	MORASS CK	1
DEEP CK	M06	BLACK DOG CK	3
DEEP CK	M09	THOMSON R	25
DEEP CK	L11	FRANKLIN R	27
DEEP CK	K09	O'SHANNASSY R	29
DEEP CK	I09	MARIBYRNONG R	30
DEEP CK	E10	BRUCKNELL CK	36
DEEP CK	D08	CULTIVATION CK	38
DELATITE R	L08	LAKE EILDON	5
DEN HILLS CK	C09	KONONG WOOTONG CK	38
DEPTFORD CK	O08	HAUNTED STREAM	23
DEVIL PLAIN CK	L08	DELATITE R	5
DEVILS BEND MIDDLE BRANCH	M07	BUCKLAND R	3
DEWING CK	G10	BARWON R, EAST BR	33
DIAMANTINA CK	N07	KIEWA R	2
DIAMOND CK	K10	BUNYIP R	28
DIAMOND CK	J09	YARRA R	29
DIGGERS CK	N07	LITTLE SNOWY CK	1
DINAH CK	Q09	BEMM R	21
DINGO CK	M07	BUCKLAND R	3
DINGO CK	L11	AGNES R	27
DINNER CK	P07	BUCKWONG CK	1
DIVIDING CK	G11	BARWON R	33
DJERRIWARRH CK	I09	MELTON RESERVOIR	31
DOCTORS CK	G08	BET BET CK	7
DOCTORS CK	J09	YARRA R	29
DOG TRAP CK	G09	LEIGH R	33
DOLODROOK R	M09	WELLINGTON R	25
DONNELLY CK	L09	ABERFELDY R	25
DRAIN	L06	BOUGHYARD CK	4
DRAIN NO.1		DRAIN NO.1	38
DRAIN NO.2		DRAIN NO.1	38
DRAINS	I09	MERRI CK	29
DRUMMER CK	R09	THURRA R	21
DRY CK	J08	SUNDAY CK	5
DRY CK	I09	SKELETON CK	31
DRY FOREST CK	N06	TALLANGATTA CK	1
DRY R	M08	WONNANGATTA R	24
DRYSDALE CK	E10	MERRI R	36
DUCK CK	F11	LAKE HORDERN	35
DUGGAN CK	O07	TAMBO R	23
DUNDAS RIVER	C09	WANNON R	38
DUNGEON GULLY	L08	HOWQUA R	5
DUNN CK	I10	PORT PHILLIP BAY	28
DWYER CK	B09	HENTY CK	38
DWYER CK	D09	WANNON R	38
DYNAMITE CK	Q09	BRODRIBB R	22
EAGLEHAWK CK	M10	LATROBE R	26
EASBY CK	S09	TASMAN SEA	21
EAST BRANCH CK	K09	ARMSTRONG CK	29
EAST CK	J10	WESTERN PORT	28
EASTERN CK	F11	PORT CAMPBELL CK	35
ECLIPSE CK	H09	MOORABOOL R	32
EDGARS CK	I09	MERRI CK	29
EDWARDS CK	L08	U.GOULBURN R	5
EIGHT MILE CK	L08	HOWQUA R	5
EIGHTEEN MILE CK	N08	DARGO R	24
ELDORADO CK	N08	JUNGLE CK	24
ELLERY CK	Q08	BRODRIBB R, NTH BR	22
EMU CK	H07	AXE CK	6
EMU CK	G07	CARMANUEL CK	7
EMU CK	G07	AVOCA R	8
EMU CK	I09	DEEP CK	30
ENOCH CK	L08	BIG R	5
ERRINUNDRA R, EAST BRANCH	Q09	ERRINUNDRA R	21
ERSKINE R	G11	BASS STRAIT	35
ETTERSGLEN CK	K09	WATTS R	29
EUMERALLA R	*D10*	*LAKE YAMBUK*	*37*
EUROBIN CK	M07	BUFFALO R	3
EVANS CK	L07	KING R	3
F	E07	BUNYIP CK	15
FAITHFULL CK	K07	SEVEN CREEKS	5
FAT COW CK	Q09	A219	22
FAULKNER CK	F07	AVON R	15
FENTONS CK	G07	AVOCA R	8
FERN HILL CK	C09	WANNON R	38
FERNTREE CK	Q08	BRODRIBB R	22
FERNTREE CK	O08	WILKINSON CK	23
FERRERS CK	G09	KURUC-A-RUC CK	34
FIERY CK	E09	HOPKINS CK	36
FIFTEEN MILE CK	L06	OVENS R	3
FINDLAY CK	N06	TALLANGATTA CK	1
FIRST CK	L08	TAPONGA CK	5
FIRST CK	R08	TENNYSON CK	21
FISH CK	P07	BUCHAN R	22
FISH CK	K11	TARWIN R	27
FITZROY R	C10	PORTLAND BAY	37
FIVE MILE CK	H08	CAMPASPE R	6
FIVE MILE CK	H07	PICANINNY CK	7
FIVE MILE CK		BENDIGO CK	7
FLAGGY CK	N06	MURRAY R	1
FLAGGY CK	M06	KINCHINGTON CK	2
FLOURBAG CK	L08	U.GOULBURN R	5
FLYNNS CK	M10	LATROBE R	26
FOGARTY CK	N08	KELLY CK	24
FOLEY CK	L09	ARNOLD CK	5
FOLKES CK	L09	JORDAN R	25
FOLLY CK	K07	STONY CK	5
FORD CK	L08	LAKE EILDON	5
FORD R	F11	LAKE HORDERN	35
FOREST CK	I07	CAMPASPE R	6
FOREST CK	H08	CAMPBELLS CK	7
FORLORN HOPE CK	P08	REEDY CK	22
FOSTER CK	K11	POWLETT R	27
FOUR MILE CK	I07	GOULBURN R	5
FOUR MILE CK	G07	BET BET CK	7
FRANKLIN R	L11	CORNER INLET	27
FRANKS CK	J07	GARDINER CK	5
FREESTONE CK	P07	SUGGAN BUGGAN R	22
FREESTONE CK	N09	AVON R	25
FRENCHMAN CK	L09	BIG R	5
FRONT CK	O07	MORASS CK	1
FRYER CK	L08	BIG R	5
FULTON CK	L09	ABERFELDY R	25
FYANS CK	E08	MOUNT WILLIAM CK	15
G (BEAUFORT)	F08	MOUNT COLE CK	15
GAFFNEYS CK	L08	U.GOULBURN R	5
GAP CK	O08	WILKINSON CK	23
GARDINER CK	J07	MAJOR CK	5
GARRON CK	O08	TAMBO R, SOUTH BR	23
GATTAMURH R	P07	SNOWY R	22
GEARY R	G11	BASS STRAIT	35
GENOA CK	S08	GENOA R	21
GEORGE CK	E08	MOUNT WILLIAM CK	15
GEORGE CK	N09	FREESTONE CK	25
GEORGE R	G11	BASS STRAIT	35
GEORGES CK	N06	TALLANGATTA CK	1
GERAR CK		BRANKEET CK	5
GERMAN CK	N07	OVENS R	3
GERMAN CK	N07	OVENS R	3
GIBBO R	O07	DARTMOUTH DAM	1
GIPSY CK	N07	KIEWA R	2
GISBORNE CK	I09	JACKSON CK	30
GLEN CK	N07	KIEWA R	2
GLEN CK	L08	LAKE EILDON	5
GLEN WILLS CK	N07	BIG R	1
GLENAULIN CK	B09	GLENELG R	38
GLENCAIRN CK	M09	BARKLY R	25
GLENCOE CK	N06	MITTA MITTA R	1
GLENDINNING CK	C08	ROCKLANDS RES	38
GLENDONALD CK	G08	CRESWICK CK	7
GLENELG R	B10	SOUTHERN OCEAN	38

Appendix I (continued)

Stream name	Grid No.	Tributary of:	Basin
GLENLOGIE CK	F08	AVOCA R	8
GLENMAGGIE CK	M09	THOMSON R	25
GLENMAGGIE CK	M09	LAKE GLENMAGGIE	25
GLENMAGGIE CK E BR	M09	THOMSON R	25
GLENMAGGIE CK W BR	M09	GLENMAGGIE CK	25
GLUE POT CK	S08	MARAMINGO CK	21
GNARITE CK	L06	BOOSEY CK	4
GNARKEET CHAIN OF PONDS	F10	LAKE BURRUMBEET	34
GOBARUP CK	I07	WANALTA CK	5
GODFREY CK	K08	HOME CK	5
GOLDEN CK	L11	BILLY CK	27
GOLDEN POINT CK	M09	BEN CRUACHAN CK	25
GOLTON CK	D07	MOUNT WILLIAM CK	15
GOOD HOPE CK	L10	BULLBEEF CK	26
GOOD LUCK CK	N08	WONGUNGARRA R	24
GOOD MORNING BILL CK	E08	LAKE BUNINJON	36
GOODMAN CK	H09	LERDERDERG R	31
GOODWIN CK	P07	LITTLE R	22
GOOLENGOOK CK	Q09	BEMM R	21
GOONGERAH CK	Q09	BRODRIBB R	22
GOULBURN R	L08	LAKE EILDON	5
GOULBURN R	I06	MURRAY R	5
GRACE BURN	K09	WATTS R	29
GRADY CK	N08	DARGO R	24
GRANGE BURN	C09	WANNON R	38
GRANGE BURN DRAIN	D09	GRANGE BURN	38
GRANITE CK	R09	REEDY CK	21
GRASS CK	H10	BASS STRAIT	35
GRAY CK	O08	SWIFTS CK	23
GRAYS CK	E09	HOPKINS R	36
GREEN CK	D08	DWYER CK	38
GREEN GULLY CK	H08	LODDON R	7
GREEN HILL CK	K08	STEAVENSON R	5
GREEN HILL CK	G07	CARMANUEL CK	7
GREEN WATTLE CK	O08	LIVINGSTONE CK	1
GREIG CK	M11	TARRA R	27
GRIMME CK	M08	MACALISTER R	25
GUM GULLY CK	F11	GELLIBRAND R	35
GUNBOWER CK	H05	MURRAY R	7
GUYS FOREST CK	N06	BURROWYE CK	1
GYPSY CK	D10	SPRING CK	36
HAMILTON CK	J08	KURKUVA CK	5
HANDFORD CK	L08	JAMIESON R	5
HAPPY VALLEY CK	M07	OVENS R	3
HARD TO SEEK CK	R09	WINGAN R	21
HARDY CK	K08	BEECH CK	5
HAROLD CK	L10	LATROBE R	26
HARRIS CK	P09	YELLOW WATER-HOLE CK	23
HARRISON CK	S08	MALLACOOTA INLET	21
HASSALL CK	C09	KONONG WOOTONG CK	38
HAUNTED GULLY	F10	LAKE LITTLE CORANGAMITE	34
HAUNTED STREAM	O08	TAMBO R	23
HAWTHORN CK	L09	LATROBE R	26
HAZEL CK	K10	MOE R	26
HEALTH CK	K08	ACHERON R	5
HELLHOLE CK	N07	KIEWA R	2
HENSLEIGH CK	R08	COMBIENBAR R	21
HENTY CK	C09	WANNON R	38
HERMIT CK	P06	MURRAY R	1
HEWITT CK	C09	LITTLE TEA TREE CK	38
HICKEY CK	M09	MACALISTER R	25
HIGH PLAINS CK	N07	BUNDARRA R	1
HINES CK	F07	CHERRY TREE CK	8
HODDINOTT CK	M10		27
HODDLE CK	L11	FISH CK	27
HODDLE CK	K09	YARRA R	29
HODGSON CK	L06	OVENS R	3
HOLLAND CK	K07	BROKEN R	4
HOLLANDS CK	N07	BIG R	1
HOME CK	K08	GOULBURN R	5
HOME CK	Q08	DEDDICK R	22
HOME STATION CK	L08	DELATITE R	5
HOMEBUSH CK	G07	AVOCA R	8
HONEYMOON CK	K08	GOULBURN R	5
HONEYSUCKLE CK	N06	TALLANGATTA CK	1
HONEYSUCKLE CK	N06	TALLANGATTA CK	1
HONEYSUCKLE CK	J06	SEVEN CREEKS	5
HONEYSUCKLE CK	D08	DEEP CK	38
HOPE CK	L09	TANJIL R, EAST BR	26
HOPKINS R	E10		36
HOSPITAL CK	P09	BASS STRAIT	22
HOUSE CK	N06	KIEWA R	2
HOVELL CK	H10	PORT PHILLIP BAY	32
HOWES CK	L08	LAKE EILDON	5
HOWQUA R	L08	LAKE EILDON	5
HUGHES CK	J07	GOULBURN R	5
HUMFFRAY R	M08	WONNANGATTA R	24
HUMPY CK	B09	STOKES R	38
HURDLE CK	L06	KING R	3
ICY CK	L09	TANJIL R, WEST BR	26
ICY CK	L09	LOCH R	26
IGUANA CK	N09	MITCHELL R	24
ILLABAROOK CK	G09	MOUNT MISERY CK	34
INDI R	P06	MURRAY R	1
INDIGO CK	M06	MURRAY R	3
INGEEGOODBEE R	P07	SUGGAN BUGGAN R	22
IRONBARK CK	Q08	BRODRIBB R	22
ISLAND CK	J08	YEA R	5
ITALIAN GULLY	G09	WOADY YALOAK CK	34
JACK CK	J08	GOULBURN R	5
JACK R	Q09	BRODRIBB R	22
JACK R	M11	ALBERT R	27
JACKSON CK	I09	MARIBYRNONG R	30
JACKSON CK	E08	HOPKINS R	36
JACOBS CK	L10	TYERS R	26
JAMIESON R	L08	GOULBURN R	5
JARVIS CK	N06	LAKE HUME	1
JEERALANG CK	M10	TRARALGON CK	26
JEWS HARP CK	I08	PIPERS CK	6
JIM CROW CK	H08	LODDON R	7
JIM JACK CK	O08	LIVINGSTONE CK	1
JIM WALKER CK	R08	CANN R	21
JIM WALKER CK	R08	CANN R	21
JOHANNA R	F11	BASS STRAIT	35
JOHNSON CK	J08	GOULBURN R	5
JONES CK	R08	GENOA R	21
JONES CK	N08	LITTLE DARGO R	24
JONES CK	F11	GELLIBRAND R	35
JORDAN R	L09	THOMSON R	25
JOYCES CK	G08	LODDON R	7
JUNCTION CK	O08	TAMBO R	23
JUNGLE CK	Q09	BRODRIBB R	22
JUNGLE CK	N08	WONGUNGARRA R	24
KADNOOK CK	B08	GLENELG R	38
KANE CK	O06	LUCYVALE CK	1
KANGAROO CK	N06	DRY FOREST CK	1
KANGAROO CK	H07	AXE CK	6
KANGAROO CK	H08	COLIBAN R	6
KANGAROO CK	C09	CRAWFORD R	38
KANGDERAAR CK	G07	BULLABUL CK	7
KANUKA CK	Q08	ERRINUNDRA R	21
KARLO CK	R09	WINGAN R	21
KATE CK	R08	CANN R	21
KEELANGIE CK	O06	CUDGEWA CK	1
KEFFREU CK	L11	ALBERT R	27
KELLY CK	N08	WENTWORTH R	24
KENNEDY CK	N09	FREESTONE CK	25
KENNEDYS CK	F11	GELLIBRAND R	35
KENNETT R	G11	BASS STRAIT	35
KENNY CK	P09	BOGGY CK	23
KIEWA R	M06	MURRAY R	2
KIEWA R, EAST BR	N07	KIEWA R	2
KIEWA R, WEST BR	N07	KIEWA R	2
KILGOWER CK	N08	WENTWORTH R	24
KINCHINGTON CK	M06	YACKANDANDAH CK	2
KING CK	O06	TALLANGATTA CK	1
KING CK	G10	BARWON R	33
KING PARROT CK	J08	GOULBURN R	5
KING PARROT CK	K10	YALLOCK CK	28
KING R	L06	OVENS R	3
KING R, WEST BR	L07	KING R	3
KINGOWER CK	G07	LODDON R	7
KOETONG CK	N06	LAKE HUME	1
KONAGADERRA CK	I09	DEEP CK	30
KONONG WOOTONG CK	C09	WANNON R	38
KORKUPERIMUL CK	H09	WERRIBEE R	31
KOROITE CK	C09	KONONG WOOTONG CK	38
KORONG CK	G06	LODDON R	7
KOROROIT CK	I09	ALTONA BAY	31
KOROROIT CK E BR	I09	KOROROIT CK	31
KOROROIT CK W BR	I09	KOROROIT CK	31
KUMBADA CK	L07	KING R	3
KURKURUC CK	J08	SUGARLOAF CK	5
L	D07	WIMMERA R	15
LA TROBE CK	F11	GELLIBRAND R	35
LABERTOUCHE CK	K10	TARAGO R	28
LAKE MARMAL CK	G06	LAKE MARMAL	8
LAL LAL CK	H09	MOORABOOL R	32
LALBERT CK	F04	LAKE TIMBORAM	8
LAMBING HUT CK	D08	DWYER CK	38
LAMONT CK	L11	AGNES R	27
LANCE CK	K11	POWLETT R	27
LANG LANG R	K10	WESTERN PORT	28
LAMMERS CK	N09	THOMSON R	25

Appendix I (continued)

Stream name	Grid No.	Tributary of:	Basin
LANKY TOM CK	O09	SHADY CK	23
LARDNER CK	G11	GELLIBRAND R	35
LARDNER EAST BR	G11	LARDNER CK	35
LARSEN CK	O07	DARTMOUTH DAM	1
LAZARINI CK	*L09*	*BLACK R*	5
LE HARDIES CK	O07	BUENBA CK	1
LEAHY CK	F11	GELLIBRAND R	35
LEIGH R	G09	BARWON R	33
LERDERDERG R	H09	WERRIBEE R	31
LEVIATHAN CK	L09	U.GOULBURN R	5
LICKHOLE CK	L08	HOWQUA R	5
LIGHTNING CK	N07	SNOWY CK	1
LIGHTWOOD CK	N08	DARGO R	24
LILLY PILLY CK	Q09	BRODRIBB R	22
LIMESTONE CK	P07	INDI R	1
LIMESTONE CK	J08	YEA R	5
LIMESTONE CK	E10	MUSTON CK	36
LINDSAY R	B02	MURRAY R	14
LITTE R	K08	ACHERON R	5
LITTLE ADA CK	K09	ADA R	26
LITTLE ALBERT R	M11	ALBERT R	27
LITTLE ARTE R	Q09	GOOLENGOOK CK	21
LITTLE BOY CK	L09	THOMSON R	25
LITTLE CABBAGE TREE CK	Q09	CABBAGE TREE CK	22
LITTLE CK	*G07*	*LODDON R*	7
LITTLE COLIBAN R	H08	COLIBAN R	6
LITTLE COORIEMUNGLE	F11	SCOTTS CK	35
LITTLE DARGO R	N08	DARGO R	24
LITTLE GOOLENGOOK CK	Q08	GOOLENGOOK CK	21
LITTLE JACK CK	M11	JACK R	27
LITTLE MONKEY CK	N10	MONKEY CK	27
LITTLE MORWELL CK	L10	MORWELL R	26
LITTLE MURRAY R	G04	MURRAY R	7
LITTLE PYRAMID CK	R09	TONGHI CK	21
LITTLE R	R09	SYDENHAM INLET	21
LITTLE R	S08	MALLACOOTA INLET	21
LITTLE R	I09	PORT PHILLIP BAY	32
LITTLE R	M08	WONNANGATTA R	24
LITTLE RUBY CK	K11	TARWIN R, WEST BR	27
LITTLE RUNNING CK	N08	WONGUNGARRA R	24
LITTLE SCRUBBY CK	N06	MITTA MITTA R	1
LITTLE SNOWY CK	N06	MITTA MITTA R	1
LITTLE SNOWY CK	N06	MITTA MITTA R	1
LITTLE TEA TREE CK	C09	WANNON R	38
LITTLE TOORONGO R	L09	TOORONGO R	26
LITTLE YALMY R	P08	YALMY R	22
LITTLE YARRA R	K09	YARRA R	29
LIVINGSTONE CK	O07	MITTA MITTA R	1
LIVINGSTONE CK	O07	MITTA MITTA R	1
LOCH R	L09	LATROBE R	26
LOCK CK	R08	CANN R	21
LOCK UP CK	R08	CANN R	21
LOCK'S CK	L10	MOE R	26
LOCKHART CK	N06	SANDY CK	1
LODDON R	G04	MURRAY R	7
LOG BRIDGE CK	O06	CUDGEWA CK	1
LOG BRIDGE CK	R08	CANN R	21
LOG BRIDGE CK, EAST BRANCH	O06	CUDGEWA CK	1
LOG BRIDGE, WEST BR	O06	CUDGEWA CK	1
LOLLYPOP CK	I09	LITTLE R	32
LONG CK	N07	OVENS R, WEST BR	3
LONG GULLY CK	H09	SUTHERLAND CK, W BR	32
LONG HUT CK	C08	KOROITE CK	38
LONG MARSH GULLY	N09	MOITON CK	24
LOONGELAAT CK	P08	SNOWY R	22
LOONGELAAT CK, NORTH BRANCH	P09	LOONGELAAT CK	22
LOONGELAAT CK, SOUTH BR	P09	LOONGELAAT CK	22
LORD CK	N07	SNOWY CK	1
LOY YANG CK	M10	LATROBE R	26
LUCKY HIT CK	O06	CUDGEWA CK	1
LUCYVALE CK	O06	CUDGEWA CK	1
LYALL CK	E10	DRYSDALE CK	36
LYNE CK	C09	DARLOT CK	37
MACFARLANES CK	P07	INGEEGOODBEE R	22
MACK CK	F10	LAKE CORANGAMITE	34
MACLACHLAN CK	G08	JOYCES CK	7
MACPHERSON CK	B09	WANDO R	38
MAGPIE CK	M06	REEDY CK	3
MAIN CK	I10	BASS STRAIT	28
MAJOR CK	J07	GOULBURN R	5
MALLETT CK		GOULBURN R	5
MARAMINGO CK	S08	GENOA R	21
MARTIN CK	Q09	BRODRIBB R	22

Stream name	Grid No.	Tributary of:	Basin
MASON CK	E08	MOUNT WILLIAM SWAMP	36
MATHER CK	C08	GLENELG R	38
MATLOCK CK	L09	THOMSON R	25
MCCALLUM CK	G08	TULLAROOP CK	7
MCCOLL CK	*M09*	*AVON R*	25
MCCRAE CK	K09	WOORI YALLOCK CK	29
MCDONALD CK	N09	FREESTONE CK	25
MCKENZIE R	D07	WIMMERA R	15
MCKENZIE R	Q09	BEMM R	21
MCKERLIE CK	L09	LATROBE R	26
MCMAHON CK	K09	YARRA R	29
MEADOW CK	L07	KING R	3
MELANESIA CK	F11	BASS STRAIT	35
MELLICK MUNJIE CK	P08	BUCHAN R	22
MENAAK CK	P07	SNOWY R	22
MERINO CK	C09	HENTY CK	38
MERRI CK	I09	YARRA R	29
MERRI R	D10		36
MERRICKS CK	J10	WESTERN PORT	28
MERRIGIG CK	H10	THOMPSON CK	35
MERRIJIG CK	N09	SANDY CK	24
MERTON CK	K08	LAKE EILDON	5
MIAKITE CK	C09	HENTY CK	38
MIDDLE BR	M08	WELLINGTON R	25
MIDDLE CK	N07	BIG R	1
MIDDLE CK	*N07*	*BIG R*	1
MIDDLE CK	N08	COBUNGRA R	1
MIDDLE CK	M06	KIEWA R	2
MIDDLE CK	L07	FIFTEEN MILE CK	3
MIDDLE CK	K07	SEVEN CREEKS	5
MIDDLE CK	K08	HOME CK	5
MIDDLE CK	G08	LODDON R	7
MIDDLE CK	F07	CARAPOOEE CK	8
MIDDLE CK	F08	MOUNTAIN CK	8
MIDDLE CK	P07	BUCHAN R	22
MIDDLE CK	L10	MORWELL R	26
MIDDLETON CK	H08	LODDON R	7
MILL CK	K08	ACHERON R	5
MILL CK	J08	DABYMINGA CK	5
MILLER CK	O07	BENAMBRA CK	1
MINCHIN CK	P08	DEDDICK R	22
MISERY CK	L11	TARWIN R, EAST BR	27
MISSISSIPI CK	O09	CUNNINGHAM ARM	23
MISSISSIPPI CK	K09	BIG PATS CK	29
MITCHELL CK	L08	JAMIESON R	5
MITCHELL R	O09	LAKE KING	24
MITTA MITTA R	N06	MURRAY R	1
MOE R	K10	LATROBE R	26
MOITON CK	N09	MITCHELL R	24
MOLESIDE CK	B10	CRAWFORD R	38
MOLIAGUL CK	G07	COCHRANES CK	8
MOLLISON CK	J08	KURKURUC CK	5
MONKEY CK	O09	TAMBO R	23
MONKEY CK	N10	MERRIMAN CK	27
MONKEY CK	L11		27
MONUMENT CK	I08	DEEP CK	30
MOON CK	I07	WANALTA CK	5
MOONEE CK	L07	BROKEN R	4
MOONEE PONDS CK	I09	MOONEE PONDS CK	29
MOONLIGHT CK	L08	U.GOULBURN R	5
MOORA CHANNEL	D08	U.GLENELG R	38
MOORABOOL R EAST BRANCH	H09	MOORABOOL R	32
MOORABOOL R WEST BRANCH	H09	MOORABOOL R	32
MOPOKE CK	G08	CRESWICK CK	7
MORASS CK	O07	DARTMOUTH DAM	1
MORASS CK	O08	LITTLE R	23
MORASS CK	M09	NAVIGATION CK	25
MORGAN CK	O09	NICHOLSON R	23
MOROKA R	M08	WONNANGATTA R	24
MORRIS CK	N08	WENTWORTH R	24
MORSES CK	M07	OVENS R	3
MORWELL R, EAST BR	L10	MORWELL R	26
MORWELL R, WEST BR	L10	MORWELL R	26
MOSCOW CK	P07	BERRIMA R	22
MOSQUITO CK	A08	BOOL LAGOON (SA)	39
MOSQUITO CK	A08	GLENELG R	38
MOUCHONG CK	*D08*	*ROCKLANDS RES*	38
MOUNT ANGUS CK	M09	AVON R	25
MOUNT COLE CK	F08	WIMMERA R	15
MOUNT ELIZABETH CK	O09	TIMBARRA R	23
MOUNT HUMP CK	M09	AVON R	25
MOUNT MACKS CK	M11	TARRA R	27
MOUNT PLEASANT CK	I07	CAMPASPE R	6
MOUNT SELWYN CK	N08	WONGUNGARRA R	24
MOUNT SKENE CK	L08	BARKLY R	25
MOUNT TABOR CK	N07	MITTA MITTA R	1
MOUNT WILLIAM CK	E08	WIMMERA R	15

Appendix I (continued)

Stream name	Grid No.	Tributary of:	Basin
MOUNT WILLS CK	N07	SNOWY CK	1
MOUNTAIN ASH CK	L08	BARKLY R	25
MOUNTAIN CK	N07	KIEWA R	2
MOUNTAIN CK	I07	CAMPASPE R	6
MOUNTAIN CK	F08	AVOCA R	8
MOUNTAIN CK	R09	LITTLE R	21
MOUNTAIN CK	P08	SNOWY R	22
MOUNTAINEER CK		LAKE EILDON	5
MOYNE R	D10	BELFAST LOUGH	37
MT HOPE CK	H05	KOW SWAMP	7
MT MISERY CK	G09	WOADY YALOAK CK	34
MT TALBOT CK	C08	TOOLONDO RESERVOIR	15
MUCH CK	Q08	DEDDICK R	22
MUCKLEFORD CK	H08	LODDON R	7
MUDDY CK	D09	GRANGE BURN	38
MUDDY WATERHOLE CK	J07	WORMANGAL CK	5
MUELLER R	R09	BASS STRAIT	21
MULLAGONG CK	N07	KIEWA R	2
MUNDIC CK	L09	TOORONGO R	26
MUNDIE CK	O09	STONY CK	23
MUNDY GULLY	F10	LAKE LITTLE CORANGAMITE	34
MURMURING CK	R08	GENOA R	21
MURPHY CK	G07	BRADFORD CK	7
MURPHYS CK	G07	BULLABUL CK	7
MURRABIT R	G05	LODDON R	7
MURRAY BROOK	D10	MOYNE R	37
MURRAY R	N05	LAKE HUME	1
MURRAY R	N06	MURRAY	2
MURRAY R	M06	MURRAY R	3
MURRAY R	L06	MURRAY R	4
MURRAY R	I05	MURRAY R	5
MURRAY R	I05		6
MURRAY R	I06	MURRAY R	6
MURRAY R	I06	MURRAY R	7
MURRAY R	G04	MURRAY R	8
MURRAY R	F04	MURRAY R	14
MURRAY R (GUNBOWER)	H05	MURRAY R	7
MURRAY R (HATTAH)	D03	MURRAY R	14
MURRAY RIVER (BARMAH)	J05	MURRAY R	4
MURRINDAL R	P09	BUCHAN R	22
MURRINDINDI R	J08	YEA R	5
MUSK CK	J10	WESTERN PORT	28
MUSTON CK	E10	HOPKINS R	36
MUSTON CK	E09	HOPKINS R	36
MYERS CK	H06	MT HOPE CK	7
MYRNIONG CK	H09	WERRIBEE R	31
MYRTLE CK	M07	BARWIDGEE CK	3
MYRTLE CK	H07	COLIBAN R	6
McGILL CK	C09	DUNDAS R	38
McIVOR CK	I07	LAKE EPPALOCK	6
McKAY CK	O07	DART R	1
McKINNON CK	C09	GRANGE BURN	38
NAGSHEAD GULLY CK	G09	WOADY YALOAK CK	34
NARIEL CK	O06	CORRYONG CK	1
NARIEL CK	F11	GELLIBRAND R	35
NARINGHIL CK	G09	WOADY YALOAK CK	34
NARRACAN CK	L10	LATROBE R	26
NATIVE CAT CK	P07	BUCHAN R	22
NATIVE HUT CK	H10	BARWON R	33
NAVIGATION CK	O09	NICHOLSON R	23
NAVIGATION CK	M09	AVON R	25
NEKEEYA CK	E08	GOOD MORNING BILL CK	36
NELSON CK	Q08	DELEGATE R	21
NEW CHUM CK	J09	WATTS R	29
NEW COUNTRY CK	P08	SNOWY R	22
NEW PLACE CK	M09	VALENCIA CK	25
NEW RUSH CK	O07	LIVINGSTONE CK	1
NEWRY CK	M09	MACALISTER R	25
NEWTON CK	Q09	CABBAGE TREE CK	22
NICHOLSON CK	O09	NICHOLSON R	23
NICHOLSON R, EAST BR	O08	NICHOLSON R	23
NINE MILE CK	O07	MITTA MITTA R	1
NINE MILE CK	K06	BROKEN CK	4
NINE MILE CK	I07	WANALTA CK	5
NINE MILE CK	E08	MOUNT WILLIAM CK	15
NINE MILE CK	M11	CORNER INLET	27
NINE MILE CK	D09	WANNON R	38
NO.1 UNNAMED CK	P07	LIMESTONE CK	1
NO.1 UNNAMED CK	N08	COBUNGRA R	1
NO.1 UNNAMED CK		MURRAY R	1
NO.1 UNNAMED CK	N07	BUNDARRA R	1
NO.1 UNNAMED CK	N07	BIG R	1
NO.1 UNNAMED CK	O06	BURROWYE CK	1
NO.1 UNNAMED CK	N06	DRY FOREST CK	1
NO.1 UNNAMED CK		BULLOCKY CK	1
NO.1 UNNAMED CK	N06	LAKE HUME	1
NO.1 UNNAMED CK	N06	WATCHINGORRA CK	1
NO.1 UNNAMED CK	N06	MITTA MITTA R	1
NO.1 UNNAMED CK		BURROWYE CK	1
NO.1 UNNAMED CK	O07	MORASS CK	1
NO.1 UNNAMED CK	N07	RUNNING CK	2
NO.1 UNNAMED CK	M06	KINCHINGTON CK	2
NO.1 UNNAMED CK	L07	BLACK RANGE CK	3
NO.1 UNNAMED CK	L06	HODGSON CK	3
NO.1 UNNAMED CK	L07	FIFTEEN MILE CK	3
NO.1 UNNAMED CK	L07	KING R	3
NO.1 UNNAMED CK	M07	BUCKLAND R	3
NO.1 UNNAMED CK	M07	DANDONGDALE R	3
NO.1 UNNAMED CK	M07	ROSE RIVER	3
NO.1 UNNAMED CK	M07	BUFFALO R	3
NO.1 UNNAMED CK	L06	REEDY CK	3
NO.1 UNNAMED CK	M07	WHOROULY CK	3
NO.1 UNNAMED CK	M07	OVENS R	3
NO.1 UNNAMED CK	K07	MOONEE CK	4
NO.1 UNNAMED CK	L07	SAMARIA CK	4
NO.1 UNNAMED CK	L07	BROKEN R	4
NO.1 UNNAMED CK	K07	BADDAGINNIE CK	4
NO.1 UNNAMED CK	L06	LAKE MOKOAN	4
NO.1 UNNAMED CK	L06	BOOSEY CK	4
NO.1 UNNAMED CK	K08	TAGGERTY R	5
NO.1 UNNAMED CK	K09	ACHERON R	5
NO.1 UNNAMED CK	K08	CRYSTAL CK	5
NO.1 UNNAMED CK	K09	LITTLE R	5
NO.1 UNNAMED CK		NO.1 UNNAMED CK	5
NO.1 UNNAMED CK	L09	FRENCHMAN CK	5
NO.1 UNNAMED CK	L08	EDWARDS CK	5
NO.1 UNNAMED CK	L08	BLACK R	5
NO.1 UNNAMED CK	J07	WORMANGAL CK	5
NO.1 UNNAMED CK	I07	MAJOR CK	5
NO.1 UNNAMED CK	I08	PRICE CK	5
NO.1 UNNAMED CK	L08	JAMIESON R	5
NO.1 UNNAMED CK		GOULBURN R	5
NO.1 UNNAMED CK	J08	KURKUVA CK	5
NO.1 UNNAMED CK	L08	U.GOULBURN R	5
NO.1 UNNAMED CK	I07	WANALTA CK	5
NO.1 UNNAMED CK	L08	DELATITE R	5
NO.1 UNNAMED CK	J08	YEA R	5
NO.1 UNNAMED CK	K07	FAITHFULL CK	5
NO.1 UNNAMED CK	K08	GLEN CK	5
NO.1 UNNAMED CK	L08	FORD CK	5
NO.1 UNNAMED CK	L08	SNAKE CK	5
NO.1 UNNAMED CK	H07	AXE CK	6
NO.1 UNNAMED CK	H08	LITTLE COLIBAN R	6
NO.1 UNNAMED CK	I07	MOUNTAIN CK	6
NO.1 UNNAMED CK	I07	MOUNT PLEASANT CK	6
NO.1 UNNAMED CK		CAMPASPE R	6
NO.1 UNNAMED CK	H08	COLIBAN R	6
NO.1 UNNAMED CK		LODDON R	7
NO.1 UNNAMED CK	H06	MYERS CK	7
NO.1 UNNAMED CK	H06	MOUNT HOPE CK	7
NO.1 UNNAMED CK	G07	RYAN CK	7
NO.1 UNNAMED CK	I07	MOUNT HOPE CK	7
NO.1 UNNAMED CK	F07	AVOCA R	8
NO.1 UNNAMED CK	F07	NO.1 UNNAMED CK	8
NO.1 UNNAMED CK	F07	FAULKNER CK	15
NO.1 UNNAMED CK	F07	RICHARDSON R	15
NO.1 UNNAMED CK	E07	WALLALOO CK	15
NO.1 UNNAMED CK	E07	ANDERSON CK	15
NO.1 UNNAMED CK	E07	RICHARDSON CK	15
NO.1 UNNAMED CK	F07	SANDY CK	15
NO.1 UNNAMED CK	J09	STEELES CK	29
NO.1 UNNAMED CK		YARRA R	29
NO.1 UNNAMED CK	I08	DEEP CK	30
NO.1 UNNAMED CK	I09	KONAGADERRA CK	30
NO.1 UNNAMED CK	H09	PYKES CK	31
NO.1 UNNAMED CK	H09	GOODMAN CK	31
NO.1 UNNAMED CK	C10	FITZROY R	37
NO.1 UNNAMED CK	D10	MOYNE R	37
NO.1 UNNAMED CK	D08	CATTLE STATION CK	38
NO.1 UNNAMED CK	C09	WANNON R	38
NO.1 UNNAMED CK	B08	CHETWYND R	38
NO.1 UNNAMED CK	C10	CRAWFORD R	38
NO.1 UNNAMED CK	C08	MATHER CK	38
NO.1 UNNAMED CK		GLENELG R	38
NO.1 UNNAMED CK	B09	WANDO R	38
NO.1 UNNAMED CK	C08	PIGEON PONDS CK	38
NO.10 UNNAMED CK	G07	WEHLA CK	8
NO.11 UNNAMED CK	F07	AVOCA R	8
NO.12 UNNAMED CK	F07	TARPAULIN CK	8
NO.13 UNNAMED CK	G07	FENTONS CK	8
NO.14 UNNAMED CK	F07	AVOCA R	8
NO.15 UNNAMED CK	F07	STRATHFILLAN CK	8
NO.17 UNNAMED CK	G06	LAKE MARMAL CK	8

Appendix I (continued)

Stream name	Grid No.	Tributary of:	Basin
NO.18 UNNAMED CK	G06	LAKE MARMAL CK	8
NO.19 UNNAMED CK	G07	BURNT CK	7
NO.2 UNNAMED CK		MURRAY R	1
NO.2 UNNAMED CK	O07	MORASS CK	1
NO.2 UNNAMED CK	M06	REEDY CK	3
NO.2 UNNAMED CK	L07	BLACK RANGE CK	3
NO.2 UNNAMED CK	M07	WHOROULY CK	3
NO.2 UNNAMED CK	M07	ROSE R	3
NO.2 UNNAMED CK	L07	KING R	3
NO.2 UNNAMED CK	M07	DANDONGDALE R	3
NO.2 UNNAMED CK		BROKEN R	4
NO.2 UNNAMED CK	L06	BOOSEY CK	4
NO.2 UNNAMED CK	K08	LITTLE R	5
NO.2 UNNAMED CK		NO.2 UNNAMED CK	5
NO.2 UNNAMED CK	J08	YEA R	5
NO.2 UNNAMED CK	L08	DELATITE R	5
NO.2 UNNAMED CK	L08	HOWQUA R	5
NO.2 UNNAMED CK		NO.1 UNNAMED CK	5
NO.2 UNNAMED CK		GOULBURN R	5
NO.2 UNNAMED CK		CAMPASPE R	6
NO.2 UNNAMED CK	H08	COLIBAN R	6
NO.2 UNNAMED CK	H08	LODDON R	7
NO.2 UNNAMED CK	G07	RYAN CK	7
NO.2 UNNAMED CK	F07	NO.1 UNNAMED CK	8
NO.2 UNNAMED CK	E07	RICHARDSON CK	15
NO.2 UNNAMED CK		YARRA R	29
NO.2 UNNAMED CK	I08	DEEP CK	30
NO.2 UNNAMED CK	I08	BOLINDA CK	30
NO.2 UNNAMED CK	I09	BOYD CK	30
NO.2 UNNAMED CK	H09	LERDERDERG R	31
NO.2 UNNAMED CK	D10	MOYNE R	37
NO.2 UNNAMED CK		CRAWFORD R	38
NO.2 UNNAMED CK	D08	SCOTT CK	38
NO.2 UNNAMED CK	B09	WANDO R	38
NO.2 UNNAMED CK		GLENELG R	38
NO.2 UNNAMED CK	C09	WANNON R	38
NO.20 UNNAMED CK	G07	KANGDERAAR CK	7
NO.21 UNNAMED CK	G07	NO.20 UNNAMED CK	7
NO.22 UNNAMED CK	G06	KORONG CK	7
NO.22 UNNAMED CK	G06	BULLABUL CK	7
NO.23 UNNAMED CK	G06	KORONG CK	7
NO.24 UNNAMED CK	G06	KORONG CK	7
NO.3 UNNAMED CK		MURRAY R	1
NO.3 UNNAMED CK	M07	ROSE R	3
NO.3 UNNAMED CK	L07	KING R	3
NO.3 UNNAMED CK	K06	BROKEN CK	4
NO.3 UNNAMED CK		NO. 2 UNNAMED CK	5
NO.3 UNNAMED CK		GOULBURN R	5
NO.3 UNNAMED CK	L08	DELATITE R	5
NO.3 UNNAMED CK		HOWQUA R	5
NO.3 UNNAMED CK	H08	LODDON R	7
NO.3 UNNAMED CK	F07	NO.1 UNNAMED CK	8
NO.3 UNNAMED CK	I08	DEEP CK	30
NO.3 UNNAMED CK	I08	EMU CK	30
NO.3 UNNAMED CK		GLENELG R	38
NO.3 UNNAMED CK	C09	WANNON R	38
NO.4 UNNAMED CK		NO.3 UNNAMED CK	1
NO.4 UNNAMED CK	L07	KING R	3
NO.4 UNNAMED CK		BROKEN R	4
NO.4 UNNAMED CK		HOWQUA R	5
NO.4 UNNAMED CK	H08	LODDON R	7
NO.4 UNNAMED CK	F07	CHERRY TREE CK	8
NO.4 UNNAMED CK	I08	DEEP CK	30
NO.4 UNNAMED CK		GLENELG R	38
NO.5 UNNAMED CK		MURRAY R	1
NO.5 UNNAMED CK	L07	KING R	3
NO.5 UNNAMED CK		BROKEN R	4
NO.5 UNNAMED CK	G08	AVOCA R	8
NO.5 UNNAMED CK		GLENELG R	38
NO.6 UNNAMED CK	L07	KING R	3
NO.6 UNNAMED CK	G08	AVOCA R	8
NO.6 UNNAMED CK		GLENELG R	38
NO.7 UNNAMED CK		OVENS R	3
NO.7 UNNAMED CK	G08	AVOCA R	8
NO.7 UNNAMED CK		GLENELG R	38
NO.8 UNNAMED CK	G08	AVOCA R	8
NO.9 UNNAMED CK	G07	FENTONS CK	8
NO1 UNNAMED CK	M07	BARWIDGEE CK	3
NOLAN CK	B08	GLENELG R	38
NORTH BRANCH CK	L08	JAMIESON R	5
NORTH BRANCH CK		JAMIESON R	5
NORTON CK	D07	WIMMERA R	15
NOWHERE CK	F08	WIMMERA R	15
NUG NUG WA CK	M07	BUFFALO R	3
O'GRADY CK	L10	LT MORWELL R	26
O'KEEFE GULLY	L09	ABERFELDY R	25
O'MAHONY CK	K10	LANG LANG R	28
O'SHANNASSY R	K09	YARRA R	29
OAKS CK	L09	BIG R	5
OLANGOLAH CK	G11	GELLIBRAND R	35
OLD HAT CK	L11		27
OLD PADDOCK CK	O08	TAMBO R	23
OLD SHEEP STATION CK	O08	TAMBO R	23
OLINDA CK	J09	YARRA R	29
OLIVE BRANCH CK	Q09	PYRAMID CK	21
OMEO CK	P07	MURRAY R	1
ONE MILE CK		OVENS R	3
ORVILLE CK	G07	KANGDERAAR CK	7
OUTLET CK	C05	LAKE BRAMBRUK	15
OVENS R	L06	MURRAY R	3
OVENS RIVER E BR	M07	OVENS R	3
OVENS RIVER W BR	M07	OVENS R	3
PADDY JOY CK	O07	WHEELER CK	1
PADDYS CK	Q09	BEMM R	21
PARADISE CK	F07	AVON CK	15
PARKER R	G11	BASS STRAIT	35
PARWAN CK	H09	WERRIBEE R	31
PEGLEG CK	O07	WOMBAT CK	1
PENDYK PENDYK CK	C08	ROCKLANDS RES	38
PERCIVAL CK	I08	MOLLISON CK	5
PERRY R	N10	DISHER BAY	25
PHEASANT CK	O06	KEELANGIE CK	1
PHEASANT CK	O07	BUENBA CK	1
PHEASANT CK	K10	LANG LANG R	28
PICANINNY CK	H06	MT HOPE CK	7
PIGEON PONDS CK	B08	GLENELG R	38
PINCH SWAMP CK	Q08	BONANG R	22
PINNACLE CK, EAST BRANCH	N08	WONNANGATTA R	24
PIPERS CK	I08	CAMPASPE R	6
PLAYBOY CK	M08	MOROKA R	24
PLEASANT CK	E08		15
PLENTY R	J09	YARRA R	29
PLENTY R	J09	YARRA R	29
PLOWMAN CK	I08	CAMPASPE R	6
POOLES GULLY	L09	JORDAN R	25
POOR FELLOW CK	L11		27
PORCUPINE CK	G10	LOVE R	35
PORT CAMPBELL CK	F11	BASS STRAIT	35
PORTLAND CK	C09	CRAWFORD R	38
POULTON CK	Q08	BOG CK	21
POWELL CK	S08		21
POWERS CK	B08	GLENELG R	38
POWLETT R	K11	BASS STRAIT	27
PRANJIP CK	J07	GOULBURN R	5
PRICE CK	I08	KURKURUC CK	5
PROSPECT CK	O09	MITCHELL R	24
PUNCHEN CK	N09	SWAMP CK	24
PYKES CK	H09	WERRIBEE R	31
PYRAMID CK	G05	LODDON R	7
PYRAMID CK	Q09	BEMM R	21
PYRITES CK	H09	COIMADAI CK	31
QUEENSBOROUGH R	R08	BENDOC R	21
RAMROD CK	O09	TAMBO R	23
RASPBERRY CK	L08	GAFFNEYS CK	5
RAVEN CK	H10	THOMPSON CK	35
RAWES CK	O06	CORRYONG CK	1
RAYMOND CK	P08	SNOWY R	22
RED CAP CK	O07	WILSON CK	1
RED CK	S09	TASMAN SEA	21
RED HILL CK	L10	SHADY CK	26
RED JACKET CK	L09	THOMSON R	25
REDBANK CK	F07	CHERRY TREE CK	8
REDWATER CK	F11	AIRE R	35
REED BED CK	R09	TONGHI CK	21
REED CK	Q08	BENDOC R	21
REEDY CK	O07	LIVINGSTONE CK	1
REEDY CK	N08	COBUNGRA R	1
REEDY CK	O06	CUDGEWA CK	1
REEDY CK	L06	OVENS R	3
REEDY CK	J07	WORMANGAL CK	5
REEDY CK	J07	GOULBURN R	5
REEDY CK	H07	BENDIGO CK	7
REEDY CK	F07	AVON CK	15
REEDY CK	R09	CANN R	21
REEDY CK	P08	BUCHAN R	22
REEDY CK	O08	SANDY CK	23
REEDY CK	M11	BRUTHEN CK	27
REEDY CK	J09	YARRA R	29
REEDY CK	E09	HOPKINS R	36
REILLY CK	H09	STONY CK	32
RETREAT CK	G10	BARWON R	33
RICH RIVER	Q09	BRODRIBB R	22
RICHARDSON CK	E07	RICHARDSON R	15
RICHARDSON R	E06	LAKE BULOKE	15
RIDDELLS CK	I09	JACKSON CK	30
RIDDLE CK	Q09	BRODRIBB R	22

Appendix I (continued)

Stream name	Grid No.	Tributary of:	Basin
RIGGS CK	K07	HONEYSUKLE CK	5
RILEY CK	O08	SWIFTS CK	23
RILEY CK	M08	HUMFFRAY R	24
RILEY CK, NTH BR	N08	DARGO R	24
RIMMONG CK	Q08	DEDDICK R	22
RINTOUL CK	M10	LATROBE R	26
RINTOUL CK	M10	LATROBE R	26
RINTOUL CK	M10	LATROBE R	26
RINTOUL CK, E BR	L10	RINTOUL CK	26
RIVERVIEW CK	Q08	DELEGATE R	21
ROBERTSON CK	C08	BROOK CK	38
ROBERTSON CK	B09	WANDO	38
ROBSON CK	C09	KOROITE CK	38
ROCK CK	N09	MITCHELL R	24
ROCK PLAINS CK	P07	SUGGAN BUGGAN R	22
ROCKY CK	J08	YEA R	5
ROCKY R	Q09	JACK R	22
ROCKY VALLEY CK	N07	KIEWA R	2
RODGER R	P08	SNOWY R	22
ROGERS CK	O06	TALLANGATTA CK	1
ROSE R	M07	DANDONGADALE R	3
ROSE R	M07	BUFFALO R	3
ROSS CK	F10	SCOTTS CK	35
ROUGH CK	P07	MURRAY R	1
ROUGH CK	P07	BUCHAN R	22
ROYD CK	S08	WALLAGARAUGH R	21
RUBICON R	K08	GOULBURN R	5
RUNNING CK	M06	KIEWA R	2
RUNNING CK	N07	KIEWA R	2
RUNNING CK	Q09	A223	22
RUNNING CK	Q08	DEDDICK R	22
RUNNING CK	O08	TAMBO R	23
RUNNING CK	J09	ARTHURS CK	29
RUSSELL CK	L09	LOCH R	26
RUSSELL CK	L09	TANJIL R	26
RYAN CK	K07	HOLLAND CK	4
RYAN CK	G07	KINGOWER CK	7
RYLAND CK	J07	GARDINER CK	5
RYSON CK	K09	BUNYIP R	28
S	F07	WATTLE CK	15
SALT CK		MIDDLE CK	7
SALT CK	E08	MOUNT WILLIAM CK	15
S	K08	MURRINDINDI R	5
SALT CK	E08	CONCONGELLA CK	15
SALT CK	H10	ANGLESEA R	35
SALT CK	E10	HOPKINS R	36
SALT CK	C08	GLENELG R	38
SALT CK	C08	GLENELG R	38
SALT PAN CK	C09	WANNON R	38
SALTPETRE CK	O07	SASSAFRAS CK	1
SAM CK	K07	HOLLAND CK	4
SAMARIA CK	L07	BROKEN R	4
SANDY CK	O07	MORASS CK	1
SANDY CK	N06	LAKE HUME	1
SANDY CK	K06	BOOSEY CK	4
SANDY CK	H07	BENDIGO CK	7
SANDY CK	F07	AVOCA R	8
SANDY CK	F07	AVON R	15
SANDY CK	O08	TAMBO R	23
SANDY CK	N09	MITCHELL R	24
SANDY CK	N09	PERRY CK	25
SANDY CK	F11	GELLIBRAND R	35
SANDY R	P07	SNOWY R	22
SANDY WATERHOLE CK	S08	MARAMINGO CK	21
SARDINE CK	Q09	RIDDLE CK	22
SARDINE CK	L08	BARKLY R	25
SASSAFRAS CK	O07	GIBBO R	1
SAWPIT CK	Q08	DEDDICK R	22
SAWPIT CK	J09	WATTS R	29
SAWPIT CK	C09	WANNON R	38
SCATABIT CK	M09	DEEP CK	25
SCHOFIELD CK	C08	GLENELG R	38
SCOTT CK	B09	GLENELG R	38
SCOTT CK	D08	CULTIVATION CK	38
SCOTTS CK	F10	CURDIES R	35
SCRUBBY CK	N07	MITTA MITTA R	1
SCRUBBY CK	O06	NARIEL CK	1
SCRUBBY CK		GOULBURN R	5
SCRUBBY CK	S08	GENOA R	21
SCRUBBY CK	O08	TAMBO R	23
SCRUBBY CK	M08	LITTLE R	24
SCRUBBY CK	O09	CLIFTON CK	24
SCRUBBY CK	G10	BARWON R	33
SCRUBBY CK	D08	U.GLENELG R	38
SCRUBBY CK	D08	U.GLENELG R	38
SCUDDER CK	R09	WINGAN R	21
SECOND CK	L08	TAPONGA CK	5
SECOND CK	P07	MOSCOW CK	22
SEPARATION CK	G11	BASS STRAIT	35
SERPENTINE CK	P07	MURRAY R	1
SERPENTINE CK	R09	TONGHI CK	21
SERPENTINE CK	P08	YALMY R	22
SERPENTINE CK	M09	MACALISTER R	25
SERPENTINE CK	L10	TANJIL R	26
SEVEN CREEKS	J06	GOULBURN R	5
SHADY CK	O07	WHEELER CK	1
SHADY CK	O07	DARTMOUTH DAM	1
SHADY CK	O09	TAMBO R	23
SHADY CK	K10	MOE R	26
SHADY CK	L11		27
SHAW CK	M08	CALEDONIA R	25
SHAW RIVER	D10	LAKE YAMBUK	37
SHEANS CK	K07	SEVEN CREEKS	5
SHEEP STATION CK	M06	REEDY CK	3
SHEEPWASH CK	H07	AXE CK	6
SHEEPWASH CK	E07	BUNYIP CK	15
SHEEPWASH CK	E07	BUNYIP R	15
SHELTONS GULLY	O08	TAMBO R	23
SHEPHERDS CK	N08	DARGO R	24
SHEPHERDS CK	K09	WOORI YALLOCK CK	29
SHERBROOK R	F11	BASS STRAIT	35
SHIPWRECK CK	S09	TASMAN SEA	21
SILVER CK	J08	KING PARROT CK	5
SIMMONDS CK		KIEWA R	2
SIMPSON CK	O06	NARIEL CK	1
SIMPSON CK	P09	EWING MARSH	22
SINGLE HUT CK	Q08	DEDDICK R	22
SIX MILE CK	E08	WIMMERA R	15
SKELETON CK	I09	PORT PHILLIP BAY	31
SKENES CK	G11	BASS STRAIT	35
SKINNER CK	F11	CHAPPLE CK	35
SKULL CK	O09	MITCHELL R	24
SLATY CK	F07	AVOCA R	8
SLAUGHTER YARD CK	M07	BUFFALO R	3
SMITH CK	N08	DARGO R	24
SMITHS CK	K09	O'SHANNASSY R	29
SMOKE OH CK	P07	LIMESTONE CK	1
SMOKY CK	F07	AVOCA R	8
SMYTHE CK	G11	BASS STRAIT	35
SNAKE CK	L08	U.GOULBURN R	5
SNAKE CK	L09	ICY CK	26
SNOBS CK	K08	GOULBURN R	5
SNOWY CK	N07	MITTA MITTA R	1
SNOWY CK	N07	OVENS R	3
SNOWY CK, BORONG BR	N07	SNOWY CK	1
SNOWY CK, W BR	N07	SNOWY CK	1
SNOWY CK, W BR	N07	SNOWY CK	1
SODA CK	R09	ALLAN CK	21
SOLDIER CK	O07	DARTMOUTH DAM	1
SOUTH BRANCH CK	L08	JAMIESON R	5
SOUTH BRANCH CK	F11	CHAPPLE CK	35
SPION KOPJE CK	K09	TARAGO R	28
SPLITTERS CK	O07	MORASS CK	1
SPRING CK	N08	COBUNGRA R	1
SPRING CK		MITTA MITTA R	1
SPRING CK		GOULBURN R	5
SPRING CK	H08	JIM CROW CK	7
SPRING CK	H07	BULLOCK CK	7
SPRING CK	Q09	JACK R	22
SPRING CK	P09	SNOWY R	22
SPRING CK	P08	BUTCHERS CK	22
SPRING CK	H10	BASS STRAIT	35
SPRING CK	E11	CURDIES R	35
SPRING CK	C09	CRAWFORD R	38
SPRING CK 1	N06	LAKE HUME	1
SPRING CK 2	N06	LAKE HUME	1
SPRING GULLY	O08	LITTLE R	23
SPRING HILL CK	F09	MOUNT EMU CK	36
SPRING VALLEY CK	F10	LAKE CORANGAMITE	34
SPRINGDALLAH CK	G09	WOADY YALOAK CK	34
SPRINGS CK	L09	BIG R	5
ST PATRICKS R	Q08	BIG R	22
STACEY CK	O06	NARIEL CK	1
STAFFORD CK	F11	JOHANNA R	35
STAGG CK	Q08	QUEENSBOROUGH R	21
STANLEY CK	M08	HOWQUA R	5
STARVATION CK	K09	YARRA R	29
STATION CK	E07	WIMMERA R	15
STATION CK	O08	RILEY CK	23
STEAVENSON RIVER	K08	ACHERON R	5
STEELES CK	J09	YARRA R	29
STEEP BANK RIVULET	B08	GLENELG R	38
STEEP CK	O07	WHEELER CK	1
STEWARTS CK	J07	HUGHES CK	5
STOCKYARD CK	L07	BROKEN R	4
STOCKYARD CK	L08	HOWQUA R	5
STOCKYARD CK	H08	FIVE MILE CK	6

Appendix 1 (continued)

Stream name	Grid No.	Tributary of:	Basin
STOCKYARD CK	M09	AVON R	25
STOCKYARD CK	L11		27
STOKES RIVER	B09	GLENELG R	38
STONE JUG CK	I08	CAMPASPE R	6
STONEY CK	Q09	BRODRIBB R	22
STONEY CK	M08	MT SELWYN CK	24
STONEY CK	M08	SCRUBBY CK	24
STONEY CK	K11	TARWIN R	27
STONY CK	N07	SNOWY CK	1
STONY CK	O06	CUDGEWA CK	1
STONY CK	O07	BUENBA CK	1
STONY CK	O07	MURRAY R	1
STONY CK	O07	MORASS CK	1
STONY CK	L07	KUMBADA CK	3
STONY CK	N07	OVENS R	3
STONY CK	L08	U.GOULBURN R	5
STONY CK	K07	HONEYSUCKLE CK	5
STONY CK	Q08	DEDDICK R	22
STONY CK	O09		23
STONY CK	N09	MITCHELL R	24
STONY CK	M09	VALENCIA CK	25
STONY CK	M09	THOMSON R	25
STONY CK	M10	WATERHOLE CK	27
STONY CK	H09	LITTLE R	32
STONY CK	E10	HOPKINS R	36
STONY CK	C09	DUNDAS R	38
STONY CK, NEAR GLENMAGGIE	M09	MACALISTER R	25
STONY CK, NR LICOLA	M09	MACALISTER R	25
STORE CK	O09	NICHOLSON R	23
STOREY CK	R09	TONGHI CK	21
STRAIGHT RUNNING CK	O07	GIBBO R	1
STRATH CK	J08	KING PARROT CK	5
STRATHFILLAN CK	F07	CAMPBELL CK	8
STUTTERING FREDS CK	O09	NICHOLSON R	23
SUGAR LOAF CK	C08	GLENELG R	38
SUGARLOAF CK	J08	GOULBURN R	5
SUGARLOAF CK	G11	BASS STRAIT	35
SUGGAN BUGGAN R	P08	SNOWY R	22
SUNDAY CK	J08	GOULBURN R	5
SUNDAY CK	F10	SCOTTS CK	35
SUNDAY CK	C10	FITZROY R	37
SUNNY CK	L10	MOE R	26
SUPPLEJACK CK	L08	TAPONGA CK	5
SURPRISE CK	R09	WINGAN R	21
SURREY R	C10	PORTLAND BAY	37
SURVEYORS CK	P06	MURRAY R	1
SUTHERLAND CK E BR	H10	MOORABOOL R	32
SUTHERLAND CK W BR	H09	MOORABOOL R	32
SWAMP CK	K08	ACHERON R	5
SWAMP CK	Q08	DEDDICK R	22
SWAMP CK	N09	MITCHELL R	24
SWAMPY CK	M06	YACKANDANDAH CK	2
SWIFTS CK	O08	TAMBO R	23
SWINGLER CK	L09	THOMSON R	25
T	D09	SPRING CK	36
TABLETOP CK	N08	DARGO R	24
TAGGERTY R	K08	STEAVENSONS R	5
TALLANGALOOK CK		LAKE EILDON	5
TALLANGATTA CK	N06	LAKE HUME	1
TALLANGATTA CK E BR	N06	TALLANGATTA CK	1
TAMBO R, SOUTH BR	O08	TAMBO R	23
TANJIL R, EAST BR	L09	TANJIL R	26
TAPONGA R	L08	BIG R	5
TARAGO R EAST BR	K09	TARAGO R	28
TARGET CK	M09	MACALISTER R	25
TARILTA CK		LODDON R	7
TARPAULIN CK	F07	AVOCA R	8
TARRANGULLA CK	N06	LAKE HUME	1
TARRENGOWER CK		LODDON R	7
TARWIN R	K11	ANDERSON INLET	27
TARWIN R, EAST BR	K11	TARWIN R	27
TARWIN R, WEST BR	K11	TARWIN R	27
TAYLOR CK		LAKE EILDON	5
TAYLOR CK	O08	NICHOLSON R, E BR	23
TEA TREE CK	N07	BIG R	1
TEA TREE CK	H09	MOORABOOL R	32
TEA TREE CK	C08	GLENELG R	38
TEAPOT CK	P06	MURRAY R	1
TEAPOT CK	N08	WENTWORTH R	24
TEATREE CK	P09	YELLOW WATER-HOLE CK	23
TENNENT CK	K10	BASS R	27
TENNYSON CK	R08	CANN R	21
THIELE CK	M09	DOLODROOK R	25
THILLUNA CK	O07	DART R	1
THIRTY MILE CK	N09	CROOKED CK	24
THOMPSON CK	H10	BASS STRAIT	35
THOWGLA CK	O06	CORRYONG CK	1
THREE MILE CK	S08	GENOA R	21
THREE MILE CK	O09	MITCHELL R	24
THURRA R, WEST BR	R08	THURRA R	21
TIERNEY CK	O08	HAUNTED STREAM	23
TIMBERTOP CK	L08	DELATITE R	5
TIMBOON CK	E10	CURDIES R	35
TIN CK	K09	BUNYIP R	28
TOKE CK	O07	DARTMOUTH DAM	1
TOM CK	N09	LAKE VICTORIA	25
TOM'S CAP CK	M11	BRUTHEN CK	27
TOMAHAWK CK	K09	SHEPERDS CK	29
TOMAHAWK CK	F10	KENNEDYS CK	35
TOMCAT CK	P07	SNOWY R	22
TONGHI CK	R09	CANN R	21
TONGIO CK	O08	TAMBO R	23
TOOLERN CK	I09	WERRIBEE R	31
TOOMEY CK	L10	TARWIN R, WEST BR	27
TOORONGO R	L09	LATROBE R	26
TORBRECK R	L09	BIG R	5
TOWSER CK	Q09	CABBAGE TREE CK	22
TRAPPERS CK	N07	SNOWY CK	1
TRARALGON CK	L10	LATROBE R	26
TRAWALLA CK	E08	MOUNT EMU CK	36
TUCKER CK	N08	WENTWORTH R	24
TULLAROOP CK	G07	LODDON R	7
TULLOH CK	C09	WANNON R	38
TURNBACK CK	O07	GIBBO R	1
TURNIP CK	K07	STONY CK	5
TURTON R	M09	AVON R	25
TURTONS CK	L11	TARWIN R, EAST BR	27
TUSSOCK CK	O07	WILSON CK	1
TWENTY FIVE MILE CK	N08	THIRTY MILE CK	24
TWO MILE CK	K07	STONY CK	5
TWO MILE CK	N08	DARGO R	24
TWO MILE CK	N09	SANDY CK	24
TYERS R, EAST BR	L09	TYERS R	26
TYERS R, WEST BR	L09	TYERS R	26
TYRRELL CK	E04	LAKE TYRRELL	8
U	D09	MUSTON CK	36
UN-NAMED CK 1	O06	CUDGEWA CK	1
UN-NAMED CKS		BUCKWONG CK	1
VALENCIA CK	M09	AVON R	25
VICTORIA R	N08	COBUNGRA R	1
VIOLET CK	C09	GRANGE BURN	38
W	D10	WIMMERA R	15
WABBA CK	O06	CUDGEWA CK	1
WADES CK	L10	LATROBE R	26
WALKERS CK		YARRA R	29
WALL CK	P08	SPRING CK	22
WALLA WALLA CK	L11	AGNES R	27
WALLABY CK	E11	SCOTTS CK	35
WALLAGARAUGH R	S08	MALLACOOTA INLET	21
WALLALOO CK	E07	RICHARDSON R	15
WALPOLLA CK	C02	MURRAY R	14
WALSH CK	K09	YARRA R	29
WALWA CK	P07	MURRAY R	1
WANALTA CK	I07	GOULBURN R	5
WANDIN YALLOCK CK	K09	WOORI YALLOCK CK	29
WANDO RIVER	B09	GLENELG R	38
WANGARABELL CK	R08	GENOA R	21
WANNON R	B09	GLENELG R	38
WAPPENTAKE CK	I07	MAJOR CK	5
WARATAH CK	R08	LOCK UP CK	21
WARATAH CK	L11	FISH CK	27
WARBISCO CK	Q08	DEDDICK R	22
WARM CORNER CK	Q08	DEDDICK R	22
WARRAMBINE CK	G10	BARWON R	33
WASHAWAY CK	N06	HUME W	1
WASHINGTON CK	N07	OVENS R E BR	3
WATCHINGORRA CK		MITTA MITTA R	1
WATERFALL CK	N07	BIG R	1
WATERFALL CK	N06	TALLANGATTA CK	1
WATERHOLE CK	M10	MERRIMAN CK	27
WATSON CK	J09	YARRA R	29
WATTLE CK	E07	STATION CK	15
WATTLE CK	K10	BASS R	27
WATTLE HILL CK	C10	PORTLAND BAY	37
WATTLE SWAMP CK	Q08	BONANG R	22
WATTS RIVER	J09	YARRA R	29
WAURN PONDS CK	H10	BARWON R	33
WEBBER CK	L09	U.GOULBURN R	5
WEERANGOURT CK	C09	DARLOT CK	37
WEHLA CK	G07	FENTONS CK	8
WENNICOTT CK	C09	WANNON R	38

Appendix I (continued)

Stream name	Grid No.	Tributary of:	Basin
WERRIBEE R	I09	PORT PHILLIP BAY	31
WEST BRANCH CK	K09	SHEPERDS CK	29
WEST CK	K11	POWLETT R	27
WHEELER CK	O06	NARIEL CK	1
WHIM CK	L06	BLACK DOG CK	3
WHISKY NOB CK	M09	MT SKENE CK	25
WHITE CK	L08	TAPONGA CK	5
WHITE STAR CK	L09	DONNELLY CK	25
WHITEHEAD CK	D10	SPRING CK	36
WHITEHEADS CK	J08	GOULBURN R	5
WHITELAW CK	L09	THOMSON R	25
WHITELAW CK, W BR	L09	THOMSON R	25
WHITTAKER CK	C08	TEA TREE CK	38
WHOROULY CK	M06	OVENS R	3
WIBENDUCK CK	P09	SNOWY R	22
WILD BULL CK	L09	LATROBE R	26
WILD COW	Q09	BRODRIBB R	22
WILD DOG CK	L10	WILKUR CK	27
WILD DUCK CK	I08	CAMPASPE R	6
WILD HORSE CK	N08	WENTWORTH R	24
WILDERNESS CK	L10	MORWELL R	26
WILKINSON CK	O08	TIMBARRA R	23
WILKUR CK	L10	TARWIN R, WEST BR	27
WILLIAMS CK	L08	U.GOULBURN R	5
WILLIAMSON CK	G09	LEIGH R	33
WILSON CK	O07	LIVINGSTONE CK	1
WINKLE CK	N09	FREESTONE CK	25
WINNOT CK	R08	CANN R, EAST BR	21
WINTER CK	G09	YARROWEE CK	33
WINTON CK	L06	LAKE MOKOAN	4
WISES CK	N06	LAKE HUME	1
WOADY YALOAK R	G10	LAKE CORANGAMITE	34
WOADY YALOAK CK	G10	WOADY YALOAK R	34
WOMBARGO CK	P07	LITTLE R	22
WOMBAT CK	O07	DARTMOUTH DAM	1
WOMBAT CK	P09	HARTLAND R	22
WOMBAT CK	P09	HARTLAND R	22
WOODS CK		LAKE EILDON	5
WOORI YALLOCK CK	J09	YARRA R	29
WORMANGAL CK	J07	PRANJIP CK	5
WRONG CK	Q08	RODGER R	22
WULGULMERANG CK	P07	GOODWIN CK	22
WYE R	G11	BASS STRAIT	35
YACKANDANDAH CK	M06	KIEWA R	2
YAHOO CK	G10	LOVE R	35
YALLAGALORRAH CK	I07	CORNELLA CK	5
YALMY R	P08	RODGER R	22
YALOAK CK	H09	PARWAN CK	31
YALOAK CK	E10	MOUNT EMU CK	36
YAMBULLA CK	R08	GENOA R	21
YAN YAN GURT CK	G10	BARWON R	33
YANAC CK	B06		15
YANDOIT CK	H08	JIM CROW CK	7
YARRA CK	J09	PLENTY R	29
YARRA RIVER	I09	PORT PHILLIP BAY	29
YARRAMYLJIP CK	C08	GLENELG R	38
YARRARABULA CK	M07	BUFFALO R	3
YARRIAMBIACK CK	D07	WIMMERA R	15
YEA RIVER	J08	GOULBURN R	5
YEERUNG R, E BR	Q09	YEERUNG R	22
YEERUNG R, W BR	Q09	YEERUNG R	22
YELLOW WATER-HOLE CK	P09	BOGGY CK	23
YELLOW WATER-HOLE CK	P07	SUGGAN BUGGAN R	22
YOUL CK	D10	SPRING CK	36
YOUNG CK	P09	A219	22
YOUNG CK	F11	AIRE R	35
YOUNG CK	C09	KOROITE CK	38
Z	E10	LIMESTONE CK	36
ZULU CK	O07	WHEELER CK	1

Notes:

1. The first 200 entries are unnamed streams. Their locations are identified on a record set of maps in the Council's office.

2. Grid Number identifies the point at which the stream meets the mainstream named. The grids and their numbers are shown on Map 1.

Appendix II

INTERNATIONAL RIVER-SPECIFIC HERITAGE PROTECTION MEASURES

New Zealand	Canada	United States
Policy/legislative framework		
National legislation - 'Wild and Scenic' Rivers Amendment to *Water and Soil Conservation Act* 1967	National Policy - Canadian Heritage Rivers System	Federal legislation - *Wild and Scenic Rivers Act* 1968
Objective		
Recognise and sustain the amenity afforded by waters in their natural state	Manage and give national recognition to important rivers so that: the natural and human heritage features they represent are conserved and interpreted; and opportunities for recreation and heritage appreciation are realised by Canadians and visitors to Canada	Protect for future generations rivers and their immediate environments that possess outstanding scenic, recreational, geological, ecological and cultural features
Designation		
Conservation order	Single category - Canadian Heritage River	Three category National Wild and Scenic River System - wild, scenic, recreational categories are dependent on existing land use

Appendix II (continued)

New Zealand	Canada	United States
Water body selection		
One of the following values to be significant at a national level: wilderness, scenic, other natural values, recreation, fisheries, wildlife habitat, scientific or other water body feature	One of the following to be outstanding at a national level: natural heritage, human heritage, and recreation	Possess outstanding scenic, recreational, ecological, and cultural features
Application		
Only applies to 'instream' values of rivers or lakes and cannot directly regulate land use. May apply to specific reaches of the stream network within a large catchment	River segments must be of sufficient size and contain most of the key resources and ecosystem components necessary to demonstrate its heritage value	Based on the preservation of a comparatively narrow corridor along the river banks. The first eight rivers designated had 400 m corridors on both sides of the river
Mechanisms for protection		
Granting of a conservation order that may * prohibit damming of the river, or backing up of water from a dam further downstream into a protected reach * setting of minimum and maximum levels in lakes	The system is overseen by Canadian Heritage River Board (CHRB). Values are protected through the implementation of a Management Plan that ensures that nomination criteria are maintained and that water quality is of a standard to sustain the processes,	The riverine environment is maintained through the protection of the water, and the land immediately adjacent by restricting incompatible land use. The Act prohibits Federal approval, funding, licensing or assistance for any project such as dams or canals that might affect

Appendix II (continued)

New Zealand	Canada	United States
Mechanisms for protection (continued)		
* imposing minimum conditions on water quality	features or activities that make the water body unique	the values that qualify the river
(Water rights are required to take, dam, or divert fresh water or to discharge to fresh or sea water)		
Other issues		
Water for private domestic use, livestock or fire fighting, does not require a water right. Existing rights may only be amended with the agreement of the holder, and rights are subject to re-application every 10 years.	This system is voluntary relying on co-operation between different levels of government. The system has a 'de-designation' process that allows rivers to be removed from the system when review shows that river values have been reduced.	Upstream and downstream impoundment and regulation may occur provided it does not invade or unnecessarily diminish the scenic, recreational, and fish and wildlife values of the designated reach
Designation process		
Applicants for a water conservation order must be a public authority, a local authority, a statutory body, or a Minister of the Crown, and must have a function power or duty relating	Designation is achieved through a two-step process. The river values are assessed by the nominating and managing agency and if deemed suitable, the agency may submit the nominations	Designation is achieved through a two-step process. Congressional agreement is required to initiate an investigation of a suitable river. Following the investigation congress must again

Appendix II (continued)

New Zealand	Canada	United States
Designation process (continued)		
to or affected by water and soil conservation. Applications are examined by Tribunal which holds a public submission process to which any interested person or body may make a submission. Tribunal recommendations are referred to the Minister. Appeals against a Tribunal recommendations may only be made on a point of law	to the CHRB. If the nomination is accepted and *ministerial agreement* reached, a management plan must be prepared within 3 years. The river may then be designated a Canadian Heritage River	enact a Bill for Wild and Scenic River designation.

Appendix III

EXTRACT FROM THE STATE CONSERVATION STRATEGY

The Government's objectives for restoring Victoria's water bodies are to:

* protect, restore and enhance rivers to ensure that ecological processes, native species, and features of scientific, cultural or scenic interest are maintained, and to provide for present and future recreational and commercial uses; and
* manage recreational and commercial fisheries within the parameters of sustainable levels of production, in order to provide for a satisfactory recreational experience and a viable commercial fishing industry.

What the Government Has Done

Work following the 1983 *State of the Rivers* report by the Standing Consultative Committee on River Improvement has resulted in a Government policy commitment to stop the degradation of the State's waterways, their catchments and environs and achieve a significant and visible improvement by the year 2000.

A natural resources inventory has been started to help managers protect the environmental values of rivers. Water from the Dartmouth and Thomson Dams has been allocated to maintain flows necessary to sustain native flora and fauna downstream.

What the Government Will Do

The integrated planning and management of rivers and their associated catchments is the most important step towards protecting or reviving these areas.

Planning and management

The Government will co-ordinate the planning and management of water and related land including frontages, floodplains, and catchments. Priority will be given to stabilising the relationship between soil and water in catchments to protect and rehabilitate rivers and estuaries. Single-purpose management will only be permitted in special circumstances and the Government will ensure that all competing demands (including natural ecosystem maintenance, water supply, flood control, drainage, primary production, urban or industrial activities, fishing and recreation) are given due recognition. The charters of those organisations responsible for managing rivers or catchment areas will include conservation and recreation objectives as well as more traditional concerns such as flood and erosion control, stream stability, and drainage.

The Government will ensure that the environmental effects of both construction and operation of any proposed works affecting bodies of water and associated land are assessed as part of the approval process.

Water pollution policies and controls will focus more on diffuse sources than they have in the past.

Specifically, the Government will:

* accelerate research into the biology and habitat requirements of native aquatic life;
* prepare management plans for high value river frontages, giving particular attention to sites of ecological significance, habitats important to fisheries and areas suffering from degradation. These plans will be prepared in consultation with the community;
* review all statutes relating to the management of water resources to provide a new Water Act. The new legislation will require that conservation objectives be included in the charters of all water and river management boards; provide a mechanism to enable water to be allocated to the environment and give these allocations the same legal standing and appropriate security of supply as with the use of water for other purposes; eliminate routine single-purpose management; and promote a whole-catchment approach to water resource management emphasising objectives and goals. The details of the legislation will be developed in consultation with community groups;

* develop an inventory of the State's natural resources, documenting environmental information on water and related land for water managers. The inventory will be updated every five years and a report will be prepared to assist the development of a long-term data base.

The Government will identify those rivers and streams (or stretches of them) which essentially remain in their natural condition. As these waterways are scarce and irreplaceable, the Government will ensure special protection is extended over their entire catchments. The Government will upgrade management of Crown river frontages, paying particular attention to environmentally significant and vulnerable areas.

As a general principle, the Government will ensure that protection from flood hazard will, where possible, be achieved through land-use planning rather than stream modification. In-stream dam construction will also be avoided where possible and any new dam proposals will require an environmental assessment and an assessment of needs and alternatives. The Government will only approve the withdrawal of water from rivers and any form of dam construction, after ensuring that a flow pattern is maintained which provides for existing in-stream uses such as aquatic ecosystems or canoeing.

Modifications such as fish ladders or multi-level offtakes will be required in some places. In new projects, the costs of water allocated to maintain the natural stream environment will be borne by users who remove water from the stream.

The Government will develop education and advisory services for water managers stressing the importance of habitat maintenance, and showing ways it can be incorporated into general management of water resources.

Specifically, the Government will:

* manage and protect Crown river frontages through measures such as revegetation (with native species wherever possible); fencing to protect significant natural features; pest plant and animal control; preventing cultivation, grazing and stock access in vulnerable areas; and allowing public access for recreation where appropriate. The preliminary survey and data base for all Crown river frontages in the State will be completed by the end of 1990;
* develop guidelines by the end of 1987 for the renewal of leases for public land on river frontages in the light of environmental, access and equity issues and the potential effects on the water resource;
* establish catchment-based river management boards throughout the State, which will be responsible for substantial parts of complete river systems;
* complete by 1988, the details of a Heritage Rivers program which will enable systematic selection and protection of streams and their catchments. This will help ensure that representative examples of all stream types, as well as rivers of special wilderness, scenic, recreational or scientific value are maintained in at least their present condition;
* carry out assessments, by the end of 1987, of the conservation and recreation value of rivers and waterbodies in part of south-western Victoria and the Western Port catchment;
* accelerate research into defining survival-flow regimes for major streams where new diversions are proposed;
* examine existing allocations of water from town and irrigation storages and the quality and quantity of effluent discharges from sewage treatment plants to determine the possibility of maintaining survival-flow regimes in regulated perennial streams (the required changes to allocations will be implemented in stages);
* require all new diversions and abstractions of water from rivers to accommodate the flow patterns necessary to minimise the impact on downstream ecosystems; and
* require the design of all new on-stream dams to maintain water quality sufficient to protect downstream ecosystems, particularly with respect to temperature and oxygen levels.'

Appendix IV

RECOMMENDATION WORDING FOR LCC CATEGORIES LISTED IN CHAPTER 7

Water production, supply, regulation and drainage areas

That

* storage areas, diversions, and their buffer zones be used for water-supply purposes, be permanently reserved, and be managed by the water supply authority

* off-river storages, installations, and channels remain under existing tenure and control

* (specified) areas be used to facilitate regional drainage and flood protection

* (specified) reservoirs be used for: domestic and irrigation water storage and distribution; flood mitigation; nature conservation and recreation (where consistent); tree-planting; and occupancies and other uses at the manager's discretion

Public land water frontage reserves

That public land water frontages

* be used to protect adjoining land from erosion, to maintain the landscape, to conserve flora and fauna, for low-intensity recreation, for flood mitigation, and for licensed grazing where appropriate

* where licensed, be available for passive recreation, not be cultivated without approval, be fenced to exclude stock where and when necessary, and be permanently reserved

Streamside reserves

That streamside reserves

* be used for passive recreation, conservation of flora and fauna, and landscape protection; be used for camping and grazing at the manager's discretion where these do not conflict with other uses or affect water quality; and be permanently reserved

River Murray reserve

That the River Murray reserve

* be used: to protect natural and scenic values, and conserve flora and fauna; for flood mitigation and stream-bank protection; for informal recreation; for limited timber extraction where consistent with scenic and conservation uses; for honey production; for hunting, grazing, stock water, and dispersed camping at the discretion of the land manager; for licensed pump sites; for works for bank stability and public safety; and for legal access

* where licensed, be available for recreational activities

* be zoned for the above uses, and permanently reserved

Lake reserves

That lake reserves

* be used for: recreation, including hunting; wildlife conservation; scientific study; water supply; drainage and flood storage; and grazing under the land manager's control

and that they be permanently reserved

Gippsland Lakes reserve

That the Gippsland Lakes reserve

* be used: for recreation and education associated with natural environments; to conserve and protect natural ecosystems and geomorphological and historical features; and to conserve flora and fauna

that

* measures necessary for land stability be undertaken; legal access and (specified) rights of access continue; honey production be permitted; grazing continue unless it conflicts with the primary aims; existing legal occupations continue unless they conflict with public use, but 2 permissive occupancies be phased out; (specified) land if purchased be added to the reserve

and that it be reserved

Wildlife reserves

That wildlife reserves be used

* primarily to conserve the habitat of native animals, particularly water birds (in many cases)

* for public recreation and education where this does not conflict with the primary aim; and for grazing, at the discretion of the land manager

and that they be permanently reserved

Hydro-electricity Production

That the hydro-electric scheme area

* be used to: transport, store, and regulate water; operate, maintain, and protect installations; provide low-intensity recreation and protect nature conservation values, consistent with State Electricity Commission requirements

State forest - rainforests

That the areas indicated

* be used to conserve rainforest; and each be protected by a buffer

that

* no tree be felled into the buffers; passive recreation such as nature study be permitted; logging and grazing not be permitted; and plans for roadworks be submitted to the managers for approval

and that they be permanently protected

State forest - natural features zones

That the primary aims of management be

* the protection of natural and scenic values; and the provision of recreational facilities and interpretative aids where this does not conflict

and that

* timber-harvesting and gravel extraction not be permitted; any new roading be constructed only where essential (for specified purposes) and be designed to minimise effects on scenic and nature conservation values

Appendix V

A SELECTION OF RECOMMENDED WATER QUALITY CRITERIA

Criterion	Potable water supply	Agriculture		Recreation	Aquatic ecosystems[3]	Water-associated wildlife
	(no treatment; current acceptable levels)	Stock supply	Irrigation	(primary contact)	(freshwater; level II protection)	
Health						
Bacteria - total (or faecal) coliforms	No more than 20/100 ml in 90% samples	< 1000/100 ml (mean of 5 samples) (faecal)	<1000/100 ml (mean of 5 samples) (faecal)	<1000/100ml (total) < 200/100ml (faecal) (both means of 5 samples)		
Escherichia coli	No more than 2/100 ml in 90% samples	—	—	—	—	—
Dissolved oxygen	> 6.5 mg/L	—	—	—	Not less than 6 mg/L; a formula links the required level with saturation level	Bottom waters should remain aerobic
Biochemical oxygen demand	1.5 mg/L	—	—	—	—	—
pH	6.5-9.2	—	4.5-9.0	6.5-8.3	6.5-8.5	7.0-9.2
Toxicants	Maximum concentrations specified for metals, inorganics, pesticides, other organics and radio-active substances	Maximum concentrations for different stock specified for various elements, nitrate/nitrite, and organics; radioactivity and pesticides as for potable supply	Maximum concentrations of phyto-toxic elements for continuous irrigation specified; herbicide levels which injure crops vary with the crop, the herbicide, and the method of irrigation	Recommended levels - as for potable supply	N+0.2 (T-N), where N is the natural back-ground level of a toxicant, and T is the threshold concentration of chronic sub-lethal effects. (Edible fish) maximum concentrations specified for various metals, pesticides, other organics	Oils - no visible presence; hydrocarbons <1 mg/g; chlorinated hydrocarbons (eg DDT) <1 ug/g; polychlorinated biphenyls < 0.5 ug/g in food, and <0.001 ug/L in water; mercury <0.5 ug/g in food; radioactivity and heavy metals - as for aquatic ecosystems

Physical/palatability

Colour	50 Pt-Co units	—	—	100 Pt-Co units	Photosynthesis compensation point depth must not vary more than 10% from seasonal background level	Photosynthesis compensation point depth must not vary more than 10% from seasonal background levels
Turbidity	25 NTU	—	—	1.2m *Secchi disc* depth		
Suspended solids	—	—	—	—	25 mg/L	—
Odour	3 TON	—	—	Unobjectionable	—	—
Taste	Unobjectionable	—	—	Unobjectionable	(Edible Fish) guideline concentrations recommended for various organics, metals, motor fuel, and wastewaters which cause tainting	—
Temperature	—	—	Irrigation water should not change the temperature in the root zone	Within the range 20-30°C for prolonged exposure	Several criteria specified to limit: maximum temperature above ambient; rate of temperature change; temperature in brief exposures; and temperature during reproductive stages. No change is to be greater than 0.5°C beyond background maximum and minimum temperatures	
Settleable Matter	—	—	—	*Free of all materials which settle to form objectionable deposits*	*Background level*	*Level minimised*

Appendix V (continued)

Criterion	Potable water supply	Agriculture		Recreation	Aquatic ecosystems[3]	Water-associated wildlife
	(no treatment; current acceptable levels)	Stock supply	Irrigation	(primary contact)	(freshwater; level II protection)	
Floatable matter	—	—	—	No visible debris, oil, scum, foam or other matter	—	—
Dangerous objects	—	—	—	No floating or sub-merged objects that may injure or obstruct users	—	—
Chemical						
Total soluble salts	—	1500mg/L (broilers)	Suitable level de-pends on soil type, drainage, crop; TSS levels are recommended in 5 irrigation classes, eg. 175 mg/L is class1 limit	—	Must not vary more than 2% from back-ground limits	Should not vary more than 1000mg/L (in water from 0 to 3500 mg/L) (aquatic plants)
Nutrients and biostimulants	—	—	—	Below levels causing excessive algal growth	Must not cause ex-cessive or nuisance growth of algae or other aquatic plants, or deleterious reduc-tions in oxygen con-centration	
Sodium	270 mg/L	—	Suitable level varies with Ca^{2+}/ Mg^{2+} level; crop tolerance varies with exchangeable sodium percentage	—	—	—

Chlorine	600mg/L	1400mg/L (poultry)	Suitable level varies with leaching fraction, crop, variety, irrigation method; eg 35 mg/L for sensitive avocadoes, raspberries, strawberries (10% leaching factor)	—	—	—
Phosphate	—	—	—	—	Total P: 100/ug/L in streams; 50 ug/L in lakes	—
Nitrate, nitrite	10mg/L	30mg/L (pigs)	—	—	—	—
Iron	1.0mg/L	50mg/L	5.0mg/L	—	—	—
Manganese	0.5mg/L	—	0.2mg/L	—	—	—
Boron	1.0mg/L	5mg/L	1.0mg/L (sensitive crops)	—	—	—
Aluminium	—	5mg/L (horses)	5.0mg/L	—	—	—
Calcium	200mg/L	700mg/L	Suitable level linked with HCO_3^-, CO_3^{2-} and sodium level	—	—	—
Bicarbonate	—	—	1.25mg/L	—	—	30-130mg/L; fluctuation not greater than 50 mg/L
Calcium carbonate (hardness)	600mg/L	—	Suitable level linked with Ca^{2+}, HCO_3^- and sodium levels	—	—	—

Source: Environment Protection Authority (1983) - Recommended Water Quality Criteria. Publication number 165.

Notes:
1. Criteria are also recommended for industrial uses and for shellfish culture.
2. Aquatic ecosystems include edible fish and crustacea; criteria specific to that purpose are marked.
3. Other criteria, specific to one use, have not been listed.

Appendix VI

CRITERIA USED TO ASSESS WATER QUALITY

(from State of the Environment Report 1988 - Victoria's Inland Waters)

		River tract[1]	
Rating	Mountain	Valley	Plain
Turbidity (NTU)			
Excellent	< 5.0	< 10.0	< 15.0
Good	< 7.5	< 12.5	< 17.5
Moderate	< 10.0	< 15.0	< 20.0
Poor	< 12.5	< 22.5	< 30.0
Degraded	> 12.5	> 22.5	> 30.0
Suspended solids (mg/L)			
Excellent	< 10	< 20	< 30
Good	< 15	< 25	< 35
Moderate	< 20	< 30	< 40
Poor	< 25	< 45	< 60
Degraded	> 25	> 45	> 60
Electrical conductivity (uS/cm)			
Excellent	< 30	< 80	< 100
Good	< 90	< 240	< 250
Moderate	< 150	< 400	< 500
Poor	< 225	< 600	< 750
Degraded	> 225	> 600	> 750
Total phosphorus (mg/L)[2]			
Excellent		< 0.010	
Good		< 0.025	
Moderate		< 0.050	
Poor		< 0.100	
Degraded		> 0.100	
Reactive phosphorous (mg/L)[2]			
Excellent		< 0.008	
Good		< 0.020	
Moderate		< 0.040	
Poor		< 0.080	
Degraded		> 0.080	
Total nitrogen (mg/L)[2]			
Excellent		< 0.20	
Good		< 0.35	
Moderate		< 0.50	
Poor		< 1.00	
Degraded		> 1.00	
pH[2]			
Excellent		6.0 to 7.5	
Good		< 8.0 and 5.5 to 6.0	
Moderate		< 8.5	
Poor		< 9.0	
Degraded		> 9.0	
Biochemical oxygen demand (mg/L)			
Excellent	< 1	< 1	< 2
Good	< 2	< 2	< 5
Moderate	< 5	< 5	< 10
Poor	< 7	< 7	< 15
Degraded	< 7	> 7	> 20

Notes:

1. > = 'more than'; < = 'less than', but more than the next highest rating.
2. Level for each rating is the same for the mountain, valley, and plain tracts.

Appendix VII

SCIENTIFIC NAMES OF ANIMALS AND PLANTS MENTIONED IN THE TEXT

Fish	
Australian bass	*Macquaria novemaculeata*
Australian grayling	*Prototroctes maraena*
Australian smelt	*Retropinna semoni*
Black bream	*Acanthopagrus butcheri*
Black mangrove cichlid	*Tilapia mariae*
Blue-spot goby	*Pseudogobius olorum*
Bony bream	*Nematolosa erebi*
Bridled goby	*Arenigobius bifrenatus*
Broad-finned galaxias	*Galaxias brevipinnis*
Brown trout	*Salmo trutta*
Carp	*Cyprinus carpio*
Chinook salmon	*Oncorhynchus tshawytscha*
Climbing galaxias	*Galaxias brevipinnis*
Common galaxias	*Galaxias maculatus*
Convict cichlid	*Cichlasoma nigrofasciatum*
Cox's gudgeon	*Gobiomorphus coxii*
Crimson-spotted rainbow fish	*Melanotaenia splendida*
Eastern little galaxias	*Galaxiella pusilla*
English perch	*Perca fluviatilis*
Estuary perch	*Macquaria colonorum*
Flat-headed galaxias	*Galaxias rostratus*
Flat-headed gudgeon	*Philypnodon grandiceps*
Freshwater blackfish	*Gadopsis marmoratus*
Freshwater catfish	*Tandanus tandanus*
Freshwater hardyhead	*Craterocephalus stercusmuscarus*
Freshwater herring	*Potamalosa richmondia*
Golden perch	*Macquaria ambigua*
Goldfish	*Carassius auratus*
Lake Eyre hardyhead	*Craterocephalus eyresii*
Long-finned eel	*Anguilla reinhardtii*
Macquarie perch	*Macquaria australasica*
Mosquito fish	*Gambusia affinis*
Mountain galaxias	*Galaxias olidus*
Murray cod	*Maccullochella peeli*
Oriental weather loach	*Misgurnus anguillicaudatus*
Pouched-lamprey	*Geotria australis*
Rainbow trout	*Salmo gairdneri*
Redfin	*Rerca fluviatilis*
Roach	*Rutilus rutilus*
Sea mullet	*Mugil cephalus*
Short-finned eel	*Anguilla australis*
Silver perch	*Bidyanus bidyanus*
Small-mouthed hardyhead	*Altherinosoma microstoma*
Southern pigmy perch	*Nannoperca australis*
Southern purple-spotted gudgeon	*Mogurnda adspersa*
Spotted galaxias	*Galaxias truttaceus*
Striped gudgeon	*Gobiomorphus australis*
Tamar river goby	*Favonigobius tamarensis*
Tasmanian mudfish	*Galaxias cleaveri*
Tench	*Tinca tinca*
Trout cod	*Maccullochella macquariensis*
Tupong	*Pseudaphritis urvilli*
Two-spined blackfish	*Gadopsis bispinosis*
Western carp gudgeon	*Hypseleotris klunzingeri*
Western chanda perch	*Ambassis castelnaui*
Yarra pigmy perch	*Edelia obscura*
Yellow-eyed mullet	*Aldrichetta forsteri*

Appendix VII (continued)

Birds	
Australian pelican	*Pelecanus conspicillatus*
Azure kingfisher	*Ceyx azurea*
Barking owl	*Ninox connivens*
Bitterns	*Botaurus* sp., *Ixobrychus* sp.
Black-fronted plover	*Charadrius melanops*
Black swan	*Cygnus atratus*
Brown gerygone	*Gerygone mouki*
Clamorous reed warbler	*Acrocephalus stentoreus*
Crakes	*Porzana* spp.
Dusky moorhen	*Gallinula tenebrosa*
Eastern whipbird	*Psophodes olivaceus*
Egrets	*Egretta* spp., *Ardeola* sp.
Eurasian coot	*Fulica atra*
Great cormorant	*Phalacrocorax carbo*
Grebes	*Podiceps* sp., *Poliocephalus* sp., *Tachybaptus* sp.
Grey teal	*Anas gibberifrons*
Gulls	*Larus* spp.
Herons	*Ardea* sp., *Nycticorax* sp.
Ibis	*Threskiornis* spp., *Plegadis* sp.
Large-billed scrubwren	*Sericornis magnirostris*
Little grassbird	*Megalurus gramineus*
Little pied cormorant	*Phalacrocorax melanoleucos*
Maned duck	*Chenonetta jubata*
Martins	*Cecropis* spp.
Masked lapwing	*Vanellus miles*
Musk duck	*Biziura lobata*
Pacific black duck	*Anas superciliosa*
Purple swamphen	*Porphyrio porphyrio*
Rails	*Rallus* spp.
Satin bowerbird	*Ptilonorhynchus violaceus*
Spoonbills	*Platalea* spp.
Superb lyrebird	*Menura novaehollandiae*
Swallows	*Hirundo* sp., *Cheramoeca* sp.
Swamp harrier	*Circus aeruginosus*
Terns	*Sterna* spp., *Chlidonias* sp., *Gelochelidon* sp., *Hydroprogne* sp.
Whistling kite	*Haliastur sphenurus*
White-bellied sea-eagle	*Haliaeetus leucogaster*
White-breasted woodswallow	*Artamus leucorhynchus*
White-faced heron	*Adea novaehollandiae*
Woodswallows	*Ardea* spp.
Mammals	
Bush rat	*Rattus fuscipes*
Dusky antechinus	*Antechinus swainsonii*
Large-footed myotis	*Myotis adversus*
Long-nosed bandicoot	*Perameles nasuta*
Platypus	*Ornithorhynchus anatinus*
Squirrel glider	*Petaurus norfolcensis*
Swamp wallaby	*Wallabia bicolor*
Tiger quoll	*Dasyurus maculatus*
Water rat	*Hydromys chrysogaster*
Reptiles	
Carpet snake	*Morelia spilota variegata*
Amphibians	
Great barred frog	*Mixophyes balbus*

Appendix VII (continued)

Crayfish and yabbies	
Murray crayfish	*Euastacus armatus*
Spiney crayfish	*E. crassus, E. bidawalus, E. kershawi, E. diversus, E. neodiversus, E. woiwuru, E. yarraensis, E. bispinosus*
Yabbies	*Cherax albinus, Cherax destructor*
Land yabbies	*Austroastacus* spp., *Engaeus* spp., *Geocherax* spp., *Pseudengaeus* spp.
Insects	
Damselfly	*Hemiphlebia mirabilis*
Otway stonefly	*Eusthenia nothofagi*
Wingless stoneflies	*Riekopera darlingtonii, Thaumatoperla* spp.
Bugs	*Hemiodoecus wilsoni, H. leai, H. donnae*
Plants	
Alpine ash	*Eucalyptus delegatensis*
Blackberry	*Rubus fruticosus* spp.
Blue gum	*Eucalyptus globulus*
Candlebark	*Eucalyptus rubida*
Common reed	*Phragmites* spp.
Cumbungi	*Typha* spp.
Giant rush	*Juncus ingens*
Grey box	*Eucalyptus microcarpa*
Lilly pilly	*Acmena smithii*
Manna gum	*Eucalyptus viminalis*
Messmate	*Eucalyptus obliqua*
Mountain ash	*Eucalyptus regnans*
Mountain grey gum	*Eucalyptus cypellocarpa*
Mountain swamp gum	*Eucalyptus camphora*
Mountain tea-tree	*Leptospermum grandifolium*
Myrtle beech	*Nothofagus cunninghamii*
Narrow-leaf peppermint	*Eucalyptus radiata*
River peppermint	*Eucalyptus elata*
River red gum	*Eucalyptus camaldulensis*
Shining gum	*Eucalyptus nitens*
Southern mahogany	*Eucalyptus botryoides*
Southern sassafras	*Atherosperma moschatum*
Swamp gum	*Eucalyptus ovata*
Yellow box	*Eucalyptus melliodora*
Yellow gum	*Eucalyptus leucoxylon*
Yellow stringybark	*Eucalyptus muelleriana*

Appendix VIII

GEOMORPHIC/HYDROLOGICAL RIVER CATCHMENT TYPES

(proportion of geomorphic units in the catchment to each flow gauge analysed by Hughes and James)

Hydrological regions	Geomorphic unit groups	Basin/flow gauge, stream	% area of each geomorphic unit in flow gauge catchment
5	3.1	35/219 Aire River	3.1 - 100%
		35/205 Arkins Creek	3.1 - 100%
5	1.1, 1.3	2/406 West Kiewa River	1.1 - 95%; 1.3 - 5%
4	1.1, 1.3	1/216 Big River	1.1 - 75%; 1.3 - 25%
		2/200 Kiewa River	1.1 - 92%; 1.3 - 8%
		5/227 Big River	1.1 - 98%; 1.3 - 2%
4	3.1, 8.2	35/216 Cumberland River	3.1 - 100%
		35/202 Gellibrand River	3.1 - 100%
		35/212 Chapple Creek	3.1 - 80%; 8.2 - 20%
		35/210 Lardner Creek	3.1 - 97%; 8.2 - 3%
4	3.4	27/203 Franklin River	3.4 - 100%
4	1.1	1/212 Nariel Creek	1.1 - 100%
		1/210 Snowy Creek	1.1 - 100%
		5/209 Acheron River	1.1 - 100%
		5/219 Goulburn River	1.1 - 100%
		5/205 Murrindindi River	1.1 - 100%
3	1.1, 1.3 (north)	1/204 Mitta Mitta River	1.1 - 98%; 1.3 - 2%
3	1.1, 1.3 (south)	23/207 Timbarra River	1.1 - 70%; 1.3 - 30%
		24/205 Dargo River	1.1 - 93%; 1.3 - 7%
		24/207 Wongungarra River	1.1 - 97%; 1.3 - 3%
		26/216 Tanjil River	1.1 - 82%; 1.3 - 10%; 9.3 - 8%
3	1.1 (north)	1/203 Mitta Mitta River	1.1 - 100%
		1/208 Cudgewa Creek	1.1 - 100%
		2/206 Running Creek	1.1 - 100%
		3/205 Ovens River	1.1 - 100%
		5/217 Yea River	1.1 - 100%
3	1.1 (south)	26/204 Latrobe River	1.1 - 96%; 9.3 - 4%
		26/205 Latrobe River	1.1 - 100%
		26/007 Tyers River	1.1 - 100%
		28/206 Tarago River	1.1 - 100%
		29/220 Don River	1.1 - 100%
		29/214 Little Yarra River	1.1 - 100%
		29/215 Woori Yallock Creek	1.1 - 100%
3	1.1, 1.2, 1.3	3/222 Buffalo River	1.1 - 95%; 1.2 - 3%; 1.3 - 2%
		3/226 Boggy Creek	1.1 - 75%; 1.2 - 25%
		3/217 Rose River	1.1 - 65%; 1.2 - 35%
		24/201 Wonnangatta River	1.1 - 75%; 1.2 - 18%; 1.3 - 7%
		24/206 Wonnangatta River	1.1 - 50%; 1.2 - 35%; 1.3 - 15%
3	1.2, 1.1, 1.3	5/214 Delatite River	1.2 - 70%; 1.1 - 28%; 1.3 - 2%
		25/217 Barkly River	1.2 - 70%
		25/209 Macalister River	1.2 - 75%; 1.1 - 20%; 1.3 - 5%
		25/219 Macalister River	1.2 - 85%; 1.3 - 15%
3	3.1, 8.2	35/208 Gellibrand River	3.1 - 50%; 8.2 - 50%
3	3.4	26/218 Narracan Creek	3.4 - 100%
		26/410 Traralgon Creek	3.4 - 100%
		26/405 Middle Creek	3.4 - 90%; 9.3 - 10%
		27/219 Bass River	3.4 - 100%
		27/211 Agnes River	3.4 - 100%
		27/216 Albert River	3.4 - 100%
		27/213 Jack River	3.4 - 100%
		27/210 Bruthen Creek	3.4 - 100%

Appendix VIII (continued)

Hydrological regions	Geomorphic unit groups	Basin/flow gauge, stream	% area of each geomorphic unit in flow gauge catchment
2	1.1, 1.3 (north)	1/214 Mitta Mitta River	1.1 - 92%; 1.3 - 8%
2	1.1, 1.3 (south)	22/206 Buchan River	1.1 - 85%; 1.3 - 15%
		22/213 Suggan Buggan River	1.1 - 70%; 1.3 - 30%
2	1.1 (north)	1/218 Tallangatta Creek	1.1 - 100%
		2/204 Yackandandah Creek	1.1 - 100%
		3/214 Happy Valley Creek	1.1 - 100%
		3/224 Hurdle Creek	1.1 - 93%; 4.2 - 7%
		4/208 Moonee Creek	1.1 - 100%
		5/228 Hughes Creek	1.1 - 100%
		5/237 Seven Creeks	1.1 - 100%
2	1.1 (south)	21/201 Cann River	1.1 - 100%
		22/202 Brodribb River	1.1 - 100%
		25/213 Aberfeldy River	1.1 - 100%
		26/017 Jacobs Creek	1.1 - 100%
		28/212 Bunyip River	1.1 - 100%
		28/204 Dandenong River	1.1 - 100%
		28/217 Toomuc Creek	1.1 - 96%; 9.1 - 4%
2	1.1, 1.2	3/213 Fifteen Mile Creek	1.1 - 60%; 1.2 - 40%
		4/207 Holland Creek	1.1 - 50%; 1.2 - 35%; 4.2 - 15%
2	1.2, 1.1, 1.3	25/211 Avon River	1.2 - 75%; 1.1 - 22%; 1.3 - 2%
2	1.1, 9.3	21/204 Thurra River	1.1 - 40%; 9.3 - 55%; 9.1 - 5%
		21/210 Genoa River	1.1 - 32%; 9.3 - 6%; 9.1 - 2% (NSW - 60%)
2	2.1, 7.1	7/221 Jim Crow Creek	2.1 - 80%; 7.1 - 20%
		31/209 Werribee River	2.1 - 35%; 7.1 - 65%
		31/213 Lerderderg River	2.1 - 95%; 7.1 - 5%
2	3.4, 9.3, 9.2	26/408 Morwell River	3.4 - 55%; 9.3 - 45%
		26/406 Little Morwell River	3.4 - 30%; 9.3 - 70%
		27/200 Tarra River	3.4 - 50%; 9.3 - 50%
		27/202 Tarwin River	3.4 - 88%; 9.2 - 12%
2	7.1, 8.1	37/202 Fitzroy River	7.1 - 80%; 8.1 - 20%
2	8.2, 7.1, 7.2	35/211 Kennedys Creek	8.2 - 100%
		35/203 Curdies River	8.2 - 75%; 7.1 - 13%; 7.2 - 12%
		36/212 Brucknell Creek	8.2 - 55%; 7.1 - 45%
1	1.1, 1.3	1/215 Morass Creek	1.1 - 95%; 1.3 - 5%
		23/202 Tambo River	1.1 - 90%; 1.3 - 10%
1	1.1 (south)	23/204 Nicholson River	1.1 - 100%
		29/218 Watsons Creek	1.1 - 100%
1	1.1, 4.2	5/229 Wanalta Creek	1.1 - 70%; 4.2 - 30%
		5/226 Pranjip Creek	1.1 - 40%; 4.2 - 60%
		5/230 Cornella Creek	1.1 - 45%; 4.2 - 25%; 2.1 - 30%
1	2.1, 7.1	7/220 Bet Bet Creek	2.1 - 75%; 7.1 - 25%
		7/215 Loddon River	2.1 - 85%; 7.1 - 8%; 7.2 - 7%
		7/213 McCallum Creek	2.1 - 60%; 7.1 - 40%
		30/204 Riddells Creek	2.1 - 70%; 7.1 - 30%
		33/215 Leigh River	2.1 - 70%; 7.1 - 30%
		34/201 Woady Yaloak River	2.1 - 80%; 7.1 - 20%
1	2.1	6/214 Axe Creek	2.1 - 100%
		8/200 Avoca River	2.1 - 98%; 4.2 - 2%
		8/202 Avoca River	2.1 - 100%
		15/207 Wimmera River	2.1 - 100%
1	2.1, 4.2	7/253 Piccaninny Creek	2.1 - 55%; 4.2 - 45%
		7/236 Mt Hope Creek	2.1 - 45%; 4.2 - 55%
		8/203 Avoca River	2.1 - 78%; 4.2 - 20%; 6.1 - 2%

Appendix VIII (continued)

Hydrological regions	Geomorphic unit groups	Basin/flow gauge, stream	% area of each geomorphic unit in flow gauge catchment
1	2.2	38/221 Dwyer Creek	2.2 - 100%
1	2.3, 2.4	38/223 Wando River	2.3 - 90%; 2.4 - 10%
		38/229 Chetwynd River	2.3 - 100%
1	7.1, 2.1	7/214 Creswick Creek	7.1 - 70%; 2.1 - 30%
		7/222 Tullaroop Creek	7.1 - 85%; 2.1 - 15%
		30/200 Maribyrnong River	7.1 - 65%; 2.1 - 35%
		30/205 Maribyrnong River	7.1 - 70%; 2.1 - 30%
		30/208 Maribyrnong River	7.1 - 55%; 2.1 - 45%
		32/200 Little River	7.1 - 70%; 2.1 - 30%
		32/204 Moorabool River	7.1 - 60%; 2.1 - 40%
		32/202 Moorabool River	7.1 - 55%; 2.1 - 45%
		36/203 Mt Emu Creek	7.1 - 75%; 2.1 - 25%
1	7.1, 7.2, 2.1	36/210 Hopkins River	7.1 - 70%; 7.2 - 8%; 2.1 - 22%
		36/209 Hopkins River	7.1 - 70%; 7.2 - 12%; 2.1 - 18%
1	7.1, 7.2, 8.1 8.2	37/205 Darlot Creek	7.1 - 80%; 7.2 - 14%; 8.1 - 6%
		37/206 Eumeralla Creek	7.1 - 70%; 7.2 - 20%; 8.1 - 10%
		37/200 Moyne River	7.1 - 55%; 7.2 - 40%; 8.2 - 5%
1	8.2, 7.2	34/203 Pirron Yallock Creek	8.2 - 60%; 7.2 - 40%;
1	3.3	28/203 Eumemmering Creek	3.3 - 100%

Notes:

1. The river catchment types are identified by a combination of the first two columns above. For example, the second last type listed above - Pirron Yallock Creek catchment - is 1/8.2, 7.2.

2. The hydrological regions are described in Chapter 10 and Table 11.

3. The geomorphic units are outlined in Chapter 9 and Table 10.

Appendix IX

HISTORIC PLACES

This appendix summarises the results of a preliminary inventory of themes and places related to the post-contact occupation of Victoria. The information is drawn from a 1989 report to the Land Conservation Council by I.D. Clark on 'Themes Related to the Past 150 Years of Victoria's Rivers, Streams, and Water Systems'.

The themes and their division are numerically labelled below. The places listed are in basin and theme number order. When a place illustrates more than one theme, this is indicated by listing the additional theme on the following line.

Significance is ranked as follows:

- N Significant at a national level
- S Significant at a State level
- R Significant at a regional level

THEMATIC DIVISIONS

1 CULTURAL CONTACT

1.1 Aboriginal-European contact
- 1.1.1 Sites of conflict over water resources
- 1.1.2 Massacre sites associated with rivers and streams
- 1.1.3 Rivers and Streams with post-contact significance (i.e., named after/by Aborigines)
- 1.1.4 Aboriginal reserves, missions, etc.

2 RIVERS AND COMMUNICATION

2.1 Exploration
- 2.1.1 Campsites, crossing places

2.2 Shipping
- 2.2.1 Vessels
- 2.2.2 Infrastructure
- 2.2.3 Navigation
- 2.2.4 Engineering
- 2.2.5 Informal/folk responses

2.3 Barrier
- 2.3.1 Over river
- 2.3.2 On river (frontage features)
- 2.3.3 On river (river features)
- 2.3.4 Permanent barrier (rivers, streams, swamps etc. that have to be avoided)

3 RIVERS AND WATER SUPPLY (CONSUMPTION)

3.1 Urban
- 3.1.1 Urban foundations
- 3.1.2 Urban/domestic consumption
  - 3.1.2.1 Rivers, lakes as water supply
  - 3.1.2.2 Storage
  - 3.1.2.3 Related engineering
  - 3.1.2.4 Major regional schemes
  - 3.1.2.5 Diversions, pondages, etc.

3.2 Rural (non-metropolitan, non-urban use)
- 3.2.1 *Pastoral properties*

3.2.2 Depots
3.2.3 Regional variations in run siting

4 RIVERS AND RAW MATERIALS AND ENERGY

4.1 Primary industry

4.1.1 Pastoralism
4.1.1.1 Stock use
4.1.1.2 Stock work
4.1.2 Agriculture
4.1.2.1 Irrigation pre-1880s
4.1.2.2 Irrigation post-1880s
4.1.2.3 River drainage
4.1.2.4 Swamp/wetlands drainage
4.1.2.5 Water table control
4.1.3 Mining (Gold)
4.1.3.1 Alluvial (panning)
4.1.3.2 Allvuial (hydraulic)
4.1.3.3 Alluvial (dredging)
4.1.3.4 Deep leads
4.1.4 Mining (other)
4.1.4.1 Coal: stream removal
4.1.4.2 Sand, gravel extraction
4.1.4.3 Salt extraction
4.1.4.4 Tin mining

4.2 Secondary industry
4.2.1 Processing agent
4.2.2 Energy/power source

5 RIVERS AND WELL BEING

5.1 Active
5.1.1. Swimming, water skiing, other sports
5.1.2 Fishing, hunting
5.1.3 Picnicking, camping, hiking
5.1.4 Frontage activities
5.1.5 Boating, canoeing, racing etc.

5.2 Passive
5.2.1 Vistas, aspect, popular frontages, preferred landscapes
5.2.2 Incorporation into public gardens, town plans, civic design etc.
5.2.3 Water as aesthetics

6 RIVERS AND HAZARDS

6.1 Hazards
6.1.1 Flood controls
6.1.1.1 Control/abatement measures
6.1.1.2 Engineering specifics
6.1.1.3 Engineering controls (drainage measures)

6.2 Public health
6.2.1 Waste disposal
6.2.1.1 Collection works
6.2.1.2 Disposal works
6.2.2 Waste transportation
6.2.3 Swamp hazards
6.2.4 Events: drownings, stock losses etc.

6.3 Environmental despoilation
6.3.1 Salinity
6.3.2 Erosion
6.3.3 Inundation

Theme	Feature and name	
BASIN 1		
2.3.1	Rail Bridge (Boggy Creek, Koetong)	S
2.3.1	Rail Bridge (Koetong Creek, Koetong)	S
2.3.1	Rail Bridge (Boundary Creek, Shelley)	S
2.3.1	Rail Bridge (Boundary Creek, Shelley)	S
2.3.1	Rail Bridge (Boundary Creek, Shelley)	S
2.3.1	Rail Bridge (Reids Creek, Shelley)	S
3.1.1	Tallangatta (Lake Hume)	S
3.1.1	Flooding of Tallangatta by Lake Hume	R
4.1.3.2	Hydraulic Sluicing (Mitta Mitta River)	R
4.1.3.2	Oriental Claims (Livingstone Creek Omeo)	S
4.2.2	Cassilis Gold Mining Co. Victoria Falls (near Omeo)	S
BASIN 2		
2.3.1	Stone Bridge (Yackandandah Ck, Yackandandah)	S
2.3.1	Rail Bridge (Kiewa River, Bandiana)	S
2.3.1	Road Bridge (Commissioners Creek, Yackandandah)	S
BASIN 3		
1.1.4	Lake Moodemerre Aboriginal Reserve	S
2.3.1	Newtown Bridge (Spring Creek, Beechworth)	S
2.3.1	Rail Bridge (Ovens River, Wangaratta)	S
2.3.1	Escort Bridge (Black Dog Creek, Rutherglen)	S
2.3.1	Three Chain Bridge (Black Dog Creek, Rutherglen)	S
2.3.1	Road Bridge (Ovens River, Bright)	S
2.3.2	Horse & Jockey Hotel (Black Dog Ck,Chiltern)	R
2.3.3	Foord's Punt site (Murray River, Wahgunyah)	R
3.1.1	Black Dog Ck. Conservation Precinct (Chiltern)	R
3.1.2.2	Barambogie Reservoir (Barambogie Ck, Chiltern)	R
3.1.2.2	Happy Valley Water Reserve	R
4.1.2.1	Chinese Gardens (Reedy Creek, Eldorado)	R
4.1.3	Beechworth Historic Park	S
4.1.3	Cunningham Gully Mine Site & Weona Mine Plant	S
4.1.3.1	Pennyweight Flat Water Race (Beechworth)	R
4.1.3.1	Woolshed Reedy Creek Alluvial Gold Field	R
4.1.3.1	Cyanide Quartz Treatment Works (Chiltern)	R
4.1.3.1	Nine Mile Creek Alluvial Gold workings (Stanley)	S
4.1.3.2	Rocky Mountain Extended Gold Mining Co. Tunnel Race	S
4.1.3.2 4.1.3.3	Gold & Tin Mining (Reedy Creek, Eldorado)	R
4.1.3.3	Bucket Dredging (Ovens R. Valley)	S

Theme	Feature and name	
BASIN 3 (continued)		
4.1.3.3	Cock's Pioneer 'Topcut' Open Cut Mine (Eldorado)	R
4.1.3.3 4.2.4.4	Cock's Eldorado Gold Dredging Co Dredge (Eldorado)	S
4.1.3.4	Water Wheel & Race (Wandiligong)	R
4.1.3.4	Reform Quartz Gold Mine (Happy Valley Ck, Myrtleford)	R
4.1.3.4	Wallaby Quartz Gold Mine (Nine Mile Ck, Stanley)	S
4.2.1	Flour Mill (Milawa)	S
5.2.3	Cemetery (Ovens River, Bontherambo)	S
5.2.3	Cemetery (Reedy Creek, Eldorado)	S
5.2.3	Cemetery (Buckland River, Buckland)	S
6.1.1.3	Granite culvert (Woolshed -Eldorado Road)	R
BASIN 4		
2.3.1	Rail Bridge (Broken River, Benalla)	S
2.3.1	Road Bridge (Broken River, Benalla)	S
4.2.1	McLelland's Spring Creek Saw Mills (Moorngag)	R
4.2.1	McCashney & Harper's Mill Site & Tramway (Ryans Ck)	R
BASIN 5		
1.1.4	Goulburn River Aboriginal Protectorate Station	S
2.1.1	Chateau Tabilk Winery (Tabilk)	S
2.2.1	Kilmore Creek & Hudson Park Precinct (Kilmore)	R
2.3.1	Hanford's Creek Railway Bridge (Pyalong)	S
2.3.1	Mollison's Creek Railway Bridge (Pyalong)	S
2.3.1	Rail Bridge (Goulburn River,Seymour)	S
2.3.1	Fry's Bridge (Goulburn River, Howqua)	S
2.3.1	Chinaman's Bridge (Goulburn River, Nagambie)	S
2.3.1	Road Bridge (Hughes Creek, Avenel)	S
2.3.1	Road Bridge (Pranjip Creek, Old Longwood)	S
2.3.1 5.2.1	Kilmore Creek North (Reserve)	R
2.3.1 5.2.1	Kilmore Creek South (Reserve)	R
2.3.3	Site of Day's Punt (Goulburn River, Noorilim)	R
3.1.1	Darlingford Reach (Lake Eildon)	R
3.1.2.2 5.1.1	Lake (Kilmore)	R
3.1.2.3	Goulburn Weir, Stuart Murray Channel, et al	W
3.1.2.3	Water Trust Pump (Goulburn River, Murchison)	S
3.1.2.3	Wanalta Weir Water Trust	R

Appendix IX (continued)

Theme	Feature and name	
BASIN 5 (continued)		
3.2.1	Coach House (Hume Highway, Hughes Ck Bridge, Avenel)	S
4.1.2.2	Warranga Irrigation System	S
4.1.3.1	Lehman's Water Race (Gaffney's Ck, Wood's Point)	S
4.1.3.2	Hydraulic Sluicing Claim (Brankeet Ck, Tallangallook)	R
4.1.4.2	Broadford Quarry (Sunday Creek, Broadford)	R
4.2.1	Brewery Hill (Kilmore)	R
4.2.1	Maxfield Flour Mill (Kilmore)	S
4.2.1	Former Albion Flour Mill (Kilmore)	R
4.2.1 4.2.2	Trainor's Steam Flour Mill (Kilmore)	R
4.2.2	Days Flour Mill (Murchison)	S
5.1.5	Murchison Rowing Club (Goulburn River, Murchison)	R
5.2.3	Burial Site (Broken River, Benalla)	S
BASIN 6		
2.2.1	Paddle Steamer 'Adelaide'	R
2.2.1	Hulks of River Barges (Murray River,Echuca)	R
2.2.2	Echuca Wharf	S
2.2.2	Port of Echuca Customs House	R
2.2.2	Site of Clough's Wharf (Murray River, Echuca)	R
2.2.2 4.2.1	Timber Sawmill & Log Slipway (Murray River, Echuca)	R
2.2.2 4.2.2	Echuca Conservation Area	S
2.3.1	Railway Viaduct (Coliban River, Malmsbury)	S
2.3.1	Taradale Viaduct (Back Creek)	S
2.3.1	Mia Mia Bridge (Campaspe River, Redesdale)	S
2.3.1	Bridge (Murray River, Echuca)	S
2.3.1	Woodend Bridge (Five Mile Creek)	S
2.3.1	Rail Bridge (Campaspe River, Carlsruhe)	S
2.3.1	Rail Bridge (Campaspe River,Rochester)	S
2.3.1	Russell's Bridge (Campaspe River, Fosterville)	S
2.3.1	Road Bridge (Campaspe River, Kyneton)	S
2.3.1	Road Bridge (Campaspe River, Rochester)	S
2.3.1	Site of Hopwood's Campaspe Bridge (Echuca)	R
2.3.1	Road Bridge (Five Mile Creek, Woodend)	S
2.3.2	Site of Maiden's Inn & Murray River Crossing (Echuca)	R
2.3.2	Steam Packet Hotel (Echuca)	R
2.3.2	Bridge Hotel (Murray River, Echuca)	R
2.3.3	Site of Hopwood's Pontoon Bridge & Punt (Echuca)	R

Theme	Feature and name	
BASIN 6 (continued)		
2.3.3	Ferry Site (Campaspe River, Echuca)	R
3.1.2.1	Pumping Station (Murray River, Echuca)	R
3.1.2.2 4.1.3.1	Argyle Dam & nearby Water Works	R
3.1.2.3	Heathcote Water Supply Race	R
3.1.2.4	Coliban Water Supply Regional Scheme	S
3.1.2.4	Hazlett's Water Race (Poverty Gully - Fryerstown)	S
4.1.3.1	Puddling machines & dams (Curly Dog Ck, Heathcote)	R
4.1.4	Stone Quarry (Coliban River, Malmsbury)	R
4.2.1	Tannery (Mandurang)	R
4.2.1	Flour Mill (Murray River, Echuca)	R
4.2.1	Degrave's Mill (Campaspe River, Carlsruhe)	S
4.2.1 4.2.2	Blythe Brothers Mill (Coliban River, Malmsbury)	R
4.2.1 4.2.2	Ellis' Mill (Coliban River)	R
4.2.2	Pumping Station (Murray River, near Moama Bridge)	S
5.2.1	Boggy Creek Mineral Spring (Campaspe River)	R
5.2.2	Malmsbury Botanic Gardens	S
5.2.3	Cemetery (Murray River, Echuca)	S
BASIN 7		
2.2.1	Major Mitchell Crossing (Loddon River, Fernihurst)	R
2.2.4 4.1.3	Jim Crow Dredging Remains	R
2.3.1	Rail Bridge (Barkers Creek, Harcourt)	S
2.3.1	Rail Bridge (Buckeye Creek, Ravenswood)	S
2.3.1	Rail Bridge (Creswick Creek, Creswick)	S
2.3.1	Road Bridge (Bendigo Creek, Bendigo)	S
2.3.1	Jorgenson's Bridge (Bullarook Creek, Clunes)	S
2.3.1	Road Bridge (Bullarook Creek, Lawrence)	S
2.3.1	Road Bridge (Bullarook Creek, Newlyn)	S
2.3.1	Government Bridge (Creswick Creek, Creswick)	S
2.3.1	Condidorios Bridge (Gunbower Creek, Koondrook)	S
2.3.1	Janevale Bridge (Loddon River, Laanecoorie)	S
2.3.1	Foley's Bridge (Tullaroop Creek, Glengower)	S
2.3.1	Glenmona Road Bridge (Bet Bet Creek, Bung Bong)	S
2.3.1	Road Bridge (Langdons Creek, Blampied)	S
2.3.1	Road Bridge (McCallum's Ck, Dunach)	R
2.3.1	Leonard's Bridge (Creswick's Creek, Clunes)	R

Appendix IX (continued)

Theme	Feature and name	
BASIN 7 (continued)		
2.3.1	Bolties Bridge (Back Creek, Talbot)	R
2.3.1	Road Bridge (Bullarook Crk, Smeaton)	R
2.3.1	Road Bridges (Coghills Creek, Clunes)	R
2.3.1	Bridge (Murray River, Koondrook/Barham)	R
2.3.1	Road Bridge (Murray River, Swan Hill)	S
2.3.1 3.1.1	Creswick's Creek	R
2.3.1 3.1.1	Bet Bet Creek	R
2.3.1 3.1.2	Back Creek	R
2.3.1 3.1.2.2	Tullaroop Creek	R
2.3.1 3.1.2.2	McCallum's Creek	R
2.3.2	Ford (Maldon-Sandy Creek Road)	R
2.3.2 5.2.1	Dulapwhang Waterhole (Bet Bet Creek, Glenmona)	R
2.3.3	Punt & Ferry Site (Loddon River, Eddington)	R
3.1.1	Amhurst Township (Daisy Hill Creek)	S
3.1.1	Talbot Township (Back Creek)	S
3.1.1	Clunes Township (Creswicks Creek)	S
3.1.2.2	Water Reserve Dam (Rheola)	R
3.1.2.2	Carisbrook Reservoir	R
3.1.2.2	Pincotts Reservoir	R
3.1.2.2	'Big Water Hole' & Basalt Cellar (Back Ck, Talbot)	R
3.1.2.2	Talbot Reservoir (Stony Creek, Evansford)	R
3.1.2.2	Ararat Reservoir	R
3.1.2.2 3.1.2.3	Crocodile Reservoir and Aqueducts (near Newstead)	R
3.1.2.2 4.1.3.1	Eaton's Dam & Associated Waterworks (Creswick)	R
3.1.2.2 4.1.3.1	St Georges Lake (Creswick)	R
3.1.2.2 4.1.3.1	*Nuggetty Dam*	R
3.1.2.2 4.1.3.1	Amherst Reservoir	R
3.1.2.2 4.1.3.1	'Big Dam' (Creswicks Creek, Clunes)	R

Theme	Feature and name	
BASIN 7 (continued)		
3.1.2.2 5.2.1	Recreation Reserve (Tarnagulla)	R
3.1.2.2 5.2.1	Dam (Coghill's Creek, Clunes)	R
3.1.2.2 3.1.2.3	Clunes Water Supply Works (Birch's Ck)	S
3.1.2.3	Loddon United Waterworks Trust Relics	R
3.1.2.3	Loddon Chewton Water Race	R
3.1.2.3	Water channel (Harney's Bridge, Bendigo)	R
3.2.2 5.2.1	Camp Reserve & Environs (Castlemaine)	R
4.1.1.2	Cotswold Sheep Wash (Moolort)	R
4.1.3	Water Channel (*Daylesford-Upper Loddon State Forest*)	R
4.1.3	Jubilee Mine & Dam	R
4.1.3.1	River Shafts (Spring Gully, near Bendigo)	R
4.1.3.1	Chinese Camp (Creswick)	R
4.1.3.1	Forest Creek Environs (Castlemaine)	R
4.1.3.1	Barkers Creek Environs (Castlemaine)	R
4.1.3.1	Puddler Dam (Tambourine Gully, near Wedderburn)	R
4.1.3.1	Puddling Machine (Golden Gully, near Fryerstown)	R
4.1.3.1	Alluvial Panning (Castlemaine district)	S
4.1.3.1	Blowhole (Sailors Ck, Hepburn Regional Park)	R
4.1.3.2	Water Wheel Abutments (Mopoke Gully, Yapeen)	R
4.1.3.3	Gold Dredge & Dragline Excavator (Maldon)	R
4.1.3.3	Bromley Gold Dredge Site (Bromley, near Dunolly)	R
4.1.3.4	Mining Sites (Maldon Township)	S
4.1.3.4	Maynard's Mine (Marong)	R
4.1.3.4	Frederick the Great Mine (Sebastion)	R
4.1.3.4	Garfield Water Wheel Base (Chewton)	S
4.1.3.4	Duke & Main Lead Consols Mine (Loddon R, Eddington)	R
4.1.3.4	Victoria Hill Conservation Area (Bendigo)	S
4.1.3.4	Belgian & Perserverence Mines (Barp, near Bet Bet)	R
4.1.3.4	Deep Lead Mining (Creswick region)	S
4.1.3 4.2.2	Central Lake and Springs Reserve	S
4.1.3 5.2.1	Sailors Falls & Sailors Falls Springs	R
4.2.1	Flour Mill (Birch Ck, Smeaton)	S
4.2.1	Bridgewater Flour Mill	R
4.2.1	Steam Flour Mill (Barker's Ck, Castlemaine)	S

Appendix IX (continued)

Theme	Feature and name	
BASIN 7 (continued)		
4.2.1	Anderson's Mill (Smeaton)	S
4.2.1 4.2.2	Flour Mill (Loddon River, Newstead)	R
5.1.1	Public Baths Reserve (Clarkesdale)	R
5.2.1	Hepburn Springs Reserve	S
5.2.1	Loddon Falls & Reserve	R
5.2.2	Castlemaine Botanical Gardens (Barkers Creek)	R
6.1.1.1	Walling of Bendigo Creek (Bendigo)	R
6.1.1.3	Bridge Culvert (Spring Ck, Breakneck Gorge Rd)	R
BASIN 8		
2.2.1	Wreck of the 'Kookaburra' (Murray River, Nyah)	R
2.3.1	Road Bridge (Avoca River, Quambatook)	S
3.1.2.2	Reservoir (St Arnaud)	R
3.1.2.2	Dam (Boola Boloke)	R
3.1.2.2	Water Race & Dam (Boola Boloke)	R
4.1.2.2	Flume (Tyntynder Main Channel RWC easement)	R
4.1.2.2	Flume (Tyntynder Main Channel, RWC easement)	S
4.1.2.2	Flume (Tyntynder Main Channel, RWC easement)	S
4.1.2.2	Cannie Ridge Irrigation Pump (Murray River)	R
4.1.2.2	Nyah Pumping Station	R
4.1.3.1	Puddler (Percydale)	R
4.1.3.1	Puddler (Carapooee)	R
4.1.3.1	Murray's Puddler (Carapooee West)	R
4.1.3.3	Avoca River Dredging Dams and Alluvial Workings	R
4.1.3.3	Donkey Hill Slate Quarry & Mine (Yehrip, near Avoca)	R
4.1.3.4	Rodwell's Reef (Yehrip, near Avoca)	R
BASIN 14		
2.2.1	Wreck of the 'Alewein' (Murray River, Piangil)	R
2.2.1	Wreck of barge 'Florence Annie' (Murray-Kulkyne N.P)	R
2.2.1	Wreck of the 'Hero' (Boundary Bend, Murray River)	S
2.2.3	602 Mile Tree (Boundary Road)	R
3.1.2.1	Windmill (Robinvale Urban water supply)	R
3.1.2.2	Iron Clad Catchment Tank	R
3.1.2.2	Nowingi Iron Clad Catchment	S
3.1.2.2	Log tank (Trinita)	S
3.1.2.3	Lockmaster's residence (Murray River, Kulkyne East)	R
3.1.2.3	Millewa C re-lift pumping station (Yarrara)	R

Theme	Feature and name	
BASIN 14 (continued)		
3.1.2.3	Redcliffs A Re-lift Pumping Station	S
3.1.2.3	Old Redcliffs Urban Pump	S
3.1.2.3	Redcliffs C Re-lift Pumping Station	S
3.1.2.3	Psyche Bend Pumping Station	S
3.1.2.3	Kings Billabong Pumping Station	S
3.1.2.3	Nichols Point Pumping Station	R
3.1.2.3 4.1.1.1	Millewa A Pumping Station (Lock 9, Murray River)	S
4.1.2.2	Merbein Main Pumping Station	R
4.1.4.3	Tramway Formation (Lake Becking)	R
4.1.4.3	Spectacle Lake Salt Harvesting Area	R
5.2.3	Cemetery (Murray River, Mildura)	S
5.2.3	Cemetery (Murray River, Mildura)	S
BASIN 15		
1.1.4	Ebenezer Aboriginal Mission (Wimmera R, Antwerp)	S
2.3.1	Bridge Remnant (Wirrengren Plain Inlet Creek)	R
2.3.1 2.3.2	Bridge (Richardson River, Donald) & Meyer's Shanty	R
2.3.2	Ford (Wimmera River)	R
2.3.2	Four Posts Inn (Wimmera River, Glenorchy)	R
2.3.2	Ford (Wimmera River, Glenorchy)	R
3.1.2.2	Water Tower (Yarriambiack Ck, Warracknabeal)	S
3.1.2.2	Hullard's Iron Clad Catchment Tank (adj Wyperfeld)	R
3.1.2.2	Hullard's Iron Clad Catchment Tank (adj Wyperfeld)	S
3.1.2.2	Reservoir (Yarriambiack Creek)	R
3.2.1 5.2.2	Dam & Historic Garden (Woodlands, Wimmera River)	R
4.1.2.2	Experimental Orchard (Yarriambiack Ck, Hopetoun)	R
4.1.3.4	Wattle Creek Tunnel Gully (Landsborough)	R
4.2.1	Stewart's Fellmongering Shed (Wimmera R, Glenorchy)	R
4.2.1 4.2.2	Wehl's industries (Pleasant Creek, Stawell Flat)	S
4.2.1 4.2.2	Fellmongery & Tannery (Wimmera River, Horsham)	R
4.2.1 4.2.2	Oliver's Mill (Nhill)	R
5.1.2	Lake Buloke	S
5.2.3	Cemetery (Wimmera River, Horsham)	S

Appendix IX (continued)

Theme	Feature and name	
BASIN 21		
2.3.1	Road Bridge (Bemm River, Bemm River)	S
2.3.1	Road Bridge (Lower Bemm River, Bemm River)	S
2.3.1	Road Bridge (Princes Highway, Genoa River)	R
2.3.1	Road Bridge (Sardine Ck, East Gippsland)	R
4.1.3.4	Gippsland Boulder Reef Gold Mine (Bola Creek)	R
BASIN 22		
2.2.4	Snagger's Lane (Snowy River, Orbost)	R
2.3.1	Road Bridge (Murrindal River, East Gippsland)	R
2.3.1	Road Bridge (Deddick River, Ambyne)	S
2.3.1	Road Bridge (Snowy River, Orbost)	S
2.3.1	Rail Bridge (Snowy River Flood Plain)	R
2.3.3	Ferry & House Site (Mackillop Bridge, Snowy River)	R
3.1.2.2	Orbost Town Reservoir (Young's Creek)	R
4.1.3.1	Back Creek Alluvial Gold Field (Bendoc)	R
4.1.3.2	Mining Relic (Quinburra River)	R
6.1.1.1	*Flood Retardent Works (Buchan -Orbost Rd, Snowy R.)*	S
BASIN 23		
1.1.2	Butcher's Creek (Metung)	S
1.1.4	Lake Tyers Aboriginal Mission (Lake Tyers)	S
2.2.2	Mossiface Wharf & Swinging Basin (Mossiface)	R
2.2.2	Cross's Landing (Lake Tyers)	R
2.2.2 2.3.2	Tambo Crossing (Tambo River, Omeo Highway)	R
2.2.4	The Entrance (Lakes Entrance)	R
2.3.1	Railway Trestle Bridge (Stoney Creek, Nowa Nowa)	S
2.3.1	Rail Bridge (Nicholson River, Nicholson)	S
2.3.1	Road Bridge (North Arm, Lakes Entrance)	S
2.3.1	Road Bridge (Shady Creek, Tambo Crossing)	S
2.3.1	Road Bridge (Tambo River, Swan Reach)	S
4.1.2.1	Gardener's Creek (Chinaman's Creek, Metung)	R
4.2.1	Sawmill (Maringa Creek, Kalimna)	R
4.2.1 2.2.1	H. Clues Memorial Park (Johnsonville)	R
BASIN 24		
2.2.1	'Burrabogie' (near Government Slip, Paynesville)	R

Theme	Feature and name	
BASIN 24 (continued)		
2.2.2	Waddy Point Wharf (Lake Victoria)	R
2.2.2	Government Slip (Paynesville)	R
2.2.2	Steamer Landing (McMillan Strait, Raymond Island)	R
2.2.2	Silt Jetties (Mitchell River, Gippsland Lakes)	R
2.2.2	Bairnsdale Wharf (Mitchell River, Bairnsdale)	R
3.1.2.2	Bairnsdale Waterworks (Picnic Point, Bairnsdale)	R
4.1.2.2	Glenadale Weir (Mitchell River, Glenadale)	R
4.1.2.2	Taylor's Hop Irrigation Scheme (Mitchell R, Bairnsdale)	S
4.1.3.1	Chinese Workings (Boggy Creek, Melwood)	R
4.1.3.2	Jirnkee Water Race (Wentworth River)	S
5.2.1	Howitt Park (near Mitchell River Bridge, Bairnsdale)	R
BASIN 25		
1.1.4	Ramahyuck Aboriginal Reserve (Avon River, Stratford)	S
2.2.2	Steamer Wharf Site (Avon River, Redbank)	R
2.2.2	Holland's Landing	R
2.2.2	The Loggings (Roseneath)	R
2.2.2	Wharf & Swinging Basin (Thomson River, Sale)	R
2.2.4	Sale Canal	S
2.3.1	Poverty Point Bridge (Thomson River, Walhalla)	S
2.3.1	Brunton's Bridge (Thomson River, Walhalla)	S
2.3.1	Rail Bridge (Avon River, Stratford)	S
2.3.3	Punt Site & Swinging Basin (Avon River, Stratford)	R
3.1.1	Glenmaggie (Lake Glenmaggie)	R
3.1.1	Partial inundation of Glenmaggie township	R
3.1.2.1 4.2.2	Railway Weir (Avon River, Stratford)	R
4.1.2.2	Chinese Gardens (Stringers Creek, Walhalla)	S
4.1.3	Walhalla Conservation Area	S
4.1.3.1	Thomson River Diversion Tunnel (Coopers Ck, Walhalla)	S
4.2.2	Mining Boiler (jnctn of Thomson & Jordan R, Toombo)	S
5.1.5	Rowing Practice Machine (Thomson River, Sale)	R
5.2.1	Knob Reserve (Avon River, Stratford)	R
5.2.3	Cemetery (Thomson River, Sale)	S
BASIN 26		
2.2.2	Seacombe (Shire of Rosedale)	R
2.3.1	Railway Trestle Bridge (Noojee)	S
2.3.1	Swing Bridge (La Trobe River, Longford)	N

Theme	Feature and name	
BASIN 26 (continued)		
3.1.2.2	Reservoir (Tyers Creek, Tyers)	R
4.2.1	Cansick's Tannery (La Trobe River, Rosedale)	S
BASIN 27		
1.1.2	Massacre Site (Warragul Creek)	S
2.3.1	Foot Bridge (Albert River, Balook)	S
2.3.1	Road Bridge (Little Albert River, Hiawatha)	S
4.1.2.4	Hedley Drains (Gellion's Run, Welshpool)	R
4.1.3.1	Jordan River Tunnel (Jericho)	R
4.1.4.4	Toora Tin Field (Tin Mine Creek)	S
4.2.1	Tanneries (Tarraville)	R
4.2.2	Water Wheel (Morning Star Ck, Butgalla)	S
4.2.2	Mining Battery (Dry Creek, Red Jacket, Moolpah)	R
BASIN 28		
4.1.2.4	Koo-Wee-Rup Swamp reclamation scheme	S
BASIN 29		
4.2.2	McVeigh's Water Wheel (Don River, Launching Place)	R
BASIN 30		
2.3.1	Road Bridge (Maribynong River, Keilor)	S
2.3.1	Road Bridge (Jacksons Ck, Sunbury)	S
2.3.1	Railway Bridge (Riddell)	S
2.3.1	Foot Bridge (Deep Creek, Bulla)	S
2.3.1	Rail Bridge (Sunbury Creek, Sunbury)	S
2.3.1	Road Bridge (Deep Creek, Bulla)	S
2.3.1	Road Bridge (Deep Creek, Lancefield)	S
2.3.1	Sunbury Creek Viaduct (Sunbury)	S
2.3.1	Arundel Bridge (Maribynong River, Keilor)	S
2.3.1	Rail Viaduct (Kismet Ck, Rupertswood, Sunbury)	R
4.2.1 4.2.2	Flour Mill (Maribynong River, Bulla)	R
BASIN 31		
1.1.1	Glenmore Station (Parwon Creek & Werribee River)	S

Theme	Feature and name	
BASIN 31 (continued)		
2.3.1	Road Bridge (Djerriwarrh Creek, Bacchus Marsh)	S
2.3.1	Kororoit Creek Road Bridge (Diggers Rest)	R
2.3.1	Melton Viaduct (Werribee River)	S
2.3.1	Rail Bridge (Werribee River, Melton)	S
2.3.2	Ford (Melb-Geel Coach Rd, Werribee River)	S
2.3.2	Coach Ford (Djerriwarrh Creek)	R
3.1.2.2	Melton Reservoir (Werribee River)	R
3.1.2.2 4.2.2	Rowsley Railway Reservoir	R
3.1.2.2 5.1.1	Shaws Lake (Blackwood)	
3.1.2.2 5.2.1	Korweinguboora Reservoir and Mineral Springs	R
3.1.2.3	Bacchus Marsh Water Supply Channel	R
3.1.2.5	McFarlane's Channel (Werribee River, Bacchus Marsh)	R
3.2.1 5.2.1	Werribee Park, Werribee	S
4.1.2.2	Werribee Vale Irrigation System	R
4.1.2.2	Chaffey Experimental Irrigation Scheme (Werribee)	R
4.1.2.2	Pearce Irrigation Works (Bacchus Marsh)	R
4.1.3.1	Tunnel Point (Lerderderg River)	R
4.1.3.1 4.1.3.2	Blackwood Township Historic Area	S
4.2.1	Timber Mill (junction of Lerderderg R. & Nolan Ck.)	R
4.2.2	Water wheel (Lerderderg River, Newburry)	R
5.2.1	Werribee Vale Road Vista (Werribee R, Bacchus Marsh)	R
5.2.3	Cemetery (Werribee River, Ballan)	S
BASIN 32		
1.1.4	Steiglitz Aboriginal Reserve	S
2.3.1	Rothwell Bridge (Little River, Little River)	S
2.3.1	Moorabool Viaduct (Moorabool River, Moorabool)	S
2.3.1	Road Bridge (Moorabool River, Batesford)	S
2.3.1	Rail Bridge (Cowies Creek, Moorabool)	S
2.3.1	Road Bridge (Little River, Little River)	S
2.3.1	Road Bridge (Moorabool River, Fyansford)	N
2.3.1	Road Bridge (West Moorabool River, Mt. Egerton)	S
2.3.1	Bridge (Dog & Rocks Rd, Batesford)	R
2.3.2 2.3.3	Travellers' Rest Inn (Moorabool River, Batesford)	S

Theme	Feature and name	
BASIN 32 (continued)		
3.1.2.2	Moorabool Reservoir	R
3.1.2.2	Lower Stoney Ck Reservoir Wall	R
3.1.2.3	*Stoney Ck Aqueduct & Anakie Gap Bridge Tunnel*	*R*
4.2.1 4.2.2	Hope's Flour Mill (Moorabool River, Batesford)	R
4.2.1 4.2.2	Dann's Mill (Moorabool River, Bannockburn)	R
4.2.2	Bucyrus Steam Shovel (Quarry, Batesford)	S
5.2.1	Lal Lal Falls	S
BASIN 33		
1.1.3	Buckleys Falls	R
1.1.4	Geelong Aboriginal Depot	S
1.1.4	Birregurra Aboriginal Mission	S
1.1.4	Winchelsea Aboriginal Reserve	S
1.1.4	Mt. Duneed Aboriginal Aboriginal Reserve	S
2.3	The Breakwater (Barwon River, Breakwater)	R
2.3.1	Rail Bridge (Muddy Water Holes Creek, Lethbridge)	S
2.3.1	Road Bridge (Barwon River, Winchelsea)	S
2.3.1	Road Bridge (Barwon River, Geelong)	S
2.3.1	Road Bridge (Barwon River, Gnarwarre)	S
2.3.1	Road Bridge (Leigh River, Mt. Mercer)	S
2.3.1	Road Bridge (Waurn Ponds Creek, Waurn Ponds)	R
2.3.1	Road Bridge (Liegh River, Shelford)	S
2.3.2	*Inverleigh Hotel (Leigh River, Inverleigh)*	S
2.3.2	Former 'Lawson's Inn' (Leigh River, Inverleigh)	R
2.3.2	Ford (Barwon River, Winchelsea)	R
2.3.2 2.3.3	Swan Hotel *(ex-Fyanstown Inn, Barwon R, Fyansford)*	S
3.1.2.1 3.1.2.2	Lake Wendouree-Botanic Gardens (Ballarat)	S
3.1.2.2	Gong Gong Reservoir	R
3.1.2.2	Beale's Reservoir	R
3.1.2.2	Wilson's Reservoir	R
3.1.2.2	Kirk's Reservoir	R
3.1.2.2 4.1.3.1	Nerrina Gold Field	R
3.1.2.2 5.2.2	Buninyong Botanic Gardens	R
4.1.3	Yarrowee River	S

Theme	Feature and name	
BASIN 33 (continued)		
4.1.3.1	Mine and Tunnel (Clarendon)	R
4.2.1	Barwon Paper Mill Water Race (Fyansford)	S
4.2.1	*Former Clyde Co. Mill (Russells Bridge,* Bannockburn)	*R*
4.2.1	Sunnyside Wool Scour (Barwon River, Breakwater)	N
4.2.1 4.2.2	Carrah Mill (Barwon River, Inverleigh)	S
5.2.1	'Barwon Grange' (Barwon River, Newtown)	S
5.2.1	'Sladen House' (Barwon River, Newtown)	R
5.2.1	'Barwon Bank' (Barwon River, Newtown)	N
6.1.1.3	Specimen Vale-Yarrowee Creek Area (Ballarat)	R
6.1.1.3	Bridge Abutment (Leigh River, Inverleigh)	R
6.2.2	Barwon River Sewer Aqueduct (Breakwater, Geelong)	S
BASIN 34		
1.1.4	Pirron Yaloak Aboriginal Reserve	S
1.1.4	Ellimynt Aboriginal Reserve	S
2.3.1	Road Bridge (Springdallah Creek, Linton)	S
2.3.1	Road Bridge (Little Woady Yaloak River, Rokewood)	S
2.3.1	Road Bridge (Woady Yaloak River, Cressy)	S
3.1.2.2	Cape Clear Water Reserve	R
4.1.3.2	Sluicing along Woady Yaloak River	R
BASIN 35		
2.3.1	Rail Bridge (Curdies Creek, Timboon)	S
5.2.1	The Sanctuary (Erskine River)	R
BASIN 36		
1.1.1	Lake Bolac & Salt Creek	S
1.1.2	Murdering Gully (Mt. Emu Ck, Merida Station)	S
1.1.2	Lubra Creek (near the Penshurst-Caramut Rd. crossing)	S
1.1.3	Good Morning Bill Creek (runs into Lake Buninjon)	R
1.1.3	Billy Billy Creek (Buangor)	R
1.1.4	'Burrumbeep' Station (Hopkins River)	S
1.1.4	Framlingham Aboriginal Mission (Hopkins River)	S
1.1.4	Lake Keilambete Aboriginal Reserve	S
1.1.4	Lake Terang Aboriginal Reserve	S
1.1.4	Chepstowe Aboriginal Reserve	S

Appendix IX (continued)

Theme	Feature and name	
BASIN 36 (continued)		
2.2.1 6.2.4	'Nestor' sinking (Hopkins River, Warrnambool)	N
2.3.1	Wollaston Bridge (Merri River, Warrnambool)	S
2.3.1	Road Bridge (Burchetts Creek, Caramut)	S
2.3.1	Road Bridge (Hopkins River, Framlingham)	S
2.3.1	Road Bridge (Hopkins Rover, Warrnambool)	S
2.3.1	Road Bridge (Mt. Emu Creek, Darlington)	S
2.3.1	Road Bridge (Mt. Emu Creek, Skipton)	S
2.3.1	Road Bridge (Mt. Emu Creek, Terang)	S
2.3.1	Quamby or Wombagil Bridge (Youls Ck, Woolsthorpe)	S
2.3.1	Stock Bridge (Fiery Ck, Eurambeen)	R
2.3.2	Bluestone Ford (Trawalla Creek, Buangor)	R
3.1.2.2	Langi Ghiran Reservoir	R
3.1.2.2	Goldfields Reservoir	R
4.1.3.1	Water Race (Raglan West)	R
4.2.1	Dallimore's Fellmongery (Lake Gillear)	R
4.2.1 4.2.2	Flour Mill (Hopkins River, Allansford)	R
4.2.2 5.2.1	'Carranballac' Homestead (Mt. Emu & Broken Creeks)	S
5.1.1 5.1.5	Jubilee Park (Hopkins River, Allansford)	R
5.1.2 5.1.4 5.1.5	Proudfoot's Boathouse (Hopkins River, Warrnambool)	S
5.2.1	'Dalvui' Garden (Noorat)	S

Theme	Feature and name	
BASIN 37		
1.1.4	Lake Condah Aboriginal Mission Station	S
2.2.2 4.2.2	Moyne R. Waterfront & Maritime Precinct (Port Fairy)	S
2.3.1	Road Bridge (Scott's Ck, Byaduk)	R
2.3.1	Road Bridge (Scotts Rd, Kirkstall)	R
3.1.2.2	Mainsbridge Weir (Heywood)	S
4.1.1.2	Bessiebelle Sheepwash	S
4.2.1	Moyne Flour Mill (Moyne River, Port Fairy)	R
4.2.1	Hurst's Wool Scouring Indust.(Eumeralla R, Macarthur)	R
4.2.1	Davis Wool Wash (Darlot's Ck, Tyrendarra)	R
4.2.1 4.2.2	McGregor's Timber Mill (Fitzroy River, Heywood)	R
BASIN 38		
1.1.1	Capt. Rupert Allan's station under Mt. William Range	S
1.1.2	Murdering Flat (far end of Clover Flat, Wannon River)	S
1.1.2	Fighting Hills (The Hummocks, Wando Vale)	S
1.1.4	Junction of Wannon and Glenelg Rivers	S
2.3.1	Rail Bridge (Glenelg River, Dartmoor)	R
2.3.1	Road Bridge (Crawford River, Hotspur)	S
2.3.1	Killara Bridge (Glenelg River, Shire of Glenelg)	R
2.3.1	Road Bridge (Glenelg River, Nelson)	R
BASIN 39		
	None recorded to date.	

Appendix X

SITES OF BOTANICAL SIGNIFICANCE

Basin	Stream name	Rating	Community/rare species
Basins 1-8, 14, 29, 30, 31, 37, 38 and 39 (see Note 1) - various sources			
1	Benambra Creek	S	MON-W (E. camphora)
1	Benambra Creek	S	MRF (E. camphora, Acacia melanoxylon)
1	Bucheen Creek	S	WSF
1	Bullhead Creek	S	OF (E. radiata, E. dives)
1	Bundarra River	S	Heath (Podocarpus lawrencei)
1	Bundarra River	S	Riparian (E. pauciflora, E. stellulata, E. radiata)
1	Bunroy Creek	S	Riparian (E. camphora)
1	Burrowye Creek	S	MON. Bog
1	Deep Creek	S	MRF (E. camphora, Acacia melanoxylon)
1	Five Mile Creek	S	Riparian-WSF (E. viminalis, E. obliqua)
1	Gibbo River	R	OF-W (E. macrorhyncha)
1	Gibbo River	S	Aqua
1	Lucyvale Creek	S	WSF (E. radiata)
1	Middle Creek	S	Bog (Richea sp., Sphagnum sp.)
1	Mitta Mitta River	R	OF-W (E. radiata, E. viminalis)
1	Mitta Mitta River	S	-
1	Mitta Mitta River	S	RCS (E. radiata, E. viminalis, Leptospermum brevipes Leptospermum phylicoides)
1	Mitta Mitta River	S	Riparian
1	Morass Creek	S	MON. marsh (Carex sp., Myriophyllum sp., Azolla sp.)
1	Murray River	S	L-Herb (Pseudoraphis spinescens)
1	Murray River	S	Riparian (E. camaldulensis)
1	Murray River	S	Riparian (E. camphora)
1	Sandy Creek	S	Riparian
1	Victoria River	S	W (E. stellulata, E. pauciflora)
1	Wises Creek	S	Riparian
Var	Murray River	R	Grass (Sporobolus mitchellii, Calocephalus sonderi)
Var	Murray River	R	W (E. camaldulensis, various)
Var	Murray River	S	Aqua
Var	Murray River	S	Flood-Grass (Sporobolus sp.)
Var	Murray River	S	Grass (Sporobolus mitchellii, Calocephalus sonderi)
Var	Murray River	S	L-Shrub (Maireana pyramidata)
Var	Murray River	S	L-Shrub (Pachycornia triandra)
Var	Murray River	S	LW-LOW (E. largiflorens, Atriplex nummularia)
Var	Murray River	S	OF (E. camaldulensis)
Var	Murray River	S	OF (E. camaldulensis, Eleocharis acuta)
Var	Murray River	S	Riparian (E. largiflorens, E. camaldulensis)
Var	Murray River	S	Sedge (Eleocharis pallens)
Var	Murray River	S	Shrub (Muehlenbeckia cunninghamii)
Var	Murray River	S	T-Shrub (Acacia stenophylla)
Var	Murray River	S	T-Shrub (Melaleuca lanceolata)
Var	Murray River	S	T-Shrub (Muehlenbeckia cunninghamii)
Var	Murray River	S	Various
Var	Murray River	S	Various riparian sp.
Var	Murray River	S	W (E. camaldulensis)
Var	Murray River	S	W (E. camaldulensis), Grass (Chenopodium sp.), US, Aqua (Typha sp.)
Var	Murray River	S	W (E. camaldulensis, E. largiflorens)
Var	Murray River	S	W (E. camaldulensis, E. largiflorens)
Var	Murray River	S	W (E. camaldulensis, E. largiflorens)
Var	Murray River	S	W (E. camaldulensis), (E. largiflorens, Chenopodium sp.), (E. largiflorens)
Var	Murray River	S	W (E. camaldulensis, E. microcarpa)
Var	Murray River	S	W (E. camaldulensis, Paspalum distichum)
Var	Murray River	S	W (E. largiflorens)
Var	Murray River	S	W (E. largiflorens)
Var	Murray River	S	W (E. largiflorens)
Var	Murray River	S	W (E. largiflorens, Chenopodium nitrariaceum)
Var	Murray River	S	W (E. largiflorens, Chenopodium nitrariaceum)
Var	Murray River	S	W (E. largiflorens, Chenopodium nitrariaceum)
Var	Murray River	S	W (E. largiflorens, Chenopodium sp.)
Var	Murray River	S	W (E. largiflorens, E. camaldulensis)
Var	Murray River	S	W (E. largiflorens), Shrub (Muehlenbeckia cunninghamii)

Appendix X (continued)

Basin	Stream name	Rating	Community/rare species
Var	Murray River	S	W-Grass-Herb (E. camaldulensis, E. largiflorens, Sporobolus Sp., Centaurium sp.)
Var	Murray River	S	W-OW (E. largiflorens, Chenopodium nitrariaceum)
Var	Murray River	S	W-OW (E. largiflorens, Danthonia sp.)
Var	Murray River	S	W-OW (E. microcarpa, E. melliodora)
Var	Murray River	S	Wood (E. largiflorens)
2	Bogong Creek	S	MRF (Leptospermum grandifolium)
2	Kiewa River	S	Bog (Sphagnum)
2	Kiewa River East Branch	S	Bog, Heath (Sphagnum sp.)
2	Pretty Valley Creek	S	MRF (Leptospermum grandifolium)
2	Rocky Valley Creek	S	Herb (Caltha introloba)
3	King River	S	Riparian (E. camphora)
3	Ovens River	S	OF-W (E. camaldulensis)
3	Ovens River	S	Riparian (E. camaldulensis, Acacia dealbata), Grass, US
4	Broken Creek	S	OF (E. camaldulensis, E. melliodora, E. microcarpa)
4	Broken Creek	S	W (E. largiflorens)
4	Broken Creek	S	W-OF (E. microcarpa)
4	Broken River	S	OF (E. albens, E. microcarpa)
4	Murray River (Barmah)	N	Grass (Pseudoraphis spinescens)
4	Murray River (Barmah)	N	OF-W (E. camaldulensis)
4	Murray River (Barmah)	N	OW (E. microcarpa, E. melliodora, E. largiflorens)
4	Murray River (Barmah)	N	Rush (Juncus ingens)
4	Murray River (Barmah)	N	W-OF (E. camaldulensis, various)
4	Murray River (Barmah)	R	Sedge (Eragrostis sp., Fimbristylis sp.)
4	Murray River (Barmah)	S	OF (E. camaldulensis, Carex tereticaulis)
4	Murray River (Barmah)	S	TOF (E. camaldulensis, Pseudoraphis spinescens)
4	Murray River (Barmah)	S	W (E. microcarpa)
4	Murray River (Barmah)	S	Wet Grass (Amphibromus gracilis)
4	Murray River (Barmah)	S	Wetland (Ampibromus gracilis, Pseudoraphis spinescens, Marsilea angustifolia)
5	Acheron River	S	CTR (Nothofagus cunninghamii, Atherosperma moschatum)
5	Acheron River	S	MCF (Nothofagus cunninghamii, Atherosperma moschatum)
5	Acheron River	S	OF (E. ovata, E. camphora)
5	Acheron River	S	Riparian-WSF (E. viminalis)
5	Acheron River	S	WSF (E. regnans, Acacia dealbata)
5	Acheron River	S	WSF-FG (Nothofagus cunninghamii, E. regnans)
5	Acheron River	R	Riparian-TOF (E. viminalis)
5	Frenchman Creek	S	Riparian-WSF (E. viminalis)
5	Goulburn River	S	Aqua
5	Goulburn River	S	OF (E. camaldulensis)
5	Goulburn River	S	OF-W (E. camaldulensis, E. microcarpa)
5	Goulburn River	S	W-OF (E. camaldulensis, E. melliodora, E. microcarpa)
5	King Parrot Creek	N	CTR (Nothofagus cunninghamii, Atherosperma moschatum)
5	King Parrot Creek	N	WSF (E. obliqua, E. regnans)
5	King Parrot Creek	N	WSF (E. regnans)
5	Oaks Creek	S	Riparian-WSF (E. viminalis)
5	Taggerty River	R	Heath (Richea sp., Epacris sp.)
5	Taggerty River	S	Bog-OHeath (Sphagnum sp., Poa sp, Epacris sp.)
5	Torbreck River	S	Bog-OHeath (Sphagnum sp., Poa sp, Epacris sp.)
6	Campaspe River	S	OF-W (E. camaldulensis, E. largiflorens, E. microcarpa)
6	Campaspe River	S	Riparian (E. camaldulensis, E. viminalis)
7	Bullock Creek	S	OF-W (E. camaldulensis, E. largiflorens, E. microcarpa)
7	Bullock Creek	S	W-OF (E. largiflorens, E. camaldulensis)
7	Creswick Creek	S	
7	Loddon River	R	W (E. largiflorens)
7	Loddon River	S	W (E. camaldulensis)
7	Mount Hope Creek	S	OF-W (E. camaldulensis, E. largiflorens, E. microcarpa)
7	Murray River (Gunbower)	S	OF-W (E. camaldulensis)
7	Murray River (Gunbower)	S	SHRUB (Muehlenbeckia cunninghamii)
14	Lindsay River	N	W (E. largiflorens, Chenopodium nitrariaceum)
14	Lindsay River	S	W (E. camaldulensis), Grass (Sporobolus sp), Herb (Centaurium sp.)
14	Wallpolla Creek	N	W (E. largiflorens, Chenopodium, Nitrariaceum)
14	Wallpolla Creek	S	W (E. camaldulensis, Herb (Cent. sp.), Paspalum sp.), Grass (Sporobolus sp.)
14	Wallpolla Creek	S	W (E. largiflorens)
29	Armstrong Creek	S	WSF-FG (Nothofagus cunninghamii, E. regnans)
29	Britannia Creek	S	FG (Dicksonia antarctica)
29	Britannia Creek	S	Riparian-WSF (E. viminalis)
29	Cement Creek	N	WSF (E. regnans, E. delegatensis, E. cypellocarpa, E. radiata)
29	Cement Creek	S	WSF-FG (Nothofagus cunninghamii, E. regnans)

Appendix X (continued)

Basin	Stream name	Rating	Community/rare species
29	Clear Creek	R	DSF (E. dives)
29	Contentment Creek	S	WSF-FG (Nothofagus cunninghamii, E. regnans)
29	Grace Burn	N	WSF (E. regnans)
29	Grace Burn	S	Riparian (E. viminalis)
29	Grace Burn	N	CTR (Nothofagus cunninghamii, Atherosperma moschatum)
29	Grace Burn	R	WSF-FG (Nothofagus cunninghamii, E. regnans)
29	Grace Burn	S	DSF (E. obliqua, E. radiata, E. dives)
29	Grace Burn	S	MRF (Nothofagus cunninghamii, Atherosperma moschatum)
29	Little Yarra River	R	Swamp (E. obliqua, E. viminalis)
29	McMahon Creek	S	DSF (E. radiata, E. cypellocarpa)
29	Merri Creek	S	Grass (E. camaldulensis, Themeda sp.)
29	Merri Creek	S	Riparian (E. camaldulensis, Callistemon sieberi)
29	O'Shannassy River	N	CTR (Nothofagus cunninghamii, Atherosperma moschatum)
29	O'Shannassy River	N	WSF (E. regnans)
29	O'Shannassy River	N	WSF-FG (Nothofagus cunninghamii, E. regnans)
29	O'Shannassy River	S	DSF (E. obliqua, E. radiata, E. dives)
29	O'Shannassy River	S	Riparian (E. viminalis)
29	Olinda Creek	S	OF (E. ovata, E. viminalis)
29	Olinda Creek	R	WSF-DSF (E. obliqua, E. radiata)
29	Plenty River	S	Aqua
29	Starvation Creek	S	WSF-DSF (E. obliqua, E. cypellocarpa)
29	Tomahawk Creek	S	WSF-DSF (E. obliqua)
29	Wandin Yallock Creek	S	Riparian-WSF (E. viminalis, E. obliqua)
29	Watson Creek	R	Riparian (E. viminalis)
29	Watts River	N	CTR (Nothofagus cunninghamii, Atherosperma moschatum)
29	Watts River	N	WSF (E. regnans)
29	Watts River	S	DSF (E. obliqua, E. radiata, E. dives)
29	Watts River	S	MCF (Nothofagus cunninghamii, Atherosperma moschatum)
29	Watts River	S	Riparian (E. viminalis)
29	Watts River	S	WSF-FG (Nothofagus cunninghamii, E. regnans)
29	Yarra River	N	Flood (E. ovata, E. viminalis)
29	Yarra River	R	Bog (Drimys sp., Richea sp., Trochocarpa clarkei)
29	Yarra River	R	OF (Acacia mucronata, Acacia verticillata)
29	Yarra River	R	OF (E. ovata)
29	Yarra River	S	Flood (E. viminalis, Poa sp.)
29	Yarra River	S	OF (E. viminalis)
29	Yarra River	S	OF-W (E. polyanthemos, E. goniocalyx, E. macrorhyncha)
29	Yarra River	S	Riparian (E. viminalis)
29	Yarra River	S	Riparian (E. viminalis)
29	Yarra River	S	Riparian (E. viminalis, E. ovata)
29	Yarra River	S	Riparian (E. viminalis, E. ovata)
29	Yarra River	S	Riparian (E. viminalis, E. ovata)
29	Yarra River	S	Riparian-WSF (E. viminalis)
29	Yarra River	R	Riparian (E. ovata)
30	Jackson Creek	S	OW (E. camaldulensis, E. microcarpa)
31	Lerderderg River	R	Aqua (Carex fasc, Triglochin procera)
31	Lerderderg River	S	Riparian (E. globulus, E. viminalis)
31	Lerderderg River	S	Riparian (E. viminalis, E. St Johnii)
31	Skeleton Creek	S	SM (Halosarcia halocnemoides)
31	Werribee River	R	Riparian (E. camaldulensis)
37	Darlot Creek	S	-
37	Darlot Creek	S	Aqua
37	Darlot Creek	S	Riparian
38	Glenelg River	S	OF (E. camaldulensis)
38	Glenelg River	S	OW (E. camaldulensis)
38	Glenelg River	S	Riparian
38	Glenelg River	S	Riparian
38	Glenelg River	S	Sedge
38	Green Creek	R	OF (E. camaldulensis)
39	Mosquito Creek	S	SM (Eriocaulon australasicum)

Wimmera (see Note 2) - various sources listed in Kunert and Macmillan (1988)

15	Fyans Creek	B	Pultenaea maidenii (B), Burnettia cuneata (B), Swainsona brachycarpa (B), Gonocarpus mezianus (B)
15	Golton Creek	B	Pultenaea graveolens (B)
15	Lake Hindmarsh	A	Acacia trineura (C), Atriplex australasica (A), Bergia ammanioides (A), Cyperus rigidellus (A), Ammania multiflora (A), Sporobolus mitchellii (B), Triglochin hexagona
15	Outlet Creek	A	Psoralea patens (A), Stenopetalum velatinum (A), Triglochin suavissima (B)

Appendix X (continued)

Basin	Stream name	Rating	Community/rare species
15	Wimmera River (Ellis crossing - Wail Forest)	B	Salt paperbark communities (B); riparian community and adjacent woodland/heathland
15	Wimmera River (Wail - Dimboola)	B	Many rare, endangered or localised species
15	Yarriambiack Creek	A	Brachycome curvicarpa (A), Digitaria ammophila (B)

East Gippsland (see Note 3) - Forbes *et al* 1981

21	Back Creek	O	Croton verreauxii, E. agglomerata, Lomandia obliqua
21	Cabbage Tree Creek	O	Cryptostylis erecta, C. hunterana, Leucopogon esquamatus, Pterostylis pedoglossa
21	Combienbar River (headwaters)	O	Athyrium japonicum
21	Dinner Creek	O	Olax stricta
21	Dowell Creek	H	Warm temperate rainforest; Ficus coronata, Lastreopsis microsora, Macroglena caudata, Sambucus australasica, Sphaeropteris australis, Tmesipteris ovata, T. parva
21	Euchre Creek	O	Warm temperate rainforest
21	Harrison Creek	O	Mixed-species rainforest; Ficus coronata, Pittosporum revolutum, Ripogonum album, Sticherus flabellatus
21	Hensleigh Creek	O	Cool temperate rainforest; wet sclerophyll forest
21	Jim Walker Creek	O	Wet sclerophyll, riparian forests
21	Jones Creek	O	Warm temperate rainforest; Lindsaea microphylla, Ripogonum album, Sphaeropteris australis, Tmesipteris ovata
21	Lockup Creek	O	Wet sclerophyll, riparian forests
21	Maramingo Creek	H	Eight rare species
21	Tonghi Creek	O	Wet sclerophyll, riparian forests
21	Upper Genoa River	O	Ten rare species
22	Berrima River	O	Riparian forest
22	Butcher Creek	H	Rulingia pannosa
22	Central Snowy River (Wood Point)	H	Adiantum formosum, Symplocos thwaitesii
22	Deddick River	O	Goodenia grandiflora, Myoporum floribundum
22	Ingeegoodbee River	O	Botrichium lunaria, Corybas hispidus, Pomaderris pallida, Sorghum leiocladum
22	Little River	O	Brachycome petrophila, Corybas hispidus
22	Murrindal River	H	Athyrium japonicum, Centaurea australis, Rulingia pannosa
22	Nelsons Creek	H	Sphagnum spp. pollen record
22	Raymond Creek	O	Riparian community
22	Reedy Creek	O	Botrichium lunaria, Grevillea sp., Poa clivicola, Pomaderris pallida
22	Rodger River	O	Wet sclerophyll forest, rainforests
22	Shaw Creek	H	Adiantum hispidulum, Polystichum formosum, Pteris vittata
22	Snowy River (above Deddick River)	H	Bertya cunninghamii, Desmodium brachypodum, Myoporum floribundum
22	Upper Buchan River	O	Astrotricha crassifolia, Cystopteris filix-fragilis
22	Upper Snowy River (Deddick River-Betts Creek)	O	Eighteen rare species
22	Yalmy River	O	Wet sclerophyll forest, rainforests
23	Deep Creek	H	Beyeria lasiocarpa, Schaeropteris australis
24	Conglomerate Creek (Piemans Creek)	O	Eight rare species
24	Mitchell River (gorge)	H	Bertya cunninghamii, Olearia sp.
24	Moroka River	H	Spyridium eriocephalum
24	Upper Wonnangatta River	H	Montane riparian forest; Pultenaea paleacea

Central Gippsland (see Note 4) - Gullan *et al* 1984

26	Bull Beef Creek	S	Damp sclerophyll forest; woodland
26	Latrobe River	S	Wet sclerophyll forest
26	Morwell River, West Branch	S	Wet sclerophyll forest; E. regnans
26	Serpentine Creek	S	Damp sclerophyll forest; woodland
26	Tyers River	S	Damp sclerophyll forest; woodland
26	Tyers River, East Branch	S	Damp sclerophyll forest; woodland
26	Tyers River, West Branch	N, S	Alpine heath, E. pauciflora
27	Dingo Creek	S	Wet sclerophyll forest; E. obliqua
27	Franklin River	S	Wet sclerophyll forest
27	Merriman Creek	N	Leptospermum myrsinoides heathland
27	Tarra River	Int	Wet sclerophyll forest; rainforest

Appendix X (continued)

Basin	Stream name	Rating	Community/rare species
Western Port (see Note 5) - Opie *et al* 1984			
28	Back Creek	S	Bunyip State Park
28	Bunyip River (downstream of weir - G1/7a)	S	Bunyip State Park
28	Bunyip River (upstream of weir - G1/7b)	N	Cool temperate rainforest, wet sclerophyll forest
28	Diamond Creek	S	Bunyip State Park
28	Ryson Creek	N	Grevillea barklyana
28	Tin Creek	N	Cool temperate rainforest, wet sclerophyll forest
Basins 32-36 (see Note 6) - various sources			
32	Little River	?	Brachycome debilis (R), Rutidosis leptorrhynchoides (ER/End), Stipa breviglumis (R/EL), Pilularia novaehollandiae (R)
32	Moorabool River (West Br)	?	Discaria pubescens (R/T)
32	Stony Creek	?	Helichrysum sp. aff. acuminatum (R/L), Schoenus fluitans (R/L)
33	Barwon River	?	Schoenus fluitans (R/L), E. yarraensis (Vul), Rhagodia parabolica (VL)
35	Anglesea River	H	Tetrarrhena acuminata (Ra/L), Burnettia cuneata (Ra/Vul), Corybas fordhamii (Ra/L), Chorizandra sp. (Ra), Asperula subsimplex (Res), Hydrocotyle muscosa (Res)
35	Boggy Creek	?	Tetrarrhena acuminata (Ra), Burnettia cuneata (Ra/Vul), Thelymitra vernosa
35	Chapple Creek	?	Helichrysum rogersianum (Re)
35	Curdies River	?	Cyclosorus parasiticus (R)
35	Erskine River	?	Leptospermum gatesii (ER)
35	Parker River	?	Lycopodium varium (Loc), Cyathea marcescens (Loc), Tmesipteris sp.
35	Sherbrooke River	?	Cyclosorus penniger (Re)
36	Hopkins River	?	Sparganium erectum (Re)

Notes: Significance ratings are as follows:

1. N - National; S - State; R - Regional, where a community represents an excellent example in terms of size, lack of disturbance, diversity, botanical intactness, or presence of significant species (BIOSIS Research and Ecological Horticulture, 1988).

2. A - extremely rare; B - endangered or localised in occurrence (Kunert and Macmillan, 1988).

3. O - outstanding significance; H - high significance (Forbes, Gullan, and Walsh, 1981).

4. I - international significance; N - national significance; S - State significance (Gullan, Earl, Forbes, Barley, and Walsh, 1984).

5. N - National significance; S - State significance (Opie, Gullan, van Berkel, and van Rees, 1984).
6. R - rare; L/VL/EL - localised/very localised/extremely localised; T - threatened (Frood, 1985); ER - extremely rare; Re - rare (Willis, 1978); Ra - rare; Lo - localised; Res -restricted (Meredith, 1986);
   Loc - localised (Land Conservation Council, Corangamite Area Resources Report, 1976);
   End - endangered; Vul - vulnerable (Frood and Calder, 1987).

7. References for Notes 1-5 are listed in Chapter 15. References for Note 6 are as follows:

Frood, D. (1985). The vegetation of the Melbourne Area, District 1. Report to the Land Conservation Council.

Frood, D. and Calder, M. (1987). 'Nature Conservation in Victoria - Study Report.' (Victorian National Parks Association Inc.: Melbourne.)

Meredith, C. (1986). The vegetation of the Anglesea lease area. Report to the Land Conservation Council.

Willis, J.H. (1978). A list of rare, very localised and endangered indigenous plants of Victoria. (Forests Commission: Victoria.)

Appendix XI

RECREATION OPPORTUNITY SETTINGS

Remote

Essentially unmodified environments of large size where interaction between users is very low and evidence of other users is minimal. Evidence of restrictions and controls is absent. Motorized access by the public is not permitted. The recreation emphasis is on tranquility and self-reliance. Such areas offer a high degree of challenge, and risk opportunity.

Semi-remote

Predominantly natural or natural-looking environments of moderate to large size. Interaction between users is low, but there may be evidence of other users. Minimum on-site controls and restrictions are obvious. Limited vehicle tracks exist, for vehicle access if permitted. The probability is high to moderate of experiencing: isolation from the sights and sounds of humans; independence; closeness to nature; tranquility; and self-reliance. Such areas offer a moderate degree of challenge and risk.

Roaded natural

Natural-looking environments with moderate evidence of the sights and sounds of humans. Interaction between users may be low to moderate, but evidence of other users is prevalent. Opportunities for both motorized and non-motorized forms of recreation are available with a high degree of interaction with the natural environment. Impressions of nature are not dominated by modifications and recreation facilities.

Semi-developed

Substantially modified natural environments. Sights and sounds of humans are readily evident, and interaction between users is often moderate to high. Includes facilities designed for use by large numbers of people and those provided for special activities.

Developed

Substantially urbanized environments, although the background may have natural-looking elements. Vegetative cover is often exotic and usually heavily managed. Sights and sounds of humans are predominant and large numbers of users can be expected. Opportunities for competitive and spectator sports and for passive uses are common.

Source: From Department of Conservation, Forests and Lands (1988). 'Recreation, Policy, Planning and Monitoring.' (Department of Conservation, Forests and Lands: Melbourne.)

Appendix XII

PRINCIPAL LANDSCAPE CHARACTER TYPES OF VICTORIA (after Leonard and Hammond, 1984)

Murray Basin Plains

Landform: Flat alluvial plains 30--200 m in elevation with occasional bedrock outcropping to 350 m: area 80 500 sq.km
Vegetation: Desert heathlands and mallee scrub woodlands in north-west; scattered open river red gum forests along rivers; box--ironbark open forests in the east; extensive agricultural clearings in central, eastern, and south-western sections
Waterform: Murray River on northern boundary with gentle gradient and many tributaries in eastern section; smaller, more intermittent streams in western section, some flowing to terminal saline lake-beds: annual precipitation 200--500 mm
Land use patterns: Mostly agricultural land with grain crops and grazing; some scattered forests; large desert areas with sparse use
Significant features: Murray River reservoirs, saline lakes, blown-out sand dunes

Western Plains

Landform: Flat plains (mainly volcanic) ranging in elevation from 10 m near coastline to 280 m in northern section, with many inactive volcanic cones rising up to 400 m throughout the plains: many scattered stony rises: area 36 400 sq.km
Vegetation: Mostly agricultural grasslands; some stringybark woodlands on basalt rises; extensive stringybark open forest in the south-western section; remnant open river red gum forests on the river flats; large pine plantations in extreme south-western section; shelter-belts common throughout
Waterform: Seven small rivers flow across plains; many moderate-sized lakes throughout; several swamps in the extreme western section: annual precipitation 500--1000 mm
Land use patterns: Mostly grazing with some crop lands; some scattered forests and isolated pine plantations
Significant features: Volcanic cones, basalt rises, and lakes; eucalypt and cypress shelter-belt plantings

Southern Lowlands

Landform: Flat to undulating alluvial plains and drained swamps; elevation range 20--120 m: area 14 200 sq.km
Vegetation: Agricultural clearings with scattered shelterbelts in western and central sections; open heathlands adjacent to coastline; open forest in east
Waterform: The large Latrobe River flows into the Gippsland Lakes in the central section; many deeply dissected streams in the eastern section: annual precipitation 700--1000 mm
Land use patterns: Agricultural pasture and fodder crops in the western and central section; brown-coal open-cut mines in central section; forest in the eastern section
Significant features: Pastoral landscapes, sand dunes, heathlands, open-cut mines, transmission lines, and tidal river estuaries

Appendix XII (continued)

West Central Hills

Landform: Moderate to gently sloping low rounded hills, mixed with flat sedimentary and volcanic plains; hills extend from the Great Dividing Range; elevation 200--500 m with a few peaks rising to 750--1000 m: area 19 500 sq.km
Vegetation: Stringybark and box--ironbark open forests on moderate hill slopes; agricultural crops and pasture on the plains and gentle hill slopes
Waterform: A few moderate-sized streams north and south from the main divide; some moderate-sized lakes and reservoirs in the southern section: annual precipitation 450--700 mm
Land use patterns: Agricultural uses on plains and gentle slopes; forest on moderate slopes and hill tops; pine plantations in the Ballarat area
Significant features: Mt Cole and Mt Buangor at approximately 1000 m; several lakes and reservoirs

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Foothills

Landform: Moderate to steeply sloping hills descending from Eastern Highlands to adjacent lower elevation landscapes; rounded ridges in western section; sharply crested ridges in north-east and south-west sections; broad 'U'-shaped valleys in north-east section, more narrow 'V'-shaped valleys in west and south-east; elevation range 300--900 m; relative relief diminishes further from Great Divide: area 22 400 sq.km
Vegetation: Mostly tall open forest species: stringybark, peppermint, and gums; some large pine plantations in the north-eastern and western sections; some agricultural crop lands in valleys; small, isolated rainforest areas in eastern section
Waterform: Many rivers and large streams flow through foothills; Murray River on north-eastern boundary; several large reservoirs: annual precipitation 600--1000 mm
Land use patterns: Mostly native forest with some pine plantations; agricultural uses in valleys; water catchments
Significant features: Several large reservoirs and extensive pine plantations; occasional winter snowfields at upper elevations; isolated rainforests

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Eastern Highlands

Landform: High, steep mountains extending from the Great Dividing Range, trending north-east to south-west; lateral ridges rise between deeply incised valleys to rounded main summits; elevation range 900--1800 m; isolated high peaks uncommon, but many summits over 1200 m and a few over 1800 m: area 40 200 sq.km
Vegetation: Altitudinal zonation of tall open forest species on foothills and mountains (stringybark, mountain ash, alpine ash, etc.) at low to mid-slope elevations; low open snow gum forest and woodland in sub-alpine areas; treeless tussock-grassland and heathlands in small disconnected alpine areas at highest elevations
Waterform: Numerous streams flow north and south from the Great Divide; 'V'-shaped south-flowing rivers and deeply incised 'U'-shaped north-flowing rivers; streams fed by snow at upper elevations during winter and spring: annual precipitation 700--2000 mm
Land use patterns: Mostly forest; notable skiing areas in several alpine locations; a few water supply and power generation reservoirs
Significant features: Winter and spring snowfall; unique alpine and sub-alpine vegetation

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Appendix XII (continued)

Grampians

Landform: Four parallel sandstone ridges and valleys in cuesta formation rise abruptly from the surrounding plains; general elevations 450--640 m with individual peaks up to 1200 m: area 2900 sq.km
Vegetation: Mostly stringybark open forest and woodland with limited agricultural clearings in the valleys
Waterform: Several streams flow into four moderate-sized reservoirs; a few cascades and waterfalls: annual precipitation 600--1000 mm
Land use patterns: Mostly forest with minor agricultural land areas; extensive forest picnic, camping, and other recreation use areas; notable reservoirs
Significant features: Cuesta formations, massive sandstone cliffs and outcrops, waterfalls, and reservoirs

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Southern Uplands

Landform: Steep, deeply dissected mountains and hills with rounded ridgetops; block-faulted sedimentary and metamorphic uplifts; two isolated sections - the Otways Ranges in the west and the South Gippsland Hills in the east; main ridges trend north-east to south-west with north- and south-flowing lateral streams: elevation range 600--750 m: area 7500 sq.km
Vegetation: The Otways mostly have tall open mountain and foothill forests in the east with some agriculture in the west: the South Gippsland Hills are mostly agricultural grazing and pasture lands with open mountain and foothill forest in the western section, and extensive pine plantations on derelict farmland in the eastern section
Waterform: Many streams flow north and south from the main ridges: many south-flowing streams in the Otways terminate in submerged coastline valleys; several waterfalls throughout: annual precipitation 700--1400 mm
Land use patterns: Otway Range - mostly forest with some pine plantations; large domestic water supply catchments; notable housing subdivisions on south slopes overlooking coastline; limited agriculture, except in west: South Gippsland Hills - mixture of forest, pine plantations, and agriculture
Significant features: A few isolated high-rainfall forest enclaves and a few waterfalls

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Coastline

Landform: Southern Ocean and Bass Strait coastal landforms: sand beaches, dunes, cliffs, offshore bars and islands, stacks, arches and Wilsons Promontory: elevation range 0--750 m: length 1200 km: width variable
Vegetation: Wide range of vegetative habitats resulting from coastal zonation: dune-colonizing grasses; salt marshes; heathlands; and woodlands: several eucalypt species adapted to coastal conditions
Waterform: Southern Ocean, Bass Strait and surf: numerous streams and rivers enter ocean; coastal lagoons, tidal lakes, and river estuaries: annual precipitation 600--1500 mm
Land use patterns: Extensive beaches; many coastal recreation sites; many small coastal towns, some with commercial fishing industries; increasing recreation housing subdivision
Significant features: Coastal formations, islands, inlets, and swimming beaches; Wilsons Promontory is especially significant

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Appendix XIII

POSITIVE SCENIC ELEMENTS

Key to landscape character type abbreviations:

MBP - Murray Basin Plains	SL - Southern Lowlands	WCH - West Central Hills	G - Grampians	C - Coastline
WP - Western Plains	FH - Foothills	SU - Southern Uplands	EH - Eastern Highlands	

Scenic element	River-setting category				
	Natural	Semi-natural	Farm--forest[1]	Agricultural	Small town[2] - suburban
Landform					
Deeply cut gorges, highly dissected tightly enclosed 'V'-shaped valleys	G, FH, EH, EH, SL, SU	G, SL, FH, EH, WCH, WP, SU	WP, G, SL, FH, EH, WCH, SU	WP, G, SL, FH, EH, WCH, SU	SL, FH, EH, WCH, WP, SU
Sharply defined and incised tributary valleys	C	C	-	C	C, WP
Rock outcrops or jumbles of large boulders	EH, SU, SL, C	WP, SU, SL, C, FH, EH, WCH, MBP	WP, SU, SL, MBP, FH, EH, WCH	WP, SU, SL, MBP, FH, WCH, EH	WP, SU, SL, C, WCH, MBP, FH, EH
Outstanding, colourful, or distinctive cliffs or geological formations in river banks or valley walls	SL, C, FH, EH, SU, G	-	-	-	-
Distinctive river terraces	FH, EH, SL, C	FH, EH, SL, C, MBP, WCH, WP	SL, MBP, WCH, WP, FH	EH, SL, C, MBP, WCH, WP	SL, MBP, WCH, WP, FH
Sharply defined steep-sided drainage channels; high and/or distinctive dune formations contrasting with the surrounding plains	-	MBP	MBP	MBP	MBP
Large sand or gravel bars, or extended shorelines[3]	EH, FH, SL, C	WP, SL, C, FH, EH, MBP, WCH	WCH, WP, SL, EH, MBP, FH	WP, SL, C, FH, EH, MBP, WCH	WP, SL, C, FH, EH, MBP, WCH

Landform (continued):

Isolated or distinctive peaks, volcanic cones, ridges, or large feature land-forms that become focal points	EH, C, SL, SU, G	EH, C, WCH, SL, SU, G, WP	WCH, WP	WCH, WP	WCH, WP
Medium to large islands	FH, EH, SL	WP, SL, MBP, FH, EH, WCH	WP, SL, MBP, FH, EH, WCH	WP, SL, MBP, FH, WCH	WP, SL, MBP, EH, WCH
Steep escarpments, plateau rims, sharp crested narrow or extended ridges	FH, EH, SU	FH, EH, WCH, SU	FH, EH, WCH, SU	FH, EH, WCH, SU	FH, EH, WCH, SU
High dune formations with sand-blown edges and steep slopes	C	C	-	C	C
Distinctive promontories, peninsulas, or islands	SL, C	SL, C	SL	SL, C	SL, C
Hanging valleys or elevated terrace formations	SU	SU	SU, EH	SU, FH	SU, FH, C
Vegetation					
Distinctive swamp or wetland vegetation; diverse vegetation pattern in terms of of height, density, colour and form; diverse height and structural form[4]	SL, FH, G, SU, C, EH	-	-	-	-
Sharp contrast between river zone vegetation and surrounding forest vegetation	-	WCH	-	-	-
Vegetation stands or patches with dramatic displays of seasonal colour	FH, G, SU, SL, C	-	-	-	-
Gradual edge transition between riparian vegetation and adjacent land use	-	WCH	-	-	-

Scenic element	River-setting category				
	Natural	Semi-natural	Farm--forest[1]	Agricultural	Small town[2] - suburban
Vegetation (continued)					
Diverse patchwork effect created by, for example, row crops, market gardens, orchards, and gardens	-	-	SL, SU, WP, MBP	SL, SU, WP, MBP	SU, SL, FH, EH WP
Clusters of exotic trees or shrubs that visually enhance the landscape	-	-	-	C, MBP, FH, EH, WCH, SU	C, WCH
Feature trees, tree rows, and specimen stands that are visually distinctive in colour, form, and texture	-	-	G, SL	WCH, WP, SL, C, G	-
Reeds, rushes, and mangroves that strongly define coastal character, strongly defined and diverse patterns of coastal trees, shrubs, and grasslands	C	C	-	C	C
Woodlands and golf courses with areas of diverse tree and grass cover	-	-	-	C	C
Waterform					
Moderate to large waterfalls, chutes, cascades, or white-water rapids	FH, EH, G, SU, SL, C	-	-	-	-
Distinctive lakes or reservoirs that visually enhance the river zone or landscape setting[5]	FH, SU, G, EH, SL	WCH, WP, G, SL, EH	-	EH, SU, MBP, WP, G, SL	WP, MBP, SU, SL
Moderate to large reservoirs that visually enhance the landscape	-	MBP, FH, SU	-	FH, WCH	FH, WCH, EH

Waterform (continued)

Moderate to large pools, still clear water, or billabongs	SL, SU, FH, EH, G, C	-	-	-	-
Highly sinuous or braided stream pattern stream pattern	FH, EH, SU, C	-	WP, SU, WCH, MBP, FH, EH,	C, WCH, MBP, FH, EH, WP	MBP, WCH, C FH, EH, WP,
Highly diverse stream characteristics of riffles, pools, rapids, and chutes	SL, FH, EH, SH, C, G, SU	-	-	-	-
Blow holes, coastal platforms, and other dramatic coastal water features, visually distinctive estuarine lake systems or wetlands	C	C	-	C	C
Cultural features					
Bridges, weirs, fords, locks, or other structures associated with river crossings	-	MBP, WCH, WP, SL, C, FH, EH, G, SU	MBP, FH, EH, WCH, WP, G, SU, SL	MBP, F, EH, WCH, WP, G, SU, SL	MBP, C
Distinctive buildings that visually enhance the setting	-	-	MBP, FH, EH, WCH, WP, G, SU, SL	MBP, FH, EH, WCH, WP, G, SU, SL, C	MBP, F, EH, WCH, WP, SU, SL, C
Distinctive fences and gates that complement the landscape[6]	-	-	MBP, FH, EH, WCH, WP, G, SU, SL	C, MBP, EH, WCH, WP, G, SU, SL, FH	F, EH, WCH, WP, SU, C, MBP
Windmills and other special structures such as kilns, pumping stations, and water-wheels	-	-	MBP, WCH, WP, FH, EG, SU, G, SL	MBP, WCH, FH, EH, WP, G, SU, SL	MBP
Small to medium irrigation or fire-control dams that blend with and visually enhance the landscape	-	-	MBP, FH, EH, WCH, WP, G, SU, SL	MBP, WCH	-
Well-maintained parklands or golf courses with visually enhancing trees, shrubs, statues, or other art forms; grassed areas; and recreation facilities	-	-	-	-	MBP, FH, EH, WCH, WP, SU, SL, C

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Appendix XIII (continued)

Scenic element	River-setting category				
	Natural	Semi-natural	Farm--forest[1]	Agricultural	Small town[2] - suburban
Cultural features (continued)					
Visually distinctive cemeteries in the river zone	-	-	-	-	FH, EH, WP, SU, SL, MBP, WCH
Boatsheds, jetties, wharves, and similar structures that enhance the settings[7]	-	-	-	-	MBP, C
Wildlife					
Stock such as horses, cattle, etc. that visually enhance the farm--forest character	-	-	MBP, WP, SL, WCH, FH, EH, G, SU	-	-
Ducks, geese, swans, and other water birds[8]					MBP, WP, SL, WCH, FH, EH, SU
High visual presence of fish, reptiles, water birds, birds of prey, and native mammals	C	C	-	C	C

Notes:
1. Farm--forest settings were not recorded for the Coastline landscape character type.
2. Small town settings were not recorded for the Grampians landscape character type.
3. Includes deltas for Coastline landscape character type.
4. Along the coast trees are often dwarfed, gnarled, or windswept.
5. The lakes and reservoirs are small to moderate in size.
6. Includes stockyards for farm--forest and agricultural settings.
7. Includes lighthouses and moorings for Coastline landscape character type.
8. Includes native mammals for Murray Basin Plain, Western Plains, West Central Hills and Southern Lowlands landscape character types.