MELBOURNE AREA

DISTRICT 2 REVIEW

DESCRIPTIVE REPORT

LCC LAND CONSERVATION COUNCIL

MELBOURNE AREA

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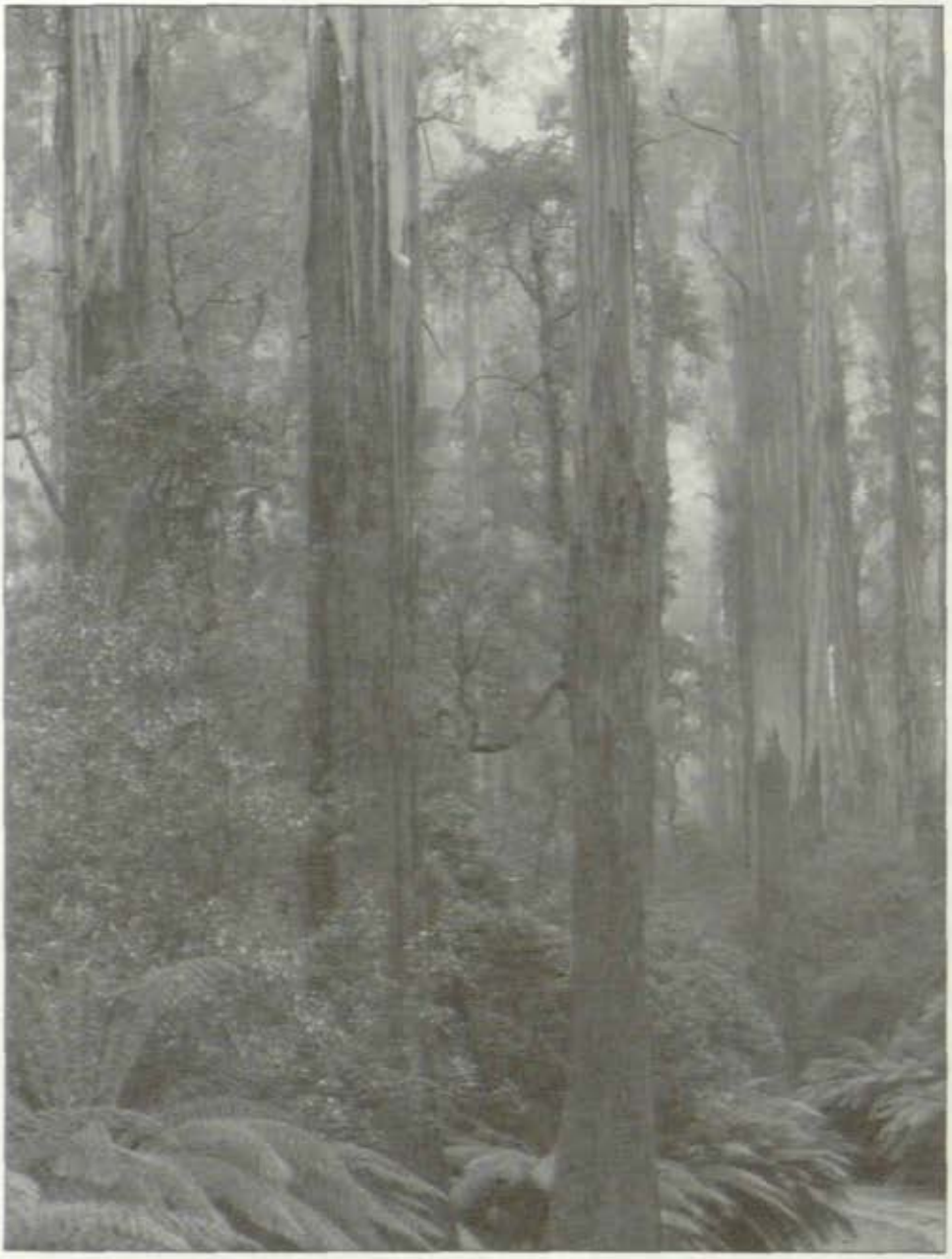
DESCRIPTIVE REPORT



LCC LAND CONSERVATION COUNCIL

SUBMISSIONS INVITED UNTIL 25 NOVEMBER 1991

State Government of Victoria Printed on recycled paper

LAND CONSERVATION COUNCIL

The Land Conservation Council is an independent statutory body established under the *Land Conservation Act* 1970. It makes recommendations on the use of public land to the Victorian Government.

The Land Conservation Council is reviewing the use of public land in the Melbourne Area, District 2.

STUDY AREA

All public land in the study area outside cities and rural cities is included in the review. Private lands are excluded from the review, as is metropolitan Melbourne. Council will make no recommendations over private land.

Diversity is a feature of the study area - it includes coastal areas, foothill forests and tall ash forests, and subalpine environments. The major features of the study area are the forests of the Central Highlands, Western Port, and its rivers and streams.

Municipalities wholly or partially in the study area are: Alexandra, Bass, Broadford, Buln Buln Cranbourne, Diamond Valley, Eltham, Flinders, Hastings, Healesville, Kilmore, Korumburra, Lillydale, Mansfield, Mornington, Narracan, Pakenham, Phillip Island, Seymour, Sherbrooke, Upper Yarra, Warragul, Wonthaggi, and Yea.

THE DESCRIPTIVE REPORT

This report describes the study area's

* physical and biological resources
* current public land uses
* values and attributes on public lands
* major issues relating to current and potential land uses

The report has almost 400 pages, contains 14 maps and includes colour maps of vegetation and public land use.

It contains chapters on Aboriginal and European history, landscape evolution, climate, water resources, flora, fauna, marine and coastal environment, land systems, public land use, nature conservation, recreation, timber production, minerals and extractive resources, water production and use, utilities, hazards and conflicts, and issues.

The Descriptive Report is the first stage in Council's review process.

WHAT HAPPENS NEXT?

Council's review features a role for public consultation. Public submissions are now invited on the Descriptive Report. The submission period is 90 days. After considering these submissions, Council will prepare its proposed land-use recommendations. These Proposed Recommendations are then released for public comment. Following this second submission period, Council prepares its Final Recommendations, which are presented to the government.

* Resources Report
  (released August 1991)

* Close of first submission period
  (November 1991)

* Proposed Recommendations

* Close of second submission period

* Final Recommendations to government

MELBOURNE AREA DISTRICT 2 REVIEW, DESCRIPTIVE REPORT

Copies may be inspected at:

* Department of Planning and Housing
  - Library
  477 Collins Street, Melbourne

* Regional Libraries in the study area

* Shire Offices in the study area

Copies may be purchased from:

* *Information Victoria Bookshop*
  318 Little Bourke Street, Melbourne

* Department of Planning and Housing
  - Bookshop
  477 Collins Street, Melbourne

* Regional offices - Department of Conservation and Environment:

  46 Aitken Street, Alexandra
  205 Thomas Street, Dandenong
  71 Hotham Street, Traralgon

Fill in the form for mail orders.

Send to:

Law Printer Sales
PO Box 203
North Melbourne 3051

Please send me:

.... copies of the Land Conservation Council's Melbourne Area, District 2, Review - Descriptive Report at $21.00 which includes $5.00 for postage. (Overseas postage costs advised on application.)

I enclose a cheque/money order for:
$..... payable to the Law Printer Sales

OR

I wish to pay by Bankcard/Mastercard/Visa Card:

No: .....

Expiry date: .....

Signature: .....

Please send to:

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SUBMISSIONS WELCOMED

Who should be involved?

Anyone with an interest in the use of public land in the study area.

How to be involved

Make a submission

It is a positive way for you to participate in the Land Conservation Council's land-use investigation by:

* supplying information on one or more particular areas
* supplying information on physical and biological resources
* describing values and uses of public land in the study area
* any other land-use issues in the study area you wish Council to consider

How to make a submission:

* Make sure your comments are clear - it would help us if you list points or break up your submission into subject headings.
* It can be brief, or even in point form - your information and ideas are more important than presentation.
* If you wish to make a confidential submission, or discuss particular issues of concern to you, or have difficulty preparing a written submission, please contact the Council.

What happens to your submission?

Submissions are welcomed and all are actively considered. It is a legislative requirement that the Land Conservation Council only make recommendations after considering submissions.

Submissions are important and we acknowledge their receipt so please write your name and address, and the date on them.

Send your submission to:

Secretary
Land Conservation Council
1st Floor, 477 Collins Street
Melbourne 3000
Fax: (03) 628-5080

SUBMISSIONS CLOSE -

Submissions must reach the Council's offices by Monday, 25 November, 1991.

More information

If you need to know more about the review please contact:

Mr Leigh Glover
Phone: (03) 628-5142

Victorian country callers may call toll-free on (008) 134803

INVESTIGATION PROCESS

Government directs Council to carry out study

Council announces study — Advertisements in State and regional newspapers

Interdepartmental Study Group formed

Collection/collation of information on key values and uses. Prepare Descriptive Report

Submission period for public comment

Publish and advertise in State and regional newspapers availability of Descriptive Report. — Descriptive Report available for purchase copies sent to relevant municipal councils, regional public libraries, and key organisations

Assess submissions, collect additional data, prepare draft Proposed Recommendations. Council inspects study area.

Council discusses and approves Proposed Recommendations.

Submission period for public comment

Publish and advertise the availability of Proposed Recommendations — Proposed recommendations available on request, copies sent to relevant municipal councils, regional public libraries, and key organisations and those who made a submission on the Descriptive Report

Assess submissions, collect additional data where relevant, prepare draft Final Recommendations

Council discusses and approves Final Recommendations

Publish and advertise availability of Final Recommendations — Final Recommendations available on request, copies sent to relevant municipal councils, regional public libraries, and key organisations.

Final Recommendations to Minister for Conservation and Environment

Consideration by Government

Accept/modify | Reject

Governor in Council directs relevant agencies to implement recommendations. — Implementation of recommendations

media summaries. The process of formulating proposed recommendations will include an assessment of their economic and social consequences and these, if any, will be summarised in the recommendations.

11. **Second Submission Period**
During the second submission period, again at least 60 days, Chairman and research staff are available, as they were in the first submission period. Staff are involved in extensive follow-up of issues with individuals and community groups.

12. **Final Recommendations**
At the conclusion of the second submission period the Council considers submissions, and the information and ideas that have emerged from meetings, and decides whether it wishes to change its proposed recommendations. It then prepares final recommendations to be presented to the government.

WHAT HAPPENS NEXT?

Final recommendations are presented by the Chairman to the Minister for Conservation and Environment, together with a copy of all submissions received. This concludes the LCC process.

The *Land Conservation Act* 1970 requires that a copy of all recommendations be tabled before both Houses of Parliament within 14 days if Parliament is currently sitting, or within 14 days of the commencement of the next Parliamentary session.

If the government accepts the LCC recommendations, with or without amendments, the Minister notifies other departments of his intention to implement the recommendations, and gives them 14 days in which to raise any issues of concern.

Interest groups can make direct representation to government, opposition parties, or individual members of parliament to criticise or support the final recommendations to government.

Orders in Council would be issued, and a copy forwarded to the Ministers responsible for administering the appropriate department or authority, requiring them to implement the recommendations.

Depending upon the recommendation, implementation can be through legislation, such as amendments to the National Parks Act to include new parks in an appropriate schedule to that Act. Other LCC recommendations dealing with the management of public land, and the way in which public land should be reserved or used, can be implemented through the preparation of management plans by the land managing agency, usually the Department of Conservation and Environment. The department's management planning process also provides for and encourages public participation.

For further information, contact

The Secretary
Land Conservation Council
First Floor, 477 Collins Street
Melbourne 3000

Telephone: (03) 628 5142
Fax: (03) 628 5080

State Government of Victoria
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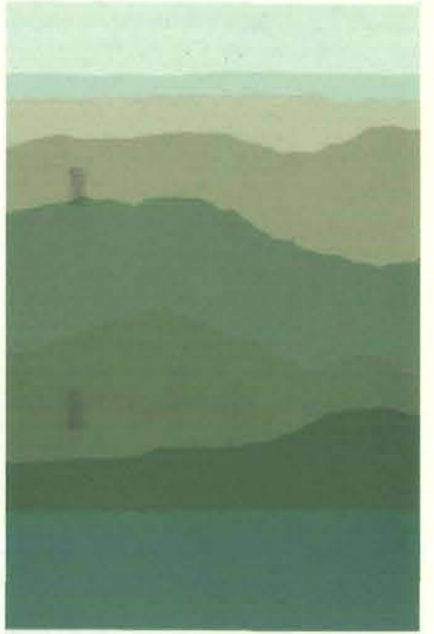
LAND CONSERVATION COUNCIL VICTORIA

PUBLIC LAND USE HAVE YOUR SAY



How You Can Participate in Advice to the Government on the Balanced Use of Public Land

LCC

THE LAND CONSERVATION COUNCIL
Victoria's Public Land Planning Agency

The Land Conservation Council is an independent body established under the *Land Conservation Act* 1970. Its task is to carry out investigations and make recommendations to the government "with respect to the use of the public land in order to provide for the balanced use of land in Victoria". Public land is defined as public land outside cities and rural cities. The Council is also required to recommend to the government on the proclamation of water catchments and on land use determinations for catchments. It currently reports to the government through the Minister for Conservation and Environment.

The Council makes its recommendations independently of government and its policies. The Council has 14 members. The Act specifies the membership of Council on the basis of the specialised knowledge that is relevant to the task of the Council.

The Chairman of the Council is the full-time Chief Administrator. There is a staff of 17. This includes a Director of Land Use Planning and six research officers.

Research officers co-ordinate and collate information provided by departments and other authorities which is included in descriptive and other reports. Outside consultants may be appointed to provide supplementary information. The Act provides for two submission periods; the first after the descriptive report is published, and the second after the proposed recommendations.

CONSULTATION

People and organisations have a right to participate in the LCC's procedures for advising government on the balanced use of public land outside cities and rural cities in Victoria. This right was established in the *Land Conservation Act* 1970 which requires that there be two periods in which the people are able to make written and verbal submissions during the course of an LCC study.

The value of participation is that it generates and makes available information and ideas that may not otherwise be available to governments and bodies that advise governments. This helps to ensure that the advice the Council finally gives to government is more likely to be comprehensive, understood, and accepted. Participation also provides the opportunity for individuals and interest groups to contribute to making public policies. They are also able to widen their interest and understanding through access to information and the ideas of others.

There are now many people interested in environmental issues, and a large number of well organised special interest groups. The process used to encourage participation is consultation. The LCC has a number of ways in which it tries to ensure that through consultation people are aware of its reviews and special investigations, and are able to contribute.

REQUIREMENTS FOR EFFECTIVE CONSULTATION

Knowing about LCC studies

The first step in effective consultation is to ensure that people and organisations know that a study is taking place, and that they are encouraged to participate. The Council publicises the beginning of a land area review or a special investigation with advertisements in newspapers, notices sent to shire offices, and media releases.

The Council establishes a register of people and organisations interested in particular investigations so that they can be sent notices of the progress of the study, information and advice of opportunities for participation. If you would like to be placed on the mailing list for information relating to publications, please contact the Council Secretary.

Access to information

People can only respond if they have access to information that enables them to understand the issues and make constructive contributions. An essential step in the Council's procedures is to publish a descriptive report which brings together all that is known about public land in the area under review, or of the topic of any special investigation such as wilderness or rivers and streams. The descriptive reports are available at a subsidised price.

Copies are sent to each shire in the study area. One report will be available for public reference in each shire office. Additional copies for shire use are available on request from the LCC offices.

Reports may be available for purchase at shire offices in a study area and at Department of Conservation and Environment offices, but the main selling point is:
Information Victoria Bookshop
318 Little Bourke Street, Melbourne,

and the
Department of Planning and Housing Bookshop
Ground floor at 477 Collins Street, Melbourne.

Copies will also be available for reference at regional libraries, and regional offices of the Departments of Conservation and Environment, and Planning and Housing. For statewide investigations, other access locations will be advertised.

The Council Secretary and staff are also available to provide information on the LCC and its work.

With the co-operation of local government bodies outside the metropolitan area, the Council tries to ensure that information about its activities is readily available at local government offices. Notices about LCC investigations and their progress will be sent to all shire offices.

Genuine consultation cannot be achieved if people are unable to understand the information in the way it is presented. Some of the material in LCC reports is of a scientific nature, and every effort is made to achieve clarity and to explain technical terms. LCC staff are always available to provide explanations or assist in other ways.

Ability to participate

Even if there is knowledge of a study and information is available that is readily understood, there may be other barriers that prevent people from responding. These include lack of time or money to attend meetings or prepare submissions; physical distance; lack of experience in preparing submissions; difficulty with the English language; concern about the consequences of a submission being made public that could generate hostility in a local community.

The Council provides a submission period of at least 60 days, in some cases 90 days, to give people adequate time to talk to others and prepare a written or verbal response. The staff are available to help people to make submissions and suggest ways of overcoming barriers to contributing to a study.

Copies of submissions are available as part of the public record which can be read at the LCC offices. It is also possible to make a confidential submission from which identifying information is deleted.

If you have any concerns about making submissions, please contact the Council's Secretary.

The following suggestions may help you to prepare submissions:

- Clearly state your ideas and suggestions. It is usually easier to list a number of points.
- If mentioning particular localities, please be specific or mark them on a map.
- Your proposals will be more useful if you give reasons why you think something needs to be considered or changed.
- Please include your name and address. It would also be helpful to include the telephone number of the person making the submission. If the submission is from an organisation or group, please indicate one person who can be contacted for more information, and who can be kept informed of the progress of the study.
- If you wish to talk to LCC staff about a study and are concerned about the cost of a phone call from country areas, ring the Council on its toll free number (008-134-803) and a staff member will assist you.
- If there are other obstacles to participating, the Council would consider ways of assisting people or organisations. Please contact the secretary to indicate any difficulties that are of concern to you.

WHAT HAPPENS TO SUBMISSIONS?

Copies of all submissions and letters received after the submission closing date are sent to each member of the Council. Copies are also available for public inspection at the LCC offices.

Written and verbal submissions are valuable information for research staff and the study group, as well as Council members. All submissions are acknowledged. In writing reports, the Council endeavours to make it clear that contributions have been taken into account in preparing recommendations. A list of people and organisations making submissions will be included in the proposed and final recommendations reports. Where possible, summaries of the issues raised in submissions will also be included. Every submission is treated equally. Submissions are not counted as votes for or against a particular proposal. Their value is in the information they provide and the ideas and opinions they express.

STEPS IN THE LCC PROCESS

(see Figure)

1. Advertisement of commencement of an area review or special investigation. Media releases will supplement advertising.

2. At the beginning of a study or after the publication of the descriptive report, a seminar may be held to identify issues and exchange information about the subject of the study.

3. A study group is formed. It is made up of the nominees of Council members from government departments, and the non-government members of Council. The LCC research officer co-ordinates and collates the information about the study area or special investigation that the members of the group provide. The study group carries out field visits.

4. **Descriptive Report**
Research staff consult with other organisations in the preparation of the descriptive report, which includes all information that is available about environmental, economic, historic and other values and capabilities of the public land in the review area or in relation to the topic of the special investigation. Some issues that the Council seeks responses to will be identified to assist responses, but people can make any comments they wish.

5. Publication of a report is followed by a submission period of at least 60 days, in some cases 90 days. This allows people to provide additional information and seeks views as to whether there should be changes in existing protection or uses of public land, and the reasons for any proposed changes.

   In the case of special investigations such as wilderness and rivers and streams, the descriptive report brings together information relevant to these topics.

6. The Chairman and staff have the main responsibility for meeting with individuals and interest groups. Council members, who generally have experience of the area or of the issues, may make their own personal visits during studies, and all members take part in field visits to areas under review.

7. The Chairman and research officers visit shires in or adjacent to the areas relevant to the review or special investigation, to meet with shire councillors and officers, and individuals or representatives of interest groups by appointment at accessible locations within the relevant area.

8. The media, journals, and local government bulletins will be used to inform the public of the availability of reports and submission periods.

9. At the end of this submission period the research officer arranges meetings of the study group to consider the material and, with the Chairman, prepare drafts and options for the members of Council to consider.

10. **Proposed Recommendations**
Members of the Council, having read and discussed submissions and made field visits to the study area, prepare proposed recommendations. These are published and publicised through the media, with advertisements and

MELBOURNE AREA

DISTRICT 2 REVIEW

DESCRIPTIVE REPORT

AUGUST 1991

LAND CONSERVATION COUNCIL

Olderfleet Buildings
First Floor, 477 Collins Street,
Melbourne, Victoria 3000
Phone: (03) 628 5142
Fax No: (03) 628 5080
Toll Free: 008 134803

Cover Photograph:

Old-growth ash forest in the Board of Works' Wallaby Creek water supply catchment

Photograph: Provided courtesy of the Board of Works

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CONTENTS

MAPS

FIGURES

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 land in Victoria. (An extract of the Act is provided in Appendix I).

This report provides a factual basis for the preparation of submissions to the Council, by describing and assessing the natural, economic, and cultural resources and characteristics of public land in the study area. Its purpose is to ensure that all those persons and bodies who have an interest in the future use of this public land can obtain and study the basic information that the Council itself will study, and so make informed and constructive suggestions to the Council for its consideration.

Council is also aware that numerous community and industry groups and individuals possess specific information about the values and uses of such areas, and is therefore seeking their involvement in expanding its information base, prior to formulating any land-use recommendations.

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 Victorian *Government Gazette*, and advertised in State and regional newspapers. After considering all submissions Council will prepare its proposed recommendations and these will be published. Another public submission period will follow. The Council will then prepare its final recommendations and these are presented to the Minister for Conservation and Environment and tabled in Parliament.

DAVID SCOTT
Chairman

Land Conservation Council
1st floor
477 Collins Street
Melbourne 3000

ACKNOWLEDGEMENTS

The Council wishes to gratefully acknowledge the assistance and co-operation of those individuals and organisations who contributed to this report.

Information and advice has been provided by the review's study group (current and former members) - M. Calder, A. Cooney, J. Drohan, S. Ferguson, A. Hingston, D. Hooley, N. Howard, J. Lane, L. Lumsden, D. Malcomlson, P. McHugh, R. Moodie, P. O'Shaughnessy, D. Parkes, G. Savage, A. Teese, G. Tresoldi, A. Volum, and K. Weston.

A number of studies were conducted or material prepared specifically for the review:

* Aboriginal Occupation by M. Goulding
* European History and Historic Sites Survey by T. Griffiths, G. Perham, and R. Supple
* Fauna Survey and Report by L. Lumsden (leader), R. Hill, and C. Silveira
* Flora Survey and Report by A. Moorrees (leader), A. Lau, N. Marine, J. McCallum, C. Molnar, R. Robinson, K. Swayn, J. Stuwe, and L. Turner
* Minerals and Stone by A. Cooney
* Invertebratres by P. Vaughan

A range of government and non-government agencies have provided information to the review:

* Australian Heritage Commission
* Alpine Resorts Commission
* Bird Observers Club of Australia
* Board of Works
* Department of Conservation and Environment
* Department of Manufacturing and Industry Development
* Environment Protection Authority
* Department of Agriculture and Rural Affairs
* Rural Water Commission
* Victorian Association of Forest Industries
* Victorian National Parks Association

The following individuals made significant contributions to the study: D. Axelrad, K. Buckley, N. Byrne, E. Chesterfield, P. Christoff, R. Clark, W. Clifford, G. Gooding, J. Holland, L. Jeremiah, J. Koehn, C. Martin, M. McFarlane, J. Pittock, R. Scott, M. Smith, R. Smith, M. Turner, B. Weavers, and C. Williams.

Graphic design of the report is by C. Jackson, Department of Housing and Construction, while cartographic services were provided by D. Chalmers, J. Green, J. Hart, and L. Mills of the Ministry for Finance.

Editing services were by Y. Roberts, with word processing by J. Hainsworth and V. Barry. Technical assistance was by T. Francisco, H. Joyeux, G. Port, J. Whitten, and M. Sheahan.

The report was prepared by L. Glover, while the initial work on the project was by M. Cecil. Assistance and advice was provided by D. Hough, B. Miles, M. McKinty, and S. Ransome.

Photographs were provided by A. Austin, Board of Works, Department of Conservation and Environment, B. Glover, L. Glover, D. Hough, LCC archives, L. Lumsden, M. McKinty, I. Miles, A. Moorees, P. Robertson, S. Smith, Victorian Board of Canoe Education, and the Victorian Archaeological Survey.

Direction of the report was by I. Miles, Director of Land Use Planning, Land Conservation Council.

ABBREVIATIONS

Organisations

ARC	Alpine Resorts Commission
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DCE	Department Conservation and Environment
DCFL	Department Conservation, Forests and Lands
DMID	Department of Manufacturing and Industry Development
DPUG	Department Planning and Urban Growth
DVA	Dandenong Valley Authority
DWR	Department Water Resources
EPA	Environment Protection Authority
LCC	Land Conservation Council
LRWA	Latrobe Region Water Authority
LVWSB	Latrobe Valley Water and Sewerage Board
MMBW	Melbourne and Metropolitan Board of Works
MPE	Ministry for Planning and Environment
MPDWB	Mornington Peninsula and District Water Board
RAN	Royal Australian Navy
RWC	Rural Water Commission
SECV	State Electricity Commission of Victoria
SWL	State Water Laboratory
UYVDRA	Upper Yarra Valley and Dandenong Ranges Authority

Measurement Units

%	per cent
$	dollar
£	pound
cm	centimetre
cu.m	cubic metre
cu.m per ha per annum	cubic metre per hectare per annum
^{o}C	degrees Celsius
gm	gram
ha	hectare
kg	kilogram
kg per ha per annum	kilogram per hectare per annum
km	kilometre
kV	kilovolt
L	litre
m	metre
mg per litre	milligram per litre
ML	megalitre
ML per annum	megalitre per annum
ML per month	megalitre per month
ML per ha per annum	megalitre per hectare per annum
mm	millimetre
NTU	nephelometric turbidity unit
oz	ounce
sq. km	square kilometre
μS per cm	micro siemen per centimetre

PART I

INTRODUCTION

1. INTRODUCTION

This review follows the Land Conservation Council's first investigation of the Melbourne Area, which commenced in 1971. Council published a descriptive report in 1973 (LCC 1973), and released final recommendations for the use of public land in the area in 1977 (LCC 1977).

Since the first investigation, the Melbourne Area has been divided into two districts: District 1 west of the Hume Highway and District 2 east of the Hume Highway. The location of the study area is shown on Map 1. A review of District 1 has been completed; Council produced a descriptive report in 1985 (LCC 1985) and published its final recommendations in 1987 (LCC 1987a).

Advertisements stating that the Council intended to review the Melbourne Area, District 2 appeared in the *Government Gazette* and in local and Victorian newspapers on or about 18 July 1984.

Council made 540 recommendations for the Melbourne Area in 1977, of which some 36 were deferred or rejected and a further 33 varied by government. These recommendations were dominated by the land-use categories of hardwood timber production, parks, and uncommitted land. Baw Baw National Park and, Eildon, Kinglake, and Bunyip State Parks were among the 29 parks proposed by Council, as well as numerous other conservation reserves. In the original Melbourne investigation, the largest total area was recommended for hardwood production, amounting to some 39% of the public land. 'Uncommitted land' accounted for a further 21%. Since the time of the 1977 recommendations, Uncommitted land has been managed and used in the same way as hardwood production areas (and recent Council recommendations have amalgamated the two categories into one, called 'State forest').

Details of current land use are given in Chapter 11, Public Land Use.

Two special investigations conducted by Council have overlapped small portions of the Melbourne, District 2, study area: LaTrobe Valley Special Investigation (LCC 1987b, 1987c); and Hill End Special Investigation (LCC 1982, 1983). Current LCC investigations at the State-wide level also overlap: the Wilderness and Rivers and Streams Special Investigations. Descriptive reports have been released for both studies (LCC 1989, 1990), and those land-use recommendations arising from them, where specified, supersede the previously approved recommendations for the study area.

Council's policy for undertaking reviews, as explained in the 'State-wide Assessment of Public Land Use' (LCC 1988), is also to re-evaluate unresolved issues from earlier studies, respond to altered demands or values regarding public resources, and incorporate some of Council's changed policies arising out of more recent studies. Some of these issues are discussed later in this chapter.

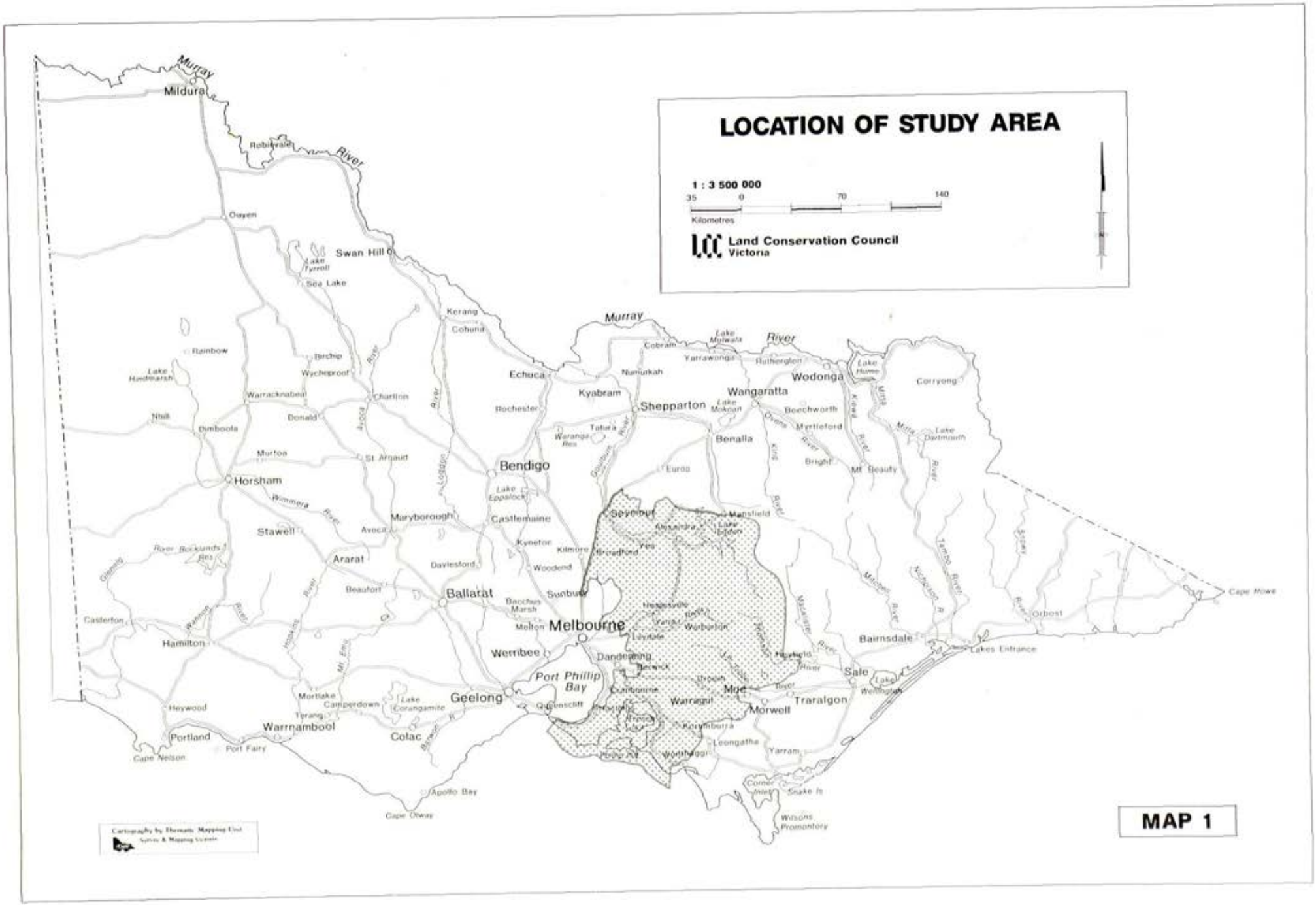
The Council is aware that many changes in demand for the use of public land cannot be foreseen, and that the value of resources will change as exploration, research, and technology progress. For these reasons, the Council believes that periodic reviews of public land use in the State are desirable, and it must be expected that resources will be reallocated or adapted to meet changed demands.

Aims and methods

The aims of this descriptive report are:

* to describe the physical and biological attributes of the study area, including an assessment of various natural resources
* to describe present public land uses
* to examine alternative forms of land use
* to assess hazards and conflicts associated with specific land uses
* to identify the major issues relating to current and potential land uses

As with other Land Conservation Council reviews, this review draws upon materials in earlier investigations, in this case the 1973 'Report on the Melbourne Study Area' (LCC 1973).


LOCATION OF STUDY AREA
1 : 3 500 000
35 0 70 140
Kilometres
Land Conservation Council
Victoria
MAP 1
Murray
Mildura
Robinvale
River
Swan Hill
Lake Tyrrell
Sea Lake
Kerang
Cohuna
Echuca
Kyabram
Shepparton
Wangaratta
Wodonga
Bendigo
Castlemaine
Maryborough
Stawell
Ararat
Horsham
Ballarat
Melbourne
Geelong
Warrnambool
Portland
Hamilton
Colac
Werribee
Port Phillip Bay
Dandenong
Sale
Bairnsdale
Lakes Entrance
Traralgon
Morwell
Mansfield
Benalla
Seymour
Cape Howe
Wilsons Promontory
Cape Otway
Cape Nelson
Port Fairy
Apollo Bay

A large variety of information contributed to the compilation of this report, including consultancy studies, data from government agencies, non-government organisations, and the public, as well as from published and unpublished materials. Where chapters draw strongly on commissioned consultancy studies this is acknowledged; these studies are available for inspection at the Council's offices. A major feature of the current review is the addition of information and data available since the earlier report. Readers seeking a more comprehensive description of some aspects of the study area should consult the original descriptive report and that investigation's Final Recommendations. Copies of these documents are held in local libraries and shire offices, and by regional and Melbourne offices of government departments such as the Department of Conservation and Environment. Copies are also available for inspection at the offices of the Land Conservation Council.

Review process

This review forms the first stage in the decision-making process for the future use of public land in the study area.

Figure 1 depicts the process, indicating the opportunities for public consultation and the respective roles of the independent Land Conservation Council and of government. Readers seeking an understanding of the powers and responsibilities of the Council are directed to an extract of the *Land Conservation Act* 1970 in Appendix I. Copies of the complete Act are available from the Government Information Centre, public libraries, and similar organisations.

As Figure 1 indicates, the present report contains no recommendations, but provides a factual basis for the formulation of land-use recommendations.

Structure of the report

This report consists of predominantly the same chapter topics and structures as the other recent LCC area investigations and reviews, and is divided into three:

* Part 1 - Introduction
* Part 2 - Physical and Biological Resources
* Part 3 - Current Resource Use

Comprehensive chapters on European history and Aboriginal occupation in Part 1 are based on studies conducted for Council, which represent a considerable addition to Council's information base. A specific chapter on the marine and coastal environment, principally describing Western Port, has been added to Part II. (The topic was not specifically covered in the earlier Melbourne Area investigation.) Water resources are also described in Part II, but water production and use are covered in a separate chapter in Part III. This change from earlier Council reports reflects the importance of water-harvesting in the study area.

Readers of Council's 'State-wide Assessment of Public Land Use' (LCC 1988) will discover that many of the suggested approaches for future studies have been incorporated here.

The study area

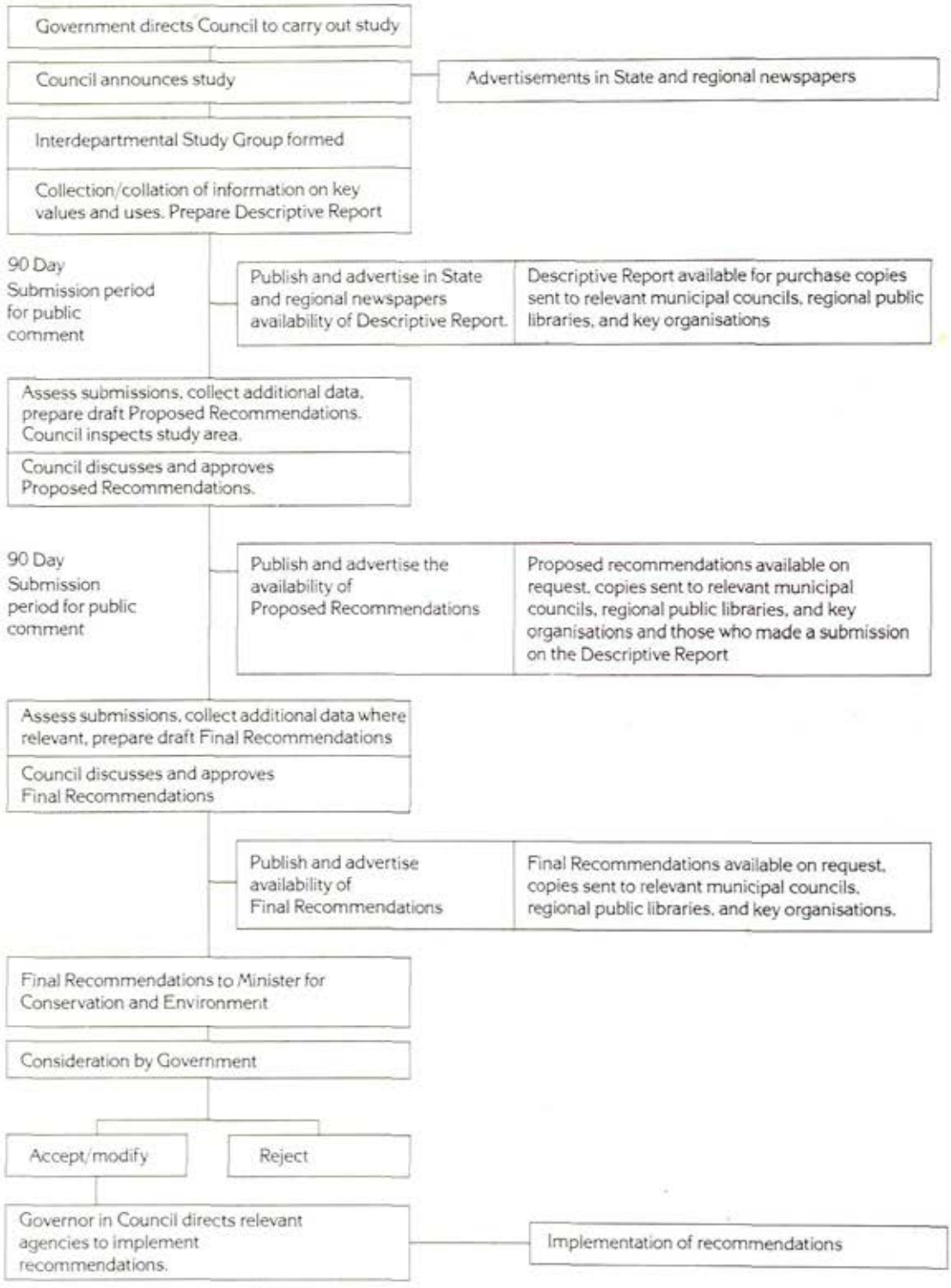
Melbourne Area, District 2 comprises the eastern portion of the original Melbourne region. It comprises some 20 entire local government areas plus sections of a further four - Broadford, Kilmore, Mansfield and Seymour; metropolitan Melbourne is excluded. Map 2 shows the study area boundaries and the local government units.

Along the western boundary, which follows metropolitan Melbourne from Hastings to Diamond Valley, the Hume Highway divides the Shires of Kilmore, Broadford, and Seymour. The northern boundary extends from Seymour across to Mansfield Shire; from the eastern boundary extends to Wonthaggi on the coast, while the coastline around to Mornington forms the southern edge.

Cities and rural cities are excluded from the Council's jurisdiction, under the *Land Conservation Act* 1970. Since this review began, the Shire of Whittlesea has become a city and, although information on the area is provided in parts of this report, no new land-use recommendations will be made for it in this review.

The Borough of Wonthaggi has now been added to the study area, although it was excluded from Council's earlier investigation. The City of Moe lies within the study area and is excluded from consideration. Further changes to the status of local government

FIGURE 1:
INVESTIGATION PROCESS



municipalities seem likely in the near future, as those highly urbanised shires on Melbourne's fringe become cities. Indeed, the Shire of Lillydale may become a rural city during the course of this review.

Western Port, including Phillip and French Islands falls within Melbourne District 2, although Port Phillip Bay lies within District 1. The sea and associated coastal waters out to the 5.5-km territorial limit are Victorian public lands and included in this investigation.

The total area of the Melbourne Area, District 2 is 1 711 800 ha, of which some 30% (508 500 ha) are public land. The areas of the local government municipalities are listed in Table 1.

Table 1

LOCAL GOVERNMENT AREAS

Municipality	Area (ha)
Alexandra	219 700
Bass	52 000
Broadford	48 700
Buln Buln	125 900
Cranbourne	75 500
Diamond Valley	7 438
Eltham	27 700
Flinders	32 400
French Island[2]	17 000
Hastings	30 500
Healesville	46 600
Kilmore	11 000
Korumburra	61 400
Lillydale	39 800
Mansfield[1]	141 900
Mornington	9 100
Narracan	232 100
Pakenham	87 400
Phillip Island	10 100
Seymour[1]	62 400
Sherbrooke	19 200
Upper Yarra	173 200
Warragul	35 200
Wonthaggi	5 699
Yea	139 200
Total	1 711 837

Notes:
1. Portion only within study area
2. French Island is without local government, but is included in the study area

Source: Holzer, K.L. (Ed) (1988)

As described in the chapter on water resources, the study area covers six river basins: all of Bunyip, nearly all the Yarra, most of the upper Goulburn, upper Thomson (including Thomson Reservoir), and upper La Trobe, and a portion of South Gippsland.

Changes since the earlier investigation

Numerous changes to the policies, strategies, and administrative structures relating to the environment and natural resources have occurred since Council's first investigation of this area.

Legislative changes to several principal Acts in the environment and natural resource fields and the introduction of new Acts will need to be taken into account in the current review.

Administrative changes between and within the agencies responsible for environmental and natural resource issues have been numerous. Readers seeking details should refer to the Victorian Government Directory which lists the Acts administered by each agency, and to the annual reports of relevant departments for details on their roles and responsibilities.

A number of broad government strategies and plans have influenced public land and the management of public resources. Prominent among those relevant to this study are:

* timber industry strategy (Victoria 1986)
* conservation strategy (Victoria 1987a)
* economic strategy (Victoria 1987b)
* social justice strategy (Victoria 1987c)
* *Flora and Fauna Guarantee Act* 1988
* salinity strategy (Victoria 1988a)
* wetlands conservation program (Victoria 1988b)
* greenhouse effect - strategy (Victoria, DCE 1990)
* *Forests (Timber Harvesting) Act* 1990

In addition, specific strategies and local programs apply within the study area, many of which are discussed in the report.

Changes in land use are described in Chapter 11 'Public Land Use', and other relevant developments are covered in each chapter.

Setting for the Review

Currently the community has great interest in and awareness of natural resources and conservation and this has been highlighted by international concerns about such issues as the greenhouse effect and climatic change, rainforest clearance, species extinction, and land degradation. Local and regional matters involving the environment can attract great attention, and the consideration of many of them now occurs in a broader context.

The Council has endeavoured, where possible, to embrace these wider concerns. In fulfilling the aim of achieving balanced land use in Victoria, Council recognises the relationship of regional land use planning to wider natural resource and environmental issues.

Greater legislative powers, regulations, and planning instruments, now in place, act to protect environmental values. Developments are now more carefully assessed for their environmental effects, and proposals may be modified to reduce losses of environmental values.

Considerable advances have been made in available information on the physical and biological resources in the State. Greater scientific knowledge has enabled land planners to recognise existing environmental values, and much decision-making has responded accordingly.

One outcome of these changes has been to make Council's task more complex. Demands on public resources have increased, greater volumes of information must now be examined and analysed, and the body of community and expert opinion to be consulted has grown.

Population growth and urban expansion

Since the first Land Conservation Council investigation (LCC 1973) significant changes have occurred in the population characteristics of the study area. As stated above, population size and distribution strongly influence the demands, uses, and management of public land and natural resources.

Aspects of public land resources and values subject to that influence include:

* utilities - transport, communications, water supply and waste disposal, energy supply, community and emergency services
* urban land use - public open space, floodways
* recreation
* nature conservation
* resource use - such as timber, water, minerals, stone, and sand

Metropolitan Melbourne is the major influence on the levels and pattern of population growth in the study area.

Examination of these population characteristics, and of the plans for Melbourne's future urban expansion, indicates the distribution and influences that population changes impose on the region. Of particular interest are the urban growth corridors along the Plenty Valley and Berwick/Pakenham axis.

Local government areas provide a convenient geographical unit for examining population trends and are used by the Australian Bureau of Statistics for population data collection (ABS 1987, 1989). Three measures are size, rates of growth, and density within the region.

A pattern is evident when this information is analysed. Local government areas (LGAs) adjacent to metropolitan Melbourne and on the Mornington Peninsula differ from those elsewhere in the study area. All of the former had in excess of 20 000 residents in 1988, while the 'rural' shires had less than 20 000. Closer to Melbourne the LGAs tend to be smaller so the rural shires have relatively low population densities, measuring less than 50 persons per square kilometre, while population densities in LGAs fringing Melbourne exceed 50. Increases in population size can present difficulties in interpretation, but the largest increases in size, measured by the 1971, 1976, 1981, and 1986 censuses, have been concentrated around Melbourne. Table 2 gives details of population levels in each Local Government Area.

Within metropolitan Melbourne, population density averages approximately 1400 persons per sq.km using 1988 data (ABS 1989). No

MELBOURNE AREA, DISTRICT 2 - STUDY AREA BOUNDARIES AND LOCAL GOVERNMENT AREAS

LEGEND

BOUNDARY OF STUDY AREA

MUNICIPAL BOUNDARIES

NAME OF MUNICIPALITY HASTINGS

10 0 10 20 30

Kilometres

Land Conservation Council Victoria

Cartography by Thematic Mapping Unit Division of Survey and Mapping

MAP 2

Table 2

POPULATION SIZE BY LOCAL GOVERNMENT AREA - 1976–1988

Local government area	Estimated resident population as at 30 June			
	1976	1981	1986	1988 Est.
Alexandra	4 360	5 210	5 580	5 910
Bass	4 070	3 390	4 220	4 410
Broadford[1]				N/A
Buln Buln	8 610	9 450	10 640	10 980
Cranbourne	25 830	35 910	49 230	58 340
Diamond Valley	45 800	51 900	57 000	59 600
Eltham	29 000	36 000	41 500	43 100
Flinders	22 100	27 000	34 900	37 400
French Island	70	70	70	70
Hastings	13 600	18 000	23 700	25 700
Healesville	7 990	8 870	11 110	11 690
Kilmore[1]				N/A
Korumburra	6 740	6 870	7 250	7 450
Lillydale	52 200	64 000	74 000	77 700
Mansfield[1]	1 669	2 008	3 155	N/A
Mornington	20 900	24 600	28 500	29 900
Narracan	8 820	10 980	11 170	11 290
Pakenham	15 420	18 500	23 620	25 680
Phillip Island[2]	2 340	3 070	4 350	4 780
Seymour[1]	9 892	7 767	8 588	N/A
Sherbrooke	25 900	31 100	36 100	37 400
Upper Yarra	8 090	10 400	14 150	14 850
Warragul	10 690	11 280	12 360	12 620
Wonthaggi		5 370	6 230	6 340
Yea	3 160	3 600	4 420	4 660

Notes:
1. N/A - Not available
2. Local government areas divided by the study area boundary are described using collector Districts substantially within the area for each census.

Source: ABS (1987) Cat No 3202-2, ABS (1989) Cat No 3203-2, ABS taken from Melbourne office

LGAs in the study area are not yet sufficiently urbanised to reach that density, although the Shire of Diamond Valley has in excess of 800 persons per sq.km. Shires such as Cranbourne, Eltham, Lillydale, Mornington, and Sherbrooke seem likely to achieve significantly increased population densities on the basis of current trends - a measure of increased urban development.

The density shows considerable variation across the study area, as expected from a mixture of rural and densely settled municipalities. Comparisons on this basis provide a useful quantification of urbanisation. Rural areas such as Alexandra, Buln Buln, and Yea have population densities around 10 person per sq.km. In more urbanised areas - Eltham, Lillydale, or Sherbrooke - the figure rises to about 100 to 200 persons. At the far end of the scale is Diamond Valley with 805 persons per sq.km; the densities for each LGA are given in Table 3.

Population growth can be assessed on the absolute increases in residents or on growth rate, which measures such increases in proportion to population size. The earlier Land Conservation Council study of Melbourne (LCC 1973) used the 1971 census

Table 3

POPULATION DENSITY BY LOCAL GOVERNMENT AREAS, 1988

Local government area	Area (sq.km)	Density (persons per sq.km)
Alexandra	2 172	3
Bass	526	8
Broadford[1]	488	9
Buln Buln	1 259	N/A
Cranbourne	755	77
Diamond Valley	74	805
Eltham	277	156
Flinders	324	115
French Island	170	>1
Hastings	305	84
Healesville	466	25
Kilmore[1]	110	70
Korumburra	614	12
Lillydale	398	195
Mansfield[1]	1 419	2
Mornington	91	329
Narracan	2 321	5
Pakenham	874	29
Phillip Island[2]	101	47
Seymour[1]	624	14
Sherbrooke	192	195
Upper Yarra	1 732	9
Warragul	352	36
Wonthaggi	57	111
Yea	1 392	3

Notes:
1. Only 1986 population data are available for Seymour and Mansfield
2. N/A - Not available

Source : ABS (1989) Cat. No 3203-2

data. The further three censuses taken since (1976, 1981, and 1986) have revealed dramatic population changes.

In terms of increases in residents, no other Victorian areas would rival the performance of the shires to the east and south of Melbourne.

Since 1976 Cranbourne, Diamond Valley, Eltham, Flinders, Hastings, Lillydale, Mornington, Pakenham, and Sherbrooke Shires have experienced large and sustained increases in population, as shown in Table 2. For example, Lillydale had about 36 000 residents in 1971, but exceeded 77 000 in 1988; Cranbourne increased from about 16 000 to more than 58 000 over the same period (ABS 1973, 1989).

By contrast, population level increases in the rural shires have been modest. Nearly all the rural shires gained fewer than 2500 residents over the 1971--88 period (ABS 1973, 1989).

Growth rates present a more complex picture. Shires with small populations can be expected to exhibit high growth rates in comparison with large shires with similar increases in population size.

A number of the rural shires have indeed done so, albeit from a low population base. At the time of the first Melbourne investigation (LCC 1973), many rural shires were declining in population. This trend has largely reversed since the 1981 census, with only Seymour fluctuating in growth rate; all remaining shires have clearly increasing populations.

Increasing population, especially its expression in urban expansion, influences public lands and resources and the decision-making associated with planning their use. A variety of resource demands increase with population: recreation opportunity, open space, water-harvesting, minerals, stone, and timber. Lands are required for residential, commercial, industrial, recreational, and other uses, and some of the demand is upon public land. Environmental threats also tend to increase - not only those posed by the greater waste outputs to land, air, and water from a greater number of persons, but those due to a wide variety of factors, such as pest plants and animals, and high-intensity recreation. In situations wnere demand is increasing for resources, conflict over allocation or distribution becomes more likely.

Melbourne's urban growth corridors

Recent population growth and the urban expansion of metropolitan Melbourne have been concentrated in three corridors, with the eastern and southern flanks influencing the study area. Urban planning has guided this expansion, with the current metropolitan policy directing growth south-east toward Pakenham and northwards in the Plenty Valley. The Plenty Valley, being within the

City of Whittlesea, lies outside the study area, although it exerts considerable influence. Readers with a particular interest in Melbourne's expansion are directed to 'Shaping Melbourne's Future: the Government's Metropolitan Policy' (Victoria 1987d).

South-east corridor

The south-eastern growth corridor is expected to house an additional 280 000 people within the next 20 years; currently its population is about 90 000 (Victoria 1990). Under the government's current plan, urban growth will be contained in well-serviced areas which are not environmentally sensitive. Growth in the established settlements will be approximately 30 000 at Officer, 60 000 at Pakenham, and 80 000 at Cranbourne. The balance will be housed around Hampton Park, Narre Warren, Berwick, and Beaconsfield.

North-west of Pakenham, north-east of Beaconsfield, and around Harkaway are excluded from urban growth to protect flora, fauna, and landscape values and also because of fire hazard and extractive industries. These non-urban areas will surround Officer, Pakenham, and Cranbourne.

Plenty Valley corridor

This relatively long and narrow area straddles the Plenty River. Accommodation for an additional 70 000 people is planned over the next 10 to 15 years, and almost 7000 ha of land will need to be rezoned. It is intended to have a metropolitan park along the Plenty River, with the immediate riparian zone serving conservation and recreation purposes. New residential allotments will cover 1600 ha, with retail, commercial, and employment zonings occupying a further 460 ha (Victoria 1989b). Nearly all the population increases occur within the City of Whittlesea, with the Shire of Diamond Valley's population expected to increase by about 3500 by the year 2000 (Henshall Hansen 1989).

It is in the context of these developments that Council is reviewing the use of public land.

Open Space 2000

This recent government initiative will develop a network of open space for Melbourne, extending from the foothills of the Central Highlands to Port Phillip Bay. The areas involved include Port Phillip Bay, foreshores, parks and reserves, rivers and frontages, wetlands, utility corridors, and other lands. These will be linked by a co-ordinated management program and the creation of new parks and open space in areas currently deficient of such amenities.

The program will provide for environmental protection, recreation, and environmental education. Objectives of the program include the co-ordination of the activities of government agencies, municipalities and community groups. Enhancement of environmental quality and community involvement will be featured.

Because of a shared involvement in public land, Council's review and the Open Space 2000 program will require close co-ordination.

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2. ABORIGINAL OCCUPATION

This chapter discusses the associations of the Aborigines with the land, recognising a continuity between the past and present of Aboriginal culture through the pre-contact and post-contact phases.

It provides details of Aboriginal life and culture prior to European settlement, and describes the effects of European settlement in the post-contact period. It provides data on known archaeological sites and survey information, and relates these to the pre-contact conditions where possible.

A report commissioned by the Land Conservation Council, 'Aboriginal Occupation of the Melbourne Area, District 2' (Goulding 1988) forms the basis of the chapter. This report, which is fully referenced, is available for inspection at the Council's offices. The report acknowledges the contributions of the Dandenong and District, Healesville and District, and Morwell and District Aboriginal Co-operatives.

A paucity of information limits the description of the pre-contact and early post-contact Aboriginal life. Most of the information used here derives from historical records dating from 1835. It is a record primarily of the impressions of explorers, settlers, and government officials.

One of the best sources of information comprises the diaries, letters, and government reports of William Thomas, Assistant Protector of the Port Phillip district and Western Port Aborigines from 1839 to 1849. In his capacity as guardian, Thomas had daily contact with the Aboriginal people. His insights are particularly valuable because of their detail, touching on all aspects of Aboriginal culture.

Aboriginal Culture - Pre-contact

The Dreaming

Every aspect of the lives of Aboriginal people, whether social, economic, or political, was tied, in some form or other, to the land they inhabited (Berndt and Berndt 1977). This link between the natural world and the daily lives of Aboriginal people is often referred to as the Dreaming or the Dreamtime. Aborigines believe that during the very distant past the world was formed by mythical beings and the characters enacting this creation took the form of features on the landscape. Aborigines recognized these characters as totems, believing '...that all forms of life (were) intimately linked: human beings and other creatures (plants and animals) shared the same general life essence and none of them (was) independent of the others' (Berndt and Berndt 1978). In this way, individuals or groups of individuals possessed an intimate relationship with a feature on the landscape or a particular plant or animal species.

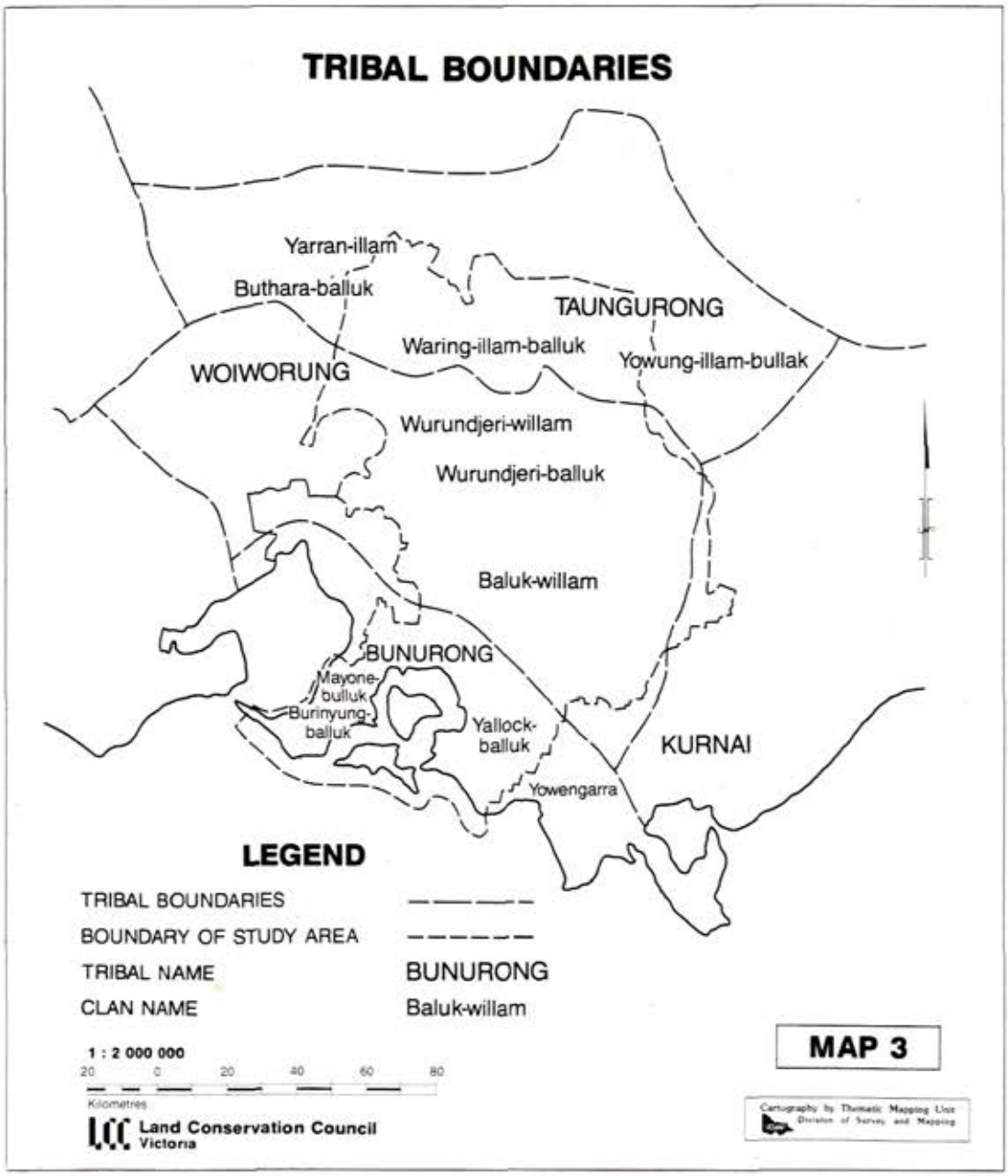
The Dreaming not only refers to a history of Aboriginal society but also represents a perspective of life and eternity, involving the past, the present, and the future in an ongoing belief system. This belief system provided Aboriginal people with guidelines for living as part of the environment they inhabited.

Aboriginal religion was maintained through myths recounting the Dreaming legends. These contained the knowledge, history, and social structures, which were maintained and passed on to each successive generation.

On one level, these beliefs were demonstrated in ceremonial practices, such as dances and songs in which stories of the Dreaming were recounted, and also in rituals such as the initiation of children once they reached puberty. On another level, tribute was paid to the forces of the Dreaming through everyday actions in the use of resources on the land. Individuals were born into clans that were responsible for designated areas of land, and each person within a clan acted as curator of the resources available.

Tribes

The study area was once occupied by several different tribes: the *Bunurong*, *Woiworung*, and *Taungurong* formed a dominant component of the '*Kulin* nation' (Barwick 1984). These tribes and their



boundaries are illustrated in Map 3. A fourth *Kulin* tribe, the *Ngurai-illan-wurring*, lived to the east of the study area and is not discussed in this report.

Because the settlement of Port Phillip (later Melbourne) occurred within the Bunurong tribal boundary, the ethno-historical information on traditional life-styles of Aborigines belonging to that tribe is more extensive than that for the *Woiworung* and far outweighs that available on the *Taungurong* which was located further north.

A very small portion of the eastern part of the study area includes land that, it is argued, belonged to the *Kurnai* Aborigines from Gippsland. The history of the *Kurnai* is described in the Land Conservation Council's East Gippsland Area Review (LCC 1985).

Social organisation

According to Howitt (1904) the *Kulin* peoples were distinguished from other tribes by their common language, referred to as the 'Eastern Kulin Language' - as well as by social and economic needs. This 'regional cultural block' was maintained by inter-marriage, a common language, and a variety of mutual interests. Complex relationships existed within and between the tribes belonging to

the *Kulin* nation. Within each tribe, individuals belonged to a clan, the membership of which derived from patrilineal descent. Within each clan, members '...had an historical, religious and genealogical identity' and each clan owned specific territories, to which they related through ceremonial and economic activities.

The interaction between the tribes in the *Kulin* nation came mostly through intermarriage and this could only be achieved through the linking of partners from the same 'moiety' (Barwick 1984). There were two moieties dividing *Kulin* society - the *Waa* (Crow) and the *Bunjil* (eaglehawk) (see Table 4). Entire clans belonged to one or the other, and individuals from each clan were compelled to find marriage partners from a clan of the opposite moiety. While spouses could be found within the local region, for social and political reasons they were preferably found in regions some distance from the clan's territory.

Table 4

TRIBES AND CLANS (IN BRACKETS) BELONGING TO THE KULIN NATION

BUNURONG

Burinyungg-Balluk (Waa)
Mayone-Bulluk (Bunjil)
Yallock-Bulluk (Bunjil)
Ngaruk-Willam (Bunjil)

WOIWORUNG

Baluk-Willam (Waa)
Wurundjeri-Balluk (Waa)
Wurundjeri-Willam (Waa)

TAUNGURONG

Waring-Illam-Balluk (Bunjil)
Buthera-Balluk (Bunjil)
Yowung-Illam-Balluk (Waa)
Yarram-Illam (Bunjil)

Source: Barwick (1984)

Individuals of a clan had rights to a certain territory within their tribes' boundaries and subsequently the resources that came with this territory. While the territory belonged to a particular clan, access could be acquired by other persons under certain circumstances.

There is little specific information on the social structure of tribes in the study area. References made to the hierarchy of tribal members mostly refer to men as holding positions of authority.

Thomas (n.d.) also gives a similar insight into the structure of clans:

> 'It does not appear that there are any persons among them which have kingly authority over the rest. Yet each leading man or men. And in all important matters which require the assemblage of the whole tribe, these influential men debate upon Public Matters, and decisions are come to by mutual consent. This kind of debating actually occurs in the evening when all are at their 'Miam Miams' and sometimes long and animated speeches are delivered'.

Men also had the authority to arrange the marriages of women within their tribe Thomas 1854).

Although it seems clear that men rather than women initiated much of the authority within a tribe or clan, it would be unwise to assume that this was the only situation. Given that the documentation of the lives of Aboriginal people during contact in the region was made by European men, it is probable that their perceptions of Aboriginal society were clouded by their own views.

Contemporary Aboriginal women in the study area argue that women did hold positions of authority in traditional Aboriginal tribes and that any group of women contained dominant female leaders. Many of these women had spiritual powers, and in some of the tribal ceremonies they were the only tribal subdivision of a tribe has one or more members who were permitted to participate.

Social relations with other tribes

A great deal of social interaction occurred between the tribes within the region and its surrounds. Tribes held large meetings in order to negotiate marriages, settle disputes, and exchange goods. Traditionally, many of these gatherings among the *Bunurong*, *Woiworung*, and *Taungurong* took place along the banks of the Yarra River where

Melbourne now stands (Sullivan 1981). They also travelled much further north for meetings. In 1841, for example, Thomas reported that the *Bunurong* and *Woiworung* tribes held a joint ceremony at Port Phillip and that they then visited the *Taungurong* to assist in a ceremony being held in their territory (Gaughwin 1983).

Settling disputes appears to be a common theme for inter-tribal meetings; however, it may be that these incidents were recorded more often because of their sensational value. On 5 December, 1844, Thomas recorded the hostile meeting between the *Barrabool* (from Geelong) and *Buninyong (Bunurong)* tribes north of Melbourne. Called together by messengers who carried two message sticks, the *Buninyongs* charged the *Barrabools* with '...killing two of the *Buninyongs* and stealing lubras' (Thomas 1854). The disagreement was only resolved after the *Buninyongs* had finished attacking and injuring some of the *Barrabool* men.

Disagreements over women seem to have been a common problem among tribes within the region, although this may have more to do with tensions resulting from European presence rather than the traditional situation.

It is well documented that the *Kulin* tribes and the *Kurnai* to the east were traditional enemies, with the latter referred to by the *Kulin* as 'bad blacks'. Many fights between these tribes have been reported, often involving large losses of lives. In one such incident in 1835, 17 people were killed by Gippsland tribes just outside Melbourne (Gaughwin 1983).

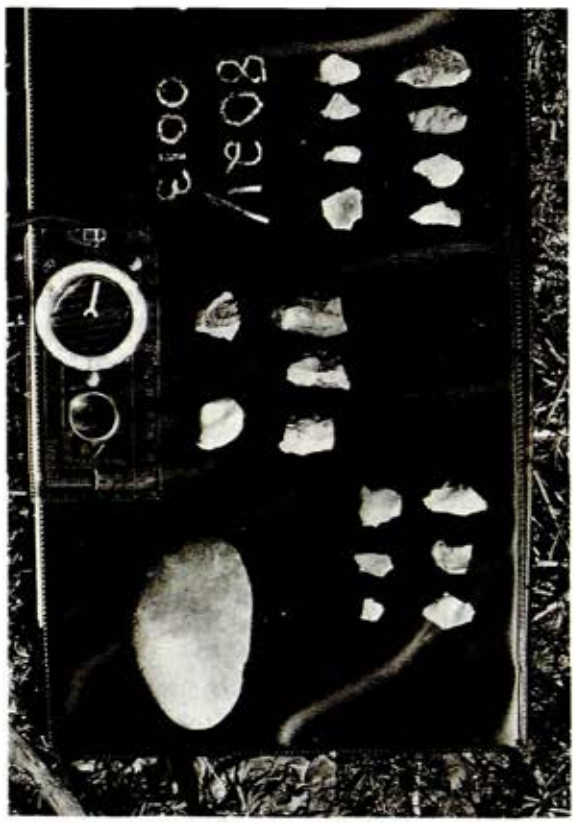
Trade and exchange

Exchange of goods between tribes enabled social ties to be maintained. The *Woiworung* tribal territory included the valuable Mount William greenstone quarry situated near Lancefield, west of the study area. Aborigines used this volcanic greenstone to manufacture hatchet heads. Many of the axes were transported several hundred kilometres away from the quarry, with some hatchet heads recovered from the Upper Yarra ranges.

Although not clearly documented for the study area, the exchange of goods such as stone for axes, possum-skin cloaks, baskets, bags, and spears probably occurred at large gatherings of tribes such as the end of season gatherings. During these times, social links were strengthened and arrangements for marriages made.

Material culture

Aboriginal people used a wide variety of material culture in their daily activities. Most of the available information concerns the *Bunurong* and *Woiworung* tribes, but it seems likely that the majority of the objects mentioned below were also owned by the *Tangurong* people.



Stone tools are among the most common evidence of Aboriginal occupation in the study area

In 1837, a European settler wrote that '...the original clothing of both men and women, seemed to be two mats, made of skins joined together, the one hanging before, the other behind' (Winter 1837). Alternatively, 'the young ladies wore around them a kind of bustle, composed of a rope yarn-like substance, which hung in pendant waves, half-way down to the knees' (Bunce 1859). In the colder season, possum-skin cloaks were manufactured and worn.

For personal decoration, people wore '...strings and a necklace called 'coornburt', composed of a number of short pieces of reed strung together, and hanging pendant from the neck'. Young men wore long pieces of bone or reed through the their noses and swan feathers in their hair.

Personal utensils were carried in individual bags. Women's bags were called *Baggerooks* and their baskets were called *Beenack*. The *Woiworung* made baskets from the leaves of reeds.

Eleven implements used by the *Bunurong* Aborigines in battle with other tribes included spears, clubs, and shields (Thomas 1840). The *Woiworung* used a boomerang called the *Barngeet*. Another important tool used by both men and women was the stone hatchet. A stone head, ground down to form a cutting edge, was usually hafted to a wooden handle using gum and twine made from animal sinews or plant fibres.

Women of the *Bunurong* tribe were rarely without their *Kannan*, a stick (usually as tall as themselves), which they used for digging roots and uncovering yams and also for fighting (Cannon 1983). The *Bunurong* also used bowls (called *Coolamons* or *Tamoks*) that they made out of the growth nodules of gum trees, used for carrying water and preparing beverages. Bark was also used to make canoes, shields, plates, and shelters.

Subsistence activities

There is little evidence in Australia that Aboriginal people cultivated plants as a food resource or participated in animal husbandry. The quest for food entailed, for the most part, a hunter--gatherer existence, involving the seasonal exploitation of foods. This required an intimate knowledge of the environment and '...although Aborigines were hunters and gatherers, the manner in which they satisfied their food needs was broadly adapted to the ecology of each region...' (Kirk 1981).

The smallest functioning component of a tribe was the band, usually comprising husband, wife/wives, and children. Normally, the band would break off from the larger tribal group, moving across the landscape to collect, catch, and process food and rest at night.

In 1840, Thomas observed the following about the movement of the *Bunurong* tribe along Western Port.

> 'They seldom travel more than six miles a day. For their migratory movements all are employed. Children are getting gum, killing bandicoots, getting grubs; the men hunting and scaling trees for opossums. They are mostly in camp an hour before sundown; the women first who get the fire and water; by this time their spouses arrive' (Thomas 1854).

During their foraging expeditions, Thomas noted, the *Bunurong* would rarely camp for more than three nights in one place, and often stayed only one night. In the warm weather when the tribe was moving about, Thomas wrote that the people seldom built *miams* (huts), preferring rather to build lean-to's, with bark sheets resting against a bough. When a more substantial 'village' was erected, he noted that it was arranged into small groups of about six mia-mias, 5 or 6 yards apart, with 20 yards between each group.

Food resources

Usually the hunting of large animals, such as kangaroos and emus, involved male members of the tribe. Although some women probably killed the occasional large animal, in general women (and children) were responsible for gathering and processing plant foods and killing small fauna. Plants formed the most reliable source of food and on many occasions, when large game could not be caught, vegetable foods were relied upon as the only source of food for camp members.

Gaughwin (1983) refers to an 1841 gathering of a group of 165 *Bunurong*, *Woiworung*, and *Taungurong* people, during which one group of people travelled to the mountains to obtain food, 'the second stayed in the camp while the third group comprising 70 people, speared eels in a nearby waterhole'.

In the summer season eels were in plentiful supply, enabling large groups of people to camp together - among the few occasions when tribes would become sedentary.

During a trip to the Dandenongs, a European botanist recorded Aboriginal men catching a range of fauna: kangaroo, porcupine, 'native

bear or sloth', wombats, opossum and fish (Bunce 1859). On one occasion, after three wombats were caught, a 'banquet' was held '...preceded, as a matter of course, by a grand corroboree' (Bunce 1859, p.72).

In 1837, there were large herds of kangaroos around the Port Phillip and Western Port regions, as well as emus (Jamieson 1853). Emus and their eggs were eaten by Port Phillip Aborigines; other birds were caught with nets (Coutts 1981).

References in the ethno-historical literature to Aboriginal exploitation of marine resources such as fish and shellfish are very rare. Men were recorded as having speared flounder and stingrays in Port Phillip Bay. They also caught fish at night, using fires on canoes to attract the fish. Fish were sometimes caught in a net with a draw-string opening.

Aborigines ate both fresh- and salt-water shellfish. Although there are few references to shellfish gathering and consumption on the coast, it is clear from the numerous Aboriginal shell middens along the coastline of both Port Phillip Bay and Western Port that this was a common activity. Europeans noted that men and women collected shellfish near Melbourne, and women procured fresh-water mussels from rivers and creeks.

Aborigines ate a large variety of vegetable foods. Tubers comprised an important component of their diet, the yam daisy (*Murnong*) is often referred to in the literature. Other types of edible root were available in summer and autumn and, according to Thomas (n.d.), formed the main dietary focus of women and children. There are several references to Aborigines eating tree-fern pulp and gum from wattle trees. Other plant foods included wild raspberries, cherries, currants, kangaroo apple, pigface, and mushrooms. They also ate many swamp-dwelling plants such as the roots of rushes.

On their food-gathering quests, the women also collected the large white moth larvae. Considered a delicacy, these grubs were slightly roasted before being eaten.

Nectar was often sucked out of certain flowers, and honey, when available, was also much relished.

Population - 1788

Estimating the size of the original populations of tribes inhabiting the study area is extremely difficult. No official censuses were taken of tribal numbers when Europeans first began to settle in the Port Phillip district in 1835. Information from the documents and letters of these first settlers are clearly inaccurate. Even by 1835, it is highly likely that the Aboriginal population was already affected by 50 years of European settlement. For 30 years prior to the settlement of Port Phillip, sealers and whalers had been making camps along Victoria's southern coast. During their stays, they often captured and kept Aboriginal women as sexual partners and domestic servants. Venereal disease and possibly smallpox were transmitted to these women, affecting population numbers. Historians also argued that disease also travelled overland from the settlement in New South Wales, claiming large numbers of Aborigines in Victoria.

Researchers have attempted to reconstruct the size of the Victorian Aboriginal population at contact and pre-contact. In 1930, Professor Radcliffe-Brown estimated that 11 500 persons had inhabited the whole of Victoria prior to European contact. Since this estimate, other authors have arrived at more radical figures. Smith (1980) argues that 15 000 would be a conservative estimate. Butlin (1983) argues that the figure of 15 000 probably reflects the period after 1835 and that a more realistic estimate of the 1788 population is between 50 000 and 100 000 people.

In 1840, William Thomas estimated that the total number of people in the *Bunurong* and *Woiworung* tribes in 1835 would have been between 300 and 500 people (Sullivan 1981). If 250 individuals (representing the *Taungurong* tribe) are added to this figure, then according to Thomas' estimates, the three tribes in the study area would have numbered between 600 and 750 people. This figure differs drastically from the later calculations. The study area covers about one-eighth of Victoria. If an even distribution of Aboriginal people living in Victoria prior to European contact were assumed, then available estimates for the *Taungurong*, *Woiworung*, and *Bunurong* vary from 1500 to between 6000 and 12 000.

With estimates between 600 and 12 000 individuals for the three tribes the difficulties of estimating the population sizes are clear. On present evidence it is difficult to challenge or substantiate any of the above figures.

The Frontier and Beyond

Events prior to Batman's Treaty

Between the years 1797 and 1802, both Western Port and Port Phillip Bays were surveyed by ship. From 1803 to 1804, the British government established a settlement at present-day Sorrento. During the next 20 years, European contact with Aborigines in the Port Phillip region was made by sealers, whalers, and escaped convicts.

In 1824, Hamilton Hume and William Hovell commenced exploration through inland Victoria. As a result of their favourable report to the New South Wales government, a military and convict post was established on the eastern shores of Western Port in 1826. It was abandoned in 1828 after being proclaimed as uninhabitable. Six years later, Edward Henty settled at Portland Bay without government approval. In the following year, Batman arrived to make his land purchase from the Aborigines.

Batman's Treaty - 1835

On 6th June, 1835, the Aborigines of Port Phillip signed a treaty with John Batman, a pastoralist from Van Dieman's Land. The treaty stipulated that for the exchange of £200 worth of goods, Batman could take possession of 600 000 acres of land around the Port Phillip district. This interaction with Batman signified the beginning of the 'Frontier', a period of European settlement that would have the most devastating effects on Aboriginal society.

This deal with the Aborigines was not considered legal by the British government in New South Wales. The implications of the deal for Aboriginal people must have been blatantly obvious to Batman, as he had been personally involved in the demise of Aboriginal society in Tasmania as a direct result of land conflicts with Europeans. It is unlikely that the Aboriginal people fully understood these implications or comprehended the European perception of land ownership. Batman states that the Aboriginal people understood the treaty; however, he did not comprehend that they had no concept of buying and selling land. To them, land was an inherited possession, a part of an individual's psychological and physical existence. The simplicity of the transaction stands in contrast to the catastrophic impact of Batman and future settlers.

Loss of land 1835–1850

One of the most devastating effects the presence of Europeans had on Aborigines living in Victoria was the incredible speed with which the area was settled and opened up to pastoralism Within months of the Batman treaty, numerous settlers had moved onto land around the Yarra, hereafter called the Port Phillip District.

In 1836, the Sydney government was compelled to issue grazing licences for the growing Port Phillip District. At that time, the number of European people in the settlement and surrounds totalled approximately 200. In 1837 there were more than a thousand settlers in Port Phillip, with large numbers of pastoralists arriving from Great Britain.

By 1840, the entire Western District had been settled. Those people settling in the north along the Murray were quickly making their way south and in 1840 met with settlers moving north from the Port Phillip District, along the Avoca and Loddon Rivers, north-east of the study area. In 1839/40, A. McMillan and P.E. de Strzelecki pioneered explorations into Gippsland, and by 1841 this region was also settled by pastoralists. At this time more than 20 000 Europeans were living in Victoria.

By 1851, when the Colony of Victoria was officially proclaimed, only the heavily forested mountains and the dry regions of the Mallee remained unoccupied. The total European population numbered 80 000 people. In the next 3 years, large numbers of people flocked into Victoria during the gold rushes at Ballarat, in Castlemaine, and in Bendigo. In 1854, 20 years after Port Phillip was first settled by a handful of people, Victoria's European population numbered almost 300 000.

Effects of Pastoralism - the First 5 Years of Settlement

The basic conflict underlying black--white relations was the incompatibility of pastoralism and the life-styles of the Aborigines. For the Aboriginal people, the most devastating effect of the influx of pastoralists was the loss of access to land.

Depletion of food resources

Constantly driven off the land by shepherds and pastoralists, the Aborigines were often denied access to the most basic resources such as water. This situation was exacerbated by pastoralists often settling on the best parcels of land around water-holes and rivers. These restrictions on the Aborigines severely disrupted their hunter--gatherer life-style.

Sheep and cattle had an enormous impact on the ecology of environments. In 1838, the first census undertaken for Port Phillip recorded the presence of nearly 311 000 sheep (Bride 1856). By 1851, the figure had grown to approximately 6 million (Cole 1981). Large tracts of bush were cleared for pastures, destroying the many diverse food resources (both flora and fauna) on which the Aborigines relied. In the first 4--5 years of settlement around Port Phillip (from 1835 to 1840), much of the study area land was claimed as pastoral runs and settled. Only the hilly and mountainous regions to the east remained relatively unoccupied.

The delicate balance between the foraging activities of Aborigines and the food yield of their environments was severely disrupted, often leading to critical shortages of food. These shortages often led Aborigines to kill sheep grazing on their former tribal lands. Constant conflicts between whites and blacks resulted and many Aborigines were shot attempting to kill sheep for food. This basic injustice led to attacks by Aboriginal people on the settlers and their workers. During the first 12 months of the settlement of Port Phillip, several shepherds were murdered (Bonwick 1956).

Christie (1979) argues that while the initial acts of aggression by Aborigines were 'unco-ordinated' and opportunistic, the increased tension arising from European presence on tribal lands led to 'organised resistance'.

Several accounts describe cases of outright massacre of Aborigines in the early settlement of the region, and no doubt many more went unreported. Massacres had been committed by the whalers at Portland Bay and other whaling stations. Some settlers also gave flour laced with poison to groups of Aborigines, although the frequency of such behaviour is impossible to gauge.

Another form of conflict arose from the maltreatment of Aboriginal women by male settlers, and in particular shepherds. Rape and forced detention had been inflicted on the Aboriginal women around Western Port by settlers and whalers for 30 years prior to settlement of Port Phillip. These attacks probably became more frequent during the frontier period. The rape and detention of Aboriginal women was commonplace in the more remote regions of the settlement.

Such abuse of Aboriginal women often led to attacks of revenge by Aboriginal men, with casualties occurring on both sides. The Assistant Protector wrote as late as 1845 that the maltreatment of Aboriginal women by Europeans was the cause of 'nearly every Aboriginal outrage which has occurred in my district'. In 1837, Governor Bourke proclaimed that it was illegal for squatters and their workers to forcibly detain Aboriginal women. However, there was no way of successfully policing these incidents.

Native police

In 1837, Captain Alexander Maconachie developed the concept of forming a native police corps that would act as a mediating body between the 'troublesome' Aboriginal people and the Europeans (Christie 1979). Initially the native police were recruited from *Woiworung* and *Bunurong* tribes. They refused to act against their own tribes; however, further afield, they were prepared to kill Aboriginal people causing disturbances. Their barracks were set up at Narre Warren (the site of the present-day police paddocks at Dandenong).

Although the corps was expected to act as a 'civilizing' body, Christie argues that it played a large part in crushing Aboriginal resistance around the Port Phillip District. Its members were expert trackers, and were under pressure from their European officers to kill rather than capture offending

Aborigines. But they were plagued by alcoholism and violence and in 1853 the corps disbanded after a highly controversial existence.

The Protectorate 1839--49

Despite the general lack of concern among settlers for Aborigines in Victoria by settlers, some members of the community wanted to see the situation change.

In 1837, a report from the Secretary of State recommended that the British Government set up a system enabling a group of protectors to look after the Aborigines throughout Victoria. An immediate task was the physical protection of the Aborigines, while the longer-term goal was to inculcate them with European values of religion, employment, and education. The protectors were to learn Aboriginal language and culture, protect them from cruelty and exploitation, and maintain a population census.

In 1839 the Protectorate commenced under the leadership of George Augustus Robinson. He was in charge of four assistant protectors, of whom William Thomas was responsible for the region encompassing most of the study area, with James Dredge's region encompassing the northern one-third.

There was a great deal of public opposition to the Protectorate system, made worse by the fact that it took the assistant protectors over 12 months to move into the field. Initially Thomas established a station at Arthur's Seat on the Mornington Peninsula. In 1840 he moved the station to Narre Warren (present-day police paddocks). The station provided an important refuge for Aboriginal people around the growing Port Phillip settlement. Food, medical supplies, clothing, and blankets were made available, where possible, to Aboriginal people frequenting the station.

By the time the assistant protectors reached their designated regions in 1839--40, the Aboriginal tribes had been severely affected by disease, starvation, and heavy population losses. Alcohol also posed a big problem, especially for those living on the outskirts of the Port Phillip settlement where it was most accessible. In order to pay for the alcohol and other supplies such as tobacco, Aboriginal women were often prostituted to settlers by their husbands or other male relatives. Some money was earned from odd jobs or begging.

When Thomas first visited the camps along the Yarra and other parts of the District, many of the Aborigines were seriously ill, suffering from venereal diseases and from dysentery, influenza, measles, whooping cough, and smallpox.

Dredge reported a similar situation among the *Taungurong* when he moved to Mitchellstown in 1839. All of the Aboriginal people he met with were hungry and many were cold and ill (Cannon 1982b). The *Taungurong* were also affected by diseases.

While the medical assistance of Thomas, Dredge, and Dr Cussens (the Port Phillip doctor) relieved the suffering of some Aboriginal people, they could only control the often epidemic health problems to a limited extent. The Aboriginal population was steadily declining and continuing violent conflict with Europeans exacerbated the decline. Alcohol and shortages of women eligible for marriage also led to frequent fighting among the Aborigines themselves.

Depopulation

While the presence of disease and the outright massacre of Aborigines by settlers are obvious causes of the depopulation of the Aboriginal people, other factors such as sterility, starvation, alcoholism, dietary changes, infanticide, inter-tribal conflict, and psychological stress were also involved.

In 1839 by Thomas took the first official census of the Aborigines living around the Port Phillip District (presented in Table 5). No known census figures for 1839 are available for the *Taungurong* tribe to the north.

The 12 years between the 1839 census and the early '50s censuses show dramatic population losses, especially for the *Woiworung*. In 1839, 124 *Woiworung* were recorded. By 1853 only 36 remained, representing a population loss of 88 people, approximately two-thirds of the 1839 population. The *Bunurong* tribe had a less dramatic population loss of 20 individuals. In 1852, Thomas visited the *Taungurong* in

the Upper Goulburn, counting 53 males and 31 females, a total of 84 people.

The situation for the remnant Aboriginal populations in the early 1850s was extremely dim. Comprising only one-fifth - in conservative estimates - of the original population at the beginning of the 'Frontier', the Aboriginal people were well on the way to becoming extinct. The seriousness of this situation was compounded in 1850 by the abolition of the Protectorate, which, although largely ineffective, had at least given some relief to surviving Aborigines.

Table 5

POPULATION NUMBERS BY AGE GROUP AND SEX FOR THE *WOIWORUNG* AND *BUNURONG* TRIBES IN 1839

***Woiworung* tribe (Yarra)**

Age	Male	Female	Total
<1	-	1	1
1--10	19	15	34
11--20	17	6	23
21--30	11	12	23
31--50	18	14	32
51--70	7	2	9
71--80	2	-	2
Total:	74	50	124

***Bunurong* tribe (Yarra)**

Age	Male	Female	Total
<1	-	-	-
1--10	11	8	19
11--20	14	7	21
21--30	13	6	19
31--50	9	10	19
51--70	2	2	4
71--80	-	1	1
Total:	49	34	83

Beyond the Frontier

After the Protectorate was abandoned in 1850, Aboriginal people in the study area lived on the reserves in Warrandyte, along Mordialloc Creek, and the Merri Creek lands. Thomas continued to look after the Aborigines as a guardian, although his territory was restricted to the Bourke, Evelyn, and Mornington counties. On 1st July, 1851, Victoria was declared a separate colony. During this time, government concern for the remnant population of Aborigines was dwindling, and most of the assistance given to Aborigines was by concerned missions.

Acheron Station

In February, 1859, two *Woiworung* and five *Taungurong* Aborigines put in a request to Thomas to obtain a tract of land at the junction of the Acheron and Little Rivers on which survivors of the *Kulin* nation could settle (Christie 1979). They chose the Acheron run as a compromise. The land was hilly and not ideally suited to pastoral activities, but carried plenty of kangaroo and possum. The plan was approved and the Aborigines moved onto the 4500-acre reserve late in 1859. Four settlers were appointed as trustees for the Station to ensure that it was being run properly and that '...the land was being used effectively'.

In June 1860, Peter Snodgrass, one of the trustees, proposed that the Station be moved 4 miles up the river to a run belonging to Stephen Jones. Jones wanted to sell the property back to the government because he claimed that the Aborigines' dogs were killing his sheep. After months of negotiations, Jones was paid £1000 compensation and the run was officially designated as the new Aboriginal Station. The Aborigines were upset at having to move off the land they had chosen for themselves and many refused to leave the Acheron site. The injustice of having to make the move was compounded by the fact that the trustees then allowed two local squatters to use the Acheron run. Only about 25--30 of the original 90 *Taungurong* and *Woiworung* who used the Acheron site settled on the new land.

Central Board for the Protection of Aborigines (1861--85)

In 1858, a select committee appointed by the Victorian government investigated the current state of Aboriginal people and their needs, leading to the formation of a central Board for the Protection of Aborigines (BPA). With the assistance of the Presbyterian,

Anglican, and Moravian missions, the BPA established Aboriginal reserves throughout Victoria.

Move to Coranderrk Station

In 1862 the BPA closed down Acheron Station. In March 1863, two leaders from the *Woiworung* tribe - Wonga and Barak - led more than 40 Aborigines across the Dividing Range and through the Black Spur to a new site they had chosen between Watts River and Badger Creek, just south of present-day Healesville (Wiencke 1984). The *Woiworung* were soon joined by the *Taungurong* people. In June 1863, the area was made into a temporary reserve of some 2300 acres, which the Aborigines named 'Coranderrk'.

The grave of Barak at Coranderrk Station cemetery

Although Coranderrk (like other stations in Victoria) probably saved Aboriginal people from extinction, its primary aim was to assimilate the Aboriginal people into European society, thereby destroying Aboriginal culture. This aim of 'civilising' the Aboriginal people involved maintaining total control over their lives at the stations.

The daily lives of the Aborigines living on Coranderrk were regulated by a strict routine, which included domestic duties and schooling. Although the Aborigines were permitted to hunt animals on the station, they were only allowed to do so to obtain food and skins and not for sport (Massola 1975). All other aspects of the Aboriginal culture, particularly their spiritual beliefs, were banned. Where possible, children were separated from the influence of parents and tribal elders so that they were more likely to become indoctrinated with the 'civilised' European ways.

One of the aims of the station was to produce a self-sufficient community, where men were taught farming skills and women were educated in domestic duties. In 1874, the Aborigines began growing hops as a cash crop and eventually the venture grew into a commercial success. The residents also made traditional artefacts and sold these to tourists.

From 1863 to 1886 the population at Coranderrk steadily increased. Many of the diseases that formerly killed Aboriginal people had been eradicated and, on the whole, the living conditions were much healthier than had been the case during the Frontier period.

Despite the 'success' of the station in ensuring the healthy existence of some of the remaining Aboriginal people in Victoria, in the early 1870s the BPA attempted to move the station and its inhabitants to an isolated area along the Murray. The call for closure of the station was also backed up by the high number of deaths that occurred in 1875, when 38 of the 158 residents died from a measles epidemic and resulting respiratory problems.

The now-politically aware Aboriginal community sent several deputations to Melbourne to protest against the closure. Under increased public criticism for its treatment of the Aborigines, the BPA dropped the idea of closing the station. The Aborigines at Coranderrk had won the first battle against the European establishment. They had acquired a new-found power and with it came confidence and a sense of self-pride.

The *Aborigines Protection Act* 1886

The 'rebelliousness' of the Coranderrk residents represented a threat to the BPA and in 1886, on its recommendations, the *Aborigines Protection Act* was passed in both Houses of Parliament. Essentially the *Act* amended the previous definition of who was legally an Aboriginal person. It stipulated that:

> 'Aborigines were full bloods, half-castes over 34, female half-castes married to 'Aborigines', the infants of 'Aborigines' and any half-caste who was licensed by the BPA to reside on a station' (Christie 1979).

The aim of the *Act* was to assimilate half-castes, who did not fit into the above categories, into the European community. The policy had disastrous effects on the Aboriginal people as a whole. Half-castes were forced from the relative security of the stations into a generally racist white community, where they had to compete for jobs with non-Aboriginal workers. At the same time, the Coranderrk station lost most of its farm labour force. The *Act* also forced Aboriginal families to split, disrupting one of the only stable components in their lives since European settlement. Christie argues that the *Act* represented a form of 'legal genocide':

> '...By restricting the full-blood and other half-castes to stations and by discouraging the marriage of younger half-caste girls with this group, the new policy virtually ensured that 'Aborigines', as defined by the Act, would eventually die out. There was ample evidence to show that the mortality rate of this group exceeded its birth-rate'.

Closure of Coranderrk

In the early 1900s, only small numbers of Aborigines were left living on stations in Victoria, and in 1917 the government recommended that, for economic reasons, all remaining Aborigines on stations should move to Lake Tyers in Gippsland. In 1922 some 42 Aborigines remained on Coranderrk station and, despite protests, the station was closed down during the years 1923 and 1924. Six would not shift to Lake Tyers and were permitted to remain there (Massola 1975).

Aboriginal History - 1924--1988

It is difficult to discuss in specific terms the history of the original tribes in the study area after the closure of Coranderrk in 1924. Many Aborigines moved to Lake Tyers in Gippsland and since this time, families have gradually moved out into the wider community, settling where possible in family clusters.

Several major changes in legislation concerning Aboriginal people have occurred during the last 65 years. In 1957 a government investigation was held into the state of the Aboriginal population in Victoria. The Board for the Protection of Aborigines was then replaced by the Aborigines Welfare Board and with this came a change in the definition of an Aborigine to include all people of Aboriginal descent. Despite the creation of this Board, Aborigines have continued to remain virtual outcasts in Australian society.

The turning point for the Aboriginal people came in 1968 with the introduction of the *Aboriginal Affairs Act*, which encouraged Aborigines to handle their own affairs. In 1975, the Commonwealth Department of Aboriginal Affairs was established to service the social, educational, health, employment, and housing needs of the Aboriginal community.

The recent history of Aboriginal people within the study area is highlighted by the strength gained and maintained through a group identity, which bonds people of Aboriginal descent together as a subculture. The basic units of identity within Aboriginal society today rest with the family and the region a family comes from. During the last 20 years this community spirit has been successfully channelled into community groups that provide the power and resources to allow Aboriginal people to take charge of their own lives and their culture.

Present-day Aboriginal communities

Two main Aboriginal groups now live within the study area - the Dandenong and District Aboriginal Co-operative and the Healesville and District Aboriginal Co-operative. The majority of members of these co-operatives are descendants of the tribes inhabiting the region at the time of contact. Both co-

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> '...By restricting the full-blood and other half-castes to stations and by discouraging the marriage of younger half-caste girls with this group, the new policy virtually ensured that 'Aborigines', as defined by the Act, would eventually die out. There was ample evidence to show that the mortality rate of this group exceeded its birth-rate'.

Closure of Coranderrk

In the early 1900s, only small numbers of Aborigines were left living on stations in Victoria, and in 1917 the government recommended that, for economic reasons, all remaining Aborigines on stations should move to Lake Tyers in Gippsland. In 1922 some 42 Aborigines remained on Coranderrk station and, despite protests, the station was closed down during the years 1923 and 1924. Six would not shift to Lake Tyers and were permitted to remain there (Massola 1975).

Aboriginal History - 1924--1988

It is difficult to discuss in specific terms the history of the original tribes in the study area after the closure of Coranderrk in 1924. Many Aborigines moved to Lake Tyers in Gippsland and since this time, families have gradually moved out into the wider community, settling where possible in family clusters.

Several major changes in legislation concerning Aboriginal people have occurred during the last 65 years. In 1957 a government investigation was held into the state of the Aboriginal population in Victoria. The Board for the Protection of Aborigines was then replaced by the Aborigines Welfare Board and with this came a change in the definition of an Aborigine to include all people of Aboriginal descent. Despite the creation of this Board, Aborigines have continued to remain virtual outcasts in Australian society.

The turning point for the Aboriginal people came in 1968 with the introduction of the *Aboriginal Affairs Act*, which encouraged Aborigines to handle their own affairs. In 1975, the Commonwealth Department of Aboriginal Affairs was established to service the social, educational, health, employment, and housing needs of the Aboriginal community.

The recent history of Aboriginal people within the study area is highlighted by the strength gained and maintained through a group identity, which bonds people of Aboriginal descent together as a subculture. The basic units of identity within Aboriginal society today rest with the family and the region a family comes from. During the last 20 years this community spirit has been successfully channelled into community groups that provide the power and resources to allow Aboriginal people to take charge of their own lives and their culture.

Present-day Aboriginal communities

Two main Aboriginal groups now live within the study area - the Dandenong and District Aboriginal Co-operative and the Healesville and District Aboriginal Co-operative. The majority of members of these co-operatives are descendants of the tribes inhabiting the region at the time of contact. Both co-

operatives provide services for the health, social, housing, and cultural needs of Aborigines within a 50-km (approximately) radius of their headquarters.

In recent years Aboriginal people have become more politically active. One focus of these activities has been claims regarding former tribal land by the Dandenong and Healesville Co-operatives. For the Aboriginal people, the current land claims represent a way of redressing some of the wrongs European society has inflicted upon their culture. At the same time, the land recovered represents a symbol of strength for Aboriginal people living in the present and provides hope for Aboriginal society in the future.

Archaeology Related to Aboriginal History and Prehistory

Background archaeology

The basic aim of archaeological investigation is to reconstruct the behaviour of people who once lived in the past. Archaeologists rely on diverse sources of information of which the most common techniques are systematic survey, excavation, and reference to historical records.

Excavations

Five excavations have been undertaken in the study area, all of them on coastal sites relating to pre-contact human occupation. As a result of the sea-level changes, the age of most of the sites associated with coastline occupation does not exceed 6000 years.

Stinker Bay shell midden

The Stinker Bay deposit comprised a shell midden situated in a small rock shelter on Phillip Island.

Excavations here recovered quantities of shellfish, stone, bone, and charcoal (Gaughwin and Brennan 1986). The base of the midden has been dated to 280 plus or minus 55 years bp (before present). Results of the analysis indicate that shellfish from intertidal zones predominate in the deposit, although some shells requiring subtidal diving and the occurrence of animal remains

Coastal middens mark occupation sites and contain shellfish remnants, charcoal, and stone tools.

suggests some foraging inland from the coast. The site probably represents the remnants of a single occupation and it was concluded that 'the contents of the site reaffirm the lack of intense use of the site and surrounding area'.

Corinella 3

Corinella 3 shell midden lies at the base of cliffs north of Settlement Point headland in Western Port Bay The midden, totalling some 30 m in length, with a deposit approximately 1 m deep, was excavated in 1986. The aim of the excavation was to establish whether it was formed by natural or human agencies and, while the results were inconclusive, two stone artefacts in the lower levels suggest that people had occupied the site during the past 2500 years (this date coming from radiocarbon samples) (Brennan 1987).

Point Grant 1

In 1983 the midden was excavated but the analysis of materials is as yet uncompleted. Situated on a cliff facing Seal Rocks, this midden has been dated: the pre-midden layer yielded a date of 1900 plus or minus 60 years bp and the midden layer a date of 1470 plus or minus 60 years bp (Gaughwin 1983).

Other excavations

Two other coastal middens were excavated by the Victoria Archaeological Survey in 1985/86 at Cape Schanck 7 and Boags Rocks. Reports on the studies are not completed.

Surveys

Detailed surveys undertaken by Hilary Sullivan (1981), Denise Gaughwin (1981), and Hilary Du Cros (1988) provide the greatest volume of background data on archaeological sites in the region.

The aims of these surveys were broadly: to locate archaeological sites; to generate information on the distribution of sites by environmental zone; and to assess sites and areas in terms of their significance.

Some 289 sites located during a 1981 survey of the Mornington Peninsula were occupied within the last 6000 years (Sullivan 1981). Coastal exploitation by small groups of Aborigines would have focused on the Bass Strait coast of the Peninsula and inland movement would have been towards the faunal resources on the Western Port plains.

A survey of Phillip Island, French Island, and the area around the northern end of Western Port Bay located 260 sites (Gaughwin 1981).

The author argues that camp sites are mostly on the coastal dunes facing high-energy rock platforms and near fresh water, and observed that these sites rarely contain land-mammal or bird bone, suggesting that they were used exclusively to exploit coastal resources.

At inland areas north of the bay, subsistence activities were focused on swamps and other water sources where food resources abounded. Gaughwin argues that '...the coastal margins were relatively unimportant in the food quest' and that the subsistence strategies were keyed more to coastal plains '...particularly those areas which were adjacent to wetlands' (Gaughwin 1983).

A 1987/88 survey of the Upper Yarra Valley located 37 sites, with the author concluding '...there is no area which appears not to have been used by the Aborigines in the region' (Du Cros 1988).

Highland areas were occupied sporadically and probably on a seasonal basis, and camp sites '...are likely to be found on well drained settings overlooking resource-rich zones and in the forested regions, such sites might be found on ridge tops. In addition, Du Cros suggests that while sites were concentrated along the banks of the Yarra River they could also be expected on the floodplain and that larger sites were probably located close to swamps or lakes.

Analysis of some of the stone recovered revealed that many local sources of stone were probably exploited. Two hatchet-heads recovered were sourced to Mount William near Lancefield, indicating the long-distance movement of raw materials, possibly via exchanges.

Summary of archaeological work

Relative to most of Australia, the region has been extensively investigated. Despite this, we still know very little about the activities of Aborigines across the diverse landscapes of the study area. While the surveys have

demonstrated that Aborigines occupied the entire region at some time during the past, the focus of more detailed follow-up research has been limited to only one environmental area, the coast.

One of the reasons for this lack of research in inland areas is that these contain very few sites with the potential for excavation - that is, have undisturbed deposits.

Moreover, because no sites older than 6000 years have been excavated, little specific information is available about the length of human occupation in the area. It seems highly likely, however, given the dates from archaeological investigations just north of the New South Wales--Victoria border at Lake Mungo, that people had been inhabiting Victoria for at least the last 32 000 years. Future excavations inland should shed more light on the antiquity of the region.

Archaeological Sites on Public Land in the Study Area

Pre-contact sites on public land

Nine different site types of pre-contact origin occur on public land in the study area. Their frequency is listed in Table 6.

Shell middens comprise concentrations of shell and often flaked stone, animal bones, and charcoal remaining from human occupation. Middens may comprise the refuse of one occupation, although occasionally they are made up of successive occupation levels. Shell middens are common along the coastline and may occur up to a kilometre inland while fresh-water shell middens are usually associated with lakes and rivers.

Surface scatters of stone artefacts and worked stone often represent specific stone-working areas where tools were produced, but may also represent the surviving remnants of a camp site, where the organic components have disappeared.

Isolated artefacts, implements, and worked stone have no obvious relationship with a larger site.

Scarred trees are those scarred by the deliberate removal of bark. One type of scar is formed after the removal of a slab of bark

Table 6

FREQUENCY OF PRE-CONTACT SITE TYPES ON PUBLIC LAND IN THE STUDY AREA

Site type	Number
Shell midden	448
Surface scatter	175
Isolated artefact	60
Scarred tree	45
Quarry/stone source	2
Rock shelter/cave	1
Isolated hearth	1
Burial	1
	733

Source: **Site Register, Victoria Archaeological Survey**

from the tree trunk to make items such as shields, canoes, or carrying containers (Coutts and Witter 1977). Often these scars are symmetrical because they were deliberately cut into specific shapes. A second type of scar formed when Aborigines fashioned toe-holds in the trunk in order to climb the tree.

Scarred tree at Cranbourne

Quarry/stone sources are areas from which stone was obtained for the manufacture of stone tools and frequently include refuse from stone-working.

Rock shelters/caves provided protection from the weather. During the occupation of such shelters, debris such as stone tools, bones, shells, and charcoal from fires often accumulated.

Isolated hearths define the remnants of campfire, usually occurring as a cluster of ash and burnt bone, shell, and other materials, and possibly scorched earth or sand.

Burials include any pre-contact human remains.

Post-contact sites on public land

Two post-contact sites on public land in the study area had a direct relationship with Aboriginal culture and history - the Dandenong Police Paddocks and Coranderrk Reserve. Each was assessed by the Dandenong and Healesville Aboriginal Co-operatives as having historic significance.

Assessing Significance

Australian archaeology employs a variety of methods for determining the significance of archaeological sites.

Three major criteria are used here to determine site significance:

* scientific value
* representative value
* social value
  - educational
  - value to Aboriginal people

Scientific value

A highly significant site has the potential to provide a substantial amount of scientific information, plus evidence of its age and the activities associated with it. For the study area this is an important consideration, given that very little is known about the pre-contact history of people living in the region away from the coast. Significant sites generally have *in situ* well-preserved or undisturbed deposits.

Some site types found on the surface of the ground, such as lithic scatters, may yield a wealth of information. Large scatters in particular provide greater research opportunity to supply answers to a variety of questions.

Representative value

Rare sites are highly significant because they may represent unique manifestations of pre-contact human behaviour. A representative sample of site types needs to incorporate rare sites.

Social value

Sites may have the potential to provide information for the general public about post- and pre-contact Aboriginal history and also be significant for present-day Aboriginal groups. Those with public-education potential need to be clear and well-preserved examples of the site type being displayed.

Value to Aboriginal people

In assessing the significance of archaeological sites, Aboriginal people may differ from archaeologists. For the majority of them, the value of a site lies not in its scientific qualities but rather in its cultural ones.

In order to gauge the opinions of Aboriginal people on the value of different site types, representatives from the Dandenong, Healesville, and Morwell Co-operatives were consulted.

It was not possible to assess the significance of each individual site recorded; assessments were limited to those sites within the areas surveyed by Sullivan (1981), Gaughwin (1981), and Du Cros (1988).

Further assessment is not possible until more detailed surveys of the remaining areas are undertaken.

Pre-contact Sites of Significance

Most pre-contact sites of significance are coastal, particularly middens. This is not surprising given that two of the major surveys were undertaken along the coast. Ten of the significant sites occur in the Upper Yarra Valley survey area. Table 7 lists the site types recorded to date.

Table 7

NUMBER OF SIGNIFICANT PRE-CONTACT SITE TYPES

Site type	Number
Shell midden	32
Surface scatter	6
Isolated artefacts	-
Scarred trees	6
Quarry/stone source	2
Rock shelter/cave	1
Isolated hearth	1
Burial	1
	49

Middens

In the majority of cases, the middens were considered to be of value because they contain *in situ* deposits. The coastal region is particularly vulnerable to erosion and hundreds of middens have been disturbed by erosion during the past.

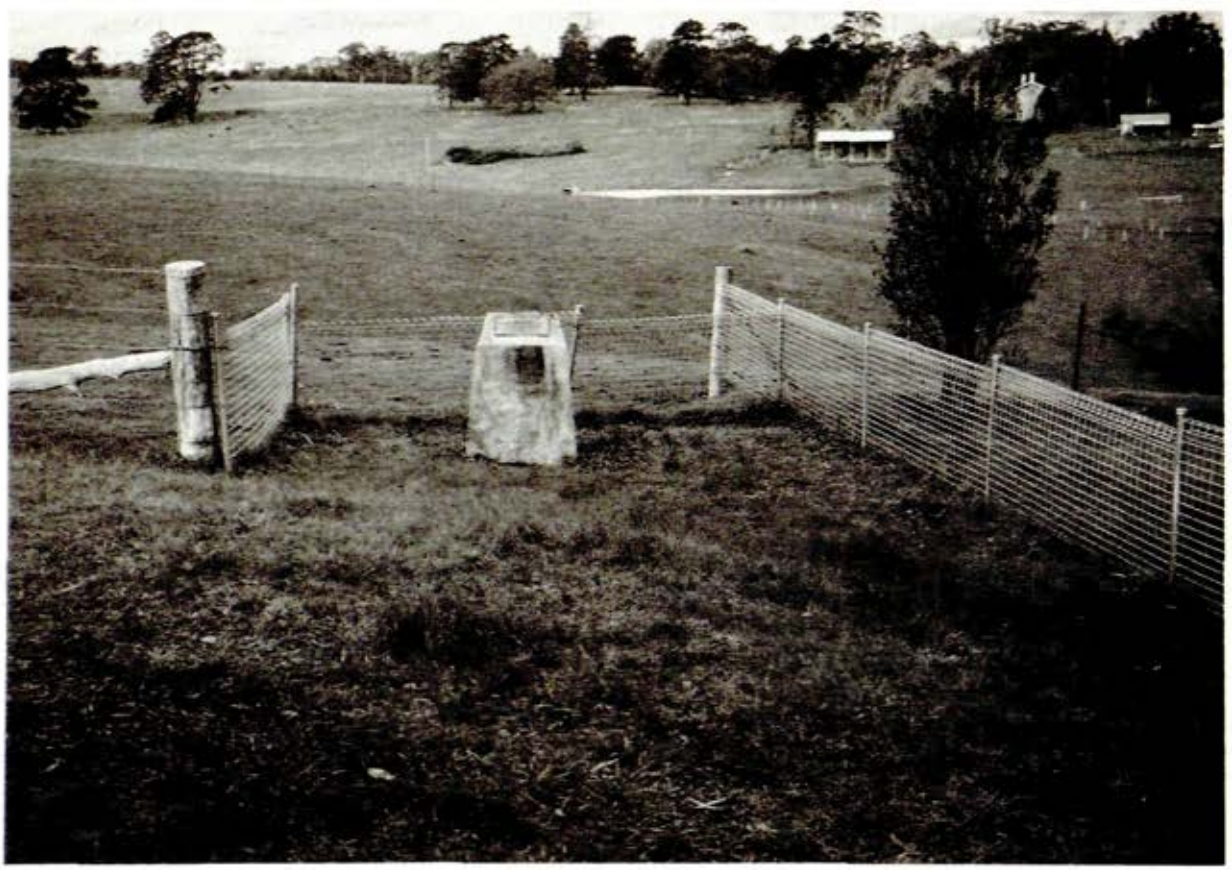
Seven of these middens are rare because each one has unique contents (in terms of both the size of the deposits and the artefacts present). Two of these sites, Stinker Bay and Cape Schanck 7, have been excavated. Swan Lake 4, which is located on the edge of a lagoon, is the only midden situated away from the coast (Gaughwin 1981).

Surface scatters

The surface scatters given significance values have research potential due to their size and the uniqueness of their contents, whether the type of stone-working reflected in the artefacts or the raw material used.

Scarred trees

All six scarred trees occur in Du Cros' survey area. Five are significant because of their educational value. These trees are located in the Healesville Wildlife Sanctuary and accessible to large numbers of people. The Cement Creek scarred tree is the only one within the area surveyed by Du Cros in a mountainous environment. It should be noted here that it was only possible to consider 6 of 45 scarred trees occurring on public land in the study area.



The former Coranderrk Station site, as it appears today

Rare sites

Five site 'types' are particularly rare on public land within the region. These are: the two stone/quarry sources, La Trobe Valley Silcrete Quarry and Cape Woolamai 4 Quartz Quarry; Jessie's Cave 3; the Cape Woolamai 1 Isolated Hearth; and the San Remo Back Beach Burial.

Assessment of pre-contact sites by Aborigines

On the whole, the Aboriginal people interviewed about the significance of the archaeological site types found on public land in the study area saw little value in the archaeological definitions of site types. Some of them believe that all sites, both pre- and post-contact types, are equally significant.

Members of the three co-operatives (the Dandenong, Healesville, and Morwell Aboriginal Co-operatives) felt very strongly that the burial at San Remo has great significance and should not be tampered with. At the time the site was first located, several bones had eroded out from the sand-dune grave. This skeletal material was documented and reburied in accordance with *Wurundjeri* (*Woiworung*) burial practices in September 1988.

Post-contact Sites of Significance

Two areas of public land have historical significance for the Aboriginal people of the Dandenong and Healesville Co-operatives: the Dandenong Police Paddocks and Coranderrk Reserve at Healesville. Both are currently subject to land claims by the two co-operatives.

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3. EUROPEAN HISTORY

This account of European history is organised into distinct themes of direct relevance to natural resource use and land use features of the study area. These themes are the pattern of public land, tracks, mining, forests, fire, farms, water, and recreation, and form part of a broader set of issues to be developed.

A comprehensive listing of the historical sites in the study area has been compiled by the Historic Places section of the Department of Conservation and Environment for this Review. A report written by the project leader (Griffiths 1990) forms most of this chapter. Copies of the report containing full referencing, the historic site listings, and site location maps are available for inspection at the Council's offices.

The Pattern of Public Land

Historical and cultural values reside not only in particular sites and places, but in the whole shape and balance of the landscape. Existing parcels and allotments of public land are themselves relics, historically defined and defended. Attention must be given not only to the history of what happened on the land and to the land, but also to what people wanted to happen there.

A distinctive characteristic of Australian history has been the prominent role of government in overseeing and planning district development. Crown land reserves were one tool by which a central and often distant government sought to shape local community attitudes and priorities. Space was formally allocated for essential and desirable purposes: a school, a cemetery, a quarry, a water reserve, a recreation ground, or a botanic garden. Although the survey and assessment of land often occurred in response to private initiative, the geography of official sanction remained a fair measure of the frontier of settlement. Often the two went hand in hand. In far-flung Matlock, the 1864 survey followed on the heels of the gold-rush settlement and accommodated the streets around the existing buildings.

Another role of Crown land reserves was the protection of resources, such as river-banks, water resources, valued timber, and known minerals. Usually the definition of these reserves was a source of bitter contention. They limited and constrained settlement, and settlement was regarded as the highest public benefit of all, and the true measure of progress.

By the end of the 1840s, squatters occupied most of the plains and open valleys of the study area - much of the Mornington Peninsula, Western Port, French and Phillip Islands, the Yarra flats, and the Goulburn valley. Few towns had been proclaimed in the study area before the mid 1850s. The population was dispersed and the main centres lay along the Sydney road, and further east at Port Albert. But, within the study area, 'township' reserves were declared as early as 1847.

In that year, an Order-in-Council defined a number of significant areas, particularly water reserves, along the northern and eastern shores of Western Port. They were prospective sites, potential urban centres, placed strategically within a region of Victoria that, until the gold rushes, was one of the areas of higher population. The discovery of gold revolutionised the pattern of settlement, and few of these early reserves were activated.

The most revealing legislative history of resources concerns the forests. Most public land is forest, and most forests are on public land. This is because the first signature to private ownership was a clearing.

One of the obvious reasons why forests have been allowed to remain is because they occupied lands regarded as marginal for settlement or agriculture: too wet, too dry, too steep, or too inaccessible. 'Reserves for native peoples' were a product of the enlightenment and of evangelical Christianity, which held that dispossessed races deserved compassion and could be 'civilised'. Two principal places were nominated for this purpose: the site of the present Dandenong Police Paddocks, selected for Aborigines from 1837, and sites in the Acheron and Healesville districts (Coranderrk Station) from 1859.

During World War II, Australia interned enemy aliens and 'naturalised British subjects of enemy origin', some of them in forest camps within the study area. Prisoners of war including from overseas were also housed in large internment camps, including two forestry camps in the Mount Disappointment forest and one in the Dandenong forest.

A different sort of prison was that established on French Island in 1915, where inmates experienced farming as well as isolation.

Parcels of public land have been set aside for the management of Nature from the earliest times, but the reasons for their proclamation have changed markedly. Modifications of a wholly utilitarian land management perspective appeared in Victoria from the 1860s with the protection of timber reserves and water frontages.

It took longer before Crown land was reserved for non-economic purposes. The early history of Victoria's national parks illustrates the growing importance of outdoor recreation as much as the emergence of any conservation ethic. Often these roles were in tension, as is suggested by the term 'park'.

The modern mosaic of Nature reserves has its own historical context. It reflects a new respect for scientific opinion such that the 'romantic' vision, so important in the formation of the first parks, now has much less influence. Many of the parks and reserves have 'disturbed environments'. For example, the Langwarrin Flora and Fauna Reserve has a long military history; Mount Worth State Park includes original forest as well as abandoned farms, and much of Fraser National Park was settled by graziers, and parts of it had been subject to mining.

Tracks

The first recorded European in the study area was probably George Bass, who named and explored Western Port in January 1798. Many of the early coastline incursions were for defence purposes, and the enemy was not the Aborigine; but the French.

In 1800, H.M. brig *Lady Nelson* was dispatched to make survey of Bass Strait, and it returned in 1800--02 for a more detailed exploration of possible settlement sites and to consolidate the British claim. On 9 March 1802 at Point King, the Union Jack was raised and all the southern shores of New South Wales formally annexed.

Others followed: Matthew Flinders climbed Arthur's Seat in 1802 and, in 1803, land parties from the Cumberland walked around Port Phillip Bay, crossed the peninsula to Western Port, and ventured up the Yarra River as far as Studley Park. The British government, to further forestall the French, had decided to form a settlement at Port Phillip. But a hostile Aboriginal presence, poor soil, scarce water, and sickness meant that the settlement at The Sisters lasted less than a year.

Another official settlement - this time of 20 soldiers, some with their wives, and 20 convicts - was established at Western Port in 1826, near the present town of Corinella. It too was later abandoned.

Throughout this period of the beginnings of official exploration of the coastline of Port Phillip, many informal, seasonal camps (especially in Western Port) must have been established by sealers and whalers who were harvesting the rich resources of Bass Strait.

In December 1824, Hamilton Hume and William Hovell reached Corio Bay from the north. In doing so, they crossed the Yea district, climbed Mount Disappointment, and named it for its lack of view. One of their lasting tracks was the pass they found over the Divide, which was followed by later overlanders and perpetuated by the railway line and (roughly) the western boundary of the study area.

Another route into the study area from the north was pioneered by Count Paul de Strzelecki, who led a party across the Australian Alps into Gippsland and across to Western Port in 1841. Attempts to establish a trading route linking Melbourne with south Gippsland were frustrated by 'the Great Swamp' north of Western Port and heavy forest between Bunyip and Moe. By 1847, C.J. Tyers had surveyed a route from Traralgon to Melbourne, although people generally preferred the route by sea to Port Albert until a rail link to Sale was made in 1877.

Nevertheless the pastoralists, and soon the miners, were the chief pathfinders. An

Railway construction near Korumburra

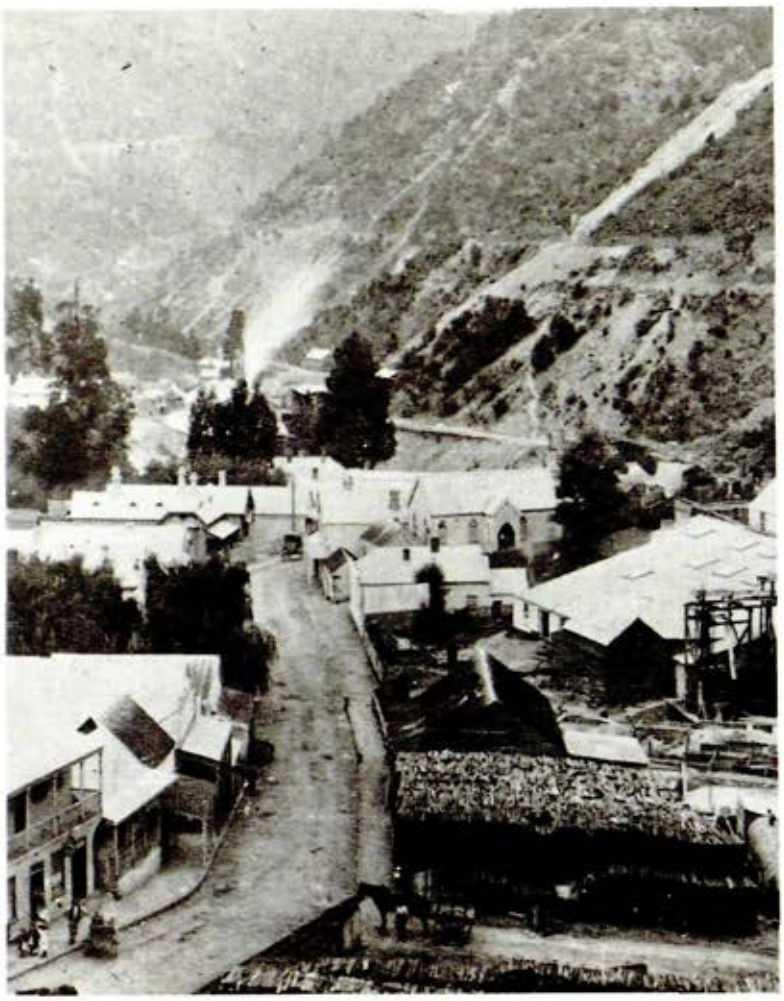
overlander, John Gardiner, came across rich pastures in the Croydon--Mooroolbark area when seeking lost cattle in 1837. By the early 1840s, squatters had claimed most of the flat land along the Goulburn Valley, and by 1850 their runs encircled the Dandenongs and extended down the Mornington Peninsula and along the Yarra Valley. The Surveyor-General, Robert Hoddle, made the first exploration of the Upper Yarra in 1844, but the miners opened up the rugged country beyond.

The discovery of gold probably delayed development in the east. For most of the 1850s, the central and western goldfield drew money and population. From the late 1850s, however, gold was found in the eastern valleys and mountains. Mining generated new settlements and strings of stores, hotels, and townships along the tracks made to the diggings. Miners' tracks were often barely a foot in width, and they expended much time and money in cutting them. From 1863, the development of the Yarra Track up the Blacks' Spur from Healesville to Marysville, and on to Woods Point, had enormous impact on settlement along the Yarra Valley.

The early European history of the study area was played out along these tracks, commemorated by the name of their creator or by a feature they passed: Mia Mia, Campbell's, Porter's, McEvoy's, Yarra, Hogarth's, McDonald's. Their monuments are the avenues of ferns, the stone culverts, the string of hotel sites, and the modern overlay of bitumen. The routes of the most successful tracks have been preserved by modern roads, but at the expense of their physical monument.

Sea transport and coastal development played a major role in the State's development. Ships brought immigrants, stores, and stock, carried resources for export, and plied a trade between the colonies' coastal settlements.

Until around the turn of the century their journeys were especially hazardous undertakings, with frequent shipwrecks and much loss of life. More than 600 shipwrecks



Walhalla, in its heyday in 1910

occurred along the Victorian coast, with over a dozen involving vessels exceeding 100 tons wrecked from Port Phillip Heads to Cape Paterson. Of the 62 possible shipwrecks in the study area, the Victorian Archaeological Society knows the location of 14. As expected, most of the known sites cluster around the navigation hazards - Point Nepean, Cape Schanck, and Western Entrance - and most are close to shore.

Mining

The major goldfield in the study area (often known as the Jordan) stretched along a 3-mile-wide belt of auriferous land from Jamieson in the north to Walhalla in the south. It had significance for several reasons. Opened up in the 1860s, it was the site of Victoria's major gold-rush in that period and was the only goldfield in the colony where the miners were also the explorers, the first white settlers. It boasted Walhalla, which for 50 years was one of Victoria's outstanding mining districts.

One of the first Victorian discoveries of gold occurred in 1851, east of Melbourne at Anderson's Creek (Warrandyte). However, finds in the Ballarat, Bendigo, and Beechworth districts drew miners north and west for most of the 1850s. Emerald field was opened up in 1858 and short-lived rushes developed along the Little Yarra and Upper Yarra Rivers. Despite a small rush near the Jamieson Flat in 1854, it was not until 1857 that miners returned to explore the Big River and discover gold at Enochs Point - the first gateway to the Upper Goulburn field.

Jamieson developed from 1860 as a stopping place and market town for the new and rapidly extending goldfield. There, the packhorses took over from drays and began their tortuous journey south. The cost of isolation was one reason why wooden water wheels proliferated as a means of power in the early years of this district. They could be constructed from local timber, and only the iron hub and buckets needed to be imported.

Woods Point field was opened up from the north in May 1861. During the next 3 years, spectacular quartz reefs (particularly the Morning Star) were quietly developed in this area while the bulk of the miners were seeking fast alluvial wealth in the broader Jordan River valley further south. This new field revived Victoria's gold fever of the early 1850s. Nuggets were plentiful and sluicing was richly rewarded. In February 1862, 3 months after the first parties had reached the Jordan, the Mining Registrar for the division reported some 4000 diggers on the field.

Initially this new extension of the Jamieson field was tethered to civilisation by a 12-mile (19-km) precipitous track over the Divide and then by a further 40-miles (64-km) of packhorse trail to Jamieson. New tracks were quickly established to the west and

south. The Yarra Track, the most direct route from Melbourne to Woods Point via Healesville and Marysville, was first used in 1862. Porter's, Campbell's, and, pre-eminently, McEvoy's Tracks were forged. Packers discovered Donnelly's Creek field in late 1862 and, by February 1863, Edward Stringer spread word of his find at Walhalla. Thus the major fields and transport routes in the rugged Upper Goulburn and Jordan valleys were established within 3 years of their discovery.

The working population came to depend on the few continuously operating mines - the Al, Morning Star, All Nations, Loch Fyne, Golden Lily, and the Toombon, as well as the Long Tunnel at Walhalla.

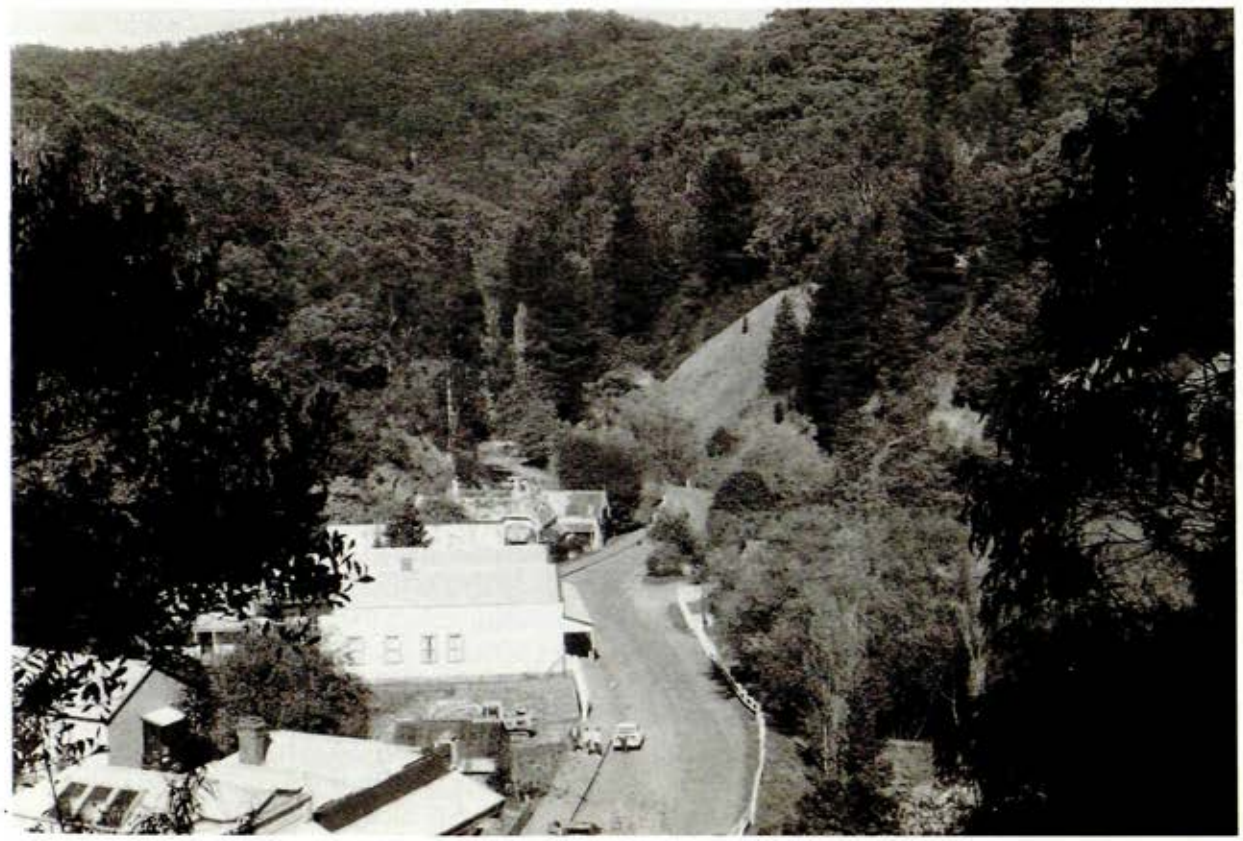
At the end of 1867, as the richer portions of the original reefs were exhausted, the boom quickly collapsed. The goldfield drifted into decline in the 1870s.

By the 1880s about 2000 people lived in Walhalla, the centre of a field that was second only to Bendigo in gold production. But the town itself remained a frontier settlement and even by 1896 had no domestic water supply, court house, or railway.

The 1890s and early 1900s witnessed a widespread mining revival which continued until World War I. The first decade of the twentieth century was one of Walhalla's most successful mining periods, but also the eve of its sudden decline. Built after decades of lobbying, the Walhalla railway was completed in 1910, just in time to take people, their belongings, and some of their houses away.

Mining continued quietly along the Jordan goldfield in the 1920s and, in the 1930s depression, received some impetus from the rising price of gold and high national levels of unemployment. The 1939 bushfires drew a black, final line across the lives of the already dwindling mining communities. Only two mines continued to operate after the 1930s: the Al at Gaffneys Creek and the Morning Star at Woods Point. Both figured among the top ten gold producers in Victoria until well after World War II.

Mining activity revived in the 1980s and, combined with a new interest in history,



Walhalla, as it is today

further diminished the evidence of past mining. The 1970s and '80s have therefore been a period of rapid loss of mining heritage.

Waterwheels were particularly dominant in the district's history. One has survived intact (Donnelly's Creek), and the remains of others indicate major battery sites. Incline tramways, used to ferry ore from the mine to river-side batteries, and extensive tramway networks to supply wood for the boilers were peculiar to mountain mining. At the Royal Standard and Sir John Franklin mines, incline tramways survive as notable features in the forest and retain associated relics and stonework. Walhalla developed an intricate network of tramways to supply timber for the mines.

Quartz reefs were the main object of mining in this goldfield, but some evidence of alluvial diggings remains, particularly on the Jordan and Jamieson flats. These features include sluicing banks and channels, river-diversion tunnels, and congregations of shafts. One human dimension of alluvial, as opposed to quartz, mining was Chinese settlement. There were relatively few Chinese on the whole Jordan goldfield, and evidence of their activities is scarce. A ceremonial oven and some isolated, unmarked graves are perhaps the only conspicuously non-European relics in the district.

The signs of 1860s settlement and industry are obviously important. The 1890s and early 1900s were the other years of major development, and relics dating from this later time are also important elements in the district's heritage. The area's isolation has, in some cases, ensured the survival of relics that have become scarce in the more accessible mining districts of Victoria.

Coal became the dominant extractive industry in Gippsland this century. Mining was undertaken at Cape Patterson from 1859 and at Kilcunda in the early 1870s. A syndicate at Coal Creek brought its mine into production in 1890, and by 1892 others had opened at Jumbunna and Outtrim and soon had their critical rail links with Melbourne. Seams at Wonthaggi were discovered in 1908, and production in this area peaked in the late 1920s. The last of the Wonthaggi shafts closed in December 1968.

Although most brown-coal deposits were located outside the study area, the development of the La Trobe Valley had great impact on patterns of settlement in Gippsland. From the early 1950s there was progressive large-scale development of the La Trobe Valley industrial region, and from the late 1960s of natural gas and oil supplies in Bass Strait.

Other forms of mining plumbed and scraped the surface of the study area. Lime-burning for mortar was a very early and significant industry on the Mornington Peninsula, and a large limestone deposit was quarried for building purposes at Lilydale from 1878. Tin, Victoria's second most valuable mineral, was found at the head of the Bunyip River in 1876; wolfram was mined in the Yarra Valley; and saltworks were established on the shores of Western Port Bay. Copper ore was mined at Cooper's Creek on the Thomson River from 1863 until 1881.

Forests

The first Europeans to venture into the vast mountain forests east of Melbourne regarded them with awe. They captured the popular imagination and have persisted as symbols of the region. Some colonists regarded the lushness and magic of the mountain forests as almost un-Australian: they applied place-names like Jordan and Jericho a response to their sense that the forests were truly 'Eastern'. This wonder at the forests did not stop Victorians from destroying them.

So vast were the forests, and so much did they dwarf the human figure, that restraint in their use seemed unnecessary. However, in just a few decades, miners, splitters, and millers wrought immense destruction.

The search for Victoria's (and the world's) giant trees - which took place from the mid nineteenth century - illustrated some of these conflicting feelings about the forest. Inter-colonial and international exhibitions were occasions to boast about Victoria's tall trees. At the time of the Centennial International Exhibition held in Melbourne in 1888, a reward of £20 ($40) was offered to anyone who could locate a tree 400 feet (122 m) in height. No such tree was found, but several over 300 feet were identified.

Forest clearing near Mt Horsfall -
last century

Tall trees and huge stumps and logs continue to be made into artefacts of wonder. In 1933 Harold Furmston discovered a magnificent mountain ash on Mount Monda with a circumference of almost 64 feet (19.5 m). The Healesville Shire President led an excursion to the tree and it became a popular pilgrimage for hikers. In 1976 a monument was unveiled to the 'World's Tallest Tree' near Thorpdale in the Strzeleckis, which, in 1884, was said to be 375 feet (114 m) high.

The Cumberland Reserve near Marysville was proclaimed to preserve a stand of tall mountain ash.

Trees were initially regarded as an enemy rather than as a resource. Ringbarking, which created landscapes of gaunt, dead trees, was the supreme expression of this attitude. Settlers were often overwhelmed and frustrated by the quantity of bush timber. Clearing it was seen not only as a private necessity but as a public good.

In a pioneer country, settlement was the priority. Squatting, selection, and mining, the three major phases of land use in nineteenth century Victoria, all placed pressure on the forests. As the Secretary of the Forests Commission put it in 1924, 'in most parts of the State today burnt and ring-barked skeletons bear mute witness where fine timber has been destroyed, but settlement has not been able to make good'. The slowness with which forest husbandry was adopted in Australia was probably partly due to the dominance of the British, who came from a country where few original forests remained, and where a cherished right and freedom (particularly for the landless poor) was to chop down trees.

The first Victorian legislation to create reserves for 'the growth and preservation of timber' was embodied in the 1862 *Land Act*, although trees on such reserves could still be cut. This provision was strengthened in the 1865 Act, and within years more than a million acres of Victoria had been set aside as State forests or timber reserves.

A series of reports from the 1870s detailed huge waste in the timber industry and irresponsible and ineffective management of the forest resource. Forestry Bills were presented to Parliament in 1879 1881, 1887, and 1892, but none was enacted.

These circumstances eventually culminated in a Royal Commission on Forests, which sat from 1897 to 1901, produced 14 reports, and led to the 1907 *Forests Act*, which established a Department of Forests. This professional emergence of scientific forestry consolidated with the establishment of the 1910 School of Forestry at Creswick. The development of forest management coincided with the early years of intensive commercial sawmilling in the eastern forests. Much of the momentum for this legislative change came from the devastation and exhaustion of forests in other parts of Victoria, particularly in the goldfield districts.

This timber tramway era is most represented in the physical relics left in the forest today. It began with the extension of the railways into the east and ended with the construction of roads and use of motor vehicles during salvage operations following the 1939 fires.

Sawmills were established from as early as the 1850s. Some mills developed directly from mining, such as the earliest in the Gembrook district, which converted its waterwheel from driving a battery to operating a saw. Other well-known mills existed at Bass River in the 1870s, at Crystal Creek near Alexandra in 1875, and at Monkey Creek near Yea in 1878.

A new, large-scale era of sawmilling was initiated in the eastern forests by the extension of the Victorian Railways system to towns such as Wandong and Nar Nar Goon (in the 1870s), Yea (1883), Healesville (1889), Fern Tree Gully (1890), Gembrook (1898), Warburton (1901), Alexandra (1909), Erica and Walhalla (1910). During the period from 1885 to 1950, sawmilling developed a common and relatively stable pattern.

Tramways developed as a cheap, efficient, and year-round means of conveying timber to the rail lines, where it was destined for the Melbourne market. They were first constructed of wooden rails with closely packed wooden sleepers, which provided a firm base for horses as they hauled the bogies. Steel rails, sometimes used on corners, eventually totally replaced many wooden lines, and steam locomotives and winches took over the work of the horse and bullocks.

Sawmilling activity in the study area peaked in the 1920s and immediately after World

War II with fire-salvage work. The number of forest sawmills reached a peak of 241 in 1921, and then dropped steadily, especially after 1924, to 169 in 1930. Yarra Junction, where the lines from the Warburton and Powelltown forests met, boasted that more timber passed through it than any other place in the world except for Seattle in the United States.

In the 1920s the sawmilling industry was taking off further east. As gold-mining declined in the Walhalla district, timber took over as the major source of employment. Mills sprang up in the forests from Moondarra and Erica across the ranges to the Upper Tanjil Valley and Mount Baw Baw. Erica took over as the district's major centre. By the early 1930s millers were entering the 'virgin bush' country around Matlock and on the Tanjil.

The 1939 fires claimed the lives of many timber workers, destroyed 41 mills, and destroyed much of the forest vegetation. Salvage work following the fires meant that the tramway network was used and extended in some areas until the 1950s.

But mills eventually established themselves more safely in the towns - a move facilitated by the use of roads and trucks. Tractors were used for snigging logs, roads took over from tramlines, the chainsaw replaced the axe and cross-cut saw, diesel and electricity replaced steam power, and milling equipment became more sophisticated. This technological revolution and the retreat to the towns left their residue: sawdust heaps, mill sites and huts, tramway formations, cross-log bridges ('make-ups'), and trestle bridges.

The 1939 fires created an urgent and widespread need to understand the circumstances under which mountain ash successfully regenerated. Artificial regeneration by 'tubing' was experimented with at this time, and became widely used. Seedling regeneration in burnt ash areas varied and areas of higher elevation were generally slower to recover. In badly damaged stands of ash, coppice regeneration predominated. Messmate and silvertop, by contrast, regenerated quickly and well. The balance between salvage work for immediate gain and restraint for long-term benefit was confronted directly in many districts. Feet, machinery, and rolling logs were destroying young seedlings. By the end of the 1940s, timber-salvage operations were being curtailed in many fire-killed areas, due to the increasing damage that logging operations caused to advanced regrowth.

Both before and after the war, the Forests Commission aimed at diversifying the range of forest products. The development of the kiln seasoning and reconditioning process in the early 1920s replaced the slow air-drying of timber for joinery, and enhanced the competitiveness of Australian timber with imported oregon and Baltic woods.

By 1931, the Commission, in its annual report, was noticing an increased use of local kiln-seasoned hardwoods. Also, from the early years of the Commission, encouragement was given to the production of paper pulp from mountain ash. In 1936, the government, the Commission, and Australian Paper Manufacturers Limited reached an agreement that led to the establishment of a pulp plant at Maryvale in Gippsland. This commenced production in October 1939 and for several years drew its wood supply from the fire-killed ash forests.

Softwood (and some hardwood) plantations were also developed in the study area. Examples of the early plantations were those at Frankston from the early 1900s, on French Island from 1910, and at Korumburra and on abandoned farmland in the Strzeleckis; a tree nursery was established at Broadford in 1910.

At the same time, the Commission recognised the need to establish wildflower sanctuaries within some of its forests. 'Multiple use' of the forests, although long said to be a policy, had to be more effectively implemented in the face of growing community concern about environmental issues.

Fire

The years 1851, 1898, 1902, 1926, 1932, 1939, 1962, 1983: this litany of dates is instantly recognisable to bush-dwellers. They represent some of the major fires that have swept across the study area. The most critical of these was 1939. In January of that year, perhaps 1.4 million hectares burned, whole settlements were incinerated, and 71 lives were lost. Most of the forests in the study area were severely damaged or killed.

Effects of fire at Tanjil Bren, 1939

The eucalypt is adapted to fire and dependent on it. In the study area, human settlement, the eucalypt, and fire clustered intimately and dangerously. Fossil ash deposits confirm the presence of lightning-started fires long before any human habitation. Recent research into modern fires indicates that lightning continues to be the cause of half, perhaps more, of Victoria's forest fires. But the human factor - in ignition and control - remains the dominant influence.

Aboriginal land-use practices included the use of fire. On the open plains, and the margins of the wet sclerophyll forests, they kept their hunting grounds open and freshly grassed by burning them regularly and lightly.

Europeans initiated a thickening of the forest. Although graziers used fire much as the Aborigines had, to ensure a sweeter pasture, the attachment of Europeans to material belongings and property made fire more often their enemy. They feared it and fought it, and the scrub grew back.

Aboriginal 'fire-stick' farming had created one landscape; European suppression of fire, and its consequent explosive outbreaks, fashioned another. However, pollen analysis has supported the contention that white settlement, in some parts of Victoria, produced more fires. So it is clearly a question not just of the number of fires, but also of their type, placement, regularity, and seasonality.

Europeans introduced a host of new sources of ignition. Miners fired the bush to ease prospecting, graziers burnt their paddocks, selectors cleared the land with a sequence of axe and fire, bush- dwellers protected themselves from fire with fire.

The fire that has had most effect on the landscape of the study area was the 1939 one. It killed or damaged most of the forests in the study area, timber mills eventually moved out of the forests, and the industry shifted away to centres in eastern and north-eastern Victoria. The 1939 fire paradoxically gave new, if brief, life to many of the established timber-producing districts due to salvage logging. But it proved the knockout blow for many of the mining settlements that had lingered through the depression years.

The *Forests Act*, 1939, gave the Forests Commission responsibility for forest-fire protection in all unoccupied Crown lands, plus a strip of land 1 mile (1.6 km) beyond State Forests and national parks. This increased the Commission's territorial fire responsibility threefold, from 5 500 000 acres to upwards of 16 000 000 acres (that is, from 2.2 to 6.5 million ha).

The Annual Report of the Forests Commission Fire Protection Officer for 1939/40 identified 'an entirely new and potent hazard' due to the 1939 fires: the vulnerability of the ash seedlings posed a threat to the hope of regeneration. A second burn of the seedlings would result in 'the permanent deforestation of a portion of the best water catchments - and their reversion to scrub areas'. Lake Mountain offered another example of how a rapid succession of burns affected an Ash forest. There, the original cover of alpine ash, which needs fire but at the right frequency for regeneration, was entirely killed off by the fires of 1926 and 1939, and has been replaced by wattles.

Farms

Two themes emerge strongly in the history of farming: firstly, that farming was a form of land use charged with social and moral ideas: secondly, that it changed the landscape dramatically, perhaps even more than mining. Often the two themes were closely related, especially in the promotion of closer settlement. The attempt to settle 'yeoman farmers' dominated the alienation of land in Victoria for a century.

The squatters, although few in number, made significant ecological impact. Their lonely names printed across vast spaces of the early pastoral maps give a misleading representation of the density of their invasion. Each was accompanied by thousands of cattle and sheep whose hooves compacted the delicate vegetation and light soil, muddied and eroded precious watercourses, and introduced and spread new grasses and seeds. Their displacement of the Aborigine and dingo originally created the conditions for an increase in the population levels of some marsupial species.

Because they occupied vast spaces with thousands of animals but few people, the squatters were seen as the enemies of closer

Cleared land in the Strzelecki Ranges, 1895

settlement. Surviving examples of homesteads, such as Gulf Station in the Yarra Valley, illustrate the self-contained nature of the squatter's community.

The *Land Acts* of the 1860s were designed to break their dominance, and to 'unlock the lands'. The 1869 *Land Act*, the first to allow selection before survey, was the most successful in settling farmers. Under the Act, men and single or widowed women could select up to 320 acres (130 ha) under licence for 3 years, and then could become eligible to lease it and gain it freehold. Commitment to the land was measured by requirements to live on it, pay two shillings per acre rent, and make 'improvements' to the extent of £1 per acre. 'Improving' included building huts, constructing fences, and clearing lands.

One selector in eastern Victoria estimated that in the first 5--10 years of settlement, nine-tenths of the labour was devoted primarily to axe-work. This fight with the forest assumed gargantuan proportions in South Gippsland where, each summer, neighbours gathered to watch the giant burns that, they hoped, would turn last year's fallen and ringbarked forest into this year's clearing.

Many selectors were misled into believing that tall forests guaranteed rich and fertile soil. Through clearing, they also unleashed the savage forces of erosion. Animals attacked newly sown paddocks: insects, wild

pigs and horses, cockatoos, kangaroos and wallabies, possums, and even wombats harried the selector. Rabbits arrived later in the study area than in many other parts of Victoria.

The moral dimensions of farm settlement emerged clearly with the *Settlement of Lands Act* of 1893. A response to the poverty and unemployment of the depression years, the *Act* was inspired by the belief that the countryside would restore the failed city-dweller to innocence.

People with little or no experience of the bush were sent into some of the most difficult areas for farming. Three village communities were established in the Dandenongs - at Monbulk, Ferny Creek, and Woori Yallock Creek - and, although the one at Monbulk had some success, the other two failed utterly.

At Koo-Wee-Rup, the government set up labour camps for unemployed men to cut timber and dig drainage channels. After the World War I, the Koo-Wee-Rup swamp and surrounding lowlands also provided blocks to accommodate nearly 300 returned soldiers. On their small, flood-prone blocks, they faced continual hardship and frustration.

Agriculture developed successfully in many parts of the study area. The new markets created by the gold rushes stimulated wheat-growing and flour-milling. Wheat and oats were grown on the flats of Olinda and Brushy Creeks in the 1850s, and the Cashin brothers operated a mill there, driven by a waterwheel, one of the first in Victoria.

Dairying commenced in the Yarra valley as early as the 1860s, but it was not until the 1880s that the industry took off there and in the Warragul district. After 1888, farm dairies were replaced by district butter factories, and these became notable community features, especially in Gippsland. Hop-growing an drying became especially profitable at the Coranderrk Aboriginal Reserve and, for a while, gave the Aboriginal community some economic independence. Orchards were developed along Melbourne's eastern fringe, in the Dandenongs (berry fruits especially) and on the Mornington Peninsula. For about 50 years, the Toomuc valley apple orchard near Pakenham was the largest in Victoria producing a single fruit. The cleared and drained land at Drouin, Koo-Wee-Rup, and Carrum produced cereal crops and potatoes were a successful

At Gembrook, Carl Exel Nobelius bought land in 1886 and, by the early twentieth century, had established the largest nursery in the Southern Hemisphere. Vineyards were established very early in the Yarra valley, but suffered severely from phylloxera in 1880s. Wine-making and associated tourism have revived there in recent decades.

Water

Irrigation has played only a small and indirect part in the history of the region, whereas hydro-power, swamp drainage, and water-harvesting have been major themes.

The harnessing of water for power was widespread for mining purposes from the 1850s and '60s, and the dominance of waterwheels in the Jordan goldfield has been discussed. Water races remain as some of the most prominent and intriguing relics of this period. These primitive but exact features of engineering extended for miles through rugged country, carefully maintaining a steady gradient.

A hydro-electric scheme was mooted for Snobs Creek as early as 1910, but only in the 1920s was one eventually established in the Rubicon district. Five generating stations were built on tributaries of the upper Goulburn and fed into a substation at Sugarloaf near the Eildon dam, which was part of the irrigation system designed for the lower Goulburn valley. The Eildon reservoir, built in 1927, went through a further transformation - for irrigation and power - when it was greatly enlarged in 1955.

Massive swamps at Carrum, Koo-Wee-Rup, and Moe were major landscape features at the time of European settlement. Reputedly haunted by the bunyip, thickly covered in tea-tree, and frequently under water, they discouraged settlement and isolated Gippsland from Melbourne. Some land was selected on the border of Koo-Wee-Rup swamp from 1865, and a further 8873 acres (3591 ha) were made available for settlement in 1875.

These farmers faced a battle for survival, with their cattle wading belly-deep, and feuds with neighbours constantly erupting over drains, walls, and outlets. Agitation for

governmental action to drain the swamp grew in the 1880s.

The 1884 *Land Act* included swampland provisions, and a Swamp Board was set up in the following year. Between 1889 and 1897, £184 996 was spent on drainage works, more than double the Swamp Board's original estimate. The work provided some unemployment relief during the 1890s depression and formed the nucleus of a doomed village settlement scheme. The disastrous bushfires of 1898 destroyed crops, fences, and houses in the area and ignited the underlying peat, which burnt for months. Major floods occurred in 1901 and 1911, and excavation for a new drainage network began near the end of World War I.

During its first two decades, Melbourne's population relied on tanks, wells, and water from the Yarra. Water from the first reservoir, Yan Yean, reached the city on 27 December 1857. Yan Yean also drew attention in the 1850s as one of the world's largest artificial water storages. It remains part of the Melbourne water supply system, although the early concern about the quality of its catchment area persisted and its water was increasingly drawn from more distant sources.

Construction of the Wallaby Creek weir and aqueduct in 1883 and the Silvery Creek aqueduct in 1886 made this the only part of the Melbourne system to draw water from north of the Divide.

In the same decade, the building of the Clear Water Channel and the Toorourrong Reservoir, and the exclusion of water from the western branch of the Plenty River and Scrubby Creek, enhanced the quality of the Yan Yean supply. These dams, weirs, and bluestone aqueducts are remarkable early feats of surveying and engineering and many of them, now notable historic features, continue in use.

Melbourne's population grew quickly in the boom decade of the 1880s and settled increasingly in the undulating eastern suburbs. The Melbourne and Metropolitan Board of Works (MMBW) was constituted in 1890 and embarked on its principal task for sewering 'Marvellous Smellbourne'. For the next two decades, construction work for Melbourne's water supply took place - further diversions into the Watts River, the building of service reservoirs, and extension of the mains to outer suburbs.

A weir was built on the O'Shannassy River from 1911 to 1914 and, a decade later, a dam. In the 1920s, the Maroondah dam was also built, as was the Silvan reservoir in the Dandenongs.

This period of construction work was a response to Melbourne's rising population, who had a steadily increasing average daily water consumption. This rose from 53.50 gallons per head in 1891 to 76.89 gallons in 1940 (that is, from 243 to 350 L).

The Upper Yarra dam, built upstream of Warburton, was completed in 1957 and tripled the amount of water impounded for Melbourne's use. The severe drought 10 years later provided further impetus to the MMBW's building program, and new reservoirs at Cardinia Creek (filling 1973--77) and the Thomson River (dam wall completed 1983) each created new capacity records.

The Board of Works controls some 120 000 ha of catchments, most of which is forested. Since the Board was formed in 1890, and indeed before then, one of the recurrent debates has concerned the 'closed catchment' policy, and especially whether or not timber-harvesting is compatible with water conservation. This debate has continued throughout the twentieth century, focused in the dialogue of the MMBW and the Forests Commission.

Recreation

The study area includes Melbourne's chief holiday resorts, and has catered for the city tourist since last century. Tourism took off in the 1880s as Melbourne's population boomed and railways extended further into the hinterland. The wedge of forested land between the Sydney and Gippsland rail lines attracted visitors, with its image of ferns and waterfalls and mountains glens.

Victoria's first tourist information office had been established at Flinders Street station in 1888, as a service to visitors to the Centennial Exhibition.

Formation of clubs such as the Field Naturalists' Club of Victoria in 1880, the

Melbourne Amateur Walking and Touring Club in 1894, and the Walhalla Mountaineering Association in 1907 signalled a new interest in active, outdoor recreation.

The declaration of national parks, which was particularly intensive in the first and third decades of the twentieth century, was a measure of this new enthusiasm for Nature. Victoria's second national park was Ferntree Gully, reserved for recreational use in 1882, and was already a popular destination for Melbourne's day-trippers.

One of the most popular walking trails in the first decades of the twentieth century followed part of the Yarra Track. In 1906, the Public Works Department laid out a tourist track from north of Warburton to Walhalla which opened access to the spectacular Yarra Falls and the Baw Baw plateau. The track enjoyed a further burst of popularity during the 'hiking craze' of the 1930s depression, but the 1939 fires destroyed the huts.

Not until the turn-of-the-century was skiing actively encouraged in the Victorian mountains, and resorts only developed after World War II. A local Rover Scout crew cut ski runs on the Baw Baw plateau in the mid 1930s, and in 1944 the Mount Erica division of the Ski Club of Victoria was formed.

In 1963 the Country Roads Board completed a new road to the Baw Baw alpine village site, where lodges were built and downhill runs and tows developed. With the surge of interest in cross-country skiing since the 1970s, Lake Mountain has become the most popular snow resort in the study area.

In the mountain valleys and along the coast, guesthouses proliferated, particularly between the wars. Healesville, Warburton, Marysville, and the Dandenongs boasted stylish accommodation for thousands.

Although Healesville was a popular outing for many of the new car clubs established between the wars, cars eventually opened up wider and more distant tourist horizons for the city traveller. From the 1930s, the holiday fashion became more lively and informal.

People increasingly turned to the beach for this informality. Sorrento had been an attractive and dignified holiday town since the 19th century, boasting new pier baths in the 1880s, and steam and horse trams running across to the surf beach in the 1890s.

But the growing private ownership of cars eventually spelt the end of many of the seaside boarding houses and the steamers that ferried people down the Bay to their doorsteps. The era of the tent and caravan had begun. Rosebud, and similar resorts along the Mornington Peninsula, became the sought-after holiday spots.

Boating grew in popularity, and by 1973 some 40 000 people were annually towing their registered power boats to the Bay, Eildon, or elsewhere.

The history of recreation revives and brings together many of the other themes: the renewal of old tracks for tourists, the modern search for gold, enthusiasm for the natural environment and ecological integrity, new pressures on forest management, and the economic dependence of this region on a mobile urban populace.

Popular pursuit of history and its relics, an emergent hobby since the 1960s, has robbed the area of many of its historical treasures. Many significant landscape features and artefacts have recently been lost to 'collectors', and those remaining need protection.

Historic sites

A listing of historic sites, with an evaluation of their significance, is given in Appendix II.

Reference

Griffiths, T.L., 'Environmental History of the Melbourne 2 Study Area.' Report to the Land Conservation Council.

PART II

PHYSICAL AND BIOLOGICAL RESOURCES

4. LANDSCAPE EVOLUTION AND SOILS

Coastal and riverine plains, foothills, and mountains comprise the topography of the study area, which is geomorphologically diverse and geologically complex. The descriptive report of the first investigation of the Melbourne area (LCC 1973) described geology, physiography, and soils in separate chapters. These physical features are brought together in this chapter, with an emphasis on the integration of these elements and on the contribution of each to the development of the contemporary landscape.

Dominating the study area are the Central Highlands, oriented east--west, their elevations increasing from around 300 m in the west to more than 1500 m in the east. South of the Highlands lie extensive plains and foothills (under 300 m), with only the Dandenong Ranges and southern Victorian uplands rising above this height. In the north of the area, the riverine plain of the Goulburn River and its larger tributaries separates the Central Highlands from the Strathbogie Ranges in the north. The major physiographic units are shown in Map 4.

The following descriptions employ a number of technical terms defined in the Glossary (see Appendix IX) and refer to geological time, as outlined in Table 8.

Geomorphic evolution

Many processes have combined to form the existing landscape, and some continue to shape existing landforms in a dynamic process - vulcanicity, surface and sub-surface forces, sea-level change, weathering, and deposition.

Eastern Australia was an extensive erosional plain close to sea level by the Jurassic period, and extending eastward. Late in this period, uplift and warping initiated the development of the Central Highlands, with depressions to the north and south. While uplift and downwarping continued intermittently during the Tertiary period, the study area's basic topography was formed.

Watercourses draining the uplands were short tributaries, forming broad plains to the north and south and mature valleys in softer rocks. Resistant rocks (granites, Devonian lavas, and Palaeozoic sandstones) remained as larger features, with remnants of the Mesozoic plain forming monadnocks and plateaux. In the river valleys extensive gravel deposits were laid down. Remnant erosion surfaces on the Kinglake Plateau, the hills east of Melbourne, and the Dandenong Ranges provide evidence of the advanced stages that erosion reached in the Tertiary period.

During the Eocene and Oligocene, much earth movement and volcanic activity occurred with eruptions and tectonic movements. Lava flows filled river valleys, and a lava plain formed in South Gippsland.

Table 8

GEOLOGICAL TIME SCALE

Era	Period	Epoch	Age (million years)
Cainozoic			
	Quaternary	Holocene	0.01
		Pleistocene	1.8
	Tertiary	Pliocene	5
		Miocene	24
		Oligocene	37
		Eocene	54
		Palaeocene	65
Mesozoic			
	Cretaceous		143
	Jurassic		212
	Triassic		247
Palaeozoic			
	Permian		289
	Carboniferous		367
	Devonian		416
	Silurian		446
	Ordovician		509
	Cambrian		575
Precambrian		Not outcropping in Victoria	

Lower areas were submerged by the sea's advances during the Oligocene and Miocene epochs, notably the Port Phillip District. Sedimentary deposits have provided evidence of this ingression. A further lifting of the Central Highlands, with warping in some places, accompanied a retreat of the sea towards its present level. These changes led to further erosion. Valleys deepened and the Central Highlands were dissected by watercourses. Valley tracts with mature profiles developed and lateral planation produced broad plains, depositing sheets of sands, clays, and gravel on the lowlands.

In the late Pliocene and early Pleistocene, the South Gippsland Uplands were elevated by tectonic activity and the Central Highlands further uplifted by renewed earth movements. A number of faults, that have influenced the topography of several areas, including the Rowsley Fault and Beaumaris Monocline, occurred at this time. Areas of uplift were subject to erosion; uplifted gravels were dissected, creating hill cappings in the South Gippsland Uplands and on the margins of the Eastern Highlands.

Volcanic activity was a feature of central and western Victoria during the Upper Tertiary and Quaternary. Portions of the resulting extensive basalt plains extend into the south-west of the study area.

Melting of glacial ice at the end of the Pleistocene caused sea-level rises, which combined with final downwarpings to drown Port Phillip Bay, Western Port, and Bass Strait. A concomitant upwarp brought the Central Highlands to their present level. No glaciation took place anywhere in Victoria during the Pleistocene ice age, although watercourses might have carried greater discharges during the heavier rainfall of this time. Many minor watercourses now occupying large river valleys may be features of this period. Former sea-floor sediments, now comprising calcareous sand dunes along coastal stretches, are the result of exposure due to the eustatic sea-level fall.

Geomorphology

Geomorphology is the description and interpretation of landforms, and includes the study of processes affecting the Earth. This section concentrates on the major landforms within the study area: northern uplands (Central Highlands), southern uplands (South Gippsland Hills, southern Mornington Peninsula), and southern lowlands (Western Port and Mornington Peninsula lowlands).

Northern uplands

These mountains and foothills comprise several geomorphic entities, notably a series of stepped plateaux - Baw Baw, Kinglake, and Nillumbik.

The Baw Baw surface, composed of volcanics and granites, is the oldest and highest in the study area. Several high plateaux constitute the unit - Baw Baw, Cerberean, and Acheron, with remnants outlying at Mounts Matlock, Selma, Terrible, and Useful. Steep escarpments mark the perimeter of the units in several places along the Acheron and Baw Baw Plateaux and Cerberean Ranges, often with associated waterfalls.

The Kinglake unit comprises an extensive area of the northern uplands, and includes a number of linked and separate surfaces: Gregory Plateau, Kinglake Plateau, and Strathbogie Plateau. Dissection is generally moderate on these surfaces of Palaeozoic sedimentary and igneous materials, whose elevations are some 300 m lower than those of the Baw Baw unit. Steep escarpments have developed on the southern Kinglake and Strathbogie Plateaux and western Gregory Plateau. Along the upper reaches of the western watercourses - Big, Goulburn, La Trobe, and Thomson Rivers, and parts of the Yarra River - the edges of the Kinglake unit are indistinct from the adjoining foothills, which are highly to moderately dissected. Erosion has left few remnants of the Kinglake unit in the upper Goulburn and Big Rivers, in producing a steep mountain terrain. The Blue Ranges and Cathedral Ranges are outlying remnants of the Kinglake unit, in which erosive processes have produced a similarly rugged topography. A general slope across the Kinglake unit rises from west to east, with Mt Disappointment being about 800 m, the Black Ranges 900 m, and the Gregory Plateau 1100--1200 m.

The Nillumbik surface almost extends across the south of the study area. Although of similar origin to the remaining uplands, Nillumbik has lower elevation and subdued relief. At its western extension, the unit has

The western aspect of the Strzelecki Ranges, where the central lowlands meet the southern upland landform, near Trafalgar.

elevations of less than 100 m, rising to around 300 m near the Dandenong Ranges and to 500--600 m in the east, on the Erica Plateau. As elevation increases to the east, the topography becomes dissected and the slopes steeper.

Southern uplands

This unit comprises the South Gippsland Hills and parts of the Strzelecki Ranges and the Mornington Peninsula Horst, both of which result from block faulting.

Central lowlands

The lowlands unit contains the (former) Koo-Wee-Rup Swamp, (former) Carrum Swamp, Brighton coastal plain, the northern and south-western Mornington Peninsula and French and Phillip Islands. There are few distinct borders between the lowlands and northern and southern uplands. Comprising sedimentary and small areas of older volcanic plains, this unit has low elevation and subdued relief.

Numerous faults in the lowland belt have influenced local topography and mark geomorphic features. Prominent faults include Selwyn Fault, Tyabb Fault, Clyde Monocline, Beaumaris Monocline, Heath Hill Fault, and Yarragon Monocline. Selwyn Fault marks the western edge of the Mornington Peninsula, and is still active with occasional movements, such as the earthquake at Mornington in 1932.

Extensive Quaternary dune sands around Frankston--Cranbourne--Langwarrin form one of the major sand supplies for eastern Melbourne.

Ancient dune sands on the Pt Nepean coast have become lithified as dune limestone.

Areas with little dissection are generally located on the sunklands, namely the Brighton coastal plain, French and Phillip Islands and Lang Lang district.

Newer volcanic plains

A small area of the eastern extension of the Werribee volcanic plains lies north of Melbourne. Except for a few small volcanic cones, it has a gently undulating surface. A few major streams have dissected channels into the plain along Darebin and Merri Creeks.

River plains

The four main areas of river flats in the study area adjoin the present locations of the Goulburn, Acheron, Moe, and Yarra Rivers.

Composed of alluvial materials, the river plains are typically less than a few kilometres wide.

Foothills and river valleys

Within the northern uplands, major watercourses and other sources of erosion have created extensive areas of foothills and river valleys, notably the Goulburn River and its tributaries, the upper Aberfeldy, Thomson, and Yarra Rivers.

Geology

This brief account of the complex geology of the study area concentrates on major features. Readers seeking greater details are directed to the geological maps of the area, together with explanatory guides by the Victorian Geological Survey, as well as Douglas and Ferguson (1988) and the numerous other references.

For most of the Palaeozoic the study area lay under the sea, and the resulting marine sediments were uplifted in the late Devonian and folded along east--west axes, with intrusions of granite and areas of acidic volcanic flows. The bedrock of the study area consists of these Palaeozoic rocks.

Cambrian to Carboniferous

Within the Tasman Geosyncline, extruded submarine volcanics were covered by marine sedimentation from the Cambrian to early Devonian. Consequently, a thickness of sediment occurred - 5800 m for the Silurian sediments west of Melbourne, 4300 m for the Lower Devonian sediments north-west of Melbourne. These sediments consist of inter-bedded sandstone, siltstone, and block shale. In the Middle Devonian period, they were subject to considerable folding.

Areas of folded sediments underwent intrusions of acid igneous rocks during the late Devonian. The study area contains several granitic landforms, including the Baw Baw--Gembrook granodiorites and granites, Mt Cobaw, Mt Disappointment, and the Strathbogie Ranges, as well as those smaller features on the Mornington Peninsula - Arthurs Seat, Mt Eliza, and Mt Martha. Downfaulted basins containing deep layers of volcanic materials, known as cauldron subsidences, are found in the Acheron, Cerberean, and Dandenong Ranges.

Permian–Triassic

Sediment deposition, of fluvial and marine origin, occurred during the Permian period. These sandstones and siltstones were originally widespread, but subsequent erosion during the Triassic and Jurassic periods removed most deposits.

Cretaceous

In southern Victoria, prior to the Cretaceous, a lengthy trough running east--west formed, filling with arkose, conglomerates, and mudstones. Coal seams found at Wonthaggi and Korumburra were created from the accumulation of plant debris in swamps. During the Cretaceous, earth movements resulted in the lifting of the Central Highlands area, flanked by depressions to the north and south.

In the lower Cretaceous beds, fossil plant assemblages indicative of the Mesozoic era are prominent, which include liverworts, moses, horsetails, cycads, ferns, and conifers. Dinosaur remains also from the lower Cretaceous have been found at Cape Paterson.

Tertiary

Sea-level changes caused the deposition, generally confined to the La Trobe Valley, Port Phillip sunkland, and Western Port Basin, to have two terrestrial phases interspersed by a marine phase.

Volcanic activity occurred intermittently during each of these phases. Thick sequences of older volcanic material (basalts) resulted from extrusions in downfaulted basins, such as the Mornington Peninsula. The Erica, Gembrook, and Noojee districts contain elongated valley flows of older volcanics.

Marine sediments were covered by a widespread, thin sequence of terrestrial sand, gravel, and silt from the rivers draining the highlands. The Werribee Plains, represented only in the extreme west of the study area, were formed by basaltic lava flows in the late Pleistocene.

Quaternary

In the early Pleistocene, the modern drainage system developed and the Pleistocene sediments and volcanics were dissected to produce wide river valleys and sediment deposits. Older fault lines were the sites for movement that produced several features within the area.

Both marine (sandy limestone, shelly limestone and shell-beds) and non-marine (alluvium, calluvium, calcarious sand, and dune limestone) were deposited in coastal and riverine locations. These Quaternary sediments comprise the surface geology of the KooWeeRup Swamp and Lang Lang areas, south-western Mornington Peninsula, and the river valleys of the Goulburn and its larger tributaries, Yarra River, Powlett, Bass, and the Moe, lower La Trobe, and lower Tanjil Rivers.

Soils

Soil types vary considerably across the study area. The Land Conservation Council descriptive report for the first investigation (LCC 1973) described each of the major soil types, but only a brief description of the major ones and their distribution are provided below. Soil type is one of the elements of the land systems description (see Chapter 10). The purpose of this chapter is to provide sufficient information to allow readers to comprehend the soil component of the land systems mapping.

A few technical terms and concepts are provided here for readers unfamiliar with the subject. Particle size determines the feel or texture of soils, and the form of any aggregation of particles is its structure. Soil colour refers to the lower horizons, which are more highly colour-differentiated than the upper horizon. Duplex soils have a distinct upper horizon of sand or loam, with clayey subsoils. Gradational soils increase uniformly in clay content with depth. Soils with a high proportion of exchangeable sodium (called sodic) cause clays to disperse when wet, inhibiting both drainage and aeration (Rowan 1982).

The following broad description of soil type distribution is based on the land systems information, using geomorphic units as the basis for description.

On the elevated plateaux and tablelands, the high rainfall and low temperatures of the sub-alpine climate have resulted in the formation of organic loamy soils. These organic loams include brown friable earths and peats.

Over the dissected uplands of the Central Highlands, the complex geological features, incised valleys, and intricate stream networks are strongly influenced by structure and local lithology. Several soil types have been recorded: red and brown friable earths, hard acidic duplex soils with red clay subsoils, shallow stony soils, and yellow duplex soils.

The uplands of the Mornington Peninsula have hard acidic duplex soils with yellow clay subsoils and red friable porous earths. Soils recorded include yellow duplex, red friable, grey clay, yellow earth, and pale sands. Soils are similar in the South Gippsland uplands, but with the addition of brown friable earths. Recorded soils are yellow duplex, red and brown friable earths, and shallow stony loam.

To the north-west, the South Gippsland Uplands give way to the alluvial East Gippsland plains in the Moe swamp area. A range of soil types includes yellow duplex, brown earths, dark clays, pale sands, and gravels.

Fans and terraces of the western Gippsland and Western Port coastal plains feature sands and duplex soils with yellow clay subsoils. The Koo-Wee-Rup and Lang Lang area carry pale sands, calcareous sands, dark clays, yellow duplexes, and yellow earths. French and Phillip Islands have pale and calcareous sands, yellow and dark clay and yellow duplex soils.

Sands and clays predominate on the Point Nepean coast and peninsula and in the Brighton district. At Cranbourne and the lower Mornington Peninsula, areas of leached sands are important for horticultural production.

Hills, ranging from gentle to steep and the plains surrounding the Yarra River and its tributaries, comprise the Yarra Valley, a productive agricultural area. Soils of the hills are red friable earths, yellow duplexes, and shallow stony earths. On the river plains are loams, dark clays, and yellow duplex soils.

The flat and undulating volcanic plains north and north-east of Melbourne have hard

alkaline or neutral soils with yellow clay subsoils, variable friable earths, and loamy soils. Prominent soil types recorded are yellow duplex, yellow stony, and shallow stony soils with areas of dark clay.

Geological and Geomorphological Features of Interest

Geological and geomorphological features in the landscape can be of value for education, research, or reference, or have scenic landscape, or other outstanding values. Their conservation requires a basis of inventory and research.

Several studies of sites and/or features of significance have been conducted in the study area and a State-wide study has been completed, as shown in Table 9, but these do not give a complete coverage of the area in detail.

Assessing the significance of a feature usually involves an appraisal of how representative or outstanding it is. The degree to which it is representative can be more objectively determined, being based, in summary, on the area the feature represents - local, regional, State, national or international. The studies often use different criteria to assess each one and lack any consensus on the significance of particular features.

Table 10 summarises the results of these studies. Although the results of different studies are not comparable, this information is useful for land planning and for the identification of geological and geomorphological features.

Some features are protected by appropriate land management - most notably the Organ Pipes National Park in the Melbourne Area, District 1. Protection can also occur through provisions of public land management plans. National Estate listings also include some features. However, there is no comprehensive system of conservation of these features.

Table 9

STUDIES OF SITES OR FEATURES OF SIGNIFICANCE

Area covered	Author(s)	Sites or features	
		Significance	Number
Gippsland Lakes catchment	Rosengren (1984a)	local	3
		regional	18
		State	7
		national	1
Floodplain of upper Yarra River	Rosengren *et al.* (1983)	local	36
		regional	21
		State	2
Victorian coast	Bird (1977)	not ranked	29
Western Port	Rosengren (1984b)	local	24
		regional	124
		State	64
		national	8
		international	2
Victoria	Joyce and King (1980)	nominated	697
		local	36
		State	5
		international	1
		(unassessed)	26
Port Phillip Bay	Rosengren (1988)	regional	10
		State	12
		national	1

Notes:
1. These sites occur wholly or partly in the study area
2. These sites occur on public and private lands
3. Classifications of significance are not comparable necessarily between different studies

Dava Beach, Mt Martha - part of the Fossil Beach area site of geological and geomorphological significance

Table 10

GEOLOGICAL FEATURES OF VICTORIAN, AUSTRALIAN, AND WORLD SIGNIFICANCE

Feature number[1]	Name	Description	Significance level
ML 82	Limestone Road, Yea	Baragwanathia fossil site, representing the oldest known vascular flora in the world	World
QN 03	Cape Schanck to Burrabong Creek, Boneo	Freshwater limestone overlies igneous clay and basalt of the Older Volcanics sequence	Victorian
QN 08	Fossil Beach/Fishermans Point, Mt Martha	Type section of the Balcombian Stage. Fluviatile, marine sediments and Older Volcanics also present	Victorian
QN 18	Pyramid Rock to The Nobbies, Cowes	The coastline shows two distinctive physiographic types: the high cliffs and Lower Tertiary basalt; and dunes of Quaternary calcareous sands	Victorian
WR 11	Cathedral Range, Buxton	Dip slopes developed on Middle Devonian sediments; alluvial fans formed at the base of escarpments	Victorian
WR 43	Loyola Limestone Quarries	The only known Emmsian fauna in the Melbourne Trough	Victorian

Note:
1. The feature number is prefixed by the relevant 1:250 000 geological map name - ML-Melbourne; QN-Queenscliff; WL-Warragul; WR-Warburton.
2. Geological features of local significance and those as yet unassessed are not included in this table.

Source: Joyce and King (1980)

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5. CLIMATE

Climatic conditions across the study area can be generally described as 'Mediterranean', meaning a dry and warm to hot summer and a wet winter. A feature of temperate latitudes is regular changes in weather, a characteristic here. For most of Victoria, including the study area, the weather systems move from west to east, producing a cycle of weather from cool, through warming up, to rapidly becoming cool again; although variable, the cycle usually lasts 5--7 days (ACBCS 1973).

In general, the climate is temperate, with altitude, landform, geography, and distance from the coast influencing the patterns of temperature and rainfall.

The Great Dividing Range, prominent in the east, is a major climatic influence. South-westerly winds carry cool and moist air from the southern oceans, often bringing cloud and rainfall to coastal and rising country of the Great Dividing Range. North of the Divide cloud cover is less frequent in winter, giving greater temperature ranges and colder nights; in summer, the northern areas are hotter than the south.

Precipitation

Mean annual rainfall varies from less than 700 mm on the plains in the north-west and south-west, and in rain-shadow areas such as the Goulburn and Big River valleys, to in excess of 1400 mm on the high-altitude and southern slopes of the Great Dividing Range. Rainfall comprises the bulk of precipitation, except for snowfalls across the alpine areas.

Landform combines with the westerly frontal weather systems to account for the predominant pattern of precipitation. Slopes along the southern and western aspects of the highlands and mountains receive substantially higher rainfalls than the rain-shadow areas. The major rain shadows occur in the river valleys to the north, predominantly the upper Goulburn River and its tributaries, and on the plains north of Melbourne, which are affected by the mountains and highlands to the west.

Examination of the monthly and annual rainfall statistics (as shown in Table 11) reveals the seasonality, as well as indicating the distribution, of rainfall. Map 5 shows the distribution of mean annual rainfall. December to March generally is the period of lowest rainfall, with May to August receiving the highest monthly totals.

Snowfalls

As the Bureau of Meteorology does not record the snow depths at weather stations, the only available data are those collected privately at the alpine resorts. Regular snow falls above 950 m; areas above 1200 m have snow cover throughout winter (LCC 1973).

Temperature

Temperature regimes vary across the study area, from alpine to coastal. Seasonality of temperatures is common throughout; highest temperatures occur in February and the lowest in June or July. Table 12 shows, this pattern, reflected in the mean daily maximums and minimums for a number of stations.

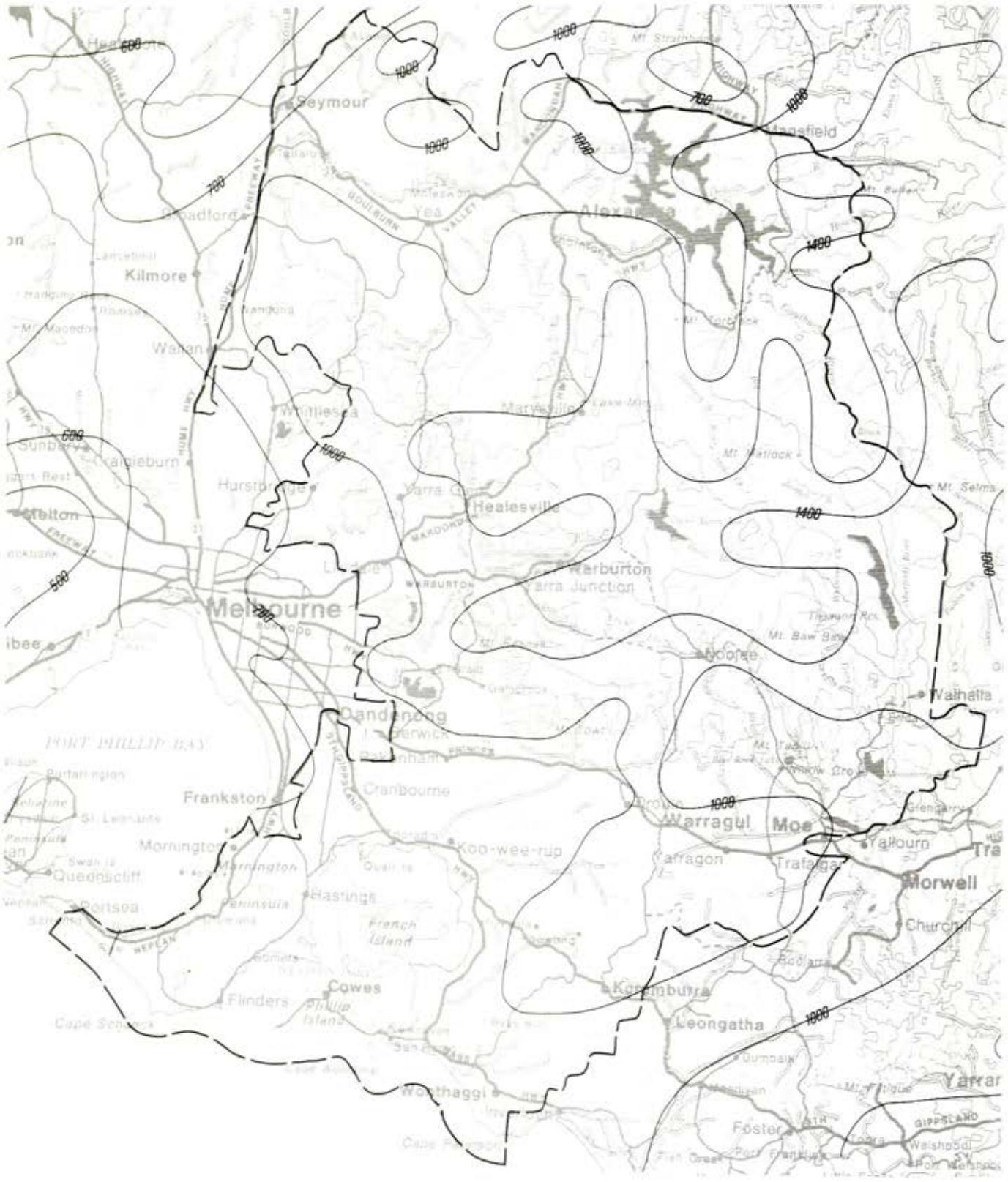
Altitude, local topography, and distance from the coast influence temperatures. Alpine areas experience extreme low temperatures in winter; when the Mt Baw Baw weather station was in operation, it recorded mean monthly temperatures below 0°C during June and July (LCC 1973). In contrast, the coastal and plains areas, such as Cape Schanck and Scoresby, have the lowest range of mean monthly temperatures about 8°C and 6°C respectively (see Table 12).

Areas in the north of the study area experience the highest summer temperatures, as indicated by the data for Mangalore and Lake Eildon.

Climatic Change and the Greenhouse Effect

The condition and composition of Earth's atmosphere exert a fundamental influence on the world's climate. Some atmospheric gases allow sunlight to reach the Earth's surface and act to trap a portion of the outgoing radiation reflected from the surface. As a result of human activities, the concentrations

MEAN ANNUAL RAINFALL



LEGEND

ISOHYET (mm) — 900

STUDY AREA — — —

1 : 1 000 000

10 0 10 20 30 40 50

Kilometres

Land Conservation Council Victoria

Cartography by Thematic Mapping Unit, Division of Survey and Mapping

MAP 5

Table 11

MEAN RAINFALL BY MONTH (mm)

Month	Rainfall station								
	Cape Schanck	Melbourne	Scoresby	Mt St Leonard	Wonthaggi	Mangalore	Rubicon	Lake Eildon	Warragul
January	41	48	52	84	47	39	70	45	62
February	40	47	52	72	44	28	54	40	51
March	54	52	56	87	63	38	74	55	71
April	63	57	73	106	80	43	117	62	85
May	77	58	101	138	101	66	188	80	97
June	77	49	67	106	94	49	186	95	94
July	78	49	78	119	97	59	226	95	93
August	73	50	85	142	99	69	219	98	105
September	60	59	56	136	86	59	158	80	104
October	70	67	89	131	86	49	149	81	108
November	57	60	82	132	68	47	114	67	91
December	52	59	73	122	60	43	87	55	82
ANNUAL	750	655	894	1375	925	589	1642	853	1043
Year commenced	(1879)	(1855)	(1948)	(1953)	(1911)	(1947)	(1943)	(1887)	(1888)
Number of years recorded:	102	134	41	36	77	31	45	100	101

Source : Bureau of Meteorology data, Melbourne Office, 1989

of these gases have been increasing, causing a greater amount of heat radiation to be trapped, and thus probably causing Earth's temperature to rise. The main greenhouse gases are carbon dioxide, methane, nitrous oxide, chlorofluorocarbons (CFCs), halons, and tropospheric ozone (Victoria 1989).

Prior to the Industrial Revolution, the greenhouse gases remained relatively stable for several thousand years. Our burning of fossil fuels, large-scale deforestation, and the release of artificial gases have generated large quantities of greenhouse gases. Carbon dioxide (CO_2) has increased by 23% since pre-industrial times, methane (CH_4) by 110% and nitrous oxide (N_2O) by 8% (Pearman 1988 pp. 3--21). Over the next 50 years the estimates of the increases for these gases above the pre-industrial level are 45--115% for CO_2, 200--500% for CH_4, and 25--60% for N_2O. Chlorofluorocarbons (CFCs) did not exist in the atmosphere prior to the 1930s; the two key ones now have an annual rate of increase of 5%. Over the next 50 years CFCs are expected to increase by 300%.

Although no link between greenhouse gases and a warmer world climate has yet been scientifically proved, there is considerable concensus in the scientific community on the potential for the effect to occur. The timing and rate of change to the climate system

Table 12

TEMPERATURE - MEAN DAILY MAXIMUM AND MINIMUM (^{o}C)

Month	Weather station									
	Cape Schanck	Melbourne	Scoresby	Mount St Leonard	Wonthaggi	Mangalore	Rubicon	Lake Eildon	Warragul	Noojee
January										
MAX	21.4	25.8	25.8	22.7	23.7	29.3	23.5	28.2	25.9	24.7
MIN	14.0	14.0	13.2	11.0	12.5	13.9	12.2	12.3	12.5	10.1
February										
MAX	22.1	25.6	26.6	23.7	24.7	29.3	23.9	29.0	26.2	25.6
MIN	14.9	14.3	14.1	12.2	12.9	14.2	12.7	12.6	13.3	9.5
March										
MAX	20.7	23.8	23.9	20.5	22.5	26.1	20.5	25.1	23.9	22.7
MIN	14.1	13.0	12.7	11.0	12.0	12.4	10.9	10.7	11.7	9.9
April										
MAX	18.0	20.2	19.9	15.9	19.4	21.3	15.5	20.5	19.8	18.7
MIN	12.3	10.6	10.5	8.8	10.1	8.8	8.1	7.9	8.9	7.5
May										
MAX	15.3	16.6	16.3	12.2	16.6	16.5	10.8	15.9	16.0	15.0
MIN	10.4	8.4	8.6	6.9	8.3	6.2	5.5	6.2	6.6	5.7
June										
MAX	13.0	13.9	12.7	9.3	13.8	13.4	8.3	12.2	13.5	11.6
MIN	8.4	6.7	6.3	4.6	6.1	3.7	3.4	3.9	4.8	3.3
July										
MAX	12.2	13.3	14.1	8.4	13.2	12.4	6.9	11.5	12.9	11.4
MIN	7.5	5.8	5.8	3.6	5.7	3.0	2.3	3.4	3.8	1.7
Years of record	24	134	24	21	18	30	29	18	18	7

Source: Bureau of Meteorology data, Melbourne Office, 1989

remain the most difficult aspects of greenhouse to predict.

Climatic changes resulting from the greenhouse effect are currently predicted to include:

* an increase in global mean temperature, with changes to temperature regionally
* change in the incidence of extreme events - for example, cyclones, floods, droughts, and heat waves
* changes in rainfall patterns
* a rise in global mean sea level
* some melting of ice

Victoria's draft strategy for a response (Victoria 1989) gave the following projections:

* temperatures possibly 2--4^{o}C higher in winter and summer, possibly with higher evaporation, drier soil, and less run-off
* wetter summers
* greater rainfall intensity
* reduced snowfalls and shorter snow seasons
* sea-level rises of 10--30 cm, possibly increasing to 20--70 cm by the year 2080
* wave patterns and storm frequency/ intensity may alter

Although the exact timing of the greenhouse effect and its impacts are uncertain, progressive effects are expected over the next 20--50 years. The degree of disturbance across the study area will vary, depending on local circumstances and conditions. Aspects to be affected will include ecosystems,

coasts, primary production, water resources and water-harvesting, and urban settlements.

Greenhouse and Nature conservation

The existing system of Nature conservation parks and reserves depends on an implicit assumption that our current climate will continue and the areas will thus retain a capacity for such conservation. Public lands primarily designated for flora and fauna conservation currently cover about 10% of Victoria and represent ecosystems in a natural condition, which have become disjunct and dispersed among modified environments (Mansergh and Bennett 1989).

Rapid climatic change occurring as a result of the greenhouse effect would greatly affect native flora and fauna, and reduce the certainty of effectiveness of existing Nature conservation reserves. Climatic change will alter the perturbation regime, producing changes in flora composition, species dominance, and ecosystem structure (Pearman 1988 pp. 361--74). Such changes in distribution will involve movement, expansion, contraction, and elimination. Those species having disjunct ranges or distributions face habitat losses and extinction.

Within the existing parks and reserves, the land types will continue to represent the range of geological, geomorphological, and soil types within the State. However, climatic changes after an area was designated as a reserve may result in an alteration to the composition of the flora and fauna species. As a result, reserves will reflect changes in biotic conditions.

Other associated factors influencing Nature conservation include fire and its effects on biota, predators, introduced species, disease, habitat fragmentation, and the absence of critical resources.

Species considered most at risk are those with one or more of the following characteristics:

* small and/or genetically impoverished populations
* poorly dispersed species, annual plants, alpine species
* peripheral or disjunct populations
* coastal species
* montane and alpine species

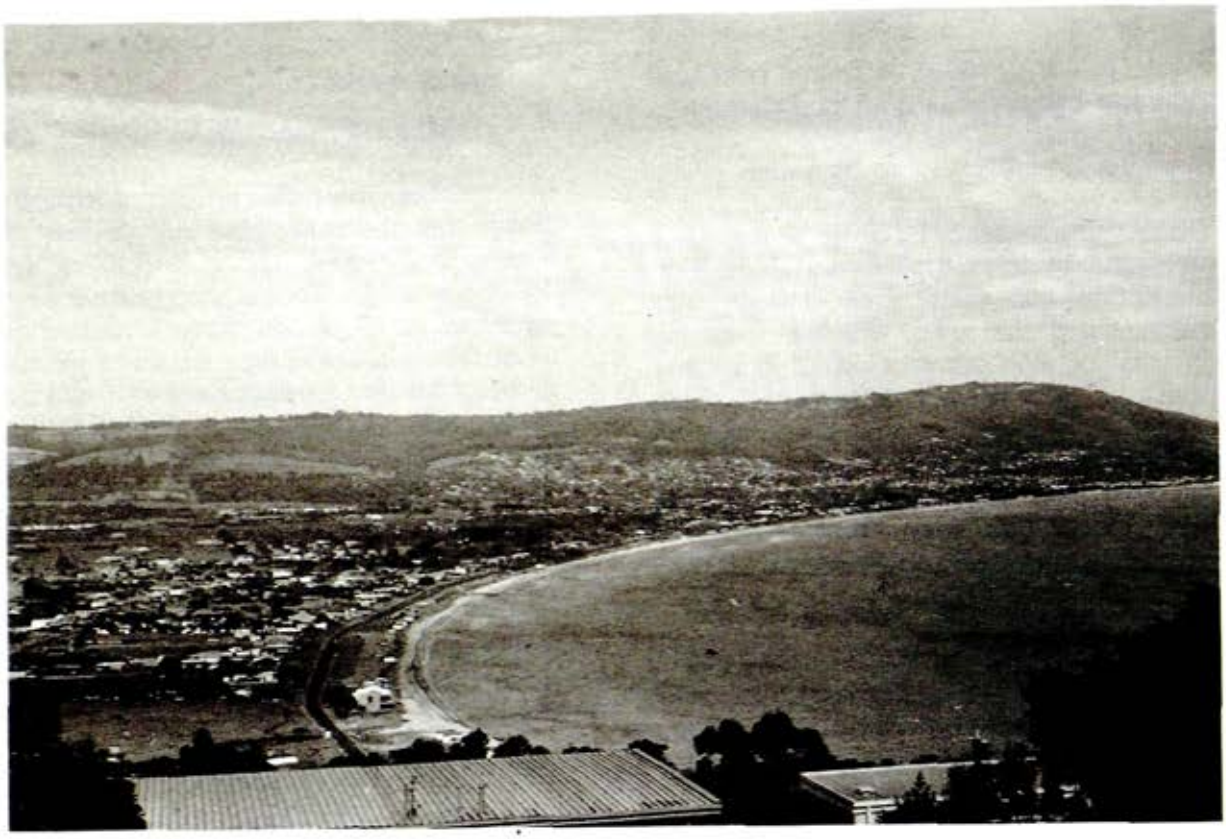
Uncertainties about the effects of climatic change and the consequent complexities of Nature conservation create difficulties for decision-making. Several themes have been identified for flora and fauna conservation under these circumstances. Retaining genetic diversity has the greatest chance of success where the reserves cross climatic and latitudinal gradients. Increased resilience in the parks and reserves can be achieved by gaining an optimum environmental reserve system, and further encouragement of conservation practices on private land could enable species protection when biotic distributions move beyond conservation areas. State forests have a role in providing habitat and habitat linkages outside the reserve system. Avoiding further fragmentation or elimination of native communities and implementation of regional corridors would also help.

Coastal impacts of the greenhouse effect

Sea-level rise is the most comprehensively researched coastal phenomenon in relation to the greenhouse effect; potential impacts on the marine environment have received little attention. A range of other climatic changes would accompany sea-level rise and would also affect coastal areas.

Research has yet to confirm how a rise in temperature would influence sea levels, or how different elements would contribute to any changes in levels. A combination of local, regional, and global factors will determine sea-level changes at any specific locality. An expansion of the volume of the near-surface waters, due to rising surface temperatures decreasing its density, is likely to be the major contributor to sea-level rise, while partial melting of snowfields, ice-sheets, and glaciers will make a minor contribution in the shorter term (Bolin *et al.*, 1986 pp. 323--59).

Estimates on the magnitude of sea-level rises vary. Estimated rises over this century, on a global scale, are 12 +/- 5 cm. Bolin *et al.* (1986) projected that a rise of 1.5--5.5°C would result in sea-level rises of 20--165 cm. Under one CSIRO scenario, an atmospheric temperature rise of 2--4°C would lead to a



Sea-level rises could threaten coastal areas along Port Phillip Bay with inundation.

sea-level rise of 20--140 cm (Pearman 1988), although the upper estimate has now been revised to 60 cm.

Those locations at risk within the study area have yet to be identified, although work on Port Phillip Bay (MPE 1988) and other studies have begun. The current best estimate proposed is an average rate of global mean sea-level rise of about 6 cm per decade, amounting to a rise of 20 cm by 2030. Inundation impacts will depend on cross-shore gradient, affecting permanent sea-level inundation and shoreline retreat (Pearman 1988). Higher-frequency events associated with waves, tides, flooding, and storm surges will cause inundation some metres above sea level.

Northern Western Port, where the inter-tidal mudflats and coastal zone ecosystems are highly sensitive to tidal inundations, will be especially at risk. Shoreline retreat will also erode the public land foreshore reserve, much of which abuts private lands. Losses of coastal zone vegetation, beaches, and inter-tidal flats, especially in Port Phillip Bay and Western Port, could be permanent. On the more steeply sloping beaches, increased erosion is likely to result in the loss or significant reduction to foredunes behind many beaches.

Most measurements of sea levels have involved tide gauges, which cannot distinguish eustatic sea-level movement from land margin movement. It has been argued that existing tidal gauges (especially in the Southern Hemisphere) and geodetic surveys have not provided sufficient evidence of sea-level change to date. A number of other parameters have been suggested as being suitable for measuring this, including changes in shoreline and salt-marsh vegetation, enlargement of estuaries and lagoons, new coastal wetlands, and upward migration of zoned shore organisms.

A number of monitoring, planning, and research activities have been proposed for coastal areas in the government's Greenhouse Strategy (OCE 1990).

Alpine climatic change

A report on alpine climate (Ruddell *et al.* 1990) stated that long-term records of snow cover suggest no statistically significant trends. Climatic fluctuations occurred at the decade time scale, but were not sustained in

the long term. Analysis revealed that snow cover related well to variables such as winter temperature and precipitation, but that few records exist that can be used to establish climatic trends in alpine country (that is, above 1400 m).

Government action

A strategy, 'Greenhouse: Meeting the Challenge' (DCE 1990), describes the Victorian government's response, which covers actions in five fields:

* research into atmosphere conditions and the impact of the greenhouse effect, climatic and sea-level monitoring
* limiting greenhouse gas emissions
* education and community awareness
* planning to accommodate climatic change
* national co-ordination

The actions to limit greenhouse gas emissions and slow down the potential impacts include a staged phase-out of ozone-depleting substances (CFCs and halons) by the mid 1990s. An (interim) target for reduced CO_2 levels was set at a 20% reduction of CO_2 levels from the 1988 levels by 2005. Implementing energy-demand management measures has begun, as have investigations of transport-fuel conservation and efficient electricity generation and transmission. 'Tree Victoria', a major revegetation program, has significant implications for land use and Nature conservation, as well as contributing to a showing of the greenhouse effect. Under the program, it is planned to plant 100 million trees by the year 2010. A proposed planning scheme amendment requiring permits to clear native vegetation on private land has also been introduced.

Long-term planning will be necessary to allow for potential changes in urban development, flora and fauna conservation, coastal areas, agriculture and forestry, water resources, and tourism.

The ozone layer

Ozone is a natural constituent of the upper atmosphere, where it functions as a shield protecting the Earth against exposure to harmful ultraviolet rays from the sun by reducing these rays to safe levels at the Earth's surface.

Discovery of a hole in the ozone layer above the Antarctic in 1984 has given cause for great concern that other holes could similarly appear in other parts of the world. Depletion of the ozone layer results in increased quantities of solar ultraviolet radiation reaching the earth's surface. Some ultraviolet reaches the Earth's surface normally, where it causes a range of human health problems - sunburn, forms of skin cancer, and some eye conditions. The effects of increased ultraviolet penetration are currently unknown; however, an escalation in human health problems is likely, crop productivity and the health of livestock would probably diminish, and major ocean food chains could be severely damaged (Hare 1988, Gribben 1988).

Ozone depletion is the outcome of human agency. Chlorofluorocarbons (CFCs) and halons (artificial chemicals containing chlorine or bromine), released through a variety of human-induced sources are the primary causes of ozone loss. In Australia, CFCs are used in refrigeration and air-conditioning, aerosol propellants, plastic foams, and cleaners in the electronics industry (Hare 1988). In its response to the Greenhouse issue, the Government is committed to introduce specific controls to achieve a phase-out of CFCs and halons by 1998 (DCE 1990).

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6. WATER RESOURCES

This chapter broadly describes the surface water resources of the study area, by river basin, covering stream flow and yield, and water quality. A section on groundwater, provided by the Department of Manufacturing and Industry Development, is also included. Chapter 17 describes water harvesting and use, and its associated issues.

Surface Waters

River basins

An amalgamation of river and stream catchments forms a river basin, which is a convenient unit for describing and analysing water resources. Six basins, as designated by the Australian Water Resources Council (AWRC 1976), lie either wholly or partly within the study area and are recognised by all water authorities.

The largest watercourses in the study area, as measured by stream flow, are the La Trobe, Thomson, and Yarra Rivers. A list of the major ones within each basin is given in Table 13.

Watercourses in the Goulburn River basin drain to the Murray River, while those of the Thomson and La Trobe basins drain to the Gippsland Lakes. Waters from the Yarra, Bunyip, and South Gippsland River basins flow to the sea, into Bass Strait, Port Phillip Bay, or Western Port Bay. All the basins are shown on Map 6, and four are divided by the study area boundary. In the Goulburn River basin the majority of the upper catchments, including Eildon Reservoir, lie within the study area, which also includes the upper Thomson River and upper catchments of the La Trobe basin.

In South Gippsland basin, the two easternmost rivers and part of the upper catchment of the Tarwin River are within the study boundary. All of the Yarra and Bunyip River basins are included.

The study area does not contain any large, natural fresh-water bodies: water storages comprise the largest expanses. Intertidal areas and wetlands are distributed around the coastal fringe, notably Western Port. Wetland studies have been conducted in the South Gippsland, upper Yarra, La Trobe, and most of Bunyip River basins.

Table 13

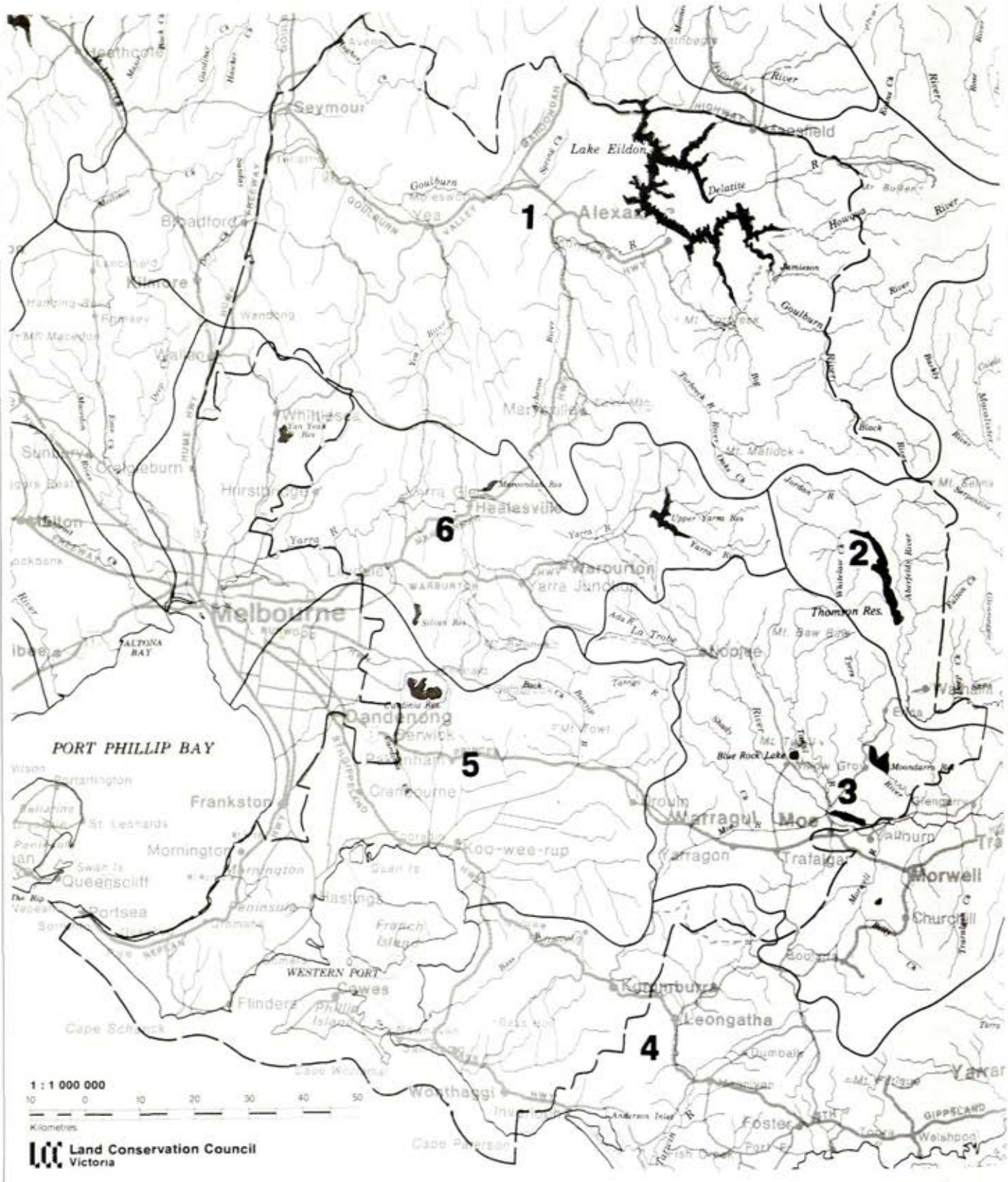
MAJOR WATERCOURSES IN STUDY AREA

Basin	Watercourse
Goulburn	Acheron River
	Big River
	Delatite River
	Goulburn River
	Howqua River
	Jamieson River
	King Parrot River
	Murrindindi River
	Rubicon River
	Yea River
Thomson	Aberfeldy River
	Jordan River
	Thomson River
La Trobe	Ada River
	La Trobe River
	Moe River
	Tanjil River
	Tyers River
South Gippsland	Bass River
	Powlett River
Bunyip	Bunyip River
	Dandenong Creek
	Lang Lang River
	Paterson River
	Tarago River
Yarra	Little Yarra River
	O'Shannassy River
	Plenty River
	Watts River
	Woori Yallock Creek
	Yarra River

Stream flow and yield

Measurement of stream flow over time constitutes a basic element in determining the character of a watercourse. Base flows vary continually, and are disrupted by drought and

RIVERS & RIVER BASINS



LEGEND

- Rivers and streams
- Lakes and reservoirs
- Drainage basin boundaries
- 4 Drainage basin numbers
- Boundary of study area

KEY TO BASINS

1. GOULBURN
2. THOMSON
3. LA TROBE
4. SOUTH GIPPSLAND
5. BUNYIP
6. YARRA

Notes:

1. Major rivers and streams are shown, but the small map scale has resulted in not all 3rd order streams being shown.
2. The drainage basins shown as those used by the Australian Water Resources Council. They are major river catchments or groups of catchments.

MAP 6

Cartography by Thematic Mapping Unit
Survey & Mapping Victoria

low flows, or by high flows and floods. Both the yield of a watercourse and the patterns of stream flow, especially extreme events (drought and flood) are critical to the in-stream environment and also to floodplain and riparian ecosystems. Stream flow is a major determinant of geomorphic change. Both the exploitation of water resources and environmental protection require knowledge of stream flow and catchment yields.

Table 14 gives selected stream flow information for a number of the larger watercourses. It does not cover the major watercourses as many have no gauging stations and several have insufficient data to derive an accepted mean result. Mean annual stream flow provides a useful relative measure of stream size, but the variability of stream flow also needs to be considered.

Most Australian rivers and streams, including those of the study area, are characterised by great variability and a marked seasonality of flow, as indicated in Table 14. It is not uncommon for the record maximum monthly flow to exceed 50% of the mean annual discharge. Stream flow can vary greatly on a daily, monthly, or yearly basis. Examination of flows at a single gauging station reveals the extent of variation. Tonga Bridge Gauging Station, upstream of Eildon Reservoir on the Delatite River, has a record mean maximum daily flow of 26 800 ML and a record minimum annual flow of 39 600 ML (SRWSC 1984): the record monthly discharge at the same site is 105 000 ML, which approaches the mean annual flow of 131 000 ML (SRWSC 1984).

In most cases, the range between maximum and minimum flows can be expected to increase with the period of record, as a greater number of extreme events are recorded.

Extreme variability is common, although the data in Table 14 indicate actual flows, which reflect the influence of changes due to water storage and extraction. Few of the larger watercourses remain unaffected by water storages, an issue covered in Chapter 17.

Much of the variation in stream flow reflects the seasonality of flow. Most rivers and streams carry the greater proportion of their annual flow in winter and spring. A major effect of water storages is the disruption of this seasonality. Under natural conditions, the July--September period accounted for 52% of the Goulburn River's annual flow, with a mere 5% in January--March. Since the operation of Eildon Reservoir, the winter flows account for 33% and the summer flows have risen to 23% of annual stream flow (DWR 1989).

Water quality

Measurements of the physical, chemical, and biological characteristics of water are used to assess its quality. Although this varies under natural conditions, any significant and persistent loss of water quality harms aquatic ecosystems and reduces the value of the resource. Water quality influences various uses of the resource, including human consumption, industrial, recreational, agricultural, scientific, and educational.

Across the study area, catchment conditions and water quality generally coincide. Forested, undisturbed catchments retain high water quality, while agricultural and urbanised catchments have lowered water quality and riverine conditions. Land-use practices resulting in erosion and export of nutrients and toxicants, urban run-off, and point-source discharges of pollutants are the major causes of loss of water quality.

Physico-chemical parameters are most commonly used for the regular analysis of water quality. They include turbidity (a measure of light scattering), suspended solids, conductivity (a measure of salinity), nutrient levels (usually nitrogen and phosphorus), pH, temperature, and dissolved oxygen. Elevations, especially of a persistent nature, of any of these parameters from background levels usually indicate changes in water quality. Biological monitoring offers important insights into aquatic conditions, but complexity and expense limit its application.

Describing surface water quality involves assessing characteristics that can be highly variable. Changes over time (such as in stream flow) often significantly influence water quality measured at any monitoring point, but it also alters naturally along the length of a watercourse. Assessing water quality is therefore a complex task, involving numerous measurements to understand the variations in different parameters, and assessing quality against the natural conditions expected for any particular reach.

Table 14

MEAN ANNUAL DISCHARGE, MAXIMUM AND MINIMUM MONTHLY DISCHARGE FOR SELECTED WATERCOURSES

Watercourse	Gauging station (RWC)	Period of record (to 1981)	Mean annual discharge (ML)	Maximum monthly discharge (ML)	Minimum monthly discharge (ML)
Basin 5 - Goulburn					
Acheron River	Tagerty (209)	1945-	337 000	112 000	1 220
Big River	Jamieson (227)	1958-	330 000	153 000	1 460
Delatite River	Tonga Bridge (214)	1947-	131 000	105 000	379
Goulburn River	Seymour (202)	1957-	2 650 000	871 000	23 900
Goulburn River	Trawool (201)	1908-1909 1925-	2 520 000	1 070 000	20 400
Goulburn River	Eildon (203)	1916-	1 650 000	907 000	235
Goulburn River	Dohertys (219)	1954-	394 000	246 000	377
Howqua River	Glen Esk (215)	1947-1954 1955-1956 1973-	200 000	132 000	537
Jamieson River	Gerrans Bridge (218)	1954-	246 000	127 000	619
King Parrot Creek	Flowerdale (231)	1961-	35 200	21 800	57
Murrindindi River	Colwells (205)	1939-	59 000	18 500	778
Rubicon River	Rubicon (241)	1922-1928 1949-	138 000	60 000	1 610
Yea River	Devlins Bridge (217)	1954	113 000	45 800	267
Basin 25 - Thomson					
Aberfeldy River	Beardmore (213)	1963-	83 000	95 300	0
Aberfeldy River	Lily Creek (100)	1972-	37 400	19 000	111
Thomson River	Cooper Creek (208)	1929-1950 1952-	353 000	172 000	1 720
Thomson River	Narrows (210)	1953-	241 000	88 500	1 570
Thomson River	Thomson Adit (103)	1973-	69 700	21 700	899
Basin 26 - La Trobe					
La Trobe River	Yallourn (400)	1919-	631 000	456 000	9 080
La Trobe River	Willow Grove (204)	1924-	226 000	77 200	2 330
La Trobe River	Noojee (205)	1925-1931 1957-	112 000	27 100	1 860
Moe Drain	Trafalgar East (402)	1957-	112 000	62 000	72
Moe River	Darnum (209)	1949-1960 1960-	51 200	23 600	128
Narracan Creek	Thorpdale (218)	1955-	25 000	9 880	261
Tanjil River	Tanjil South (216)	1955-	150 000	48 700	1 630
Toorongo River	Noojee (219)	1924-1933 1957-	42 000	8 930	833
Tyers River	Boola (006)	1958-	60 200	62 500	104
Basin 27 - South Gippsland					
Bass River	Loch (219)	1966-	17 500	9 250	0
Bass River	Forbes South (231)	1973-	59 300	32 500	14
Powlett River	Foster Creek (236)	1979-	Insufficient data		
Foster Creek	Dam Site (238)	1979-	Insufficient data		
Basin 28 - Bunyip					
Bunyip River	Iona (213)	1962-	106 000	51 900	97
Bunyip River	Bunyip (200)	1907-1952 1953-1963	153 000	93 600	1 800
Bunyip River	Tonimbuk (212)	1962-	27 700	8 870	87
Bunyip River	Headworks (207)	1948-	7 630	4 120	4
Dandenong Creek	Dandenong (204)	1924-1967 1968-	49 600	39 300	8
Basin 29 - Yarra					
Blue Jacket Creek	Coranderrk Weir (119)	1958-	372	83	5
Don River	Launching Place (220)	1967-	5 390	1 560	44
L. Yarra River	Yarra Junction (214)	1963-	45 600	12 200	595
Plenty River	Mernda (216)	1964-	15 400	25 400	0
Woori Yallock Creek	Woori Yallock (215)	1963-	95 300	38 400	367
Yarra River	Mill Grove (212)	1963-	171 000	93 700	1 300
Yarra River	Warrandyte (200)	1891-1933 1959-	751 000	459 000	1 560
Yarra River*	Heidelberg (135)	1965-	428 000	266 000	1 550

* Downstream of study area

Source: State Rivers and Water Supply Commission (1984).

The following description makes qualitative assessments, ranging from excellent, good, moderate, poor, to degraded. These terms are based on those used in the 1988 State of the Environment Report 'Victoria's Inland Waters' (OCE 1988) using basic physico-chemical data. Published RWC (1990) data, current to 1987, are used to exemplify selected water quality parameters. Readers seeking current data are directed to the Rural Water Commission and the Environment Protection Authority, which have unpublished data available.

Goulburn River basin

Most of the larger watercourses above Eildon Reservoir are within forested catchments: they include the Jamieson, Howqua, Goulburn (above Eildon Reservoir), Big, Rubicon, and Acheron Rivers. Yea and Delatite Rivers have substantial lower reaches in cleared agricultural lands, as does the Goulburn River below Eildon Reservoir.

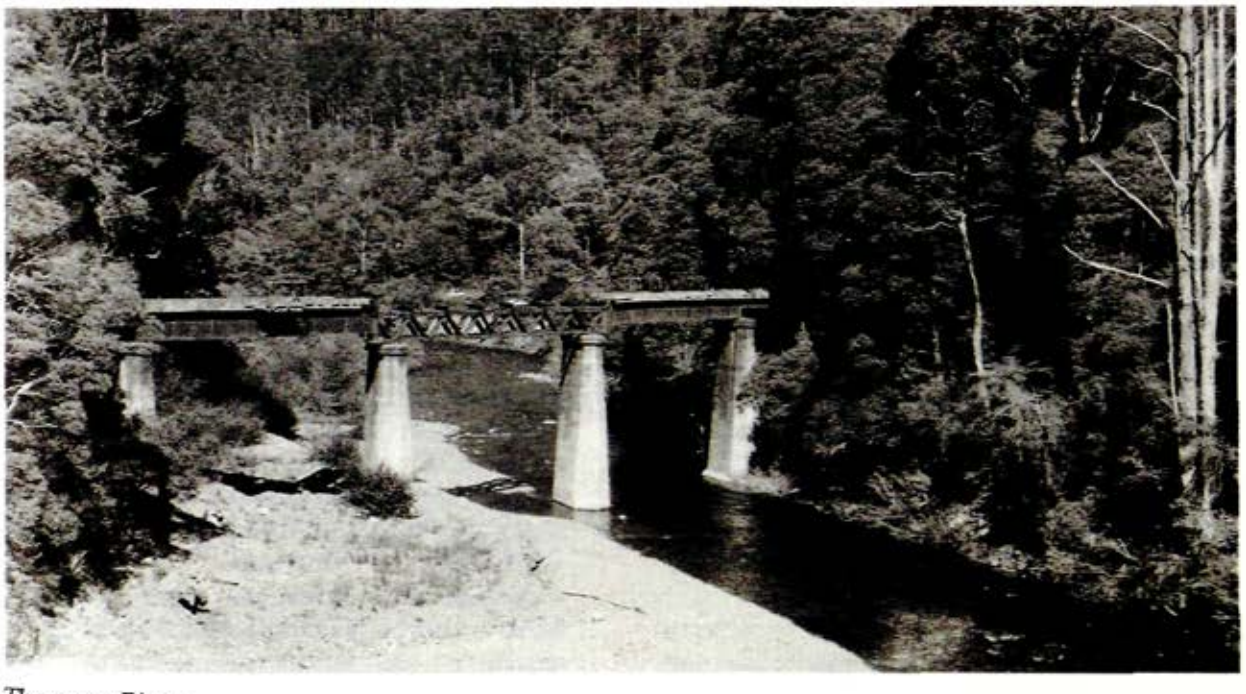
Water quality is generally excellent in the forested areas: turbidity is low (mean values less than 5 NTU); salinity is low (mean values below 90 μS per cm); pH is close to neutral on the Delatite, upper Goulburn, Howqua, Jamieson, Murrindindi, and Rubicon Rivers. Turbidity in the Goulburn River increases slightly downstream from Eildon Reservoir to Seymour, but remains relatively low there, as is salinity. The nutrients phosphorus and nitrogen are at moderate to good levels, although a trend of increasing phosphorus has been evident.

Big River has excellent clarity, nutrients, and other physico-chemical measurements. Relatively high turbidity levels on the lower reaches of the Yea River have reduced its water quality.

Mercury contamination has been recorded in the upper Goulburn, and its tributaries Morning Star and Raspberry Creeks (Ealey *et al.* 1983, EPA 1984), an outcome of gold mining last century. Fish and drinking water from Eildon Reservoir have, on some occasions, exceeded the levels recommended for safe consumption (EPA 1984).

Thomson River basin

Water quality in the Thomson River has been influenced by the effects of the Thomson Reservoir. Salinity levels are low (mean values below 70 μS per cm), pH is close to neutral, and levels of the nutrients nitrogen and phosphorus are also low (mean values total phosphorus 0.038 mg per L). Turbidity data suggest high levels during peak stream



Thomson River

flows (90% of 18 NTU at the Narrows station). Examination of trends in these data suggests that, following completion of the Reservoir, high turbidity levels downstream of the storage and associated with its construction, are now in decline.

Data on turbidity, salinity, pH, and dissolved oxygen for the Aberfeldy River are indicative of excellent water quality.

La Trobe River basin

While the headwaters of the northern basin are forested, the area south of the La Trobe River and the larger valleys and plains are predominantly cleared agricultural lands. Above Willow Grove, water quality is excellent to good, with low turbidity, low salinity, and a pH close to neutral. However, quality declines along the length of the La Trobe, particularly in the reach downstream of Willow Grove to Thoms Bridge, just beyond the study area, where turbidity, suspended solids, salinity, and the nutrients phosphorus and nitrogen all increase significantly. For example, mean salinity increases from 87 to 285 μS per cm, mean turbidity from 5 to 19 NTU, and mean total phosphorus from 0.016 to 0.083 mg per L.

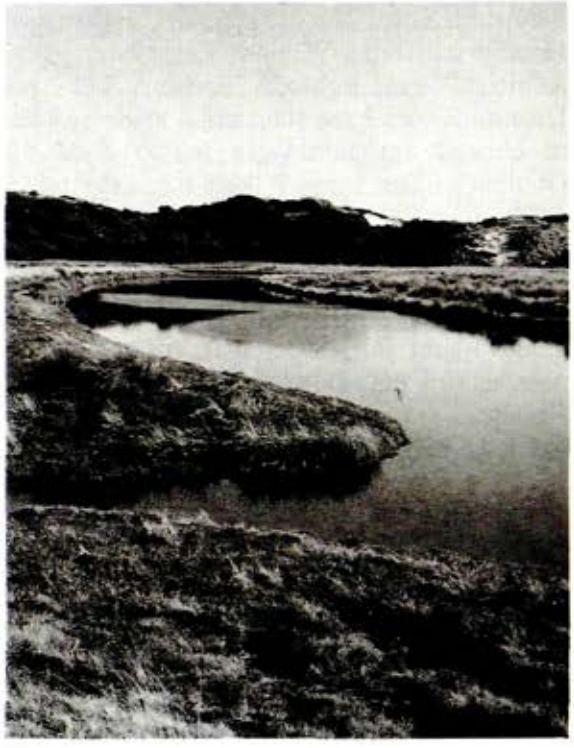
The Moe River is in poor condition for much of its length. It has high turbidity (mean value 26 NTU), relatively high salinity (mean value 307 μS per cm), high phosphorus (mean value total phosphorus 0.554 mg per L), and high nitrogen (mean nitrate and nitrite as N 1.44 mg per L), indicative of poor water quality.

South Gippsland basin

Very little of this basin carries native vegetation; most is cleared agricultural land. Comprehensive monitoring on the Bass River at Glen Forbes South shows high turbidity on occasions (90% of 33 NTU), high salinity (mean value of 744 μS per cm), and fairly high levels of the nutrients phosphorus and nitrogen (mean value total phosphorus 0.09 mg per L). Monitoring on the Powlett River indicates fairly high salinity and turbidity levels.

Bunyip River basin

Clearing is extensive across the plains and foothills, which are used for agriculture, with forest cover across the headwaters. Bunyip River exhibits an increasing level of turbidity and salinity downstream along its length; turbidity levels are occasionally relatively high in the lower reaches (90% value 37 NTU), as are nutrient levels. Lang Lang River similarly has high turbidity levels (mean value 21 NTU), with high suspended solids and relatively high levels of the nutrients phosphorus and nitrogen. On the basis of their turbidity, salinity, pH, and dissolved oxygen, Tarago River and Toomuc Creek have moderate water quality. Cardinia Creek has recorded very high turbidity levels (mean value 39 NTU), resulting in degraded water quality.



Powlett River

Yarra River basin

As the high-elevation areas are largely within forested water supply catchments, water quality is excellent. Clearing has been extensive in the foothills and plains in the lower reaches, with a resulting decline in water quality. Salinity, pH, and dissolved oxygen are indicative of excellent to good water quality at McMahons, Millgrove, and Warburton. However, turbidity and suspended solids levels at Warburton are high (mean value 16 NTU), as are the levels of the nutrients, phosphorus (mean value total phosphorus 0.132 mg per L), and nitrogen

(mean value nitrate and nitrite as N 0.544 mg per L). Further downstream of Launching Place, Healesville, Spandonis Reserve, and Warrandyte, the nutrient levels increase. Between Spandonis Reserve and Warrandyte, nutrient increase is marked (notably phosphorus) due to urban run-off and point-source discharges. Suspended-solids levels also tend to increase downstream, especially below Warrandyte - although a trend towards some improvement appears to be occurring.

Watercourses in cleared areas are characterised by relatively high turbidity, some with higher salinity levels, and occasionally low levels of dissolved oxygen, indicative of poorer water quality. Such watercourses include Diamond Creek, Plenty River, and Watsons Creek. Those draining forested areas, such as the Don River at Launching Place, have higher water quality.

Biological monitoring of the Yarra River using macro-invertebrates indicated considerable deterioration of the fauna progressively downstream (Pettigrove 1988). These changes were associated with water quality decline and the physical characteristics of individual sites - such as water depth and riparian vegetation.

Groundwater

Groundwater refers to all water found below the Earth's surface. The more permeable saturated geologic units beneath the surface such as sand, gravel and limestone are called aquifers and the water in them can be tapped by bores.

Water moves slowly through these aquifers with input by recharge from rainfall and output by discharge to the land surface, streams, and the sea.

The available resource depends on the hydraulic characteristics of the aquifers, the rate of recharge, and the composition of the groundwater. Further, the behaviour of groundwater can play an important role in the environment in maintaining wetlands or where it comes close to the surface, causing salinity.

For convenience the groundwater resources of the Melbourne region are discussed in terms of groundwater basins and provinces; They differ from surface-water catchments, because the surface-water flow pattern does not necessarily coincide with the groundwater flow pattern.

Four groundwater basins or provinces underlie the study area - Port Phillip basin, Western Port basin, Gippsland basin, and the Highlands province.

Port Phillip basin

The basin underlies and surrounds Port Phillip Bay. The onshore thickness of its sediments is up to 280 m - with the exception of the Nepean Peninsula, where maximum thickness exceeds 1000 m.

The Cainozoic sequence contains several aquifers, the most important of which are sand, gravel, and limestone of the Werribee Formation, Fyansford Formation, Bridgewater Formation, and the Brighton Group.

Major extractions occur south-east of Melbourne, for watering golf courses and market gardens, and west of Melbourne for use in industry. The resource is not used to supplement the supply for Melbourne because of limited yield and variable quality, although in times of water restrictions, groundwater is used extensively for the watering of public parks and private gardens in the south-eastern suburbs. Particularly in the western suburbs, the shallow groundwater is polluted by waste-disposal practices.

Western Port basin

Like the Port Phillip basin, Western Port basin has a sequence of Cainozoic sediments - up to 300 m thick.

Although less than 1000 sq.km in area, groundwater in the Western Port basin has high use. More than 10 000 ML are extracted annually, principally for market gardening and irrigation. Increased use of groundwater for irrigation during the 1950s and 1960s caused a drop in the potentiometric surface, centred around Dalmore--Cora Lyn; indeed, the potentiometric surface there lies below sea level, creating the potential for saline water intrusion from Western Port Bay.

In order to manage the groundwater resource on a sustainable basis, the Western Port basin was proclaimed a Groundwater Conservation

Area in 1971, which limits the extraction of groundwater in order to prevent overuse and degradation of the resource.

Gippsland basin

This thick sedimentary basin lies in the eastern part of the study area. It contains a large storage of good-quality groundwater (usually less than 1000 mg per L Total Dissolved Solids).

Some regional decline of the potentiometric surface of the main sand aquifer, the La Trobe Valley Group, has been caused by de-watering of the brown coal open-cut mines in the La Trobe Valley and off-shore extraction of petroleum.

Highlands province

Covering approximately one-third of Victoria, the southern portion lies within the study area. It is composed of folded rocks and intrusives. The major aquifer is in the weathered fracture zone at depths up to 70 m. Alluvial aquifers are an important water source in the Acheron and Goulburn River valleys.

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7. FLORA

The current distribution and condition of native vegetation in the study area reflects the effects of European settlement. Most of the plains and foothills have been cleared of their native vegetation, principally for agriculture, but also for urban, industrial, recreational, mining, road, and other uses. While the landscape of private land is predominantly agricultural, public land has generally retained a native vegetation cover, predominantly in the forests of the Central Highlands. In addition to the forests, woodlands, and native grasses, wetlands - such as Koo-Wee-Rup, Dalmore, and Tobin Yallock Swamps - have been cleared and drained. Natural drainage regimes have also been altered through catchment clearance, water storage, wetland drainage, river straightening, levee construction, riparian vegetation clearance, and other activities.

Public land contains the bulk of native vegetation, but much of it has been subject to a range of land uses and other factors that have influenced the extent, composition, and condition of vegetation communities.

Native vegetation on public land is an essential environmental resource, providing environmental, economic, social, scientific, and aesthetic values to the community. This chapter describes the vegetation communities within the study area, provides an analysis of the conservation status of each one and discusses those factors that influence the conservation values of flora.

Vegetation Community Descriptions

The following description of the major vegetation communities of the study area is based on the analysis of floristic vegetation surveys undertaken by the Flora and Fauna Survey Group, Resource Assessment Branch of the Department of Conservation and Environment. It represents a synthesis of data gathered during a range of regional and localised studies conducted since 1979, with additional information gathered in the course of this study, particularly for northern areas.

The floristic vegetation map (Map 7) was produced using aerial photograph interpretation and field checking. Its scale has necessitated a substantial amount of simplification and stylisation of community boundaries.

In order to simplify presentation, the following description groups vegetation communities. It attempts to group vegetation communities that occur in the same broad geographical areas, or that display some other gross similarities.

It is important to note that the intensity of sampling undertaken for this study is sufficient only to identify and describe the major, common vegetation communities. Moreover, vegetation communities seldom occur in discrete stands; rather, they merge into one another, sometimes over a considerable distance.

Substantial variation in the structure and species composition of similar vegetation communities may occur from area to area. Although some attempt has been made to describe such variation, the lists of characteristic species presented for each community are indicative rather than absolute.

Sub-alpine Vegetation

Sub-alpine vegetation occurs on and around the mountain tops of the study area, including the Baw Baws, Lake Mountain, the Federation Range, and Mounts Bullfight and Torbreck.

High precipitation (around 1400 mm per annum), low temperatures (mean monthly averages from 0°C to 13°C, and exposure to high winds are prominent environmental factors. While no portion of the study area is truly alpine, in the sense of occurring above the tree-line, winter snowfalls are frequent here, with a layer of snow remaining for up to 4--5 months. Cold air drainage into gully-heads produces local extremes of cold.

Most of these mountains are weathered granite or granodiorite peaks. Soils range from peats and organic loams at the highest elevations to friable brown to red-brown gradational and uniform soils on the slopes. They are mainly free-draining, although the

accumulation of organic material in the depressions produces peaty, waterlogged soils, which may have complex profiles.

These mountain-tops are typically broad, with shallow-sided gully-heads between the ridges and spurs. They carry the four major vegetation communities described here.

Dry sub-alpine shrubland

A sparse to dense dry shrubland occurs on north-facing slopes and in saddles on the Baw Baw Plateau, often in the vicinity of granite tors. The shallowness of the soils overlying the granite may inhibit the establishment of trees and even shrubs on these sites.

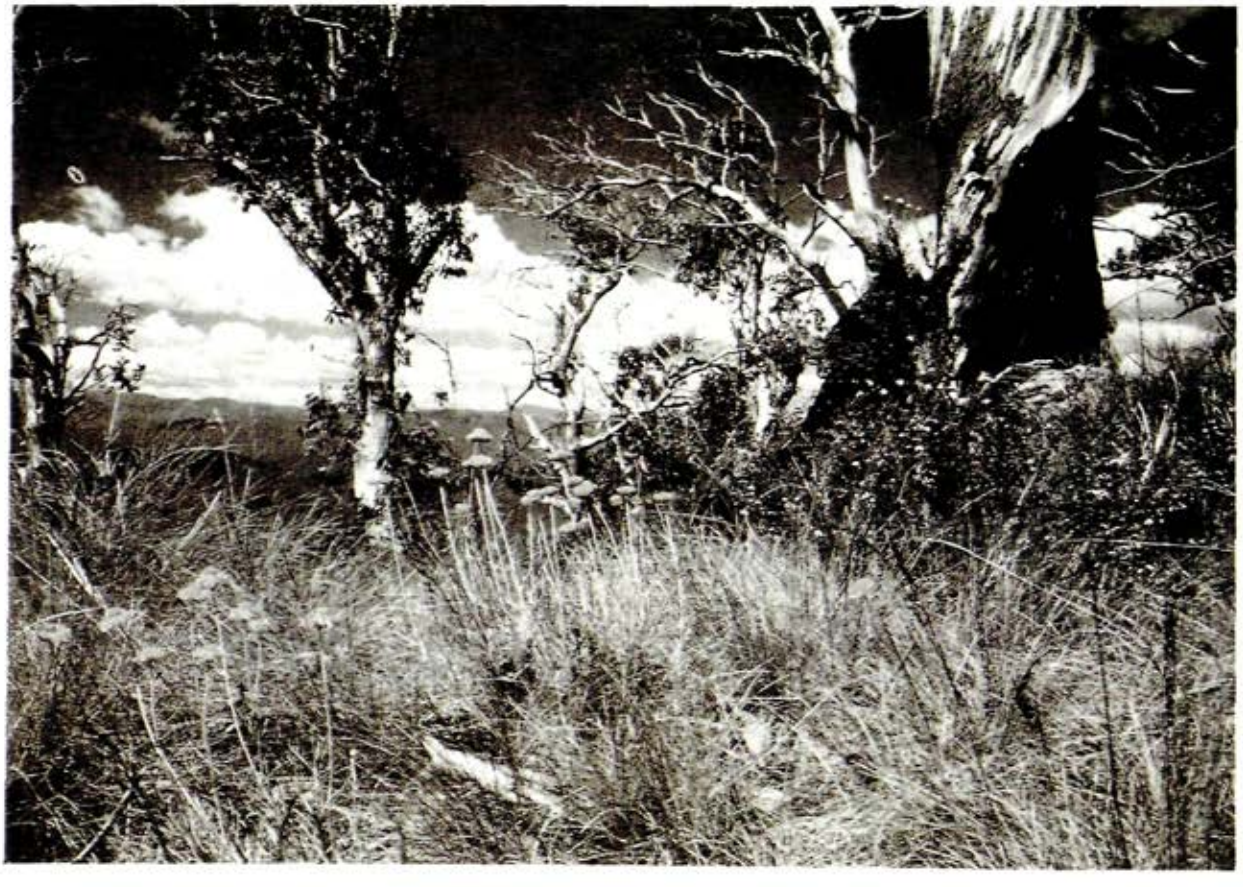
Characteristic shrubs include dusty daisy-bush (*Olearia phlogopappa*), alpine orites (*Orites lancifolia*), cascade everlasting (*Helichrysum secundiflorum*), and Muellers bush-pea (*Pultenaea muelleri*). The ground layer, which may be quite dense if the shrubs are sparse, is characterised by mountain woodruff (*Asperula gunnii*), short-stem sedge (*Carex breviculmis*), silver daisy (*Celmisia asteliifolia*), alpine wallaby-grass (*Danthonia nudiflora*), and Australian carraway (*Oreomyrrhis eriopoda*).

Fire may have been a factor in generating this community, which contains a curious mixture of herbs of higher altitudes in conjunction with shrubs normally from lower altitudes. The patchiness of the shrub layer reinforces this conclusion.

Damp sub-alpine heathlands

This intermediate band usually occurs between dry sub-alpine shrubland and wet sub-alpine heathland, or on raised areas within the latter.

The dense shrub layer includes alpine star-bush (*Asterolasia trymalioides*), alpine grevillea (*Grevillea australis*), scaly everlasting (*Helichrysum hookeri*), snow heath (*Epacris petrophila*), and alpine orites. The soils, which are deeper and wetter than those of dry sub-alpine shrubland, support a



Sub-alpine woodland

ground layer that includes spreading rope-rush (*Empodisma minus*), soft tussock-grass (*Poa hiemata*), mountain woodruff, and alpine podolepis (*Podolepis robusta*).

Wet sub-alpine heathland

The wettest sites in the depressions and gully heads of the Baw Baw Plateau, Lake Mountain, and Mt Bullfight support an open to very dense heathland characterised by the following shrubs: candle richea (*Richea continentis*), swamp heath (*Epacris paludosa*), alpine baeckea (*Baeckea gunniana*), drumstick heath (*Epacris breviflora*), and mountain daisy-bush (*Olearia algida*).

This vegetation community would include most sites commonly known as alpine or sphagnum bogs. The deep, peaty, sodden soils are usually covered by a layer of sphagnum moss (*Sphagnum* spp.). Other characteristic ground-layer species include spreading rope-rush, matted nertera (*Nertera granadensis*), alpine astelia (*Astelia alpina*), and mountain gentian (*Gentianella diamensis*). The underlying soils accumulate organic material due to slow rates of decomposition, which can be attributed to low temperatures and anaerobic conditions.

Large volumes of water are retained in the moss and peaty soil, seeping downslope until small trickles and streams form. Frequently, the increased erosional power of the stream at the outlet of the bog has produced a steeper-sided descending gully. These gullies often support montane riparian thicket (see below).

Sub-alpine woodland

This community forms a woodland or forest on slopes above 1200 m, and on relatively free-draining soils. Usually dominated by snow gum (*Eucalyptus pauciflora*), the understorey may variously consist of a rich suite of grasses and herbs, or a dense layer of woody shrubs such as Muellers bush-pea, alpine oxylobium (*Oxylobium alpestre*), alpine pepper (*Tasmannia xerophila*), and lilac berry (*Trochocarpa clarkei*).

An interesting variant of this community is found on Mt Useful, where the ash-mallee (*Eucalyptus kybeanensis*) occurs with alpine wattle (*Acacia alpina*), drooping beard-heath (*Leucopogon gelidus*), and a rare, as-yet-unnamed species of broom-heath (*Monotoca* sp. aff. *elliptica*). Another unusual record is that of spinning gum (*Eucalyptus perriniana*), which occurs north of Mt Whitelaw.

Montane Vegetation

Montane vegetation occurs along the Great Dividing Range and its northward extensions, the Blue, Royston, Federation, and Terrible Ranges. South of the Divide, the Baw Baw and Toorongo Plateaux support substantial areas of this vegetation type. These communities generally occur between 900 and 1200 m.

The climate of these ranges is characterised by relatively low temperatures (monthly means between 5°C and 15°C), high rainfall (mean annual rainfall between 1000 and 1400 mm) and moderate to high exposure to winds. Insolation levels depend strongly on aspect. Snow falls regularly in winter, but does not persist as a layer throughout the winter. The tendency for the upper slopes to be shrouded in mist for lengthy periods may indicate that the effective precipitation is particularly high.

Montane vegetation occurs typically on the upper slopes and in gullies of deeply dissected valleys. Such terrain provides sites with a wide range of physical conditions. The deep gully-heads are among the most protected sites available, particularly with respect to fire frequency, fire intensity, and evaporation.

The montane areas coincide with diverse igneous geologies ranging from Devonian granite and granodiorite around Baw Baw and Toorongo to Devonian rhyolite and rhyodacite, which extends from the Upper Yarra to the Cerberean Range. Extensive areas of uplifted Devonian marine sediments (principally siltstone, claystone, and sandstone) also support montane vegetation - for example, on the watershed between the Big, Yarra, and Thomson Rivers. Soils include shallow stony soils on steep, exposed slopes, and friable brownish gradational soils on more protected ones. Four major vegetation communities are included.

Montane dry woodland

The drier, more exposed aspects of the mountain slopes support montane dry

woodland, a woodland or forest from 15 to 25 m in height.

Characteristic trees include broad-leaf peppermint (*Eucalyptus dives*), candlebark (*E. rubida*), and narrow-leaf peppermint (*E. radiata*). Snow gum (*E. pauciflora*) is often present at higher altitudes. Other notable eucalypts found in this community include brittle gum (*E. mannifera*), which is at the western limit of its distribution, and the uncommon bogong gum (*E. chapmaniana*) both of which are found in the Woods Point--Upper Goulburn area.

The characteristic shrubs here include common cassinia (*Cassinia aculeata*), moth daisy-bush (*Olearia erubescens*), and gorse bitter-pea (*Daviesia ulicifolia*), with prickly starwort (*Stellaria pungens*), spiny-headed mat-lily (*Lomandra longifolia*), pink-bells (*Tetratheca ciliata*), austral bracken (*Pteridium esculentum*), grey tussock-grass (*Poa sieberiana*), and Tasman flax-lily (*Dianella tasmanica*) frequently present in the ground layer.

This community is closely related to damp sclerophyll forest, with which it intergrades between 800 and 1000 m.

Montane damp forest

The more protected mountain slopes support a tall forest up to 40 m in height, dominated in its lower altitudinal range by mountain grey gum (*Eucalyptus cypellocarpa*), messmate (*E. obliqua*), narrow-leaf peppermint, and occasionally manna gum (*E. viminalis*). At higher altitudes, pure stands of alpine ash (*E. delegatensis*) often dominate the community.

Montane damp forest features an open to rather dense layer of tall shrubs, among which silver wattle (*Acacia dealbata*), blackwood (*A. melanoxylon*), mountain hickory wattle (*A. obliquinervia*), elderberry panax (*Polyscias sambucifolia*), blunt-leaf bitter-pea (*Daviesia mimosoides* var. *laxiflora*), and rough coprosma (*Coprosma hirtella*) are prominent.

Characteristically, grasses and herbs, in the ground layer include bidgee-widgee (*Acaena novae-zelandiae*), sword tussock-grass (*Poa ensiformis*), mountain cotula (*Leptinella filicula*), derwent speedwell (*Parahebe derwentiana*), common lagenifera (*Lagenifera stipitata*), and ivy-leaf violet (*Viola hederacea*). Mother shield-fern (*Polystichum proliferum*) is common in moister sites.

Montane wet forest

The most protected sites, usually south-facing slopes and gullies, carry montane wet forest. Here soils are deep, fertile, and well-drained. The canopy may grow to more than 60 m, and consists of pure or mixed stands of alpine ash and shining gum.

Manna gum may be a codominant in the Blue and Royston Ranges, while significant occurrences of Tingaringy gum (*Eucalyptus glaucescens*) and Errinundra shining gum (*E.* sp. aff. *nitens* [Errinundra]) are recorded from montane wet forest on the Baw Baw Plateau.

On the north-eastern face of the Baw Baw massif, mountain ash (*E. regnans*) ascends to approximately 1200 m in association with species characteristic of both montane wet forest and wet sclerophyll forest (see below). This unusually high-elevation occurrence may be a response to the tempering effect of the massif on the prevailing south-westerly winds, or to soil temperature variation due to insolation.

The tall second storey of montane wet forest commonly includes myrtle beech (*Nothofagus cunninghamii*) and forest wattle (*Acacia frigescens*), which grow above a dense layer of soft tree-ferns (*Dicksonia antarctica*). At ground level, hard water-fern (*Blechnum wattsii*), bat's-wing fern (*Histiopteris incisa*), and mother shield-fern are characteristic.

Although this community is closely related to wet sclerophyll forest, the floristic distinction lies in the substitution of most of the characteristic shrubs and trees. Notably absent in montane wet forest are broad-leafed shrubs such as hazel pomaderris (*Pomaderris aspera*), blanket-leaf (*Bedfordia arborescens*), musk daisy-bush (*Olearia argophylla*), austral mulberry (*Hedycarya angustifolia*), and tree lomatia (*Lomatia fraseri*), and the rough tree-fern (*Cyathea australis*).

On the north-eastern face of the Baw Baw massif, mountain ash (*Eucalyptus regnans*)

ascends to approximately 1200 m in association with species characteristic of both montane wet forest and wet sclerophyll forest (see below). This unusually high-elevation occurrence may be a response to the tempering effect of the massif on the prevailing south-westerly winds, or to soil temperature variation due to insolation.

The presence of myrtle beech in the second storey reflects the strong association between montane wet forest and cool temperate rainforest. In protected sites, especially following a long fire-free period, understorey stands of myrtle beech may achieve a degree of canopy closure sufficient for them to be considered cool temperate rainforest, despite the presence of emergent eucalypts.

Montane riparian thicket

Dense thickets of mountain tea-tree (*Leptospermum grandifolium*) occur along drainage lines in montane and sub-alpine areas. Montane riparian thicket is associated with a number of other vegetation communities, often arising at the outlets of sub-alpine heathlands, and descending to intergrade with cool temperate rainforest or riparian thicket at lower altitudes.

The canopy of this community may vary in height up to approximately 15 m. Cool temperate rainforest dominants, myrtle beech and southern sassafras (*Atherosperma moschatum*), are frequently subdominant.

Soils are similar to the sodden, peaty soils of the wet sub-alpine heathland. A thick substrate of sphagnum is often present. The ground layer flora includes alpine water-fern (*Blechnum penna-marina*), tall sedge (*Carex appressa*), forest sedge (*C. alsophila*), pretty grass-flag (*Libertia pulchella*), and hard water-fern. The Baw Baw berry (*Wittsteinia vacciniacea*), although considered rare, is frequently encountered as a low shrub. It is endemic in the Victorian Central Highlands.

An unusual variant of this community occurs at Bellel Creek, south-east of Marysville, and at the Xylophone Bridge on the Murrindindi River. Here, mountain tea-tree is locally absent, but the ferns, herbs, and sedges of the understorey remain to produce curious open bogs. The sequence of events leading to the establishment of such vegetation is unclear, although such sites frequently occur immediately upstream of the confluence of two streams.

Moist Forests

Moist forests occur throughout the study area, but are concentrated in the high-rainfall foothill or mountain country in the upper catchments of the Yarra, Goulburn, Thomson, and La Trobe Rivers, generally between 100 and 1000 m in elevation. Extremes of temperature are uncommon, and annual rainfall averages exceed 1000 mm. Deeply dissected valleys separated by broad ridges are the typical topographic feature.

These forests occur on friable brownish gradational soils derived from Devonian or Silurian sediments or acidic igneous rocks, with the exception of some riparian communities, which occur on sandy, silty, or gravelly alluvial soils. They include six vegetation communities.

Cool temperate rainforest

This type of rainforest occurs in protected gully heads, on surrounding slopes, and along streams throughout the wetter, mountainous parts of the study area. Moisture and the absence of fire are the key determinants of its distribution.

It is dominated by myrtle beech and southern sassafras, which typically form a more or less continuous dense canopy up to 40 m in height. Scattered emergent eucalypts may be present. Blackwood may form part of the closed rainforest canopy in some stands, but it is also widespread in other vegetation communities.

The understorey features an array of ferns, including soft tree-fern, hard water-fern, and mother shield-fern. The moist, sheltered conditions allow an number of epiphytic fern species to flourish, including kangaroo-fern (*Microsorum diversifolium*), filmy ferns (*Hymenophyllum* spp.), and long fork-fern (*Tmesipteris billardieri*). Mosses and liverworts are abundant.

Several rare species occur in some cool temperate rainforest stands in the upper Bunyip River catchment, notably tall astelia (*Astelia australiana*), oval fork-fern (*Tmesipteris ovata*), and bristly shield-fern (*Lastreopsis hispida*).

Wet sclerophyll forest

Mountain ash usually dominates wet sclerophyll forest, forming the tallest forests in the study area. The community occupies the protected slopes of the ranges, plateaus and outlying hills, which tend to have abundant rainfall and deep, rich, well-drained soils, and offer some degree of fire protection.

The canopy may grow to 80 m in height. Beneath it, a second storey of trees including silver wattle and blackwood may reach 35 m. The third storey comprises broad-leafed shrubs such as hazel pomaderris (*Pomaderris aspera*), blanket-leaf (*Bedfordia arborescens*), musk daisy-bush (*Olearia argophylla*), austral mulberry (*Hedycarya angustifolia*), tree lomatia (*Lomatia fraseri*), and banyalla (*Pittosporum bicolor*) grow to 20 m in height.

A dense layer of soft tree-fern and rough tree-fern (*Cyathea australis*) to 5 m is characteristic. The moist, shaded ground layer supports mother shield-fern, hard water-fern, shade nettle (*Australina pusilla*), and white elderberry (*Sambucus gaudichaudii*). In the wettest fern-gullies, shiny shield-fern (*Lastreopsis acuminata*), and mother spleenwort (*Asplenium bulbiferum*) are common.

Of particular note are the extensive areas in the Central Highlands where two extreme fires in succession (such as in 1926 and 1939) have led to the development of thickets, usually of silver wattle or blackwood, without a eucalypt overstorey. The interval between these fires was insufficient to allow eucalypt seed stores to be replenished.

While extremely severe and widespread fires, such as those on Black Friday 1939 and Ash Wednesday 1983, may completely raze vast areas of forest, other less-severe fires can produce a variety of localised effects that result in the development of mixed-age stands of mountain ash. Although not extensive, these stands are common.

Wet sclerophyll forest species may also occur in stands that are transitional between this community and cool temperate rainforest, having a consistent, dense understorey of myrtle beech. They tend to do so in forests at the upper limit of elevation for this community, usually 700--1000 m. The transition to rainforest will continue only in the absence of fire or other major disturbance.

The following rare species are associated with wet sclerophyll forest in the study area: butterfly orchid (*Sarcochilus australis*) and gully grevillea (*Grevillea barklyana*) in the Bunyip River area, and shiny phebalium (*Phebalium wilsonii*) in the O'Shannassy Catchment.

Damp sclerophyll forest

This is a widespread vegetation community occupies a range of sites on a variety of soils and aspects. It occurs from 200 to 1000 m in elevation. It differs from wet sclerophyll forest in that it has a simpler structure without a distinct tree-fern layer, its characteristic shrubs usually have smaller, tougher leaves, and the ground layer is much drier, supporting more herbs and grasses. Messmate and mountain grey gum are the characteristic dominants in the overstorey, but mountain ash, manna gum, silvertop (*Eucalyptus sieberi*), and eurabbie (*E. globulus* ssp. *bicostata*) may be locally dominant.

The species comprising the shrub layer of damp sclerophyll forest vary across the study area, although the following are widespread: hazel pomaderris, prickly coprosma (*Coprosma quadrifida*), bootlace bush (*Pimelea axiflora*), prickly moses (*Acacia verticillata*), and snow daisy-bush (*Olearia lirata*).

The ground layer is similarly variable across the study area, but characteristic species include common ground-fern (*Culcita dubia*), ivy-leaf violet, rough tree-fern, mountain clematis (*Clematis aristata*), cinquefoil (*Geranium potentilloides*), and tall sword-sedge (*Lepidosperma elatius*).

Riparian thicket

Dense thickets of woolly tea-tree (*Leptospermum lanigerum*) and/or scented paperbark (*Melaleuca squarrosa*) occur on broad beds of smaller streams or on the regularly flooded terraces of larger streams and rivers. Soils are usually sandy or gravelly, but with high silt levels.

Woolly tea-tree occurs throughout the study area, while scented paperbark is confined to areas south of the Divide.

Cool temperate rainforest

The ground layer is usually dominated by tufts of fishbone water-fern (*Blechnum nudum*), in association with soft tree-fern, red-fruit saw-sedge (*Gahnia sieberiana*), sedges (*Carex* spp.) and spreading fan-fern (*Sticherus lobatus*). In the upper reaches of the La Trobe River, on Pioneer Creek, this community includes tall astelia (*Astelia australiana*), a vulnerable species in the lily family (Liliaceae).

Although riparian thicket is structurally very similar to montane riparian thicket, it tends to intergrade with cool temperate rainforest. Cool temperate rainforest occupies the better-drained, fire-protected sites which are associated with the steeper slopes and deeper gullies, while montane riparian thicket occurs in the high altitude peaty drainage lines. Riparian thicket is found on the lower elevation stream banks and terraces.

Riparian forest

Riparian forest is a tall forest of river banks and alluvial terraces. It tends to occur along quite swift-flowing streams. It is normally dominated by manna gum (*E. viminalis*), with silver wattle (*Acacia dealbata*), blackwood (*A. melanoxylon*), hazel pomaderris (*Pomaderris aspera*), Victorian christmas-bush (*Prostanthera lasianthos*) and prickly coprosma (*Coprosma quadrifida*) in the shrub layer.

An abundance of moisture combined with fertile, well-drained soils explains the strong floristic links with wet sclerophyll forest. The richness of the understorey of riparian forest is noteworthy, with a wide variety of terrestrial species as well as a suite of semi-aquatic plants. Usually present are fishbone water-fern (*Blechnum nudum*), tall sedge, mother shield-fern, swamp club-sedge (*Isolepis inundata*), small-leaf bramble (*Rubus parvifolius*), and soft tree-fern.

Environmental weeds are a common component of riparian forest. The variety of factors responsible include the natural pattern of disturbance through flooding, the amenable environment, and the history of human activity along rivers.

Swampy riparian forest

Swamp gum (*Eucalyptus ovata*) usually dominates swampy riparian forest, although mealy stringybark (*E. cephalocarpa*) and

messmate may also be present, particularly in the La Trobe, Bunyip, and Tarago River catchments.

The second storey includes blackwood, woolly tea-tree, hazel pomaderris and, south of the Great Dividing Range, scented paperbark.

Common plants in the ground layer include soft tree-fern, red-fruit saw-sedge (*Gahnia sieberiana*), water-ferns (*Blechnum* spp.), tall sword-sedge, common reed (*Phragmites australis*), and brooklime (*Gratiola peruviana*). Showy willow-herb (*Epilobium pallidiflorum*), which is considered to be depleted, may be present if the area is not grazed.

Swampy riparian forest occurs on saturated river flats, sometimes adjacent to a swiftly flowing river. The sites are regularly flooded. Soils are silt-rich river sands and gravels, although sites with heavier clay soils may also support swampy riparian forest. The community has strong affinities with riparian thicket, riparian forest, and swamp heath.

The many variants of this community include the stand of Buxton gum (*E. crenulata*) on river flats beside the Acheron River south of Buxton, where the atypical understorey combines elements of wet heathland and floodplain wetland complex, as well as many of the usual swampy riparian forest species listed above.

Dry Forests

Dry forests occur on the foothills and slopes of the higher ranges throughout the study area, from 50 to 1000 m. Annual rainfall varies across the area where they grow, but generally averages 5000--1000 mm.

In predominantly wet areas, dry forests occur exclusively on exposed aspects, usually north-east to north-west. They may occupy all aspects in drier areas, but typically occur on slopes in the dissected catchments of the Yarra, La Trobe, and Goulburn Rivers.

The varied underlying geologies include Devonian and Silurian marine sediments, Devonian granites and granodiorites, and Devonian volcanics (rhyolite and rhyodacite). These forests are found on shallow stony soils, acidic duplex soils, yellow gradational soils, and leached sands.

They include seven major vegetation communities.

Herb-rich foothill forest

Forest of this type grow mainly in the northern part of the study area. The canopy is usually 20 to 35 m tall, and commonly includes narrow-leaf peppermint, eurabbie, manna gum, and candlebark. Messmate may occur, especially where the community intergrades with shrubby foothill forest in the Black Range and Mt Disappointment areas.

The sparse low shrub layer consists normally of two species: common cassinia and silver wattle.

By contrast, the forest has a dense and species-rich ground layer. This frequently contains the following species: kidney-weed (*Dichondra repens*), weeping grass (*Microlaena stipoides*), common lagenifera, bidgee-widgee, cinquefoil, ivy-leaf violet, grey tussock-grass, soft tussock-grass (*Poa morrisii*), austral bear's-ears (*Cymbonotus preissianus*), and prickly woodruff (*Asperula scoparia*). Austral bracken is usually present, and may tend to dominate the ground layer following frequent disturbance, particularly by fire.

Shrubby foothill forest

Similar in structure to herb-rich foothill forest, shrubby foothill forest has a more dense and varied shrub layer, but tends to lack a diverse ground layer. It is widespread on higher slopes, particularly between 400 and 900 m elevation, both north and south of the Great Dividing Range.

The dominant trees are messmate and narrow-leaf peppermint, although silvertop, mountain grey gum, and scent-bark (*E. aromaphloia*) may occur in the Walhalla area.

A wide variety of shrubs characterise this community across its range. Common among these are narrow-leaf wattle (*Acacia mucronata*), dusty miller (*Spyridium parvifolium*), handsome flat-pea (*Platylobium*

formosum), prickly bush-pea (*Pultenaea juniperina*), rough bush-pea (*P. scabra*), varnish wattle (*Acacia verniciflua*), common cassinia (*Cassinia aculeata*), shiny cassinia, hop goodenia (*Goodenia ovata*), and pink-bells.

The ground layer includes ivy-leaf violet, common raspwort (*Gonocarpus tetragynus*), and grey tussock-grass. Forest wire-grass (*Tetrarrhena juncea*) and austral bracken are commonly present, and sometimes dominant.

Heathy foothill forest

Although closely related to the two previous communities, heathy foothill forest tends to occur at lower elevations, on yellowish gradational soils and leached sands of low fertility. Examples are found mainly on the lower slopes in the La Trobe, Bunyip, and Tarago River catchments. It differs from the two previous communities by having an understorey with close affinities with heathy woodlands and heathlands.

The canopy includes silvertop, yertchuk (*Eucalyptus consideniana*), and messmate. Occasionally, white stringybark (*E. globoidea*) and brown stringybark (*E. baxteri*) are present.

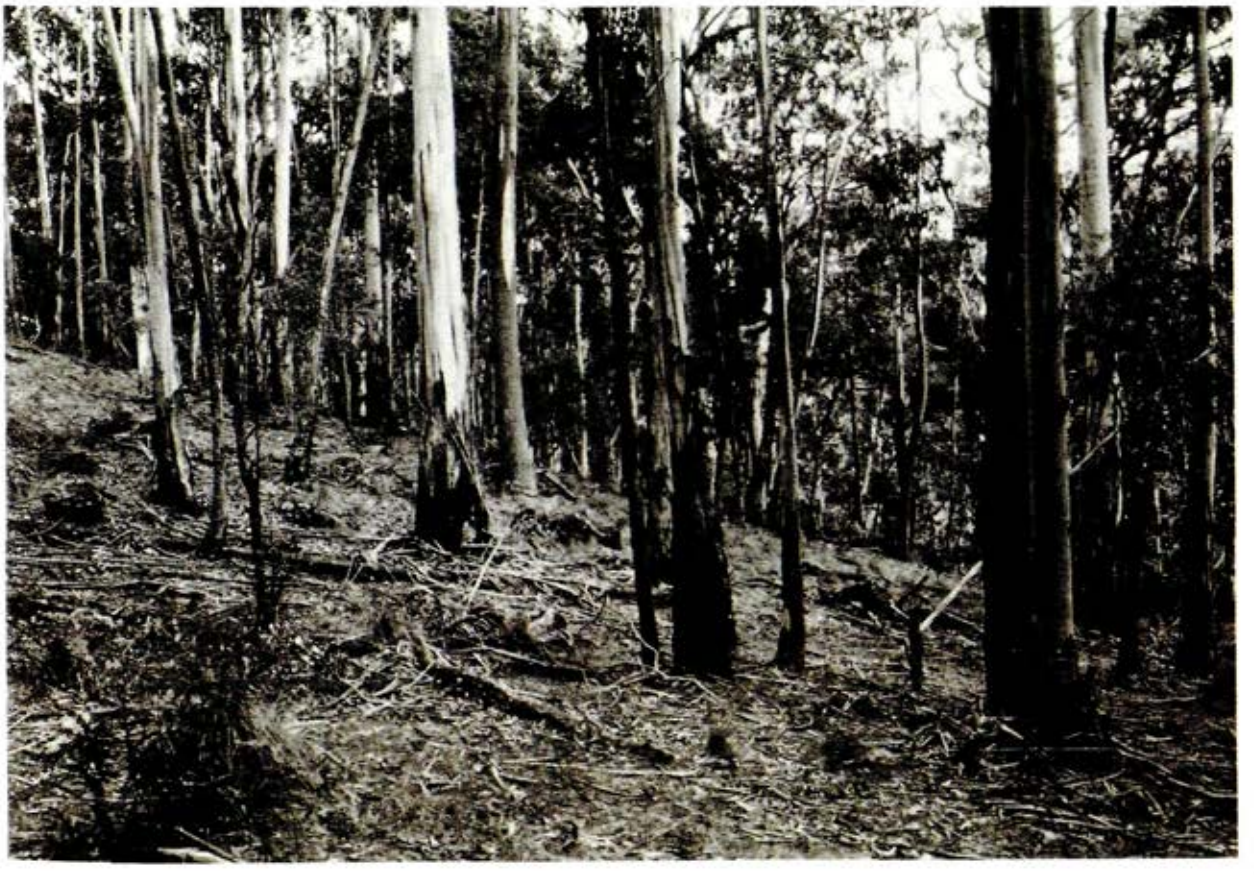
Its shrub layer has quite variable density and species composition but normally includes prickly tea-tree (*Leptospermum continentale*), golden bush-pea (*Pultenaea gunnii*), wiry bauera (*Bauera rubioides*), bushy hakea (*Hakea sericea*), common heath (*Epacris impressa*), and broom spurge (*Amperea xiphoclada*). Patches of hairpin banksia (*Banksia spinulosa*) are common.

The ground layer features forest wire-grass, austral bracken, thatch saw-sedge (*Gahnia radula*), blue dampiera (*Dampiera stricta*), small grass-tree (*Xanthorrhoea minor*), and trailing goodenia (*Goodenia lanata*).

Heathy foothill forest frequently occurs in conjunction with heathy woodland, wet heathland, and swamp heathland (see below).

Valley forest

This community is restricted to the lower slopes and valleys of the foothill country to



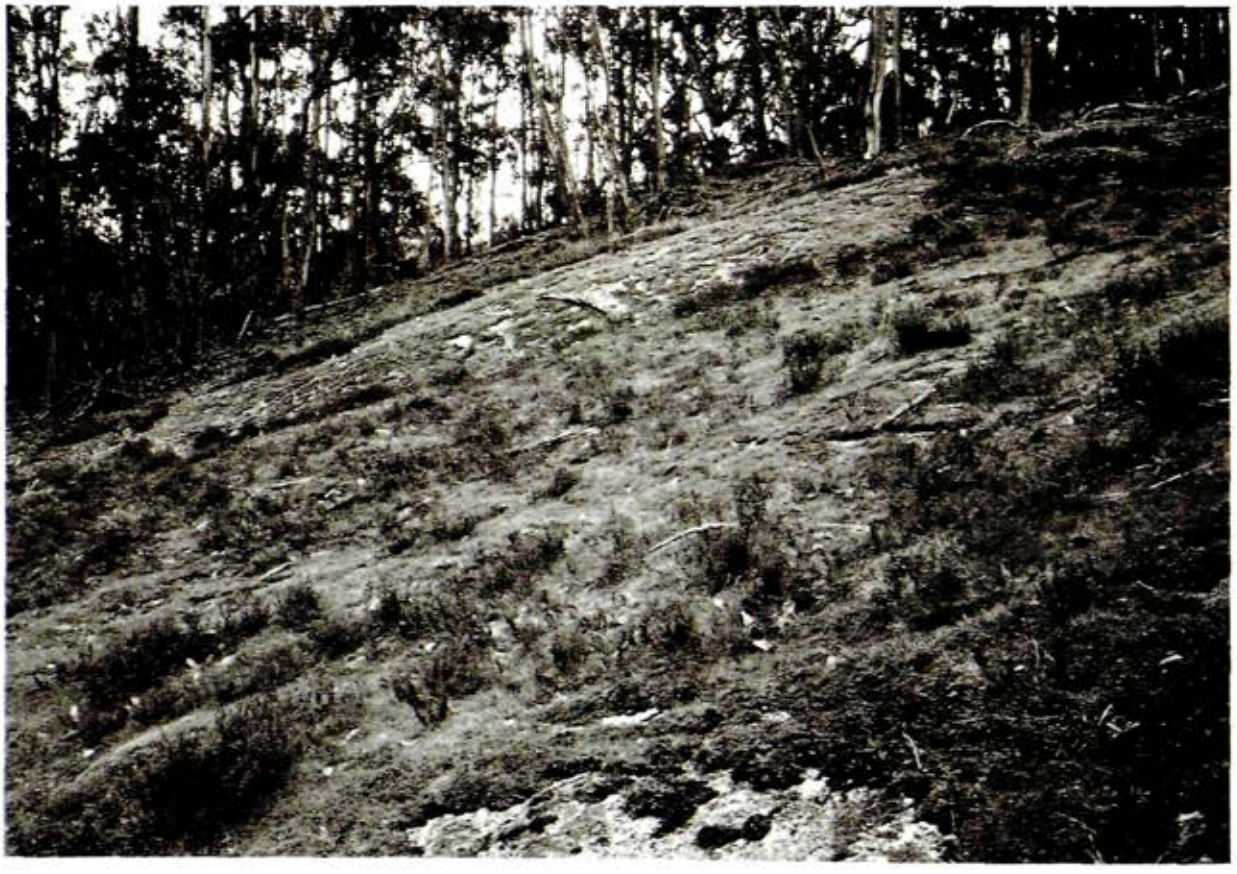
Herb-rich foothill forest

the north-east of Melbourne, usually on acidic duplex soils and on southerly aspects.

Its overstorey is dominated by a mixture of red box (*Eucalyptus polyanthemos*), red stringybark (*E. macrorhyncha*), long-leaf box (*E. goniocalyx*), and yellow box (*E. melliodora*). In low-lying sites, often adjacent to seasonally inundated areas, swamp gum may be present.

The shrub layer tends to be rather sparse, often comprising a scattering of burgan (*Kunzea ericoides*), cherry ballart (*Exocarpos cupressiformis*), black wattle (*Acacia mearnsii*), sweet bursaria (*Bursaria spinosa*), and common cassinia. Sweet pittosporum (*Pittosporum undulatum*), although possibly indigenous to the study area, is an invasive environmental weed in this community. Also commonly present as a weed is monterey pine (*Pinus radiata*).

A rich array of native grasses and herbs occur in the low ground layer. Weeping grass, kangaroo grass (*Themeda triandra*), grey tussock-grass, and silvertop wallaby-grass (*Chionochloa pallida*) are common, in association with kidney-weed, common maidenhair (*Adiantum aethiopicum*), and ivy-leaf violet.



Granite outcrops in rocky outcrop shrubland

Heathy dry forest

Three localities within the study area - the Kinglake area, upper Goulburn Valley, and upper Thomson Valley - carry heathy dry forest. In most places, it tends to occur on shallow stony soils of low fertility, with poor water-retention capabilities. However, some sites around Kinglake appear to lie on the margins of acidic duplex soils, which may explain some floristic differences there.

Generally, heathy dry forest is dominated by a low canopy of broad-leaf peppermint. It may also include messmate, long-leaf box, and mealy stringybark near Kinglake or, in

the upper Thomson Valley, stunted mountain grey gum, silvertop, and yertchuk. In the upper Goulburn Valley, broad-leaf peppermint often occurs at higher elevations with candlebark, indicating the close links between this community and montane dry woodland. In fact, these two communities may intergrade for considerable distances on northerly slopes.

The understorey of heathy dry forest features a number of species of the Australian heath family, the Epacridaceae, including prickly broom-heath (*Monotoca scoparia*), common heath, daphne heath (*Brachyloma daphnoides*), and common beard-heath (*Leucopogon virgatus*).

In the Kinglake area, other understorey species include rosy baeckea (*Baeckea ramosissima*), wire rapier-sedge (*Lepidosperma semiteres*), austral grass-tree (*Xanthorrhoea australis*), the rare creeping grevillea (*Grevillea repens*), cat's claws grevillea (*G. alpina*), silver banksia (*Banksia marginata*), and bushy hakea.

In the upper Goulburn and Thomson Valleys, common species, in addition to the heaths mentioned above, include narrow-leaf bitter-pea (*Daviesia leptophylla*), gorse bitter-pea, and narrow-leaf wattle. (These legumes are prolific post-fire colonisers, producing large quantities of hard-coated seeds that remain in the soil. If fires occur too frequently in heathy dry forest, they may become dominant at the expense of the heaths.) Cluster-flower geebung (*Persoonia confertiflora*), dwarf geebung (*P. chamaepeuce*), heath milkwort (*Comesperma ericinum*), and common hovea (*Hovea linearis*) are also common here.

Throughout the range of heathy dry forest, silvertop wallaby-grass is a common, often dominant, member of the ground layer. Its dominance at some sites may reflect that the site has remained unburnt for a long period. Clearly, fire regimes are of great importance to the understorey species composition.

A number of vegetation communities are closely allied to heathy dry forest. Stands of vegetation intermediate between this and dry sclerophyll forest are common. The Coranderrk Aqueduct south of Healesville winds through vegetation intermediate between this and heathy woodland (see below).

Dry sclerophyll forest

This community occurs on relatively exposed aspects, often on moderately fertile acidic duplex soils. It is best developed in the hills to the north-east of Melbourne and in the foothills of the Goulburn Valley between Jamieson and Seymour.

Dry sclerophyll forest is dominated by the same suite of eucalypts as valley forest, with which it is often associated. These are red box, red stringybark, long-leaf box, and yellow box.

It has an open, grassy understorey rich in species. Commonly present are grey tussock-grass, silvertop wallaby-grass, Velvet wallaby-grass (*Danthonia pilosa*), plume-grasses (*Dichelachne* spp.), grey guinea-flower (*Hibbertia obtusifolia*), purple coral-pea (*Hardenbergia violacea*), stinking pennywort (*Hydrocotyle laxiflora*), blue pin-cushion (*Brunonia australis*), green rock-fern (*Cheilanthes austrotenuifolia*), cotton fireweed (*Senecio quadridentatus*), and common raspwort.

Some stands of dry sclerophyll forest have an unusual feature: dense thickets of burgan. These may form following a particular sequence of fire events and, once established, prevent the previously dominant eucalypts from regenerating. They are frequently associated with a rich orchid flora. Good examples occur in the Cathedral Range State Park. Burgan thickets may also occur with a suite of understorey species common to valley forest, especially in riparian or rocky gorge situations.

Dry sclerophyll forest is prone to invasion by a wide range of environmental weeds, particularly herbs and grasses. Fire frequency is likely to be quite high at sites supporting this community. If unburnt for long periods (more than 25 years), tussock grasses will tend to predominate.

Rocky outcrop shrubland

Rocky outcrops are frequently of botanical interest because they contain a range of microhabitats, from highly exposed rock-faces to damp, sheltered crevices.

Rather than being a consistent vegetation community, rocky outcrop shrubland

commonly includes a number of rock-adapted species, with a suite of those distinctly different from the surrounding vegetation that can tolerate the outcrop environment. For this reason, it is pertinent to discuss the vegetation of a number of prominent rocky outcrops in the study area separately. This is not a complete list, nor does it suggest any significance ranking.

Seven Acre Rock (in the headwaters of the Bunyip River) supports scattered mountain grey gum and silvertop, with lemon bottlebrush (*Callistemon pallidus*) and long-leaf wax-flower (*Eriostemon myoporoides*).

Ben Cairn, west of Mt Donna Buang, supports similar vegetation except that the dominant eucalypt is brown stringybark. Of note in this area is the stand of dwarf silver wattle (*Acacia nano-dealbata*) and the presence of alpine westringia (*Westringia senifolia*).

The Cathedral Range consists of a steeply uplifted sedimentary rock, which supports vegetation with affinities to the surrounding dry sclerophyll forest. Stunted examples of red stringybark, broad-leaf peppermint, and, rarely, snow gum occur along the crest. Common shrubs include round-leaf mint-bush (*Prostanthera rotundifolia*), fairy wax-flower (*Eriostemon verrucosus*), and lemon bottlebrush. The ground layer includes a wide range of grasses and herbs characteristic of dry forests.

Murchison/Strath Creek Falls (in the north of the Mt Disappointment State forest) has a broad, exposed rocky hillside to the east that supports a sparse shrubland of black wattle, clustered everlasting (*Helichrysum semipapposum*), kangaroo grass, and a variety of herbs of dry sites.

Outcrops of granite occur frequently along the slopes above the Goulburn River in the Yea--Seymour area. On protected sites, these carry a dense, low moss-bed or herbfield, which may be very species-rich.

Plains Vegetation

Plains vegetation occurs on the basalt plains immediately to the north of Melbourne, and on the alluvial plains of the Yarra, Goulburn, and Plenty Rivers. Most of these have a mean annual rainfall of 700 to 1000 mm, occurring predominantly in winter, with hot, dry summers being typical.

Soils vary substantially, ranging from grey clays, black clays, and shallow gradational soils derived from basalt to reddish calcareous duplex soils on alluvium.

Five communities and one community complex are included.

Box woodland

Within the study area, open, grassy woodland dominated by grey box (*E. microcarpa*) is restricted to the lower slopes and upper terraces of the Goulburn River. Around Alexandra, the best examples can be seen along road reserves. The relatively fertile soils there have led to a dramatic reduction in the extent of box woodland through clearing for agriculture. It is, however, widespread in northern and western Victoria.

A variant of this community that includes white box (*E. albens*), red box, and yellow box occurs sporadically along the Goulburn Valley from near Merton to Trawool. This variant has affinities with dry sclerophyll forest, and is reminiscent of dry forests of north-eastern Victoria.

The understorey of box woodland is dominated by wallaby-grasses (*Danthonia* spp.) and spear-grasses (*Stipa* spp.), with a scattering of hedge wattle (*Acacia paradoxa*).

Due to the fertility of the soils, a history of grazing, and proximity to agricultural land, stands of box woodland usually contain a suite of introduced grasses, herbs, and woody shrubs.

Plains grassy woodland

The most common components of this community are the grassy woodlands dominated by river red gum (*E. camaldulensis*), occurring on seasonally waterlogged clays and clay loams.

These soils may be alluvial, or derived from either sedimentary rock or basalt. Plains grassy woodland may occur on lower slopes or swampy river flats, from Cardinia Creek in the south-east to the Goulburn Valley in the north and the basalt plains around Wallan in the west.

A curious variant occurs in the Yan Yean catchment, where candlebark and a lowland ecotype of snow gum dominate a characteristic understorey.

Plains grassland

Dominated by kangaroo grass, plains grassland is a tussock grassland with a scattered and much depleted distribution, mostly on fertile, basalt-derived soils. It once occurred from Melbourne in the east to the Hamilton district in far south-western Victoria, but has largely been cleared or grossly modified for agriculture.

In addition to kangaroo grass, characteristic species include pink bindweed (*Convolvulus erubescens*), common bog-sedge (*Schoenus apogon*), lemon beauty-heads (*Calocephalus citreus*), sheep's burr (*Acaena echinata*), and common wallaby-grass (*Danthonia caespitosa*). The presence of a wide variety of environmental weeds, mainly grasses and herbs, is a feature of the remnants of this community.

It is important to note that kangaroo grass is widespread, being a characteristic species of several other vegetation communities. It should therefore not be assumed that all patches of kangaroo grass constitute plains grassland.

Plains grassland is restricted in the study area to isolated occurrences, mainly on private land around Somerton, on the outskirts of metropolitan Melbourne. It occurs on public land at Epping Cemetery.

Floodplain riparian woodland

The community comprises the woodland vegetation that typically occurs along the banks of the larger rivers of the study area, including the Goulburn, Yea, Acheron, and Yarra Rivers. It frequently occurs in conjunction with one or more floodplain wetland communities.

River red gum forms a tall, woodland canopy over a medium to tall shrub layer including silver wattle, tree violet (*Hymenanthera dentata*), river bottlebrush (*Callistemon sieberi*), and river tea-tree (*Leptospermum obovatum*). The ground layer features common tussock-grass (*Poa labillardieri*) on the drier, elevated banks, with club-sedges (*Isolepis* spp.), rushes (*Juncus* spp.), common reed, and water-ribbons (*Triglochin procera*) occupying the saturated or inundated soils at the water's edge.

Environmental weeds form a major component of this community in virtually all stands. Willows (*Salix* spp.) and a wide variety of pasture grasses are ubiquitous.

Grassy wetland

Small, seasonally flooded depressions on fertile, basalt-derived soils carry grassy wetland often as scattered patches among plains grassland. The dominant species include veined swamp wallaby-grass (*Amphibromus nervosus*), brown-back wallaby-grass (*Danthonia duttoniana*), common spike-sedge (*Eleocharis acuta*), small spike-sedge (*E. pusilla*), common tussock-grass, and Australian sweet-grass (*Glyceria australis*).

In the study area, this community is restricted to private land and rail reserves in the Wallan district, and in the headwaters of the Merri and Darebin Creek catchments.

Floodplain wetland complex

The following description of this complex should be considered as provisional. The completion of a current State-wide survey and classification of wetland vegetation will increase our understanding of this community.

Deep, permanent billabongs occur along the floodplains of the Yarra and Goulburn Rivers. Typically, they have a dense fringe of vegetation, but, due to the greater depth of water in the centre, tend to include open water. This open water may support a carpet of duckweed (*Lemna* spp.) and/or azolla (*Azolla* spp.). The fringing vegetation includes tall spike-sedge (*Eleocharis sphacelata*), milfoils (*Myriophyllum* spp.), water-ribbons, cumbungi (*Typha orientalis*), common reed, and rushes.

Shallow, seasonal billabongs that dry out in summer commonly support a herbfield including common spike-sedge, slender knotweed (*Persicaria decipiens*), lesser joyweed (*Alternanthera denticulata*), common blown-grass (*Agrostis avenacea*), and sneezeweeds (*Centipeda* spp.). They may dry out due to

the poorer water-holding capabilities of the clay substrate, or the lack of recharge. Within the study area, such billabongs occur along the Yarra and Goulburn Rivers.

Floodplain wet flats occur on river flats where the river-side levee-banks retain seepage or overflow. Characteristic vegetation includes common reed, marsh club-sedge (*Bolboschoenus medianus*), tassel sedge (*Carex fascicularis*), tall sedge, large bindweed (*Calystegia sepium*), and common tussock-grass.

Heathland Vegetation

Five vegetation communities comprise this category: heathy woodland, wet heathland, swamp heathland, sand heathland and coastal heathland. These all occupy flat or gently undulating areas, on soils of low natural fertility. Trees are usually stunted, often absent, while a dense layer of wiry shrubs is typical.

Heathy woodland

Gentle, north-facing, lower slopes around Gembrook, Tonimbuk, and Moondarra carry heathy woodland. Soils are commonly sandy at the surface, with a clay or coffee-rock impeding layer at some depth. They may be seasonally wet, but dry out in the summer.

A low woodland of narrow-leaf peppermint, mealy stringybark, messmate, and/or yertchuk overtops a shrub layer including hairpin banksia, bushy hakea, furze hakea (*Hakea ulicina*), dagger hakea (*H. teretifolia*), prickly tea-tree, and common heath.

The ground layer includes a number of grass species: wiry spear-grass (*Stipa muelleri*), kangaroo grass, and reed bent-grass (*Deyeuxia quadriseta*). Other ground layer species include thatch saw-sedge, common raspwort, and wattle mat-lily (*Lomandra filiformis*). Small grass-tree is also commonly present.

Wiry spear-grass dominates in some stands, presumably due to a combination of factors relating to fertility and fire frequency. Similarly, the absence of members of the proteaceae (hakeas and banksias) in some stands contrasts with their virtual dominance in others. These species, which rely on seed germination for post-fire regeneration, may be suppressed by frequent, low-intensity fires, which favour species that resprout from rhizomes (such as wiry spear-grass and thatch saw-sedge).

Wet heathland

This normally occurs in depressions or on lower slopes where soils are saturated for considerable periods of the year, possibly due to the impeding layer in the soil being much closer to the soil surface than is the case for heathy woodland. Species characteristic of wet heathland are therefore those that can tolerate saturated soils.

Mealy stringybark forms a stunted, scattered canopy in some stands, but is absent from others. Scented paperbark, yellow hakea (*Hakea nodosa*), prickly tea-tree, and pink swamp-heath (*Sprengelia incarnata*) form a dense shrub layer. In the ground layer, spreading rope-rush, hair-sedge (*Tetraria capillaris*), square twig-sedge (*Baumea tetragona*), pouched coral-fern (*Gleichenia dicarpa*), and swamp selaginella (*Selaginella uliginosa*) are prominent.

Wet heathland occurs around Bunyip, Hill End, Mt Tanjil, and Moondarra.

Swamp heathland

This tall heathland or scrub dominated by scented paperbark grows on drainage lines of deep, saturated siliceous sands, and is frequently associated with the outlets of wet heathlands.

Other characteristic species include rosemary everlasting (*Helichrysum rosmarinifolium*), red-fruit saw-sedge, soft water-fern (*Blechnum minus*), coral-ferns (*Gleichenia* spp.), centella (*Centella cordifolia*), tassel cord-rush (*Restio tetraphyllus*), and running marsh-flower (*Villarsia reniformis*).

Swamp heathland has significant floristic and structural affinities with low-elevation occurrences of riparian thicket.

Environmental differences segregate its scented-paperbark-dominated stands from swamp-paperbark-dominated swamp scrub. These centre on soils, with the former tending towards sands or sandy clays while the latter occurs on heavy clays.

Swamp heathland grows around Tonimbuk, Woori Yallock, and Moondarra.

Sand heathland

Deep, siliceous sands of low fertility, usually close to the coast, carry sand heathland, which typically has no tree layer. The dense shrub layer commonly includes prickly tea-tree, heath tea-tree (*Leptospermum myrsinoides*), prickly broom-heath (*Monotoca scoparia*), silver banksia, common aotus (*Aotus ericoides*), and common heath.

The ground layer features sand-hill sword-sedge (*Lepidosperma concavum*), thatch saw-sedge, austral grass-tree, and small grass-tree.

Where present, the tree layer comprises scattered coast manna gum (*Eucalyptus pryoriana*), and narrow-leaf peppermint. Sand heathland commonly occurs in conjunction with coastal grassy forest and coastal heathland.

Its largest occurrences are on French Island and the Mornington Peninsula.

Coastal heathland

This community occupies sites on deep sandy soils that remain wet for longer periods than those supporting sand heathland. Reflecting that, the dominant shrubs include scented paperbark, dwarf she-oak (*Allocasuarina pusilla*), scrub she-oak (*A. paludosa*), silver banksia, and prickly tea-tree.

The sedge-dominated understorey includes a number of species of bog-sedge (*Schoenus* spp.), sword-sedges (*Lepidosperma* spp.), thatch saw-sedge, small grass-tree, germander raspwort (*Gonocarpus teucrioides*), bordered panic (*Entolasia marginata*), and common flat-pea (*Platylobium obtusangulum*).

Within the study area, coastal heathland is largely restricted to French and Quail Islands, with isolated examples on the Mornington Peninsula and near Wonthaggi. Most constituent species regenerate readily after fire. However, Meredith (1988) suggests that an average fire interval of 15 to 20 years is most desirable from an ecological perspective, with 8 years as a minimum recommended fire-free period.

Coastal Vegetation

Coastal vegetation occurs around the two major bays, Port Phillip and Western Port, and along the exposed coastline of the Nepean and Mornington Peninsulas, Phillip Island, and the Kilcunda--Cape Paterson area.

A typically moderated maritime climate prevails, with rainfall spread evenly throughout the year and a very low incidence of frost or extremes of temperature. A major climatic factor affecting the vegetation is the action of strong, salt-laden winds, which occur throughout the year.

A wide variety of landforms support coastal vegetation within the study area, including rocky cliffs, sand dunes, sedimentary plains, and sunklands.

Soils range from calcareous sands of the dunes, through leached sands derived from older-marine and riverine deposits of the coastal plains, to acidic duplex soils. Black and grey clays also occur in swampy areas, such as the former Koo-Wee-Rup Swamp.

Seven communities are included.

Coastal grassy forest

A low forest to woodland occurs on flat or undulating areas, particularly on the Mornington Peninsula. Its constituent species suggest affinities with heathy woodland and dry sclerophyll forest, especially in the open, grassy understorey. The dominant trees are narrow-leaf peppermint and coastal manna gum, although swamp gum, messmate, and mealy stringybark occur frequently.

The shrub layer varies from quite dense to almost absent. Where present, it commonly contains black she-oak (*Allocasuarina littoralis*), prickly tea-tree, black wattle, hedge wattle, and cherry ballart.

The diverse ground layer includes semi-shrubs such as common heath, honey-pots (*Acrotriche serrulata*), and cranberry heath (*Astroloma humifusum*), as well as a range of grasses such as kangaroo grass, weeping grass, reed bent-grass, and tussock-grasses. Also represented in the ground layer is a suite of annually resprouting geophytes including greenhoods (*Pterostylis* spp.),

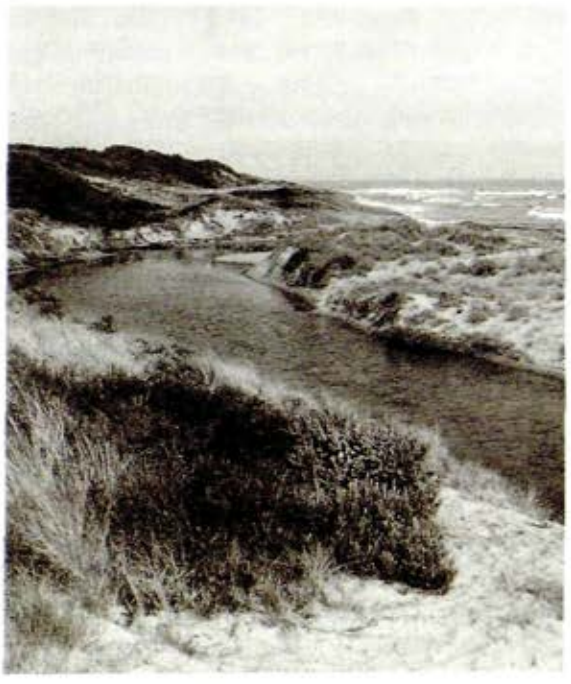
twining fringe-lily (*Thysanotus patersonii*), blue squill (*Chamaescilla corymbosa*), and chocolate-lily (*Dichopogon strictus*).

An apparent frequency of fire here has led in places to a predominance of austral bracken and thatch saw-sedge.

Coastal grassy forest appears to be prone to invasion by introduced species, particularly by shrubs and trees, such as sweet pittosporum, coast tea-tree, coast wattle, boneseed (*Chrysanthemoides monilifera*), mirror-bush (*Coprosma repens*), and myrtle-leaf milkwort (*Polygala myrtifolia*). Introduced climbers including common ivy (*Hedera helix*) and smilax asparagus (*Myrsiphyllum asparagoides*) are also commonly present.

Coastal dune scrub

This broad vegetation community includes a variety of floristic communities. It ranges from the low, sparse vegetation colonising the primary dune, continues across the crest into the dense scrub in the lee of the dune, and also includes the scrub occupying the limestone cliffs of the rocky shores. More detailed studies may result in the classification of some or all of these components as distinct communities.



Coastal dune scrub

Foredunes, immediately inland from the high-tide level, carry the first band of vegetation. It consists of the sand-stabilisers hairy spinifex (*Spinifex sericeus*) and the introduced marram grass (*Ammophila arenaria*), often with beach rocket (*Cakile maritima*), sea celery (*Apium prostratum*), and a groundsel (*Senecio spathulatus*).

Dune tops and low coastal bluffs, particularly along the southern coast of the Nepean and Mornington Peninsulas, support a wind-pruned scrub of a variety of woody shrubs such as coast everlasting (*Helichrysum paralium*), coast daisy-bush (*Olearia axillaris*), coast wattle (*Acacia sophorae*), white correa (*Correa alba*), sea box (*Alyxia buxifolia*), common boobialla (*Myoporum insulare*), coast tea-tree, cushion-bush (*Calocephalus brownii*), and coast beard-heath (*Leucopogon parviflorus*). The ground layer, commonly includes black-anther flax-lily (*Dianella revoluta* var. *brevicaulis*), blue tussock-grass (*Poa poiformis*), knobby club-sedge (*Isolepis nodosa*), coast sword-sedge (*Lepidosperma gladiatum*), and prickly spear-grass (*Stipa stipoides*).

Swales and secondary dunes carry a taller scrub dominated by coast tea-tree and coast beard-heath, on the inland side of the primary dune. The understorey of this scrub may be quite sparse, but commonly features bower spinach (*Tetragonia implexicoma*), seaberry saltbush (*Rhagodia candolleana*), and small-leaved clematis (*Clematis microphylla*). This vegetation is prone to invasion by species such as myrtle-leaf milkwort, smilax asparagus, and ivy groundsel (*Delairea odorata*).

Coast tea-tree (*Leptospermum laevigatum*) and coast wattle rapidly colonise disturbed areas, particularly on the inland side of their usual distribution. Stands of coastal banksia woodland (see below) have been significantly invaded and reduced in area by these species in association with a suite of introduced plants. Some studies have identified and described this association as a distinct vegetation community.

Moonah scrub forms another floristic unit within coastal dune scrub. The characteristic moonah (*Melaleuca lanceolata*) forms a tall scrub to 10 m. This floristic community currently has a disjunct distribution, which correlates with neutral or alkaline soils,

whether derived from basalt or limestone. Invasion by coast tea-tree and coast beard-heath has reduced its extent. There are scattered occurrences on Phillip Island and the Mornington Peninsula.

Coastal banksia woodland

Although it has a scattered distribution in coastal areas throughout eastern Victoria, coastal banksia woodland has been substantially depleted in the study area by housing and resort development. The coastline of Port Phillip Bay once supported extensive stands, but today it occupies relatively protected sites on old dunes where some organic matter has accumulated in the upper layers of the soil.

Floristically, coastal banksia woodland is related to the scrub of the swales and secondary dunes, where coast tea-tree dominates with the addition of a tall woodland overstorey of coast banksia (*Banksia integrifolia*) and coast manna gum. Once again, the shrub and ground layer include many introduced species such as boneseed, myrtle-leaf milkwort, veldt grasses (*Ehrharta* spp.), hare's tails (*Lagurus ovatus*), soursob (*Oxalis pescaprae*), and smilax asparagus. Frequent disturbance may also lead to austral bracken becoming very dense in the ground layer.

As previously stated, coastal banksia woodland is being displaced in many areas by coastal dune scrub. This may be related to the increased incidence of fire and other disturbance since human settlement, although this trend has been shown to occur also in areas with a long-term absence of these disturbances (McMahon *et al.* 1987).

Coastal tussock grassland

An open tussock grassland occurs on the exposed cliff tops on the southern coast of Phillip Island. Blue-tussock grass dominates the ground layer, with cushion-bush as the only characteristic woody shrub. Other characteristic species include bidgee-widgee, knobby club-sedge, and black-anther flax-lily.

This community is at the margins of its distribution in the study area, being more extensively represented elsewhere, particularly on the islands of Bass Strait.

Coastal salt-marsh

Like coastal dune scrub, coastal salt-marsh is a broad vegetation community that contains distinct floristic communities as bands or zones in the same location, although not all of the five are necessarily present. It occurs on and immediately above marine and estuarine tidal flats. The main factor affecting the vegetation, and to some extent determining the positioning of the various floristic communities, is the saline environment.

White mangrove (*Avicennia marina*), which forms a distinctive scrub, dominates the most seaward band, where present. Notable occurrences in the study area include Quail Island and the Tooradin area, both in northern Western Port Bay. A variety of marine and estuarine algae may be associated with it.

In the littoral salt-marsh, beaded glasswort (*Sarcocornia quinqueflora*) forms a herbfield on the landward side of mangrove. This succulent herb may occur in pure stands, or in association with austral seablite (*Suaeda australis*) and creeping brookweed (*Samolus repens*). It appears to be well-adapted to the saline conditions, shifting substrate, and the volume of seagrass and seaweed detritus that accumulates at the high-tide level.

Shrubby glasswort (*Sclerostegia arbuscula*) dominates a low shrubland on the landward side of the littoral salt-marsh zone. It too may occur in pure stands or with some or all of the following species: Australian salt-grass (*Distichlis distichophylla*), prickly spear-grass, trailing hemichroa (*Hemichroa pentandra*), austral seablite, beaded glasswort, and creeping brookweed.

Mixed salt-marsh occupies the most landward and elevated zone. It comprises a varied association of species including streaked arrow-grass (*Triglochin striata*), Australian salt-grass, sea rush (*Juncus krausii*), prickly spear-grass, southern sea-heath (*Frankenia pauciflora*), salt angianthus (*Angianthus preissianus*), rounded noon-flower (*Disphyma crassifolium*), and shiny swamp-mat (*Selliera radicans*). The widespread salt-marsh species of beaded glasswort, shrubby glasswort, austral seablite, and creeping brookweed also frequently occur in this floristic community. The greater floristic