28 MAR 1995

SOUTH WESTERN REGION WATER MANAGEMENT STRATEGY

ENVIRONMENTAL ISSUES BARWON DOWNS GROUNDWATER

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October 1986

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METRES 0 500 1000 1500 2000 METRES

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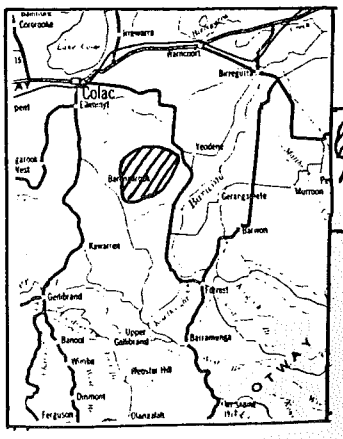
RECHARGE AREA WITHIN THESE BOUNDS


Colac
Warrnambool
Beeac
Yeodene
Gellibrand
Forrest
Barwon
Gerangamete
Murroon
Kawarren
Barongarook
Upper Gellibrand
Barramunga
Wimba
Beaufort Hill
Dinmont
Ferguson
Dunkeld
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BACKGROUND

BARWON DOWNS PUMPING PROJECT

The Barwon Downs wellfield is operated by the Geelong and District Water Board and forms one component in a combined surface and groundwater headworks system supplying the urban water requirement of Geelong and District.

The present development comprises four wells between 500 and 600 metres deep, a treatment plant and associated pumping facilities and a delivery pipeline.

Operation of the wellfield is subject to a licence issued by the Rural Water Commission. The licence limits the permissible extraction volumes from the aquifer to 12 600 ML in one year and 80 000 ML over 10 years.

The Geelong and District Water Board propose to place the wellfield into operation to maximise the system yield and to obtain data from which the safe extraction rates may be determined with greater confidence. The objective of this test pumping program is to obtain data to quantify the permissible short and long term extraction rates from the aquifer and thereby to:

(a) prove the viability of the existing development
(b) assess the capacity for futher development
(c) review and, if necessary, revise the wellfield licence conditions.

The prime consideration in the assessment of the test results shall be the likely impact upon:

(a) Users of the aquifer including both the Geelong and District Water Board and private users
(b) Users of surface water
(c) The environment.

This report relates to the third consideration.

PROJECT BRIEF

"ENVIRONMENTAL ISSUES - BARWON DOWNS GROUNDWATER
PROJECT BRIEF 16th SEPTEMBER 1986

1. OBJECTIVE

Develop a program to clarify the environmental issues relevant to groundwater investigations in the Barwon Downs area and assist in directing the establishment of the appropriate monitoring program.

2. METHOD

2.1 Prepare a draft paper with the following sections:

- A review of the environmental issues relevant to pumping and recharge of groundwater in the Barwon Downs area and the values associated with those issues.
- A discussion of study options and a draft program.
- Recommendations on ways of undertaking the program.

2.2 Present the draft paper to Working Group 2 of the South-Western Region Task Force.

2.3 Prepare a final paper taking into account suggestions and additional information provided by working Group 2.

2.4 Assist with directing the establishment of the environmental study program.

3. TIME

Draft paper to be ready for consideration by Working Group 2 in late October 1986. Study program to be established following acceptance of recommendations.

4. PERSONNEL

Project officer - Q. Farmar-Bowers, Rural Water Commission.
Supervisor - R. M. Bugeja, Department of Water Resources."

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Telephone (03) 508 2222

Direct Dial (03) 508 2572

Your Reference:
Our Reference : 85/3252

27 November, 1986

Mr R.M. Bugeja
Department of Water Resources
590 Orrong Road
ARMADALE 3143

Dear Reg,

"ENVIRONMENTAL ISSUES - BARWON DOWNS GROUNDWATER"

Attached is the final paper for the task "Environmental Issues - Barwon Downs Groundwater". I have taken account of the suggestions made by Working Group 2. This now completes the initial part of the objective of the task. In achieving this I have taken a total of 21 days.

The second part of the objective is to "assist in directing the establishment of the appropriate monitoring programme". I am keen to proceed with this and presume that this will be possible once the recommendations in my paper have been reviewed. When it is convenient, I should like to discuss with you how this second part of the objective can be achieved.

Yours sincerely,

QUENTIN FARMAR-BOWERS
bddllhs6

Telex WATERCO AA 30739 Facsimile (03) 508 2686 Ausdoc DX 21

SUMMARY

1 IMPACT OF BARWON DOWNS SCHEME

Extraction of groundwater from the Barwon Downs borefield could draw down groundwater levels in the Barongarook area. This may adversely affect riparian vegetation, vegetation associated with swamps and springs and some forest adjacent to these areas. Forest and woodland on higher terrain will not be affected. Perched water tables and variability in soils could mask the response of vegetation to lower groundwater levels. Lower groundwater levels may also reduce the flows in Boundary Creek.

2 IMPACTS OF ARTIFICIAL RECHARGE SCHEME

Schemes to artificially recharge the groundwater system in the Barongarook area could damage riparian vegetation at the works sites and downstream. Flows in Boundary Creek will be greatly reduced and concomitantly aquatic habitat will be altered. Reduced flows could also have an impact on the Barwon River below the junction of Boundary Creek.

3 DESCRIPTION OF RECHARGE AREA

3.1 Tenure

Most of the land is freehold. The public land is uncommitted.

3.2 Productivity of area

The area has low agricultural and timber production values. Soil fertility is low and some low lying areas are often waterlogged.

3.3 Vegetation

The flora and fauna of the area is not well studied. Some broad scale information is available. Better sites support open forest II (15-28 metres) while the majority is open forest I (less than 15 metres) and woodland. The area seems to be rich in plant species. The principal trees are peppermints, messmate stringybark and manna gum. Fuel reduction burning is conducted on a 10 year rotation.

3.4 Fauna

The fish fauna of Boundary Creek has been sampled once and appears to be similar to other tributaries on Barwon River. A survey of ground dwelling mammals suggested that these animals were in low abundance. There is information on the occurrence of 22 mammal species in the general area.

3.5 Landscape

The Visual Management System (C.F.L.) places most of the area likely to be impacted into zones "A" and "B". The Management objectives for these zone range from change being visually inevident to being visually dominant but the visual dominance should not exceed two years.

3.6 Recreation

The area provides a number of opportunities of recreational activity based on open forest and woodland that appear to have high floristic diversity. The area's potential for recreation is not fully utilized at present.

4 PROPOSED STUDIES

4.1 Vegetation Mapping (estimated 45 man days)

* Structure and floristic mapping to define the vegetation that has developed with an interaction with groundwater.
* Establish permanent plots to monitor vegetation changes.

4.2 Fauna (estimated 50 man days)

* Possible minimum stream flow study (to identify a flow regime which would maintain an agreed percentage of aquatic habitat)
* Field survey of mammals, reptiles and frogs in the areas likely to be affected by the proposal.

4.3 Water Quality Modelling (estimated 15 man days)

* Use Rural Water Commission's water quality model to determine the effect of reduced flows in Boundary Creek on the water quality of the Barwon River.

4.4 Landscape (estimated 5 man days for V.M.S. or 35 man days for alternative)

* Extension of existing Visual Management System

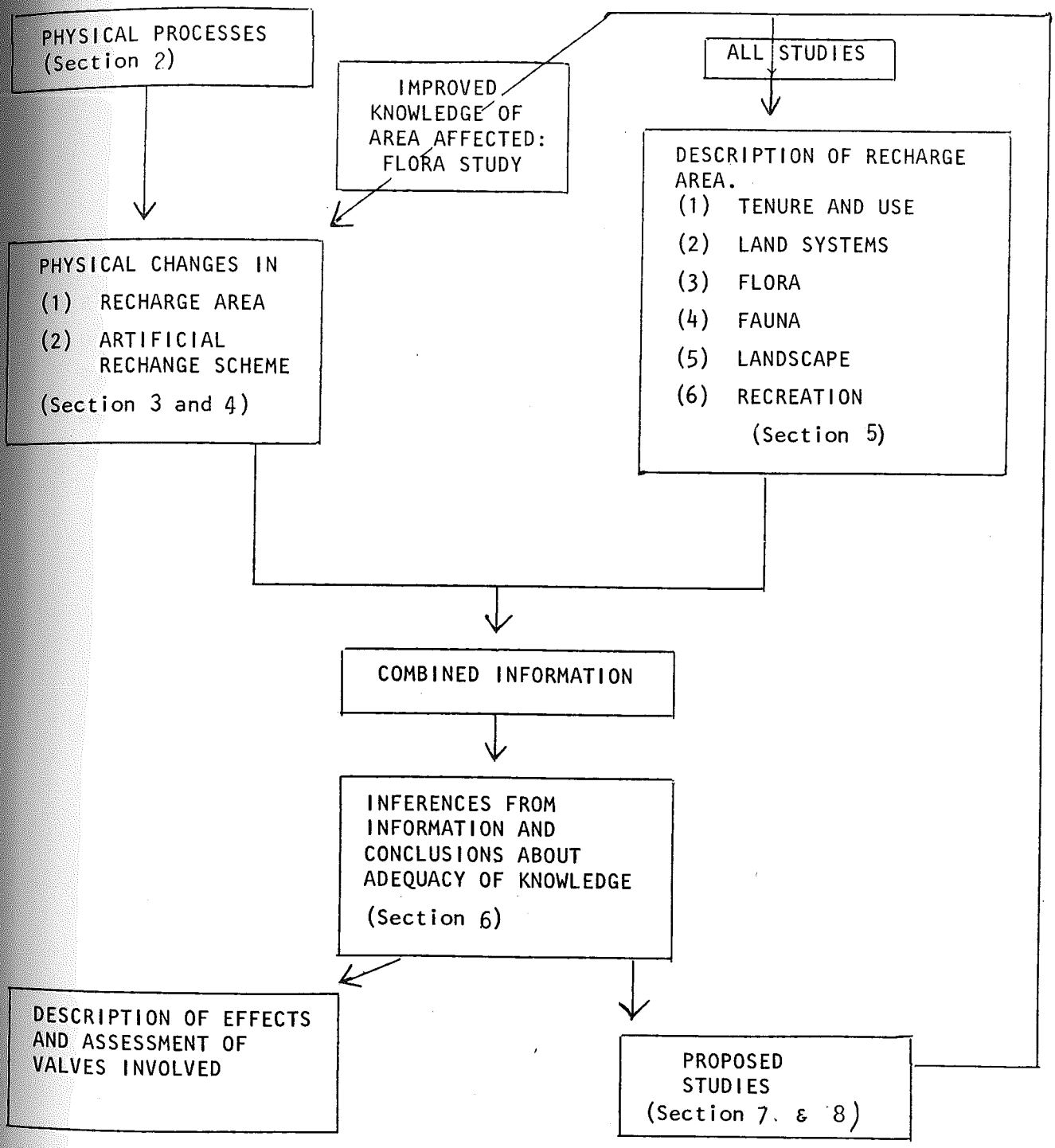
and/or

* Apply the scenic assessment of rivers procedure. (But only justified if needed for other purposes)

5 IMPLEMENTATION OPTIONS

* Vegetation work can be done by other government agencies.
* Fauna work may have to be done partly by consultants.
* Scenic assessment of rivers would have to be done by consultants.

REPORT STRUCTURE



ACKNOWLEDGEMENTS

A number of people have helped me with this project. I cannot thank them all by name here but the following have been especially helpful in providing information and comment: Prof. Tony Lee, Cambell Beardsell, Paul Gullen, Dr. Murray Littlejohn, Barry Tunbridge, Dr. Fred Neuman, John Leonard, Mike Sandford, Geof Bielby and Joe Hubbard. Thanks also to Dr. Jim Morris for the field work.

1. INTRODUCTION

1.1 REPORT LIMITS

This report is limited to identifying the environmental effects that may occur in the recharge area for the Barwon Downs groundwater project.

The recharge area has been identified by the Department of Industry, Technology and Resources and covers about 1100 ha adjacent to the middle reaches of Boundary Creek where the aquifer formations outcrop (J. Leonard, Pers. Com. 1986).

1.2 ENVIRONMENTAL INFORMATION FOR THE GROUNDWATER DEVELOPMENT DECISIONS

Groundwater is a "free reservoir" but one that is expensive to find and evaluate and quite expensive to use because of the pumping and water treatment costs. The high operating expense of using groundwater contrasted with the cost structure of surface storages where the operational expense is small and average cost per megalitre declines as use increases. The cost structure for groundwater use will probably influence the way the water resource is used within the Geelong supply system. Very likely it will continue to be used as a back up supply in drought periods rather than become part of the basic day to day supply. The way the resource is used will influence the nature and degree of many of the environmental impacts.

Money is only part of the cost of a project. Economists have to consider the full cost of any project. This includes money, social changes and environmental considerations. Normally many people, other than economists, will be involved in the decision process. Nevertheless, the formula they use has the following three parts.

A. Identify <u>all costs</u> and <u>all benefits</u> for the alternatives.
B Compare the alternatives.
C. Apply criteria developed independently to choose the most appropriate alternative (i.e. what is cheapest, fairest, easiest or politically smartest and so on).

There are lots of techniques that can be used to help in this selection process. None are easy to apply, Sinden (1980) reviewed the problem and it is referred to but not discussed in the Rural Water Commission Economic Evaluation Manual (RWC 1986).

For the Barwon Downs groundwater project the alternatives are probably surface water developments. More than likely the decisions could revolve around using marginally more groundwater or marginally more surface water.

The environmental information gathered for groundwater projects has to describe the effects of the projects involved but will be used to compare the environmental costs of using this groundwater resource with the environmental costs of alternative (surface) supplies. Probably the comparisons will be of incremental changes in use rather than comparisons of whole schemes. Using descriptions to choose between projects raised some difficulties, especially when the descriptions vary greatly in content and reliability. Surface water developments are likely to be quite well investigated, especially as much of the background information is already being researched on a regional basis for the South West Strategy. In addition, any new surface water projects would probably require the preparation of environmental effects statements and these can improve the knowledge of relevant systems in detail. Environmental information on groundwater needs to match this quality if it is going to be useful for comparative purposes in the future.

A substantial commitment has already been made to groundwater development at Barwon Downs. The environmental considerations only relate to the level of utilisation and further development of the aquifers. The kinds of questions that could come up in future are as follows.

(A) "How great do the environmental impacts need to become before the community would be better off switching to another water supply alternative?" or

(B) "By how much are different environmental values reduced by using "X" volume of groundwater as opposed to using "X" volume of surface water?"

These questions assume that the nature of environmental changes will be known and that cause/effect relationships have been established. I will return to the assumptions later on in this report because in some instances they are not valid.

Decisions on the further development of the Barwon Downs groundwater field may be a few years away, but preliminary decisions concerning that development may be taken within a year or two. In addition experience in pumping groundwater in the next year may lead to changes to the estimated money cost of using groundwater and this may influence the way groundwater could be used in the supply system for Geelong.

In these circumstances, high quality (reliable) comparative environmental information is going to be required.

1.3 TIMETABLE

The Barwon Downs borefield will be pumped at the maximum licenced rate for one to two years starting in the summer 1986/87.

Current environmental fieldwork is sampling the pre-test situation. Any additional work needing to examine the pre-test situation will have to be established this year because some environmental effects may become apparent within a few weeks of the commencement of pumping.

2. PROCESSES INVOLVED

2.1 AQUIFER SYSTEMS

The Barwon Downs borefield taps the Pebble Point, Dilwyn and Mepunga Formations located between 450 and 600 m below groundlevel. These formations outcrop at Barongarook.

The aquifers at Barwon Downs appear to be fully saturated at least in winter/spring and have an approximate through flow of 1600 ml per year. The water flowing through the system comes from surface infiltration in the outcrop areas and is probably discharged at the lower end of the aquifer beds where they outcrop below sea level off the coast.

The aquifers at Barwon Downs are probably linked in some way to other aquifers in the Tertiary Sediments that lie to the north of the Otway Range and run westwards to South Australia. For the purpose of this report I am assuming that the Barwon Downs aquifers form a more or less separate sub system.

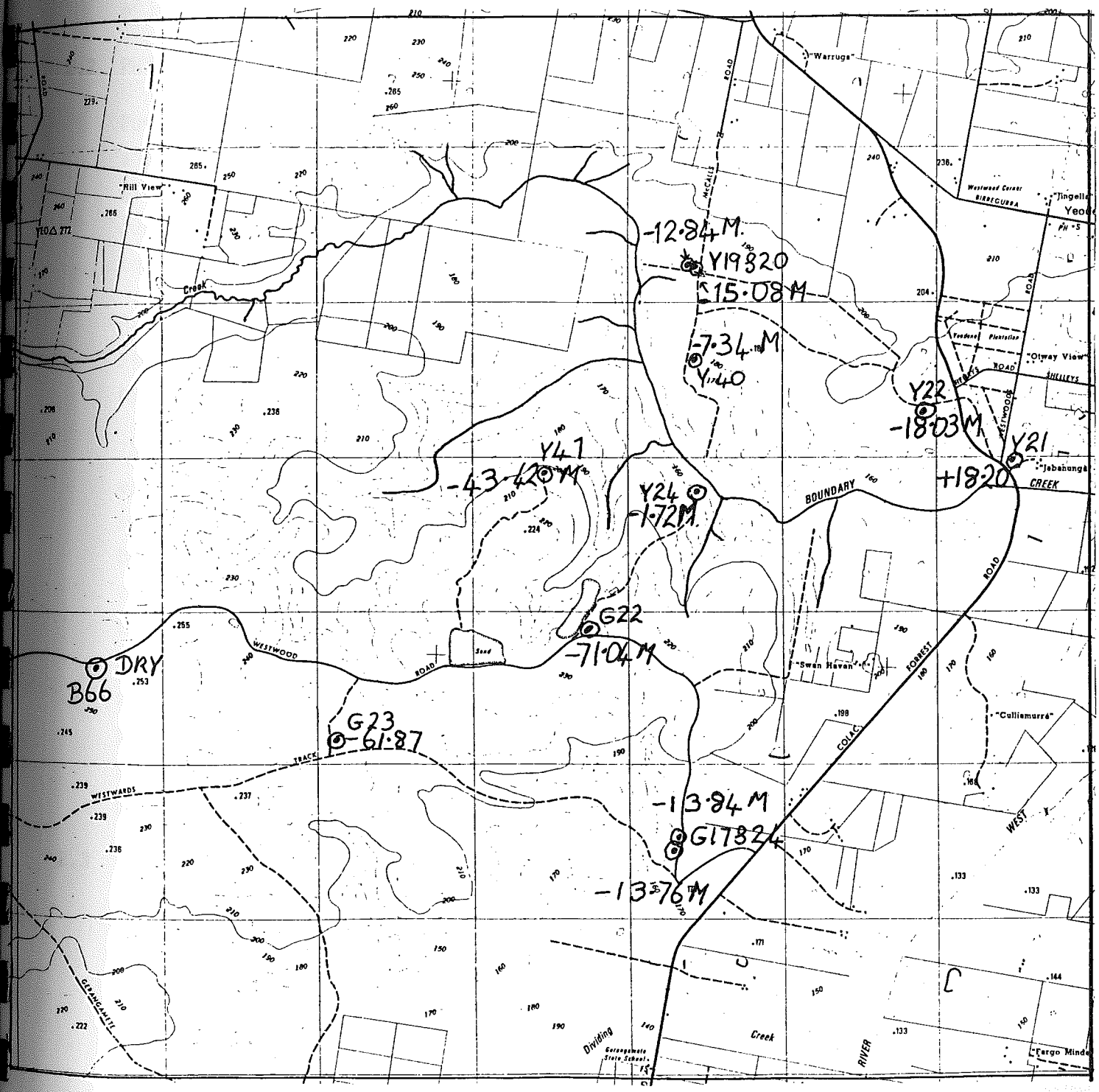
The Pebble Point, Dilwyn and Mepunga Formations outcrop near Boundary Creek and occupy about 1100 ha. This area is considered by D.I.T.R. to be the principal recharge area for the aquifers. Although these sediments also outcrop to the south, near Forrest, current information indicates that they are hydraulically separated from their equivalents in the Barwon Downs area by the Bambra Fault which may curtail large movements of groundwater. Goundwater movement in these aquifers will be studied further during the proposed long term pump test.

The average annual infiltration in the Boundary Creek area could be about 150 mm based on the estimated through-flow of 1600 ML derived from the whole recharge area.

In addition to the 1100 hectares identified as aquifer recharge area, it is probable that a proportion of soil water throughout the catchment infiltrates the sediments below and eventually reaches the aquifer system. Conversely in lower areas there may be some upward movement of water out of the aquifer. However, I assume that these volumes are trivial in the overall figures of water flowing through the aquifer.

MAP No 2

GROUND WATER LEVELS IN METRES BELOW LAND SURFACE



Groundwater levels in the recharge area are probably directly related to the aquifer system although there is the possibility of perched water tables. Currently water tables appear to be quite stable and there is little movement between seasons or years. (J. Leonard Pers. Com.).

Map 2 gives information on groundwater levels in the area adjacent to the middle reaches of Boundary Creek. The levels are taken from current (1986) readings of D.I.T.R. bores. They indicate that groundwater adjacent to the creek is artesian.

2.2 PHYSICAL CHANGES IN AQUIFERS CAUSED BY PUMPING

Pumping water out of the aquifer at Barwon Downs creates a potential for additional water to move from the soil into the aquifer. This potential will persist until the aquifer regains a saturation state equivalent to current (and former) levels, that is until it re-establishes its natural equilibrium.

As the natural through-flow is an estimated 1600 ML/year, pumping "X"Ml a year may create the potential for the 1600 ML through-flow to be increased by "X" Ml as a maximum per year.

There may be reasons for the increased inflow volume to be less than the volume pumped. For instance aquifer compaction may reduce the available storage volume in the sediments of the aquifer (estimates have been made by Evans 1986) or the normal replenishment processes may not be able to replace the volume pumped on an annual basis. The recharge area may be too small. Soil permeability may be too low or rainfall may not be adequate or evapotranspiration too great. Thus the natural groundwater replenishment rates may well be below the rate at which water will be pumped from the aquifer. This would lead to mining of the groundwater reserves. This mining may be temporary or permanent depending upon the pumping regime and the aquifer recharge rate.

2.3 TIME AND RAINFALL VARIATIONS

Pumping rates substantially greater than the estimated average aquifer throughflow (1600 ML/year) will probably create a deficit. The environmental effects related to reduced surface water and a higher rate

of deep seepage will persist until the deficit is removed and the aquifer system returns to the current saturated state.

However if the deficit period is substantial some of the environmental changes will have become entrenched and will not easily reverse.

The environmental changes are related to a physical change that to a degree probably occur naturally from time to time as a result of rainfall variability. A substantial and long period of low rainfall could result in loss of surface water and lowered water tables. Table 1 provides some information on rainfall and Figure 1 shows the frequency of annual rainfall over the last 80+ years.

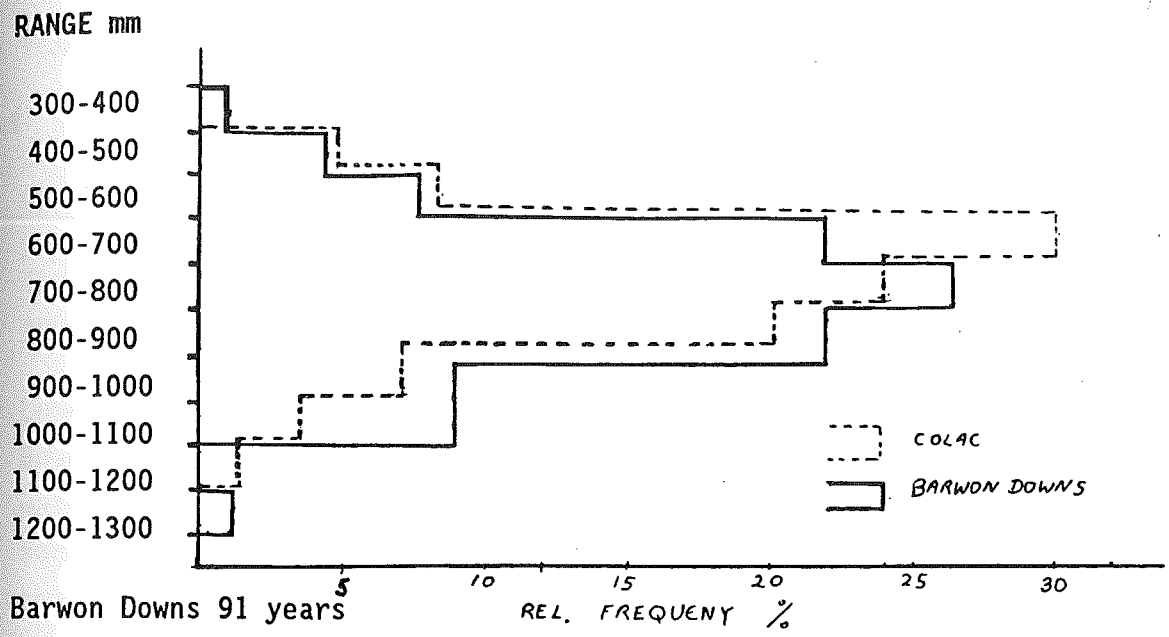
Reduced surface water and lowering of water tables as a result of aquifer pumping would be an additive effect to the natural variability. The pumping of the Barwon Downs wellfield is likely to create changes in groundwater levels of the order of 25 to 50 metres at the site and would be well beyond that exhibited naturally (L. Barrow, Pers. Com. 1986). Aquifer pumping during droughts, as is proposed, would tend to exacerbate the effect of natural variation by extending the effects of drought.

The environmental changes that occur as a result of the groundwater extraction will depend to some extent on the resilience of the ecosystems being affected.

TABLE 1 RAINFALL BARWON DOWNS AND COLAC

	ANNUAL RAINFALL		MM	
Station & years of records	Maximum mm	Minimum	Mean	Standard Deviation
Barwon Downs 1889-1985 (91 complete)	1,207	393	771	158
Colac 1898-1984 (83 complete)	1,143	448	740	140

FIGURE 1 FREQUENCY DISTRIBUTION OF ANNUAL RAINFALL TOTALS



Barwon Downs 91 years
Colac 83 years

A description of droughts in Victoria is given in Gibbs and Maher (1967). Eleven major droughts occurred between 1865-1965. Rainfall occurrences do not form a cyclic pattern but meteorological trends tend to persist; the average length of runs (say low rainfall) tend to be greater than would be expected in a random series. From this information it appears that the vegetation has been able to develop with a substantial degree of rainfall variability. This resilience may greatly delay the response of the vegetation to falling groundwater levels.

3. ENVIRONMENTAL EFFECTS: BARWON DOWNS GROUNDWATER PUMPING

3.1 FLORA

3.1.1 Recharge Area:

The effects can be grouped into three areas as follows:

The recharge area is hilly. The higher areas are well above the "Regional" groundwater table. They would not be affected by the program.

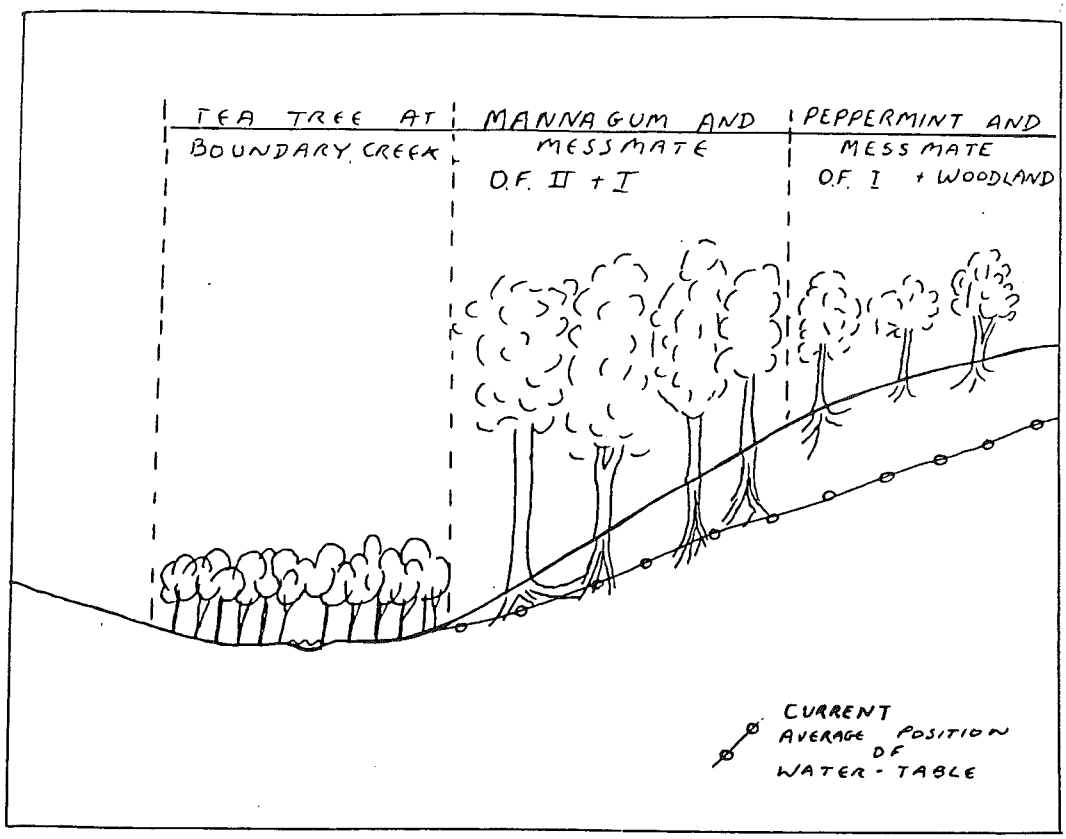
Lower areas in the topography are influenced by groundwater. Near Boundary Creek water is released from the water table forming springs and waterlogged areas at least during winter and spring. These areas support forms of vegetation that cope with the periodically (or constantly) wet conditions. These areas would be affected by a fall in ground water level. In the extreme, the existing vegetation (and animals that use it) would be replaced by other vegetation more able to utilize the new drier conditions. This change may occur quite rapidly perhaps within a few years.

Between these two zones is an intermediate area where the water table comes within the rooting zone of at least some of the vegetation some of the time. This rooting zone can extend to 25 m in some circumstances (see Morris appendix AI).

Figure 2 shows this situation diagramatically.

The vegetation responds to the increased water availability in the intermediate area. The tree height tends to increase and there is a change in species composition. For example manna gum occurs in these areas.

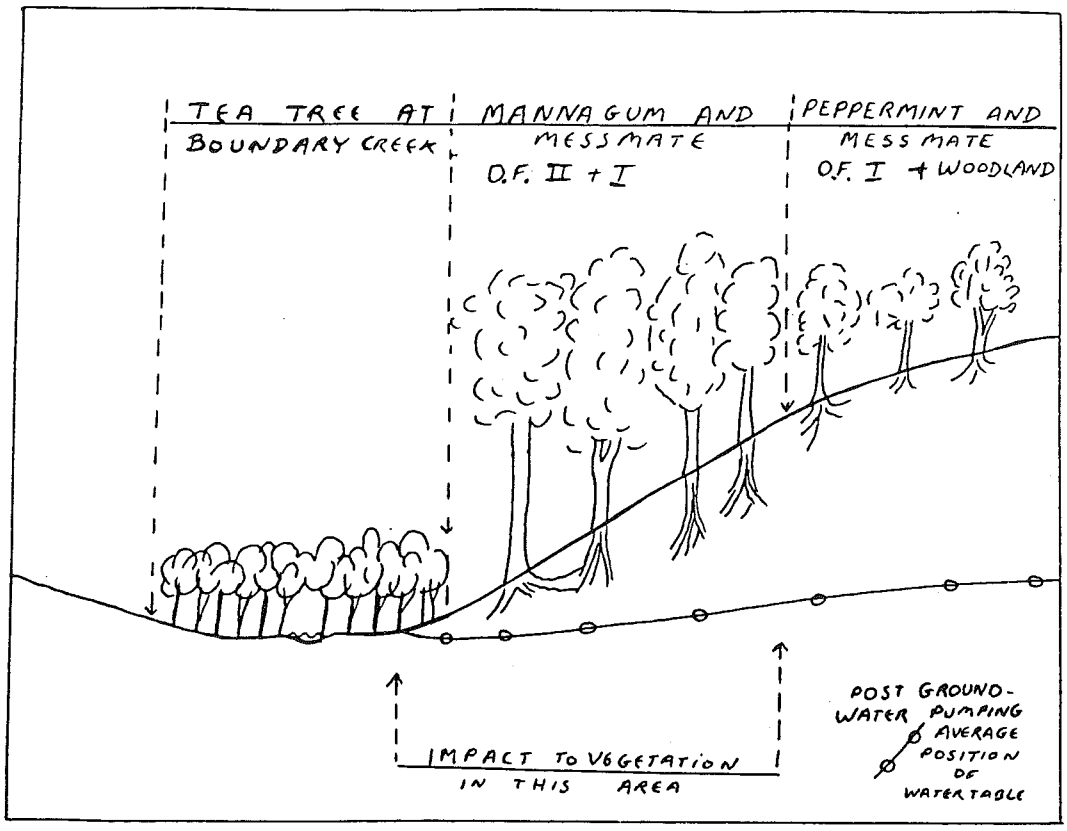
FIGURE 2 DIAGRAM OF GROUNDWATER-VEGETATION RELATIONSHIP CURRENT SITUATION



In addition to the water table it is possible that there may be higher soil fertility in this area. The higher soil fertility may be due to a number of related factors. For example improved vegetation growth would tend to increase the organic content of the soil. Good vegetation cover would tend to reduce soil erosion and so lead to increased soil depth. High water tables may reduce nutrient leaching.

Figure 3 illustrates diagramatically the areas in which change could occur if ground water level fell for a very substantial period.

FIGURE 3 DIAGRAM OF GROUNDWATER VEGETATION RELATIONSHIP
- POSSIBLE FUTURE SITUATION.



In summary the changes in the intermediate area could be:

(A) Slight loss in tree growth at higher elevations where only the deepest roots reach the groundwater.

(B) Loss of the vigour in areas where trees make regular use of high groundwater levels. This could result in lower growth, increased insect and pathogen attack, gradual change in species composition as trees die and are replaced.

(C) Increased leaching of soil nutrients.

(D) Lower strata of the vegetation (shrubs and ground cover) may also change in response to different tree cover and edaphic changes (especially soil moisture).

The changes in the intermediate area may occur slowly because of the resilience of the vegetation to natural climate variability. The change may be masked for some time by above average rainfall or change in insect infestation. On the other hand drought may speed the changes. It is probable that the drier vegetation may marginally increase the fire hazard or perhaps it may slightly increase the intensity of a fire. It may be that fire could be the agent to effect changes in species composition once new drier soil conditions are established. Without fire the changes may occur quite slowly, perhaps over a decade or so.

3.1.1.1 Complications

Perched water tables may complicate the response considerably. Some parts of the forest pond water for days after rain indicating that infiltration rates are, in some areas, very low. Perched water tables and soil variability could confound a simple monitoring program.

3.1.2 Surface Water

Boundary Creek is the main body of surface water. Most of the creek runs through agricultural land where it is confined or channelised. Tea-tree areas tend to be swampy. Most of the catchment is in outcropping Dilwyn formation but only a small part of this is the Barwon Downs aquifer recharge area as defined by D.I.T.R. It may be that run off will be little affected by the pumping program in the upper reaches of the creek.

Seepage entering Boundary Creek from the recharge area would probably stop with prolonged pumping and some infiltration from the creek to groundwater may occur where the creek flows through the recharge area. In other words, creek flow may decline as it passes through the research area rather than increase as it does now. The view currently held in D.I.T.R. is that infiltration from the creek bed to the aquifer as a result of lowering the water table may be significant (J. Leonard, Pers. Com. 1986).

Some of the Riparian area is swamp with fine mud, rich in organic matter. This material is several meters deep and might tend to reduce infiltration rates by sealing the stream bed against water loss. The dense swamp

vegetation prevents flood flows scouring the bed and banks of the creek. Infiltration may be higher where the creek is channelised.

Existing dams and tanks in the area are unlikely to be affected because of the sealing layers of fine organic rich sediments normally deposited. However, springs that feed dams may be affected.

Swampy areas above the creek where springs occur are likely to dry. These wet areas may not be perennial but information from the R.W.C. Spring Survey suggests that at least some may flow all year.

Overland flows during storms may be little affected. It is difficult to know how much overland flows occurs but some tracks have gully erosion. Overall, the rolling, hilly terrain suggests that it may not be significant. (Soil water moving down hill becomes over land flow when it reaches the saturated zone adjacent to the creek. This saturated zone may shrink in size).

There would appear to be some concern that creek flows would diminish especially during droughts when normal flows are very low. However, during wet periods, creek flows could remain normal.

Riparian vegetation in the recharge area and aquatic vegetation at spring and swampy areas, may be affected as these areas dry.

3.2 FAUNAL HABITAT

3.2.1 Recharge Area

The changing vegetation structure and species composition would probably lead to some changes in the value of the area as faunal habitat.

In most of the area, the change may be gradual, one habitat being replaced by another, however in the wetter areas, (riparian zones adjacent to springs and wet areas), the change may be quite rapid.

The change would be from a less common habitat (wet area) towards a drier habitat type. Whether this is important will be discussed in section below.

3.2.2 Surface Water

Lowering the watertable below the stream stage in Boundary Creek may result in significant induced streambed infiltration. This could make a substantial difference to streamflows and would be most noticeable during periods of natural low flows. This creek may become dry in summer or in drought periods. Consequently, the aquatic habitat in the longer term may be substantially altered.

The riparian vegetation and vegetation adjacent to springs and swampy areas may regress in the recharge areas as the water supply dries up. This vegetation change will influence the kind of habitat available in part of Boundary Creek.

3.3 AGRICULTURAL ASPECTS

The groundwater project could have an effect on agriculture in the recharge area. Providing detailed estimates of this effect is not part of this study brief, but a general discussion is appropriate. Lowered regional water tables may effect groundwater near the soil surface and therefore effect crop growth and flow from springs.

The Rural Water Commission has a Spring Survey in the Boundary Creek and Kawarren areas. Eight springs are being investigated on a regular basis. These springs have been identified as supplying water for agricultural purposes (under the Groundwater Act). Four of the springs are in the upper/middle reaches of Boundary Creek. Three are probably upstream of the recharge area for the Barwon Downs borefield.

TABLE 2 SPRING WATER QUALITY

DATE	ELECTRICAL CONDUCTIVITY Spring No.:			
	5	6	7	8
20. 2.86	1 600	1 000	330	560
22.11.85	490	400	280	N/A
14. 8.85	340	280	260	N/A

Table 2 provides information of the salinity of the spring water. The salinity increases during summer. The information on the water flow from the springs is poor but from the comments on the file, it appears that water flow is much reduced in summer. The increasing salinity suggests that some process is tending to concentrate the salt. This process could be evapostranspiration. It it is, it would indicate that the springs are not backed by substantial aquifers but could be relatively small and shallow.

In addition to the four springs identified in this project there are probably others currently not used and not licenced under the Groundwater Act, but nevertheless, of potential agricultural value.

There are other springs or seep areas within the Boundary Creek valley, that could be affected if groundwater levels in the area fall. These springs are not necessarily on the aquifer formations.

A fuller account of the potential agricultural effects could be obtained from an agricultural specialist familiar with the farming systems and businesses in the area.

4. ENVIRONMENTAL IMPACTS : ARTIFICIAL RECHARGE

4.1 SITE

At present the area occupied by the pre-pilot test site is small. However, the pilot project and final project would involve much more extensive work. In summary, the project would involve road construction, power line installation, canal or pond construction, maintenance facilities and provision for some form of pond or canal scouring and dump for the scoured material. The canals or ponds may be located close to the creek (other things being equal) to reduce pumping costs or allow for gravity flow. The sites for these works have not been finalised.

4.1.1 Archaeology

Creek and river valleys have high archaeological potential in this area (Presland - 1982). The area would need to be inspected prior to any earthworks by the Victorian Archaeological Survey. The recent dam failure on Boundary Creek and consequent sedimentation may have obscured surface sites in part of the creek valley.

4.1.2 Vegetation

Depending on the sites chosen there may be a loss of forest and riparian vegetation.

4.2 BOUNDARY CREEK

There are three aspects to the creek. The first is the water flow in the creek itself and its habitat value, second is the riparian vegetation the creek supports, especially the tea tree swamp down stream. Third is the contribution Boundary Creek makes to the low summer flows in the Barwon River.

Although a scheme has not yet been finalised, it is possible that 2,000 ML per year could be diverted out of the creek. Such a proposal would alter the flow regime of the creek substantially.

Table 3 shows mean daily flows in Boundary Creek on a monthly basis (1979-85).

Figure 4 shows the natural flow for the previous years and a line indicating 5.5 ML which would be the average daily diversion. Clearly the majority of the diversion would have to occur in winter and spring. The current concept is to use around 20 ML a day for the artificial recharge scheme when the water is available.

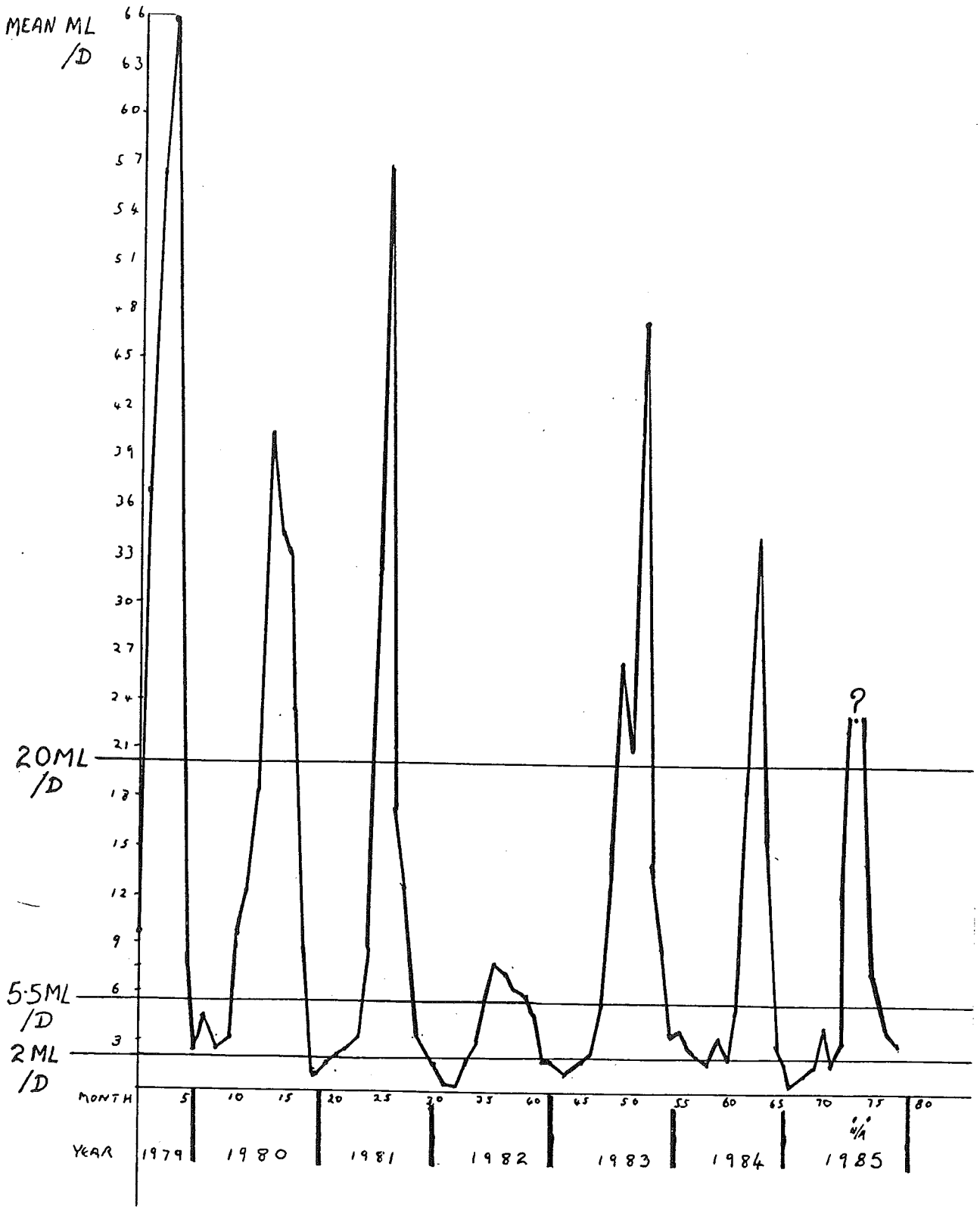
TABLE 3 MEAN FLOW IN BOUNDARY CREEK PER DAY IN ML: YEODENE STATION

YEAR	MONTH											
	1	2	3	4	5	6	7	8	9	10	11	12
1979	N/A	N/A	N/A	N/A	N/A	N/A	9.8	37	56	66	8.4	2.4
1980	4.5	2.5	3.3	9.7	12.1	18.6	41	34	33	23	8.6	3.5
1981	1.2	1.6	2.2	2.7	3.9	8.7	32	56	17.1	12.4	3.4	1.6
1982	1.1	0.8	2.0	3.0	5.8	7.8	7.2	6.2	5.9	4.6	2.8	2.8
1983	1.4	1.5	1.7	1.9	5.1	13.4	26	21	47	14.2	8.9	3.6
1984	3.8	2.9	2.2	1.6	3.3	2.0	4.7	18.8	34	15.5	2.9	1.6
1985	0.6	1.0	1.6	4.0	1.7	3.0	*N/A	*N/A	7.2	4.0	3.0	*N/A

* A number of flows occurred that were too large to be rated.

The proposal could substantially damage the riparian vegetation including the swamp vegetation downstream. If the moderate to high flows are reduced and plants tolerant of drier conditions are able to become established, the proposed diversion would tend to compound the effects of the Barwon Downs groundwater pumping.

FIGURE 4 BOUNDARY CREEK MEAN FLOW ML PER DAY



Summer flows in Boundary Creek are small, about 1 ML per day during dry periods. Nevertheless, they make a positive contribution to Barwon River flows. At present the minimum flow at Winchelsea is only 14 ML/day. If the Boundary Creek flow is lost an additional release from the West Barwon Dam may be required to compensate. The establishment of a minimum flow regime for Boundary Creek would probably protect summer flows but would be difficult to manage.

In formulating the details of the artificial recharge project the following environmental items should be resolved:

(A) A flow regime for Boundary Creek appropriate for its environmental values.

(B) Whether the riparian vegetation has sufficient value to warrant conservation and if so how this can be achieved within the project.

(C) An agreement on flow levels that would compensate for any reductions in the Barwon River system as a result of the loss of Boundary Creek flows (perhaps this may only be relevant in dry periods).

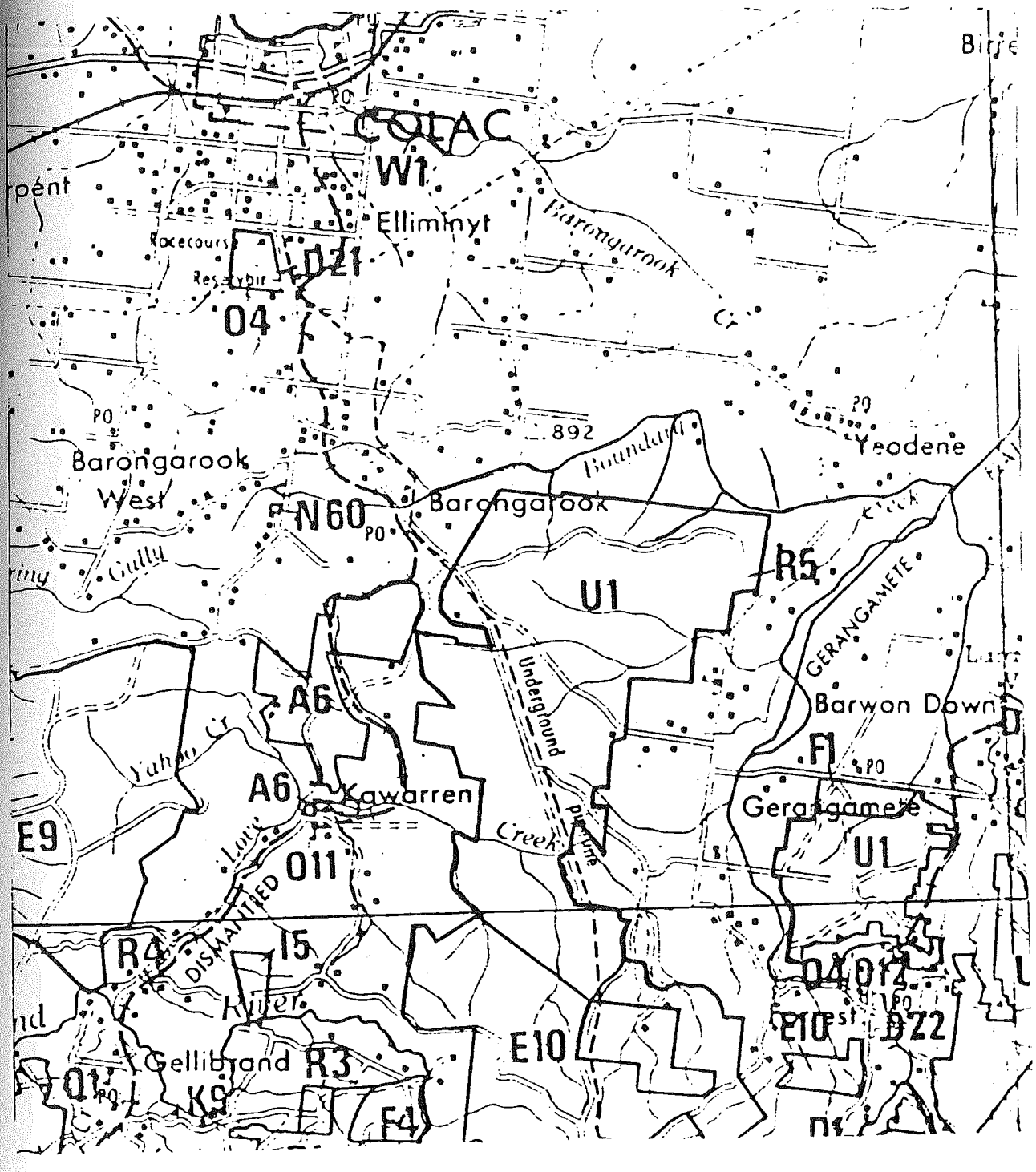
PUBLIC LAND

FINAL RECOMMENDATIONS

LAND CONSERVATION COUNCIL
VICTORIA

CORANGAMITE AREA

MAP No 3



5. DESCRIPTION OF IMPACT AREAS

5.1 INTRODUCTION

Section 3 and 4 above identified the environmental aspects most likely to be the affected by the Barwon Downs Groundwater Project and the artificial recharge scheme.

This section describes these aspects using published information and puts them into the wider context whenever the information makes this possible. These descriptions need to be combined with results from current and proposed studies, before information on envnmental values is sufficient for planning purposes.

Readers not needing to familiarise themselves with the detailed descriptions of the environmental aspects of the recharge area may wish to move directly onto Section 6 "Adequacy of the Existing Information" and Section 7 "Proposed Field Studies".

5.2 LAND USE

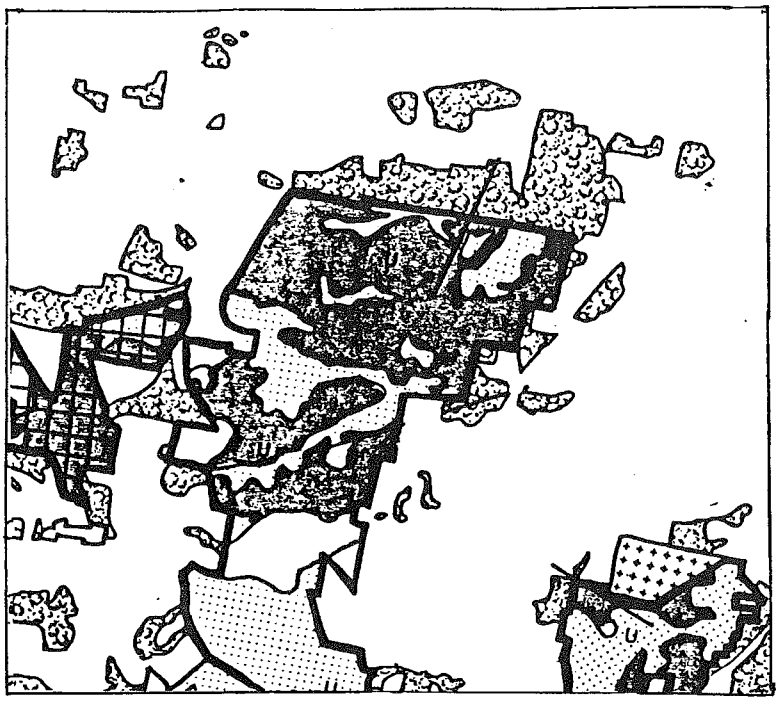
5.2.1 Public Land

Map 3 shows the location of the main blocks of public land in the area.

The Land Conservation Council has studied the land in the area (L.C.C. 1976) and recommended that the majority remain uncommitted except for a small area set aside for a quarry (R5). Six hundred and fifty hectares to the west was recommended to become the Karwarren Regional Park (A6).

STRUCTURAL VEGETATION COMMUNITIES

MAP No 4



Legend

- Open Forest I and Woodland
- Open Forest II
- Open Forest III
- Softwood Plantation
- Timbered Private Property
- Regional Park
- U Uncommitted Land

The recommendations for the uncommitted land and Karwarren Park are as follows:

RECOMMENDATIONS

UNCOMMITTED LAND

That the land indicated on the map be used to:

(a) maintain the capability of the land to meet future demands

(b) produce those goods and services required by the community (such as forest produce, grazing, and military training) that can be supplied without seriously reducing the long-term ability of the land to meet future demands

and that the land be Crown land withheld from sale and be protected forest under the provisions of the *Forests Act* 1958.

PARKS

A6 Kawarren Regional Park

Situated 12 km south of Colac on the road to Beech Forest and Apollo Bay, this park provides opportunities for activities such as picnicking and walking in a pleasant forest environment. Features include a dismantled railway-line running along the environs of the Ten Mile Creek."

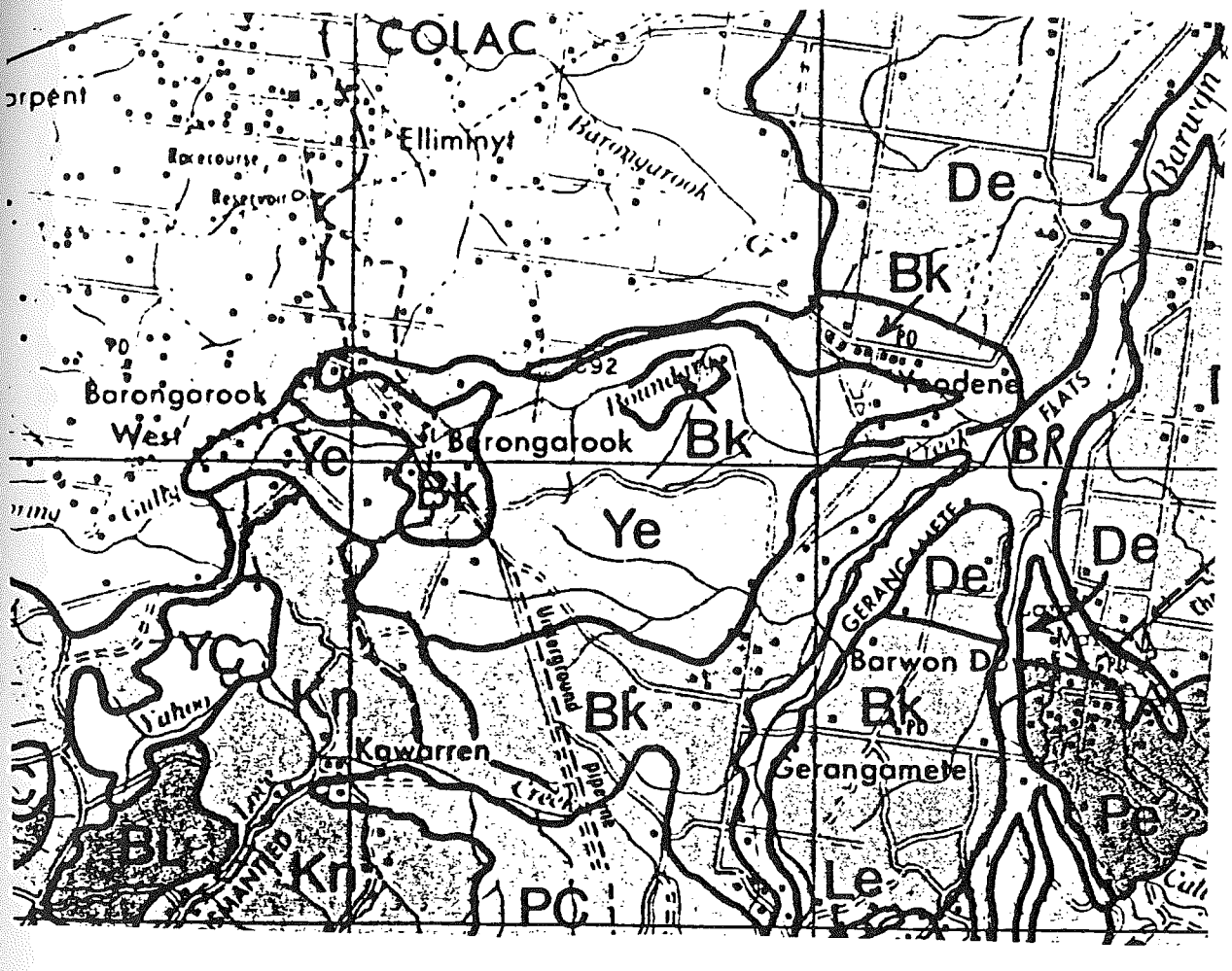
5.2.2 Private Land

A substantial proportion of freehold land in the area supports native forest and woodland, some of which is partly cleared. The uncleared areas are shown on map 4 and are used for forest products such as posts, poles, fuel, honey and forest grazing. Sand and gravel is extracted from a number of pits in the area. There is a pine plantation south of Yeodene.

Cleared land is used for sheep and cattle grazing and dairy farming. The soils on the Tertiary sediments are prone to nutrient and moisture deficiencies and the establishment of improved pasture is difficult (Pitt 1981).

LAND SYSTEMS OF THE OTWAY RANGE AND ADJACENT PLAINS

MAP No 5



5.2.3 Comment

A substantial part of the area that could be affected by the Barwon Downs Groundwater Project is private property. There is a tendency to discount nature conservation values on freehold land because the owner can clear the vegetation or change its management at any time. There is an increasing appreciation of the role of private property in conservation. Especially by land owners and local government. The Ministry of Planning and Environment's Land Mapping Program for the Shires of Otway and Winchelsea illustrate this growing appreciation. Consequently, I have not distinguished between private and public land when considering environmental impacts. However, the information is shown (approximately) on map 3 and will be important later on in the project.

5.3 LAND SYSTEMS

Pitt (1981) describes the land systems for the Otway area.

The majority of the recharge area for the aquifer system developed by the Barwon Downs Borefield occurs in the Yeodene Land System (Ye) which has been mapped as a continuous block of land occupying 58 km^2 mainly located south of Boundary Creek. Map 5 is a copy of part of Pitt's map showing the land systems in the area.

In addition to the Yeodene Land System, other systems are involved. They include parts of the Barongarook (Bk) and Barwon River Land Systems (BR).

5.3.1 Yeodene Land System

Figure 5 is a copy of Pitt's diagram of the land system. He divides the system into five components and notes that components 3 and 5 suffer from high water tables. He suggests that the poor drainage in these small areas may be related to perched water tables. One would expect their low position in the topography to be an additional factor affecting water logging. Table 4 gives some of the details for the components.

Yeodene land system

FIG 5

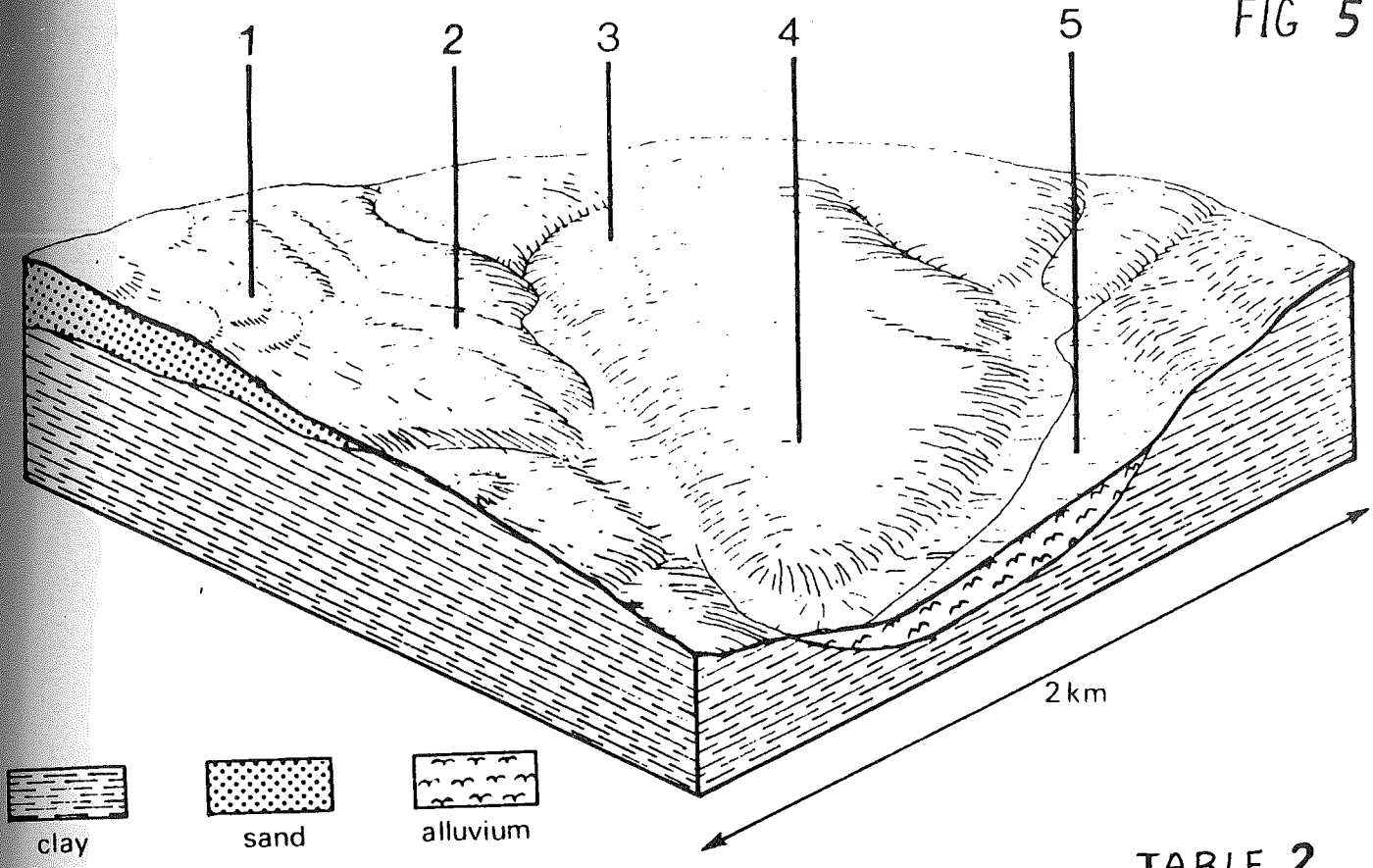


TABLE 2

YEODENE Area: 58 km^2	Component and its proportion of land system				
	1 35%	2 25%	3 5%	4 30%	5 5%
CLIMATE Rainfall, mm Temperature, °C Seasonal growth limitations	Annual: 750–850, lowest January (40), highest August (100) Annual: 13, lowest July (8), highest February (19) Temperature: less than 10°C (av.) June–August Precipitation: less than potential evapotranspiration late October–early April				
GEOLOGY Age, lithology	Paleocene unconsolidated sand, silt and clay Recent sand veneer				
TOPOGRAPHY Landscape Elevation range, m Local relief, m Drainage pattern Drainage density, km/km^2 Land form Land form element Slope (and range), % Slope shape	Rolling plain in the western parts of the Barwon catchment and northern parts of the Gellibrand catchment 120–260 40 Dendritic 1·5 Plain Crest, slope 9(1–15) Convex	Slope 15(5–20) Irregular	Broad slightly depressed area 2(0–5) Concave	Crest, slope 8(1–15) Linear	Drainage line 3(1–5) Concave
NATIVE VEGETATION Structure Dominant species	Woodland *E. viminalis, E. obliqua, E. radiata*	Woodland *E. radiata, E. ovata, E. viminalis*, occasionally *E. obliqua*	Low woodland *E. nitida, E. radiata*, occasionally *E. viminalis*	Open forest *E. obliqua, E. radiata*	Low woodland *E. ovata, Acacia melanoxylon, Leptospermum juniperinum · Melaleuca squarrosa*
SOIL Parent material Description Surface texture Permeability Depth, m	Quartz sand Grey sand soils, uniform texture Loamy sand Very high >2	Silt and clay with sand veneer Grey sand soils, weakly structured clay underlay Loamy sand Low >2	Silt and clay with sand veneer Grey sand soils, weakly structured clay underlay Loamy sand Low 0·6	Clay, silt and sand Yellow gradational soils, weak structure Sandy loam High >2	Colluvial and alluvial sand, silt and clay, plant remains Black sand soils, uniform texture Silty loam Moderate >2
LAND USE	Uncleared areas: Hardwood forestry for posts, poles and fuel; sand and gravel extraction; forest grazing; water supply; passive and active recreation; softwood forestry Minor cleared areas: Sheep and beef cattle grazing; dairy farming				
SOIL DETERIORATION HAZARD Critical land features, processes, forms	Very low inherent fertility and high permeability lead to nutrient decline.	Low inherent fertility and leaching of permeable surfaces lead to nutrient decline. Weakly structured surfaces and low permeabilities lead to sheet erosion on steeper slopes.	Low permeability and poor site drainage lead to seasonal waterlogging and soil compaction.	Weakly structured surfaces on steeper slopes are prone to sheet erosion.	High water tables lead to waterlogging and soil compaction. Run-off from adjacent hills leads to siltation and flooding.

5.3.1.1 Impact of Lowered Water Tables in the Whole Area

Lowering the water table in the whole area may make little difference if perched water tables are responsible for springs or water logged areas. For these areas there may be little or no change, even if the general water table in the area is substantially lowered.

Possibly the area described in component I would be least effected. The current high permeability of the soils and their position in the topography probably means that water tables are well below tree rooting depth and so a further fall would make no difference even to the oldest and most deeply rooted trees. Component I occupies 25% of the land system.

Component 4 may likewise remain unaffected especially where it occurs on crests or high in the topography of the area. The upper slopes of component 2 may be similar. However, parts of both these components (4 and 2) sited in lower topographic positions may be affected if some of the trees tap into the ground water. The effect will be present even if groundwater moves into the rooting zone for only part of the year or occasionally from year to year.

The loss of access to groundwater could reduce tree growth, especially during spring and summer as the soil water in the upper layers is depleted by evapotranspiration. However, it is possible that a lower groundwater table may increase the potential rooting depth of trees. This may be beneficial to existing trees or it may lead to a change in species composition as other species gain a competitive advantage. This could be one of the long term consequence. In the very long term, alterations to the nutrient recycling processes from the deeper parts of the rooting zone could occur and could lead to changes in soil fertility. (That is, more leaching, less recycling).

Any changes to the soil water conditions would probably be expressed by altered tree health and/or pathogen activity.

5.3.1.2 Inference

The information in Pitt's report indicated the land has poor agricultural potential, that soil fertility is low and waterlogging is a major problem.

FIG. 6

Barongarook land system

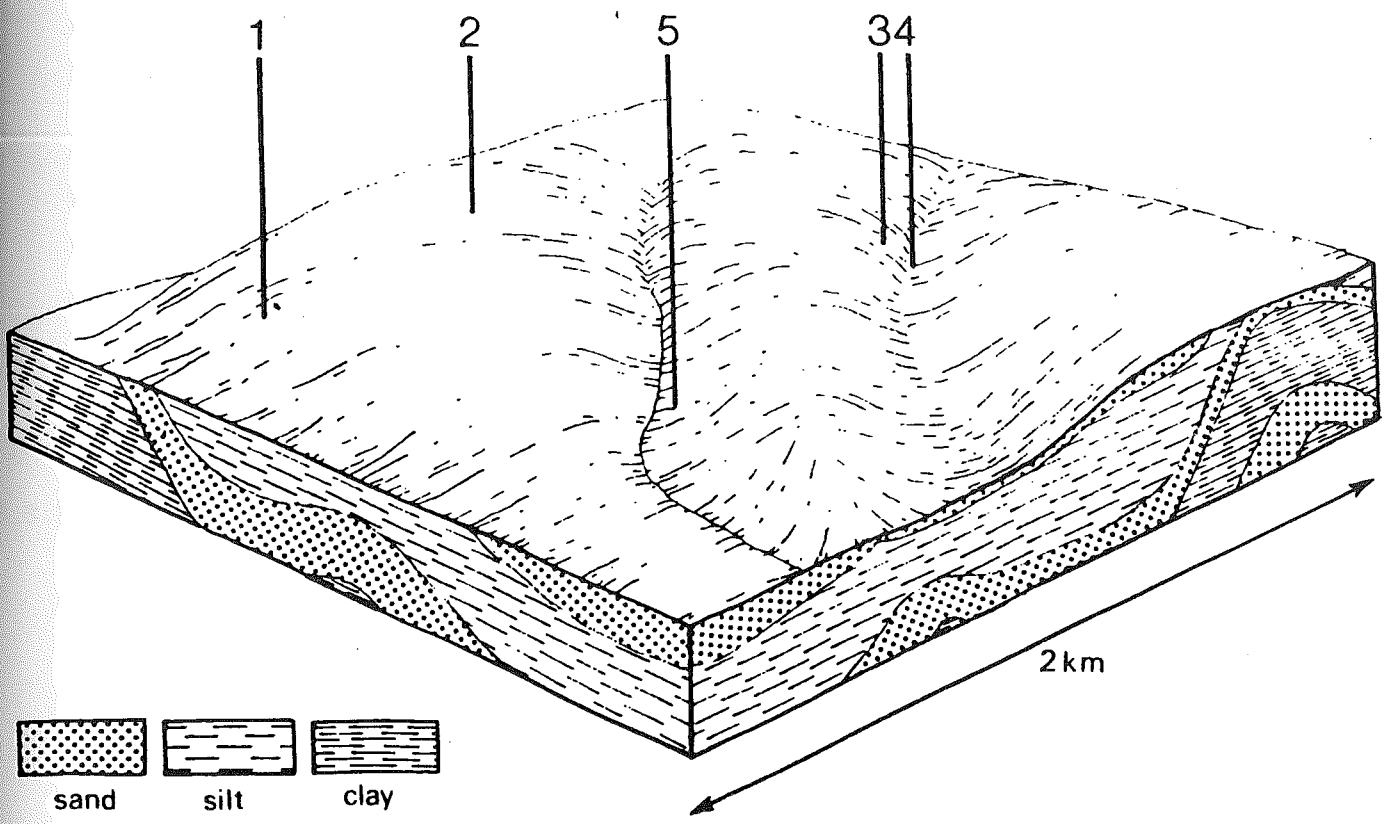


TABLE 3

BARONGAROOK Area: 65 km^2	Component and its proportion of land system				
	1 8%	2 55%	3 15%	4 15%	5 7%
CLIMATE Rainfall, mm Temperature, °C Seasonal growth limitations	Annual: 100–900, lowest January (40), highest August (80) Annual: 13, lowest July (8), highest February (18) Temperature: less than 10°C (av.) June–August Precipitation: less than potential evapotranspiration late October–early April				
GEOLOGY Age, lithology	Pliocene unconsolidated clay, silt and sand Recent sand veneer				
TOPOGRAPHY Landscape Elevation range, m Local relief, m Drainage pattern Drainage density, km/km^2 Land form Land form element Slope (and range), % Slope shape	Gently undulating to rolling plain in the western parts of the Barwon catchment 120–280 30 Dendritic 1·2 Undulating plain Steep slope 25(15–40) Linear	Crest, upper slope 5(0–10) Convex	Upper and middle slope 5(0–10) Convex	Lower slope 7(1–15) Linear	Drainage line 1(0–2) Concave
NATIVE VEGETATION Structure Dominant species	Open forest *E. obliqua, E. radiata, E. viminalis*	Open forest *E. obliqua, E. radiata,* occasionally *E. ovata, E. viminalis*	Open forest *E. radiata, E. obliqua, E. nitida*	Woodland *E. radiata, E. nitida*	Woodland *E. ovata, E. radiata* occasionally *E. aromaphloia*
SOIL Parent material Description Surface texture Permeability Depth, m	Clay, silt and sand Yellow gradational soils, weak structure Sandy loam High >2	Clay, silt and sand Mottled yellow and red gradational soils Loam Moderate >2	Clay, silt and sand with quartz sand veneer Grey sand soils, structured clay underlay Sandy loam Low >2	Clay, silt and sand with quartz sand veneer Grey sand soils, weakly structured clay underlay Sandy loam Low >2	Alluvium Mottled yellow and grey gradational soils Loam Moderate >2
LAND USE	Cleared areas: Sheep and beef cattle grazing; dairy farming Uncleared areas: Hardwood forestry for sawlogs, post and poles; nature conservation; active and passive recreation; softwood forestry; forest grazing				
SOIL DETERIORATION HAZARD Critical land features, processes, forms	Steeper slopes with weak-structured surfaces are prone to sheet erosion.	Low inherent fertility and phosphorus fixation lead to nutrient decline.	Low inherent fertility with leaching of permeable surface horizons leads to nutrient decline.	Low permeability and seasonal perched water table lead to waterlogging and soil compaction.	High seasonal water table leads to waterlogging and soil compaction.

5.3.2 Barongarook Land Systems

There are smaller areas of the recharge area mapped as Barongarook land systems. The system describes the mainly cleared land around Barongarook and to the east adjacent to Boundary Creek (the land next to the failed farm dam).

Figure 6 is a copy of Pitt's diagram of the components of the land system. Waterlogging occurs in many parts of the land system. Lower slopes (component 4) and drainage lines (component 5) are especially prone to waterlogging. The causes of waterlogging are difficult to determine. Pitt mentions the occurrence of perched water tables. In addition, position in the topography of the area may be important especially if lower areas are periodically below general groundwater tables.

5.3.2.1 Impact of Lower Water Tables in the Whole Area

A reduction in the water table throughout the area may have little effect on areas subject to waterlogging where waterlogging is caused by a combination of weather, poor site drainage and low soil permeability. In other areas a lower general water table may reduce waterlogging and so improve the land for agricultural production.

Changed soil water conditions may be beneficial for pasture productivity but it will depend on circumstances. For forested areas the changes could lead to changed tree health and perhaps later to changes in species composition of forests.

5.3.2.2 Inference

The indications are that this land is more productive agriculturally than that in the Yeodene Land System. Both occur on Dilwyn and Pebble Point formations and so the better productivity may be due to their flatter terrain and more fertile soil profiles. Once again waterlogging is a problem but lowering regional water table may be beneficial although leaching of soil nutrients would occur.

FIG 7

Barwon River land system

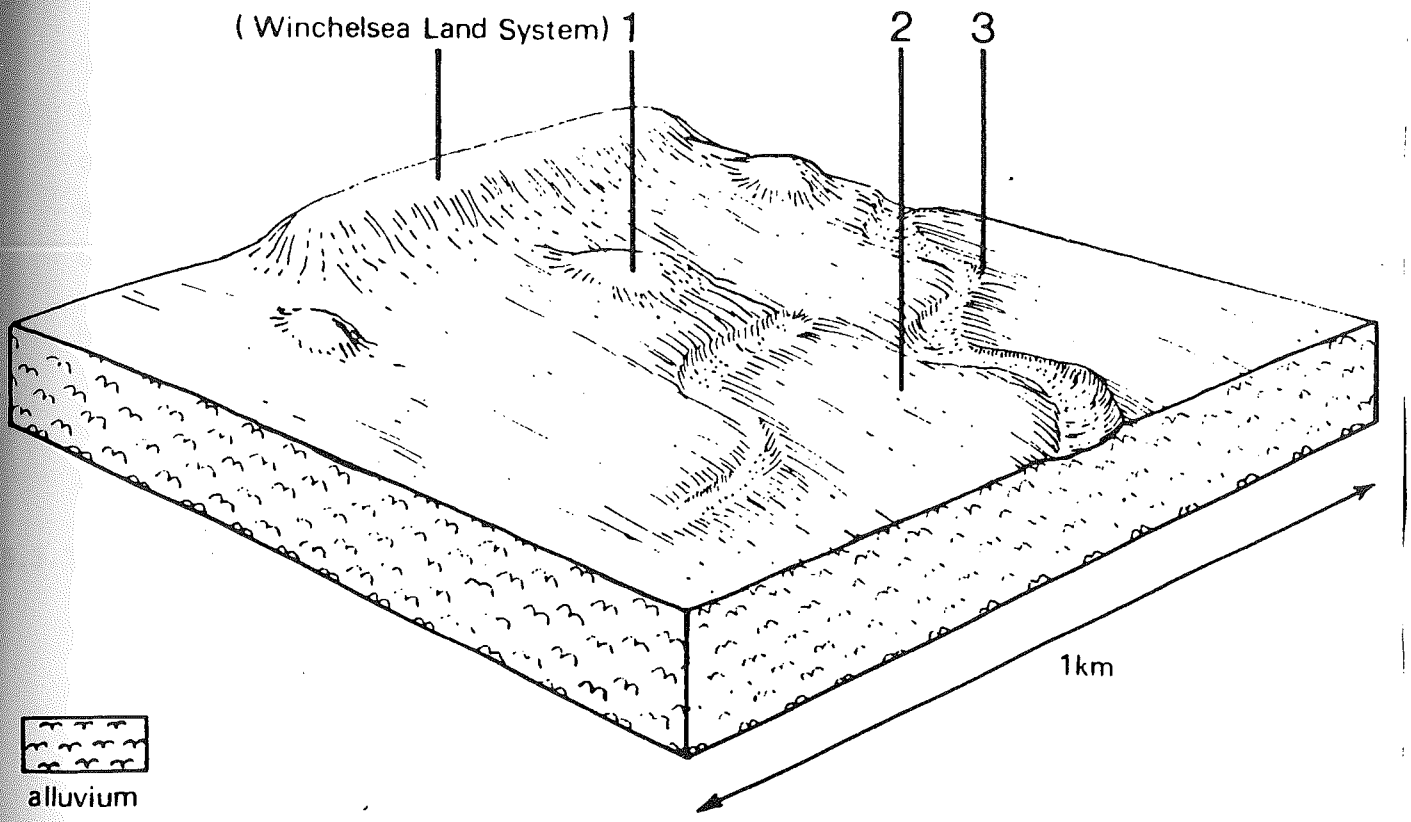


TABLE 4

BARWON RIVER Area: 115 km^2	Component and its proportion of land system		
	1 5%	2 85%	3 10%
CLIMATE Rainfall, mm Temperature, °C Seasonal growth limitations	Annual: 600–1,000, lowest January (30), highest August (80) Annual: 13, lowest July (8), highest February (19) Temperature: less than 10°C (av.) June–August (Also September in higher-rainfall areas) Precipitation: less than potential evapotranspiration October–April in lower-rainfall areas November–March in higher-rainfall areas		
GEOLOGY Age, lithology	Recent alluvium–sand, silt, clay and gravel		
TOPOGRAPHY Landscape Elevation range, m Local relief, m Drainage pattern Drainage density, km/km^2 Land form Land form element Slope (and range), % Slope shape	Alluvial flood plain of the Barwon River and its tributaries with numerous cut-off meanders 90–150 3 Deranged with major meandering channel 1·6 Plain Rise 4(1–6) Convex	Flat plain 1(0–2) Straight	Streambank, infilled meanders 2(1–8) Convex
NATIVE VEGETATION Structure Dominant species	Woodland *E. ovata, E. viminalis, Acacia melanoxylon*, in north *E. camaldulensis*		
SOIL Parent material Description Surface texture Permeability Depth, m	Sandy alluvium Brown sandy loam soils, uniform texture Fine sandy loam Very high >2	Clayey alluvium Grey gradational soils Fine sandy clay loam Moderate >2	Sandy alluvium Brown sandy loam soils, uniform texture Fine sandy loam Very high >2
LAND USE	Dairy farming; cropping; sheep and beef cattle grazing		
SOIL DETERIORATION HAZARD Critical land features, processes, forms	High permeability and leaching lead to nutrient decline.	High seasonal water table leads to waterlogging, soil compaction and salting. Dispersible clay subsoils are prone to gully and tunnel erosion. High discharge rates along some watercourses lead to flooding and siltation.	High discharge rates and weakly structured soils lead to streambank erosion and siltation. High seasonal water tables lead to waterlogging.

5.3.3 Barwon River Land System

The lower section of the Boundary Creek flow through part of the Barwon River land system. Figure 7 is a copy of Pitt's diagram of the components of the land system and details are included in table 6. Flooding and siltation are common occurrences in the system and waterlogging also occurs.

Most of the land in this land system is underlain by marls of very low hydraulic conductivity. Development of the Barwon Downs Borefield should have little effect on groundwater in the marls. Reduced flows in Boundary Creek may influence soil moisture levels in areas adjacent to the creek.

5.3.3.1 Impact of Lower Flows in Boundary Creek

Soil permeability is moderate in most of the land system. It is possible that lower creek flows may lead to earlier seasonal drying of the soils adjacent to the creek, however, this may vary considerably depending on local water tables generated by the Barwon River.

The small areas of woodland present may not be affected especially if they are watered by the groundwater associated with the Barwon River.

5.3.3.2 Inference

The effects of the project would probably be restricted to areas adjacent to Boundary Creek and would relate to reduced creek flows.

5.4 VEGETATION

5.4.1 Information from the L.C.C.

Map 6 shows the structural form of the vegetation on public land in the area. It is reproduced from the L.C.C. vegetation maps for the Corangamite study area.

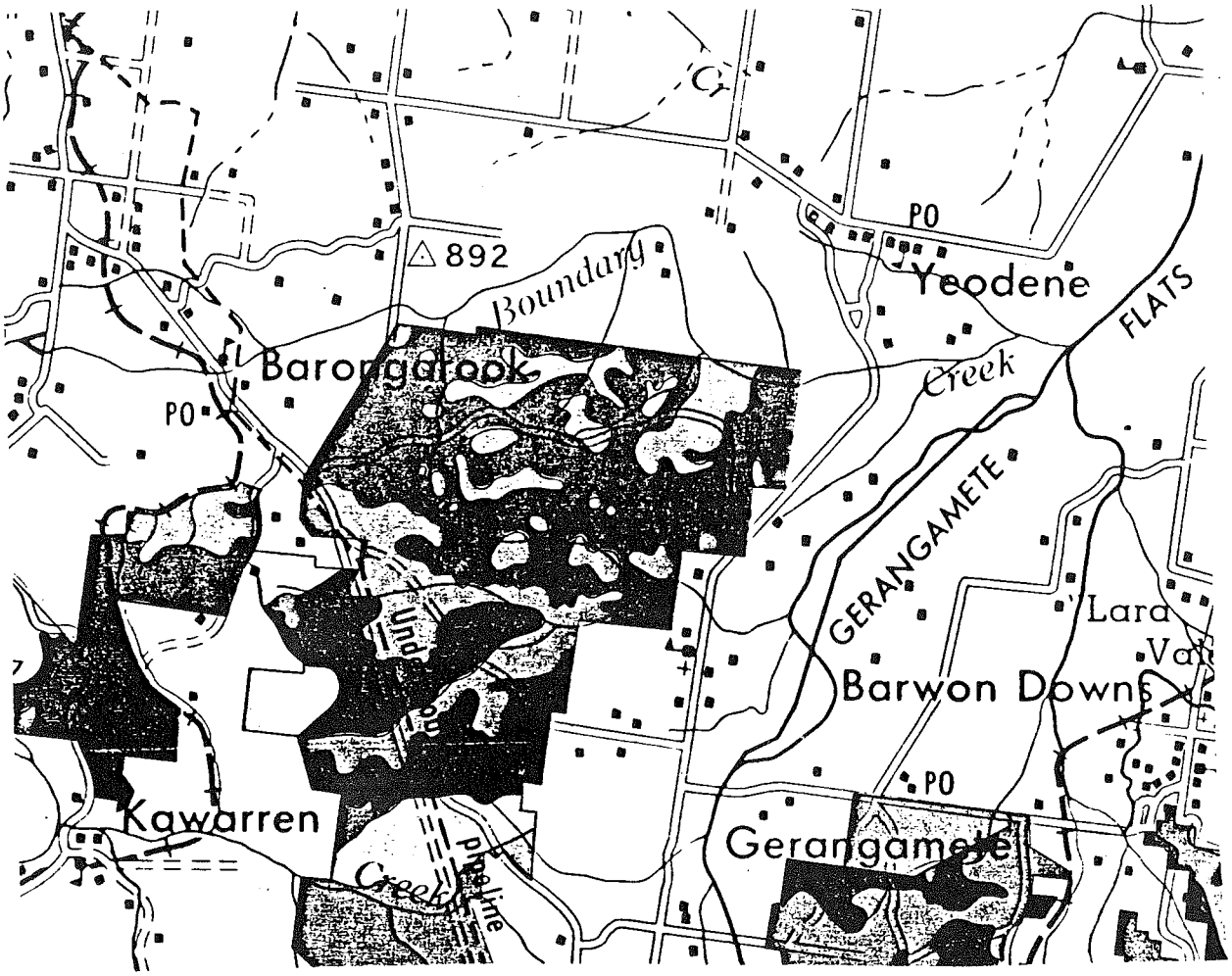
The majority is open forest II (between 15 and 28 m tall). A substantial area supports woodland (scattered trees less than 15 m) while a few small areas of open forest I occur (less than 15 m).

LAND CONSERVATION COUNCIL
VICTORIA

CORANGAMITE STUDY AREA

VEGETATION

MAP No 6



Structural form	Major species of the tallest stratum	Associated tree species
OPEN FOREST II	*Messmate stringybark*	*Eurabbie, Mountain grey gum*
	Eurabbie	*Messmate stringybark, Mountain grey gum*
	Brown stringybark	*Messmate stringybark, narrow-leaf peppermint*
	Messmate stringybark	*Narrow-leafed peppermint*
	Narrow-leaf peppermint	*Messmate stringybark, Brown stringybark*
	Manna gum	*Blackwood*
OPEN FOREST I	*Eurabbie*	*Red ironbark*
	Messmate stringybark	*Brown stringybark*
	Manna gum	
(heath or scrub understorey)	*Shining peppermint*	*Brown stringybark*
	Brown stringybark	*Shining peppermint*
	Messmate stringybark	*Brown stringybark*
WOODLAND	*Bog gum*	*Messmate stringybark Brown stringybark*

The Land Conservation Council report contains little additional information specific to the area.

The principal tree species are listed in table 7.

TABLE 7 PRINCIPAL TREE SPECIES

Eucalyptus obliqua	Messmate Stringy Bark
E. viminalis	Manna Gum
E. radiata	Narrow Leaf Peppermint
E. baxteri	Brown Stringy Bark
E. nitida	Shining Peppermint

The L.C.C. report points out that the structure and species composition of the understorey are influenced by the fire history; infrequent burning tends to produce a dense understorey of shrubs. The understorey of open forest II growing on leached sands, has an xerophytic understorey of shrubs such as Silver Banksia, Furze Hakea and Astral Grass trees. The understorey of woodlands can often be rich in species.

5.4.2 Information from Land Systems Mapping

The land system study includes information on vegetation. The description of each land system includes information on the structural form and dominant species and is shown in Section 5.3 above (Pitt 1981).

In addition, there report includes a general discussion of the major structural classes of forest. Two parts of this discussion are recevant and are reproduced below.

"OPEN FOREST

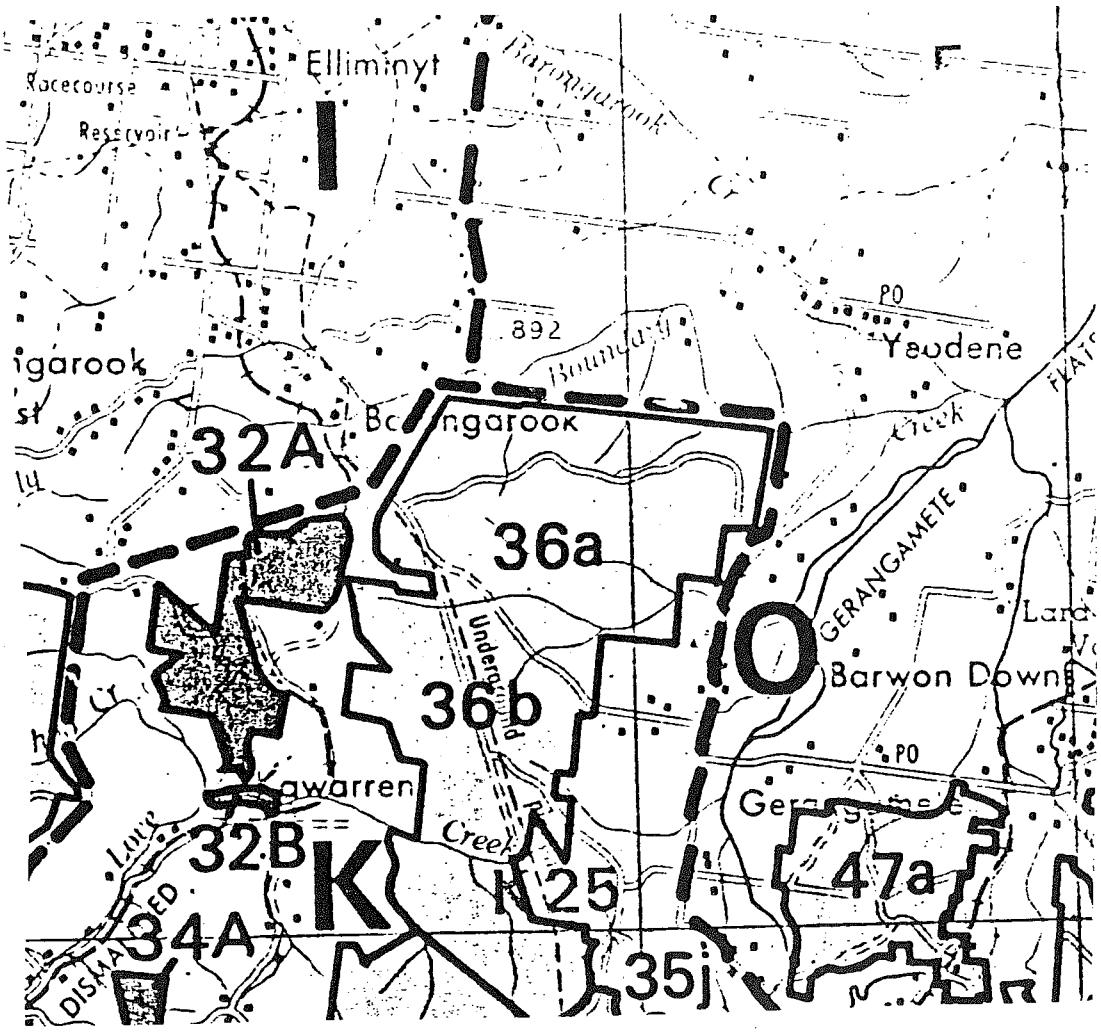
Eucalyptus ovata **and associated species**
E. ovata is also widespread, but its occurrence in any area is usually confined to either heavily textured, coarse-structured soils or low positions in the landscape that are frequently waterlogged. It grows on both acidic soils (near Paraparap) and on calcareous soils (near Princetown and Bellbrae).

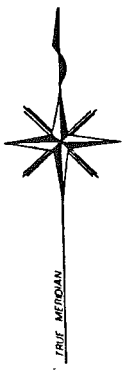
Heights sometimes exceed 30 m in the higher rainfall limits of its occurrence in the Otway Range, but most are closer to 20 m.

THE CORANGAMITE-OTWAY AREA

DIVIDED INTO SECTORS, BLOCKS, AND SUB-BLOCKS

MAP No 7





PUBLIC LAND CATEGORIES

BIOLOGICAL RESERVES (CAPITAL LETTERS)
UNCOMMITTED LAND (small letters)
OTHER PUBLIC LAND (small letters)

Study Area Boundary

Sector Boundary (C D)

Sub-Block Identification (47d, 42f)

Small Reserves

Ten-minute Grid System (K6)

E. ovata is very rarely found in pure stands and is often the subordinate species in an association dominated by other eucalypts such as *E. viminalis* or *E. obliqua*. In very waterlogged drainage lines, however, pure stands do occur, often in a woodland formation (near Barongarook and Yeodene). Understorey species in these formations include *Melaleuca squarrosa*, *Leptospermum juniperinum* and other shrubs tolerant of poor drainage. Elsewhere, understorey species vary from site to site and are similar to those found under *E. obliqua* associations on hill slopes, while some mesophytic species occur in drainage lines."

"WOODLAND

Eucalyptus radiata and associated species

E. radiata woodlands are common on the foothills of the Range, where well-drained soils of low fertility have developed on Tertiary sediments. The acidic sands in the west, which suffer sever moisture stresses in summer, are mainly colonized by *E. radiata* in association with *E. nitida*, *E. obliqua* and *E. Baxteri*.

In many areas, *E. radiata* exists as a minor member of open forest associations, particularly those dominated by *E. obliqua*. It may attain heights of 20 m or more in open forests, but in woodland communities it seldom reaches more than 15 m. Understoreys are usually moderately dense and include *Leptospermum juniperinum*, *L. myrsinoides*, *Banksia marginata*, *Xanthorrhoea australis*, *Playlobium obstusangulum*, *Dillwynia glaberrima* and *Hakea ulicina*. In the drier areas, *Acacia suaveolens*, *Epacris impressa* and *Leucopogon glacialis* become common.

5.4.3 Information from Beauglehole Report

Beauglehole (1980) has reported the distribution and conservation of vascular plants in the Corangamite-Otway area (COSA). He divided the area into sectors, blocks and sub-blocks. His divisions are shown on map 7. The area of uncommitted public land adjacent to boundary creek is block 36 within sector K.

Although he has surveyed this block, he indicates that the survey was inadequate and requires further work during favourable conditions, especially in the case of seasonal species.

The following are his comments on Sector K.

"K-SECTOR

In this Central Otways region, there are 3 Reserves (Regional Park, Education Area and Bushland Reserve), several segmented Hardwood Production areas plus 3 other non-reserve areas. Five species are not known from any reserve within COSA and 10 are known in only one reserve. The only uncommitted area (Barongarook Sub-Blocks 36a,b) has high reservation potential - indeed it would add considerably to the much smaller Kawarren Regional Park adjoining it, as it contains:

(a) 3 species not known from any reserve within

COSA: Agrostis hiemalis (only record within COSA), Prasophyllum archeri, Myriophyllum pedunculatum (one of only two records within COSA).

(b) 6 species known in only one reserve with

COSA: Baumea gunnii, Callitriche brachycarpa, Drymophila cyanocarpa, Leptospermum glabrescens, Olearia myrsinoides, Prasophyllum beaugleholei.

Further information on these plants is given below in table 8 below.

TABLE 8 RARE - INTERESTING - RESTRICTED SPECIES
(Source A. C. Beauglehole 1980)

SUB BLOCK 36		SCIENTIFIC NAME	COMMON NAME
A	B		
+		Acianthus caudatus	Mayfly Orchid
+		Agrostis hiemalis	Red top Bent grass
+	+	Amphibromus recurvatus	Dark Swamp Wallaby grass
	+	Baumea gunni	Slender Twig-rush
+		Callitriche brachycarpa	Water Starwort
	+	Comesperma retusum	Mountain Milkwort
+		Drymophila cyanocarpa	Turquoise Berry
+		Galium ciliare	Tangled Bedstraw
	+	Hypoxis hygrometrica	Golden Weather Glass
+	+	Leptospernium glabressens	Smooth Tee Tree
	+	Myrid phyllum peduncalatum	Mat Water-Milfoil
+	+	Olearia myrsinoides	Silky Daisy Bush
	+	Prasophyllum archers	Variable Midged Orchid
	+	Prasophyllum beaugleholei	Midget Orchid
	+	Prasophyllum despectans	Sharp Midget Orchid
+	+	Stylidium inundatum	Hundreds and Thousands
+	+	Thelymitra antennifera	Rabbit-ears (sun orchid)

5.4.4 Information from Hubbard

Appendix A1 includes a copy of a letter from Mr. J. Hubbard, a Colac resident, who is interested in orchids. He lists 17 species from the area and adds "This list is far from complete as I have noted sun orchids, leek orchids, small greenhood and bearded orchids which I cannot put a name to ...".

His information helps to show the value of the area for wildflowers and illustrates a recreational value for the area.

5.4.5 Vegetation Conservation

A broader perspective to vegetation conservation was given by Hook (1982) for the Otways, including the Barongarook areas. She pointed out that

"The maintenance of community types and populations of rare and interesting species is an important aim but that the vegetation responds to processes in the environment and also modifies these processes."

She gives several examples in soil erosion, hydrology and soil nutrient fields. She goes on to say that

> "In addition to the importance of the vegetation in land processes, vegetation is also important in supplying timber, in honey production and in providing habitat for wildlife. It is also a major component of the natural landscape; the aesthetic qualities of an area and the emotional satisfaction derived from natural areas are dependent on the existence of relatively large tracts of native vegetation in an intact and undisturbed state."

She reviewed the information available on the flora of the Otways (as of 1982) and pointed out that the northern areas (Barongarook area included) were the least well known. No additional work has been done since then in the northern areas. There is no information on community types and no maps of communities even at the broadest scale. The L.C.C. maps of the structure of the vegetation provide the best information available (ie. open forest or woodland) (Dr. R. Parsons pers. com.).

Hook lists 2 kinds of studies needed to determine the value of the vegetation and its conservation needs.

a. <u>Survey Information</u>

". Detailed floristic information for all areas of unsurveyed land, both public and private.

. mapping of the main community types in terms of floristic and structure.

. determination of the components of these major communities in terms of floristics, structure and age mapping of their determination. "

b. <u>Process Information</u>

. monitoring of vegetation
(to determine the changes occurring and factors responsible)

. Studies on the requirement of species and communities
(effect of management practices)

. Nutrient cycling studies

. Other
(Hook suggests that other information may be needed. We could add the effect of changes to ground water table levels).

Hook's report indicates that the intrinsic conservation value of the vegetation cannot be determined from existing information and that a lot of basic floristic work needs to be done on a regional basis to enable detailed information on a specific site to be viewed in its wider regional context.

This regional floristic work cannot be undertaken in time to assist in understanding the vegetation in the areas likely to be changed by the aquifer pumping proposals. The point is to be aware of the limited base for assessing conservation value since decisions will have to be taken before this base can be improved.

5.5 FAUNA

5.5.1 Fish

Boundary Creek was surveyed by A.R.I. as part of the fish survey work for the Barwon River system in early Winter 1986. The creek was sampled on one occasion at one site. The fish species caught are shown in table 9 below.

The creek will be sampled again during the summer period 1986/87 and more than one site may be selected.

The table suggests that Boundary Creek supports a similar range of fish species to other headwater creeks. There is not enough detail to give quantitative information on the fish fauna of the creek.

TABLE 9 FISH SPECIES RECORDED FOR BOUNDARY CREEK 1986
(Tunbridge Pers. Com.)

Number	Fish Species	Length (cm)
4	Short-finned eel *(Anguilla australis)*	30-73
1	Brown trout *(*Salmo trutta*)	36
1	River blackfish (*Gadopsis marmoratus*)	
4	Pigmy perch (*Nannoperca australis*)	4-9
24	Mountain Galaxias (*Galaxias olious*)	
1	Fresh water crayfish	

* Denotes introduced species

Area sampled 65 m x 2 m approximately
Average water depth 60 cm
Electrofisher was used.

5.5.2 Victorian Bird Atlas Data

Information from the Victorian Bird Atlas is available from the Arthur Rylah Institute on a 10 minute grid basis.

The Barongarook area falls on the boundary of two grids. The majority of land in both grids is agricultural in addition, the Colac block contains a substantial area of forest North and West of Kawarren. The information is

therefore not specific for the area around Boundary Creek, but provides a general picture for the locality.

The information for each grid is given in Appendix A2. Table 10 below lists bird species associated with wetlands. The list was developed by Beardsell (pers. com.) from his work in compiling the Victorian Bird Atlas and denotes species that may be significant for the area.

TABLE 10 SIGNIFICANT BIRD SPECIES ASSOCIATED WITH WETLANDS
C. Beardsell (pers. com.)

COLAC 10 MINUTE GRID	BIRREGURRA 10 MINUTE GRID
Baillon's crake Glossy ibis Grey goshawk* White throated gerygone	Buff-branded Rail * Latham's snipe Brolga Blue billed duck Grey goshawk Peregrin falcon* Satin bowerbird

* Denotes breeding in the area

More specific information for the area may be difficult to obtain. Some information may be available from local bird watchers via the Colac Field Naturalists Club.

5.5.3 Mammals

5.5.3.1 1974 Survey

Professor Lee trapped the Boundary Creek area in 1974 for ground dwelling mammals. His letter reporting the work is included in Appendix A2. His work suggested that most ground dwelling mammals were in low abundance. He considered that *Rattus lutreocus* would be the most likely to be affected by the proposal. *Rattus lutreocus* is common at many sites and has extensive distribution in Easter Australia.

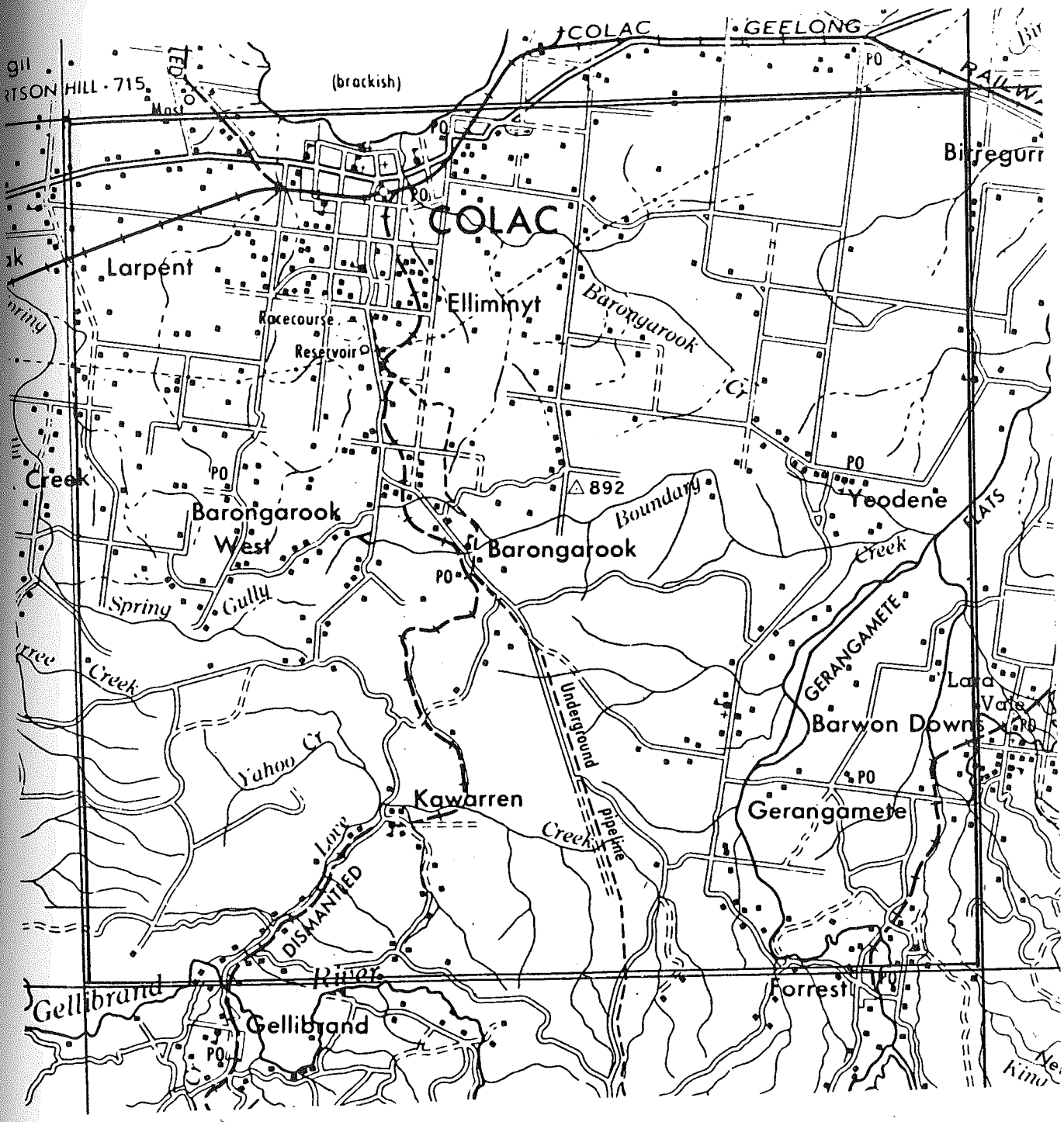
5.5.3.2 Information from the Atlas of Victorian Mammals

Information on the distribution of mammals is being complied into an atlas using the existing survey and collection data. The information is available on a latitude/longitude basis.

MAP No 8

Atlas of Victorian Mammals

co-ordinates 38, 20′ to 38, 32′and 143, 30′ to 143, 45′



Information on the area was extracted using the co-ordinates 38, 20′ to 38, 32′ and 143, 30′ to 143, 45′. The area is shown on Map 8. The area includes the freehold land north to Colac and the forests south to the town of Forrest. The species list is therefore a check for the locality. It needs to be supplemented by site survey information. Nearly all the records have a precision of 5 which is the accuracy, in minutes, of the locality details provided in the collection information. All the records given here have been confirmed by A.R.I.

TABLE 11 MAMMAL SPECIES RECORDED IN THE BARONGAROOK AREA
(Source A.R.I. Mammal Atlas)

COMMON NAME	SCIENTIFIC NAME
Platypus	Ornithorstinchus anatinus
Brown Antechinus	Antechinus stuartii
Dusky Antechinus	Antechinus swainsonii
Tiger Quoll	Pasyurus melulatus
White Footed Dunnart	Sminthopsis leucopus
Fat-Tailed Dunnart	Sminthopsis crassicaudata
Southern Brown Bandicoot	Isoodon obesulus
Long Nosed Bandicoot	Peremeles nesuta
Common Brush Tailed Possum	Trichosurus vulpecule
Feathertail Glider	Acrobates pugmaeus
Yellow-Bellied Glider	Petaurus australis
Sugar Glider	Petaurus breviceps
Common Ring Tail Possum	Pseuddcheirus peregrinus
Eastern Grey Kangaroo	Macropus giganteus
Red-necked Wallaby	Macropus rufogriseus
Long Nosed Potoroo	Potorous tridectylus
Swamp Wallaby	Wallabia bicolour
Common Wombat	Vombatus ursinus
Grey Headed Flying Fox	Pteropus poliocephalus
Lesser Long-Eared Bat	Nyctophilus geoffroyi
Broad-toothed Rat	Mastocomys fuscus
Bush Rat	Rattus fuscipes

5.5.4 Frogs

Appendix A2 includes a copy of a letter from Dr. Littlejohn, Reader in Ecology at Melbourne University. He is unfamiliar with the amphibian fauna of the area although has worked to the west and south-west. He indicated that he and Dr. G. Watson would be able to survey the recharge area later this year.

The distribution of frogs in Victoria was mapped by Brook (1975) at a broad scale. The species that may occur in the area are listed in Table 12 below.

TABLE 12 ANURAN SPECIES THAT MAY OCCUR IN THE RECHARGE AREA (From Brook 1975)

COMMON NAME	SCIENTIFIC NAME
-	Geocrinia laevis
Brown-Striped Frog	Limnodynastes peroni
Spotted Grass Frog	L.tasmaniensis
-	Ranidella signifera
-	Litoria aurea raniformis
Brown Tree Frog	L.ewingi

5.6 LANDSCAPE

5.6.1 Introduction

Landscape quality is important for a number of reasons. For example it is an important consideration in recreational use of the area.

There are many ways of assessing landscape, two systems will be considered in this report.

The Department of Conservation Forest and Lands have a statewide system that although developed to assist forest management has some value for

understanding the possible effects pf the projects. This is called the "Visual Management System".

The second system is in the final stage of development and is specific for river landscapes. The system is being prepared by Scenic Spectrums for the Australian Heritage Commission. At the moment the system is called "A Preliminary Scenic Assessment Procedure for Australia's River Landscape." It has been pilot tested on the Werribee River.

5.6.2 Visual Management System

Map 7 shows the landscape management zones for the Barongarook area. For each of the zones, visual quality objectives have been developed and are summarised as follows:

"Zone A Inevident Alteration VQO

Management alterations should range from being visually inevident to temporarily apparent. When evident, the period of impact (contrast) should not exceed one year. The recommended alteration level would be "low, least receptive to change".

"Zone B Apparent Alteration VQO

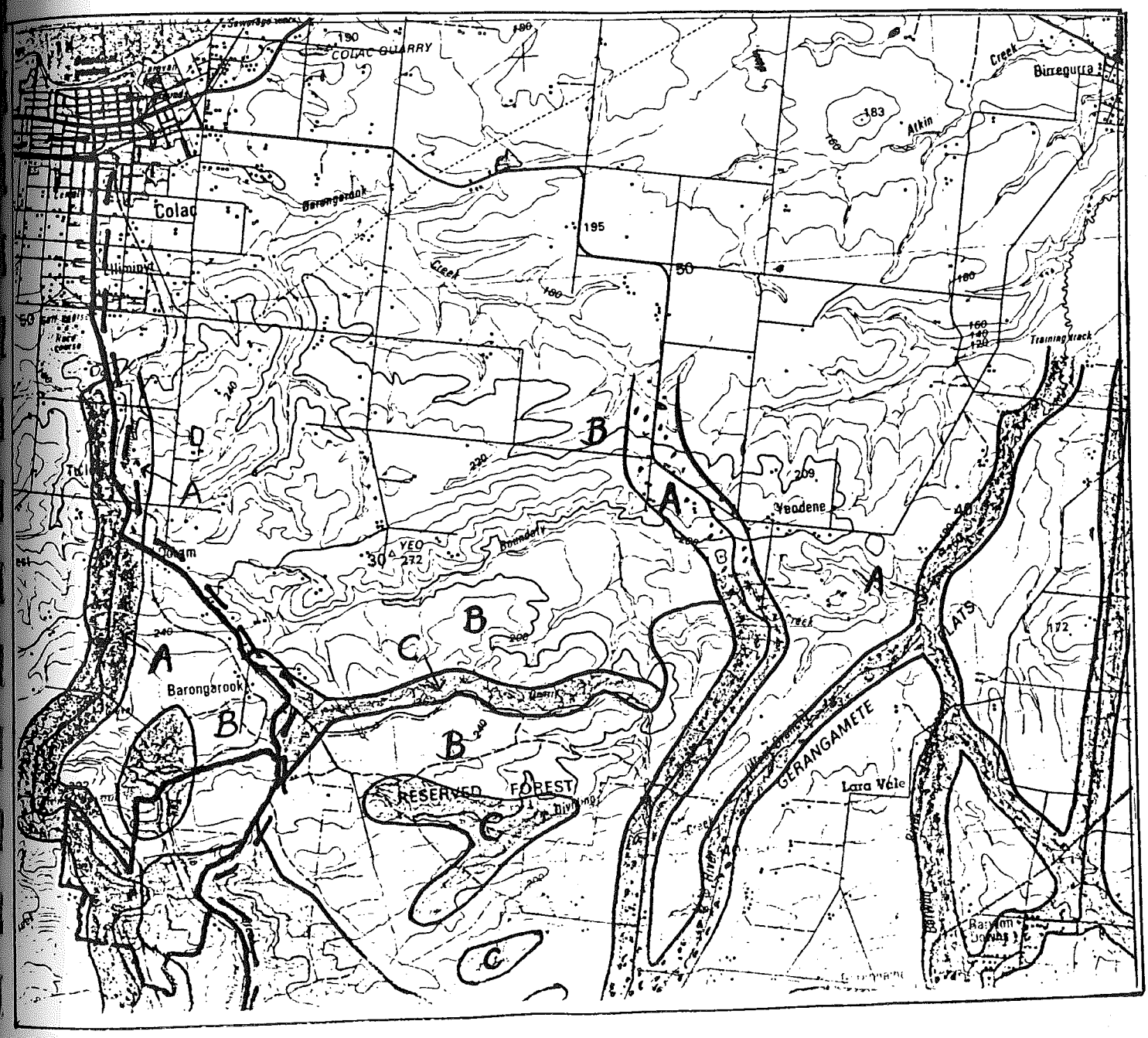
Management alterations should range for visually apparent and yet subordinate to established landscape characteristics to visually dominant. The period of visual dominance should not exceed two years. The recommended alteration level would be "moderately accommodating to change."

"Zone C Dominant Alterations VQO

Management alterations may be visually dominant but should borrow from naturally established form, line, colour and texture to be in harmony with natural occurrences within the surrounding area. The recommended alteration level would be "highly accepting of change."

Map 9

Visual Resource Inventory
Landscape Management Zone Map



Zone A
Zone B
Zone C

The Barongarook area is located at the edge of the area of primary concern for forest harvesting purposes and so the map does not include details such as the composite code for each area - explaining the reasons for the various zonings.

The maps show the land adjacent to main roads and the Barwon River is zoned "A". Most of the forest is zoned "B" while small parts are zoned "C". Because the composite code is not available it is difficult to know exactly why areas are zoned "C" but probably it is because they are not readily seen from public roads and have only a moderate visual quality rating.

I have extended the map to cover the entire area. It may be appropriate to have this area checked by C.F. and L.

Vegetation is a significant feature of landscape. Public Works, such as groundwater pumping that might damage vegetation via the chances in groundwater levels will impact landscape values. The "A" and "B" zones are of most concern. "A" is adjacent to the main road while most of the forests is in the "B" zone.

The management objective for these zones may be difficult to meet. Especially the part relating to the period of impact because the vegetation will probably adjust to the new conditions at quite a slow rate. The time period is 1 year for zone "A" and 2 years for zone "B"

5.6.3 River Landscape

A procedure for the scenic assessment of rivers as a component of the overall assessment of the conservation value of rivers has been developed. The program is co-ordinated by the Ministry for Planning and Environment as part of the National Estate Project 124. The report describing the procedure will be available shortly.

The Barwon River Basin has not been assessed using this system. However, potentially the main landscape impact would be along the Boundary Creek valley and this system would provide a more detailed and possibly more valid assessment of the landscape values than the Visual Management System.

The results of such an assessment would put the landscape value of Boundary Creek in the River Basin perspective and so provide a much more objective view of its significance. Unfortunately that work has not yet been done and currently the visual management system is the best there is.

5.7 RECREATION

5.7.1 Introduction

Most public land in the region is available to the public for outdoor recreation activities. Recreation is often a secondary use of land and in many instances has little impact on other values of the land.

The value of a forested area for recreation depends on its inherent values or attributes, the comparative commonness of these attributes in adjacent areas and recreational demand related to these attributes.

5.7.2 Recreational Value

The forests and woodlands in the Barongarook area have some inherent attributes that contribute to recreational value. The forests and woodlands are relatively open allowing fairly easy access. They are floristically rich and wildflower displays are excellent. They provide a range of habitats for birds and many animals. The educational value of the area is high, because of these attributes. Boundary Creek occupies only a small area of land but has interesting riparian vegetation and waterways tend to be especially attractive for a range of recreational pursuits.

Access to the area is good. It lies between the two main roads, Colac-Forest and Colac-Gellibrand and is only a few minutes drive from Colac. The area has good internal roads and a number of tracks that can be used in all but the wettest weather. It is one of the closest area of bushland to Colac and lies next to the Kawarren Regional Park (a recreation orientated park).

5.7.3 Recreational Use

It is difficult to say how much recreational use the area gets. It seems to be moderately popular for bushland pursuits such as walking, nature study and driving.

Three licences exist for the area. The Colac Scout Group have a scout camp in the forest on an Occupation Licence. The Colac branch of the Field and Game Association have a similar licence for a club house and shooting facilities and there is also a motorcycle trail track these sites are located well away from the area that could be impacted by the proposal. There is no specific information about recreation use of the creek and its environs.

The private land is probably also used for recreation but to a much smaller degree. The land owners may be involved and potentially it could be a significant reason for maintaining ownership as much of the forested land has low forestry and agricultural potential.

The forests are used for collecting firewood. This activity can have a recreation component.

5.7.4 Recreation Potential

Although the Barongarook block may be less attractive for recreation than the adjacent regional park, it probably offers complementary opportunities. The occupation licences and accommodation in the westland block is an example of activities that may not be compatible with the objectives of a regional park.

The Land Conservation Council report (1976) includes the following comment:

"RECREATION

The public land has a moderate capability for this use. There are no outstanding features of a recreational interest, but the natural bushland combined with the relatively subdued terrain and the proximity to Colac will result in an increased recreational use in the future."

Pitt (1981) comments of the Yeodene land system that "most of the area remains in a fairly natural state and constitutes a significant area of natural vegetation near Colac, its potential for recreation is at present not fully utilized."

5.7.5 Conclusion

Recreation appears to be based on the open forest and woodlands that have high floristic diversity. The opportunities are probably complementary to those in adjacent parks and forest. Landscape quality and aesthetics are probably very important. Activities that damage the vegetation in the area and reduce the visual quality would also reduce the recreational potential of the area.

6. ADEQUACY OF THE EXISTING INFORMATION

This report suggests that the effects of the projects in the recharge area will be restricted to the creek, the riparian vegetation and areas where trees tap groundwater (Sections 3 and 4). Information on the flora and fauna of the area is available in broad terms (Sections 5.4 and 5.5). Landscape and recreation aspects are also discussed (Sections 5.6 and 5.7).

From this base it appears that there could be quite rapid changes to the creek and its environs as a result of the artificial rechange scheme but the scheme would have little or no impact on adjacent forest. The Barwon Downs Groundwater pumping program could have wider effects on the creek and some parts of the forest. The effects are likely to be chronic but could, in the end, result in significant changes. The information currently available shows that the area has sufficient environmental value to warrant some concern.

The existing information provided an inadequate base for determining the detailed environmental effects of the proposed projects. Specific detail is not available and the area's specific environmental values cannot be properly assessed from existing information.

The conclusion is that some specific information should be gathered to provide the detail needed and to help toward evaluating the environmental values of the area.

Lots of information could be gathered but I am mindful of time and money constraints. A vegetation study is the most important study proposed. *Inter alia* it will define the area likely to be impacted by the proposal. The fish work is already under way and a small increase in effort to improve knowledge of Boundary Creek has already been organised (Turnbridge pers. com.). The other fauna work proposed would provide information needed for assessing the values of the area. The modelling work would provide a guide to the effects of reduced flow in Boundary Creek on the Water Quality in the Barwon River. The landscape study is the only other study I propose. The changes in landscape as a result of dead and dying vegetation as the country dries may be one of the more noticeable aspects of the project.

7. PROPOSED FIELD STUDIES

7.1 VEGETATION

7.1.1 Area Affected

It is possible to determine from the structure and species composition of vegetation those forests that have developed with an interaction with groundwater tables. Mapping of these forests would define the extent of possible impact caused by falling groundwater levels.

This work is therefore essential.

7.1.2 Changes Occurring

Vegetation is always changing in response to weather patterns, insect attack, fire and so on. Change can be very low or it can occur after some catastrophic event. Sometime changes are successional or cyclic.

Falling groundwater levels will probably have an acute impact on vegetation at springs and swamps declining into chronic and marginal to trivial impact as the significance of water tables to the vegetation declines.

Permanent plots coupled with regular long term monitoring would enable an accurate description of these impacts to be made.

This too is therefore essential work.

7.1.3 Time

About 45 man days would be required for both vegetation studies.

7.2 FAUNA

7.2.1 Fish

Fish fauna is being adequately sampled in the current A.R.I. Barwon River Project. In addition recent discussions have emphasised the need to ensure that Boundary Creek is thoroughly sampled. No additional studies are needed at present. However, a minimum flow regime will need to be established should a full scale recharge program be established and this would probably involve additional field work.

7.2.2 Mammals, Reptiles and Frogs

Documentation of the abundance and species composition of these groups of animals would be needed to assess the environmental values of the area. The field work should be co-ordinated with the vegetation work to facilitate survey sites and habitat description. The need for additional work could be assessed from the results of the initial surveys. At present only the initial survey work is recommended.

7.2.3 Birds

It seems unlikely that the area affected provide an especially important habitat for birds. However there are a number of local bird watchers who may be able to provide data on the area. This information together with the results of the other studies recommended here would help a specialist decide on the needs for a specific field survey.

At this stage a bird survey is not recommended but a review by a specialist should be undertaken when additional information becomes available.

7.2.4 Time

About 50 man days would be required for these fauna studies.

7.3 WATER QUALITY MODELLING

The Rural Water Commission's water quality modelling package for the Barwon River and drainage schemes could be used to indicate the effects of reduced flow in Boundary Creek on the water quality of the Barwon River.

7.3.1 Time

About 15 man days would be required for this study.

7.4 LANDSCAPE

Vegetation on and adjacent to the creek is probably going to be effected by the project. Information from the Visual Management System has shown the significance of this area. The new procedure for the scenic assessment of rivers appears to provide a detailed way of assessing the critical landscape values involved in the area. The Boundary Creek area can be studied effectively as part of a study of the Barwon River Basin. The wide scope is needed to ensure Boundary Creek values are put into perspective.

Two alternatives are available for a landscape study.

* Extend the existing information from the Visual Management System.
* Use the procedure for scenic assessment of rivers.

The scenic assessment of rivers procedure could be justified if other uses of the information were included.

7.4.1 Time

About 5 man days would be required for the visual management system. About 35 man days (minimum) would be required for the scenic assessment of rivers procedure.

7.5 ARCHAEOLOGY

The works area for the artificial recharge scheme needs to be inspected by an archaeologist to ensure that significant archaeological sites are not damaged.

Normally this can be arranged through the Victoria Archaeological Survey. The preliminary field inspection is carried out at no charge to the client.

7.5.1 Time

About 5 man days would be required for this study.

8. EXECUTION OF RECOMMENDED FIELD STUDIES

8.1 INTRODUCTION

The proposed studies can be undertaken through agreements with other Government agencies or by non-Government agencies on a consultancy basis. There are a number of choices of detail whichever approach is taken.

8.2 VEGETATION STUDIES

The first choice would be to use Government agencies (C.F.& L) because:

(1) they have the expertise and background data basis
(2) programme is long term
(3) they may gain valuable information for their own purposes and therefore may be willing to subside the work to some extent.
(4) they will help design the program
(5) they will not recommend a needlessly complex program since they have nothing to gain by doing so.
(6) they have the flexibility to draw on a number of specialists as necessary.
(7) contract administration is simplified.

AGAINST THIS IS:

(1) Group 11 may have a harder time controlling the study program.
(2) The agency doing the work has many other commitments and may not be able to do the work in time.

8.3 FAUNA

8.3.1 Fish

A.R.I. will do this work.

8.3.2 Mammals, Reptiles and Frogs

This work could be undertaken be either government agencies or universities or private consultants or a combination.

Possibly a combination would be needed to provide expertise and get the task completed in good time.

8.4 LANDSCAPE

The visual management assessment could be undertaken by C.F.& L.

The scenic assessment of rivers would probably need the services of the consultant who developed the system however a joint program may be possible.

8.5 ARCHAEOLOGY

The Victoria Archaeological Survey normally undertakes the primary field assessment.

8.6 COMMENT

A detailed study brief should be prepared for each approved study. Implementation options can be fully developed after the study is approved in principle.

Study briefs, options for implementation and budgets could be presented to Group 11 in a single document to facilitate discussion and approval.

abc1d226

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TEL : BH 052312479
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14th October, 1986

Mr. Quentin Farmer-Bowers,
Rural Water Commission,
590 Orrong Rd.,
ARMADALE 3143

Dear Quentin,

I have particular interest in the bush area at Barongarook. I am a member of the Colac Field Naturalists Club and a keen amateur photographer. I am able to pursue both interests in this area.

I believe this area contains a wide variety of plant life, birds and no doubt native animals.

Because of my interest in photography, I have been able to locate but not always identify orchids growing in the forest. I have listed some below.

Glossadia major	- waxlip orchid
Caladenia menziesii	- hare orchid
Caladenia congesta	- black tongue caladenia
Chiloglottis reflexa	- veined spider orchid
Acianthus caudatus	- mayfly orchid
Acianthus reniformus	- mosquito orchid
Acianthus exsertus	- gnat orchid
Dipodium punctatum	- hyacinth orchid
Gastrodia sesamoides	- cinnamon bells
Cryptostylis subulata	- large tongue orchid
Caladenia carnea	- pink fingers
Eriochilus cucullattus	- parson bands
Corybas unguiculatus	- small helmet orchid (pelicans)
Pterostylis nutans	- nodding greenhood
Pterostylis longifolia	- tall greenhood
Pterostylis nana	
Diuris longifolia	- wall flower orchid

This list is far from complete as I have noted sun orchids, leek orchids, small greenhood and bearded orchids which I cannot put name to.

This modest list in itself suggests that this area may be of some botanical interest.

Yours sincerely,

JOE HUBBARD

EFFECTS OF AQUIFER PUMPING ON TREES IN THE INTAKE AREA: SOME PRELIMINARY THOUGHTS

1. If the water table below the trees is deep (beyond rooting depth):

-no effect is likely. Rainfall, infiltration and runoff in the forest should not be affected, so the root zone will remain just as wet for the same period as under pre-existing conditions. The trees will not be required to adapt to a changed environment.

2. If the water table is within reach of tree roots (perhaps 3 to 5 m; but possibly as deep as 25 m):

-water supply to the trees during summer will be reduced. Dieback of tree crowns is a possibility, also long term species change.

-the profile may dry out earlier in spring leading to increased competition for water among the shallower-rooting species, with similar effects.

Monitoring then should begin by assessing the water table depth and root zone depth beneath the forest. If phreatophytic water uptake is a possibility, monitor soil moisture profiles through the rooting zone before, during and after the pumping test - by neutron probe?

Tree effects - dieback symptoms may not develop to a measurable extent during the first summer; in any case they will be difficult to quantify and there is a problem of distinguishing water table effects from climatic and other external effects. Leaf water potentials would provide a more precise measure of the effects of reduced water availability if it occurs, but their interpretation would require a suitable control population not subject to water table changes, or a pre-treatment characterisation period of several years.

BY Dr. J. MORRIS

CLAYTON VICTORIA AUSTRALIA 3168
TELEPHONE: 03 541 0811 TELEGRAMS: Monashuni Melbourne
TELEX: Monash AA 32691

DEPARTMENT OF ZOOLOGY

3 October 1986

Quentin Farmar-Bowers
Rural Water Commission of Victoria
590 Orrong Road
Armadale 3143

Dear Quentin,

I am only able to comment on the mammals inhabiting the Boundary Creek area. Some years ago (1974) I trapped this area. Capture rates were poor, suggesting that most ground-dwelling mammals were in low abundance.

The range of mammals caught was typical of open dry forest to the north of the Otways: Antechinus stuartii, Rattus fuscipes, and in riparian areas, Rattus lutreolus. Sminthopsis leucopus may also occur in the area. Of these the most likely affected would be Rattus lutreolus. This species has an extensive distribution in eastern Australia and is common at many sites.

The loss of springs may have some effect on the abundance of the macropods, Macropus giganteus and Wallabia bicolor, especially the latter which is often found near riparian vegetation. But again, they are common and widespread species.

Murray Littlejohn at Melbourne University has worked on the frogs in this area and could be of some help to you. As far as the mammals are concerned, I can not see a case for objection.

Yours sincerely,

A.K. Lee
Associate Professor in Zoology

THE UNIVERSITY OF MELBOURNE
Department of Zoology

25 October 1986

Mr Q. Farmar Bowers
Rural Water Commission of Victoria
590 Orrong Road
ARMIDALE, VICTORIA 3143

Dear Mr Farmar Bowers:

Many thanks for the information about the Barwon Downs Wellfield. I have carried out extensive field work (only during autumn) on amphibian populations to the west and southwest of the aquifer recharge site. This work has been done in association with Dr G.F. Watson (Senior Lecturer in Zoology). We are not, however, familiar with the area of concern, and so cannot make any specific comments about its significance for amphibians.

Dr Watson and I would be glad to assist the Commission in surveying the area. We are leaving for New Zealand tomorrow, for two weeks of field work on an introduced southeastern Australian frog (*Litoria ewingi*), which was introduced from Tasmania in 1875, and will contact you soon after our return (9 November).

Please accept my apologies for the delay in replying - I have been kept very busy with lectures.

Yours sincerely,

M.J. Littlejohn
Reader in Ecology

Parkville, Victoria 3052, Australia. Telephone 03 (+61 3) 344 6244 Telex AA35185 UNIMEL Cables UNIMELB

********* List of birds recorded from 10 minute block : 38'25'S. 143'35'E. ********* Species No. Order

125 species. 8 species breeding. 735 observations. 28 list(s) 3 incidental observations.

Sp#	type	#obs	obs%	#inc	#br	Species
34	U	7	25.0			Common Bronzewing
53	U	1	3.6			**Baillon's Crake**
56	U	1	3.6			Dusky Moorhen
58	U	9	32.1			Purple Swamphen
59	U	9	32.1			Eurasian Coot
60	U	2	7.1			Great Crested Grebe
61	U	6	21.4			Australasian Grebe
62	U	3	10.7			Hoary-headed Grebe
96	U	9	32.1			Great Cormorant
97	U	3	10.7			Little Black Cormorant
99	U	4	14.3			Pied Cormorant
100	U	3	10.7			Little Pied Cormorant
101	U	2	7.1			Darter
106	U	10	35.7			Australian Pelican
123	U	14	50.0			Silver Gull
133	U	10	35.7			Masked Lapwing
135	U	7	25.0			Banded Lapwing
178	U	1	3.6			**Glossy Ibis**
179	U	8	28.6			Sacred Ibis
180	U	9	32.1			Straw-necked Ibis
181	U	4	14.3			Royal Spoonbill
182	U	9	32.1			Yellow-billed Spoonbill
185	U	1	3.6			Little Egret
187	U	11	39.3			Great Egret
188	U	16	57.1			White-faced Heron
189	U	9	32.1			Pacific Heron
192	U	3	10.7			Rufous Night Heron
202	U	2	7.1			Maned Duck
203	U	11	39.3		1	Black Swan
207	U	10	35.7			Australian Shelduck
208	U	5	17.9			Pacific Black Duck
210	U	2	7.1			Chestnut Teal
211	U	3	10.7			Grey Teal
213	U	1	3.6			Pink-eared Duck
215	U	2	7.1			Hardhead
219	U	3	10.7			Marsh Harrier
220	U	2	7.1			**Grey Goshawk**
221	U	5	17.9			Brown Goshawk
222	U	4	14.3			Collared Sparrowhawk
224	U	3	10.7			Wedge-tailed Eagle
232	U	7	25.0			Black-shouldered Kite
235	U	4	14.3	1		Australian Hobby
239	U	2	7.1			Brown Falcon
240	U	4	14.3			Australian Kestrel
254	U	2	7.1			Rainbow Lorikeet
267	U	9	32.1			Yellow-tailed Black-Cockatoo
268	U	11	39.3			Gang-gang Cockatoo
269	U	8	28.6			Sulphur-crested Cockatoo
272	U	3	10.7			Long-billed Corella
273	U	11	39.3			Galah
282	U	18	64.3		1	Crimson Rosella
288	U	9	32.1			Eastern Rosella
295	U	2	7.1			Red-rumped Parrot
322	U	13	46.4			Laughing Kookaburra
326	U	1	3.6			Sacred Kingfisher
334	U	5	17.9			White-throated Needletail
335	U	2	7.1			Fork-tailed Swift
337	U	2	7.1			Pallid Cuckoo
339	C	1	3.6			Brush Cuckoo
342	U	1	3.6			Horsfield's Bronze-Cuckoo
357	U	16	57.1			Welcome Swallow
359	U	1	3.6			Tree Martin
360	U	3	10.7			Fairy Martin
361	U	20	71.4			Grey Fantail
362	U	2	7.1			Rufous Fantail
364	U	9	32.1			Willie Wagtail
366	U	2	7.1			Satin Flycatcher
369	U	4	14.3			Restless Flycatcher
377	U	1	3.6			Jacky Winter
380	U	7	25.0			Scarlet Robin
382	U	4	14.3			Flame Robin
383	U	1	3.6			Pink Robin
392	U	9	32.1			Eastern Yellow Robin
398	U	5	17.9			Golden Whistler
401	U	3	10.7			Rufous Whistler
405	U	2	7.1			Olive Whistler
408	U	13	46.4			Grey Shrike-thrush
415	U	15	53.6			Australian Magpie-lark
416	U	3	10.7			Crested Shrike-tit
424	U	10	35.7			Black-faced Cuckoo-shrike
447	U	4	14.3			White's Thrush
453	C	0	0.0	1		**White-throated Gerygone**
470	U	1	3.6			Striated Thornbill
471	U	1	3.6			Yellow Thornbill
475	U	6	21.4			Brown Thornbill
484	U	2	7.1			Buff-rumped Thornbill
486	U	4	14.3			Yellow-rumped Thornbill
488	U	6	21.4			White-browed Scrubwren
509	U	1	3.6			Rufous Songlark
521	CU	2	7.1	1		Rufous Bristlebird
524	U	2	7.1			Clamorous Reed-Warbler
529	U	14	50.0			Superb Fairy-wren
547	U	5	17.9		1	Dusky Woodswallow
549	U	1	3.6			Varied Sittella
558	U	8	28.6			White-throated Treecreeper
565	U	1	3.6			Spotted Pardalote
574	U	8	28.6			Silvereye
578	U	10	35.7			White-naped Honeyeater
591	U	4	14.3			Eastern Spinebill
593	C	1	3.6			Tawny-crowned Honeyeater
614	U	12	42.9			Yellow-faced Honeyeater
617	U	6	21.4			White-eared Honeyeater
625	U	3	10.7			White-plumed Honeyeater
630	U	4	14.3			Crescent Honeyeater
631	U	5	17.9			New Holland Honeyeater
634	U	8	28.6			Noisy Miner
637	U	2	7.1			Little Wattlebird
638	U	17	60.7			Red Wattlebird
662	U	4	14.3			Red-browed Firetail
694	U	6	21.4			Pied Currawong
697	U	3	10.7			Grey Currawong
702	U	4	14.3			Grey Butcherbird
705	U	17	60.7		2	Australian Magpie
868	U	2	7.1			Forest Raven
930	U	5	17.9			Australian Raven
954	U	9	32.1			Little Raven
957	U	8	28.6			Feral Pigeon
976	U	1	3.6			Striated Pardalote
977	U	2	7.1			Cattle Egret
991	U	14	50.0		2	Blackbird
993	U	7	25.0			Skylark
995	U	16	57.1			House Sparrow
996	U	12	42.9		1	European Goldfinch
997	U	1	3.6			European Greenfinch
999	U	17	60.7		1	Common Starling

significant species ± associated with.

Colac grid

********* List of birds recorded from 10 minute block : 38°25'S. 143°45'E. ********* Species No. Order

127 species. 23 species breeding. 785 observations. 29 list(s) 17 incidental observations.

Sp#	type	#obs	obs%	#inc	#br	Species
9	U	4	20.0			Stubble Quail
34	U	4	20.0			Common Bronzewing
43	E	1	5.0			Crested Pigeon
46	U	1	5.0		1	Buff-banded Rail
56	U	4	20.0		1	Dusky Moorhen
58	U	11	55.0			Purple Swamphen
59	U	9	45.0			Eurasian Coot
61	U	4	20.0			Australasian Grebe
62	U	6	30.0			Hoary-headed Grebe
96	U	3	15.0			Great Cormorant
97	U	2	10.0			Little Black Cormorant
99	U	1	5.0			Pied Cormorant
100	U	8	40.0			Little Pied Cormorant
106	U	5	25.0			Australian Pelican
125	U	6	30.0			Silver Gull
133	U	14	70.0	1	3	Masked Lapwing
135	U	1	5.0			Banded Lapwing
144	U	2	10.0			Black-fronted Plover
168	U	3	15.0			Latham's Snipe
177	U	1	5.0			Brolga
179	U	6	30.0			Sacred Ibis
180	U	10	50.0			Straw-necked Ibis
182	U	7	35.0			Yellow-billed Spoonbill
187	U	5	25.0			Great Egret
188	U	13	65.0		1	White-faced Heron
189	U	11	55.0			Pacific Heron
192	U	1	5.0			Rufous Night Heron
202	U	7	35.0			Maned Duck
203	U	12	60.0		3	Black Swan
207	U	13	65.0		3	Australian Shelduck
208	U	10	50.0			Pacific Black Duck
210	U	3	15.0			Chestnut Teal
211	U	5	25.0			Grey Teal
212	U	3	15.0	1		Australasian Shoveler
215	U	6	30.0			Hardhead
216	U	1	5.0			Blue-billed Duck
220	U	2	10.0			Grey Goshawk
221	U	7	35.0			Brown Goshawk
222	U	1	5.0			Collared Sparrowhawk
224	U	10	50.0			Wedge-tailed Eagle
228	U	2	10.0	1		Whistling Kite
232	U	9	45.0			Black-shouldered Kite
233	C	1	5.0			Letter-winged Kite
235	U	2	10.0			Australian Hobby
237	U	1	5.0		1	Peregrine Falcon
239	U	4	20.0			Brown Falcon
240	U	1	5.0			Australian Kestrel
242	U	1	5.0			Southern Boobook
267	U	11	55.0			Yellow-tailed Black-Cockatoo
268	U	11	55.0			Gang-gang Cockatoo
269	U	11	55.0	1		Sulphur-crested Cockatoo
272	U	3	15.0			Long-billed Corella
273	U	9	45.0			Galah
281	U	2	10.0			Australian King-Parrot
282	U	14	70.0	1	1	Crimson Rosella
288	U	12	60.0			Eastern Rosella
306	U	3	15.0			Blue-winged Parrot
322	U	12	60.0			Laughing Kookaburra
326	U	3	15.0		1	Sacred Kingfisher
334	U	7	35.0			White-throated Needletail
337	U	2	10.0		1	Pallid Cuckoo
338	U	3	15.0	1	1	Fan-tailed Cuckoo
342	U	5	25.0			Horsfield's Bronze-Cuckoo
357	U	12	60.0	1	1	Welcome Swallow
359	U	2	10.0			Tree Martin
360	U	2	10.0			Fairy Martin
361	U	14	70.0	1		Grey Fantail
364	U	14	70.0	1	1	Willie Wagtail
365	U	1	5.0			Leaden Flycatcher
366	U	2	10.0			Satin Flycatcher
369	U	4	20.0			Restless Flycatcher
377	U	4	20.0	2		Jacky Winter
380	U	9	45.0			Scarlet Robin
382	U	3	15.0			Flame Robin
392	U	11	55.0			Eastern Yellow Robin
398	U	12	60.0			Golden Whistler
401	U	4	20.0		1	Rufous Whistler
405	U	1	5.0			Olive Whistler
408	U	13	65.0		1	Grey Shrike-thrush
415	U	15	75.0	1	1	Australian Magpie-lark
416	U	3	15.0		2	Crested Shrike-tit
424	U	8	40.0			Black-faced Cuckoo-shrike
447	U	1	5.0			White's Thrush
448	U	7	35.0			White-fronted Chat
470	U	9	45.0			Striated Thornbill
471	U	2	10.0			Yellow Thornbill
475	U	7	35.0			Brown Thornbill
484	U	6	30.0			Buff-rumped Thornbill
486	U	8	40.0		2	Yellow-rumped Thornbill
488	U	9	45.0			White-browed Scrubwren
524	U	2	10.0			Clamorous Reed-Warbler
529	U	13	65.0	1	1	Superb Fairy-wren
547	U	6	30.0			Dusky Woodswallow
549	U	5	25.0			Varied Sittella
558	U	7	35.0			White-throated Treecreeper
565	U	3	15.0			Spotted Pardalote
574	U	4	20.0			Silvereye
578	U	8	40.0		2	White-naped Honeyeater
583	U	2	10.0			Brown-headed Honeyeater
591	U	9	45.0			Eastern Spinebill
614	U	9	45.0			Yellow-faced Honeyeater
617	U	9	45.0			White-eared Honeyeater
625	U	6	30.0			White-plumed Honeyeater
630	U	2	10.0			Crescent Honeyeater
631	U	7	35.0			New Holland Honeyeater
634	U	13	65.0		1	Noisy Miner
638	U	6	30.0			Red Wattlebird
647	U	10	50.0			Richard's Pipit
648	U	3	15.0			Singing Bushlark
662	U	10	50.0			Red-browed Firetail
679	U	1	5.0			Satin Bowerbird
694	U	1	5.0			Pied Currawong
697	U	6	30.0			Grey Currawong
702	U	11	55.0	1		Grey Butcherbird
705	U	16	80.0	2	4	Australian Magpie
868	U	2	10.0	1		Forest Raven
930	U	6	30.0			Australian Raven
948	U	1	5.0			Mallard
954	CU	8	40.0			Little Raven
976	U	4	20.0			Striated Pardalote
977	U	4	20.0			Cattle Egret
991	U	12	60.0		2	Blackbird
993	U	6	30.0			Skylark
995	U	10	50.0			House Sparrow
996	U	13	65.0			European Goldfinch
997	U	1	5.0			European Greenfinch
999	U	14	70.0			Common Starling

Birregurra grid

ATLAS OF VICTORIAN MAMMALS

Guide For Interpretation of Printouts

Record No - within each species all records are given a unique reference number. An asterisk preceding the record number indicates that trapping details are available.

Record Type - the records are listed under two headings; specimen-backed records and non specimen-backed records. Specimen-backed records are prefixed by 'S', non specimen-backed records are prefixed by either 'O' for observation or 'L' for literature. Further descriptors of record type are:

BU	burrow
CH	captured by hand
DG	digging, scratching
DT	dead in trap
FP	tracks
FT	feed tree (e.g. for Yellow-bellied Glider)
HD	heard
HR	hair sample
ID	found dead
IP	taken from inside predator
JT	jaw trap, snare
KP	captured by domestic animal
LT	landing tree
MR	mummified remains
NB	in nest box
NF	nest tree felled
PH	photographic record
PR	polished rocks (e.g. for Rock-Wallaby)
RK	road casualty
RL	species artifically introduced to the area
RP	resting site
RS	remains from predation
SC	scat
SF	subfossil
SK	skeletal
SM	smell
SN	observed
SO	old scats
SP	observed by spotlight
ST	deliberately killed
SY	fresh scats
TC	trapped* and collected
TR	trapped* and released

* Trapping includes mist-netting and trip-lining

Date - the first date is the date the data were collected. If two dates are given they delimit the period during which the record was made.

Latitude - degrees and minutes south.

Longitude - degrees and minutes east.

Precision - gives the accuracy, in minutes, to which we were able to reliably plot the locality details provided. Usually a 1', 5' or 10' rectangle.

Reliability - our subjective assessment of the accuracy of the identification based largely upon current knowledge of the distribution and habitat of each species. 1 - confirmed, 2 - acceptable, 3 - doubtful, requires verification.

Altitude - in metres. Read from NATMAP 1:100 000 topographic series maps.

Nearest Named Place - using place names printed on NATMAP 1:100 000 topographic series maps.

Location - gives further details of the locality, usually in relation to the Nearest Named Place.

Institute - The collection in which a specimen is held. 1 = Museum of Victoria, 2 = Arthur Rylah Institute.

Identification - the specimen's registration number.

For any further enquiries contact Peter Menkhorst or Lance Williams at the Arthur Rylah Institute for Environmental Research, 123 Brown Street Heidelberg, Victoria, 3084. Telephone: (03) 459 2900.

Arthur Rylah Institute for Environmental Research
Atlas of Victorian Mammals

BARONGAROOK AREA: N EDGE 38 20'; S 38 32'; W 143 30'; E 143 45';01/10/1986

Specimen-backed Records

RECORD NO	RECORD TYPE	DATE	DATE	LATITUDE	LONGITUDE	PRECISION	RELIABILITY	ALTITUDE	STATE	NEAREST NAMED PLACE	LOCATION	INSTITUTE	IDENTIFICATION MUSEUM VIC	ARI
Platypus							**Ornithorhynchus anatinus**							
Species code 2														
245	SID	5 1969		38 30'	143 40'	5	1		VIC	BARRAMUNGA		1	16987	149
309	S	13 4 1978		38 30'	143 40'	5	1	180	VIC	FORREST	TRIBUTARY OF BARWON RIVER; NEAR ROAD	2		11710
Brown Antechinus							**Antechinus stuartii**							
Species code 14														
552	STC	28 3 1974		38 30'	143 40'	5	1	200	VIC	BARWON DOWNS	2.5 MILES SSW OF	1	13017	9519
Dusky Antechinus							**Antechinus swainsonii**							
Species code 15														
415	SCH	9 11 1967		38 30'	143 40'	5	1	300	VIC	FORREST	2 ML S	1	12587	713
Tiger Quoll							**Dasyurus maculatus**							
Species code 17														
26	S	12 8 1922		38 30'	143 40'	5	1	300	VIC	GELLIBRAND RIVER	HEAD OF; NEAR BARRAMUNGA	1	6144	
93	S	22 6 1964		38 30'	143 30'	5	1	140	VIC	GELLIBRAND RIVER	4 MILES SOUTH OF; ALONG CHARLEYS CREEK ROAD	1	9561	
120	S	20 11 1967		38 30'	143 30'	5	1	80	VIC	GELLIBRAND RIVER	AT JUNCTION WITH CHARLEYS CREEK	1	7724	
127	S	24 7 1968		38 30'	143 30'	5	1	80	VIC	CHARLEYS CREEK	JUNCTION WITH GELLIBRAND RIVER	1	8170	
133	SJT	20 5 1969		38 30'	143 40'	5	1	160	VIC	FORREST	0.8 MILES WEST OF	1	17697	908
134	SJT	29 5 1969		38 30'	143 40'	5	1	160	VIC	FORREST	0.8 MILES WEST OF	1	17683	910
135	S	31 5 1969		38 30'	143 40'	5	1	160	VIC	FORREST	0.8 MILES WEST OF	1	17705	911
136	S	7 6 1969		38 30'	143 40'	5	1	160	VIC	FORREST	0.8 MILES WEST OF	1	17684	912
137	SJT	7 7 1969		38 30'	143 40'	5	1	200	VIC	FORREST		2		956
155	SJT	27 9 1970		38 30'	143 40'	5	1	240	VIC	FORREST	0.5 MILES SOUTH OF	1	17698	7023

APPENDIX A.2: FAUNA

Specimen-backed Records

RECORD NO	RECORD TYPE	DATE	DATE	LATITUDE	LONGITUDE	PRECISION	RELIABILITY	ALTITUDE	STATE	NEAREST NAMED PLACE	LOCATION	INSTITUTE	IDENTIFICATION MUSEUM VIC	ARI
White-footed Dunnart														
Species code 23														
50	S	4 8 1970		38 30'	143 40'	5	1	200	VIC	FORREST APOLLO BAY RD	CORNER BALHARRING RD	2		5278
62	S	7 10 1967		38 30'	143 40'	5	1	200	VIC	FORREST	2 KM N	1	14021	
65	S	31 10 1963		38 25'	143 30'	5	1	80	VIC	COLAC	18 KM STH	2		518
Southern Brown Bandicoot														
Species code 31														
45	STC	5 10 1967		38 30'	143 40'	5	1	180	VIC	FORREST	NORTH OF;0.25 MILES NORTH OF CEMETARY	1	14984	126
46	STC	6 10 1967		38 25'	143 40'	5	1	200	VIC	FORREST	2 MILES NORTH OF;0.5 MILES WEST OF CEMETARY ROAD	1	14985	127
47	STC	9 10 1967		38 30'	143 40'	5	1	180	VIC	FORREST	1 MILE NORTH OF (DEAD HORSE HILL)	1	18171	129
48	STC	31 10 1967		38 30'	143 40'	5	1	180	VIC	FORREST	1 MILE NORTH OF	2		132
63	S	21 5 1969		38 30'	143 40'	5	1	160	VIC	FORREST	0.5 MILES WEST	1	18614	167
116	STC	23 3 1974		38 25'	143 40'	5	1	220	VIC	YAUGHER	1 MILE NORTH-WEST OF;	1	19748	9525
Long-nosed Bandicoot														
Species code 34														
134	STC	15 10 1967		38 30'	143 40'	5	1	200	VIC	FORREST	2 ML N OF FORREST 2 ML N OF CEMETERY	1	18497	130
135	STC	10 10 1967		38 30'	143 43'	1	1	200	VIC	FORREST	1 ML N OF CEMETERY	2		131
136	STC	1 10 1967		38 25'	143 40'	5	1	200	VIC	FORREST	HALF ML N OF CEMETERY	1	22161	125
137	STC	4 10 1967		38 25'	143 40'	5	1	200	VIC	FORREST	QUARTER MILE N OF CEMETERY	1	15011	128
152	S	30 10 1963		38 30'	143 40'	5	1	200	VIC	FORREST		1	21540	83
153	S	29 10 1963		38 30'	143 40'	5	1	200	VIC	FORREST		1	16000	84
154	S	29 10 1963		38 30'	143 40'	5	1	200	VIC	FORREST		1	16003	87
Feathertail Glider														
Species code 43														
119	SID	26 5 1969		38 31'	143 41'	1	1	200	VIC	FORREST	1 MILE WEST OF	1	14327	810

Sminthopsis leucopus

Isoodon obesulus

Perameles nasuta

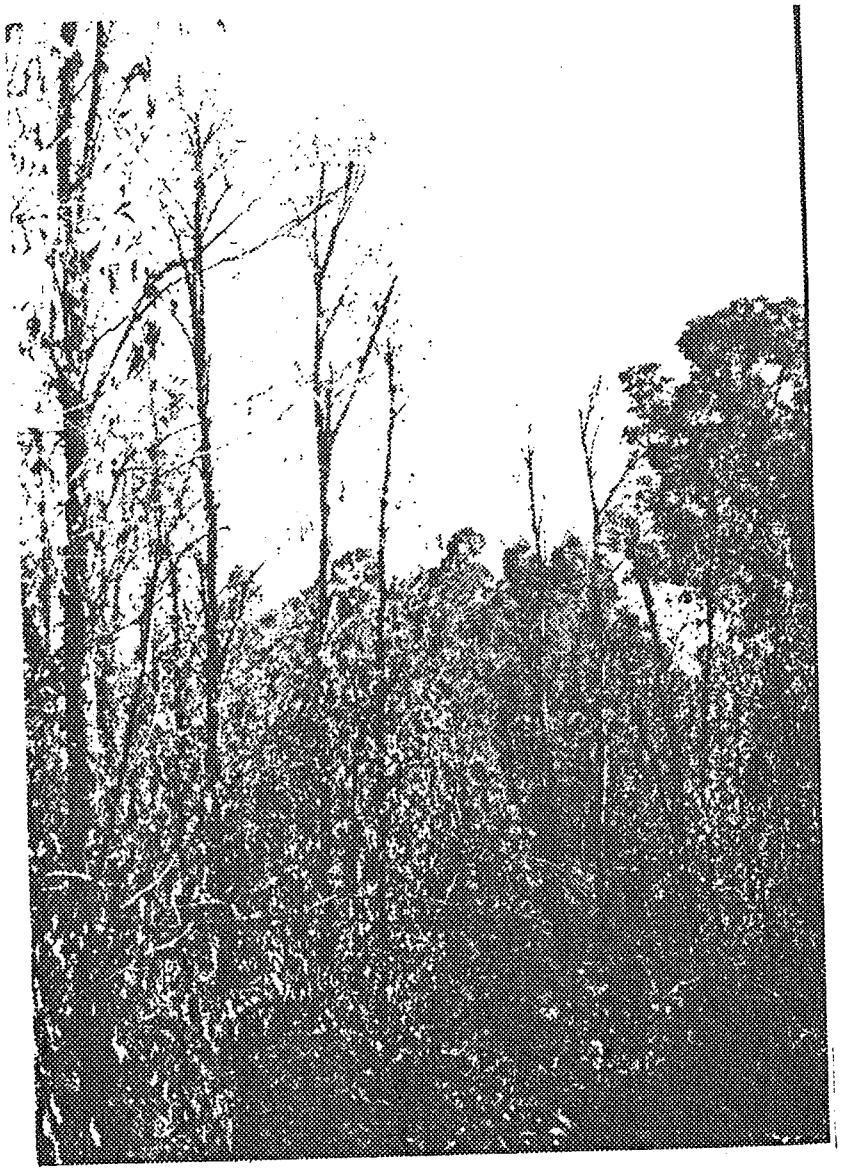
Acrobates pygmaeus

APPENDIX A.2: FAUNA

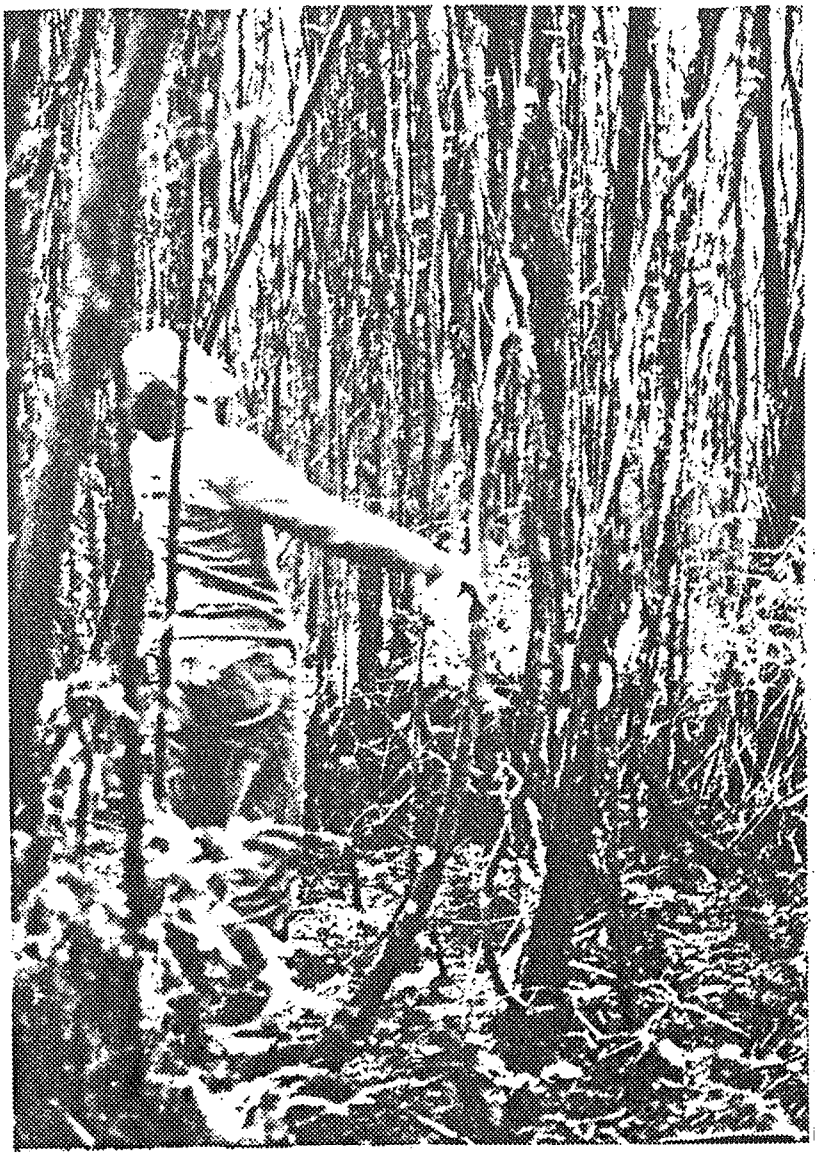
Specimen-backed Records

RECORD NO	RECORD TYPE	DATE	DATE	LATITUDE	LONGITUDE	PRECISION	RELIABILITY	ALTITUDE	STATE	NEAREST NAMED PLACE	LOCATION	INSTITUTE	IDENTIFICATION MUSEUM VIC	IDENTIFICATION ARI
Petaurus breviceps														
Sugar Glider														
Species code 53														
288	SID	5 1980		38 20'	143 30'	5	1	200	VIC	COLAC	7.5 KM SOUTH OF	2	12275	
Pseudocheirus peregrinus														
Common Ringtail Possum														
Species code 54														
413	SSK	10 1967		38 30'	143 40'	5	1	180	VIC	FORREST	1 MILE NORTH OF	1	19110	8489

Water ponded on Westwood Track (above) and near Westwood Road (below). Near-surface layers are slowing infiltration rates as groundwater levels are probable more than 30 m below the surface (photos taken 7 Oct. 1986).



Severe defoliation of peppermint trees near Westwood Road leading to dieback. The messmate stringybark in the background is undamaged. The trees have been burnt probably in a fuel reduction burn. The outbreak of Psyllids (Lerp insects) in the forest is extensive.

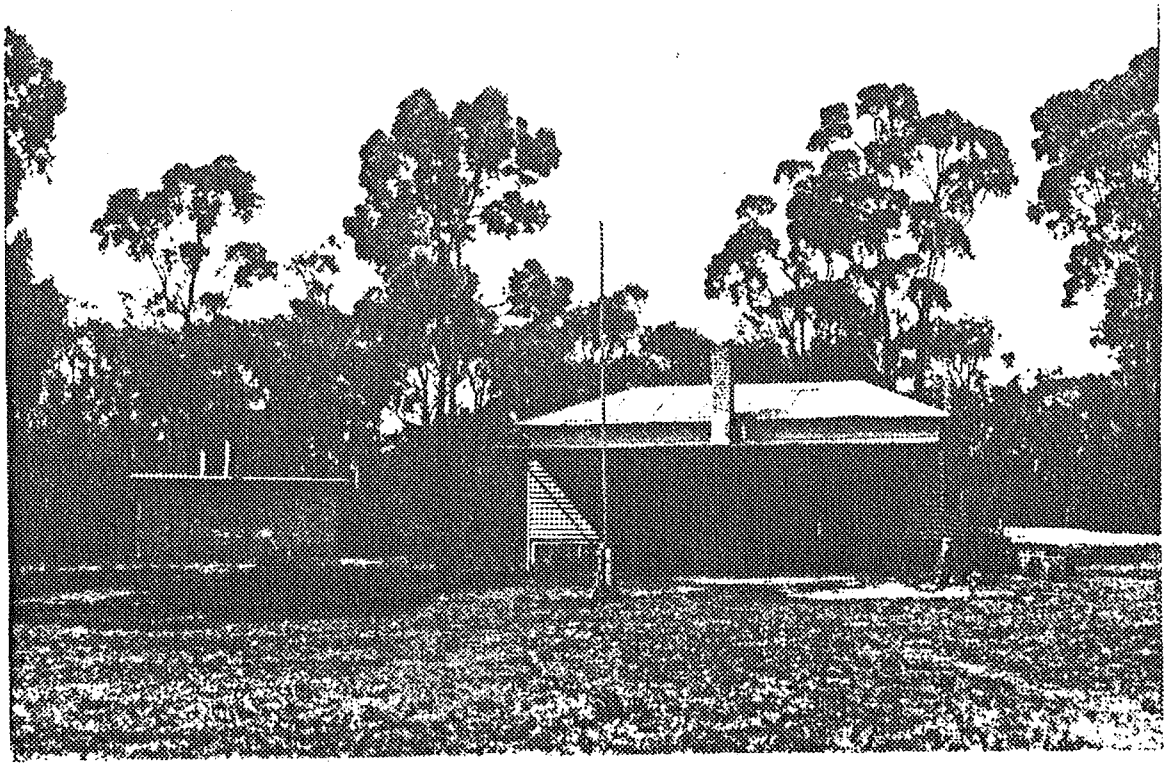


Riparian vegetation at Boundary Creek. Extensive tee-tree swamp protects the organic soils from washing away during floods.

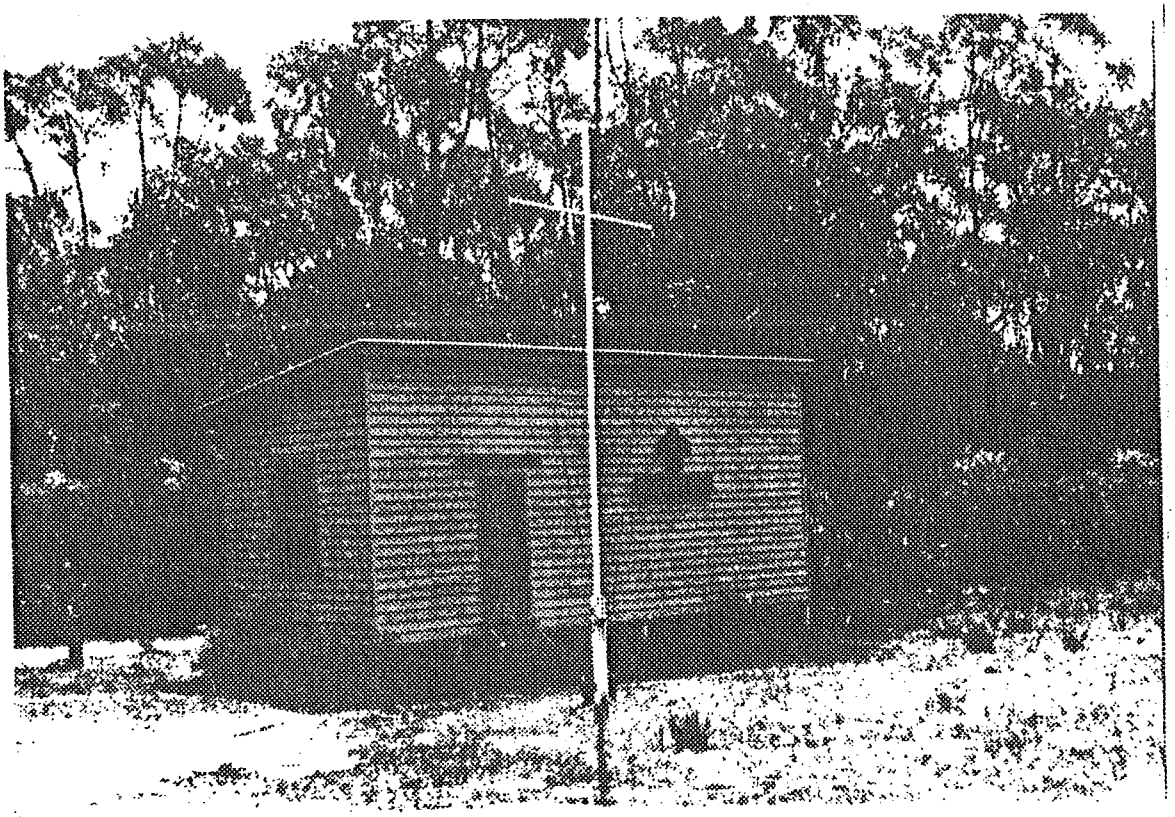
The riparian vegetation is clearly defined (on the left) by the change in slope and soil/water conditions. Boundary Creek, 7th Oct. 1986.

The edge of the riparian vegetation is dense. Wire grass and ferns are common. (Boundary Creek 7 October 1986)

Ringtail possum nest in the riparian vegetation on Boundary Creek (with resident possum!). There are many possum nests in the tee-tree swamp.



Some of the facilities for the 1st Colac Scout Group



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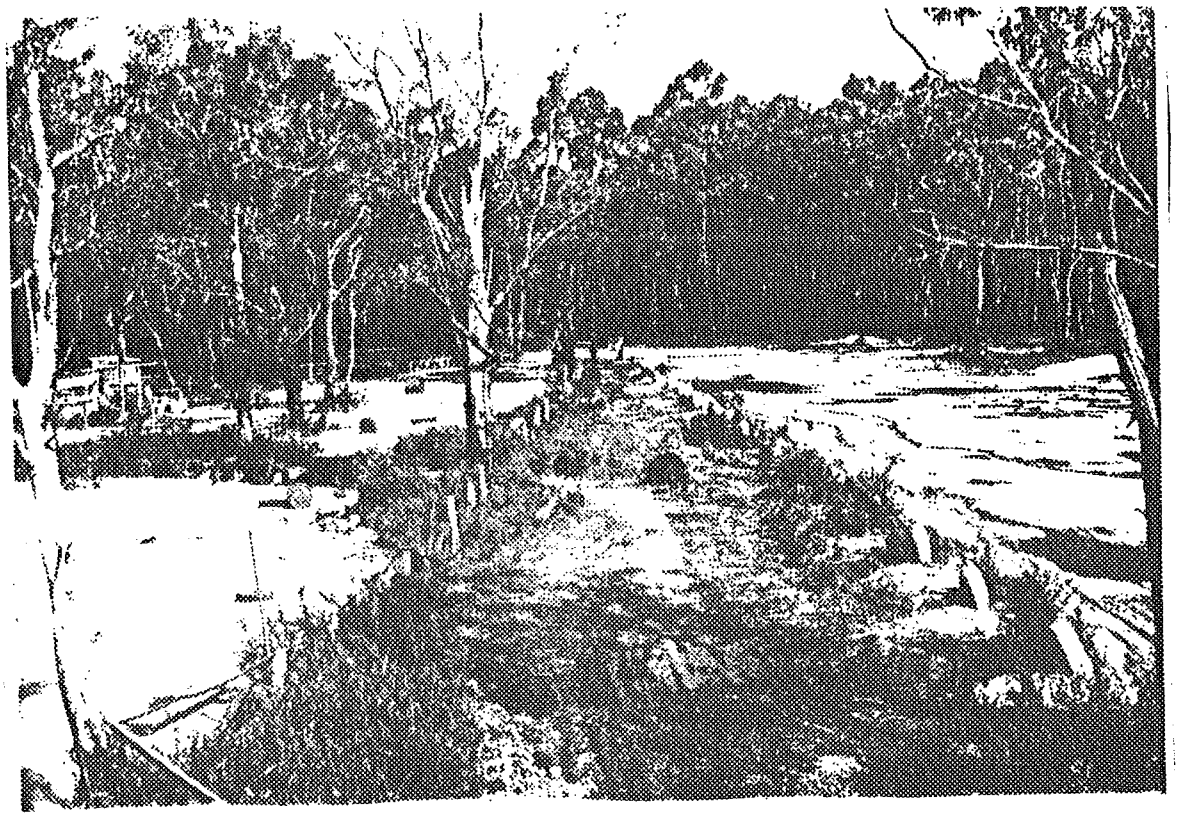
The trail bike circuit off Westwood Track. Proximity to Colac is an important consideration for recreation in the forest.