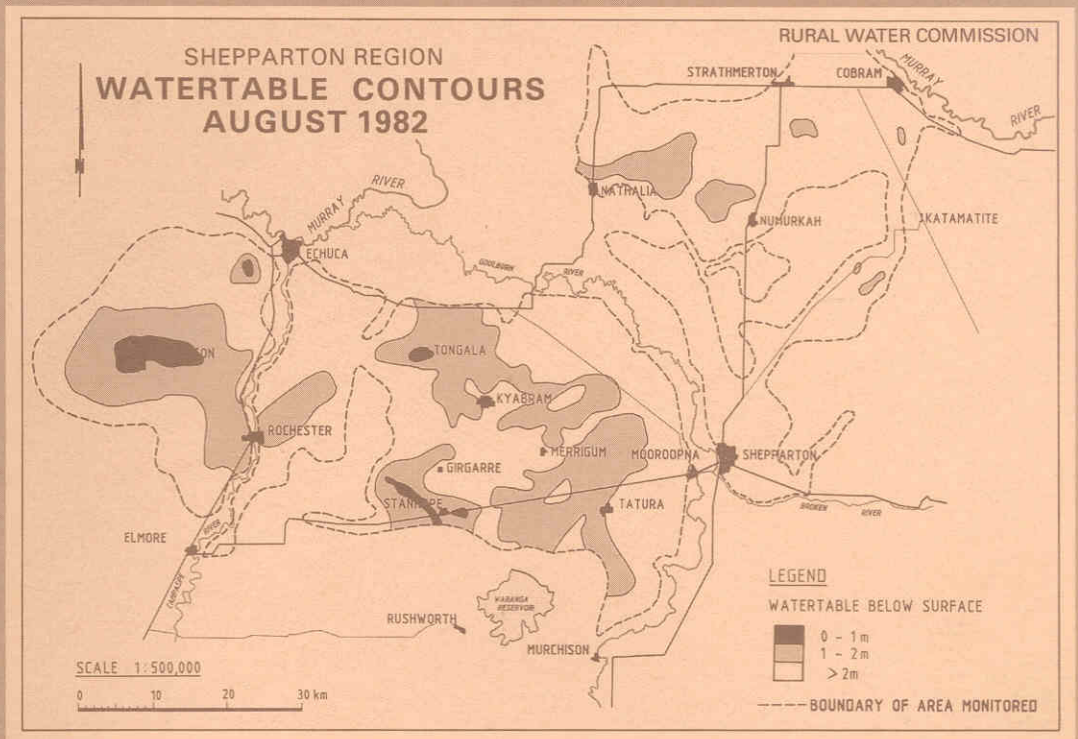
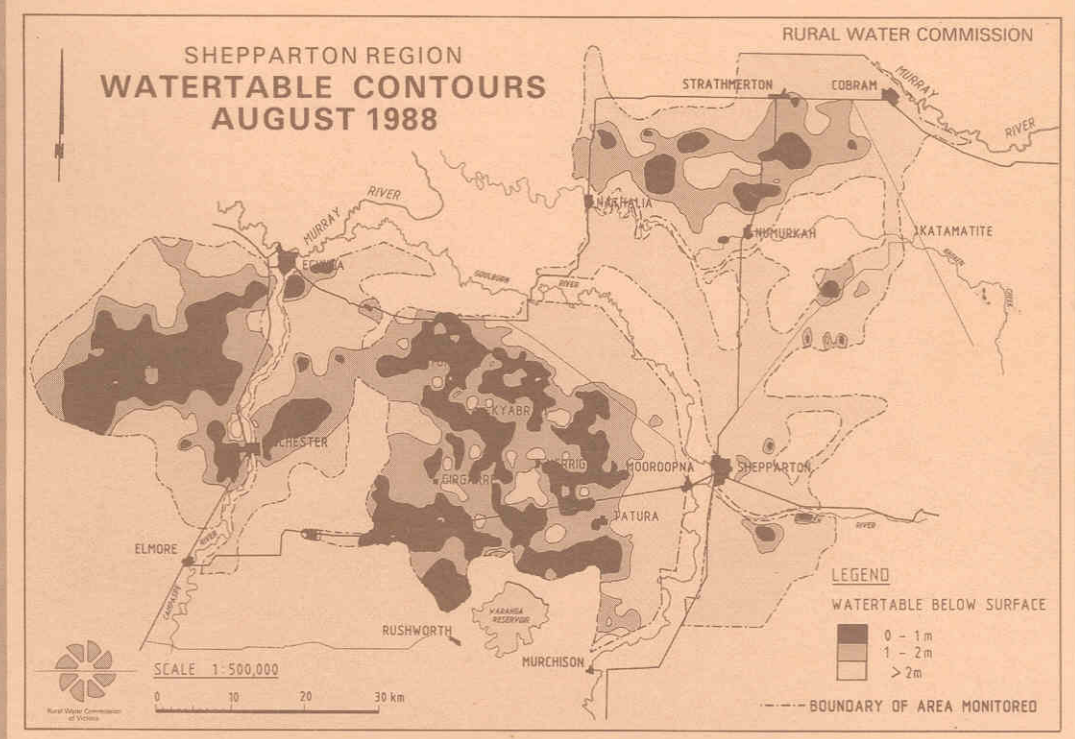
SHEPPARTON
LAND AND WATER
Salinity Management Plan





Salinity Pilot Program Advisory Council

DRAFT

August 1989

SALT ACTION VICTORIA

TERRY BATEY
Oct. 99.

DRAFT

SHEPPARTON IRRIGATION REGION

LAND AND WATER SALINITY

MANAGEMENT PLAN

AUGUST 1989

GOULBURN BROKEN REGION
SALINITY PILOT PROGRAM ADVISORY COUNCIL

PREFACE

The Goulburn Broken Region Salinity Pilot Program Advisory Council was constituted in 1986 as an initiative of the Victorian State Government. SPPAC's objectives were to:

- identify the salinity problems in the Goulburn Broken Catchment;
- alert the catchment community to the identified problems; and
- develop acceptable management plans to address these problems.

SPPAC has liaised extensively with all sectors of the catchment community, utilised the expertise of Government Departments and engaged consultants in an attempt to produce environmentally sound, socially just, economically responsible and affordable Management Plans.

Separate Plans have been developed for the Dryland and Irrigation Areas but SPPAC has identified the linkages between the two and has recommended that working groups be established to address any issues that cannot be resolved by action in the dryland or irrigation areas alone.

The Shepparton Land and Water Salinity Management Plan is a comprehensive plan Where insufficient Information was available for long term planning, research and investigation programs have been recommended. Consequently, the Plan will require ongoing review and modification as new information and technology becomes available.

The Draft Plan represents two years of constant input from SPPAC councillors, the Irrigation Sub-committee and departmental officers after consutation with the community. I would like to take this opportunity to thank all individuals and organisations who have contributed to what I believe represents the "last chance" to maintain the environment and the productive capacity of the Shepparton Irrigation Region.

SPPAC believes it has met its objectives. We look forward to receiving written comment on the plan from individuals and organisations. SPPAC needs written responses so that it can negotiate with government, after receiving evidence of regional community support, to implement the Plan (or a revised version of it).

JOHN DAINTON
Chairman
SPPAC

FOREWORD

Salinity of land and water threatens the future of the Shepparton Irrigation Region. Without concerted action by many sections of the community, the environment of the region will continue to deteriorate.

Recognising this problem and associated salinity problems in other parts of Victoria, the State Government has established the statewide salinity program, Salt Action, and last year endorsed the long-term salinity strategy, Salt Action: Joint Action. The strategy emphasises the importance of the Government working closely with the local community if the salinity threat is to be properly tackled.

Already in the Shepparton Region much has been achieved. Local Government and landholders are taking action as their awareness of the salinity problem increases. Parts of the horticultural land are protected by groundwater pumping, the Girgarre Scheme has commended, the Irrigation Grants Scheme has been extended to assist private groundwater pumping, together with community drainage and farm planning, the SEC Salinity Assessment Scheme has been launched and relevant research and investigation has been accelerated.

However, there has remained the challenge of drawing these initiatives and other desirable actions together into a long term, sustainable salinity management plan for the region, and linking the regional activities to the interstate Murray-Darling Basin Salinity and Drainage Strategy. This Draft Plan is a response to that challenge.

It has been prepared over a two year period by the Goulburn-Broken Region Salinity Pilot Program Advisory Council, representing the regional community, assisted by specialists from Government agencies and independent consultants. They have taken into account Government guidelines for the preparation of salinity management plans throughout the State.

The Draft Plan is a tribute to the remarkable commitment to the task by many people in the Shepparton Region. The Government is grateful for their time and effort. I particularly thank Mr. John Dainton, Chairperson of the Advisory Council, and Mr. Leon Heath, Chairperson of the Irrigation Sub-Committee of the Council, for their leadership of the project.

The Draft Plan is now released for consideration by the wider regional community, together with local, State and Federal Governments and the Murray-Darling Basin Commission. The Advisory Council and Victorian Government will welcome any suggestions on how the Draft Plan can be improved. At the end of the review period, the Government, in consultation with the Advisory Council, will finalise the details of the joint action Plan, including the Government's contribution. The Final Plan will then be implemented and periodically assessed in the light of the monitoring program and ongoing research and investigations.

I congratulate the Advisory Council on the preparation of this Draft Plan and look forward to a resolution later this year of the Final Plan, and to its successful implementation for the long term benefit of the region and Victoria.

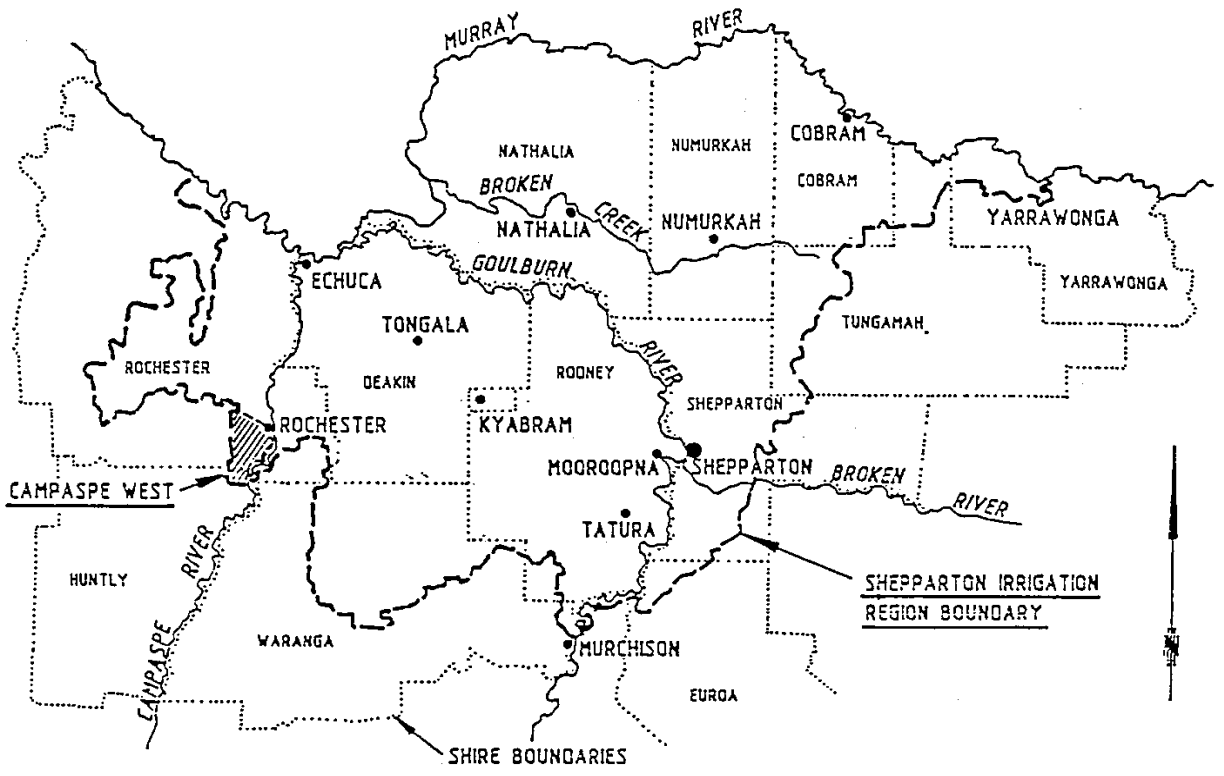
Evan Walker,
Chairperson, Rural Affairs Conservation and Environment Committee of Cabinet,
Victoria
August, 1989

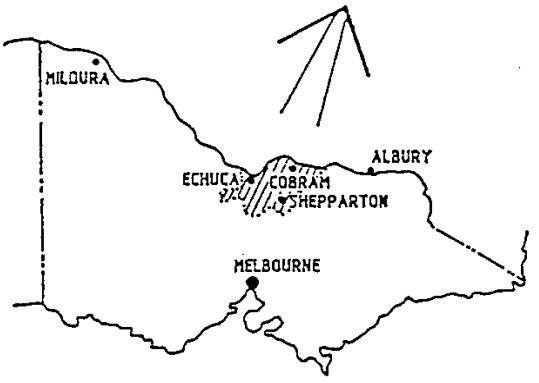
TABLE OF CONTENTS

THE PLAN

LIST OF TABLES

LIST OF FIGURES





SHEPPARTON LAND AND WATER SALINITY MANAGEMENT PLAN

GENERAL LOCALITY PLAN

SUMMARY

OBJECTIVES OF THE PLAN

The development of this Plan has been controlled by four major objectives namely:

1. The Environmental Objective: The Plan is to address current and future environmental problems resulting from high watertables and salinity within the Region. On balance, salinity control activities are to maintain and where possible, enhance existing ecological processes.

2. The Social Objective: Wherever possible, the Plan is to provide the community with equal access to decision making and the economic resources required to implement salinity control works. The Plan will reduce inequities resulting from uncontrolled salinity impacting differently on individuals.

3. The Economic Objective: Where works are undertaken to protect the Region from high watertables and salinity, the value of their benefits, both measurable and non-measurable, should exceed their costs.

4. The Financial Objective: The Plan is to be both equitable and affordable to the individual, the regional community and the nation, now, and in the future.

THE SALINITY PROBLEM

The Shepparton Irrigation Region came into being as a consequence of a series of Government initiatives from the 1860's onwards.

It now:

- covers some 0.5 million hectares;
- includes all or part of 15 local government areas;
- contains some 100,000 people, mostly in thriving urban areas;
- is growing at about the same rate as Victoria as a whole; and
- produces some $2,600 million in output each year.

The high watertable problems being experienced in the Region occur as a consequence of the major change in the hydrologic cycle of northern Victoria which commenced with the clearing of the forests of the middle and upper watersheds from the 1850's onwards. The change was exacerbated with the subsequent introduction of irrigation. This change in the hydrologic cycle is fundamentally irreversible.

High watertables now underlie some 188,000 ha. (36%) of the Region and are projected to extend to 274,000 ha (55%) of the Region within the next 30 years. The physical impacts of these high watertables on the social, environmental and economic characteristics of the Region will be substantial.

Environmental Impacts

The main impact of increasing salinity on major rivers over the planning period will be the destabilisation of the river banks due to saline seepage from the high watertable. The smaller streams will have such high salinity concentrations at various times of the year that few aquatic flora and fauna will be able to survive in them. Saline seepage into the streams will kill the riparian vegetation and precipitate bank erosion and bed widening.

The only wetlands that won't be seriously degraded by increasing salinity will be those along the river floodplains which will be protected by biannual flooding. On the wetland margins Red Gum will be replaced by lignum and saltbush, as has occurred at Kerang.

The first group of wetlands to become completely degraded will be the deflation potholes. The combination of saline groundwater intrusion, surface evaporation and a lack of flushing will cause the deflation potholes to become perennially saline, and eventually hypersaline lakes.

The Corop - Timmering Depression - Kanyapella system is underlain by very saline, rapidly rising groundwater. Marked degradation could be expected in as little as 8 to 12 years.

The other wetlands will degrade over 10 to 30 years, depending on the rate of rise and salinity of the watertable, and the salinity of stream inflows.

Remnant vegetation along streams, depressions and on the Plains will continue to decline due to waterlogging, salinity, old age and insect attack.

Socio-economic Impacts

High watertables and increasing salinity will result in large losses of agricultural output throughout the Region. In the minimum case, these losses (calculated using govt. guidelines) will rise from $27 million per annum (1989 values) in the year 2000 to $40 million per annum in the year 2025.

SPPAC has provided an alternative evaluation (based on what it considers are more realistic economic parameters) which shows that the economic losses from salinity in the Shepparton Irrigation Region would rise from $47 million per annum in the year 2000 to $120 million per annum in the year 2025.

As all marginal dairy production from the Region is exported, the above losses represent actual export income losses of $52 million per annum in the year 2000 and $78 million per annum in the year 2025. During the evaluation period of the project, total export income losses would be in excess of $3,000 million.

These losses are merely the economic value of agricultural output foregone. The regional effects of these losses on processors, suppliers and the service sector in the Region will be devastating. Thus, total losses in income (wages and salaries) paid to households is projected to rise from $22 million per annum in 2000 to $49 million per annum in 2025.

This reduction in wages and salaries paid will manifest itself in job losses - 1,600 lost jobs by 2000, 3,500 lost jobs by 2025. These lost jobs will remain just that, forever. A lost job cannot be "replaced". These losses in employment will fall disproportionately on farmer numbers and the small towns of the Region such as Stanhope, Kyabram, Tatura, Rochester, Merrigum, Nathalia and Tongala.

Farm incomes which presently average 94% of Average Weekly Earnings (AWE) are projected to fall to 58% of AWE by the year 2000 and only 26% of AWE by 2025.

THE SALINITY MANAGEMENT PLAN

The recommended Plan has been chosen after extensive and detailed evaluation of a wide range of options, all of which are presented in the Plan and its accompanying papers. In evaluating the Plan, SPPAC continually tested the options against the objectives outlined above.

Farm Program

The farm program allows farmers to proceed with farm improvement activities as and when required and seeks to achieve the following targets:

(a) the completion of whole farm plans for every farm in the Region;

(b) landforming and farm drainage on 75% of the perennial pasture and 50% of the annual pasture. The total area requiring treatment is 106,000 ha. The total capital cost is $137M with an annual cost of $2.6M. An incentive program which provides 10% of the capital outlay is proposed.

(c) drainage reuse systems installed on 50% of the farms in areas which are not currently drained at a total capital cost of $13.2M and an annual cost of $1.6M. An incentive program which provides 30% of the capital outlay is proposed.

(d) a further 250 private, moderate to high capacity groundwater pumps at a total capital cost of $10.8M. A capital grant of 20% is proposed as well as a continuation of the Groundwater Pumping Incentive Scheme and the Groundwater Exploration Scheme.

(e) private tile drainage schemes or low capacity groundwater pumps installed on 2800 ha to protect the productive capacity of up to 8000 ha in areas difficult to implement salinity control, at a total capital cost of $8M. An incentive program which provides 20% of the capital outlay is proposed.

(f) within farm restructuring to allow irrigators to concentrate water on their better land to optimize productivity. This will play a vital role in areas where salinity control is difficult.

(g) a water pricing system to encourage the use of alternative sources of irrigation water (eg. groundwater and drainage water).

(h) a farm tree program designed to ensure 14,000 ha (equivalent to 5% of the Irrigated area) is planted to trees at a total cost of $45.6M. An incentive of 30% of the total capital outlay is proposed.

Sub-surface Drainage Program

It is estimated that 274,000 ha of the Region will have high water tables by the year 2020. About 20,000 ha of this will be protected by existing sub-surface drainage activities. Sub-surface drainage will be provided by activities of individual farmers under the Farm Program and by community activity in Priority Project Areas where pump operation will be managed to provide seasonal watertable control in conjunction with regulated disposal of salt both within the Region and to the River Murray. The Plan provides for the following sub-surface drainage activities as Priority Project Area works:

(a) 85,000 ha will be protected via a 30 year, $35M program of installing 426 public groundwater pump units and some 50 evaporation basins.

(b) A further 85,000 ha will be protected by providing management arrangements and salt disposal opportunities for 395 existing and 365 new private groundwater pumps (150 of the new pumps are expected to be installed as part of the farm program).

(c) Tile drainage and low capacity groundwater pumps are proposed for a further 11,200 ha to protect the productive capacity of up to 35,000 ha in the difficult to pump areas.

The total capital cost of the Priority Project Area sub-surface drainage is $26.9M.

Surface Drainage Program

The Plan proposes a program of works that will provide the entire Region with surface drainage of varying standards within 20 years. The means by which this will be achieved are shown below.

Surface Drainage Strategies	**Area Drained ha**	**%**	**Capital Costs $million**
Existing RWC drains	183,100	35	N/A
New RWC drains	74,600	14	116.1
Community Drains	236,200	46	47.3
Water Harvesting, with channel discharge	13,400	3	10.2
Water Harvesting, without channel discharge	12,700	2	8.6
Length of Drainage Course Declarations (km)	343		11.1
Additional work require (outfall upgrading etc)			29.1
TOTAL	**520,000**	**100**	**$222.4M**

Environmental Program

The following environmental protection activities have been included in the Plan.

(a) Floodplain wetlands of high value and will be protected by the construction of suitable drainage outfalls, drainage re-use and water allocation for flushing, at a total cost of $9.0 million.

(b) Riverbanks will be protected by provision of groundwater control along 21km of Goulburn and Campaspe river frontages at a cost of $2.1 million.

(c) Existing wetlands along drainage courses will be protected by modification of drainage alignments. The surface drainage program includes $3.8 million for this purpose.

(d) New wetlands along drainage courses will be created by developing a significant number of meander loops as cut-off wetlands. The surface drainage program includes $2.0 million for this purpose. Incentives will be required to encourage landholders to maintain these areas as high quality wetlands.

(e) Isolated wetlands of high conservation value, totalling about 100, will be protected by a variety of methods including flushing, diversion works, groundwater control and the establishment of fringe vegetation at a total program cost of $10 million.

(f) Streams will be protected from salinity by establishing treed buffer zones on both banks. About 1500 km of streams will be protected by this means at a cost of $15.0 million.

(g) A Farm Tree Program designed to ensure 5% (14,000 ha) of the Region is planted to trees at a cost of $45.6 million.

(h) Research, Investigation and Monitoring to the value of $8.7 million will be allocated to support the above activities.

RIVER MURRAY SALT DISPOSAL

The total salt disposal quota required by the Plan for surface and sub-surface drainage is 19.4 EC. Groundwater reuse within the Region has been maximised and evaporation basins will be used for disposal of very saline groundwater. The total pumping requirement has been reduced to minimise salt disposal requirements by accepting limited watertable control. This policy ensures that 62% of the salt mobilised by sub-surface drainage will remain in the Region.

SPPAC considers there will be opportunities to increase the current State quota over the 30 year implementation period to accept the salt loads required by the Plan. Research will also continue over this period to develop better ways of reusing saline groundwater and utilising evaporation basins.

Costs and Benefits

The total public sector / private sector costs and benefits of the Plan are:

	Capital Costs $million	Capitalised Annual Costs $million	Benefit-Cost Ratios SEWG	SPPAC
Farm activities	202	92	1.03	1.09
Surface Drainage	223	26	0.7	0.9
Sub-surface drainage	83	115	2.6	6.0
MDBC costs	10	9	-	-
Environmental works	33	n/a	n/a	n/a
Extension & Support	20	0	n/a	n/a
Research & Investigation	75	0	n/a	n/a
TOTAL	646	240	1.4	2.4

Two sets of evaluations are presented because SPPAC considered that the Government Economic Guidelines do not provide a realistic assessment of the benefits of the Plan.

In particular, considerable concern exists regarding the economic evaluation of the surface drainage component of the Plan because it underestimates the true benefits of surface drainage. Continuing research programs are proposed to allow better assessments to be made of the benefits of surface drainage.

The total Plan, as presented, meets the economic criteria of the Government of Victoria as expressed in the Investment Evaluation Guidelines. It does this without accounting for the substantial social and environmental benefits thus understating the benefit/cost ratio.

Salt Balances

The following are current and estimated future salt balances for the Shepparton Region(all figures in tonnes).

	Now Without Plan	Year 2020 With Plan	Year 2020
Salt in from Streams and rainfall	99,000	111,600	111,600
Salt out from surface run-off and sub-surface drainage	60,900	143,000	178,250
Nett Salt Load	- 38,100	+31,400	+66,650

The Salt Disposal Quota for new surface and sub-surface drainage works has been calculated at 19.4 EC units in accordance with the Murray-Darling Basin Commission's Salinity and Drainage Strategy. This takes no account of:

(a) the large increase (82,100 tonnes) in surface drainage salt loads which will occur if the Plan is not implemented;

(b) the progressive reduction in groundwater salinity and sub-surface drainage salt loads which will occur in the longer term if the Plan is implemented.

PLAN MANAGEMENT AND IMPLEMENTATION

Management Arrangements

Implementation of the Plan will not require major changes to the existing State budgeting processes, co-ordinating functions or finance flows.

At the regional level structures will be required to represent the interest of all parties - community groups, local government and state government agencies. These will include:

(a) A Salinity Program Advisory Council whose main roles will be regional priority setting, conflict resolution, policy development and monitoring.

(b) Salinity Program Implementation Groups which will be established at the Irrigation Area level and will have direct responsibility, within State guidelines, for approved projects and programs including all decisions regarding the implementation of surface and sub-surface

COST SHARING

The Shepparton Irrigation Land and Water Salinity Management Plan argues for a program of works with combined capital and capitalised annual costs amounting to $888 million (1989 values) to be implemented over a 30 year period. The benefit/cost ratio has been calculated by SPPAC at 2.4:1, making it very attractive.

SPPAC endorses the State Government's policy of "beneficiary pays" and has adopted it in the Plan. SPPAC has identified the State, National, Regional and Irrigation communities as beneficiaries and proposes that the costs be distributed in the following manner.

The rationale for including these groups as beneficiaries is that:

(a) the Plan offers all irrigators the opportunity to participate in and benefit from the Plan;

(b) over 50% of the benefits from regional drainage result from reduction in road construction and maintenance costs;

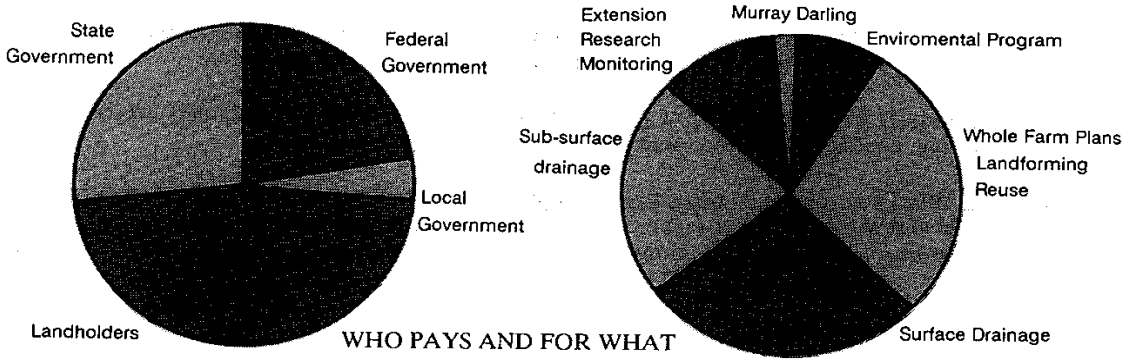
(c) rate revenue is directly under threat from the lowering of values of agriculture and non agricultural properties as the salinity problem worsens and the regional economy contracts;

(d) the cost associated with a loss of 3,500 jobs is around $40 million per annum in social welfare payments and a corresponding amount foregone in taxation revenue

(e) export earnings will be reduced by a total of $3 billion by 2020 if nothing is done;

(f) the environmental impact of uncontrolled salinity will be substantial and irrevocably damage some of the State's most valuable wetlands.

COST SHARING



WHO PAYS AND FOR WHAT

The practical implications of this cost sharing package are:

(a) landholders will receive incentives for onfarm works that reduce the amount of water that gets into the watertable or which lower the watertable;

(b) irrigators and municipalities will be expected to bear the "operations and maintenance" costs of the Plan. These will rise as the Plan is implemented over a 30 year period.
- A Salinity Control Rate will rise to an average of $3.10 per megalitre of water used (depending on the level of service a landholder receives).
- The Local Government will initially make a small contribution which will increase to a maximum average of 4.2% of the gross annual rate by 2020;

(c) the State and Federal Governments will be expected to provide the capital for public works the grants and incentives for onfarm works.

Five Year Program $M

Activity	89/90	90/91	91/92	92/93	93/94	Total
Farm Program	1.62	3.67	5.33	8.53	8.68	27.83
Environmental Protection	0.15	1.09	1.25	1.59	1.76	5.94
Surface Drainage	3.88	5.07	5.62	7.33	9.58	31.58
Sub-surface Drainage	0.66	2.42	3.25	3.82	4.17	14.32
Extension & Support	0.64	0.70	0.73	0.67	0.67	3.42
Research & Investigation	2.08	2.94	2.40	2.20	2.05	11.66
Grand Total	8.98	15.81	18.44	23.95	26.76	94.75

WHAT ARE YOUR VIEWS?

Suggestions for improvements to this Draft Plan are invited. Please send your written submission for consideration by both the Goulburn-Broken Region Salinity Pilot Program Advisory Council and the State Government,by Friday 6 October 1989 to:

Chairman,
Goulburn-Broken Region Salinity Pilot Program Advisory Council,
P.O.Box 1752,
SHEPPARTON. VIC. 3630

1. INTRODUCTION

Following European settlement of Australia 200 years ago, salinisation processes were unknowingly set in train which now threaten some of Australia's most productive regions.

The processes of salinisation do not respect property, municipal or state boundaries nor do they treat individuals equally. If left unchecked salinity has the potential to significantly reduce the environmental quality, social stability and economic performance of the Shepparton Irrigation Region.

The Victorian Government's "Salt Action Joint Action" strategy for managing land and water salinity provides broad policies to deal with the problem and also provides the framework in which individual plans can be formulated.

The Shepparton Land and Water Salinity Management Plan (The Plan) presented here has as its goal -

> *"To manage the salinity of land and water resources in the Shepparton Irrigation Region in order to maintain and, where feasible, to improve the social wellbeing, environmental quality and productive capacity of the Region".*

The Plan has been developed under the control of the Irrigation subcommittee of the Goulburn Broken Region Salinity Pilot Program Advisory Council (SPPAC) during the past two years. SPPAC has worked with Departmental staff from the Government agencies and with Dwyer Leslie Pty. Ltd, consultants in agriculture and economics.

The Plan presented provides a framework for action. The process and management arrangements proposed are consistent with the Murray Darling Basin Natural Resource Management Strategy. This strategy aims to assist "Communities of common concern" in implementing actions to address resource degradation issues - in the case of this Region, land and water resources. The Plan will be continually reviewed and updated as new information, technology or priorities are identified through time.

SPPAC believes it is now time to work toward the protection of the Region's most valuable resources - its land and water. It believes the Management Plan presented here can achieve this. It is now up to the regional community to implement the works and activities identified within the Plan and for Government to support it.

2. OBJECTIVES

The Plan has a number of objectives against which salinity control programs have been evaluated. These objectives are-

1. THE ENVIRONMENTAL OBJECTIVE - The Plan is to address current and future environmental problems resulting from high watertables and salinity within the Region. On balance salinity control activities are to maintain and, where possible, enhance existing ecological processes.

2. THE SOCIAL OBJECTIVE - The Plan is to provide the community wherever possible with equal access to decision making and economic resources needed to implement salinity control works. The plan will reduce inequities resulting from uncontrolled salinity impacting differently on individuals.

3. THE ECONOMIC OBJECTIVE - Where works are undertaken to protect the region from high watertables and salinity, the value of measurable and non-measurable benefits should exceed the costs.

4. THE FINANCIAL OBJECTIVE - The Plan is to be both equitable and affordable to the individual and the Regional and wider communities, now and in the future.

The four objectives relate to the achievement of salinity control in the Shepparton Irrigation Region. In proposing actions to achieve these objectives, the Plan acts to prevent the major Regional decline which is inevitable if high watertables are not controlled. This decline will manifest itself through:

- escalated environmental damage and decline;
- massive social costs associated with a decline in urban employment throughout the towns of the Region;
- reduction of household incomes of both farmers and urban workers; and
- the loss of significant export earnings to the State of Victoria and the nation, at a time when export income is essential in maintaining Australia's standard of living.

3. THE GOULBURN-BROKEN REGION SALINITY PILOT PROGRAM

3.1 BACKGROUND

The Salinity Pilot Program was established in October 1985 by the Victorian Government to "identify the most effective means of addressing salinity control within a region". The Goulburn and Broken River catchments were selected for the Pilot Program because of the high potential losses within the Region if salinity were to continue unabated and because of the complexity of the irrigation and dryland salinity interactions.

The Pilot Program comprises a fifteen person Salinity Pilot Program Advisory Council (SPPAC) which reports to the Rural Affairs, Conservation and Environment Committee of Cabinet. SPPAC was appointed after receiving recommendations from the Regional community and has membership from people with landholder, local government, education and industry background.

A program management team (PMT) provides executive support to SPPAC and co-ordinates departmental input from RWC, DARA, DCFL and DWR officers.

SPPAC appointed a Dryland and Irrigation sub-committee (ISC) soon after the commencement of the program to develop salinity management plans for the Dryland and Irrigation sub-regions.

The members of SPPAC, PMT and ISC are listed.

Salinity Pilot Program Advisory Council

Mr. J. Dainton(Chairman)
Mr. I. Elder
Cr. J. Gaylard
Mr. L. Heath
Mr. A. Howell
Ms. P. Jones
Mr. K. McLarty
Cr. M. Moor
Dr. M. Parameswaran
Cr. T. Perry
Mr. M. Ryan
Mr. T. Ryan
Mr. H. Vegter
Mr. G. Witten

Past Councillors

Mr. J. Regan (dec.)
Cr. P. Robinson
Mr. K. Holland
Mr. D. McPherson
Mrs. N. Oates

Pilot Program Management Team

Mr. S. Brown (Co-ordinator)
Mr. B. Garrett
Mr. W. O'Kane
Mrs. P. Collins

Past Team Members

Mr. G. David
Mr. D. Brewin
Ms. W. Mathews

SPPAC Irrigation Sub-Committee

Mr. L. Heath (Chairman)
Mr. I. Cox (Rodney IAB)
Mr. J. Dainton
Cr. J. Gaylard
Mr. C. Makin (Tongala IAB)
Mr. E. Merrigan (GIRDAC)
Mr. S. Mills (Murray Valley IAB)
Cr. M. Moor
Dr. M. Parameswaran
Cr. T. Perry
Mr. G. Trew (Shepp. IAB)
Mr. H. Vegter
Mr. G. Weller (Roch. IAB)
Mr. G. Witten

3.2 ACTIVITIES

The Salinity Pilot Program has undertaken a multidisciplinary approach to dealing with salinity in the Region.

Co-ordination of the Government Departmental Agencies delivering the salinity program was seen as a major need. The Program established a Regional Managers' Forum formally to co-ordinate departmental salinity activities but also encouraged informal co-operation with other activities.

A major community salinity awareness program has been undertaken in the Goulburn-Broken Region over the past 3 years. This awareness program has been successful in providing the Regional community with a basic understanding of the causes and impacts of high watertables and salinity on agriculture and the Regional economy.

"The Underground Flood" brochure has been widely distributed and has been a major vehicle in the awareness campaign.

Awareness of salinity as an issue has created activity within the Region. Landholder communites have become concerned about the impact of salinity in their localities. SPPAC has convened or assisted with countless information meetings. These have led directly to the formation of twenty landholder groups dealing with salinity related activities in their localities.

SPPAC established both Irrigation and Dryland sub-committees to develop management plans for dealing with salinity in the irrigation and dryland areas of the Goulburn and Broken River catchments. These management planning exercises have been demanding of SPPAC over the past three years. Major community consultation programs have been undertaken to ensure that the Regional community, through SPPAC, has an opportunity to be involved in the planning exercise.

The Salinity Pilot Program has utilised a number of methods in gaining community input to the Regional salinity program and, in particular, the development of the Shepparton Irrigation Region Land and Water Salinity Management Plan (SIRLWSMP). The program has encouraged the local media wherever possible to report on causes, impacts and management of salinity in the Region to the wider community as well as to landholders. The media co-operation during the program has been outstanding.

Specific activities undertaken in consulting with the Regional community on the development of the Management Plan included:-

(a) Public Meetings - As salinity awareness has grown within the Region, so has concern and expectation of action. SPPAC has encouraged and assisted the formation of a number of landholder groups who are prepared to address their local salinity problems.

(b) Local Government - The involvement of local government in salinity control was seen by SPPAC as essential. Local government represents the Regional community and must contribute toward the protection of the Region. The twelve municipalities have been kept informed of the Regional situation and SPPAC has had major input to the Shire of Rodney "Role of Local Government in Salinity Control Study (1989)" which identifies a multitude of potential roles for local government.

(c) Information nights - SPPAC has held information days and evenings for special interest groups including bankers, local government, service groups, accountants, business people, farm management consultants and school teachers as part of the Management Plan awareness program.

(d) Industry groups - A significant number of Victorian Farmers' Federation local and district council branches have called special meetings for their members to allow SPPAC to discuss key issues within the Management Plan.

(e) Issue papers - Where key issues in the development of the Management Plan were identified, "SPPAC CHAT" issues papers were widely distributed via landholder groups, local government, VFF branches and news media. These issues papers were directed at receiving feedback on policies which SPPAC was considering.

(f) Implementation of Works Study - To clarify the relative costs of designing and constructing the required works by private contract or by departmental resources, a consultant's study was initiated.

(g) Co-option of Personnel - SPPAC considered the co-option of a member from the five RWC Water User Committees in the Shepparton Irrigation Region to the Irrigation Sub-committee as essential.

3.3 MANAGEMENT PLAN PREPARATION

Work on preparing the Shepparton Irrigation Region Land and Water Salinity Management Plan commenced in early 1986. Since that time a massive amount of work has been undertaken by all concerned. The enormous amount of technical work and detailed investigation undertaken by Departmental Officers and Dwyer Leslie Pty. Ltd, consultants in Agriculture and Resource Economics, has been compiled into working papers. These working papers have been discussed by SPPAC and a Departmental Program Management Advisory Committee (PMAC) with representation from the RWC, DARA, DWR, State Salinity Bureau and interstate representatives from NSW, SA and MDBC.

The technical working papers written during the preparation of the Management Plan are available for inspection at most RWC and DARA offices within the Region.

A full list of these Background Papers appears as Appendix A to this plan.

For further information on this section refer to the following Background Papers:

PL11 - Regional Responses to SPPAC CHAT Issues Papers - April 1989

SE7 - Implementation of Works Study - October 1988

4. THE SHEPPARTON IRRIGATION REGION

The Shepparton Irrigation Region (see Locality Plan) extends from Cobram in the north-east to Murchison in the south and across to Tennyson and Echuca in the west. It includes the five Irrigation Areas of Murray Valley, Shepparton, Rodney, Tongala and Rochester. For planning purposes the Campaspe Irrigation District to the south and west of Rochester has been ignored because an existing Management Group has been developing a detailed sub-regional plan for that area. Although the Campaspe Plan in its present form has minimal impact on other areas within the Region SPPAC considers that for equity reasons, future planning in that area must be integrated with the Shepparton Plan. The Campaspe Plan must be implemented within the framework of the Shepparton Plan.

The Irrigation Region also interacts with the Goulburn-Broken Dryland Area and with dryland parts of the Murray and Campaspe Valleys. Again, SPPAC believes that it is vital that implementation of plans for those areas be carefully co-ordinated with the Shepparton Plan. Special attention must be given to those areas which are immediately adjacent to the irrigation region, particularly large relatively isolated areas such as Barmah Forest which cannot be dealt with effectively by either the dryland or irrigation plans in isolation.

4.1 HISTORY

Early settlement in the Shepparton region occurred after a series of acts were passed by Government in the 1860's. Growth of the agricultural industry was frustrated because of the uncertainty of rainfall in the area. When the possibility of introducing irrigation was first conceived, settlers were enthused and set about establishing an extensive irrigation system.

Irrigation development was initially controlled by Irrigation Trusts established under the Water Act of 1883. The Rodney Irrigation Trust was the first to be established under the new Irrigation Act of 1886. It drew its water from the newly completed Goulburn Weir. The Ardmona Trust commenced its operation in 1887. By 1899 there were 25 trusts operating in Northern Victoria.

Irrigation development increased with the construction of Waranga Basin in 1902 and the Trusts were taken over by the then State Rivers and Water Supply Commission (SR & WSC) in 1905. Development in the Region continued to expand with the construction of Lake Eildon and enlargement of Waranga Basin between 1919 and 1924 and, more recently, the construction of "Big Eildon" in 1955. (The SR & WSC became the Rural Water Commission in 1984.)

The Shepparton Irrigation Region now totals about 500,000 hectares, of which some 280,000 hectares are irrigated.

From the earliest times the Victorian Government has promoted land settlement based on irrigation development in North Victoria. The reasons for this were and are:

- Irrigation development provided an opportunity to implement Rural Settlement Policies (including Soldier Settlement) and also enabled decentralisation to proceed.

- Rural production of fruit and dairy products and their processing in the Region provides wealth to the Region, the State and the Nation.

- The policies and the benefits which flowed from them permitted overall regional development and provided significant improvement in the delivery of community and social services.

It is important to note that the benefits which have flowed to the region, State and Nation have come at a cost. The cost is high watertables, salinity and associated environmental degradation. This resulted because developments were at variance with the land resource and the climate.

4.2 PHYSICAL FEATURES

4.2.1 Geology

The riverine plains of the Shepparton region are alluvial deposits having a comparatively flat surface and a general north westerly slope of 1/2500. The depth of alluvium above bedrock varies, typically ranging from 20 metres to 120 metres.

The nature of the sub-surface strata is complex (see Figure 1). Very coarse sediments generally between depths of 80 metres and 120 metres mark very old infilled ancestral river systems (deep leads).

More recent ancestral streams deposited sediments over the top of the deep lead materials and bedrock. In these sediments, deposits of coarse (sand) material, referred to as aquifers, are separated by less permeable clayey materials known as aquitards. Aquifers occur at all depths in these sediments. These underground water-bearing layers of sand or gravel are capable of supplying significant quantities of water to bores or springs. Water quality in these aquifers becomes poorer with depth. High watertables have generally followed saturation of the aquifers in the uppermost 30m.

The study of regional geology has produced a general understanding of the distribution of various aquifers and aquitards across the region. In most situations there is some transfer of pressure and water between deep and shallow aquifers.

An important aspect of the Shepparton Irrigation Region is that groundwater salinities in the aquifer systems are relatively low, ranging between 150 and 12,500 EC units. This has important implications for salinity control.

4.2.2 Climate

The Shepparton Irrigation Region has an average monthly temperature range of 7.5 deg. to 22 deg. and average rainfall of 380mm to 500mm with ranges of $\pm$ 180mm.

Evaporation exceeds rainfall in the Region over nine months and averages 1350mm/year. Irrigation is therefore essential to support summer growing crops and is desirable for autumn and spring growing crops.

Winter frosts are common and spring frosts can cause significant damage to some varieties of horticultural and vegetable crops.

4.2.3 Soils

The soils of the Shepparton Irrigation Region fall into two main groups, the "red-brown earths" and the "grey-brown soils of heavy texture". The first group includes the coarser surface sediments historically deposited close to ancestral river and stream courses. The second group were deposited further out on the flood plain.

4.2.4 Land and Water Use

The Shepparton Irrigation Region totals about 500,000ha with some 487,000ha of farm holdings. 430,000 (86%) is suitable for irrigation and 280,000ha (56%) is irrigated. Of the irrigated area, the largest proportion is used for pasture production (246,000 ha or 88%) whilst a further 9,600ha (3%) is used for horticulture and the remainder is made up of grain crops, seed crops, lucerne, forage crops and vegetables (23,000ha or 8%).

Data on land use, water right available and culture types classified by the five irrigation areas making up the Shepparton Irrigation Region are shown in Table 1.

TABLE 1: Lands Under Irrigated Culture 1987/88

IRRIGATION AREA	SHEPPARTON	RODNEY	TONGALA	ROCHESTER (1)	MURRAY VALLEY	TOTAL
Total area of holdings (ha)	81,584	104,785	96,531	75,872	128,051	486,823
Area suitable for irrig. (ha)	75,054	96,548	73,572	69,148	113,084	427,406
Water rights (ML)	182,258	244,879	161,414	148,653	256,271	993,475
No of each farm type:						
Mixed	535	1,0.08	662	580	804	3,589
Dairy	274	770	670	536	713	3,063
Horticulture	329	216	4	—	92	641
Total	1,238	1,994	1,336	1,116	1,609	7,293
Area Irrigated:						
Perennial pasture (ha)	28,543	33,436	24,759	22,083	31,625	140,446
Annual pasture	15,036	26,182	13,694	18,448	32,233	105,593
Horticulture	4,035	3,231	—	—	2,314	9,580
Other	2,588	5,961	2,239	4,062	8,163	23,013
TOTAL	50,202	68,810	40,692	44,593	74,335	278,632

Source: RWCV, Goulburn and Murray North East Region Annual Reports 1987/88.
(1) Excluding Campaspe Irrigation District.

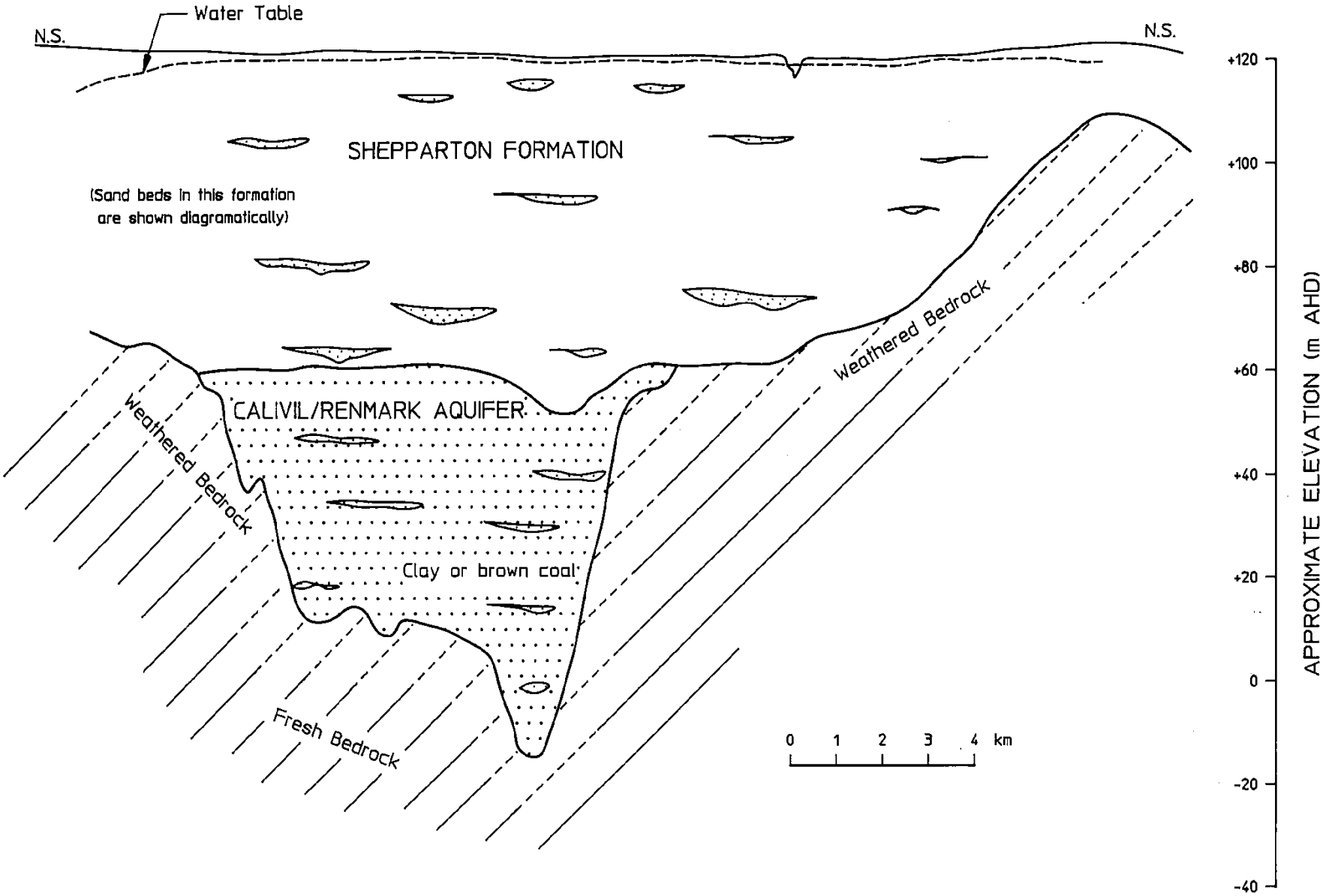
Of the 7,300 farms within the Region 3,600 (49%) are "mixed" farms, 3,100 (42%) are dairy farms and 650 (9%) are horticultural farms.

Water right available per irrigated hectare averages 3.57ML/ha with a high of 3.97 in Tongala Irrigation Area and a low of 3.33 in the Rochester Irrigation Area. Average actual application rate is around 5.5ML/ha/annum or about 3.5ML/ha/a of land commanded.

Groundwater usage for irrigation purposes is not monitored but licensed allocations total 221,000ML distributed across 800 landholders. This is approximately 2.61ML/ha/a on those properties holding licences. Actual usage is unknown.

For further information on this section refer to the following Backgound Paper:

GW1 - Hydrogeological Mapping of the Upper Shepparton Formation - February 1989



TYPICAL GEOLOGICAL CROSS-SECTION

4.3 THE SALINITY PROBLEM

4.3.1 High Watertables

The Shepparton Irrigation Region salinity problem is related to high watertables which have developed over the past 150 years. The basic reason for watertables rising, mobilising salt and thus creating land and water salinisation problems is the fundamental change in the hydrological cycle that has followed the advent of European settlement on the slopes and plains of Northern Victoria.

Removal of natural vegetation was initially undertaken for agricultural pursuits but also to provide timber for the mines and buildings of the gold rush from 1851 onward. Additionally, the Government of the 1860's passed a series of Acts which related to land settlement and which had a legal requirement for clearing land for cropping purposes.

By the late 1880's, Melbourne was reportedly using 350,000 to 450,000 tonnes of firewood per year for heating and cooking. In addition, huge amounts of wood were required for building purposes. The demand for timber was enormous and was met by removing it from the hills, slopes and plains without consideration of, or understanding of, the consequences. Tree removal in the hills and on the plains has resulted in higher stream salinities and increased groundwater accessions over time.

Subsequent interventions through the manipulation of stream flows and irrigation developments accelerated the onset of the current problem. Unfortunately, reversing past interventions will not restore the water balances to those experienced several hundred years ago except in the very, very long term.

4.3.2 The 1988 Watertable Situation

Throughout this Plan, high watertables are referred to as those within two metres of the land surface. Watertables at this level will certainly affect trees and tree crops and will begin to affect pastures. Watertable levels within one metre will produce major adverse effects upon most forms of agricultural activity.

Areas currently affected by high watertables are identified in Figure 2. Some 188,000ha of land are currently subject to high watertables. These areas comprise more than a third of the Region and are already deteriorating.

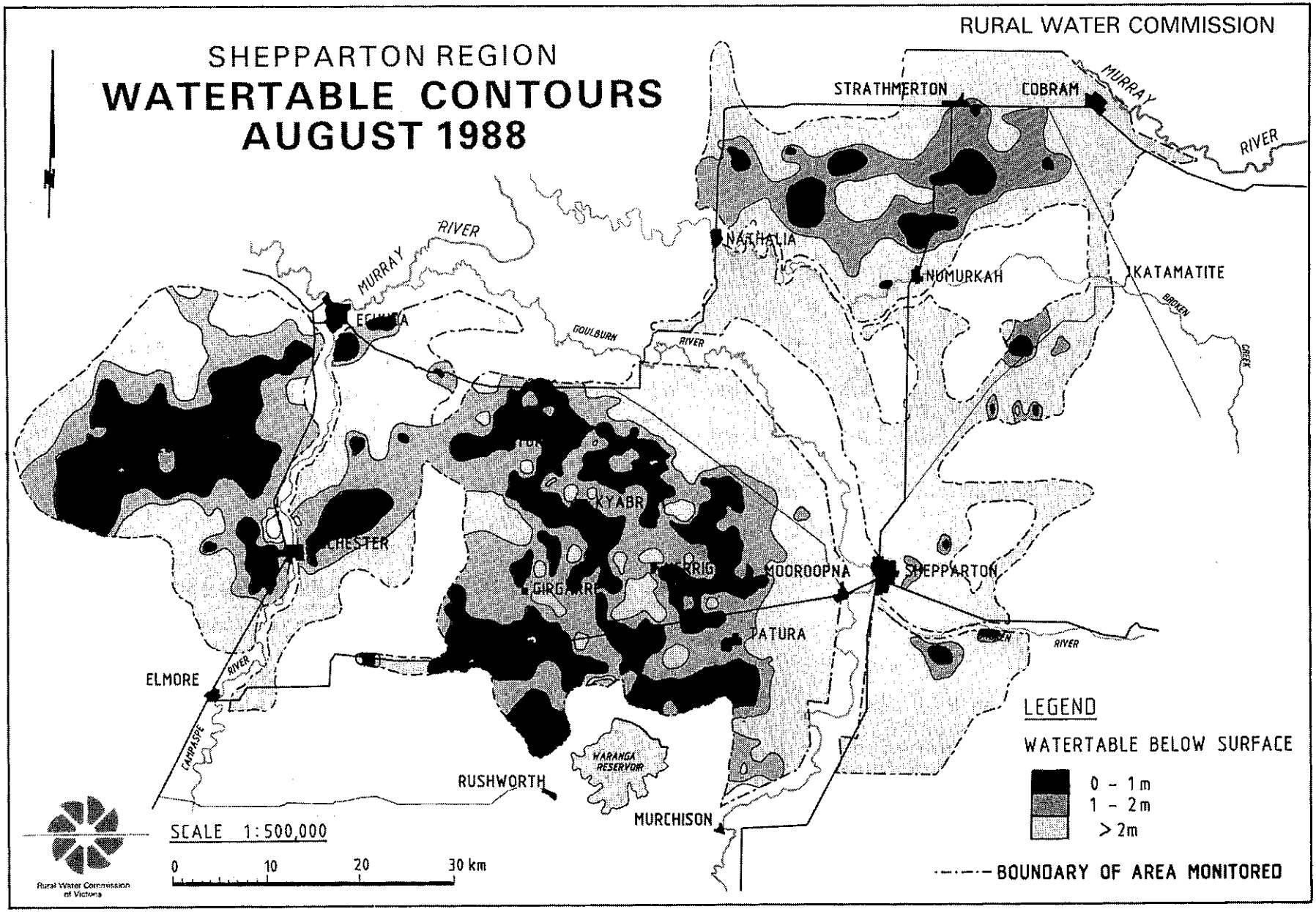
4.3.3 The Current Salinity Situation

The salinity problem is essentially caused by the existence of permanent high watertables. The high watertables cause:

- discharge of saline underground water into streams and rivers;
- soil salinisation; and
- consequent saline runoff into streams and rivers.

The problems within the Irrigation Region (and its bordering rivers and streams) are exacerbated by increasing salinity in upstream flows caused by worsening salinisation in the dryland catchments.

High watertables and salinisation problems were recorded in horticultural areas at Tongala and Bamawm in the 1930's and have spread progressively since then. Mapping of regional


RURAL WATER COMMISSION
SHEPPARTON REGION
WATERTABLE CONTOURS
AUGUST 1988
STRATHMERTON
COBRAM
MURRAY
RIVER
NATHALIA
NUMURKAH
KATAMATITE
BROKEN
CREEK
MURRAY
RIVER
GOULBURN
RIVER
KYABRAM
CHESTER
GIRGARRE
MOOROOPNA
SHEPPARTON
PATURA
ELMORE
CAMPASPE
RIVER
WARANGA RESERVOIR
RUSHWORTH
MURCHISON
LEGEND
WATERTABLE BELOW SURFACE
0 - 1 m
1 - 2 m
> 2m
BOUNDARY OF AREA MONITORED
SCALE 1:500,000
0
10
20
30 km
Rural Water Commission of Victoria

THE UNDERGROUND FLOOD (Part 3)

On the reverse side of this leaflet is the August 1988 Watertable Map of the Shepparton Irrigation Region. This map was prepared by the Rural Water Commission using data collected from a network of 1080 bores. Unlike previous years when the maps were prepared manually, the 1988 map was drawn with the assistance of computer analysis.

This leaflet should be read in conjunction with the brochure titled the "Under Ground Flood" and the 1987 watertable map. Although seasonal variations impact on the watertable, it is clear that watertables are rising at a steady rate. Production losses caused by salinity and waterlogging are also escalating. If nothing is done, losses in the order of 30% can be expected 50 years after the watertable reaches 2 metres.

We are being **"flooded from beneath"** but these trends can be slowed or stopped. For further information contact your local office of the Department of Agriculture and Rural Affairs or the Irrigation Services Division of the Rural Water Commission.

W.J. O'Kane,
Community Education Officer,
D.A.R.A.
Shepparton.

WATERTABLE INFORMATION — Estimated Area (ha) for August in given year

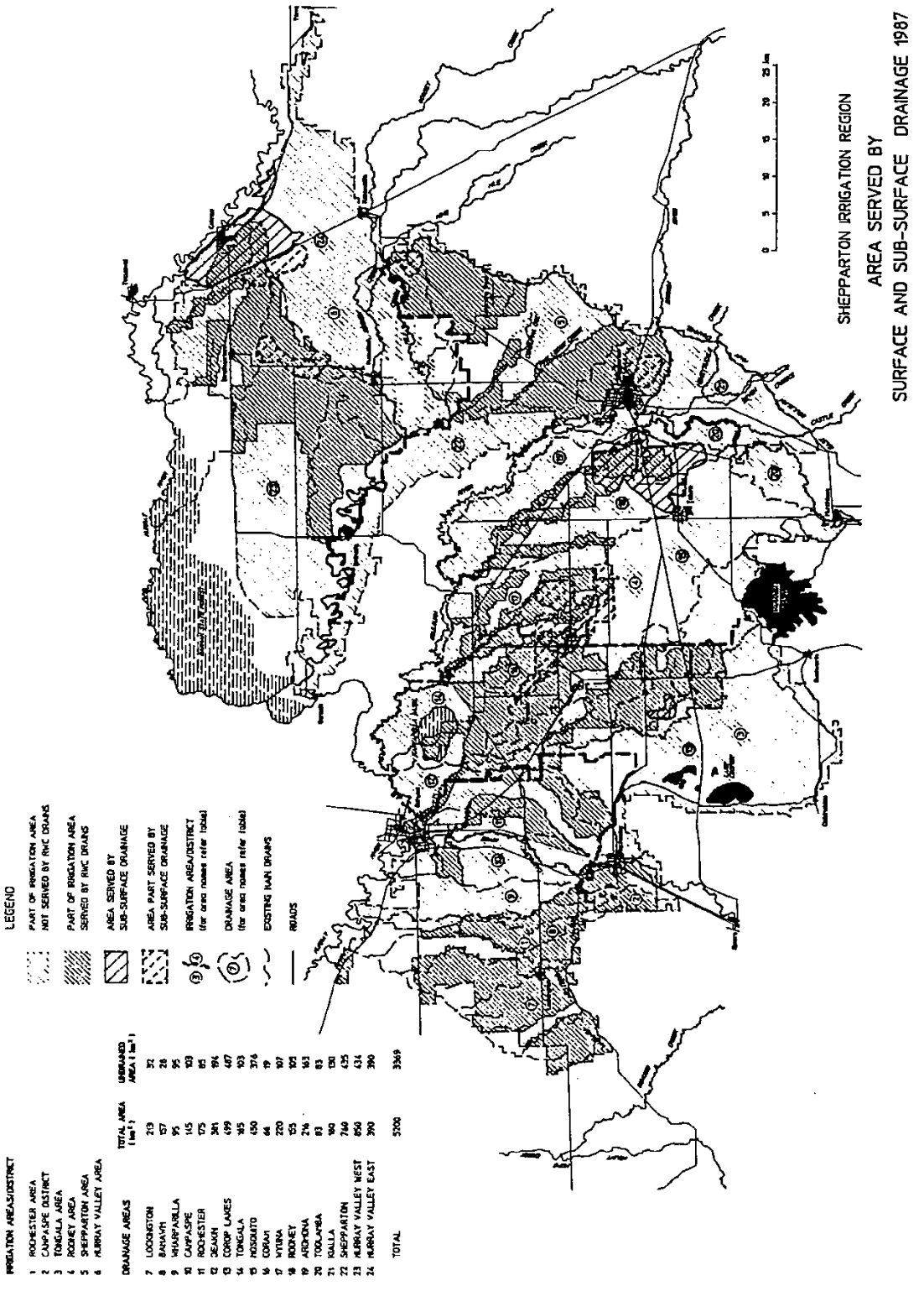
SUB-REGION	WATERTABLE 0 — 1m *1				WATERTABLE 0 — 2m					WATERTABLE 0 — 3m					TOTAL AREA MONITORED
	1988* AREA	CHANGE 84-86	86-87*	87*-88*	1988* AREA	CHANGE 82-84	84-86	86-87*	87*-88*	1988* AREA	CHANGE 82-84	84-86	86-87*	87*-88*	1988* AREA
ROCHESTER WEST & CAMPASPE	25,970	6,300	3,670	14,200	48,140	0	-500	7,660	9,680	57,920	1,800	-2,700	4,870	1,950	76,500
ROCHESTER EAST	4,290	1,700	360	1,530	10,390	-700	1,300	1,520	2,970	14,500	2,600	-2,400	2,900	1,500	24,400
RODNEY TONGALA	43,180	9,200	3,650	20,730	98,780	14,300	4,100	12,390	9,890	121,160	5,600	300	10,460	3,400	161,300
INVERGORDON SHEPPARTON EAST AND NORTH	880	1,160	-830	550	3,780	1,200	4,100	-2,800	2,040	12,070	-2,400	2,300	-3,060	4,830	78,600
SHEPPARTON SOUTH	400	—	100	300	1,390	0	580	-60	870	4,900	600	500	1,480	2,320	
MURRAY VALLEY	6,730	2,900	570	3,260	31,280	2,000	11,000	-330	8,610	55,170	-10,000	3,800	5,940	5,230	87,200
TOTAL	81,450	21,260	7,520	40,570	193,760	16,700	20,600	18,380	34,060	265,720	-1,800	1,800	22,590	19,230	428,000

* COMPUTER ANALYSIS USED

SALT FORCE Goulburn/Broken Salinity Pilot Program

Department of Agriculture and Rural Affairs

FIGURE 4: Areas Currently Served by Surface and Sub-surface Drainage



watertables commenced in 1982 and the monitoring grid now covers 66% of the Region. In August 1988 (see Figures 2 and 3), some 188,000ha had a high watertable (i.e. within 2m of surface) and 265,720ha had a watertable within 3m of surface. The areas affected at this stage include virtually all the more intensively irrigated and most productive land; the area is increasing steadily.

Some effects of the high watertables are experienced almost immediately, e.g. groundwater flows into adjacent rivers and streams and plant waterlogging. Salinisation of the soil (and consequent loss of both agricultural productivity and environmental value) progressively increases over time as a result of capillary transfer of saline groundwater into the plant rootzone and to the soil surface. Low areas, including environmentally important features such as prior stream beds and "potholes", are generally affected quickly, particularly if the underlying groundwater is saline. The extension of the salinisation into the adjacent broad agricultural lands may be a slow process taking up to 50 years.

The present extent of the problem is difficult to quantify. Areas which were obviously degraded were estimated in 1984 to total 4,000ha, and additional areas have been identified since then. However, a much larger area is likely to be suffering significant losses of production (up to 20%) although symptoms are not easily discernible. Dwyer Leslie have estimated in their economic analysis that average Net Farm Incomes in 1986 were about 17.5% below what would have been achieved with full salinity control. Detailed work in a number of areas such as Stanhope, Girgarre and Tongala has indicated that loss of productivity in those areas could already be more than 20%. Though difficult to quantify, the present effects are clearly significant and the nature of the process is such that loss of production will inevitably increase over the next 50 years even if no further spread of high watertables occurs.

4.3.4 Existing Salinity Control Projects

The progressive increase of high watertable areas continues despite some significant moves towards groundwater control. These include the RWC's Phase A Groundwater Control Project to protect major orchard areas, the Girgarre Pilot Project, the Tongala Groundwater Reuse Project, and increasing private groundwater pumping and reuse.

The Phase A Project was completed in 1981. It involves 70 RWC pumps and 9 hired private pumps which protect about 18,000ha of orchards and adjacent pasture lands. The Girgarre Pilot Project utilises 3 RWC groundwater pumps and an evaporation basin and protects up to 1,000ha. The Tongala Reuse Project involves 16 private pumps and has caused a significant increase in productivity over an area of about 600ha, but requires access to some salt disposal quota to ensure its sustainability. Total licensed volume of private groundwater pumping in the Region is about 221,000ML/yr. Actual usage is not accurately known but is only a small proportion of licensed volume except in very dry years. Incentives have recently been introduced by DARA, on a trial basis, to encourage landholders to pump more consistently.

SPPAC has also worked closely with the SEC to develop the recently announced SEC Salinity Assistance Program. This will assist farmers pumping from both deep and shallow aquifers by providing lower cost SEC power connection and much reduced weekend pumping tariffs. These measures will encourage additional pumping.

However this will be of short term value only in many cases unless some nett removal of salt can be achieved. Salinity control in the Shepparton Irrigation Region depends upon the ability to move toward a salt balance. Currently, the Region is importing more salt than it exports. Salt disposal from the Region will have costs to downstream water users. The implications for salt disposal from the Region are discussed in Section 6.12.

4.3.5 Deep Lead Systems

Regional high watertables are a result of saturation of the uppermost shallow aquifers and the overlying soils. However, some relief is gained at present in the Shepparton Irrigation Region by downward drainage of water (and salt) to the underlying deep aquifer systems.

This drainage occurs because the pressures in the deep aquifers are relatively low, generally 6 to 10m below surface. However, pressures in these aquifers have been rising steadily at rates of 0.1 to 0.2m/yr for many years and continuing rises will reduce the nett downward drainage which is occurring and thus aggravate the salinisation problem.

In some parts of the Murray and Campaspe valleys where large volumes of good quality waters are available, recent pumping from the deep lead has stabilised pressures over large areas. However, this pumping is seasonal and may diminish significantly during wet years allowing sudden increases in pressure to occur. Continuing investigation to develop a strategy for management of the deep lead has been identified in the Plan as a priority task.

4.3.6 Surface Drainage System

Irrigation leads to an increase in overall soil moisture content and this, in turn, increases runoff due to rainfall. It has long been recognised by governments, engineers, scientists and farmers that irrigation should not be introduced without being accompanied by a comprehensive surface drainage system. This recognition has not been acted on in the Shepparton Irrigation Region as most irrigation has been installed without a drainage system. The area considered by SPPAC to require surface drainage under this Plan covers much of the five irrigation areas in the Region and totals about 500,000ha. Of this area only 183,100ha (about 35%), is presently served by surface drains. The areas currently served are shown along with the RWC Irrigation Area boundaries and major drainage catchment boundaries on Figure 4.

Since the mid 1950's the strategy has been to give priority to installing drainage in specific problem areas developed to irrigation between the early 1900's and the 1960's. Since the late 1960's, newly developed irrigation schemes have included the simultaneous construction of both irrigation channels and drains.

SPPAC sees surface drainage as an essential and integral component of any salinity control strategy, not only because of the direct benefits it provides through reducing accessions to the watertable (hence reducing salinisation) by up to 19%, but because of the indirect benefits of:

- reduced road construction and maintenance costs;
- improved water use efficiency;
- providing incentive to carry out other management measures which will also reduce accessions;
- redirecting community energies which would otherwise be lost in arguments concerning drainage; and,
- provision of infrastructure for disposal of saline groundwater removed by pumps to move toward salt balance in the Region.

There has been an historic community expectation and a stated RWC longterm objective, that surface drainage should be provided to all irrigated farms within the Region. However, given that a completed RWC drainage system will cost $450M and that recent rates of expenditure have been between $1.5M and $2.0M annually, it is unlikely that these expectations and objectives will be achieved. A different strategy to complete surface drainage in the Region must therefore be put in place.

Under current legislation the RWC is required to maintain the drainage service which was intended at the time any particular scheme was adopted. This requirement ensures that the RWC keeps its drains maintained but also severely limits many drain extension proposals. In many cases, because of costs, drainage systems have not been designed to serve the whole catchment. The requirement to maintain intended standards means the existing drainage

system must be upgraded before being extended. This significantly delays programs and increases costs.

4.3.7 Farm Activities

There are many farm based activities which contribute to salinity control and which are being implemented by landholders in the Shepparton Irrigation Region. These activities are often being undertaken by landholders with the express aim of improving short to medium term farm productivity rather than salinity control.

Adoption rates of these activities are estimated to be:

(a) Lasergrading and landforming - of the 271,900 hectares of flood irrigated land in the Shepparton region, the RWC estimates (1986/87) that 80,263 hectares (29.0%) are already lasergraded. At the current cost of landforming/lasergrading of $1,200 per hectare, this represents a $96 million landholder investment across the Region. The annual rate of lasergrading is approximately 4% of the Region per year. A summary of landformed/lasergraded area by Irrigation Area appears in Table 2.

TABLE 2: Area Lasered by Irrigation Area (1986/87)

IRRIGATION AREA	AREA LASERED (ha)	FLOOD IRRIGATED AREA (ha)	%
Murray Valley	25,893	71,899	36.1
Shepparton	12,657	40,972	30.9
Rodney	18,650	70,100	26.6
Tongala	8,708	40,587	21.4
Rochester*	14,355	48,516	29.5
TOTAL	80,263	271,899	29.5

Source: RWC 1986/87
* Includes Campaspe Irrigation District.

(b) Private Groundwater Pumping
The RWC estimates there are 850 licensed private groundwater pump units in the Shepparton Irrigation Region. The majority of these units are shallow (<25 metre) spearpoint systems which were installed during or soon after the 1982/83 drought.

The units were primarily installed for supplementing irrigation water supplies but their salinity control capabilities are now being recognised by many landholders. At an average cost of $20,000 the investment in private groundwater pump units by landholders is $17M.

The rate of installation of groundwater pump units has reduced dramatically since the drought. This is principally due to the fact that high allocations of surface water from the RWC delivery system have been available and because sites with sufficient quantities of good quality groundwater are becoming harder to find.

(c) Farm Drainage and Drainage Reuse Systems
While it is difficult to quantify the number of farms which have internal drainage

systems constructed, the majority of farms with access to RWC drainage (currently 35% of properties) have systems operating. Farms without access to RWC drainage do not usually have internal drainage systems installed, as they have very limited drainage outfall capacity. Many of these farms are now installing drainage systems in conjunction with drainage reuse systems but these have the potential to control excess surface water during the irrigation season only.

The RWC estimate that 10-15% of properties now have drainage reuse systems installed and operating efficiently. These systems have generally been installed either as part of a farm development program in conjunction with landforming/lasergrading or, through necessity, to minimise the area of land flooded due to irrigation and or rainfall during the irrigation season.

(d) Irrigation Management Activities
Modern irrigation practices, including the use of irrigation scheduling, micro and sprinkler irrigation, are being gradually adopted by landholders throughout the Region.

(e) Whole Farm Planning
A whole farm plan allows farm relayout works to be undertaken in an orderly manner. DARA currently offer a 50% grant toward the activity and it is estimated 10% of the properties have completed whole farm plans. At a cost of $60 per hectare, this represents an investment of $1.68M.

The rate of adoption of these activities is necessarily tied to the financial returns of the particular industries. Consequently the most significant move to changes in management practices has occurred in the horticultural and row crop industries.

Financial assistance to carry out all the above activities is provided to bona-fide farmers by the Rural Finance Corporation via their Water-Management Loans Scheme. This scheme provides finance at interest rates below commercial rates for specific works which act to improve farm water management.

For further information on this section refer to the following Background Papers:

GW2 - *The Shepparton Irrigation Region - A Regional Hydrogeological Perspective - January 1989*

GW3 - *Riverine Plain Groundwater Usage Survey - Summary Report - November 1988*
GW6 - *The Role of Deep Lead Pumping for Salinity Control and Resource Development Within the Shepparton Region*
SE2 - *Farm Socio-Economic Survey - October 1987*

4.4 SOCIO-ECONOMIC PROFILE

4.4.1 Creating the Shepparton Irrigation Region

The development of the Shepparton Irrigation Region was an outcome of the social policy objectives of many successive Victorian Governments. From the first Selection Bill 1860, right through to the completion of the Heytesbury and Campaspe West schemes in the mid 1970's, Victorian Governments have promoted closer land settlement and irrigation development in Northern Victoria. The reasons for this policy were initially a response to the popular working class demand to unlock the land from the control of the squatter elite of the 1840's and 50's. The Government envisioned a closely settled and prosperous countryside as an outcome of the selection initiative. The fact that this vision was at variance with the land

resource and climate of the Region was lost on both the government and electorate of the day.

The development of irrigation schemes from 1883 to 1915 was a response to the failure of the selection policy in the face of drought and inadequate property size. Irrigation development provided a means of continuing the closer settlement social priorities policies of the Government.

New social priorities drove the next wave of irrigation development from 1915 onwards. The need to protect voluntary recruitment during wartime and to accommodate the social pressures of demobilisation led to the continuance of the closer settlement policy under the name of "soldier settlement". Many of the Shepparton Irrigation Region communities grew out of soldier settlement (for example Yarroweyah, Invergordon, Baulkamaugh etc).

Following the Second World War, the Victorian Government continued the development of irrigation. Successive Governments believed the investment in irrigation would result in substantial wealth creation benefits through rural production and the substantial associated processing industries. This belief has been realised and is demonstrated in Section 4.4.5.

4.4.2 The Shepparton Irrigation Region Today

In many cases the closer settlement policies of past governments have come to be seen as a failure in achieving the dream of closely settled and viable rural communities.

The Shepparton Region cannot be so easily dismissed. The Region now has a population of approximately 98,000 (1986 census) or about 2.4% of the Victorian total.

Significantly, the population growth rate of the Shepparton Region over the period 1971 to 1986 was similar to Victoria's growth rate (at 0.72% per annum and 0.92% per annum respectively). The Shires of Rodney and Shepparton and the City of Shepparton consistently grew at a faster rate than the State average (1.43% p.a. vs 0.92% p.a.).

TABLE 3: Population of the Shepparton Region 1971-1986

SHIRE	1971	1976	1981	1986	% P.A. CHANGE 1971/86
Cobram	5,520	5,765	6,206	6,157	0.73
Deakin	5,666	5,503	5,789	5,590	-0.09
Echuca	7,505	7,873	7,943	8,409	0.76
Kyabram	5,081	5,122	5,414	5,342	0.33
Nathalia	3,206	3,182	3,167	3,159	-0.10
Numurkah	5,801	5,647	5,840	6,074	0.31
Rochester	7,587	7,157	7,152	6,988	-0.55
Rodney	12,406	13,402	14,116	14,700	1.14
Shepparton City	19,410	21,239	23,579	24,744	1.63
Shepparton Shire	6,477	6,282	7,228	7,915	1.35
Tungamah	3,147	2,958	2,813	2,691	-1.04
Waranga	4,333	4,187	4,187	4,196	-0.21
TOTAL	86,139	88,317	93,434	95,965	0.72
VICTORIA	3,502,351	3,646,978	3,832,443	4,019,478	0.92
SHEPPARTON REGION AS A % OF VICTORIA	2.46%	2.42%	2.44%	2.39%	

Source: ABS Census data.

The populations of the twelve (12) local government municipalities which are included, in whole or in part, within the Shepparton Irrigation Region are shown in Table 3. Three additional municipalities (Yarrawonga, Euroa and Huntly) have only a small proportion of their area in the Shepparton Irrigation Region and have not been included.

This substantial and atypical growth is simply an expression of a robust economy, based upon irrigated agriculture and substantial local processing. It is the economy, its jobs on farms and in the towns and its existing developed social infrastructure which this Plan seeks to protect.

4.4.3 Participant Equity : The Foundation of an Implementable Plan

To achieve the social goal of safeguarding the existing Shepparton Regional community, SPPAC has been conscious of the need to produce a plan which can and will be implemented.

It must be emphasised that the success of this Management Plan will require onfarm actions by individual farmers to reduce accessions to the watertable and to remove water from watertables. It will also require co-operative action by groups of farmers and by Government at both local and State level.

An implementable plan must be seen by landholders, local towns and government people as a plan which is fair and equitable. If it is not considered fair and equitable it will have little chance of uniting the community in pursuing the required actions. Consequently (and because in salinity matters, cause and effect are not closely related in location or in time) farms will fail, factory workers will be dismissed, service industry will decline, the environment will suffer severe damage and the rural fabric of the community will decay in an inevitable progression. The scope of the Plan and the cost sharing arrangements will be the major determinants of the community's judgement of the Plan. Some evidence for this has already been provided by attitudes to cost sharing arrangements implemented under the existing Phase A program.

The Phase A program was implemented in the mid 1970's to protect the horticultural areas from high watertables and salinity. The capital for those pumps was provided jointly by the State and Federal Governments and the operation and maintenance costs recovered from all irrigators (not just horticulturalists) by way of a special drainage rate applied across entire irrigation districts on a water right basis.

The cost-sharing arrangement was undertaken by the irrigation community with an understanding that pasture areas would receive similar groundwater protection at a later time under a "Phase B scheme". The "Phase B" or the modified "Hybrid Phase B" scheme has never been implemented, but the cost recovery mechanisms for Phase A have remained.

Whilst averaging of operation and maintenance costs for horticultural protection areas has resulted in only modest extra drainage rates, the inequity of a scheme which supplies watertable protection to only a small part of the Region (less than 4%) but recovers the cost from all is obvious. There is currently a substantial cross subsidy from the pasture based industries to the horticultural sector.

The cost sharing for surface drainage on the other hand is on a user pays basis where irrigators utilising the system pay an annual operation and maintenance charge as a drainage rate on water right. Once again the equity of this arrangement is questionable on two grounds. One of the major benefits from surface drainage is road construction and maintenance cost reduction. At this time local government, responsible for road maintenance, does not contribute toward drainage rates. Also the capital cost of surface drainage is included in the RWC asset base and this forms an element in the price charged for water to all farmers irrespective of whether they have access to drainage or not. These cross-subsidies from the farmers without drainage to those with drainage and from all farmers to the

Regional community, are a cause for concern within SPPAC and need to be addressed in any future plan.

At the commencement of the Pilot Program, SPPAC rejected, on equity grounds, the proposal of the Rural Water Commission that the Plan address only that portion of the Region underlaid by high yielding low salinity aquifers. At the insistence of SPPAC, the scope and complexity of the Plan was expanded to address salinity management options for the entire Irrigation Region. This expansion is crucial for the development of an efficient and administrable cost sharing method. If everyone has something to gain, then agreement to universal cost sharing procedures will be easier to achieve. The beneficiary pays principle is very difficult to apply in practice where there are no clear indications of who will and won't benefit from salinity control activities and to what degree. Local government considerations are also significant.

The twelve local government municipalities have responsibility within the Region for planning, development, road construction and maintenance, recreation facilities, and community health and welfare issues. Historically, local government has not been involved in salinity control issues, although surface drainage activities which impinge on municipal assets have required its active involvement. The Goulburn Regional Consultative Council acts as a forum to advise Community Services of Victoria on social planning in the Region and has members from the above municipalities. SPPAC has made every effort to gain the commitment of the 12 local government municipalities within the Shepparton Irrigation Region to become active in salinity control programs. Rodney Shire undertook an important concurrent study of the role of local government in salinity control. Local government will play a vital role in effective cost sharing arrangements. With significant variations in benefits between sub-regions, common agreement with local governments will become difficult.

In summary, total participation and equity in the final Plan are vital to meeting the salt challenge.

4.4.4 How to Evaluate the Options from a Socio-Economic Viewpoint

In line with SPPAC's socio-economic objectives, this document evaluates the salinity control options from an economic and equity viewpoint.

An economic modelling process was used to evaluate the impact of each salinity control option on the Regional economy.

Equity evaluation has been undertaken through an analysis of the Regional distribution of benefit of each of the options.

4.4.5 The Regional Economy

The fundamental aspect of the Shepparton regional economy most significant to the Plan is that of the interdependency between sectors - production, processing, servicing etc. (or industries). Sectors use inputs from each other. For example, farmers purchase fuel, fertilizer, chemicals, financial services (banks, accountants), and so on in operating farms.

When farm production changes, the farm demand for purchased inputs also changes and flow-on effects are felt in other sectors of the Regional economy. The process is particularly relevant to the Shepparton Region where high technology and high levels of locally purchased inputs are used. It could obviously be seriously upset by production changes induced by salinity.

An economic research method known as "input-output analysis" has been used to measure these flow-on effects. The analysis is a statement of the ratio of the total output generated from an initial input, within the Regional economy. These ratios or "multipliers" go a long way to explaining the reliance of the Shepparton Irrigation Region's economy on irrigated agriculture.

A basic appreciation of the Regional economy can be obtained when one examines the direct contributions of the various sectors to output, income and employment where:

output: - measures business turnover at each stage, and therefore includes double counting, e.g. value of milk produced is dairy farm output but it is also included in the value of output of processed dairy products.

income:- measures payments to householders for labour input, including an imputed wage for self employed persons.

employment:- measures the number of people employed.

Table 4 shows the dependence of the Regional economy on agricultural production and processing. There are negligible forestry, mining and non-food manufacturing activities. Otherwise the Regional economy also includes substantial contributions by the building industry and the tertiary sector, in particular the trade and community services components. The agricultural and related processing activities contribute 89% of the exports from the Region.

TABLE 4: Sectoral Distributions of Output, Income and Employment (1986 Prices)

SECTOR	OUTPUT		INCOME		EMPLOYMENT	
	$'000	(%)	$'000	(%)	PERSONS	(%)
Animal Industries	125,529	4.7	36,460	5.6	2,393	6.0
Dairying	173,150	6.5	33,950	5.2	4,805	12.0
Other Agriculture	103,266	3.9	21,284	3.3	1,397	3.5
Horticulture	64,970	2.4	22,050	3.4	1,280	3.2
Forestry	2,483	0.0	960	0.1	63	0.2
Mining	7,034	0.3	1,703	0.3	53	0.1
Other Food Proc.	234,782	8.8	18,308	2.8	796	2.0
Dairy Processing	367,257	13.8	35.496	5.4	1,309	3.3
Horticulture Proc.	216,939	8.1	43,489	6.6	1,488	3.8
Wood & Paper Man.	27,348	1.0	5,312	0.8	503	1.3
Machinery, Appl. & Equip.	17,925	0.7	3,597	0.5	272	0.7
Metals	67,461	2.5	6,760	1.0	403	1.0
Non-metals	19,418	0.7	3,579	0.5	219	0.6
Other Manufacturing	45,194	1.7	8,250	1.3	616	1.6
Elec., Gas & Water	114,973	4.3	18,357	2.8	763	1.9
Building & Construction	239,551	9.0	44,201	6.8	2,176	5.5
Trade	277,828	10.4	98,905	15.1	7,332	18.5
Transport & Communication	123,133	4.6	42.160	6.4	1,982	5.0
Finance	148,642	5.6	38,806	5.9	2,009	5.1
Public Admin.	45,708	1.7	23,869	3.6	1,301	3.3
Community Services	188,178	7.1	124,342	19.0	6,406	16.2
Personal Services	53,747	2.0	22,500	3.4	2,049	5.2
TOTAL	2,664,336	100.00	654,338	100.00	39,615	100.0

A more complex and pertinent way of looking at the Regional economy is to take into account the interdependencies of the sectors and describe the flow-on effects generated for each category of output produced and sold as final demand. Many sectors sell products to other sectors which then produce a final product e.g. a dairyfarmer sells product to a dairy processor who then produces a product for final sale. The depreciation of the Regional economy accounting for flow-on activities appears in Table 5.

TABLE 5: Total Regional Impacts by Output, Income and Employment (1986 Prices)

SECTOR	OUTPUT		INCOME		EMPLOYMENT	
	$'000	(%)	$'000	(%)	JOBS	(%)
Animal Industries	38,349	1.4	10,960	1.7	712	1.8
Dairying						
Other Agriculture	89,034	3.4	20,268	3.1	1,323	3.4
Horticulture	62,149	2.3	19,615	3.0	1,188	3.0
Forestry	3,431	0.1	1,193	0.2	78	0.2
Mining	6,940	0.3	1,820	0.3	82	0.2
Other Food Proc.	488,108	18.4	94,212	14.5	5,569	14.1
Dairy Processing	675,501	25.5	120,601	18.5	9,125	23.2
Horticulture Proc.	392,447	14.8	94,963	14.6	4,917	12.5
Wood & Paper Man.						
Machinery, Appl. & Equip.	610	0.0	137	0.0	10	0.0
Metals	43,555	1.6	5,903	0.9	362	0.9
Non-metals						
Other Manufacturing						
Elec., Gas & Water	15,121	0.6	2,829	0.4	138	0.4
Building & Construction	375,504	14.1	81,571	12.5	4,564	11.6
Trade	54,649	2.1	18,066	2.8	1,278	3.2
Transport & Communication	57,415	2.2	18,646	2.9	1,000	2.5
Finance	13,891	0.5	3,792	0.6	213	0.5
Public Admin.	27,436	1.0	11,385	1.7	658	1.7
Community Services	299,380	11.3	141,763	21.8	7,898	20.1
Personal Services	9,511	0.4	3,455	0.5	283	0.7
TOTAL*	2,653,031	100.0	651,179	100.0	39,400	100.0

* Note: numbers will not exactly match those contained in Table 4 because of rounding errors.

Note that in Table 5 the sectors which sell substantially to export become relatively more important while sectors selling to other industries become less important. This is because these activities are now having their "flow-on" components attributed to the sectors which produce a final product.

The largest contributors to the Shepparton Region economy come from dairy production, other food processing (meat works, soft drink manufacturers, bakers, etc.), horticultural product processing, building and community services. The irrigated agriculture component can be approximated to the sum of dairy, horticultural and other food processing. These combined make up $1,698M of output (64% of all output), $344.8M of income (52% of all income) and 21,708 jobs (55% of all employment).

This illustrates the high dependence of the regional economy on irrigation based activities. Anything which improves the productivity of the agricultural sector improves the Regional economy. Similarly, anything reducing farm productivity has a negative impact on the Regional economy.

The dairy and horticultural activities are shown in summary form in Table 6 and in more detail in Table 7. Dairy farming produces output valued at $173.2M, using local inputs of $48.8M, imports of $33.3M, labour valued at $34.0M and other items shown at $57.1M.

All of that output is shown as being sold to processing which uses a similarly classified set of inputs to add value to the product and finally produces output valued at $367.3M. A similar set of data is shown for horticulture.

TABLE 6: The Dairy and Horticulture Industries in the Regional Economy
(All value figures are $M — 1986 prices)

OUTPUT SOURCE	DAIRY		HORTICULTURE		NOT PROC.
	FARMING	PROCESSING	FARMING	PROCESSING	(1)
Purchases of inputs from farms*	—	173.2	3.1	33.7	
Purchases of inputs from within the region*	48.8	53.5	20.2	74.7	
Purchases of inputs from outside the region	33.3	30.0	13.9	25.0	
Payments to wages and salaries*	34.0	35.5	22.1	43.5	
Gross operating surpluses, depreciation and taxes	57.1	75.1	5.5	40.0	
VALUE OF OUTPUT	173.2	367.3	64.8	216.9	31.1

*Purchases of farm inputs, other purchases of inputs from within the region and payments to wages and salaries, generate local flow-on effects. Below is a distribution of these effects by sector for output for Dairy Processing and Horticultural Processing.

OUTPUT FLOW-ON EFFECTS (2)	DAIRY PROCESSING		HORTICULTURAL PROCESSING
Dairy	129.8	Horticulture	25.9
Trade	41.2	Trade	37.7
Finance	22.6	Finance	14.9
Electricity, Gas	21.2	Elec., Gas	11.3
Transport, Communications	12.6	T'port, Commun.	13.6
Other Sectors	80.8	Other Sectors	72.2
TOTAL FLOW-ON EFFECT	308.2		175.6
TOTAL EFFECT (OUTPUT + FLOW-ON)	675.5		392.5
EMPLOYMENT EFFECTS (3)	9,125 jobs		4,917 jobs

Note:

(1) Not all production from horticulture is processed. Approximately 48% of output is either consumed locally or is exported from the region as fresh fruit.

(2) Flow-on effects are determined by multipliers which measure effects "backwards" from the sector involved. Thus all the effects of dairying are incorporated in the dairy processing sector.

(3) Employment effects are estimated in a similar way to "flow-on" effects. They represent all employment backwards from the sector involved. $33.7M of farm output is sold for processing and $31.1M is exported fresh.

Input-output analysis enables the flow-on effects to be calculated both in total and disaggregated by sectors. These are shown in Table 6 measured in terms of output and in Table 7 in terms of output and value added. In a Regional sense *value added* measures the net value production after deducting the value of inputs purchased from the industries. In Table 6, for example, dairy processing generates total output flow-on effects of $308.2M in total. Of that total, $129.8M accrues to dairy farming, $41.2M to the trade sector and so on down to negligible effects on the mining and forest sectors, as shown in Table 7.

Perusal of Table 6 reveals that the largest flow-on effects from processing are to the farm sector that produces the output. Then the major flow-ons accrue to important service activities particularly the trade, finance utilities and transport sectors. This pattern confirms that the strong linkages in the economy are between agriculture/processing activities and the key parts of the service sectors rather than to other manufacturing sectors.

TABLE 7: Flow-on and Value Added Effects ($M)

REGIONAL ACTIVITIES	DAIRY PROCESSING		HORTICULTURAL PROCESSING		HORTICULTURE NOT PROCESSED	
	FLOW ON	VALUE ADDED	FLOW ON	VALUE ADDED	FLOW ON	VALUE ADDED
Dairying	129.8	68.4	3.1	1.6	0.7	0.40
Trade	41.2	27.8	37.7	25.4	8.4	5.70
Finance	22.6	15.2	14.9	10.0	4.2	2.80
Electricity, Gas, Water	21.2	15.2	14.9	10.0	4.2	2.80
Transport, Communications	12.6	7.9	13.6	8.5	3.3	2.10
Entertainment, Recreation	9.7	6.5	5.3	3.5	1.3	0.90
Public Administration	9.6	6.9	4.0	2.9	1.1	0.80
Dairy Processing	7.5	1.1	3.2	0.5	0.8	0.50
Other Food Processing	7.5	1.1	3.2	0.5	0.8	0.10
Other Manufacturing	7.3	3.3	14.3	6.5	0.8	0.40
Community Services	7.3	5.4	4.7	3.5	1.2	0.90
Other Agriculture	7.3	5.7	2.2	1.7	1.7	1.30
Wood, Paper	5.8	1.3	3.8	0.8	0.4	0.09
Animal	5.2	3.7	1.5	1.1	0.4	0.28
Horticultural Processing	4.3	1.7	3.4	1.3	0.8	0.30
Machinery, Appliances	3.4	1.5	3.7	1.7	0.8	0.40
Metals	2.2	0.9	11.5	4.8	0.4	0.17
Non-metals	1.4	0.5	3.8	1.5	0.2	0.08
Horticulture	0.7	0.3	25.9	11.0	0.1	0.04
Building, Construction	0.6	0.2	0.6	0.2	0.5	0.20
Mining	0.1	0.1	0.2	0.1	0.1	0.05
Forest	0.1	0.1	0.1	0.1	0.1	0.06
TOTAL	308.0	178.5	175.4	98.9	31.1	19.37

Note: Numbers may not add exactly to total shown because of rounding.

It is apparent that the flow-on to the dairying sector is less than the level of output produced by dairying. This arises because some of the processed dairy production is sold to local consumers. Thus, that portion is attributed to the flow-on effects of other sectors.

For example, the community-services sector produces output and employs people who receive income. Some of that income is spent on consuming locally produced products including dairy products. Thus, a small part of dairy farm production (in fact $5.2M) is attributed to the consumption-induced flow-on effects of the community services sector. Similarly for other sectors shown as contributing to the Regional economy in Table 5.

It was noted earlier that the input-output analysis concept of output does involve double counting of some entries. This can be avoided by converting those output estimates to value added. These are shown in Table 7 for dairy and horticulture processing as both disaggregated and total effects. Value-added provides estimates that approximate national accounts measures. The disaggregated estimates show a broadly similar distribution among sectors to that of output. It is also possible to estimate the contribution to the Shepparton Regional economy of irrigated agriculture in value-added terms. These are shown in Table 8 below.

TABLE 8: Irrigated Agriculture in the Shepparton Regional Economy ($M)

	DIRECT	FLOW-ON	TOTAL
Dairy processing	110.6	178.5	289.1
Horticultural processing	83.5	97.9	181.4
Horticulture, not processed	13.2	19.4	32.6
TOTAL	207.3	295.8	503.1

The total of $503M represents almost 37% of Gross Regional Product in the Shepparton Region, estimated to be $1,366M.

Finally, the flow-on effects measured in terms of income amounted to $156M, while employment flow-ons amounted to 12,180 persons employed. These give total effects of $235M of income earned by 15,230 persons employed by these two industries. Flow-on effects have not been detailed for the "other" industries.

The preceding discussion has detailed some of the estimates relating to the irrigation-based activities in the Shepparton economy. The next question is "How will the economy be affected if production changes?". On the basis of the assumptions embedded in the input-output model, that question can be answered through the use of multipliers.

For example, the output multiplier for dairy processing is 2.154. This is a summary measure which indicates that a $1M fall in output from dairy processing will mean a further $1.154M of flow-on effects elsewhere in the economy. Further, the employment multiplier of 0.02291 (interpreted as jobs per $1000 of output) will indicate a loss of 29 jobs in total (about 4 directly and 25 through flow-on effects). Thus, the multipliers are summary measures that can be used to estimate the total (direct plus flow-on) effect of some change on the economy. It should be noted that multipliers are calculated on the basis that everything else in the Shepparton economy remains constant. Multipliers were used to produce the estimates of future losses due to salinity shown in Table 10 (p.52).

Clearly, any adverse impacts upon the productivity of farming within the Region will have major adverse impacts upon the whole economy of the Region - including the towns and cities, factories, shops, banks, schools and health services.

4.4.6 Household Incomes

Household incomes within the Shepparton Region are significantly lower than within the State of Victoria as a whole. For example the following graph (Figure 5) compares the distribution of incomes in Shepparton and in the Melbourne metropolitan region. The data are from the ABS 1986 Census.

It may be seen that across the whole distribution the Shepparton region incomes are significantly lower. Compare the following:

	Lower Quartile	**Median**	**Upper Quartile**
Shepparton	$12,000	$20,500	$32,000
Melbourne	$17,000	$27,500	$40,000

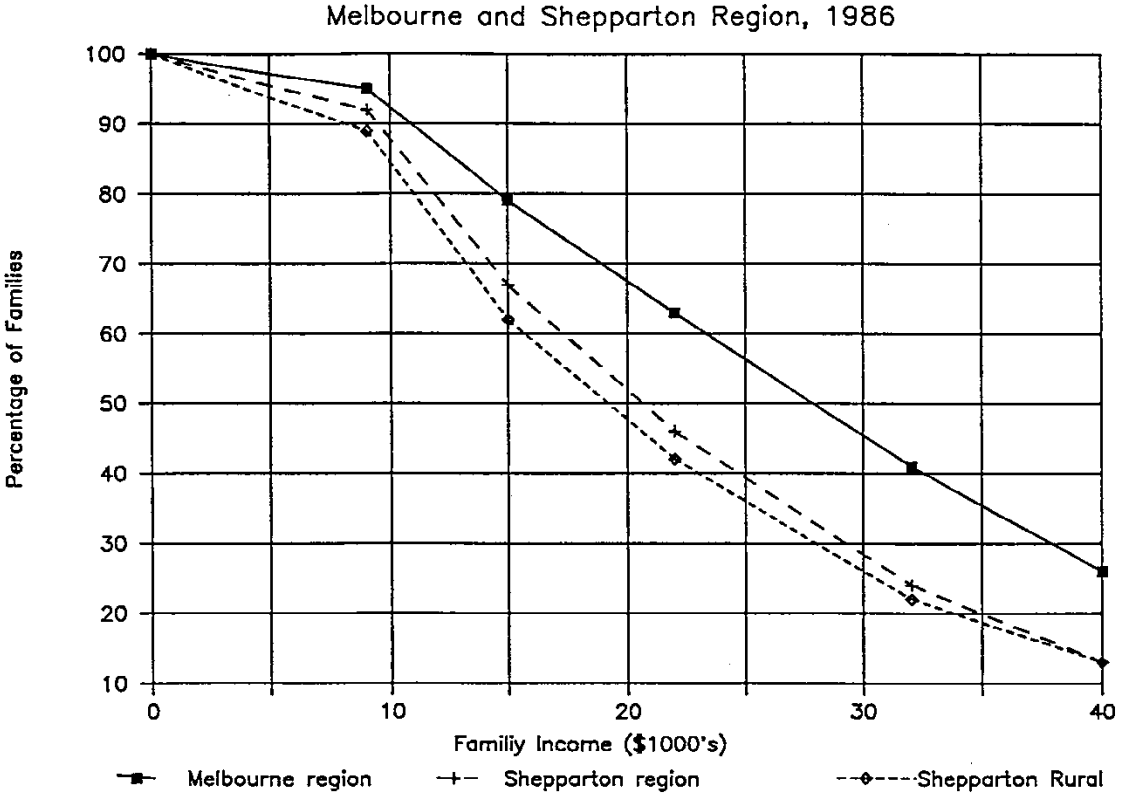
The ABS Census data for the Shepparton Region includes both urban and rural households. A farm survey in 1986 showed that, for rural households, 30% of the median household

income was obtained from "off-farm" resources. The ability of farm households to further supplement their incomes by off-farm activities is not known.

For further information on this section refer to the following Background Papers:

SE1 - *Salinity Monitoring Survey - June 1987*
SE2 - *Farm Socio-Economic Survey - October 1987*
SE5 - *Regional Economics- August 1988*

FIGURE 5: Household Incomes - Melbourne and Shepparton Irrigation Region



Source: Australian Bureau of Statistics
1986 Census of Population and Housing

4.5 ENVIRONMENTAL CONDITIONS

4.5.1 Background

The streams, wetlands and floodplains of the Shepparton Region originally provided the key elements for a very rich and diverse ecosystem. Vast stretches of open flood plains of box forest were dissected by prior streams of red gum forest, and scattered throughout were large numbers of open wetlands of varying sizes.

The flora and fauna were well adapted to the natural range of environmental conditions and, in particular, to the natural extremes of floods and droughts. For example, floodplain trees such as red gum and black box relied heavily on regular flooding or access to groundwater for regeneration and growth, while development of the thick stands of grey box on higher ground depended on their ability to establish deep root systems to intercept most of the rainfall which infiltrated the soil profile. The density of trees was largely determined by the availability of water from rainfall, floods and aquifers.

Native fish and waterbirds evolved special mechanisms to enable the species to survive under severe drought conditions and then take advantage of floods for reproduction and dispersal. Many other native birds and mammals depended on the available range of terrestrial, wetland and riparian (stream) habitats. Reports by early European settlers confirm the great abundance of wildlife in the Region and describe the pattern of hunting and gathering by the Aborigines, which was finely tuned to the availability of the various plant and animal foods.

There is ample evidence that the vegetation has played an important role in maintaining the hydrological balance of the Region. Botanical reconstruction suggests that the presence of closed red gum forests along the prior stream channels in the western part of the Goulburn Valley protected these depressions from salinisation some 20,000 years ago when high regional watertables resulting from climatic changes led to the formation of many salt lakes and salinas (saline discharge pans).

Development of the Region for agriculture following European settlement has resulted in the removal of about 95 percent of the native forests and woodlands. Extensive clearing in the upstream catchment areas and the introduction of major irrigation schemes have also had major effects on surface and groundwater hydrology. The environmental quality of a large proportion of Regional streams and wetlands has been diminished by a range of factors including clearing, grazing, drainage works, rising watertables and salinities, and the introduction of exotic plants and predators. However, some of these streams and wetlands are still ranked as high quality habitats.

The degradation of the natural environment of the Riverine Plains since European settlement has probably resulted in the extinction of 8 species of mammals, a reduction in the diversity and abundance of native flora and fauna and a serious decline in landscape values.

A number of Victorian Government initiatives including the State Conservation Strategy, Wetlands Conservation Program, the Fauna and Flora Guarantee and Salt Action:Joint Action require that the maintenance of environmental quality is afforded a high priority in the development of salinity management plans. This will ensure that the environmental values associated with the existing wetlands, rivers, streams and woodlands will be passed to future generations.

4.5.2. Existing Environmental Conditions - Geomorphology

The study area forms part of the Riverine Plains of Northern Victoria, created by alluvial deposition from the weathering of the Great Dividing Range. The major streams of the Region are the Murray, Goulburn, Campaspe and Broken rivers and the Broken Creek. Faulting activities also have had an impact on drainage patterns through their influence on stream courses. The plains are intersected by a number of ancestral stream systems which

now form a series of linear depressions, the major ones being the Muckatah, Mosquito, Stanhope and Timmering systems.

The Region is underlaid by a sequence of channel, meander cut-off or levee bank sands (aquifers), which are separated by clay and silt deposits. The stream processes have produced a range of landforms and soil types, which in turn have a bearing on surface and groundwater hydrology and vegetation associations.

Soils associated with wetlands have also been influenced by a range of physio-chemical processes. Permanent wetlands tend to have very plastic clays with good water-sealing properties. Ephemeral wetlands are generally underlain by moderately plastic, cracking clays, often with more permeable preferred pathway zones indicated by orange mottling. Soils around the margins of wetlands tend to be dense, cracking clays and silts with high runoff coefficients.

4.5.3 Existing Environmental Conditions - Rivers and Streams

The major rivers draining north to the Murray River include the Goulburn River, with its extensive headwaters in the highlands, the Campaspe and Broken rivers and Broken Creek. These are all set in red gum flood plain depressions of varying widths but their hydraulic regulation (principally for irrigation supply) has altered their natural flooding patterns. The RWC currently has a policy of providing some flow from Goulburn Weir to the lower Goulburn River for environmental purposes; however, this is not the case in the Campaspe and Broken Rivers.

The Goulburn River below Nagambie represents Victoria's most important Murray cod habitat, supports significant populations of catfish and silver and golden perch and also forms part of the natural range of the endangered trout cod. Water quality in the Goulburn is generally good and the presence of deep pools and areas of fallen timber adds to its value for native fish.

The Campaspe River downstream from the Waranga Western Channel is a potentially valuable habitat for Murray cod and other native fish; however, surveys by DCFL indicate that fish stocks are relatively low, despite stocking with juvenile fish. Factors which may contribute to this situation are low seasonal flows resulting from river regulation, suspected saline groundwater inflows and the discharge of industrial effluent.

Smaller streams tend to be ephemeral in this Region unless supplied with irrigation water.

One class of small streams originates in the higher rainfall areas of the Highlands, such as Boosey, Honeysuckle, Stoney, Seven, Castle, and Pranjip creeks west of the Goulburn; and Cornella and Wanalta creeks near Corop. These are litter-dominated ecosystems receiving the bulk of their nutrients and bio-energy from the forested red gum riparian margins.

Extensive riparian clearing and grazing has severely stressed this environment. Indeed many other factors are stressing these stream ecosystems:

(i) Regional tree clearing has increased the amount and peak height of runoff;

(ii) stream biota, especially invertebrates which perform essential nutrient cycling roles, have decreased in diversity, abundance, and productivity and are being replaced by only a few opportunistic species which become locally prolific;

(iii) pesticide and herbicide spraying at even low levels in this agrarian region may also have a significant impact on these sensitive stream environments;

(iv) bank and bed habitat degradation by erosion, vegetation removal and channelisation is common;

(v) salinity now increases substantially during summer and white salt inflorescences are common along some bare stream banks.

Prior streams are the carriers of prolonged winter runoff and many flow along old prior stream depressions such as the Muckatah, Stanhope, Mosquito, Ardmona, Murchison and Timmering drainage lines. These courses were once closed, dense red gum forest but have been extensively cleared and channelised except for a few remnant patches.

More geologically recent streams occur along Bunbartha-Sheepwash creeks, Undera North, Yambuna and Kanyapella creeks, small drainages entering the Campaspe River, and Pine Lodge, Congupna Nine Mile creeks on the eastern plains. There were red gum forests on the irrigation banks of these streams also but most are now channelised or vegetatively replaced by cumbungi and usually little remains of their original ecosystem.

4.5.4. Existing Environmental Conditions - Wetlands

A high proportion of wetlands have been significantly modified since European settlement: many have been drained for agricultural purposes whilst others have been affected (or created) by changes in hydrological regimes, rising watertables or increasing salinities. However, wetlands represent the most valuable habitat area in the Region.

Wetlands within the Goulburn and Broken River catchments are currently being assessed by the Department of Conservation Forests and Lands with field surveys underway to compile their natural resources inventories and ecosystems operational characteristics. Wetlands may be conveniently grouped into seven major associations in this Region:

- major river floodplains
- recent-aged drainage lines
- prior stream depressions
- ancient salt lakes
- deflation potholes
- Timmering Depression System
- man-made lagoons and empoundments

The major Regional wetland management units are identified in Figures 6 and 7. Figure 7 also indicates wetlands of high conservation value as defined by the Department of Conservation Forests and Lands (DCFL).

(a) Floodplain Wetlands

The Goulburn River wetlands are confined to a 1km to 4km wide depression terrace set 2 to 4m below the Regional plain. These are now regularly flooded (in 3 years out of 5) by winter/spring floods, and occasionally by major floods which may occur at any time of the year. Most occur as anabranches, abandoned river meanders, flood sloughs and levee margins and vary from very shallow to 10m deep.

Water quality influences much of the wetlands' floral and faunal characteristics in this Region. Natural flushing of the riverine wetlands during brief flood inundation provides a clean, low salinity, freshwater start to the summer evaporation and aquatic floral growth cycle, which later alters the water chemistry. Even towards the end of summer however, these waters are still very fresh (EC<300) except where polluted by irrigation and drainage runoff.

At sites of nutrient rich irrigation water runoff, weeds spread throughout the wetland, with extensive eutrification commencing first with prolific azolla duckweed growth, followed by the spreading of floating couch grass which is then replaced by an exotic cumbungi morass. Above 3000EC units, even the cumbungi ecosystem begins to fail and the riparian red gums recede to leave a lignum shrub community.

Most of the bottom muds are very plastic clays that are quite dispersible. This dispersibility accounts for the high water sealing properties of the muds and explains why the larger wetlands have remained open for over 25,000 years.

The natural indigenous vegetation is adapted to very low salinity levels (250± 125EC units), maintained by near yearly flood inundation. These conditions must be maintained if the pristine naturalness is to be preserved. In their current condition this group of wetlands has high conservation, aesthetic and recreational values.

(b) Wetlands Along Recent-aged Drainage Lines

Recent-aged drainage lines are minor, active, naturally ephemeral stream systems that have developed on the Plains within the last 15,000 years. In their pristine state they contained wetlands which were dominated by red gum riparian forests.

Irrigation runoff has now altered most of these to near-perennial flow systems. Where their red gum riparian forest has been removed, the nutrient rich waters have created an exotic, eutrified cumbungi morass.

(c) Prior Stream Depressions

The prior stream depressions meandering across the Plains are ancestral courses of the Goulburn and Murray Rivers which were created when these great rivers episodically jumped to major new flow paths. All were formed more than 40,000 years ago but have since been modified to ephemeral streams which only drain surface runoff from the Plains region. Most depressions are generally 1 to 3m deep and up to several hundred metres wide.

The main depression lines include the Murchison North, Ardmona, Mosquito, Stanhope, Echuca East, Muckatah, and Lower Broken Creek systems, most of which are currently cleared to open paddocks with spiny rush tussocks *(Juncus acutus)* and salt-scalded patches or are fully reticulated drains.

However, botanical reconstruction indicates they were once closed red gum forest wetlands with occasional open, emergent marshes in areas with prolonged standing water. Their banks contained mixed red gum-grey box open forests with yellow box and gums common among the levee margins before grading off into an open grey box forest to woodland savannah on the adjacent Plains.

An important discovery was that these drainage depressions never appeared to become salinised during a period when some parts of the adjacent plains were developing salt lakes and pans about 25,000 to 18,000 years ago. Apparently the winter flushing flow and the summer evapotranspiration by the red gum forest was sufficient to prevent salinisation of the channel bottom. This natural history example can assist in developing a solution to the present and future salinity degradation for these depressions.

At present only remnants of red gum remain along these lines, and most marginal grey box trees are dying or dead from the rising watertable. The bulk of current wetlands are permanent pastures due to man-made obstructions and are cumbungi dominated in response to high nutrient eutrification and salinity.

These prior stream depressions should be considered as an integrated flow system with occasional wetlands along their courses. As such they have been severely degraded to reach their present status, but possess a very high rehabilitation potential for return to high value wetlands.

(d) Ancient Salt Lakes

Ancient salt lakes particularly in the western part of the Goulburn Valley are relics of extensive salinisation around 25,000 to 18,000 years ago. All have developed marginal sand dunes or clay lunettes, usually on their north eastern sides, and have rounded shapes and very flat bottoms. The main large examples include the Corop Lakes (Lake Cooper, Greens and Horseshoe lakes and smaller pans), and the very large basins at Kanyapella North, all of which probably represent ancestral terminal drainage lakes. Lake Cooper for example ranges in salinity from 2500 to 3600ppm (4500 to 6000EC units) over the course of a year, develops summer thermal stratification with winter convective overturning and has a typical salt lake alkaline pH of around 10 during peak evaporation rates. However this is lowered to pH5 with spring rains. Algal growth is prolific, developing oversaturated oxygenated waters in summer, indicating a deficiency of micro-invertebrate grazing fauna due to salinity.

Reedy Lake, Doctors and Moodie swamps possibly originated from "dryland" salinisation processes, whereas Dowdle Swamp is representative of numerous isolated Plains salt pans. Their relic salinisation has long been leached away and all were recolonised with red gum forests prior to European settlement. Their present conservation value status varies with their degree of clearing.

(e) Deflation Potholes

Deflation potholes are salinisation scalds related to the previous regional salinity event. They are generally circular to ovoid depressions 1 to 3m below the Plains level, and are generally 100 to 200m across the minor raised sand, silt or clay rims. These are mini-basins with internal drainage and are only seasonally flooded with shallow water after prolonged winter rains. This lack of flushing makes them very susceptible to salinisation.

Potholes are the most numerous type of wetland in the region and several hundred are found scattered more or less randomly across the western part of the Goulburn Valley. They were created initially from shallow rising watertables which created isolated salt evaporation patches. This removed the covering vegetation and left dispersible salt scalds. Wind then eroded a shallow depression which enlarged and deepened to the near surface watertable. Wave action on the dispersible soils maintained the rounded shapes and the excavated soils were blown into a low marginal rim.

Most of these shallow depressions are currently cleared but some remaining near-natural examples represent several botanical sub-types.

(f) The Timmering Depression

The Timmering Depression system includes a wide floodway along a strong north-south lineament from Corop to the Murray River. Several circular wetlands and ancient salt lakes are set in this 250km to 2.1km wide fault bounding the depression. The entire north-draining hydraulic system which extends from Wanalta Creek through to One Tree Swamp, Wallenjoe and Mansfield swamps, then north through Timmering to the Deakin Main Drain is considered as a drainage basin entity. Logically the upper parallel drainage system including Cornella Creek - Gaynor Swamp - Lake Cooper - Horseshoe Lake - Green Valley (ancient salt lake) may also be included.

As with prior stream depressions, this intermittent drainage system was once extensively forested with red gums, only on a much larger scale and included both shallow, ephemeral wetlands and the larger, deeper Mansfield-Wallenjoe pothole-type forested swamps. Except for the above mentioned wetlands and a native forest near Timmering, the entire depression line has been cleared for pasture. Consequently the watertable is near the surface at the south end which is

underlain by shallow bedrock, preventing groundwater from leaking away to deep aquifers.

The Brolga *(Girus rubiandis)* is a regionally significant species found in association with the wetlands of this floodway, constructing nests in the shallow flooded sites.

(g) Man-Made Lagoons and Empoundments
Man-made lagoons and empoundments form about 3.7% of the wetland area in this Region, and about two thirds of this area is occupied by municipal sewerage lagoons. The remaining one third consists of farm dams and flooded excavation pits which form a diverse wetland group.

4.5.5 Existing Environment Conditions - Terrestrial Environment

Little remains of the extensive grey box open forests and woodlands which covered the majority of the Riverine Plain region before European settlement. Clearing of land for agriculture has also left little of the original stands of river red gum, yellow box, yellow gum, Murray pine and bulloak.

A large proportion of the remnant grey box has been either killed or is in poor condition as a result of waterlogging produced by the high watertables. These old trees are particularly vulnerable to rising watertable, because their root systems are unable to adapt to the changed conditions. However, experience indicates that newly-planted grey box can successfully establish in areas with high watertables by putting out shallow root systems. It remains to be seen how these new trees will respond to drought conditions.

4.5.6 Landscape Values

The landscape values of the Region have been significantly degraded by the extensive clearing and subsequent death or decline of remnant trees. Large scale tree planting will help to create a more attractive landscape as well as providing shelter for stock, fauna habitat and a means of reducing watertable elevations. The presence of healthy trees should also enhance the value of farming properties in a region where the many dead and dying trees provide a clear indication of the proximity of groundwater to the surface.

For further information on this section refer to the following Background Paper:

EN1 - Environmental Considerations - July 1989

4.6 RELATIONSHIPS WITH THE GOULBURN DRYLAND REGION

A separate salinity management plan has been produced for the Goulburn Dryland area. It is vital that the two plans be considered together and that the implementation arrangements ensure that the interactions between the two are recognised and dealt with accordingly.

Interactions between the irrigation areas and adjacent dryland areas occur in two ways:

(i) increasing salinity in dryland areas results in higher stream salinity and higher salt loads entering the irrigation areas, and

(ii) the underlying aquifers provide a link between the groundwater bodies underlying the dryland and irrigation areas.

4.6.1 Stream Salinity Effects

Stream monitoring (documented in the Goulburn Dryland Salinity Management Plan - LP10) over the 10 years from 1977 to 1988 has not identified any increasing trend in water salinity. This indicates that any trend over that time has been small. It is possible that increments occur predominantly as sharp increases following very wet periods and may not have been evident in the data for recent years. Very rudimentary process modelling suggests that salt loads emanating from the dryland catchments could more than double in the very long term. However, on the evidence available, it seems unlikely that salinity or salt load increases of more than 10% would occur over the planning period.

The effect on the Shepparton Region of a 10% increase in the Goulburn-Broken catchment stream salinities would be an increase of 6,600 tonnes/yr of salt delivered to the Region. This would result in:

(i) minor increases in groundwater accessions due to increased salinity of application. Given that present channel salinities are very low (about 95 EC units) an increase of about 10 EC units would probably leave the irrigation salinity below the threshold at which increased groundwater accessions would occur;

(ii) minor reduction in the capability of diluting reused groundwater. This would be of the order of 1 to 2% where reuse of groundwater increased irrigation salinity from 100 to 500 EC units;

(iii) an increase in surface runoff salt loads discharged from the irrigation Iegion Rue to more saline input water. This might amount to about 1200 tonnes/yr;

(iv) a longterm increase in salt loads discharged from areas with sub-surface drainage (or as saline runoff) as the Irrigation Region approached a salt balance. This might amount to 5400 tonnes/yr over a period of 100 years or more.

These increased salt discharges would cause small increases in Murray salinities, the increase at Morgan being about 0.16 EC units and 0.9 EC units for salt loads of 1100 and 6000 tonnes/yr respectively. As these increments are a direct result of processes already in train, they should be classed as "natural salt inputs" under the Murray Darling Basin Commission's Salinity and Drainage Strategy. In this case the Region would not be required to purchase additional salt disposal quotas in the short term.

Although the effects in the short term (the present planning period) are likely to be minor, the longer term picture (of the order of 100 years or more) is most disturbing. The projected ultimate increase in dryland salt loads would increase the salinity of water coming into the Goulburn Irrigation Areas by some 110 EC units, which would have significant effects on the Region initially and ultimately on the River Murray.

The effects within the Region would depend on whether or not the preferred sub-surface drainage program is implemented. If these works are not implemented, the regional salinity problem would be significantly worsened by the more saline input water. The high salinity irrigation water would increase groundwater accession rates, resulting in generally higher and more rapidly rising watertable levels. The combination of higher watertables and higher applied salt loads would cause more rapid and more severe salinisation than has been projected under the "do nothing" scenario. Surface runoff salt loads would rise immediately the more saline water was introduced and about 20% of the additional salt load (some 20,500 tonnes/yr) might reach the Murray, causing an increase in Morgan salinity of about 3 EC units.

The ability of individual farmers to safely reuse groundwater would be reduced by 15 to 30%. In the longer term, salt loads from irrigation areas discharged as runoff from saline areas would increase more quickly and to much higher values than predicted under the "do nothing" case. The equilibrium salt load output would be some 100,000 tonnes/yr greater than the equilibrium value if input salinity was unchanged. This would cause an increase of some 15 EC units in river salinity at Morgan, with an economic penalty to downstream users of some $1,200,000/yr if additional salinity interception works are not constructed.

If the preferred sub-surface drainage program is implemented in the irrigation areas the effects of increased stream salinity on accessions will be of less consequence. The strategy allows for increases of 100 EC or more in channel salinity due to injected groundwater and the number of farmers reusing groundwater onfarm at salinities up to 300 EC units would be greater. Moreover much of the area at risk by 2020 would be sub-surface drained, so that the main effect would be increased pumping and disposal costs rather than increased salinisation. The problems of salt disposal would be further increased by the reduced opportunities for dilution both onfarm and through the Regional channel system. As in the "do nothing" case, runoff salt loads would increase immediately the additional salt load was introduced, with up to 3 EC units increase in Morgan salinity.

The real impact on disposal salt loads is difficult to forecast. It is reasonable to predict that, at equilibrium in the very long term, the total salt disposal from the Region must be 100,000 tonnes/yr greater than it would otherwise be. However, the preferred Plan requires that the total salt discharge from the Region over the implementation period would increase from the current level of about 61,000 tonnes/yr to some 178,000 tonnes/yr. This is considerably greater than the expected salt input, which is estimated at 111,600 tonnes/yr (including the future input from Lake Mokoan. However, because the proposed sub-surface drainage disposal rates will allow a progressive improvement in groundwater quality, the total salt disposal requirement should decrease over a period of 20 to 100 years and approach a balance with the salt coming into the drained areas. As this is likely to occur over a similar time frame to that over which the increased stream salinities may occur, one effect may offset the other. Unfortunately, however, it is likely that over the same time frame the high watertable areas in the Region will extend beyond the areas dealt with in this Plan, i.e. the 2020 high watertable areas.

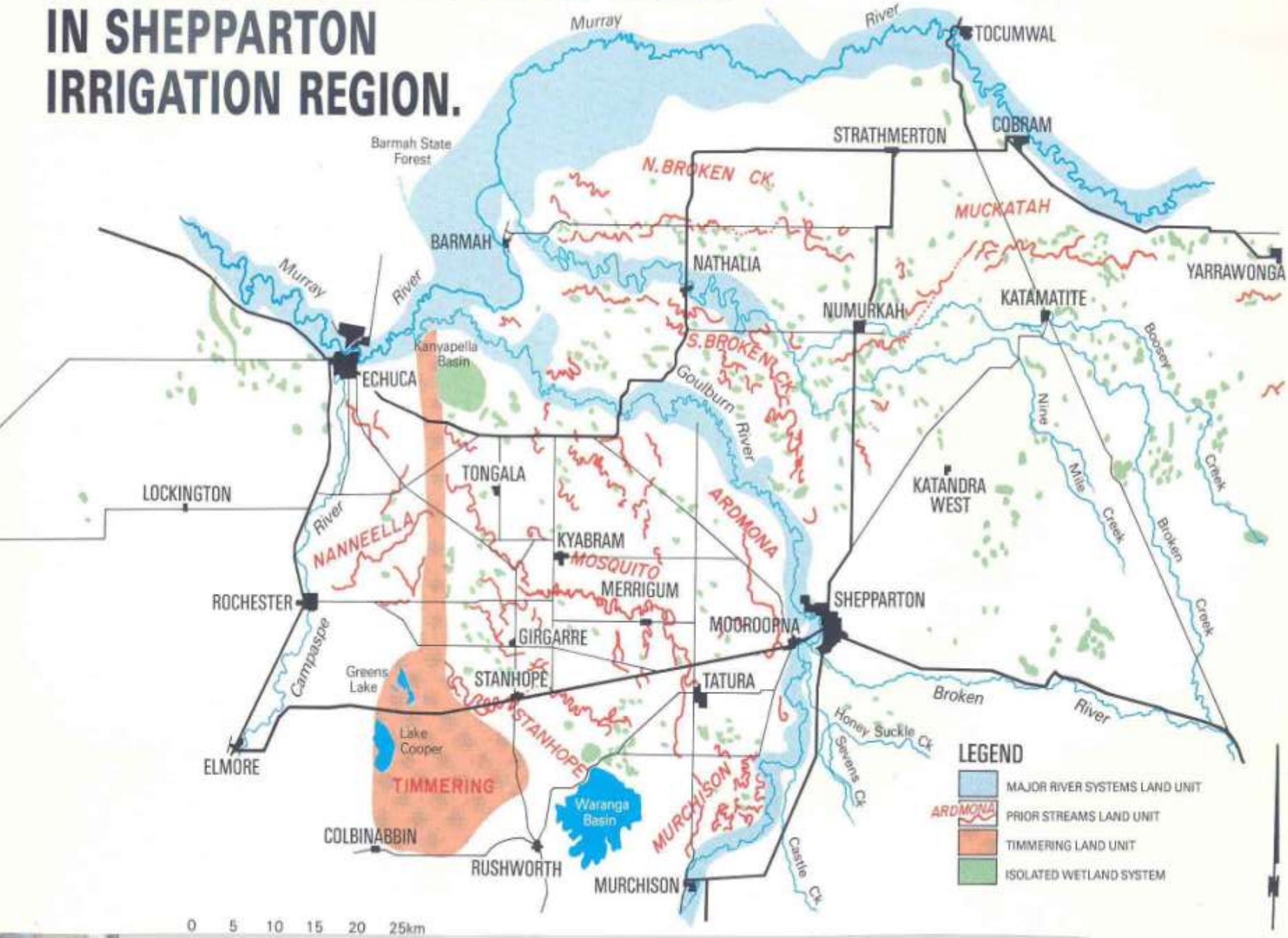
Therefore additional salt loads will be generated from these areas, either as additional saline runoff or as additional sub-surface drainage salt loads.

The available evidence suggests that the effects of increased stream salinities on the Region will be minimal in the present planning period. If, however, the projected longterm increases were to occur, the longterm sustainability of Murray Darling Basin Commission's Salinity and Drainage Strategy in its present form will be threatened. This would in turn present a real risk to the proposed disposal arrangements of the Shepparton Management Plan. Under the longterm scenario the Murray would receive 162,000 tonnes/yr in increased salt loads discharged directly down the river system, as well as the projected increases in salt loads passing through the irrigation areas. The impacts within the Region will be significantly less if the preferred Management Plan is implemented; they will be much greater in the "do nothing" case. However it is clearly vital to both the Region and to downstream users that implementation of control and remedial works be expedited in the dryland areas, and that investigations and research to accurately quantify the future problem be accelerated. $270,000 has been included in the 5 year work program to cover installation of monitoring stations and review and analysis of the data obtained.

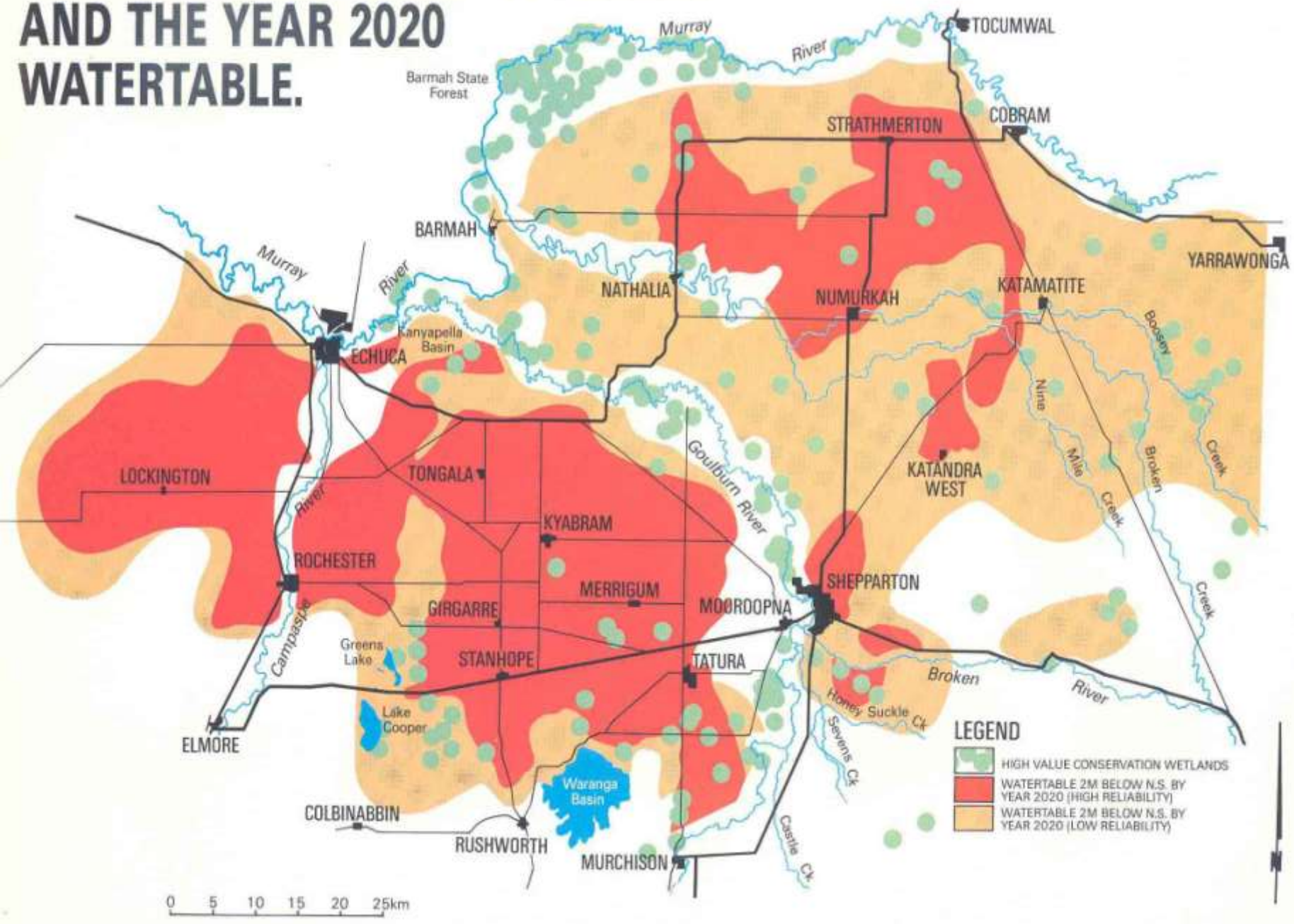
4.6.2 Groundwater Linkage

Groundwater interactions between the dryland and irrigation areas are generally associated with 3 types of aquifer systems. These are the shallow alluvial aquifers of the Upper Shepparton Formation, the major deep lead aquifers and fractured bed-rock aquifers.

WETLANDS MANAGEMENT UNITS IN SHEPPARTON IRRIGATION REGION.



HIGH CONSERVATION WETLANDS AND THE YEAR 2020 WATERTABLE.



Significant lateral transfers through the shallow aquifers generally occur only over relatively short distances of up to 10km. Direct interactions between the dryland and the irrigation areas are commonly limited to the immediate fringes of the irrigation areas, e.g.:

(i) Kialla East - there, watertables in the dryland are at slightly higher elevations than those in the irrigation area to the west. Sub-surface drainage from the dryland is retarded by the irrigation watertables while the irrigation watertable is recharged from the dryland; and

(ii) Rochester West - there, the irrigation watertable mound dissipates quickly away below the dryland immediately to the west.

The deep lead aquifers have the capacity and continuity to allow interactions to occur over much longer distances. However, estimated groundwater flows into the irrigation areas are quite small (of the order of 10,000ML/yr) compared to the total accessions to all aquifer systems within the irrigation area (of the order of 200,000ML/yr).

The Regional significance of these aquifers is not well understood, but pressure rises are occurring quite generally in areas where there is little pumping from the deep lead. The longterm consequences of continuing rises are likely to include:-

- small reductions in natural sub-surface drainage within the irrigation areas,
- possible longterm changes in the volume and salinity of groundwater pumped from the shallow aquifers; and,
- development of additional high watertable areas, particularly around the upstream margins of the irrigation areas;

The bedrock aquifers generally have a low capacity for extensive lateral transfer of groundwater, except where the topography allows steep gradients to develop. The main areas of concern are the southern margins of the Irrigation Region, where gradients generated by increased accessions in adjacent dryland areas can cause high pressures at the margin of the irrigation areas, which may then be exacerbated by recharge from water storages, channels and irrigation.

Relatively little work has been carried out in these marginal areas, although the shallow bore monitoring grid for the irrigation areas is being progressively extended to ensure that watertable trends and groundwater salinities are adequately monitored. This program will continue in collaboration with the monitoring program carried out by Department of Conservation Forests and Lands in the dryland areas. Interdepartmental working groups will be set up to assess particular problem areas which are identified.

A working group has already been set up to evaluate the possible threat to the Barmah Forest from high watertables and rising pressure levels in the adjacent irrigation area, and to develop appropriate control measures. The drilling and monitoring program and the proposed working groups will be co-ordinated through the Salinity Program Advisory Council (Section 7.1.2).

Considerable resources have been committed to Regional groundwater modelling in recent years. This will continue with the aims of:

- more precisely identifying the components of groundwater flow in the Regional deep lead aquifers so that key areas for remedial action can be identified;
- modelling solute transport processes so that longterm changes in groundwater salinity can be predicted.

For further information on this section refer to the following Background Paper:

PL10 - Goulburn Dryland Salinity Management Plan - July 1989

5. SALINITY IMPACTS IF "NOTHING IS DONE"

5.1 WATERTABLE PREDICTIONS TO 2020

The watertable monitoring grid within the Region has been progressively extended and now covers about 75% of the Region, together with some marginal areas outside the Region. The existing grid covers virtually all of the known or suspected high watertable areas. Attempts to predict the future spread of high watertables have been carried out by two methods:

- forward extrapolation of the trends in bores outside the existing high watertable areas, and
- water balance modelling.

In the forward extrapolation method the behaviour of bores outside the existing high watertable areas for the period 1980-1986 was examined and the trends over that period were extrapolated forward to 2000 and 2020. Contours of depth to watertable were then drawn for 2000 and 2020. Watertable levels were found to be rising almost universally except in a few areas where intensive pumping of shallow groundwater was occurring.

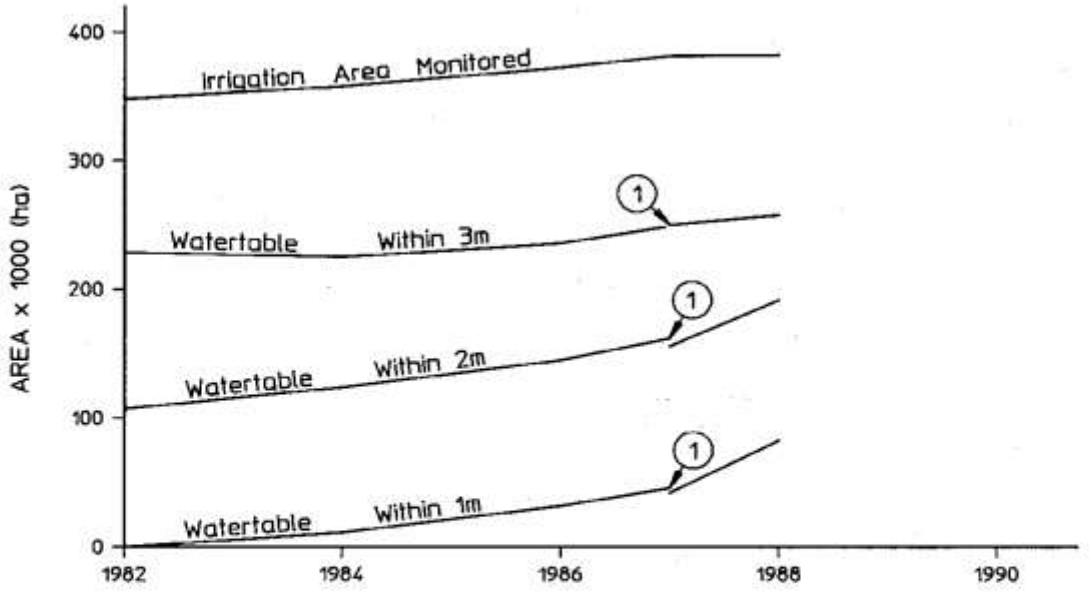
For the total area monitored (including some small areas outside the Region) the high watertable area was predicted to increase from 159,000ha in 1987 to 218,000ha in 2000 and 274,000ha in 2020. The water balance modelling also predicted continuing watertable rises across the whole Region.

The system of forward extrapolation used is susceptible to errors due to variations in climatic conditions and changes in irrigation management. The available evidence, however, indicates that changes in management other than sub-surface drainage and (perhaps) major district restructuring will reduce accessions by less than 20% overall. Under normal conditions climatic variation is likely to be the dominant parameter.

An analysis of rainfall has therefore been made for 5 stations within the Region. In all cases the average annual rainfall for the 7 year period studied is significantly below the longterm average, suggesting that extrapolation for the period studied is likely to underestimate rather than overestimate the rate of watertable rise. This is supported by Figure 8, which indicates that the rate of spread of the high watertable area has accelerated since 1986, given higher rainfalls in 1987 and the winter of 1988.

The Regional projections of future high watertable areas (Figure 9, p.43) are also likely to be low because the Regional monitoring grid is still not complete. In a number of areas, but most notably in the southern part of the Murray Valley Irrigation Area the projected high watertable areas for both years 2000 and 2020 reach to the boundaries of the areas monitored.

If additional monitoring bores were available in these areas it is most likely that additional potential high watertable areas would have been identified.



Changes in High Water Table Levels Within Irrigation Areas of the Shepparton Region (August Reading)

Figure 8: NOTE – 1. Computer aided analysis introduced for 1987 & 1988.

It must be emphasised that the accuracy of the system of projection becomes less reliable the further it is taken into the future. Subject to the climatic variability already discussed, the estimates for 2000 are considered to be realistic but the 2020 estimates are much less reliable. The available evidence, however, indicates that the situation may be worse rather than better and that there is no doubt that high watertables will eventually spread to the predicted 2020 areas and beyond.

It should be noted that the 2000 estimates are the more critical figure for the economic assessments at the Regional scale. Serious salinisation losses lag 10 to 20 years behind the development of high watertables, so that areas developing high watertables after 2000 have little impact on the estimated present value of salinity losses.

From an environmental viewpoint also, the rate of spread of high watertables is less critical than the fact that high watertables will eventually affect almost all of the Region. The likely end point if nothing is done is clearly severe environmental degradation, particularly of terrestrial and wetland values.

5.2 AGRICULTURAL EFFECTS

The contour identifying areas with watertables within 2m of surface (Figure 8) has been adopted as the primary indication of areas at risk to salinisation within the irrigation areas. When watertables are consistently within 2m of surface, almost all of the pastures and crops in the Region can draw on the underlying groundwater by capillary action. There is little lateral movement of groundwater, and a balance quickly develops between recharge areas (generally lighter soils at higher elevations and intensively irrigated) and discharge areas (generally heavier soils at lower elevations and less intensively irrigated).

The recharge areas may suffer some intermittent waterlogging of the rootzones (sufficient to debilitate mature native trees) but will not have salt accumulation in the rootzones. In the discharge areas watertables may be within 1m of surface for long periods and continual upward flow of groundwater will cause salinisation. The plants will remove the water but salt from the groundwater and any salt added with irrigation water will build up in the rootzone until the plants are destroyed.

Direct evaporation from the land surface will then occur, with salt deposition on the surface and subsequent removal of the accumulated salt with surface runoff.

The rate at which soil salinisation progresses is a function of:

- depth to watertable (the closer the watertable is to the surface the faster will be the build up of salt);
- the salinity of the underlying groundwater;
- the salinity of the applied irrigation water;
- rainfall;
- drainage;
- the past history of farming operations;
- the characteristics of the soil;
- land use (crop type); and so on.

Despite the complexity of the factors involved, it is possible to make some general or average predictions about the rate of increase in soil salinisation and its effect upon production, after the watertable reaches critical levels.

The relationship between average rootzone salinity and productivity is shown in Table 9. The productivity figures given are the percentage of maximum productivity which would normally be achieved if the average rootzone salinity was maintained at the levels shown.

TABLE 9: Pasture Productivity Functions

LAND USE	AVERAGE ROOTZONE SOIL SALINITY PPM (TDS - TOTAL DISSOLVED SALTS)	% PRODUCTIVITY AVERAGE PIEZOMETRIC LEVEL	
		LESS THAN 1M	GREATER THAN 1M
Perennial Pasture	+ < 600	90	100
	601 - 1200	65	80
	1201 - 1800	45	60
	1801 - 2400	20	40
	2401 - 3000	0	20
	> 3000	0	0
Annual & Dryland	< 450	90	100
	451 - 750	80	90
	751 - 1200	65	75
	1201 - 1800	45	55
	1801 - 2400	25	35
	2401 - 3000	5	15
	> 3000	0	0

Note:

(1) Figures are based on dry matter for pastures and include 10% loss due to waterlogging at sites with average piezometric level <1m below surface

(2) Initial average soil salinity in rootzone assumed to be 400 ppm under leached conditions.

Modelling of representative high watertable areas within the Region has allowed some estimates of typical rates of salt accumulation to be made for a range of soil types, pasture types, irrigation treatment, groundwater levels and groundwater salinities.

When the prediction of the rate of increase in soil salinisation (after the onset of high watertables) and the effect on productivity (productivity functions) are combined, a prediction of the total loss in production is obtained. This is expressed as a relationship between total production and time from the onset of high watertables.

Figure 9 shows the resulting relationship between watertables and production through time for the representative areas. On average, 12.5% of production would be lost 10 years after watertables reached critical depth, 21% would be lost after 20 years, and so on. Losses would be higher where underlying aquifers are more saline and/or where soils are heavier, low-lying or less intensively irrigated.

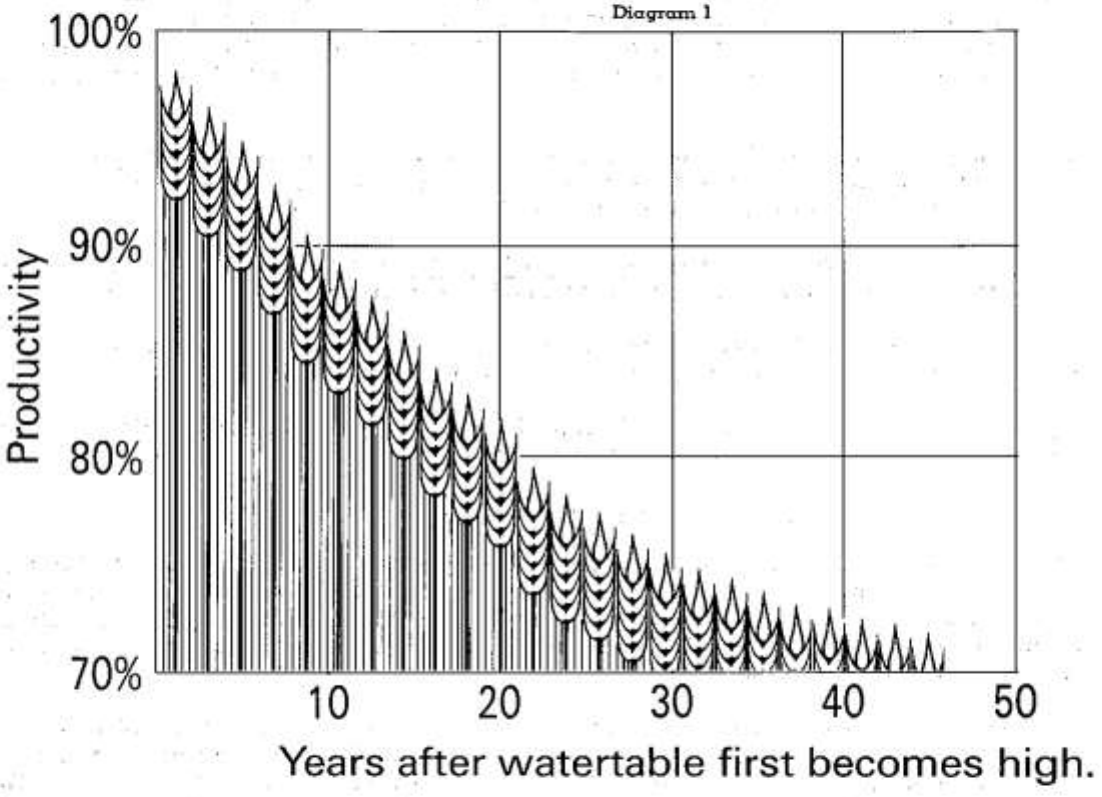


Figure 9: The effects of high watertables on production

For further information on this section refer to the following Background Papers:

PL8 - Reliability of Projections - July 1989
GW1 - Hydrogeological Mapping of the Upper Shepparton Formation - February 1989
GW2 - The Shepparton Irrigation Region - A Regional Hydrogeological Perspective - July 1989

5.3 ENVIRONMENTAL IMPACTS OF DOING NOTHING

5.3.1 Summary of Environmental Impacts

The main impact of increasing salinity on major rivers will be the destabilisation of the river banks due to saline seepage from the high watertable. Over a 150 to 300 year period, this may cause the river channel to change completely from being narrow and deep to being broad and shallow.

The streams will have such high salinity concentrations at various times of the year that few animals and plants will survive. Saline seepage into the streams will kill the riparian vegetation and precipitate bank erosion and bed widening.

The only wetlands that will not be seriously degraded by increasing salinity will be those along the river floodplains, which will be protected by the annual to biannual flooding. The other wetlands will follow a successional sequence of the natural species of submergent, floating aquatic and emergent leafy plants being replaced, firstly by dense mats of floating couch grass, then by cumbungi and finally by salt-tolerant aquatic plants such as rupia. On the wetland margins, red gum will be replaced by lignum and saltbush, as has occurred at Kerang.

The first group of wetlands to become completely degraded will be the deflation potholes. The combination of saline groundwater intrusion, surface evaporation and a lack of flushing will cause them to become perennially saline and eventually hypersaline lakes.

The Corop - Timmering Depression - Kanyapella system is underlain by very saline, rapidly rising groundwater and marked degradation could be expected in as little as 8 to 12 years.

The other wetlands will degrade over a 10 to 30 year time period, depending on the rate of rise and salinity of the watertable, and the salinity of stream inflows.

Remnant vegetation along streams and depressions and on the Plains will continue to decline due to waterlogging, salinity, old age and insect attack.

5.3.2 Impacts of No Salinity Control on Rivers

Major rivers are at medium to longterm risk only. The Goulburn River salt loads may increase by 10% over several decades and by more than 100% over 100 years or more if dryland salinity in the mid-Goulburn catchment is not addressed (refer to Goulburn Dryland Salinity Management Plan - PL10). Consequently no significant ecosystem damage is expected from river salinity in the short term.

The major environmental impact will come from rising saline watertables, which will raise the level of the spring seepage line along the river banks. This will promote extensive bank slumpage, forming saturated platform terraces that will be removed during high floods. Some of these platforms may be stabilised by couch grass or *Polygonum spp.* until the spring seepage salinity increases beyond 3,000 to 5,000EC units. At higher salinity levels, the seepage causes the soils to become dispersive, further increasing slumping and erosion, until the once narrow, deep river channel widens and shoals out. This degradation pattern may occur over a 150 to 300 year period but once started may well be difficult to reverse. Present seepage salinities range up to 9,000EC units.

The Campaspe River has a higher variability in its flow range and drains a more saline hinterland. Consequently it is at medium term (10 to 15 years) risk of developing deep, stable, anoxic saline pools that deplete the benthic life forms.

5.3.3 Impacts of No Salinity Control on Streams

The ecosystems of smaller ephemeral streams will collapse with only moderate salinity increases. Observations of an existing saline seepage on Honeysuckle Creek have shown that seepage inflows as low as 650EC units cause the essential phosphorus, nitrogen and particulate organic nutrients to decline to low levels. Waters become reducing and slightly alkaline and the benthic invertebrates fall to low levels.

Increasing salinity levels will cause further physical bank and bed destruction by killing littoral vegetation and creating dispersive soils. Siltation, erosion, and bed choking with cumbungi are initial degradation features followed by bank slumping, bed widening and shoaling as the base flow from rising saline watertables increases. These degradation scenarios may be relatively rapid, resulting in an irreversible decline within a 10 to 50 year span.

The prior stream depressions are already significantly degraded and will respond to salinisation in a different pattern. Damp channel bottoms from lateral seepage and capillary rises from shallow watertables initially support a thick community of barnyard grass grading into spiny rush tussocks *(Juncus acutus)*, an introduced weed that precludes grazing. With prolonged evaporation, salt scalds increase in area between the tussocks, initiating modest erosion. Beyond these observable degradation patterns, the salinisation sequence followed in the Kerang district will probably occur here. As further watertable rises occur, the bottom channel becomes extensively scalded and eroded as saltbush and samphire type vegetation forms isolated patches.

Winter/spring ephemeral flows and marginal runoff will not be sufficient to clear away salinisation due to summer capillary evaporation and the depression will degrade far in advance of the adjacent plains Region. This may well occur within 8 to 12 years in areas of high groundwater salinity.

5.3.4 Impacts of No Salinity Control on Lakes and Reservoirs

Lakes and reservoirs over 2 metres deep will be impacted on from both dryland and plains type salinity.

The waters received by the Waranga Basin from the Goulburn River may increase in salinity by up to 8% over several decades and by 100% (up to 200EC units) if dryland salinity in the mid Goulburn is not abated. However salinity in the lower Goulburn River might increase to within 300-500EC units, towards the upper end of salinity tolerance for pristine wetland systems there. Major ecological changes are not anticipated.

The Corop Lakes which now act as terminal drainage basins will continue to be further salinised from:

- dryland salinity out of Cornella Creek (presently contributing 7600 tonnes salt/year);
- evaporation;
- saline inflows generated by capillary evaporation;
- the direct saline groundwater base flow.

The annual summer evaporation now increases salinity 3.5 times over the base level of 1,800EC units and it may reach 7,000EC units in some years (Earl, 1989. See Goulburn Dryland Salinity Management Plan, PL10). The pH is already very alkaline which is indicative of saline conditions.

The lake may have an annual increase of 400 ppm salinity (680EC units) with present salt load inputs. Consequently the present littoral vegetation of *Phragmites australis* will soon disappear, progressively followed by *Typha domingensis* and lastly *Juncus acutus*. The submergents of *Potamogaton pectinatus* and *Chara spp* will give way to *Rupia marinata*.

All invertebrate taxa identified by Fletcher *et al* ("Final Report, Carp Program". DCFL publication, 1983) will decline, most becoming extinct within 10-20 years in this ecosystem. Molluscs will probably be the first species to die, followed by essential benthic detritivores such as fairy shrimp (*Amphipoda*) and case insects (*Trichoptera*). Consequently bottom organic matter will begin to accumulate creating strongly reducing, anoxic and toxic conditions that will remove the remaining benthic life.

Barmah Lake will be controlled by the Murray River salinity levels and effluents from the Barmah Forest. Unless significant saline base flows occur within the forest from deep aquifer overpressures, no further salinity degradation is expected.

5.3.5 Impacts of No Salinity Control on Wetlands

A general model of the plant successions that could be expected with rising salinity levels applies to all wetlands in this Region. This model will be described and then applied to each wetland system to indicate the longterm condition of each system.

Lower level sustained nutrient inputs in the range of 300 to 1,000EC units cause extensive floating couch grass communities with some cumbungi replacement.

At moderate EC levels of 500 to 3,000 units, major vegetation changes and succession are more often associated with increased dissolved nutrient content rather than directly with salinity.

Sustained nutrient loads from polluted farm runoff or drainage results in extensive and prolific azolla-duckweed surface growth. Once covered, the wetland becomes depleted in dissolved oxygen, the suspended organic matter rises to high levels and the benthic organic muds become putrid and poisoned with hydrogen sulphide and methane gases. Some "sewer" worms survive in the accumulating benthic organics but all other benthic, benthos and plegic organisms are killed. Emergent macrophytes appear to survive if flushed by winter storm floods.

Floating couch grass *(Paspalum paspalodes)* replaces most submergents, floating aquatics, and much of the emergent macrophytes with time, accumulating to around 120t/ha which is about the same as an open red gum forest. It spreads extensively from the shore to waters over 1.2m deep and alters the water chemistry during the summer growing months. Most of the biomass is in the floating zone, with only minor amounts in the deep suspended stringer zone and fine root system. The cover is thick enough to deoxygenate the lower waters and benthic organics accumulate under very reducing conditions also generating methane, carbon dioxide and hydrogen sulphide gases. This kills all benthic life forms, in contrast to the floating habitat zone which supports a rich and diverse invertebrate fauna, giant predatory water beetles and insect larvae. These are exploited mainly by carp *(Cyprinus carpio)* which feed along the floating margins. Frogs are the main vertebrate biomass in this zone, preyed upon by birds and to a lesser extent tiger snakes.

With prolonged salinities in the range of 1,000 to 3,000EC units, the riparian red gum community recedes and is replaced by lignum bushes; littoral vegetation is replaced by thick and extensive growths of *Typha* species. This heralds a completely new ecosystem with prolific annual growths around 5 to 8t/ha, resulting in a very high biomass accumulation of around 185t/ha. In fact these cumbungi swamps have a higher unit biomass than a mature closed red gum forest (at 60 stems/ha).

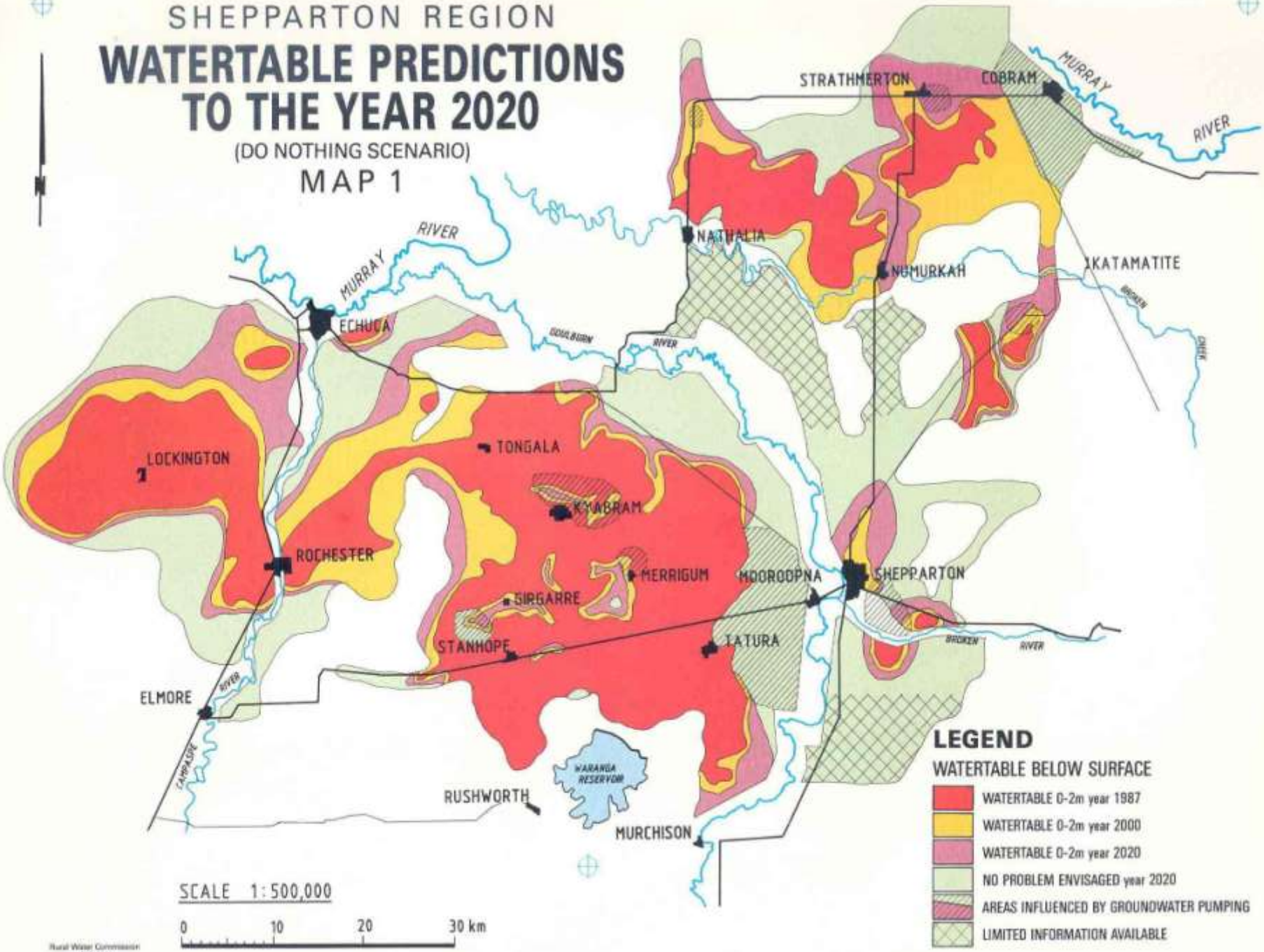
The high productivity is accompanied by a large and diverse invertebrate assemblage. Frogs form the main vertebrate biomass in this community.

SHEPPARTON REGION

WATERTABLE PREDICTIONS TO THE YEAR 2020

(DO NOTHING SCENARIO)

MAP 1



Rural Water Commission of Victoria

3

At Corop, this saline lake supports scattered littoral vegetation of *Phragmites australis* and *Juncus acutus* in the range of 4,000 to 7,000EC units.

In the Kerang Region, *Typha* communities are replaced by submergent rupia and other salt tolerant aquatics at around 6,500EC units and the riparian margins contain lignum and saltbush. Above 60,000EC units however, no vegetation appears to survive.

These salinity-plant succession models would apply to all wetlands systems in this Region.

Another low level, long term salinity problem is the replacement of dispersible clays with more stable forms that will eventually fill up the wetlands. The current grey plastic bottom muds which are dispersible have allowed many of these wetlands to remain open for some 25,000 years, as sedimented clay is periodically washed out. However, with further increases in salinity, calcium and magnesium will progressively occupy the clay exchange sites creating a more stable and far less dispersible material that may eventually fill the wetland. At present rates this may take place over 150+ years.

The wetlands along the floodplains of major rivers are largely protected from salinisation by the annual to biannual flooding. Where this does not occur, wetlands become more saline and basic by evaporation, as at Darcy's Bend on the Goulburn River. Most pristine wetlands have very low salinities of around 250± 120EC units, with annual summer evaporation increasing this to around 500EC units in only a few cases. The major environmental impact on these low-lying wetlands is from irrigation runoff and drainage. Currently, high nutrient inputs are the main problem of lower EC levels, but direct salinity degradation may occur when waters exceed 3,000EC units.

Wetlands associated with recent-aged drainage lines also follow the above plant succession with increasing nutrient and salinity levels. Many of these systems are already cumbungi-choked morasses and the red gum riparian margin is receding. Both sustained water levels from irrigation runoff and high levels of nutrients exacerbate this degradation, which may take place over a 10 to 30 year time span.

Wetlands along prior stream depressions will follow the model of plant succession due to salinity degradation as water salinity levels rise from overland runoff, interflow and base flow. Summer salinity levels will govern the plant community type rather than the quality of the ephemeral winter storm flows.

Ancient salt lake wetlands will be impacted from saline runoff and capillary salinity. Kanyapella is currently experiencing saline groundwater intrusion in the north east and south east sections and will continue to degrade. The Corop salt lakes will follow the degradation pattern outlined for Lake Cooper, and the ancient salt lakes associated with dryland salting will continue to follow an accelerated degradation sequence.

Isolated wetlands such as Moodies Swamp which receive internal drainage will also follow an accelerated degradation sequence as saline runoff and base flow from rising watertables are exaggerated by summer evaporation. The timing and rate of each wetland impact is related to the level and the salinity of groundwaters, along with other factors, and must be estimated on a case by case basis.

Deflation potholes may be one of the first land system types to be completely degraded in this Region. Internal drainage from saline runoff, saline intrusion, and surface evaporation will make these ecosystems prone to salinisation. Grey box types will be the first to die back, followed by open red gum forests, then the closed red gum communities.

The Timmering Depression System is underlain by very saline, rapidly rising groundwaters in its southern half. All wetland systems including One Tree Swamp, Wallenjoe Swamp and Mansfield Swamp will quickly die back in as little as 8 to 12 years and the broad depression bottom will become extensively salinised and retired from pasture.

A summary of the major threats to the largest wetlands in the Region is as follows.

Oct. 99.

1. Mansfield Swamp (110ha) - a swamp with both native red gum and dense stands of young regeneration which provides habitat for a wide variety of bird life:

   - threatened by saline groundwater intrusion.

2. One Tree Swamp (900ha) - a cane grass swamp drained for agricultural use, of high value in wet periods:

   - threatened by saline groundwater intrusion.

3. Two Tree Swamp (168ha) - an open swamp that is an important breeding ground for brolgas and other birds:

   - threatened by saline groundwater intrusion.

4. Lake Cooper (1194ha) - currently saline - low environmental value.

5. Lake Stewart (600ha) - currently saline - low environmental value.

6. Gaynor Swamp (422ha) - a swamp previously supporting a red gum forest now providing a valuable feeding area for waterbirds:

   - threatened by saline groundwater intrusion.

7. Reedy Swamp (1400ha) - large lake surrounded by extensive woodland of river red gum and grey box. Important nesting area for a number of bird species:

   - threatened by saline groundwater intrusion.

8. Wallenjoe Swamp (500ha) - river red gum swamp that provides a breeding habitat for at least 90 bird species:

   - threatened by saline groundwater intrusion.

9. Little Wallenjoe Swamp (100ha) - previously logged, but densely regenerated red gum swamp providing valuable waterbird habitat:

   - threatened by saline groundwater intrusion.

10. Two unnamed swamps near Corop (500, 1000ha) - smaller swamp is cumbungi dominated and provides brolga breeding habitat:

    - threatened by saline groundwater intrusion.

11. Barmah Forest (30,000ha) - This ecosystem is a mosaic of wetlands, varying from open waterbodies, grass plains and rushlands to red gum dominated, shallow freshwater marshes and red gum flood plain. It is a wetland of international importance especially as waterflow habitat, as listed under the Ramsar Convention.

    - the entire wetland is threatened by rising groundwater levels associated with both a deep lead and a groundwater mound beneath the adjacent irrigation area.

12. Dowdle Swamp (291ha) - a modified freshwater wetland comprising river red gum fringed by grey box and yellow box. An ibis breeding area which is used by a wide variety of water birds:

    - the entire catchment of this swamp is in a likely future saline discharge area.

13. Kanyapella Basin - Murphy's Swamp - note loss of red gums as a result of impoundment of swamp by diverters. Major threats are increasing salinisation which may prevent reuse of drainage water with consequent increase in salt loads to Murray.

The magnitude of the impact of high watertables on the Region's wetland systems is depicted by Figure 7 (p.33). Here the year 2020 watertable predictions have been superimposed over the Region's high conservation value wetlands. Further irreversible degradation of wetlands is imminent if nothing is done to correct the high watertable and salinity situation.

5.3.6 Impacts of No Salinity Control on Vegetation

The terrestrial environment is diminishing in area and diversity; very little of the once extensive forests and woodlands remain and landscape quality is declining from tree removal, tree vigour decline and tree death. The vegetation which has survived on private land is mainly overmature grey box and red gum trees, with public lands and roadside reserves containing the bulk of the near natural forested system.

The Murray pine *(Callitris spp)* - bulloak *(Casuarina spp)* community is found mainly on higher, better drained ground and is under less threat from capillary type salinity than most forest types. The exception is where leaky channels command high ground near these communities.

Virtually nothing remains of the plains grey box forests and woodlands and it is impossible to reconstruct the dynamics of this savannah type ecosystem. The remaining isolated trees are declining in vigour from old age, increased insect and parasite loads, waterlogged deep rootzones and salinity. No regeneration is occurring due to grazing and lack of interest in this species as an agroforestry crop.

Some grey box communities remain in isolated systems within the Barmah Forest, however the most common isolated stands are found in shallow wetland deflation potholes scattered across the plains which were too damp to effectively farm and these are mainly used for stock shelter which also represses regeneration. Because of their internal drainage and lack of flushing potential, these small potholes will be one of the first land forms to be salinised from rising watertables, with subsequent tree death.

The remaining yellow box-grey box communities along prior stream levees and sand banks will also decline from old age, parasites, grazing pressure, waterlogging from irrigation runoff and rising groundwater.

Mixed grey box-red gum stands on occasionally flooded or spring-fed slopes may remain until rising watertables continuously saturate the rootzone with increasingly saline waters. Similarly other low-lying red gum and box communities will be adversely affected.

For further information on this section refer to the following Background Papers:

EN1 - Environmental Considerations - July 1989
PL10 - Goulburn Dryland Salinity Management Plan - July 1989

5.4 SOCIO-ECONOMIC IMPACTS OF DOING NOTHING

5.4.1 "Do Nothing" Effects Upon Farm Incomes

Predictions may be made of the effects of high watertables upon farm operations within the Region. A set of such predictions is shown in Table 10 below. It uses the high watertable

forecasts shown in Figure 9 (p.43) and the effects of such high watertables on production as shown in Figure 10 (p.45). Further major assumptions are spelled out in the footnote to the table.

TABLE 10: Present and Future Net Farm Incomes (Averages — $ 1986)

YEAR	AWE (1)	NET FARM INCOME (2) WITH FULL SALINITY CONTROL		NET FARM INCOME (2) WITHOUT SALINITY CONTROL	
	$/PA	$/PA	% AWE	$/PA	% AWE
1986	22,136	25,004	113	20,890	94
2000	30,727	25,004	81	17,694	58
2020	55,188	25,004	45	14,120	26

Notes:

(1) Average Weekly Earnings: the longterm trend from 1960 to 1987 was for exponential growth @ +2.37% p.a. Projections at this rate result in an increase of 39% to the year 2000 and 149% to 2025.

(2) Other key assumptions are:

(a) All data are financial and are based upon the actual average butterfat price received by farmers in 1986 (the base year of the data) of $3.53/kg.

(b) All costs of inputs are assumed to remain constant in real terms (in accordance with SEWG guidelines).

(c) The volume of inputs is assumed to fall in proportion to the fall in gross farm income from the sixth year after watertables become high (as required by SEWG).

(d) The price for all outputs is assumed to remain constant in real terms (SEWG).

The important points to note from the above table are the relationships between what is happening elsewhere in Victoria as measured by Average Weekly Earnings and what is happening on the farm.

- In 1986 salinity had already reduced farm income from 13% <u>above</u> AWE to 6% <u>below</u> AWE.

- By the year 2020 average farm income <u>without</u> salinity control will be only 71% of what it could be <u>with</u> salinity control. It will also have fallen well behind AWE.

- By the year 2025 average farm income <u>without</u> salinity control will be only 56% of what it could be <u>with</u> salinity control. By this time average farm income <u>without</u> salinity control will have fallen to 26% of AWE.

It is essential to be aware that when the <u>average</u> farm income falls below 80% of <u>average</u> weekly earnings, real poverty will be occurring in large sections of the rural community. If average farm incomes fall below 60% of average weekly earnings as is forecast to happen without salinity control, there would be a poverty crisis of some magnitude within the community of northern Victoria.

The impact of salinity would not fall evenly upon all farmers. Depressions such as Timmering, Mosquito, Harston and Stanhope would be among the earlier areas to be hit. Higher areas would remain relatively unscathed. On the plains, salt scalds would develop at random. Without drainage or sub-surface disposal rights, the farmers of the Shire of Rodney would be particularly at risk.

For those who remain, the nature of farming would change immensely. There would be far fewer farmers. They would be forced to adopt less innovative and more cautious management techniques. Dairyfarming would be replaced by grazing in the lower area. In

short, the structure of the rural community would change significantly, producing much pain and hardship in the process. The young with low equities will be forced off their farms, while the older generation will struggle on hoping to survive until they can qualify for a pension and thus feeling guilty because there are many who would like to convince them that it is their own fault. The salt affected younger ones will probably just walk off the property, go on the dole and watch the salt devastate the landscape and the environment.

5.4.2 "Do Nothing" Effects Upon Regional Agricultural Output

Table 11 below produces estimates of the total change in Regional farm aggregate income in the "Do Nothing" and "Without Salinity" cases.

TABLE 11: Economic Value of Regional Agriculture Output ($M)

	ECONOMIC GUIDELINES CASE		SPPAC ALTERNATIVE CASE	
	2000	2025	2000	2025
A. WITHOUT SALINITY				
Gross Farm Output	210.85	210.85	368.99	619.58
Farm Costs	129.04	129.04	130.16	128.98
Net Farm Surplus	81.81	81.18	238.83	490.60
B. "DO NOTHING" CASE				
Gross Farm Output	185.04	171.50	322.09	499.69
Farm Costs	130.16	130.16	130.16	129.45
Net Farm Surplus	54.88	41.34	191.93	370.24
ANNUAL SALINITY LOSS	26.93	40.47	46.90	120.36

Notes:

(a) All costs of inputs are assumed to remain constant in real terms (in accordance with SEWG guidelines).

(b) The volume of inputs is assumed to fall in proportion to the fall in gross farm income from the sixth year after watertables become high (as required by SEWG).

(c) The price for all outputs is assumed to remain constant in real terms (as required by SEWG).

(d) The Economic Guidelines Case uses an economic value of butterfat of $3.20/kg.

(e) SPPAC, their advisers and the independent reviewers of that advice, differ with the Government economic guidelines on the issue of the butterfat price ($4.60/kg is used in this estimate) and the treatment of productivity change without the proposed project.

The differences in Regional net farm surplus in the "Without Salinity" case and the "Do Nothing" case represent the maximum potential benefits from fully implementing salinity control on all affected areas.

Therefore, if the above net farm losses are "streamed" over 50 years, assuming zero benefits in 1990, rising to maximum benefits in the year 2020, then discounted to net present values @ 4% per annum the results would be as follows:

NPV's of total Regional salinity control are:

- Economic Guidelines Case : $552 million
- SPPAC Alternative Case: $1,320 million

The above total Regional values of losses are based upon the 274,000ha of the Shepparton Region which will be subject to high watertables by the year 2020. Therefore, on a unit area basis, the NPV's of salinity control are as shown below:

		TDR 4%	TDR 16%
-	Economic Guidelines Case:	$2,015/ha	$313/ha
-	SPPAC Alternative Case:	$4,820/ha	$609/ha

An "economic" value is shown using the Government's Test Discount Rate of 4% per annum. A "financial" value is also shown which uses a discount rate of 16% per annum, which better represents the financial situation facing the farmer and hence the "profitability" to him of making the investment.

5.4.3 "Do Nothing" Effects Upon the Regional Economy

Agricultural output losses of $27 million per annum in the year 2000 and $40 million per annum in the year 2025 (figures from the Economic Guidelines Case - Table 11 above), will have various effects upon the Regional, State and National economies.

The Australian economy will suffer because all marginal butterfat production is exported. The above figures are based upon an economic farm gate value of butterfat of $3.20/kg. The average minimum f.o.b. price of butterfat (1980 to 1988 inclusive) was $6.20/kg. Export income losses will therefore total $52M per annum in the year 2000 and $78M per annum in the year 2025.

During the evaluation period of the project (the 50 years from 1990) the total expected loss of export income would therefore be in excess of $3,000M.

It must be remembered that these losses incorporate the unsustainable assumption of no change in farm productivity throughout the evaluation period. Actual losses would therefore be substantially greater than the annual $50M to $80M and total of greater than $3,000M, as quoted above.

The Regional economic analysis described in Section 4.4.5 can be used to predict the effects which salinity will have on household income and employment. These are shown in Table 12 below.

TABLE 12: Regional Losses Due to Salinity (1986 Condition, 1986 Constant Prices)

	YEAR 2000		YEAR 2025	
	HOUSEHOLD INCOME ($M)	EMPLOYMENT NO.	HOUSEHOLD INCOME ($M)	EMPLOYMENT NO.
Dairy	15.16	1147	33.51	2,536
Animals	4.14	247	9.14	547
Other	3.06	195	6.76	431
TOTAL	22.35	1589	49.42	3,514

The above figures speak for themselves: 1,600 jobs lost by the year 2000; 3,500 jobs lost by the year 2025; and losses in wages and salaries ranging from $22 million per annum in the year 2000 to over $48M by 2025.

The social costs and trauma associated with job loss, Regional decline, decay of social support structures and so on, for all those not protected from such costs, will be severe.

Whilst it is not possible to quantify the effects of this on the people of the Region, we can envisage where the losses are most likely to fall. Recent studies of small country towns in both Victoria and New South Wales do not paint a rosy picture for towns with populations less than 10,000. Most face strong competition from larger Regional centres for business and

government activity. The loss of jobs which will follow no intervention against salt, will fall disproportionately on farmers and the small towns of the Region - Stanhope, Kyabram, Tatura, Rochester, Merrigum, Nathalia, Tongala. The larger centres of Shepparton and Echuca will experience either stagnation or a much lower growth rate than could otherwise be expected.

It is not easy to describe the personal and social effects these sorts of changes would have upon the people of the Region. A useful starting point is the work of Sharman Stone (see for example, "Water Talk", No. 44, March 1980). The trauma of losing one's job, followed by the fact of having lost it, is not easy for anyone. When it happens to families in a settled, stable Region, where the "job" is also a way of life, it is devastating. It is traumatic, stress-inducing and confidence-sapping for the parents. It produces peer group problems and attitudinal changes in children, thus storing up further problems for them and the community in the future.

In addition to those actually losing their jobs (or their farms), the flow-on effects will also be devastating for small businesses and others not protected from the effects of the crisis. For many the effect will take the form of severely reduced income - poverty in other words.

On the farm, the older generation will struggle on hoping to survive until they can qualify for the pension. The salt affected younger ones will probably be faced with a choice of walking off their farm, searching for jobs in the decreasing pool of jobs in rural towns or farming with much more caution and conservatism if they have large enough holdings to absorb the impact of salt.

Economic analysis does not admit these costs to the evaluation because it makes the assumption that in the long run, resources are mobile and that they can be redeployed at zero adjustment cost. Therefore, before these costs can be admitted the theory goes, it must first be demonstrated that similar effects would not occur with any other investment. As this is virtually impossible to achieve these linked Regional effects are ignored or dismissed. This document is not the appropriate place to argue the fundamentals of economic theory. However, there do appear to be objections to the current theory on two sets of grounds namely:

(i) the resources involved (water, channels, drains, dairy factories, schools, hospitals etc), are not fully mobile and cannot be redeployed at zero cost even in the very long run; and

(ii) whilst the economic theory seems to deal reasonably well with investments designed to produce new activity and new output, it does not seem to deal equally well with investments designed to preserve what is already there - both physically and socially.

Thus, it may well be that investment to support existing operations in the Shepparton Region is a far more effective use of both public and private capital than writing off the many existing investments and moving elsewhere. Another way of phrasing this is that the opportunity cost of the existing investments is likely to be low, hence it is likely to be more favourable to retain them rather than to create new "replacement" investment.

Some commentators on the first draft of the Plan put forward the view that the dynamics of the Regional economy are such that jobs lost in one sector are likely to be taken up in another sector.

This view seems to ignore the fact that the Shepparton Region is currently short of about 2,000 jobs and, therefore, has not adjusted particularly well. The loss of a further 3,500 (or more) jobs will remain just that - lost jobs. They cannot be replaced.

The alternative question is why hasn't the economic resilience of the Regional economy already produced the extra 2,000 extra jobs (or 5,500 extra jobs if further job losses are

included) to soak up the existing pool of unemployed? Why is it not possible to retain both the agricultural processing jobs and the "replacement" jobs?

For further information on this section refer to the following Background Papers:

SE2 - *Farm Socio-Economic Surveys - October 1987*
SE3 - *Future Rural Household Incomes - February 1988*
SE5 - *Regional Economics - August 1988*
SE6 - *The Shepparton Irrigation Region in the "Do Nothing" Case - August 1988*
PL8 - *Reliability of Projections - July 1989*

6. SALINITY CONTROL

6.1 AN INTEGRATED APPROACH TO SALINITY CONTROL IN THE SHEPPARTON IRRIGATION REGION

The salinity problem in the Shepparton Irrigation Region is essentially a high watertable problem. As watertables move close to the soil surface, the process of soil salinisation begins (see 4.3 - The Salinity Problem).

Salinity control relies on two essential activities; they are:

- reducing the amount of water getting to the watertable; and,
- removing water from the watertable.

The challenge for SPPAC has been to determine the "best" way of achieving salinity control in an environmentally responsible way. In determining which activities need to be undertaken to achieve salinity control in the Shepparton Irrigation Region, SPPAC has evaluated an enormous number of activities. The activities considered fall generally into four categories - irrigation management, surface drainage, sub-surface drainage and environmental protection. These activities include a range of works which are best done by individual farmers and others best dealt with as co-ordinated works programs. For practical purposes these have been developed into programs as follows:

(a) Farm Works
Farm salinity control activities are defined as those activities which can be carried out by individual landowners on their land in order to reduce regional scale groundwater accessions. These activities generally result in an increase in the local use of groundwater, improved farm drainage and an improvement in the efficiency of water usage on farms, resulting in reduced accessions to the watertable.

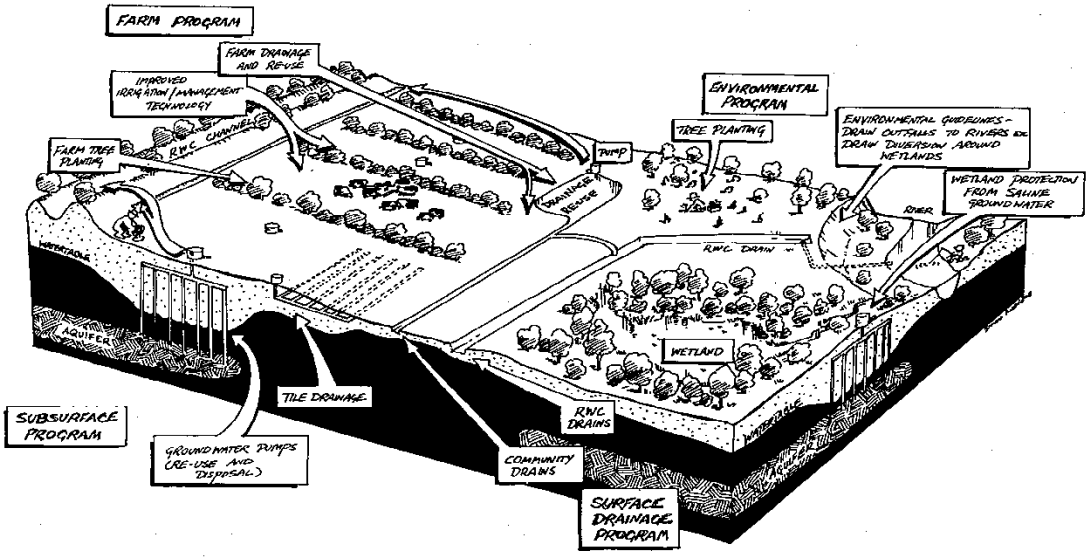
(b) Regional Surface Drainage
These measures include works required in managing rainfall generated run-off from the Shepparton Irrigation Region and thus reducing winter accessions to the watertable and waterlogging. The complementary benefits of farm activities and sub-surface drainage are also recognised.

(c) Sub-surface Drainage
The physical lowering of the watertable through sub-surface drainage provides the Region with the means to select the areas to be protected from high watertables. However, this action requires salt disposal which can be minimised through a combination of farm action and Regional drainage management.

(d) Environmental Protection
These measures are required to protect specific environments, to minimise the damage to others, and to rehabilitate or enhance other environments. The threats to the present environment that have been addressed are associated with salinity, high nutrient loads, high watertables, erosion and the impact of proposed works activities.

Some environmental protection measures are incorporated in the other three programs which are aimed at protecting the agricultural base of the Region. In the category of "environmental protection" the proposed works are solely for protection of specific wetlands, streams and bush reserves.

The interlinkage of the above activities is illustrated in Figure 11. Each activity acts to improve the efficiency of the others in a compounding manner. The specific advantages to be gained from this integrated approach to salinity control in the Shepparton Region are as follows.



(a) The farm program, in targeting reduced watertable accessions, will:

- reduce the longterm regional sub-surface drainage requirements;
- thus reducing external salt disposal needs; and,
- provide farm productivity gains through increased water use efficiency, and reduced waterlogging.

(b) The regional surface drainage program will:

- reduce groundwater accessions, thus reducing the need for sub-surface drainage and salt disposal in the longer term;
- provide a mechanism for the conveyance and distribution of sub-surface and surface drainage water for use within the Region and, as necessary, disposal out of the Region;
- act as a motivator or precursor for landholders to undertake positive salinity control activities on their properties;
- control erosion where drainage lines enter major streams;

- provide farm productivity gains through a number of interlinked actions, including greater incentive to improve water management; and

- provide an opportunity for enhancement of some high value wetlands and other areas of high conservation values.

(c) The sub-surface drainage program will:

- provide land protection through the drawing down of the watertable, thereby ensuring a downward flow of water and "leaching" of salt from plant root zones;

- provide a means of gaining a salt balance through managed salt outfall to the RWC channel and drainage network for use within and disposal from the Region;

- provide farm productivity gain through the provision of "extra" irrigation water, or allow substitution for RWC supplied water; and,

- provide a means of protecting high conservation value areas from saline groundwater intrusion.

Sub-surface drainage activities are essential for longterm sustainable salinity control from both a farm and environmental viewpoint. *Without it, some of the other activities will be ineffective in the long run.*

(d) Environmental protection programs are proposed which will:

- protect wetlands of high conservation value;

- minimise the degradation of rivers and streams;

- minimise the degradation of other wetlands;

- rehabilitate wetlands and certain prior stream areas; and

- enhance the terrestrial environment.

In addition to the above programs of activities, SPPAC also considered the contribution to groundwater from seepage from RWC channels. Previous studies had shown that at the Regional scale, channel seepage was a minor contributor to groundwater while the costs of treatment were very high (of the order of $100,000/km). Works to reduce channel seepage for salinity control purposes were considered to be justified only for specific cases where extreme losses from a channel were causing severe local problems. Additional information obtained during the development of the Plan confirmed that this was a realistic assessment. SPPAC has therefore not identified channel seepage control as a primary element of the Plan, but:

(i) A nominal provision has been made for control of seepage at sites where local seepage is clearly a major contributor to the salinity problem, and funds are unlikely to be available from other sources for remedial works; and

(ii) Continuing research and investigation to identify areas of significant seepage and to develop low cost remedial measures is included in the Plan.

For further information on this section refer to the following Background Papers.

PL1 - Guidelines and Criteria for Evaluation of Proposals - October 1987
PL2 - Preliminary Review of Options for Salinity Control - October 1987

6.2. MANAGEMENT AREA TYPES

Any salinity control plan formulated for the Shepparton Irrigation Region will be constrained by shallow aquifer characteristics of which the most important are:

(i) Yield - if water cannot be pumped from an aquifer in sufficient quantities to effect salinity control, then alternative and generally more expensive sub-surface drainage methods are required (e.g. tile drains).

(ii) Salinity - low salinity groundwater (less than 3,000EC units) provides substantial opportunities for farm use and requires only limited out of season external disposal to maintain a satisfactory salt balance. As salinities increase, groundwater becomes less usable; its disposal to the River Murray causes excessive negative effects downstream; and therefore within region evaporative disposal systems are required.

Table 13 shows the areas projected to be subject to high watertables in the year 2020, together with the yield and salinity characteristics of the underlying aquifers. These defined Management Area Types (Figure 12) provide the framework for salinity control planning in the Region for they determine which farm activities are applicable to certain areas (e.g. groundwater pumping, lasergrading) and they also have a bearing on the drainage salt loads which might be discharged to the drainage system and in turn, the River Murray. For detailed planning purposes the B3 Areas shown in Figure 12 were further subdivided into Low B3 Areas (salinity less than 3000EC units) and High B3 Areas (3,000 to 5,000EC units).

It must be emphasised that although these Management Area Types provide the essential basis for Regional planning for sub-surface drainage works, considerable variability occurs at the local scale. Local implementation plans must be based on a much more detailed understanding of local hydrogeological conditions.

For further information on this section refer to the following Background Papers:

GW1 - Hydrogeological Mapping of the Upper Shepparton Formation - February 1989.
PL8 - Reliability of Projections - July 1989.
GW10 - Review of Farm Exploratory Drilling Service.

6.3 THE SPPAC PREFERRED PLAN

In addressing salinity control in the Shepparton Irrigation Region, SPPAC has adopted an integrated program of works which is responsible and can be implemented. SPPAC has ensured that in the planning process the environmental, social, economic and financial objectives set out in Section 2 have been addressed. SPPAC recommends these activities to the Regional community and government.

The Plan activities to be implemented are summarised here, and the process undertaken by SPPAC in adopting the recommended Plan is discussed in the following sections.

The Plan consists of four key programs interlinked as described in Section 6.1. The Plan is to be implemented over 30 years.

TABLE 13: High Watertables and Aquifer Characteristics (ha)

MANAGEMENT TYPE	MURRAY VALLEY 1987	MURRAY VALLEY 2020	SHEPPARTON 1987	SHEPPARTON 2020	RODNEY 1987	RODNEY 2020	TONGALA 1987	TONGALA 2020	ROCHESTER/CAMPASPE 1987	ROCHESTER/CAMPASPE 2020	TOTAL 1987	TOTAL 2020
HIGH YIELDING AQUIFERS												
< 1,700	15,850	31,825	325	525	5,700	6,750	3,250	4,350	8,075	8,850	33,200	52,300
1,700EC to 3,300EC	525	1,225	—	—	5,000	5,975	3,675	5,350	2,375	3,100	11,575	15,650
3,300EC to 5,000EC	5,750	16,450	—	200	16,100	17,525	13,200	22,800	10,475	14,600	45,525	71,575
5,000EC to 11,700EC	50	800	—	2,800	8,800	9,475	—	200	2,050	7,000	10,900	20,275
> 11,700	—	—	—	—	400	400	1,050	4,900	2,800	5,200	4,250	10,500
LOW YIELDING OR NO AQUIFERS												
< 3,000EC	1,400	3,675	3,900	12,375	2,300	2,300	6,450	7,800	6,075	10,700	20,125	36,850
3,000EC to 5,000EC	—	900	200	2,425	13,200	16,100	3,450	7,400	4,150	7,400	21,000	34,225
5,000EC to 11,700EC	—	1,550	—	—	1,900	3,500	600	1,200	350	1,600	2,850	7,950
> 11,700	—	—	—	—	4,000	6,200	800	800	—	—	4,800	7,000
PHASE A PUMPED AREAS												
< 1,700	4,000	4,000	—	—	1,975	1,975	—	—	—	—	5,975	5,975
1,700EC to 3,300EC	—	—	—	—	1,350	1,350	—	—	—	—	1,350	1,350
3,300EC to 5,000EC	—	—	—	—	2,900	2,900	—	—	—	—	2,900	2,900
> 5,000EC	—	—	—	—	2,900	2,900	700	700	—	—	3,600	3,600
TOTAL	27,575	60,425	4,425	18,325	66,525	77,450	33,350	55,500	36,350	58,450	168,050	270,150
Monitoring Inadequate	43,350	?	59,225	?	25,650	?	42,850	?	11,300	?	182,375	?
No Problem	52,350	19,500	42,975	24,650	31,875	20,950	27,725	5,400	37,250	15,150	187,800	85,650
TOTAL AREA	123,275	123,275	102,200	102,200	124,050	124,050	103,750	103,750	84,900	84,900	538,175	538,175

The four programs are:

1. Farm Program

   - All farms in the Region are to be provided with whole farm plans under a grant scheme providing 50% of cost.

   - Landforming/lasergrading and farm drainage is to be undertaken on 75% of the Region's perennial pasture and 50% of the annual pasture areas (106,038ha). This is to be supported by a 10% grant scheme to landholders for the capital cost.

   - Drainage reuse systems are to be included with the land layout work on all farms in the Region's undrained areas. A total area of 66,150ha will be served by drainage reuse and a 30% capital grant scheme is proposed for these works.

   - Groundwater pumping and groundwater use are to be supported under two projects. Under a region-wide project up to 250 moderate to high capacity pumps will be installed primarily for onfarm use of groundwater, supported by a 20% grant towards capital cost. In Priority Project Areas where pump operation will be managed to provide both seasonal watertable control and winter disposal up to 250 pumps will be installed with grants of 80% towards capital cost.

   - Groundwater usage incentives will be continued in areas where private groundwater pumping can be undertaken prior to managed pumping schemes being implemented.

   - Tile drainage systems or low capacity pumps are to be encouraged in areas where aquifers are non-existent or of low capacity . Where appropriate these installations will be associated with farm restructuring to ensure that the actual area of works installed (up to 14000ha) will provide significant production benefits to much larger areas of farm holdings. These works will be installed under two projects. About 20% of the work will proceed as region wide activity receiving a 20% grant towards capital costs, while the remainder will occur in Priority Project Areas and receive capital grants of 80%.

   - Farm trees are to be planted on 14,000ha, equivalent to 5% of the Region's irrigated area. This will be supported by grants of 30% of the capital cost.

   - The water pricing system will be reviewed to identify a system which encourages the use of alternative sources of water, i.e. groundwater and drainage water.

2. Sub-surface Drainage Program

This program will protect 213,000ha over 30 years by a combination of public and private groundwater pumps, tile drainage and managed salt disposal:

   - 85,000ha will be protected by installing 426 public groundwater pump units and some 50 evaporation basins.

   - A further 85,000ha will be protected by providing management arrangements and salt disposal opportunities for 395 existing and 365 new private groundwater pumps. The new private pumps will come from the Farm Program under either the Region-wide or Priority Project Area project.

- Tile drainage or small groundwater pumps will be installed to protect the productive capacity of up to 43,000ha in the difficult to pump areas, as discussed in the Farm Program. High priority is given to large scale trials to evaluate this technique and develop appropriate design criteria.

- 62% of the pumped salt load will be retained within the Region by onfarm reuse, reuse via the Regional channel and drain system, and evaporation.

- A Salt Disposal Quota of 16.7EC units will be required for disposal to the River Murray of salt which cannot be reused or economically disposed within the Region.

3. Surface Drainage Program

Over the next 20 years a surface drainage program will be implemented to serve the entire Region. The traditional approach to regional drainage has been modified by adopting a lower standard of drainage for those areas where fully constructed drains are prohibitively expensive. The proposed works are:

- Upgrading existing RWC drain outfalls to accept drainage from increased areas;

- New RWC drains to service 74,600ha;

- Community drains to service 236,200ha. These drains will receive assistance toward design (90%) and construction (50%) through a continuation of the current DARA scheme;

- Water harvesting will be introduced for areas where formal drainage is difficult to construct. There will be 13,400ha serviced with channel outfall and 12,700ha without channel outfall.

- New Drainage Course Declarations are proposed for 297km of depression in the Region.

- A Salt Disposal Quota of 2.7EC units will be required for new salt loads discharged to the River Murray.

4. Environmental Protection Program

All works undertaken for salinity control are to be constructed and operated in an environmentally responsible manner. The Plan also proposes a number of activities which will result in environmental protection and enhancement to the Region.

- High value floodplain wetlands will be protected by modification of drainage outfalls, farm drainage reuse and allocation of water for flushing.

- Existing wetlands along drainage lines will be protected where possible by modifications to drainage designs.

- Riverbank protection will be provided by groundwater control where bank slumping is occurring due to saline groundwater discharge. Up to 21km of Goulburn and Campaspe river frontage may be protected.

- Wetlands on the plain will be protected from saline groundwater intrusions or inflows by providing drainage diversion works and groundwater control for some 100 high value wetlands.

- Creation or enhancement of wetlands, particularly along prior stream depressions, will be encouraged wherever possible.

- Stream protection from saline groundwater inflows and intrusion will be provided by establishing treed buffer zones (50m) along the stream courses. Approximately 500km of streams need protection.

- Tree planting onfarm will be supported under the farm program, as discussed previously.

- A major research, investigation and monitoring program for wetland and stream protection is proposed.

The activities adopted in the SPPAC Preferred Plan can provide protection from salinisation for the majority of the Shepparton Irrigation Region. The works program is large, but realistic. The total costs of the Plan and the economic analysis are summarised in Table 22 (p.116).

The total capital cost of the Plan over 30 years will be $645M and the capitalised value of the annual costs for the completed scheme will be $240M. The capitalised value of the quantifiable benefits for the completed plan is $980M according to the Government's Economic Guidelines or $1800M according to the SPPAC assessment, giving benefit/cost ratios of 1.4 and 2.4 respectively for those parts of the Plan which have quantifiable benefits.

The benefits identified do not take into account the enormous social costs associated with the major Regional economic decline and further irreversible environmental degradation which will occur if nothing is done to address salinity in the Shepparton Region. In recent times, people have shown how seriously they view the costs of social and environmental degradation.

To implement the Plan presented, a major commitment is required from all concerned to protect an environment which has sustained this highly productive Region of Victoria for the past 100 years.

The remainder of this chapter discusses the multitude of salinity control activities considered by SPPAC prior to adopting their Preferred Plan. Economic, social and environmental evaluations of various Plan packages have been undertaken and are presented.

6.4 FARM ACTIVITIES FOR SALINITY CONTROL

6.4.1 Farm Activities Included in the Plan

The following farm activities are considered by SPPAC to reduce groundwater accessions, soil salinisation and waterlogging and are to be applied in the Management Plan as Regional farm activities.

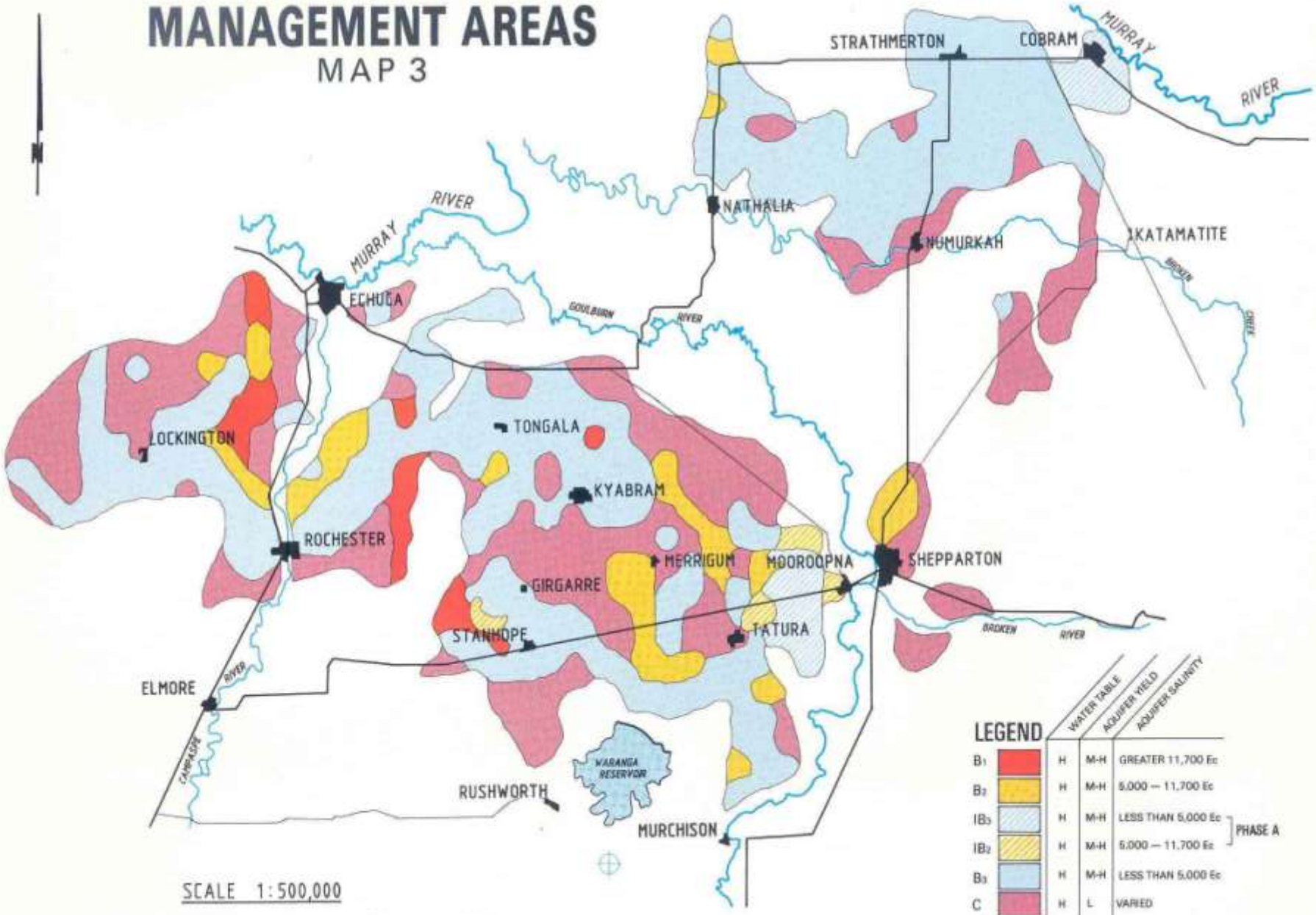
(a) Landforming and relayout
Regrading of irrigation bays to obtain better, more even slopes provides the basis for more efficient water usage during the irrigation season, and provides for better drainage conditions from agricultural lands. These more even slopes will reduce groundwater accessions by 10%, reduce the irrigation labour input and lead to more efficient pasture/crop production and hence productivity gains. The typical capital costs are $1200 per hectare of land landformed and lasergraded.

(b) Within farm restructuring
Through the restructuring of water use on the farm, accession reduction and productivity gains can be optimised. The concentration of water on

SHEPPARTON REGION

MANAGEMENT AREAS

MAP 3



Rural Water Commission of Victoria

the better land and avoidance of the poorer or more salt prone land is essential where watertables cannot physically be controlled. The restructuring activities would be carried out in association with lasergrading, farm drainage and pasture improvement program.

(c) Improved onfarm drainage

Small capacity, shallow drains can lead irrigation and rainfall runoff to drainage reuse and/or the Regional drainage system. These drains act to reduce groundwater accessions by 7.5% if Regional surface drainage is available. Other benefits range from reduced waterlogging and improved farm productivity through to improved pasture/crop yields and, if drainage reuse is incorporated, increased irrigation water availability. Typical capital costs of the internal farm drainage system are $150 per hectare drained and $25 per hectare annual cost. Farm drainage is generally incorporated in farm relayout works on a whole farm planning basis.

(d) Onfarm drainage reuse

These small capacity, below ground storages (typically 3-5ML/100ha) are used to collect surface runoff for use in developing additional irrigated areas. Storages enable irrigation runoff and runoff from small summer rainfall events to be managed to minimise groundwater accessions and waterlogging. The typical capital cost is $200 per hectare of catchment and capitalised annual costs of $70 per hectare.

(e) Tree planting

The planting of trees in shelterbelts, woodlots or in agroforestry configuration has the dual benefit of intercepting watertable accessions and removing water from the watertable. Trees also provide an opportunity to improve landscape value and the environmental condition of the Shepparton Irrigation Area.

The benefits of treeplanting are many and varied, however quantification of these benefits is not available. The value of farm trees is now being appreciated by Regional landholders and a number of very active tree groups are operating within the Region.

The capital cost of trees is estimated at $2100/ha for woodlots and $600/ha for agroforestry. Treeplanting in the Plan is to be promoted and supported on a whole farm planning and groups approach.

Particular emphasis is to be placed on siting shelterbelts and woodlots (4-6m. spacing) on channel seepage sites, the surrounds of reuse and water harvesting dams and alongside RWC and farm drains. In the longer term agroforestry spacings (20m) are to be considered along irrigation check banks in the pasture areas.

(f) Farm scale groundwater pumping and/or tile drainage and groundwater reuse

The installation of farm scale groundwater pumps and/or tile drainage works in areas where groundwater quality is good (i.e. <3600 EC) can provide the landholder with high watertable and salinity protection in the short to medium term. The activities rely on the landholder reusing the groundwater on the farm and being able to utilise enough to provide protection to a considerable area. Longterm protection to properties will only occur if salt disposal can occur to match the incoming salt from channel and rainfall sources.

As well as supplying a means of farm salinity control, these activities result in improved farm productivity through increased irrigation water availability and reduced waterlogging onfarm.

These groundwater control activities are developed as part of the sub-surface drainage activities (see Section 6.5).

(g) Water pricing mechanisms

Water pricing is seen by some groups in the community to be the means to assist in achieving salinity control. A water pricing system which encourages more efficient water management and water use from alternative onfarm sources (e.g. groundwater, drainage reuse) is seen as beneficial, provided it is equitable and does not discriminate against water using groups within the community.

(h) Improved irrigation and agronomic practices

Activities which improve irrigation water and soil management and agronomic practices have the benefit of increasing farm productivity, as well as reducing accessions to the watertable, in some cases through increased water use efficiency. These and other aspects of management which have an impact on farm productivity are not considered further in the Management Plan as they are necessarily ongoing programs which landholders will respond to for economic reasons rather than salinity control considerations.

SPPAC recognises the need for ongoing Research and Development programs into these activities, but these are the responsibility of the agricultural industries represented in the Region rather than of this Management Plan.

6.4.2 Farm Activities Not Included in the Plan

Activities which have potential to contribute to salinity control which SPPAC did not pursue are listed with an explanation of why they were not included in the Plan at this time.

(a) District restructuring

Withdrawing irrigation water rights from specific parcels of land which are considered in the longterm to be unsuitable for irrigation either because of high accession rates or high soil salinities, was considered to be inappropriate in the Shepparton Region. A program of relocating entire communities, acquiring land and water rights should not occur and is considered to be socially and politically unacceptable. The retirement of land from irrigation will guarantee its salinisation in a high watertable situation. There will be ownership and continuing management problems associated with retiring parcels of land across the Region.

(b) Regional scale tree planting programs

Reafforestation of large tracts of land within the Region was not considered to be an activity worthy of implementation as part of the Plan. To carry out such a program would require relocation of entire communities, and withdrawal of irrigation water rights as in (a) above. The effectiveness of Regional scale tree planting programs is considered to be less than that of a program of targeted tree planting onfarm as part of a whole farm plan, and in areas identified as high intake areas (e.g. channel seepage areas).

(c) Reduction in water entitlement

Reduction of water entitlements is not considered to be a salinity control activity worthy of implementation. While the reduction of water entitlement may increase efficiency of use of the remaining water, there would be less land irrigated, thus predisposing the remainder to salinity in the longer term. Farm productivity is directly related to water availability, any reduction in availability would have a large impact on farm economics,

and therefore Regional employment and productivity. If farm incomes are reduced, less finance is available for farmers to contribute funds to other salinity control works.

6.4.3 Environmental Guidelines - Farm Activities

The farm activities package of works will necessarily be carried out on private land. There are tremendous opportunities to enhance the environmental value of the Region through landholders undertaking works on their farms in an environmentally sensitive manner.

When undertaking farm relayout and drainage works for instance, there is an opportunity to identify areas which are suitable for tree planting to enhance not only farm values but the environment generally. Similarly, surface drainage works being carried out can be enhanced considerably through the correct selection and placement of trees along depressions or around drainage reuse systems.

There is now a very positive move by landholders in the Region toward the integration of tree planting with development works. In the longer term this will benefit salinity control, the environmental value of the Region and make a further contribution to the reversing of the "Greenhouse Effect".

The installation of farm groundwater pumping and/or tile drainage systems has potential to extend the life of much of the terrestrial vegetation which still exists in the Region. Although a tree planting project of major proportions is proposed in this Management Plan, the preservation of existing mature trees is also an essential part of environmental protection. Sub-surface drainage as proposed for agricultural purposes will reduce the effect of high watertables on mature trees but is unlikely to provide complete protection. Salt disposal through wetlands to the river systen could have negative effects unless managed within clear guidelines.

In order to maximise environmental benefits resulting from implementing the farm activities program, SPPAC provides the following guidelines:

(a) Farm development works will be undertaken on a whole farm plan basis. Whole farm plans are to identify areas which are suitable for environmental enhancement through tree planting and wetland development (DCFL will be responsible for providing the necessary assistance and advice).

(b) Where works to be undertaken will impact significantly on native vegetation a planning permit is to be sought from the local government authorities who will be required to consult with DCFL. Local government planning scheme changes will be required to give effect to this measure.

(c) Landholders are to be encouraged to include flora and fauna enhancement and protection as a component of farm works associated with drainage and drainage reuse schemes.

(d) Wetlands rated as having high conservation value are not to be degraded through the outfall of farm drainage containing high concentrations of nutrients, salt or chemicals.

6.4.4 Research and Investigation Requirements

In developing the farm activities program, SPPAC has identified a number of areas where further technical research and investigation is required. SPPAC considers this type of research as having statewide application and as therefore being the responsibility of the Victorian Government.

(a) High priority should be given to evaluation of the cost and benefits of tile drainage under perennial pasture based farms; immediate implementation of pilot

projects is required prior to implementing the activity in the C type management areas.

(b) Continuing research is required into the development of salt resistant legumes to assist the landholder in productively utilising groundwater.

(c) A research program is required to further identify the farm benefits resulting from the provision of surface drainage. To date, evaluation of the benefits does not accord with either the visual evidence, or the farmer's perception of the benefits as evidenced by willingness to construct community drainage schemes. These concern both SPPAC and Regional departmental advisors. The value of surface drainage appears to be grossly underestimated in this report.

(d) Further work is needed to provide economic production options to those landholders who are farming in areas where watertables cannot be physically controlled. These areas will experience major restructuring both socially and agriculturally.

(e) Monitoring programs are required to ensure the farm activities implemented under the Management Plan are :

- being adopted by landholders at a fast enough rate; and

- achieving the required salinity control and farm productivity benefits.

6.4.5 Farm Program Development

The effectiveness of farm activities in assisting salinity control is dependent on a number of factors. These factors relate to the watertable and drainage status of the property on which the works are to be carried out. The effectiveness of farm salinity control activities identified in Section 6.4.1 depends upon:

- the sub-surface drainage situation;

- the Regional surface drainage outfall situation; and

- the capacity for salt disposal.

An example of these constraints is the landforming/lasergrading of land where watertables are high, uncontrollable and saline. In such circumstances the costs of landforming would not be recovered by increased farm productivity.

In working toward a preferred farm activities program within the Management Plan, SPPAC has considered a number of activities which result in groundwater accession reductions and improved farm productivity.

These activities have been combined into a series of farm packages given different surface and sub-surface drainage situations across the Region.

Any farm activities programs implemented would be on a whole farm plan basis. SPPAC has investigated a number of farm activities programs which include:

(a) Improved onfarm drainage and drainage reuse schemes on farms not currently served by RWC drains.

(b) Landforming/lasergrading all soils in areas which, at the time of inspection, do not have a high watertable, or those areas where sub-surface drainage is feasible. Where sub-surface drainage is not feasible, and a high watertable exists, only the lighter soil classifications would be treated.

(c) Tree planting to be undertaken in two programs.

(i) Shelterbelts/woodlots on 50% of farms over 10% of the farm area.

(ii) Agroforestry on 25% of farms over 40% of the farm area.

There would be considerable overlap between the two programs.

(d) Installation of farm scale groundwater pumping/and or tile drainage schemes where possible. These activities have been evaluated as part of the sub-surface program (Section 6.5).

Items (a) (b) and (c) have been evaluated in four different farm programs. These vary according to the amount of surface drainage and sub-surface drainage works being undertaken. As mentioned previously, these two types of activities determine what can be done onfarm to contribute to salinity control.

The programs which have been investigated are:-

1. Farm Activities Only Program -

   This program represents the degree of salinity control and prevention that can be achieved from carrying out farm activities without further public scale drainage or sub-surface drainage works.

2. Full Watertable Control Program -

   This program represents what farm activities could achieve if full salinity control were provided through a Regional RWC drainage network and sub-surface drainage program.

3. Economic Guidelines Program -

   This program represents the farm activities to be undertaken if only economic program components in accordance with Government Economic Guidelines are implemented.

4. Preferred Program -

   The preferred option was determined after identifying the farm activities which complement the preferred surface and sub-surface drainage programs.

   The Full Watertable Control program is not discussed further because farm activities would only result in productivity benefits, and not contribute to salinity control.

In estimating the benefits of the three farm activities programs investigated, reduced salinisation and increased productivity benefits have been estimated where possible.

Salinisation benefits vary between the programs due to the extent of surface and sub-surface drainage works being carried out. Generally, as the level of these Regional drainage activities reduce, the salinisation benefits attributed to farm actions increase.

Clearly, it will take many years to implement Regional surface and sub-surface drainage programs and individual landholders have the opportunity (and responsibility) to implement farm works which can assist salinity control in the interim period.

A comparison of the three farm activities packages evaluated by SPPAC appears in Table 14. The comparison identifies the total costs and benefits of treating various areas with a variety of works. To enable financial comparisons between various work programs, a Net Present Value of each package appears together with a Benefit/Cost Ratio. All economic calculations have been carried out according to the State Economic Working Group (SEWG) guidelines for preparation of salinity management plans.

TABLE 14: Summary of Farm Activities Packages

	FARM ACTIVITIES ONLY			ECONOMIC GUIDELINES			PREFERRED		
	LANDFORMING & FARM DGE.	DRAINAGE REUSE	TREE PROGRAM	LANDFORMING & FARM DGE.	DRAINAGE REUSE	TREE PROGRAM	LANDFORMING & FARM DGE.	DRAINAGE REUSE	TREE PROGRAM
1. Area Treated (ha)	88790	57228	41,400	98,986			106,038	66,150	41,400
2. Total Capitalised Cost (1) ($M)	161	42.1	45.6	180.4			194	48.8	45.6
3. Benefits ($M)									
Salinisation	10.72	1.1	N.A.	9.07			9.86	1.21	N.A.
Productivity	135	27.3	N.A.	194			208	31.5	N.A.
Total	145.7	28.4	N.A.	203.1			217.4	32.9	N.A.
4. Benefit/Cost Ratio									
Activity	0.91	0.67	N.A.	1.1			1.1	0.68	N.A.
Package	0.86 (2)			1.1	Not Incl.	Not Incl.	1.03 (2)		
5. NPV's (3)	-$15.3M (2)			$12.3M			+$3.9M (2)		

Notes:

(1) Capital Cost assumes works are inplemented immediately. Figures include a capitalised annual cost for lasergrading/farm drainage and drainage reuse in 1989 Dollars.

(2) This figure does not include the Tree Program for which estimates of benefits were not available.

(3) N.P.V. assumes streaming of costs over 30 years implementation period, and benefit over 50 year period at 4%

It is significant to note that the Farm Activities Only package does not provide longer term salinity control, and can only be implemented over a small proportion of the Region. This again highlights the interconnection and reliance on an integrated program of works to achieve salinity control. The public works programs of surface and sub-surface drainage provide the linkages and salt disposal networks required for longterm control.

The Economic Guidelines package does not include the drainage reuse activity as the benefit/cost ratio for this activity does not reach unity. Similarly, the tree program is not included in the Guidelines package as benefits of a tree program of this nature have not been estimated. In dismissing drainage reuse, it must be noted that benefits have been underestimated due to the difficulty in attributing salinisation benefits between the surface drainage program and the farm program and the fact that road benefits resulting from drainage reuse have not been estimated.

The Preferred Program was selected by SPPAC after considering the following:

- the likelihood of the program being implemented by farmers:
- the need to provide incentives for landholders to undertake beneficial activities which are currently not being adopted at a fast enough rate:
- the environmental and socio-economic benefits and contributions of each activity toward the other Regional programs of surface and sub-surface drainage and environmental protection.

For further information on this section refer to the following Background Papers:

FM1 - *Quantification of Onfarm Options for Salinity Control - August 1988*
FM2 - *Development of the Farm Program - July 1989*
FM3 - *Effect of Landforming and Surface Drainage on Accessions - July 1989*
GW - *Groundwater Accession Reduction Benefits - November 1988*

6.5 SUB-SURFACE DRAINAGE ACTIVITIES

6.5.1 Available Sub-surface Drainage Techniques

In considering which sub-surface drainage activities are to be applied in the Management Plan, SPPAC is aware that watertable control within the Region can be achieved by:

- pumping from the shallow aquifers of the Upper Shepparton Formation where these exist; and
- tile drainage.

SPPAC is also aware of the contribution to watertable control which can be effected by farm activities (Section 6.4) and by surface drainage (Section 6.6). However, SPPAC wishes it to be made clear that these contributions to watertable control are mitigating ones, not controlling ones.

The following activities were investigated in developing the sub-surface drainage program, and relate to the Management Area types identified in Section 6.2.

(a) Groundwater pumping with onfarm use of groundwater
Where groundwater salinity is below 3000EC units (Low B3 management areas),

onfarm groundwater use can generally provide good watertable control as well as providing additional water resources for irrigation farmers over the irrigation season. Salt disposal from these areas is required to maintain a salt balance. Without salt disposal the activity can only be sustained in the short term as groundwater salinities will inevitably rise.

(b) Groundwater pumps outfalling to RWC channels and drains

As groundwater salinities increase, the opportunities for safe onfarm reuse diminish rapidly. Where groundwater salinity is between 3000-11,500EC (the High B3 and B2 management type areas) substantial local groundwater reuse can occur via the RWC channel and drainage networks, but it is generally not attractive to individual farmers due to the low volumes of groundwater which can be used safely. Reticulation of groundwater between properties to maximise reuse is feasible but is considered impracticable on a Regional scale. Public pumps discharging to the channels and drains are preferred because operation can be maximised without reliance on numerous agreements between groups and farmers.

(c) Groundwater pumping and disposal via local evaporation basins

Where groundwater salinities are above 11,500EC (the B1 management area types), onfarm and within region groundwater reuse is generally not feasible at present. In these situations public pumps discharging to local evaporation basins provide a means of salt disposal.

(d) Tile Drainage

Although tile drainage is more costly than large scale groundwater pumping, there are opportunities in the areas with limited pumping potential (C management type areas) to install tile drainage or low capacity groundwater pumps. These works would be private and have the same salt disposal opportunities as the B area types. i.e. onfarm reuse and off-farm disposal where quality is good, or evaporation basins where poor quality groundwater exists.

6.5.2 Sub-surface Drainage Techniques Not Included

A number of sub-surface drainage techniques and disposal methods have not been included by SPPAC at this time. Each has some potential for future development. They are:

(a) Deep aquifer pumping with groundwater reuse

There are opportunities to utilise groundwater from deep aquifers (deep leads) in the Region. Pumping from these aquifers can stabilise groundwater pressure levels and maintain the present deep drainage. This activity would not in general remove the need for shallow sub-surface drainage by pumping or tile drainage, but is none the less desirable. Onfarm use of deep lead water can provide effective disposal where the groundwater salinities are low, but as salinities increase the economics of private and public usage become extremely marginal. The importance of maintaining existing pumping levels has been recognised through inclusion of deep lead pumps in the SEC pumping assistance program. This will encourage the continued use of existing pumps in parts of the Campaspe and Murray Valley where pumping has stabilised pressure levels in recent years. There is a need to develop a longterm strategy for management of the deep leads and a high priority has been given to research programs for this purpose.

(b) Injection of salt to the deep aquifers

This option was not seriously considered, given that there is already concern about the longterm effect of rising pressures in the deep aquifers. For much of the area the salinity of the deep aquifer water is less than that of the shallow aquifers, and injection of salts would increase deep aquifer pressures and salinities and compound the future management problems. The technology for deep injection is untested and uncosted for this area.

(c) Pipe to the sea

Disposal to the sea has considerable appeal as a means of ultimate disposal for salt. Past studies have shown this to be uneconomic at this time compared to other strategies included within the Murray Darling Salinity and Drainage Strategy. However SPPAC welcomes and supports the new study recently announced by the MDBC and will carefully consider the results obtained.

(d) Disposal via the Waranga Western Channel

Use of the Waranga Western Channel as a means of recycling salt from the western part of the Region has been suggested. This would require a very expensive reticulation system with high pumping and energy costs to bring sub-surface drainage water back to the channel. It would also cause significant increases in salinity of supply to irrigation areas outside the Shepparton region. One of these, Boort, already receives water of poor quality and is seeking an improvement in water quality.

(e) Desalination was also discarded because previous studies have shown it to have very high capital and operating costs, and high energy requirements. It would also require an expensive Regional reticulation system.

6.5.3 Sub-surface Drainage Program Development

There are a number of aspects of the sub-surface drainage techniques which can be varied to achieve different levels of land protection and resultant salt disposal requirements. These relate specifically to:

(i) The target groundwater pumping rates to be applied in the program, to:

- achieve full watertable control (keeping watertables below 2 metres) as is the case in the Phase A areas; or
- achieve salinity control only and to manage the resultant high watertables at particular times of the year.

Watertable control prevents both waterlogging and soil salinisation whereas salinity control is designed to ensure adequate leaching (washing) of salt from the rootzone. However intermittent rootzone waterlogging will occur during high watertable periods.

(ii) The level of groundwater reuse to be achieved within the Irrigation Region. There is universal technical agreement that full reuse within the Region is not sustainable, but there is an infinite range of reuse options between the no disposal and total disposal to the River Murray policies.

The sub-surface drainage program has been developed around the management area types discussed in Section 6.2. The level of groundwater pumping/tile drainage and groundwater reuse has been set on the basis of groundwater quality in each area type. It should be noted, however, that groundwater quality will change in the long term depending on the relative levels of reuse or external disposal.

The technical options which were assessed by management area type are:

(i) B Type Areas

- pumping for watertable control with onfarm reuse and River Murray disposal;
- pumping for salinity control with onfarm reuse and River Murray Disposal;

- pumping for watertable control with onfarm, Regional reuse (via RWC channels and drains) and River Murray disposal;

- pumping for salinity control with onfarm, Regional reuse and River Murray disposal;

- pumping for watertable control with internal (evaporative) disposal;

- pumping for salinity control with internal (evaporative) disposal.

(ii) C Type Areas

Detailed assessment of the C type areas has been impossible due to a lack of technical data. Feasible options for watertable control in these areas are low capacity groundwater pumps or tile drains which are likely to be economically justified only for high value irrigated crops or perennial pastures. Provision has been made to properly evaluate the options as a matter of urgency.

As these areas constitute more than 35% of the area at risk by 2020 a substantial allocation of both capital and salt disposal quota has been made to safeguard the more intensively irrigated areas with small pumps or tile drains. It is considered that this could protect 50% of the C type areas.

Should sub-surface drainage prove impracticable or totally uneconomic at particular locations the following actions are available.

(i) Application of the best available saline agricultural methods, restructuring the property and changing enterprise type could improve productivity of the best parts of the property.

(ii) As a last resort, a land retirement policy will operate under guidelines which will include as pre-requisites:

- exploration of all available options for land protection;

- exploration of all avenues for sale of all or part of the affected property, including the irrigation water;

- exploration of all options under the Rural Adjustment Scheme; and the final proposals to be negotiated between the parties concerned.

However the objective of the Plan is to provide salinity control for all affected areas. Therefore, high priority research will continue on methods of protection, including the design, construction and costing of tile drainage and small scale evaporation disposal systems.

6.5.4 Constraints Considered in Developing the Sub-surface Drainage Program

A number of options listed above require that saline groundwater be pumped to the RWC channel and drainage system during the irrigation season in order to achieve within region groundwater reuse on a large scale. SPPAC have considered the following:

(i) There are costs associated with in-season pumping to both channels and drains, including operation, maintenance, monitoring and River Murray disposal costs.

(ii) Poorer quality channel or drain water available to downstream water users will result in reduced dilution capacity for onfarm groundwater reuse.

(iii) With increased channel salinities there may be increases in accessions and increased salt loads to be pumped if areas are sub-surface drained, or more rapid soil salinisation if not sub-surface drained.

(iv) Poorer water quality for town supplies may result in higher water treatment costs.

In particular there are more than 700 irrigators who use water from the drainage system. While SPPAC accepts that the drainage system is to be used for its primary purpose (i.e. disposal of drainage water), drainage diverters play a major role in intercepting existing runoff salt loads by utilising runoff water within the Region thus preventing outfall to the River Murray. SPPAC is also aware that in the "do nothing" case drain salinities will increase dramatically due to increased saline runoff from unprotected areas and improved irrigation management reducing the volume of "fresh" water reaching drains.

Therefore there will be adverse impact upon drainage diverters (both with the Plan and without it) which must be recognised in formulating specific projects within the total program.

After considering these constraints on groundwater outfall to the RWC channel and drainage system SPPAC recommends that disposal must be evaluated on a project by project basis within the following guidelines:

(i) Salt disposal from groundwater control areas will be to the existing surface drainage system where necessary.

(ii) The present drainage diverters are to be maintained where possible at reasonable cost and without severely limiting land protection in the Region (see Section 6.9).

(iii) Channel salinity increases are to be minimised with maximum limits being set by current Phase A operating rules, namely:

- average seasonal salinity to be less than 500EC (300ppm);
- maximum average for any seven consecutive days to be 750EC (450ppm);
- maximum salinity at any stage to be 850EC (500ppm).

6.5.5 Pumping Rates for Salinity Control

At the Regional scale approximately 90% of the benefits resulting from sub-surface drainage of irrigated perennial pastures results from the prevention of salinisation and 10% from reduced waterlogging. To achieve full watertable control and obtain all the benefits requires that greater salt loads be pumped and disposed than is required for salinity control only.

The lower pumping target for salinity control means high watertables will become a part of life in most of the Region during periods of high rainfall events. However, this will normally be during late winter and early spring with only minor impact on pasture productivity.

An interim pumping target of 40mm/yr (0.4ML/ha/yr) has been adopted for salinity control, with provision for this to increase to 50mm/yr for areas receiving higher salinity channel water. This compares with the estimated pumping requirement for full watertable control in, say, the B3 areas of 80 to 100mm or more. This target is to be split between the irrigation season (20mm/yr) and the winter period (remainder).

Summer pumping of 20mm/yr in the high B3 and B2 areas to the channel and drainage system is expected to see 15mm/yr of groundwater being reused by Regional irrigators with the remainder being disposed to the River Murray. The total salt exported from these areas would be greater than the salt input, and therefore groundwater salinity would reduce over time (50 to 100yrs).

The proposed pumping rates are realistic for salinity control and represent a major reduction in salt load to be disposed compared with watertable control. It will require a high level of monitoring and management to be effective, but in the longer term salt disposal will be reduced further as groundwater salinity reduces.

6.5.6 Alternative Packages Considered

The above activities have been developed into a number of different sub-surface drainage packages. The packages vary depending on:

- whether full watertable control or salinity control is achieved; and
- the degree to which salt is disposed to the River Murray or retained in the Region by reuse or evaporation basins.

The treatment of the Low B3 areas (where large volumes of very good quality water can be pumped) is common to all packages. Maximum onfarm reuse by private pumping is assumed with limited winter disposal as needed to maintain a salt balance. The only option considered for the C type areas is private installation of tile drains or small groundwater pumps for the most productive areas where water quality is good. In these areas onfarm reuse of groundwater will be required in season, but off-farm disposal will be allowed outside of season.

The packages investigated were:

1. Farm Activities Package - this includes only those activities which farmers would do individually, i.e. pumps for onfarm reuse in low B3 areas and tile drains in half of the C type areas. Controlled disposal would be allowed off-farm in the winter.

2. Full Watertable Control Package - this assumes full watertable control for all B areas and half the C types. The Low B3 and C type areas have onfarm reuse in season and off-farm disposal in winter. The high B3 and B2 areas dispose to the channel and drain system. The B1 areas discharge to local evaporation basins.

3. Economic Guidelines Package - this excludes activities which do not clearly satisfy the Government Economic Guidelines. It includes full watertable control in the Low B3 and salinity control for the High B3, B2 and B1 areas. Disposal is the same as for the Full Watertable Control Package.

4. Preferred Package - this includes full watertable control for the Low B3 and C type areas, and salinity control for the High B3, B2 and B1 areas. Disposal is the same as for the Full Watertable Control Package.

The costs and benefits for each of these packages have been estimated using representative costs for the works in each Management Area Type, and representative benefits, based on the "do-nothing" production losses, calculated according to the SEWG Guidelines. Table 15 sets out the costs for each of the major options considered for each Management Area Type, together with the benefit/cost ratio. The costs as calculated include the capitalised cost of all operation and maintenance, salt disposal costs both internally and externally, and management of the system.

For each case the benefit/cost ratio has been calculated assuming that the particular area protected has had a high watertable for 20 years at the time that the works are constructed. The discounted value of the benefits is greater in economic terms if the problem is further advanced when works are constructed. Table 15 indicates that all of the activities under serious consideration are economically justified in the "as estimated" case, except pumping and disposal to evaporation basins for the B1 Areas.

TABLE 15: Summary of Sub-surface Drainage Activities Considered, Costs & Benefits by Management Area Type

MANAGEMENT AREA TYPE	ACTIVITY (1)	DISPOSAL	UNIT AREA (2) SERVED (HA)	CAPITAL COST	PV OF REPLACEMENT CAPITAL (3)	CAPITALISED ANNUAL COSTS (4)	BENEFIT/COST RATIO (5)
LOW B3	Use existing private pumps	Onfarm reuse with winter disposal	106.5	0	7,700	70,220	5.1
	Encourage new private pumps	"	106.5	43,500	5,200	70,220	2.2
HIGH B3	New public pumps	Regional reuse with winter disposal	190	66,500	10,000	87,470	1.85
B2	"	"	190	66,500	10,000	132,360	2
B2	New public pumps & disposal basins	Disposal to evaporation basins	190	206,500	39,160	52,190	1.3
B1	"	"	190	206,500	39,160	52,190	0.85
C	Private tile drains	Onfarm reuse with winter disposal	20	38,500	6,900	33,900	1.2
C	Private tile drains & disposal basins	Disposal to evapration basins	20	65,500	12,500	35,810	1.1
C	Small groundwater pumps	Onfare reuse with winter disposal	20	24,000	2,600	41,000	1.4
C	Small groundwater pumps & basins	Disposal to evaporation basins	20	66,000	11,350	24,900	1.05

Notes:

(1) Costs and benefits are for full watertable control for Low B3 and C areas, and salinity control for High B3, B2 and B1 areas. ($ 1989)

(2) Gross area of influence of pumps discounted by 5% for public roads, channel and drain reserves. Tile drain areas based on area actually drained.

(3) Calculated on construction cost only. Existing private pumps will require replacement earlier than new ones.

(4) All operation and maintenance costs, downstream disposal costs and management costs — discounted at 4% over 50 years.

(5) Benefits calculated according to SEWG Guidelines and discounted at 4% over 50 years. Benefits are calculated for the case where high watertables have existed for 20 years.

In reality, the B1 areas will seldom exist as homogenous areas and failure to deal with them will result in migration of salt to areas where works are carried out. Examination of a typical situation where a B1 area is adjacent to B2 and B3 areas, as at Girgarre, gave a total benefit/cost ratio of 1.9 for a project including 3 Low B3 pumps, one High B3 and one B2 pump discharging to drains, and one B1 pump discharging to an evaporation basin. It must also be emphasised that costs and benefits for the C type areas are subject to confirmation by major field investigations.

The four packages are summarised in Table 16. There are significant differences in the costs and benefits of the programs which relate to the level of pumping and the amount and method of salt disposal.

The preferred strategy utilises groundwater pumping and tile drainage to protect all of the B type areas and the most productive C type areas.

It maximises onfarm reuse in areas where watertable control is possible (Low B3 areas) and maximises off-farm disposal increases by:

- reducing pumping to only that required for salinity control;
- utilising local evaporation basins where economically justified as an alternative to disposing to the River Murray.

Under the preferred regime, sixty-two percent (62%) of the pumped salt load will be retained locally by reuse or evaporation.

Successful implementation of the preferred program will require careful management and evaluation of salt disposal at the local scale to ensure Regional guidelines are met. Use of additional evaporative disposal (at increased cost) for the more saline B2 type areas remains as a "fall back" option if additional salt disposal quotas to dispose to the River Murray are not available.

6.5.7 Environmental Considerations

It has been demonstrated in Section 5.2 that uncontrolled watertables and salinisation are already impacting severely on terrestrial vegetation, landscape values and wetlands on the plains. If watertables are not controlled both the severity of damage and the areas affected will increase. There will also be increased salinity in water entering rivers and streams and adjacent high value wetlands.

Sub-surface drainage is the only technique available which can provide either complete watertable control or complete control of soil salinity. It should be noted that complete watertable control, as defined for agricultural purposes, would hold watertables at 2 or 3m below surface. This would not necessarily constitute full watertable control for some mature native vegetation which has roots to much greater depths. Nevertheless sub-surface drainage as proposed in this Plan will provide an improved environment for all existing native vegetation, and the opportunity to re-establish native vegetation. Some minor wetlands which have formed as a result of high watertables may be lost: these have low environmental value. High priority will be given in the environmental program to co-ordination of revegetation programs with sub-surface drainage programs. This will ensure the longterm sustainability of the new vegetation, while at the same time reducing the rate of groundwater accession.

While sub-surface drainage works will clearly maintain and improve the existing environment, disposal of pumped groundwater must be carefully managed. Disposal will occur by onfarm reuse, discharge to RWC channels and drains, discharge to the river system, and discharge to evaporation basins. No significant environmental effects are expected as a result of onfarm reuse (at irrigation water salinities currently recommended by DARA), or as a result of discharge to the channel and drain system. Discharge to evaporation basins will only occur

TABLE 16: Summary of Sub-surface Drainage Activities Packages

SUB-SURFACE PACKAGE	AREA PROTECTED		COST ($M)		BENEFITS (PV-$M) (4)			B/C RATIO	SALT DISPOSAL QUOTA (5)
	HECTARES	% (1)	CAPITAL (2)	ANNUAL (3)	SALINITY	PRODUCTIVITY	N.P.V. ($M)		
FARM WORKS	116,000	14	45.3	88	277	27.9	168	2.3	8.9
-On farm component	116,000	14	45.3		277	17.9			
-Public works component	0	0			0	0			
FULL WATERTABLE CONTROL	213,000	41	80.3	150.5	537	38.7	332	2.5	25.4
-On farm component	128,000	24.5	45.3		307	32.7			
-Public works component	85,000	16.5	35.0		230	6.0			
ECONOMIC GUIDELINES	170,000	33	45.3	105.5	325	38.7	281	2.4	12.6
-On farm component	85,000	16.5	10.3		218	32.7			
-Public works component	85,000	16.5	35		207	6.0			
PREFERRED	213,000	41	80.3	129	514	38.7	318	2.6	16.7
-On farm component	128,000	24.5	45.3		307	32.7			
-Public works component	85,000	16.5	35.0		207	6.0			

(1) As a percentage of total Regional areas. Area at risk by 2020 is 49% of total area.

(2) Total initial capital at 1988 values.

(3) Capitalised value of annual costs for completed project including salt disposal costs.

(4) Capitalised value of annual benefits for completed project.

(5) EC effects at Morgan.

within appropriate guidelines, which will minimise any adverse impact and offer opportunities for environmental enhancement.

Discharge to the stream system will, however, cause significant increases in stream salinity and nutrient levels at certain times, particularly in the lower Goulburn River. This would also occur in the "do nothing" case as high watertables and salinisation spread. However, the Plan requires that discharge from both private and public groundwater pumps be carefully regulated to minimise adverse effects within the region and also in the River Murray. RWC and DCFL will work closely together to develop operational rules which ensure that significant salt discharges to the Lower Goulburn do not occur at critical times. Additional work is still required to establish firm tolerance levels (in terms of maximum salinity, and timing and duration of the maximum values).

6.5.8 Identification of Priority Areas for Implementation

Section 7 discusses priorities for implementation of works will be developed by Salinity Program Implementation Groups (SPIG's) representing each of the Irrigation areas in the Region. In order to ensure that implementation can proceed without delay SPPAC has developed a 5 year work program based on its understanding of Regional priorities.

Approximately 188,000ha of the Region already has high watertables in 1988 (some of which date back to the 1930's), and mild to severe salinity damage is evident in many areas. The 5 year work program has therefore been designed to mobilise both private and public resources as quickly as possible across the Region.

This will be achieved by the following strategies:

(a) Directing public resources intensively into selected Priority Project Areas will provide complete management strategies for those areas. It is proposed that investigation would be substantially completed for up to 43,000ha of priority areas, including installation of about 80 private and 80 public pumps, and construction of 10 evaporation basins;

(b) Existing private pumps are to be included in the Management Plan as soon as possible by implementing management arrangements to ensure pump operation is optimised, and managed off-farm salt disposal occurs as required. This program would be completed in the 5 years and would bring some 200 pumps into the Management Plan. Much of this activity would occur in the Murray Valley Irrigation Area which has a high density of existing private pumps with access to good quality water;

(c) By maintaining and strengthening existing assistance programs to landholders Region wide, appropriate sub-surface drainage activities can be implemented even before an area is dealt with as a Priority Project Area; and

(d) By completing enterprise scale evaluation of the feasibility and economic value of alternative sub-surface drainage techniques for areas where groundwater control by pumping is not feasible (particularly tile drainage).

For the first two years of the program SPPAC has given priority to five areas where the Government Departments are already working with the local community to deal with problems. These are Ky Valley/Tongala, Tatura Township, Stanhope, Harston and Undera.

A further eight Priority Project Areas were considered in developing the 5 year work program. These were identified on the basis of the severity of existing salinity problems, the intensity of irrigation, and the probability of rapid implementation. However, final prioritisation by the SPIGs will also take account of the willingness of the local community to be involved, external factors such as interaction with other project areas, and overall environmental concerns.

6.5.9 Research, Investigation and Monitoring

Development of the Plan has highlighted a number of areas where current sub-surface drainage knowledge is deficient, and significant improvement in Plan performance might be achieved with improved knowledge. New and continuing research and investigations programs, and improved monitoring of a number of parameters is required. Compliance monitoring is essential in providing data for the Murray Darling Basin Commission to evaluate the effects of Regional groundwater discharges on the River Murray.

Key areas which have been identified are:

(a) completion of the groundwater monitoring system (groundwater level, quality and usage) for both deep and shallow aquifers;

(b) ongoing modelling and evaluation of both deep and shallow groundwater behaviour, including assessment of the potential groundwater resource and development of a management strategy for the deeper aquifers;

(c) evaluation of groundwater interactions between the irrigation region and adjacent dryland areas (including the Barmah Forest);

(d) detailed evaluation of both salt and nutrient transport in groundwater in areas with sub-surface drainage;

(e) continuing refinement of estimates of groundwater recharge from various sources, and development of more precise criteria for sub-surface drainage requirements;

(f) completion of current regional channel seepage investigations and trials with alternative sealing techniques;

(g) development of performance and design criteria for evaporation basins.

(h) monitoring of present and future salt loads entering and leaving the Region in surface flows.

An allocation of $5.47M has been made in the 5 year work program for these activities.

For further information on this section refer to the following Background Papers:

PL3 - *Policies for Areas Without High Yielding Low Salinity Aquifers - July 1988*
DS1 - *Guidelines to Manage Channel and Drain Salinities for Environmental Purposes - July 1988*
DS3 - *Simulation of Channel and Drain Salinities - January 1989*
GW3 - *Riverine Plain Groundwater Usage Survey. Summary Report - November 1988*
GW4 - *Solute Transport Aspects of Groundwater Pumping - 1989*
GW5 - *Modelling of Sub-surface Drainage Options in Pumpable Areas - August 1988*
GW6 - *The Role of Deep Lead Pumping for Salinity Control and Resource Development Within The Shepparton Region - March 1989*
GW7 - *Groundwater Accession Reduction Benefits - November 1988*
GW8 - *Development of Sub-surface Drainage Plan - 1989*
GW9 - *Groundwater Control by Private Pumping Systems*
GW10 - *Review of Farm Exploratory Drilling Service*

6.6. SURFACE DRAINAGE ACTIVITIES

6.6.1 Surface Drainage Activities Included in the Plan

After due consideration of many alternatives, SPPAC recommends the following Regional surface drainage activities be implemented to assist in reducing groundwater accessions, soil salinisation and waterlogging.

(a) Rural Water Commission (Public) Drains

These drains are constructed, operated and maintained by the Rural Water Commission. The standard of service to be provided by this type of drain is higher than for the other types considered and the standard of design and construction is aimed at minimising maintenance costs.

Typically RWC drains are constructed in areas where:

- intensive irrigation takes place;
- high value crops are grown;
- outfall facilities are required for community drains;
- outfall is required for groundwater pumps or tile drainage pumps; or
- environmental sensitivity exists, e.g. wetlands, potential soil erosion, flora and fauna protection.

Capital costs for new RWC drains are typically $120,000 per kilometre or $1,200/ha directly served. Design standards are generally related to the runoff from a 24 hour rainfall event which occurs on average 1 year in 10.

(b) Community (Private) Drains

Community drains are smaller than RWC drains and rely upon the goodwill and co-operation of neighbouring landowners (the community) for their construction and ongoing operation and maintenance.

They are best suited to areas where:

- RWC drains would cause significant disruption to farming operations;
- the catchments to be served are small;
- only single drainage lines are involved;
- the more expensive RWC drains are not economical;
- a lower standard of service is acceptable;
- the landowners involved all recognise the need for drainage and a common spirit of co-operation exists; and
- outfall is available to RWC drains or natural streams.

Generally, RWC approval to outfall is required where RWC drains are involved or where water is being taken from one subcatchment to another. However in the cases where State Government grant monies are being applied to these drains, RWC approval is required for all outfalls and DCFL clearance is required on the environmental aspects before construction takes place.

Community drains are generally designed to accommodate the runoff from a 24 hour rainfall event which will occur on average one year in two. They have a typical capital cost of $20,000/km or $200/ha served.

As these drains rely upon community empathy and goodwill, the desirable maximum length of the single drainage line involved is 10km for each drain. In exceptional circumstances, given a high level of community organisation, SPPAC believes longer drains may be successful. These drains are generally managed by a small committee nominated from the landowners involved. The committee organises the maintenance of the drain and recovers the cost from the landowners involved. There is also the opportunity for local government to become involved in administering these schemes.

(c) Water Harvesting

Water harvesting systems involve the collection of surface runoff in a sump and/or elevated storage then pumping or gravitating the water to the internal farm irrigation system for reuse. The larger the storage relative to the catchment served, the higher the standard of service to be provided. A storage with a capacity of 30ML/100ha served will have its capacity exceeded on average one year in three if the storage is empty at the end of the irrigation season.

Where other forms of drainage are uneconomical to install because of high outfall upgrading costs, or where there are adverse environmental consequences from constructing RWC or regional community drains, water harvesting could be used.

Water harvesting storages will generally need to be community based and serve at least 160ha each on average to achieve the economies of scale needed to make best use of the works involved. Where smaller properties are involved, the management should be similar to that used for community drains.

On average the cost of a 30ML/100ha served storage would be about $700/ha served to install and $220/ha served to operate for rainfall runoff control purposes.

(d) Water Harvesting with Pumping into Channel

The storage size used for water harvesting systems can be reduced and the level of service provided improved beyond that to be achieved with the storage alone, if it is posssible to discharge from the storage to outfall points external to the sub-region.

The RWC has about 4000km of irrigation water supply channels in the Shepparton Region and many of these channels have outfalls or escapes which are used at times of mis-regulation or shut down of the channel system. These outfalls are to either natural water courses or RWC drains.

In the Shepparton Region there are currently about 900 private pumps which periodically discharge to the RWC channel system to provide a limited drainage service. The pumps are theoretically only permitted to discharge during daylight hours when capacity is available in both the water supply channel and the outfall waterway. However, this requirement is difficult to enforce.

This form of drainage requires costly supervisory control if RWC channel security and the level of service to be provided to those adjacent to the outfalling drains is not to be threatened.

The extension of the function of irrigation supply channels as a means of disposing of surface drainage water will require a formalisation of the existing system with water harvesting storages being installed to collect the water onfarm. Upgrading of outfalls and some channel structures will be necessary so that the standard of service and operational procedures can be improved and the system

made more equitable. A drainage levy would also be imposed to cover the cost of using the channel and, where necessary, the drainage system, as a means of outfall.

The use of storages with a capacity of 15ML/100ha served will provide a standard of service equivalent to that to be provided by community drainage systems.

The average cost of a formalised water harvesting system with channel discharge is $800/ha served in capital cost (including upgrading the channel system where necessary) and $240/ha served to operate for rainfall runoff control purposes.

(e) Drainage Course Declarations

In accordance with the provisions of the Drainage of Land Act natural depressions may be Declared Drainage Courses with the appointed Authority being responsible for ensuring that the depression is cleared of "man-made" obstructions. This action restores the depression's natural water carrying capacity but does not, on its own, generally lead to an acceptable standard of drainage being provided.

Such Declarations are best suited to well defined ancestral or prior stream courses and to situations where major runoff is generated on high ground upstream of the Region and has to be passed through the Region or where major depressions exist in conjunction with water harvesting systems.

Typically, works required to remove obstructions from Declared Drainage Courses cost $30,000/km.

6.6.2 Surface Drainage Activities Not Included in the Plan

The following surface drainage activities, although capable of reducing groundwater accessions during the summer, were not included on the Plan by SPPAC due to their limitations if provided on a sub-regional scale.

(a) Onfarm Reuse

The extensive use of onfarm drainage reuse sumps (1-5ML/100ha) as an alternative to regional drainage was not recommended as a form of surface drainage because of the lack of drainage service to be provided during winter and following significant rainfall events in summer. Only irrigation runoff on individual properties is effectively handled in this manner and the system cannot be used on unirrigated farms.

(b) Pumping into RWC Channels

In the long term the use of one or more pumps discharging from each property into the RWC channel system without onfarm storages (either natural or man-made) was discarded because of the following:

- the poor standard of service to be provided if existing channel and drainage system users are to be protected;
- the impact on those downstream on the same drainage line if channel discharge is not available during periods of maintenance; and
- difficulties in controlling channel discharge (rate and timing).

6.6.3. Surface Drainage Program Development

In developing the drainage program the region was divided into 18 drainage areas or subcatchments which approximate the actual natural drainage pattern for the area. These areas are shown on Figure 4 (p.15).

All of the previously mentioned drainage activities are interdependent with many RWC and community drains depending upon outfalls being upgraded. Water harvesting with RWC channel discharge will require that outfall drains and or channels be upgraded.

Considering these constraints, the activities were combined in a number of ways to obtain programs which would make best use of specific sums of capital monies. By qualitatively referring to the following factors and available data in each of the 18 drainage areas, a total of six optimised programs were developed with capital costs which varied from $87M to $448M:

- soil types;
- photographs of the area following significant rainfall events;
- irrigation intensities within the catchment - as determined from information collected by the Department of Water Resources (DWR) for the 10 years ending May 1987;
- available contour information;
- waterlogging severity (irrigation intensity/soil permeability); where the soil permeability was determined by DWR by reference to soil types and field data;
- culture type - from RWC culture sheets;
- property sizes;
- historic public agitation together with the responses to the January 1988 call for public comment on drainage requirements;
- the catchment area (including area outside the study area);
- the degree of relief across the catchment;
- the longitudinal grade of the catchment;
- the wetlands and other features of environmental significance within the catchment; and
- the standard of service currently received and to be provided by the various forms of drainage available.

These programs were developed on the basis that the surface drainage program would be based on community driven projects with the local community determining construction priorities and standards of service to be provided. However it was assumed that the RWC legislative requirement to operate and maintain the existing drainage systems such that the originally intended standard of service is maintained must be complied with. Outfall upgrading prior to extension of drains was therefore costed into the program.

The installation of RWC drainage leads to an 11.5% reduction in total groundwater accessions within the catchment served. In addition to this benefit significant quantifiable benefits are obtained through reductions in road construction and maintenance costs, reduction in waterlogging and an increase in the water reuse benefits.

However, the drainage system construction will lead to an increase in salt load to the River Murray. Therefore it has been established that, in the longer term, RWC drains should be limited in depth to minimise this salt inflow due to groundwater seeping into the drainage system.

The cost of this salt load has been established as the cost of installing and operating interception works along the Murray to negate the increase in salt load at Morgan. Currently this cost is estimated to be $975,000/EC.

Using the programs developed for each of the drainage areas the quantifiable benefits and drawbacks of each of the programs was established with adjustments being made for depth of drain and standards of service to be provided. In addition to the quantifiable benefits there are significant benefits of an environmental and socio-economic nature which will be achieved by installing surface drainage. Surface drainage has been shown to be the catalyst for landholder co-operation in salinity control. SPPAC therefore believes that programs with a ratio of quantifiable benefits to costs of less than unity can be justified on the basis of the conservation and social issues involved.

Using this information six packages were developed as follows to gauge the sensitivity of the program to costs/benefits.

1. Full Watertable Control Package

   This program represents what community expectations for surface drainage have been historically, with all properties in the Region served by RWC drains.

2. Economic Guidelines Package

   The ratio of quantifiable benefits measured in accordance with Government Guidelines is greater than costs in each of the drainage areas. Under this option the environmental, social and "catalyst" benefits have not been considered and community drains have been increased to serve multi-branch drainage lines up to 20km in length to minimise the area with no drainage. In all other packages the length has been limited to 10km to enhance implementation and the long term viability of these drains.

3. Preferred Package

   Four packages were tested to determine the relative costs, benefits and mix of drainage types which would be achieved as capital expenditure increases. From these four options SPPAC chose the preferred package.

   This preferred option was chosen after considering the following:

   - the likelihood of the package being implemented;
   - the compromise between cost and level of service;
   - the means of addressing the problems in the worst affected areas;
   - the relative Internal Rate of Return and Net Present Values to be achieved by the quantifiable benefits in each package; and
   - the environmental, socio-economic and "catalyst" benefits of each package.

   Only three packages namely; the Full Watertable Control Package; the Economic Guidelines Package and the Preferred Package will be further discussed in this document. Details concerning the other three packages can be obtained from the background papers.

   The area of each of the drainage types to be included in each of the programs is shown together with the respective capital and annual cost in Table 17. These costs assume all works are completed in 1989.

Figures 13, 14, and 15 show the location and mix of each of these drainage types across the Region for each of the three packages.

The corresponding details concerning the quantifiable benefits for each of the three packages are shown in Table 18. Once again these benefits assume that all works are carried out in 1989 and that benefits begin to accrue immediately.

6.6.4 Environmental Considerations - Surface Drainage

There are a number of features of an environmental nature (natural and artificial wetlands, woodlands, native vegetation) along the drainage depressions in which drainage systems are proposed which require special attention in developing a drainage program.

There is sometimes a conflict between "farming" interests and "environmental" interests in relation to issues of wetlands and drainage. The quotation marks are used to describe the "farming" and "environmental" interests because the divisions are not clear cut and significant overlap or joint membership of both interests occurs.

For example, some past attempts by the RWC to design drains which either maintained existing wetlands, or sought to create wetlands, have met opposition from affected landowners. This has occurred because the wetlands concerned are usually freshwater meadows and are thus seen to be occupying valuable productive land and/or causing farm management difficulties. Similarly, diverting drains around patches to retain vegetation conflicts with the desires of some landholders to maximise the use of productive land. Resolution of these problems has been hindered by Government not making funds available for purchase of the affected lands and thus ensuring preservation of the wetlands or remnant bush.

Clearly, some compromise must be achieved whereby wetlands and drainage systems can co-exist. This compromise is essential to the best interests of all groups.

The way in which the environmental features of each drainage system are dealt with, by their nature, must be site specific. However, in order to maximise the environmental benefits of surface drainage the following guidelines are provided:-

(a) General Guidelines

(i) Wherever possible, Regional drainage works will be carried out such that environmental values will be maintained at least at current base level and further environmental degradation prevented.

(ii) Wetlands rated as having high conservation value will not be degraded by drainage works unless a compelling public interest has been demonstrated.

(iii) Landowners will be encouraged to include flora and fauna enhancement and protection as a component of farm works associated with drainage schemes.

(iv) Where community drainage schemes affect identified significant wetlands or environmentally sensitive areas, approval to proceed will be conditional upon co-operation of participating landowners and government in preserving and/or enhancing the conservation value of the area.

(v) The environmental values of retarding basins and drainage systems will be enhanced by the conditional co-operation of affected landowners and the government in developing and preserving wetlands, tree plantations and flora and fauna habitat adjacent to new drainage schemes. This may include the provision of regulators to manipulate the level of the water in the wetlands.

TABLE 17: Summary of Surface Drainage Package and Costs

TYPE OF DRAINAGE ACTIVITY	FULL WATERTABLE CONTROL PACKAGE				ECONOMIC GUIDELINES PACKAGE				PREFERRED PACKAGE			
	AREA DRAINED		CAPITAL COST	CAPITALIZED ANNUAL	AREA DRAINED		CAPITAL COST	CAPITALIZED ANNUAL	AREA DRAINED		CAPITAL COST	CAPITALIZED ANNUAL
	HA	%	$M	$M	HA	%	$M	$M	HA	%	$M	$M
Existing RWC Drains	183,100	35	—		183,100	35	—		183,100	35	—	
New RWC Drains	336,900	65	404.3	29.7	17,200	3	24.4	1.8	74,600	14	116.1	7.9
Upgrade RWC Outfalls	—	—	40.0	0.8	—	—	10.8	0.2	—	—	29.1	0.8
New Community Drains	—	—	—	—	216,700	42	43.4	9.3	236,200	46	47.3	10.1
New Water Harvesting												
-with channel discharge	—	—	—	—	—	—	—		13,400	3	10.2	3.2
-without channel discharge	—	—	—	—	—	—	—		12,700	2	8.6	2.8
Existing Drainage Course Declaration	43km	—	—	—	43km	—	—	—	43km	—	—	—
New Drainage Course Declaration	120km	—	4.0	0.3	266km	—	8.8	0.6	297km	—	11.1	0.7
Not Served by Drainage	—	—	—		103,000	20	—		—	—	—	
TOTAL	520,000	100	448.3	30.8	520,000	100	87.4	11.9	520,000	100	222.4	25.5
LOCALITY PLAN NUMBER	FIGURE 11				FIGURE 12				FIGURE 13			

Notes:

(1) The Economic Guidelines package is based on the sum of all quantifiable benefits exceeding the total cost.

(2) The additional annual costs are capitalised at 4% over 50 years.

(3) All costs assume immediate implementation in 1989 dollars.

TABLE 18: Surface Drainage Benefits

TYPE OF BENEFIT	FULL WATERTABLE CONTROL PACKAGE		ECONOMIC GUIDELINES PACKAGE		PREFERRED PACKAGE	
	$M	%	$M	%	$M	%
Salinity and water-logging reduction	55.8	28	35.1	28	46.5	26
Water Reuse	36.0	18	25.0	20	38.5	22
Road Construction and Maintenance	113.6	56	66.6	53	94.5	53
River Murray Salt Load	-3.2	-2	-1.7	-1	-2.5	-1
TOTAL	202.2 (273.0)	100	125.0 (170.9)	100	177.0 (242.3)	100
BENEFIT: COST RATIO OF TOTAL PROGRAM	0.4 (0.5)		1.2 (1.6)		0.7 (0.9)	
NET PRESENT VALUE OF TOTAL PROGRAM	-$193.9M -(151.4M)		$0.8M ($39.3M)		-$56.6M -($17.1M)	

Notes:

(1) Benefis shown are benefits to the State and are based on a gross margin of $2.20/kg of butterfat. This gross margin results from a butterfat price of $3.20/kg. The corresponding reduced salinisation benefit is $2040/ha.

(2) The benefits shown assume that all of the works are carried out in 1989 and that all benefits accrue from that time.

(3) The corresponding figures for the SPPAC adopted economic guidelines of butterfat price gross margin of $4.60 and reduced salinisation benefit of $4875/ha are shown in brackets ( ).

(vi) Where drainage lines cross floodplains the outfall works are to be designed so as to:

- not cause any significant rises in localised stream flood levels;
- control the spread of water in flood plain; and
- not cause erosion where the drain crosses any stream levee or enters the main waterway.

(vii) Measures must be taken to ensure that any seepage from or into the drainage system does not cause any slumping of adjacent banks.

(viii) Drainage flows which contain high concentrations of nutrients, salt or environmentally detrimental chemicals should be isolated from wetlands where the Regional community is satisfied that this is practicable and economically justified.

The cost of the works included as part of the preferred drainage program and which are aimed at preserving or enhancing environmentally sensitive areas is $8M. These works include the construction of erosion free outfalls, bypassing wetlands and providing works to supplement water flow into wetlands where necessary.

(b) Guidelines For Near-pristine Wetlands

Wetlands that are in near-pristine condition, such as those on the Goulburn River floodplain, have more stringent requirements for longterm protection and the following guidelines have been prepared for drainage works in their vicinity.

Outfall systems are to be capable of discharging 1 in 10 year flood flows where wetland protection is required unless it can be shown that the following water quality requirements can be satisfied during more frequent overtopping.

- limitation of the salinity of wetlands inflows to less than 500EC units to maintain both natural clay dispersion properties and existing flora communities;
- limitation of nutrient inputs that cause botanical succession away from the native and indigenous communities. Specific guidelines include N <1.0ppm, PO_4 <0.66ppm, SiO_2 <4.8ppm, pH=7±1;
- prevention of inputs of toxins, particularly herbicides and pesticides that will affect plant growth and fauna activity, particularly critical nutrient-cycling invertebrates;
- maintenance of natural flooding and drying cycles;
- diversion of drainage and diffuse runoff to existing RWC drains;
- isolation of flows in non-leaking channels through the floodplains to suitable submerged outfalls at the main river; and
- ensuring that all diffuse and discrete discharge points from farms along the embankment are directed to suitably controlled outfalls.

6.6.5 Surface Drainage Research, Investigation and Monitoring

(a) Monitoring

The major area of uncertainty is the process by which salt and nutrient loads are generated and changed as undrained catchments become drained.

Similarly, there has been little work carried out to positively ascertain how the runoff hydrographs change as drainage systems are installed into the relatively flat Shepparton Region where irrigation check banks and supply channels result in a significant attenuation of flows.

Therefore, there is an urgent need to install water quality and flow monitoring stations on about 10 major drainage lines (some with and some without cut drains) in order to provide data to verify some of the assumptions made in preparing this Plan and to make decisions concerning:

- the actual effect of drainage outflows on receiving water quality;
- the actual effect of RWC and community drains on catchment outflow hydrograph shape and size;
- the total change in salt load entering the River Murray and floodplain wetlands due to drain base flows, surface washoff water and groundwater pumping.

The estimated cost of these stations is $0.2M with the cost of operation and analysis being $1.2M over 15 years. Total cost is therefore $1.4M. An amount of $0.55M has been allowed in the 5 year work program.

(b) Research and Investigation

As part of the Plan implementation process there will be a need to investigate and develop guidelines for the implementation of permanent and interim works which will be community owned. These investigations include:

- wetland and native vegetation replacement, enhancement and maintenance program guidelines;
- guidelines for water harvesting systems;
- guidelines and planning for any proposals to use the RWC channel system as a means of disposing of drainage water until such time as alternative plans are in place;
- development of refined guidelines and computer models for the design of large scale RWC drainage systems;
- development of guidelines for the design of community surface drains;
- development of microprocessor software to reduce the manpower input to the design of drainage works;
- development of a surveillance, control and data acquisition (SCADA) system for the monitoring and control of channels to which drainage water is to be pumped;
- review and development of a surface drainage rating system to include outside district lands, pumping into channels and cost sharing proposals included in the Plan.

An amount of $0.3M has been allowed for these investigations in the 5 year work program.

(c) Pilot Schemes

There are a number of programs proposed as part of the Plan which have not been fully developed nor extensively used in the past. In order to assist with public acceptance and accelerate the implementation phase it is proposed to set up a number of pilot schemes which will include:

- water harvesting on a community scale;

- water harvesting with channel discharge (community based);

- development of offline wetlands adjacent to drainage systems and in meander loops which have been isolated from drainage systems;

- development of significant tree plantations in depressions adjacent to drains.

(d) Legislative Issues

There is a need for a review of legislative issues relating to both public and community surface drainage to reduce costs and enhance the implementation of the preferred program.

For further information on this section refer to the following Background Papers:

SD1 - *Surface Drainage Strategy - 1989*
SD2 - *A Model for Determining the Quantifiable Economic Benefits of Surface Drainage - 1989*
GW7 - *Groundwater Accession Reduction Benefits - Nov. 1988*
EN1 - *Environmental Considerations - July 1989*

6.7. ENVIRONMENTAL PROTECTION ACTIVITIES

6.7.1 Environmental Protection Objectives

Wetlands, streams and terrestrial environments in this Region are susceptible to damage both by the direct effects of salinity and by some of the works or activities carried out to alleviate the effects of salinity. It is therefore important that the Plan resolves these dilemmas and includes measures to protect specified wetlands and enhance and rehabilitate others.

The following objectives of environmental management have been adopted in accordance with the Victorian Government's policies for managing wetlands, streams and salinity, as expressed in the Wetlands Conservation Program, the State Environment Protection Policy for Waters of Victoria, and Salt Action:Joint Action respectively.

(a) Consistent with the Wetlands Conservation Program, wetlands of high value should not be adversely affected by implementation of salinity mitigation works, and detrimental effects on other wetlands will be minimised.

(b) New evaporation basins and other salinity control works will not be located in any existing wetlands, unless a compelling public interest is demonstrated through the formal approval process.

(c) Where a wetland which will not be degraded in the "do nothing" case is likely to be degraded by the proposed works, the Government may request compensation by the creation or purchase of an equivalent wetland area of equal or greater biological productivity near the site or by a payment-in-lieu for the Government to purchase or restore a similar site. The costs of this compensation should be built into the cost structure of the project.

(d) Detrimental effects on all other wetlands will be minimised.

(e) Degraded wetlands will be rehabilitated to the maximum possible extent.

(f) Flora and fauna in the Region that is rated as being significant, rare or endangered, or listed for protection under the Flora and Fauna Guarantee Act, should be protected from damage by salinisation or from the effects of salinity control works. SPPAC believes the Government should cover the cost of protection.

(g) As far as possible, salinity control and surface drainage works will be carried out in a manner which will maintain or enhance existing environmental values.

(h) Landholders will be encouraged to retain wetlands, trees and other wildlife habitat and to enhance their values as a component of farm works associated with the Regional program.

Furthermore, the following objectives are to be adopted to assist in determining appropriate levels of environmental enhancement and rehabilitation.

(a) The Plan is to address current and future environmental problems resulting from high watertables and salinity associated with the Shepparton Irrigation Region.

(b) On balance, salinity control activities will maintain and where possible enhance existing ecological conditions.

6.7.2. Environmental Protection Activities Included in the Plan

A comprehensive set of measures is required to satisfy the environmental objectives of the Plan. There will be no monetary quantification of the benefits of this program because there is no widely accepted basis for placing monetary values on environmental features. The environmental protection activities are:

(a) Protection of Floodplain Wetlands
These high value wetlands will be protected by ensuring that:

- drain outfalls discharge directly into the Goulburn and Campaspe rivers rather than onto the floodplain where waterlogging of trees and contamination of wetlands can occur ($2.2M included in the Surface Drainage Program).

- drainage from adjacent farmland is collected and either reused or fed to a drain to protect wetlands from nutrient rich inflows which can alter their species composition and their wetting-drying cycles ($0.7M included in Farm Program).

- a water allocation is provided and control works constructed to flush out/shandy wetlands that are threatened by abnormally high salinity levels.

(b) Protection of River Banks from Damage Due to Saline Discharges
Slumping of the banks of the Goulburn and Campaspe rivers due to saline discharges will be controlled by installing wellpoints to lower the watertable along 21km of river frontage at an estimated cost of $100,000/km (subject to results of a proposed pilot trial). Monitoring of the river banks for further saline discharges will be carried out.

(c) Protection of Existing Wetlands along Drainage Courses
In a number of instances it will be possible to protect wetlands from drainage works either by locating the drains along the side of the depressions or by completely bypassing the wetlands. These wetlands would then receive natural flooding when the drains are overtopped and artificial flooding through a flow regulator when the water quality is suitable and flooding is required ($3.8M is included in the Surface Drainage Program for such works).

Wetlands larger than 100ha which are to be protected are:

Mansfield Swamp (110ha)
One Tree Swamp (900ha)
Two Tree Swamp (170ha)
Lake Cooper (190ha)
Lake Stewart (600ha)
Gaynor Swamp (420ha)
Horse Shoe Lake (400ha)
Wallenjoe Swamp (500ha)
Little Wallenjoe Swamp (1000ha)
Un-named swamps at Corop (100 and 500ha)
Wildlife Co-operative Area Kanyapella (100ha)

(d) Creation of New Wetlands along Drainage Courses

A number of loops of the prior stream systems will be maintained as cutoff meander wetlands instead of being drained. These wetlands will be established as compensation for the wetlands that will be lost when the drains are constructed along the major portion of the depression. Land will be purchased, the wetlands revegetated and provision will be made to control inflows to these cutoffs. It is not possible to determine the exact number of sites at which it would be possible to create these wetlands until the drains are designed but it is estimated that around 20 sites are suitable. Establishment costs are estimated at $100,000 per wetland, providing a total cost of $2.0M (included in Drainage Program).

(e) Protection of Isolated Wetlands of High Conservation Value

Around 100 high value wetlands on the plains are threatened by either saline inflows or saline groundwater intrusions or both. A number of techniques can be used singularly or in combinations to protect such wetlands. They include:

- constructing diversion works to prevent inflows when water quality is unsatisfactory (applicable to around 59 high conservation value wetlands);
- flushing out the wetland with high quality water before wetland salinity levels rise above 1000EC units (applicable to around 40 high conservation wetlands);
- installing groundwater pumps to lower the watertable (applicable to around 100 wetlands);
- establishing a fringe of vegetation to lower the watertable (applicable to around 100 wetlands).

Wetlands larger than 100ha to be protected are:

Reedy Swamp (1400ha)
Doctors Swamp (260ha)
Dowdle Swamp (290ha)
Lake Rowan (430ha)

Accurate cost estimates for wetland protection works can only be obtained on a case-by-case basis and this preliminary planning has not been carried out. However, using the RWC estimates of costs for protecting the Corop-Timmering Depression-Kanyapella wetlands as a guide, it is estimated that the cost of protecting the 100 wetlands of high conservation value in the Plains region will be around $10M.

(f) Protection of River Banks from Damage due to Saline Discharges

Slumping of the banks of the Goulburn River due to saline discharges will be

controlled by installing pumps to lower the watertable at these sites along the Goulburn River.

(g) Protection of Streams from Saline Intrusions
Streams will be protected by establishing treed buffer zones of around 50m width each side of the stream to draw down the watertable and prevent saline discharge into the stream. Around 500 km of streams need to be protected at a cost of $10,000 per km, totalling $15.0M.

(h) Tree Growing
Farmers will be supported in establishing shelterbelts or plantations or agroforestry schemes with the aim of revegetating 5% of the Region. Particular emphasis in siting shelterbelts will be placed on channel seepage sites and the surrounds of water harvesting dams. (This activity is included in the Farm Program, Section 6.4.1.)

(i) Investigations
A Wetlands Planning Team comprising an Environmental Engineer and a Wetlands Ecologist will develop specific management plans for high conservation value wetlands in this Region, costing $120,000 p.a. for 3 years.

An investigation will be carried out into the feasibility of an alternative drainage strategy for the prior stream depressions which maintains the integrity of the depressions whilst providing a satisfactory drainage service to landholders in the catchment. The investigation would include developing a strategy for establishing red gum plantations along the depressions. Costs: $100,000 for drainage investigation and $60,000 p.a. for 3 years for agroforestry trials.

A trial will be established to determine the most appropriate method of protecting river banks from degradation due to high level seepage outfalls. Cost: $100,000.

A program of investigations into the effects of proposed drainage of the Murray Valley Irrigation District into Barmah Forest costing $430,000 is being proposed to:

(i) determine whether the drainage flows can be diverted around Barmah Forest ($140,000 included in the Surface Drainage Program);

(ii) monitor the water quality in the existing drains ($10,000 included in the Surface Drainage Program);

(iii) investigate the likely impact of disposal of drainage water into the floodplain and wetland communities of Barmah Forest (Cost: $60,000 p.a. for 3 years);

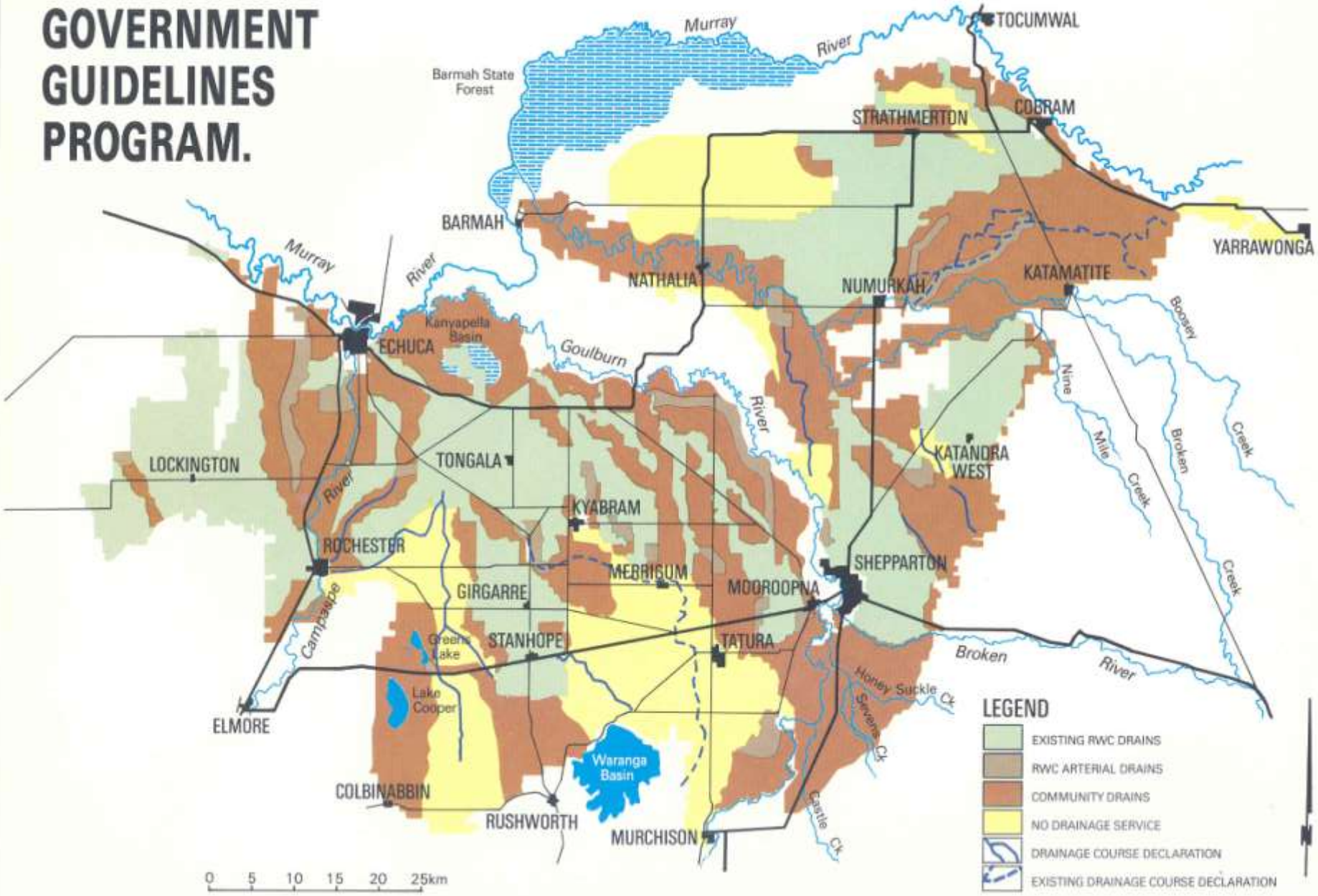
(iv) investigate the likely impact of high watertables under Barmah Forest ($100,000 is included in the Sub-surface Drainage Program).

(j) Emvironmental Monitoring
Environmental monitoring will be carried out to determine whether degradation is occurring due to salinisation or salinity management programs. The environments that require monitoring are:

- representative high value wetlands;
- Goulburn River floodplain forest and wetlands;
- bank stability along major rivers;

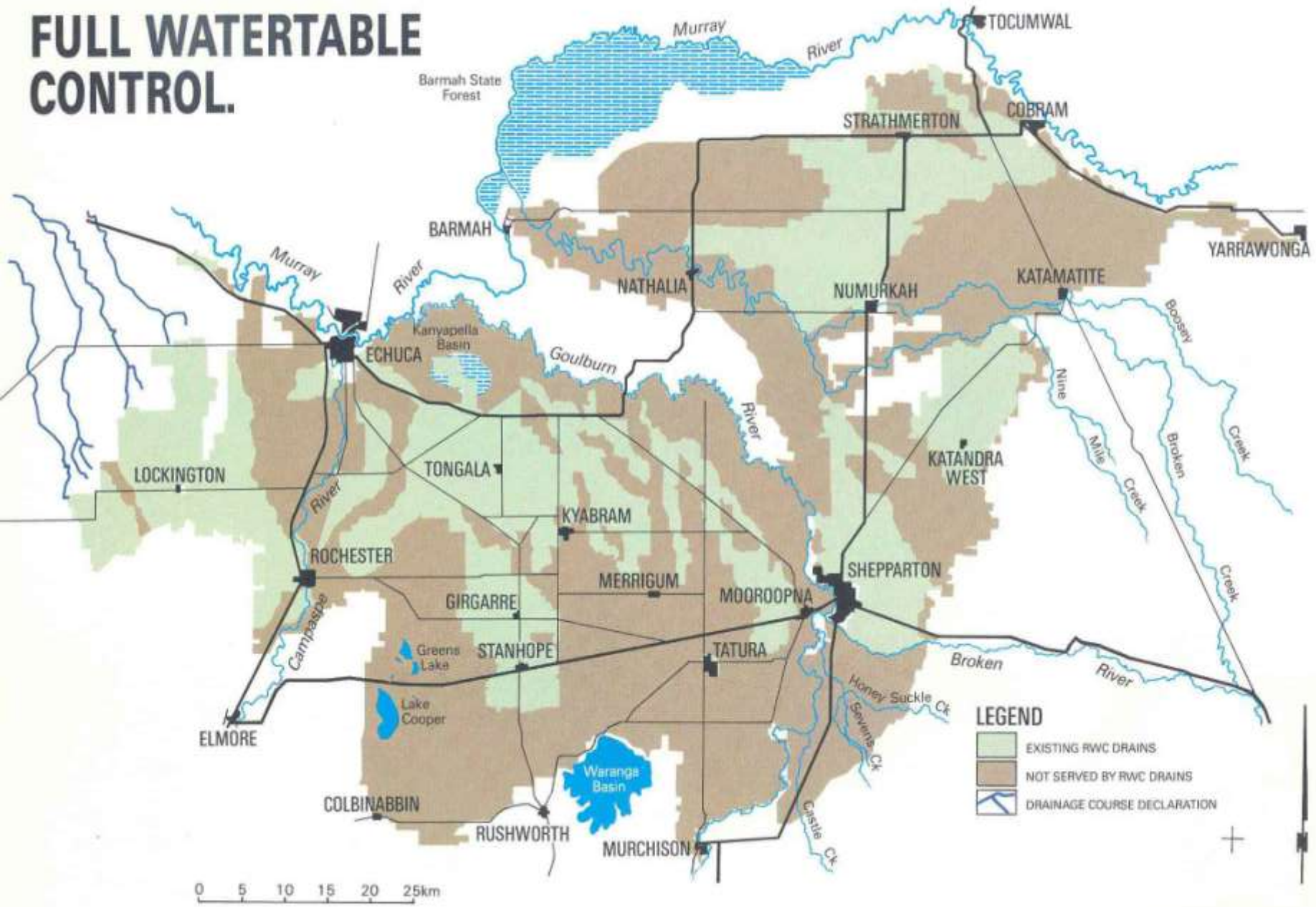
SHEPPARTON REGION SURFACE DRAINAGE STRATEGY

GOVERNMENT GUIDELINES PROGRAM.

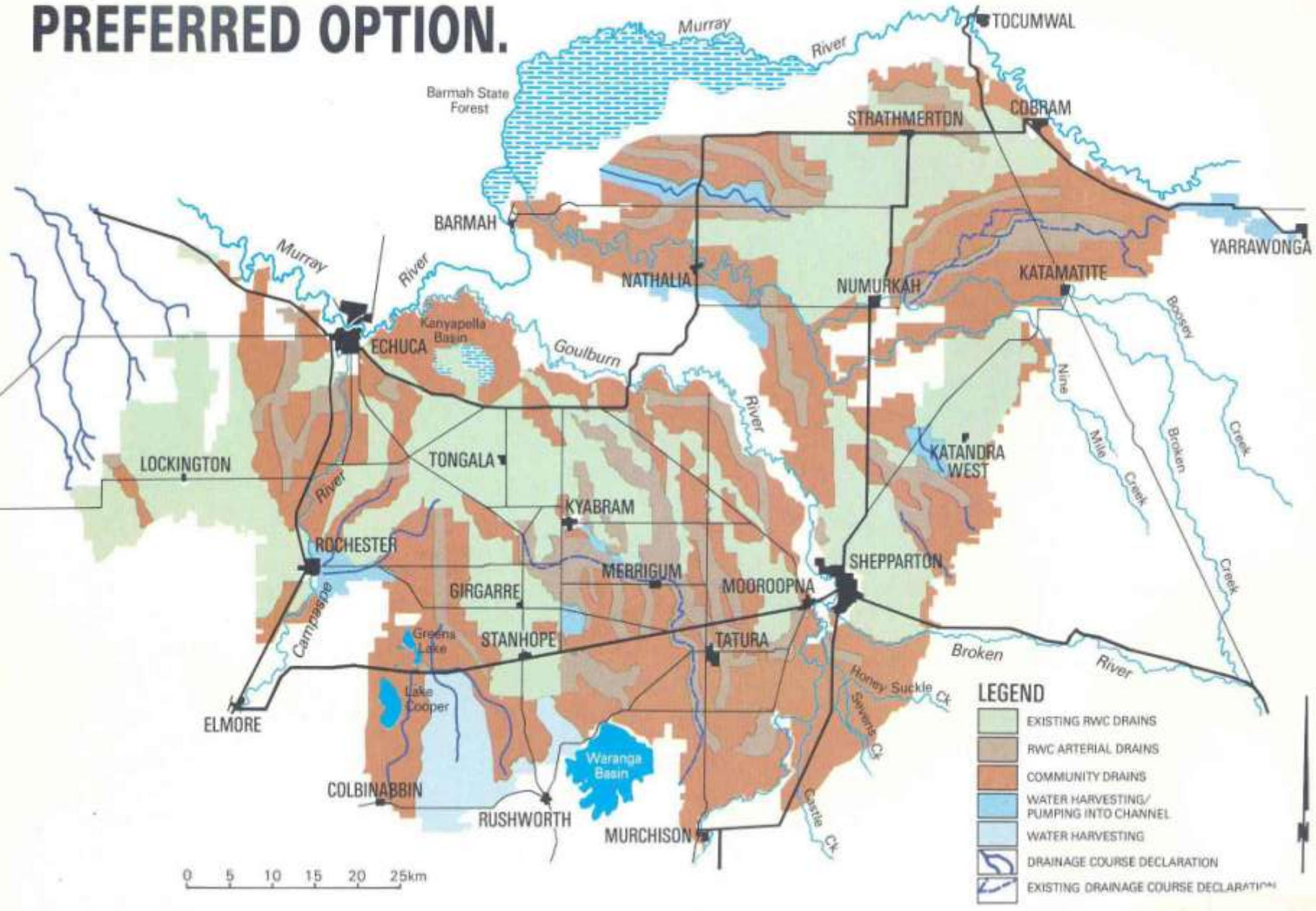


SHEPPARTON REGION SURFACE DRAINAGE STRATEGY

FULL WATERTABLE CONTROL.



SHEPPARTON REGION
SURFACE DRAINAGE STRATEGY
PREFERRED OPTION.



- water quality of minor streams;

- wetlands at high risk of salinisation.

A comprehensive program of monitoring can be carried out by a three person team ($180,000 p.a.) with appropriate funding for groundwater bores, etc. ($40,000 p.a. on average).

6.7.3 Environmental Protection Activities Not Included in the Plan

Reafforestation of Prior Stream Depressions

The proposal is that the prior stream depressions be returned to their natural hydraulic capacity by clearing man-made obstructions and that revegetation of the depressions with red gum, as an agroforestry crop, proceed.

Drainage in the catchment would be improved by a combination of short (up to 3km) and shallow (around 0.8m) community drains and water harvesting systems.

DCFL argue that landholders would benefit from improved drainage, though at a lower level of service to that currently anticipated with RWC/community drainage. Landholders along the depressions would be compensated for the changes in flow levels by having an agroforestry crop on land that would often be unsuitable for high quality pasture production or would be occupied by RWC or community drains.

The advantages of this salinity control technique are considered to be that:

(i) financial benefits accrue to the landholder through agroforestry, supply of firewood and provision of shelter.

(ii) drainage and salinity control is provided in a way that enhances the environment. The combination of reafforestation and water harvesting along these depressions will provide particularly good habitat for wetland-dependent species.

Although SPPAC was unable to support the proposal at this time, due to inadequate information being made available provision has been made in funding estimates for this proposal to be fully investigated before drains are constructed in the prior stream depressions.

6.7.4 Environmental Program Development

The environmental protection activities identified in Section 6.7.2 have been incorporated as activities in the four packages developed for the other sub-programs of farm activities, sub-surface and surface drainage.

These packages investigated are:

1. Farm Activities Only Package

   The only environmental activities included relate to the farm tree growing and drainage reuse projects.

2. Full Watertable Control Package

   All environmental protection and enhancement activities except tree growing on farms, drainage reuse and stream protection are included. These activities are not required due to the extensive sub-surface and surface drainage programs.

3. Government Economic Guidelines Package

As quantifiable benefits are not available for the environmental protection/enhancement works, only the protection activities associated with surface and sub-surface drainage works are included. The farm trees, drainage reuse, river bank protection, stream protection, wetlands enhancement programs have been excluded.

4. PREFERRED PACKAGE

This package includes all environmental protection and enhancement activities.

A summary of the environmental packages appears in Table 19. As mentioned previously, the benefits of these programs are not available at this time, hence only the cost of each package is shown.

TABLE 19: Summary of Environmental Packages ($M - 1989)

ENVIRONMENTAL PROTECTION ACTIVITY	FARM ONLY	FULL WATERTABLE CONTROL	ECONOMIC GUIDELINES	PREFERRED
1. Protection of Floodplain Wetlands	—	9.0	—	9.0
2. Protection of River Banks	—	2.0	—	2.0
3. Protection of High Value Wetlands from Drains	—	3.8 (1)	2 (1)	3.8 (1)
4. Creation of New Wetlands Along Drains	—	2.0 (1)	1 (1)	2.0 (1)
5. Protection of High Value Wetlands from Salinity	—	10	—	10
6. Protection of Streams from Salinity	—	Not required	—	15.0
7. Tree Growing	45.6 (2)	Not required	—	45.6 (2)
8. Investigation and Monitoring	—	8.7	—	8.7
TOTAL	45.6	35.5	3	96.1

Notes:
(1) These activities are included in the Surface Drainage Program.
(2) Treegrowing is included as part of the Farm Activities Program.

For further information on this section refer to the following Background Paper:

ENI - Environmental Considerations - July 1989

6.8 REGIONAL SALT BALANCES

Regional surface flow salt balances have been carried out for six cases:

(i) present situation, based on early 1980's data, to correspond with the Murray Darling Basin Commission's "benchmark" period;

(ii) Year 2020 in the "do nothing" case;

(iii) Year 2020 with implementation of the SPPAC Preferred Plan;

(iv) Year 2020 with Full Watertable Control;

(v) Year 2020 with Economic Guidelines Works;

(iv) Year 2020 with Farm Works Only.

The balances have been carried out for surface flows only, on the assumption that groundwater flow processes do not materially alter the nett storage of salt in the region, i.e. that salt may be redistributed in the system by groundwater recharge and discharge, or by groundwater pumping and reuse, but significant removal of salt will only occur through the surface system.

Surface water salt inputs have been estimated on a number of occasions in the past 20 years. The most rigorous analysis of gross irrigation salt inputs has been carried out by G. Earl (see Goulburn Dryland Salinity Management Plan - PL10). The estimated salt input to the Region (excluding Campaspe Irrigation District) is 90,000 tonnes/yr over the period 1977 to 1988. If, as is proposed, Lake Mokoan water is also introduced to the Region within the planning period the irrigation salt input will increase to 96,000 tonnes/yr. Earl has also estimated that dryland salinity could ultimately increase incoming salt loads to more than double present values (150-200 years). Over the present planning period, however, it is unlikely that an increase of more than 10% would occur. An increase of 10% in total catchment salt loads has therefore been adopted for 2020, but the water diverted to the Shepparton Region would increase by a smaller proportion because much of it is drawn from the forested parts of the catchment. Estimated increase in irrigation input is estimated to be 6200 tonnes/yr, giving a total input over the same period of 102,200 tonnes/yr including Mokoan.

Small salt inputs also occur with rain and fertilisers. The rainfall load is estimated to be approximately 9000 tonnes/yr. It has been assumed that fertiliser input is balanced by salt removed by plants and animals.

Estimates of salt removed with surface drainage are much less accurate than estimates of salt inputs. Only parts of the drainage system are monitored, and it is difficult to get accurate flow ratings in drainage systems. Drainage flows and salt loads are highly variable with time, and significant salt loads are picked up from areas upstream of the irrigation areas.

Salt loads out were estimated to be about 20,000 tonnes/yr in the late 60's and 73,000 tonnes/yr in the late 70's/early 80's. The latter figure included some Phase A salt loads. Although the figures are not precise they probably reflect a real increase in salt loads due to increasing high water tables and salinisation.

J. van Weel's "Regional Salt Balance", (RWC Folio 154, Corr. No. 84/6821) has modelled drain base flow and salt wash-off loads for 1982 and 2020 using the actual high watertable area for 1982 and the projected high watertable area for 2020. After allowing for base flow to rivers and removal of salt by diverters, he estimated that the 1982 salt output would be 39000 tonnes/yr from the high watertable areas. Items not included in his total were additional base flow in the Goulburn between Goulburn Weir and Murchison, runoff from the low watertable areas, and Phase A pump salt loads. His estimate of salt diverted from the river systems was also considered to be high. Adjustment of his figures results in a total Regional output of some 58,000 tonnes/yr for 1982 compared to the earlier estimate of 73,000 tonne/yr for the late 70's/early 80's. The major discrepancy relates to the Murray Valley I.A. for which real data was available for one small drain, which was discharging more salt than was coming in as irrigation water. Extrapolation of this to the whole Irrigation Area resulted in unrealistically high estimates of salt output for this area. On balance it was concluded that Van Weel's basic data

TABLE 20: Summary of Salt Loads for the Preferred Plan (tonnes /yr)

SOURCES OF SALT	PRESENT SCENARIO	"DO NOTHING" SCENARIO 2020	PREFERRED PLAN 2020
SALT INPUT	90,000	90,000	90,000
Rainfall	9,000	9,000	9,000
Lake Mokoan water	—	6,000	6,000
Additional salt from dry land	—	6,600	6,600
TOTAL	99,000	111,600	111,600
SALT OUTPUT			
Existing drained area loads	50,000	50,000	29,350
Additional load due to Lake Mokoan and dryland salting	—	2,500	2,500
Additional surface drainage loads due to increased salting	—	79,600	—
New drained area loads	—	—	21,000
Existing sub-surface drainage loads	10,900	10,900	10,900
New sub-surface drainage loads	—	—	114,500
TOTAL	60,900	143,000	178,250

provided the appropriate basis for comparing the existing and future salt load outputs. However, it must be emphasised that accurate estimates of present day salt discharges do not exist.

The 2020 salt load outputs for the "do nothing" case have been based on Van Weel's models, but adjusted to take account of salt sources not included in the model, (as for 1982). For both 1982 and 2020 the estimated salt load discharge from the Campaspe Irrigation District (western part) has been deleted from Van Weel's totals.

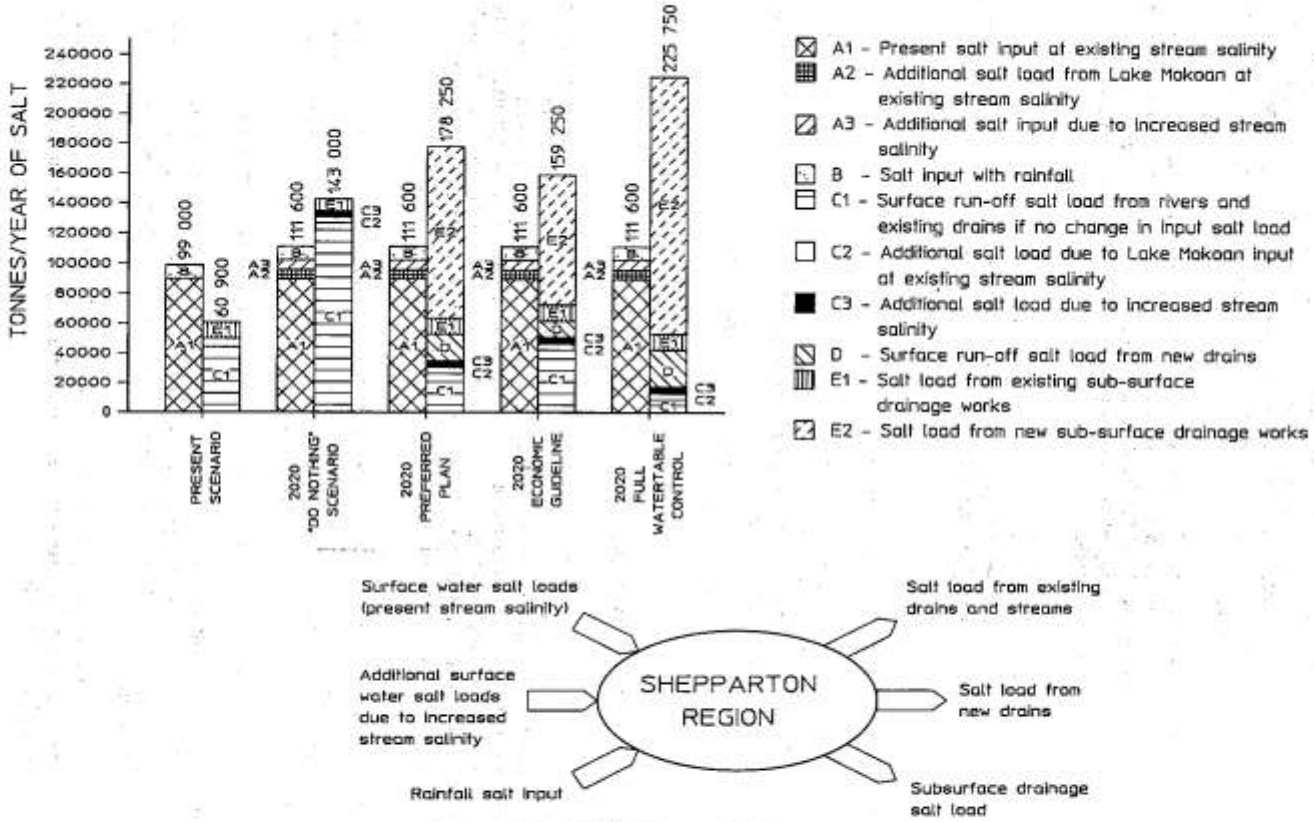
Van Weel's model assumed no change in salinity of input water as a result of dryland processes: output salt loads were adjusted upwards. It was assumed that 20% of the additional salt load would appear almost immediately as surface runoff (based on 10% of the input water running off at twice the input salinity). The remainder of the input salt load would be expected to emerge in the very long term as additional salt discharge from the groundwater system. However this would be well outside the present planning period.

For the preferred plan for 2020 it was necessary to:

(a) reduce Van Weel's salt load estimates for drain base flow and wash off salt loads because of the implementation of surface and sub-surface drainage works;

(b) add in the salt loads produced by new surface drainage works and the sub-surface drainage works.

The estimated values for each component for the Preferred Plan are set out in Table 20. The relative salt loads in and out for the Preferred Plan and all other plans considered are shown on Figure 16.



REGIONAL SALT BALANCE FOR VARIOUS OPTIONS

It should be noted that:

(a) The surface runoff salt loads will be reduced after sub-surface drainage is implemented. Hence the salt credits required for implementation of the sub-surface drainage works should be reduced by the amount by which the 1982 runoff salt loads would be reduced, i.e. about 11,000 tonnes/yr. However, this saving would be impossible to identify with the surface monitoring system.

(b) Salt loads from the "undrained" areas under the "do nothing" scenario have been assumed to have little impact on the Murray compared to equivalent salt loads from "drained" areas, because they would tend to reach the Murray mainly at times of high flow. However, this is an area requiring further research.

(c) The sub-surface drainage salt loads are based on present groundwater salinities. It is likely that, by 2020, some pumps which have external salt disposal at greater than salt balance requirements will be starting to reduce in salinity. However no correction has been made for this.

For further information on this section refer to the following Background Papers:

PL9 - *Stream Salinities and Salt Loads in the Goulburn and Broken River Catchments*
PL10 - *Goulburn Dryland Salinity Management Plan - July 1989*
DS2 - *Salt Disposal to the Murray River in Relation to the SIRLWSMP - January 1989*
DS4 - *Regional Salt Balance - July 1989*
GW4 - *Solute Transport Aspects of Groundwater Pumping - 1989*
SD1 - *Draft Surface Drainage Strategy - 1989*

6.9 MANAGEMENT OF DRAINAGE DIVERTERS

There are some 750 irrigators who reuse water from the drainage system. For some irrigators at the lower end of main drainage systems this is the only source of supply. Other irrigators are able to dilute the drainage water with channel water. All take water under agreements with the Commission, which provide no guarantee of either quantity or quality. Volumes diverted are not measured, but records are maintained of estimated volumes. Authorised diversions total about 81,000ML/yr. It is estimated that total diversions average more than 46,000ML/yr, and that at least 12,000 tonnes/yr of salt is diverted away from the Murray by this means.

The future of the diverters is at risk under both the "do nothing" scenario and the proposed strategy. Both will cause additional salt loads down the drains in season. Increased irrigation efficiency and onfarm reuse may reduce the flows of good quality runoff water. This may be partly offset in some cases by proposed extensions to the drainage system.

Under the Management Plan the following management arrangements will be implemented:

(a) assistance will be given to diverters to help with the expected changes in drain flows and salinities so that, as far as possible, their productivity can be maintained or improved, and present diversions of salt away from the Murray can be maintained;

(b) where the maintenance of the existing level of diversions is not possible at reasonable cost, diverters are to be forewarned of the likely outcome so that they can plan accordingly;

(c) before the plan is implemented due consideration will be given to establishing existing and future levels of diversion.

The appropriate management of drains will need to be determined on a drain by drain basis, taking into account salinity control works to be implemented in each catchment.

Management arrangements will be based on the formation of responsible user groups for all the main drainage systems. These will be similar to groups already existing on some drainage systems, e.g. the Bamawm Drainage Diverters Group. Each group will be responsible for:

(a) providing advice to the sub-regional SPIG about options to ensure that the available resources are used in the most equitable way. This will include the provision of advice about the issue of additional agreements or withdrawal of existing agreements.

(b) providing advice on the level of service to be provided to assist the group.

RWC will assist the management groups by:

(a) upgrading the monitoring of both flow and salinity on all significant drainage systems;

(b) making available historical records of flow and salinity so that the overall value of the resource can be assessed;

(c) providing regular reports in season of groundwater pump inputs, and of flow and salinity at strategic points on each drainage system so that appropriate onfarm management decisions can be made.

Management would also be assisted by provision of flow meters to obtain accurate volumetric records, and by the use of portable salinity meters by each diverter. It is considered that provision of salinity meters should be the responsibility of individual diverters. Their use would be of value to diverters under present conditions. Where the availability of reliable records of water use is clearly of benefit for the implementation of the Plan the costs of metering would be accepted as part of the cost of implementing and managing the Plan.

The cost of the proposed management arrangements for the full Plan is $1.04M in capital costs for metering and $200,000/yr for data analysis, information services and management.

6.10 EVALUATION OF PLAN PACKAGES

In order to develop the SPPAC preferred Plan, the numerous programs outlined in the preceding sections have been combined into four management plan packages. Each plan package manages salinity control in the Shepparton Irrigation Region in different ways.

The four plan packages have then been evaluated by SPPAC against the Plan objectives identified in Section 2. The plan packages combine farm, sub-surface, surface drainage and environmental protection/enhancement activities in different ways, and achieve different levels of protection. All are an improvement on the "do nothing" alternative.

The plan packages evaluated in this section are Farm Activities Only, Full Watertable Control, Economic Guidelines and the SPPAC Preferred.

6.10.1 The Social Impact of Plan Packages

1. The Farm Activities Only Plan

The protection afforded by groundwater pumping and surface drainage is extremely limited in this plan. Surface drainage will not be extended beyond currently drained areas. Much of Rodney Shire including Harston and the Mosquito Basin will remain undrained. Significant areas of the Murray Valley Irrigation Area and the Rochester Irrigation Area will also remain undrained. This will perpetuate one of the inequities of the current drainage rating system because the capital cost of drainage will be spread over the whole G.M.I.D., although the drains only service a minority of farmers. The major beneficiaries (local government) pay nothing.

Groundwater pumping will be limited to those areas where the individual farmer is able to recycle groundwater on his own farm: there must be an aquifer of sufficient yield and water quality. Less than 40% of farms in the Shepparton Region fulfil these criteria. Areas which will be left without groundwater control will include significant parts of Stanhope South, the Mosquito Depression, Gillieston, Undera East, Nanneela, Lemnos and Shepparton East. Within areas where implementation of groundwater pumping is feasible on the individual farm, there will still be significant barriers to implementation. The costs of private groundwater pumping will be borne on a single farm. The benefits will not be limited to the single farm. Attempts to spread the pumping cost and the cost of salt credits equitably across farm beneficiaries will prove extremely difficult. Implementation of private groundwater pumping will be slow and difficult. If the Phase A cost sharing arrangements are continued the majority of farmers will receive no benefit but will subsidise the minority.

Under that plan significant parts of the Shepparton Irrigation Region will be left without the protection of either drainage or groundwater pumping. Only about 20% of the Region will have effective protection against rising watertables. In particular, significant sections of Rodney Shire are left without both surface and sub-surface drainage protection (for example parts of Mosquito Depression, Harston and Gillieston).

For most of the Shepparton Region the scenario of the Farm Activities Only Plan is little different from the "do nothing" option with the subsequent social costs of massive structural adjustment. Farm values will fall in many places, farm sizes will increase markedly, farm management will be forced to become much less innovative, and many of the regional effects described in Section 5.4 will occur.

2. Full Watertable Control Plan

This option offers the highest level of protection to the farm. However, at double the cost, it is likely that any acceptable cost sharing proposal would falter because of the Regional, State and farming community's inability to pay. The likelihood of achieving community agreement before implementation is much less than in the preferred option. Most significantly the downstream community would suffer a much higher impact from the enormous salt disposal requirements of this option.

3. Economic Guidelines Plan

Under the Economic Guidelines, new surface drainage can only be justified where there is nearby access to an appropriate outfall. A greater proportion of the area which is to be drained will be provided with community rather than Rural Water Commission drainage. The major implication of this plan is that all areas at some distance from drainage lines or existing Rural Water Commission drains will not receive protection from surface drainage, despite the likelihood of the owners of these areas being required to contribute to the capital cost of these drains in the future under the current cost accounting policy. This is regarded as extremely unfair by many of the affected farming community. The areas remaining undrained under this proposal will include

much of the Rodney Shire, the Mosquito Basin area and Harston, Corop and Timmering, Stanhope South, Mooroopna North West, land serviced by Murray Valley Drain 11 in the Murray Valley West area. Unfortunately, many of the most active farmer groups attempting to find solutions to salinity problems are in these very areas. Without effective drainage, much of the effort of these groups will be wasted. Their productive energy would turn to aggression toward Government and each other as drainage disputation continues.

Under this option, government groundwater pumps will be used to spread the load of recycling water from aquifers too salty to be harvested and recycled on one farm. This spreads the coverage of groundwater control to those parts of the areas around Harston, Merrigum West, Gillieston and Mooroopna North West which will not have surface drainage. Provision of public pumps eases some of the cost sharing problems associated with salt credits and pumping costs. However, some 80,000 hectares of Management Type C land with poor groundwater yields remains unprotected. The half of this area with lighter soils is considered worth protecting by SPPAC.

The greater reliance on community drainage in other areas will lead to a lower standard of service and possible future problems with drain maintenance.

Although not as drastic in its implications as the Farm Works Only option, this plan still leaves significant areas without the protection of either surface or sub-surface drainage. In particular, much of Rodney Shire, including significant sections of the Mosquito Depression area and parts of Harston, are left without surface or sub-surface drainage. For these areas, the scenario is the same as the no intervention scenario significant structural readjustment in the farm sector with the associated inequity and social stress.

4. SPPAC Preferred Plan

Under this proposal, all members of the farming community are involved in some form of surface drainage protection. Furthermore, all farms where sub-surface drainage is feasible are involved in the sub-surface drainage program through continual groundwater pumping or tile drainage where the soil profile is suitable.

SPPAC sees a number of practical reasons why this package is to be preferred. First, all the community is involved in the plan, making it easier to develop and gain agreement on cost sharing measures which spread the cost across the whole community, both rural and urban. Secondly, many of the most active and involved farm salinity groups are involved in this plan, but are not involved in the Farm Activities Only and Economic Guidelines plans. This ensures the support of all shires.

The degree of protection offered in this option is significant for all but 40,000 hectares of the Region: this will not be protected by either surface and sub-surface drainage. At this stage there are few options for these farmers beyond further research into evaporative disposal and tile drainage. However, opportunities are likely to be available for part, at least, of most properties.

6.10.2 The Environmental Impact of Plan Packages

An evaluation of the environmental impacts of the four salinity control programs undertaken by SPPAC is as follows:

1. Farm Activities Only Plan (activities which can be undertaken onfarm if no further Regional surface or sub-surface drainage is undertaken).

   (a) Advantages
   - increased terrestrial habitat through tree planting;

- protection of Goulburn wetlands from some farm drainage outfall;

- lessening of saline groundwater inflow to wetlands in Low B3 type areas because of private groundwater pumping for onfarm use;

(b) Disadvantages

- further degradation of some Goulburn River wetlands through drainage outfall.

- lack of protection for Barmah Forest from saline groundwater;

- salinisation of Prior Stream depressions;

- rapid salinisation of Corop - Timmering - Kanyapella wetland systems;

- salinisation of all plains wetlands;

- occurrence of stream bank salinisation;

- death of mature trees on the plains;

- degradation of potholes will continue.

2. Full Watertable Control Plan (activities which will result in RWC drainage to entire Region, and high groundwater pumping levels).

(a) Advantages

- Barmah Forest protection from saline groundwater;

- protection of Goulburn River wetlands;

- river bank protection;

- protection of Corop - Kanyapella - Timmering - wetland systems;

- stream protection from saline inflows;

- protection of plains remnant vegetation;

(b) Disadvantages

- stream salinities rising due to high saline outflows from high pump rates;

- increase in downstream salinities;

- modification of significant geomorphological features in the Muckatah, Mosquito, Murchison, Stanhope and Timmering depressions (but to environmental guidelines);

- modification to 30 high value wetlands along these depressions (subject to guidelines);

- downstream salinities increase significantly.

3. Economic Guidelines Plan (activities which can be demonstrated to provide an economic rate of return of at least 4%, in accordance with Government guidelines).

(a) Advantages

- Barmah Forest protection from drainage outfalls;

- protection of high value wetlands in plains.

(b) Disadvantages

- degradation of Goulburn River wetlands from farm drainage outfall;
- modification of significant geomorphological features in the Muckatah and Murchison depressions (subject to environmental guidelines);
- modification of 16 high value wetlands along these depressions (subject to guidelines);
- river banks are unprotected from saline intrusion;
- downstream salinity increases.

6.10.3 The Economic Impact of Plan Packages

The economic evaluation of the Plan packages is presented in Table 21 based on the SEWG Economic Guidelines. The analysis indicates each plan package produces a positive Net Present Value. The Benefit/Cost Ratios are 1.4, 1.1, 1.6 and 1.4 respectively for the Farm Activities Only, Full Watertable Control, Economic Guidelines and Preferred plans, based on the costs and benefits of those activities which have economically quantifiable benefits.

SPPAC believes there are limitations with the economic approach to project evaluation given the difficulty in quantifying the social and environmental benefits in economic terms.

A benefit as defined in J.P. Guttinger's "Economic Analysis of Agricultural Projects" (Johns Hopkins University Press, Baltimore) is anything which contributes to society's objectives and a cost is anything which detracts from society's objectives. A benefit (or cost) thus depends on social objectives - as does the fact of whether someone is a beneficiary of not.

The longterm objective of the Victorian Government's salinity strategy has been stated in "Salt Action: Joint Action":

> *"The principal longterm goal ...is to manage the salinity of land and water resources throughout Victoria, in order to maintain and, where feasible, to improve the social wellbeing of communities, and the environmental quality and productivity capacity of the regions" (Government of Victoria 1988, p.1).*

Thus in the case of Victorian salinity control, a benefit is anything that adds to the objectives stated by the Government of Victoria (1988). Similarly a beneficiary is anyone in receipt of such a benefit. This paves the way for a very broad group of beneficiaries and suggests that any cost-benefit study will need to adopt a multi-objective analysis.

The above analyses do not use such broad definitions of benefits but rather use a narrow definition based principally upon the net value of the increased agricultural production. The SEWG Economic Guidelines do not provide an explanation of the apparent lack of correlation between the objectives of the program (and hence the definition of benefits and beneficiaries) and the required method of measuring the benefits.

Finally, as outlined in Section 5.4.3. above, economic analysis does not admit the social costs associated with the "no intervention" situation to an evaluation because it makes the assumption that in the long run, resources are mobile and that they can be redeployed at zero adjustment cost. Therefore, before these costs can be admitted, as theory goes, it must first be demonstrated that similar effects would not occur with any other investment. As this is virtually impossible to achieve, these linked regional effects are ignored or dismissed. There do appear to be objections to current economic theory on two further sets of grounds namely:

TABLE 21: Economic Evaluation of Plan Packages

PROGRAM	PLAN HORIZON YEARS	TOTAL COST $M	TOTAL BENEFIT $M	N.P.V.'s $M	ANNUAL SALT BALANCE YEAR 2020		NEW DRAINAGE WORKS SALT LOAD	NEW DRAINAGE WORKS SALT DISPOSAL
					IMPORTS TONNES	EXPORTS TONNES	TONNES	QUOTAS (EC)
1. FARM ONLY								
Farm Program	30	115.1	99.8	-15.3				
Sub-surface Drainage	30	85	253	168				
TOTAL	30	200.1	352.8	152.7	111600	144000	61000	8.9
2. FULL WATERTABLE CONTROL								
Farm Program		N.A.						
Surface Drainage	20	315.2	121.3	-193.9	-		28000	3.6
Sub-surface Drainage	30	148	480	332			172500	25.4
TOTAL	30	463.2	601.3	138.1	111600	225750	200500	29.0
3. ECONOMIC GUIDELINES								
Farm Program	30	102.7	115	12.3				
Surface Drainage	20	66.8	77.6	+10.8	—	14,000	14000	1.8
Sub-surface Drainage	30	1047	385	281			86500	12.6
TOTAL	30	272.5	577.6	304.1	111600	159250	100500	14.4
4. PREFERRED								
Farm Program	30	137.8	141.7	3.9				
Surface Drainage	20	163.7	107.1	-56.6	-	21,000	21000	2.7
Sub-surface Drainage	30	137	455	318			114500	16.7
TOTAL	30	438.5	703.8	265.3	111600	178250	135500	19.4

Notes:

(1) All costs and quantifiable benefits are discounted at 4% over 50 years. These benefits do not include the significant unquantifiable social and environmental benefits to be gained by each program. NPV's are calculated on the streamed values of capital input, annual benefits and benefits resulting from implementation over 30 years.

(2) The Environmental component of each package has not been evaluated due to the lack of quantifiable benefits. This includes the Farm Trees Program.

(i) the resources involved (water, channels, drains, dairy factories, schools, hospitals etc.), are not fully mobile and cannot be redeployed at zero cost even in the very long run; and

(ii) whilst the economic theory seems to deal reasonably well with investments designed to produce new activity and new output it does not seem to deal equally well with investments designed to preserve what is already there - both physically and socially.

Thus, the investment to support existing operations in the Shepparton Region may well be a far more effective use of both public and private capital than writing off the many existing investments and moving elsewhere. Another way of phrasing this is that the opportunity cost of the existing investments is likely to be low, whence it is likely to be more favourable to retain them rather than to create new "replacement" investment.

For all the above reasons, there must be reservations about the economic analysis presented herein.

The economic analysis of the Preferred Plan is presented in Table 22. The table presents two sets of results namely:

(i) in accordance with the various Government Economic Guidelines issued during the second half of 1988 and 1989; and

(ii) an alternative set of figures based upon the fact that SPPAC, their advisors and the independent reviewers of that advice differ with the Government Economic Guidelines on the issue of butterfat price ($4.60/kg is used in these estimates) and on the treatment of the changes which will occur without the proposed project.

In view of these groups the alternative analysis more closely represents a correct economic analysis of the Plan.

For further information on this section refer to the following Background Papers:

PL1 - *Guidelines and Criteria for Evaluation of Proposals - October 1987*
EN1 - *Environmental Considerations by DCFL - 1989*
SE5 - *Regional Economics - August 1988*
SE4 - *Costs and Benefits of the Plan - July 1989*

6.11. CRITERIA USED IN SELECTING THE PREFERRED PLAN

In selecting a preferred Plan SPPAC have explicitly taken into account all of the following factors.

(a) The Plan must be implementable.

The Plan must recognise that effective salinity control cannot be achieved by the community alone and nor can it be achieved by direct Government intervention alone. *Salt action is joint action.*

Therefore, an implementable Plan:

- must recognise that the community can, and will, carry out salinity mitigation works;

TABLE 22: Summary of Preferred Plan Costs and Quantifiable Economic Benefits

PROGRAM	AREA SERVED (ha)	CAPITAL COSTS (1) ($M)	BENEFITS (2) CAPITALISED O & M (2) ($M)	CAPITALISED		B/C RATIO (5)		N.P.V. (6)		SALT DISPOSAL QUOTA (EC)(7)
				GOVT. (3) ($M)	SPPAC (4) ($M)	SEWG	SPPAC	GOVT. ($M)	SPPAC ($M)	
Farm Activities (8)	66150 to 106038	201.9	92	250.3	265.4	1.03	1.09	3.9	17	
Regional Surface Drainage	336900	222.4	23.9	177	237	0.7	0.9	-56.6	-20.3	2.7
Sub-surface Drainage (onfarm and Public Works)	213000	(9)82.6	(9)115.3	552.7	1305.9	2.6	6.0	318	938	16.7
MDBC Costs		10.2	8.75							
SUB TOTAL		517.1	239.95	980	1808.3	1.4	2.4	265.3	734.7	19.4
Environmental		27.1								
Channel Seepage Control		6								
Extension and Support Activities		20.4								
Research Investigations and Monitoring		74.7								
TOTAL		646.1								

(1) Total capital cost at 1988/89 values.
(2) Capitalised value (4% over 50 years) of annual benefits for completed project.
(3) Benefits calculated on Govt. Guidelines.
(4) Benefits calculated using Dwyer Leslie "as estimated" parameter values.
(5) Based on capitalised total costs and benefits.
(6) Based on Present Value of all costs and benefits.
(7) Predicted increased Murray Salinity at Morgan.
(8) Irrigation management activities, including the costs of whole farm plans and the farm tree program.
(9) Includes cost of groundwater pumping incentives.

- must include a package of works and measures which are able to be understood by landholders and implemented by them;

- must propose farm works and measures which have the potential to increase farm productivity and will therefore have a high likelihood of being adopted;

- must not depend entirely upon intervention or Government "works";

- must not depend entirely upon the community to undertake all work;

- must provide for the community to be directly involved in a real and meaningful way in implementing, monitoring, setting priorities and decision making;

- must be affordable to the community as a whole.

It immediately follows that two of the plan packages do not meet the above criteria. Thus the Full Watertable Control Plan and the Farm Activities Only Plan fail to meet the implementability criteria. They also fail to meet affordability, environmental and technical effectiveness criteria.

(b) The Plan must be equitable.

A number of inequities currently exist in the Region. These have been discussed in this document. The potential for further or greater inequities exists within most of the plan packages.

An equitable Plan:

- must provide the opportunity for all landholders within the Region to participate and to address their current and future salinity problems;

- must provide a cost sharing mechanism which fairly represents the benefits received by the various groups within the community;

- must not discriminate against particular groups within the community; and

- must be seen as fair and not discriminatory.

The Economic Guidelines Plan is discriminatory and does not allow all landholders to participate.

(c) The Plan must be responsible.

The environmental dilemma, which is well illustrated in the preceding section of the Plan, is that for most of the Region there is no return to pristine conditions. Equally, in many cases, failure to act to control salinity will be more environmentally adverse than the proposed actions.

Similarly, there have been past problems of responsibility in relation to a range of other salinity related issues.

Therefore, a responsible Plan:

- will provide environmental protection where past schemes have been implemented with little regard to environmental values;

- will provide the community with responsibility for setting priorities for action and responsibility for dealing with the consequences thereof;

- will not retain all power in the Government's hands;

- will propose financially responsible cost sharing arrangements; and

- will propose reviews of current policies which are not assisting salinity control.

(d) The Plan must recognise its social environment.

The Plan provides works programs which address community perceptions of the salinity problem in the Region. It addresses the majority of areas where community action and expectations have been historically aggressive toward Government Agencies on account of perceived lack of action.

The Plan requires and depends on community participation. It states this explicitly and is therefore not being forced on individuals unless there is a compelling reason for doing so.

(e) The Plan must improve its physical environment.

Thus, an environmentally responsible Plan:

- must deal with the major environmental value areas in the Region;

- must recognise the horrific state of the environmental values of the Region under a "Do Nothing" situation;

- must provide environmental protection measures and major investigations to establish management programs;

- must propose assistance and incentive for landholders to recognise and improve farm environment;

- must propose local government planning schemes to limit degradation to native woodlots and trees in the Region, also lasergrading permits to ensure effective drainage of agricultural land does not contravene the Water Act.

The Economic Guidelines Plan does not provide for environmental protection and is therefore environmentally irresponsible.

(f) The Plan must incorporate certain wider objectives.

Thus, the Plan:

- must recognise the Victorian Government's Social Justice Strategy and the need for equal access to Government financial resources;

- must assist the Rural Employment Victoria (REV) strategy and the need to expand opportunities for decentralisation; and,

- must provide works programs to progress toward environmentally responsible sustainable irrigated agriculture.

In identifying and recommending the preferred Plan to the Regional community and the Victorian Government, SPPAC is confident the criteria for selection have been met. The preferred Plan is a complex mix of activities which satisfy the social, environmental and

economic objectives adopted by SPPAC in formulating a management plan for the Shepparton Irrigation Region.

6.12 EFFECT OF THE PLAN ON THE RIVER MURRAY

In developing its preferred Plan SPPAC has been very aware of the need to minimise salt discharge from the Region, and to conform to the Murray Darling Basin Commission's Salinity and Drainage Strategy. To minimise salt discharge SPPAC has:

(a) opted for less than complete watertable control in almost half of the area to be sub-surface drained;

(b) accepted a significant cost penalty for construction and maintenance of surface drains due to the adoption of shallow drain depths to minimise groundwater base flows into the drains;

(c) required intensive onfarm reuse of groundwater wherever this is reasonably feasible; and

(d) opted for the use of evaporative disposal of highly saline water.

Nevertheless the total salt disposal quota required for the Plan when fully implemented is estimated to be equivalent to 19.4 EC units in the Murray at Morgan. Expected salinity increments at other key points along the Murray are set out below:

Torrumbarry	45.5 EC units
Swan Hill	41.1
Euston	26.3
Red Cliffs	26.4
Merbein	26.5
Lock 9	19.4
Renmark	19.7
Berri	19.6

The salt quota required is greater than the total available to Victoria under the MDBC Strategy, which is 15 EC units (exclusive of any credits to be gained by Victoria from the Barr Creek Management Plan). Given that the Shepparton Plan is a longterm strategy with a 30 year planning horizon, SPPAC believes that there are number of options available to meet the apparent shortfall. These include:

- additional salt interception works
- use of dilution flows
- purchase of credits from N.S.W.
- off-setting payments to S.A.
- the pipeline to the sea option, which is currently being re-evaluated by the MDBC.

In relation to dilution flows SPPAC is very conscious of the recent proposal for a Murray-Goulburn Canal which would make some 200,000ML/yr of water available to Victoria for irrigation purposes. SPPAC believes that this water should not be committed for irrigation without:

- a commitment to surface and sub-surface drainage in the irrigated area;
- due consideration of the opportunity for use as dilution flows in both the short and longterm; and,

- evaluation of its effects on community interest in groundwater pumping and reuse.

Moreover, SPPAC expects that some improvement in groundwater quality will occur in the sub-surface drained areas over the implementation period, leading to a reduction in outfalled salt loads below those currently predicted. SPPAC is also giving high priority to development of commercially attractive salt tolerant species which will provide greater opportunity for local reuse. Finally, SPPAC considers that use of more local evaporation basins than presently planned, although less cost effective than external disposal for water of moderate salinity, can be used to make up any shortfall in disposal quota in the longer term.

In summary, SPPAC considers that there are a range of options available to obtain additional salt quotas for disposal to the Murray, and also to reduce salt loads from the Region over the implementation period. The plan should proceed in the short term on the basis of the salt disposal quota currently identified, but high priority must continue to be given to the evaluation of all options for obtaining additional disposal quotas. At the same time SPPAC emphasises again its commitment to maximising the safe reuse of groundwater within the Region.

SPPAC is also aware that high nutrient loads from both surface and sub-surface drainage works could exacerbate existing water quality problems in the Murray. High priority has been given to monitoring, research and investigations programs to identify the sources of nutrients in both surface and groundwater, and to monitor the transport of the nutrients within the Regional channel and drain system.

For further information in this section refer to the following Background Paper:

DS2 - Salt Disposal to the Murray River in Relation to the SIRLWSMP - January 1989

7. IMPLEMENTING THE PLAN

7.1 MANAGEMENT ARRANGEMENTS

7.1.1 General Principles

Implementation of the Plan assumes no basic changes to existing State level budgeting processes, co-ordinative functions or finance flows.

In accordance with the objectives of the Government's Social Justice Strategy, which aims to expand opportunities for genuine community participation in decision making, the following Regional and local level arrangements are recommended.

The implementation of a Plan of the scale of the SIRLWSMP is necessarily something which will need constant review. For ease of implementation, SPPAC have divided the numerous activities which need to be undertaken concurrently into two broad categories.

These categories relate to:

(a) activities which can be undertaken at any time by individuals, groups, organisations throughout the region - for convenience these are referred to as Continuing Activities; and

(b) those which can only be undertaken after considerable investigation, design and consultation with the involved community - for convenience these are referred to as Priority Project Area Activities.

In general, the Continuing Activities relate to farm activities which act to reduce watertable accessions or reclaim/protect individual farm properties from high watertables and salinisation.

The Priority Project Area programs typically relate to activities which require the joint management of activities between Government and the community (e.g. salt disposal scheme such as Phase A, Girgarre Project etc). These works are to be implemented on a priority basis across the region. The establishment of priorities is discussed in Section 7.1.3 under Salinity Program Implementation Groups (SPIG's). Initial priorities have been identified by the SPPAC's Irrigation Sub-committee for both the surface drainage and sub-surface drainage programs (these appear as works to be undertaken in the initial five year work program -See Section 7.3.1).

(a) Continuing Activities

The activities which are to be undertaken as Continuing activities particularly relate to works which can be undertaken by landholders or groups of landholders. A complete list of activities follows with a discussion of the management and cost sharing arrangements which SPPAC recommends. The farm based programs of whole farm planning, improved water management, farm drainage, private groundwater pump installation, tile drainage installation, groundwater use incentives, tree planting, drainage reuse and community drainage should be implemented as soon as possible. The majority of these activities do not rely on the installation of Regional surface or sub-surface drainage in the short term and can reduce accessions and improve water use efficiency in the interim.

An extension and incentives program is identified in the Plan to assist landholders undertaking beneficial works. The activities, the extension agency, level of assistance and thirty year implementation target are identified in Table 23. The whole farm planning approach to farm works aims to achieve the environmental guidelines identified in Section 6.4.3.

TABLE 23: Farm Based Activities, Implementation Targets, Responsible Agencies and Level of Assistance

ACTIVITY	YEAR 2020 TARGET	EXTENSION AGENCY	LEVEL OF ASSISTANCE PROPOSED
Landforming/ lasergrading and farm drainage	75% perennial 50% annual pasture	DARA	10% capital (1)
Whole Farm Planning	All properties	DARA	50% whole farm plant cost
Drainage Reuse	50% properties current undrained	DARA/RWC	30% capital
Private Groundwater Pumps	250 pumps	RWC/DARA	20% capital 100% out of season disposal S.E.C. Initiative
Tile Drainage Evap. Basins	2800ha protected		20% capital
G/W Pump Use Incentives	20,000ML/yr to year 2000, then 10,000ML to year 2010	RWC	$5 per megalitre used on farm in season
Community Drainage	236,000 ha	RWC/DARA	90% cost of design 50% cost of construction
Treeplanting	5% irrigated area (14,000ha)	DCFL	30% treeplanting cost

Notes:

(1) In calculating the cost sharing approach for farm drainage and lasergrading, a cost split of 90% Landholder and 10% State Government has been used. Although this cost share has been developed on the expected reduction in accessions resulting from the installation of these activities, SPPAC believes farm drainage ought to attract a 30% subsidy to ensure landholders increase the level of adoption above the current rate. Figures in this table assume a subsidy of 10% only. The exclusion of the higher rate of 30% subsidy was an oversight and discovered too late to allow a recalculation of figures to occur.

In each case, the level of assistance has been arrived at after considering the level of off-farm (wider community) benefit resulting from the activity, and the current rate of adoption by landholders. (Further discussion in Section 7.2.2.)

(b) Priority Project Area Activities

Where there is a likelihood of capital works programs requiring salt disposal from the Region, a process of priority project area identification and management is proposed by SPPAC. Wherever salt disposal takes place, the Regional community must be assured that the Region's salt disposal entitlement is being utilised in the most appropriate manner.

Where capital works must be undertaken on RWC drainage outfalls works to facilitate the extension of drainage schemes into the currently undrained areas, the Regional community must also be satisfied that these works are being undertaken on an appropriate priority basis.

The proposed activities which are to be implemented under the priority project approach therefore relate particularly to the Regional surface and sub-surface

drainage activities. These activities are to be implemented after consideration of the environmental protection guidelines developed in Section 6.5.7. and 6.6.4. and the environmental enhancement programs identified in Section 6.7.2.

The initial Priority Project Areas identified by the SPPAC Irrigation Sub-committee are identified in the five year work program Section 7.3.1. These priorities have been adopted after taking many factors into account including community interest, severity of current salinity situation, irrigation intensity, economic benefit of the works, environmental effects etc.

The types of activities, implementation targets, administrative agency and level of assistance for landholders carrying out required works are listed in Table 24. It is important to note that many of the cost shares change when works are implemented under a priority project approach. There are several reasons for this;

(i) There is generally a reliance on individual landholders undertaking works to complement other works in the Priority Project Area.

(ii) There is usually a reason why landholders have not already installed their own farm salinity control activities (financial, size, enterprise, social reasons).

TABLE 24: Priority Project Area Activities, Implementation Targets, Administrative Agencies and Level of Assistance

ACTIVITY	YEAR 2020 TARGET	ADMINISTRATIVE AGENCY	LEVEL OF ASSISTANCE PROPOSED
RWC Drain Remodelling		RWC	100% capital
Water Harvesting	26,100ha	RWC	90% toward storage construction
Drainage Course Declaration	297km	RWC	50% toward obstruction removal
New RWC Drains	74,600ha		100% capital
Public G/W Pumps	426	RWC	100% capital
Private G/W Pumps	215	RWC	80% capital
Tile Drainage	11200ha	RWC	80% capital
Evap. Basin	50	RWC	80% capital

It is physically not possible to deal with the entire Region in the short term under the Priority Project Area status. SPPAC have therefore argued for assistance to individuals who are outside P.P.A's but who must act now to protect themselves. The Continuing Activities allow individuals to take the initiative to protect their properties or halt their decline until their locality is deemed a Priority Project Area. This is the rationale for two similar land protection programs with differing levels of financial support.

7.1.2 Salinity Program Advisory Council

A Salinity Program Advisory Council (SPAC) is proposed which will take over the Regional co-ordination function developed by SPPAC. The SPAC is to be established in late 1989 upon completion of the Pilot Program.

Membership is to be drawn from the Goulburn-Broken Region through nomination, and will represent the interests of both the irrigated and dryland portions of the Region, as SPPAC currently does.

The SPAC is to have up to 15 members and is to be supported by:

- an executive officer based initially in DARA with Secretarial/Administrative support;
- a representative nominated from the Regional Departmental Agencies, namely, DARA, RWC and DCFL, plus a representative from the State Salinity Bureau;
- a remuneration package based on a sitting fee.

The SPAC is likely to meet less frequently than the present Advisory Council but at least quarterly and will report directly to the Rural Affairs Conservation and Environment Committee of Cabinet through the SPAC Chairperson.

The new advisory council will be required to:

(i) oversee operations of Salinity Program Implementation Groups (see Section 7.1.3);

(ii) co-ordinate salinity control activities in both the Irrigation and Dryland sub-regions of the Goulburn-Broken Region;

(iii) within State guidelines, establish overall direction for implementation including changes in direction or policy as required;

(iv) co-ordinate proposals for funding of investigations, designs and implementation of works;

(v) prepare annual budget submissions on behalf of the Regional community for salinity control works within the Region;

(vi) resolve conflicts over priorities for funding at the Regional level;

(vii) resolve, or refer to State level, problems or issues associated with the implementation of policy;

(viii) monitor projects and programs to record effectiveness against the objectives of the management plan from a community perspective.

(ix) contribute to modification of State guidelines when appropriate.

7.1.3 Salinity Program Implementation Groups

At the local level, Irrigation Area boundaries are considered by SPPAC to be the most appropriate unit on which to base implementation of the Plan. Each Irrigation Area will establish a Salinity Program Implementation Group which has the following responsibilities:

(i) within the State guidelines to review, endorse or reject all requests for assistance on works in relation to sub-surface drainage, surface drainage, water harvesting, salt disposal etc within the Irrigation Area;

(ii) to resolve conflicts over priorities for works within the Irrigation Area;

(iii) to make decisions on the location of facilities, especially where farm land is involved - for example, water harvesting storages, evaporation basins, use of community drains for salt outfall etc;

(iv) to exercise authority over all Plan projects within their Irrigation Area. The mechanism for this authority is simply the administrative requirement that Departments responsible for disbursing funds may not do so without the express and formal approval of the relevant SPIG.

Each Salinity Program Implementation Group will be comprised of the following membership:

- three elected members of the RWC Water User Group for the particular Irrigation Area;
- three representatives of the local government municipalities involved in the Irrigation Area (there may be more than one municipality involved).
- a nominated representative of the RWC, DARA, and DCFL.

The SPIGS are to be administratively supported by a DARA Implementation Officer. Members are to receive a remuneration package as a sitting fee.

The management framework and reporting mechanism for the Regionally based Salinity Program is illustrated in Figure 17.

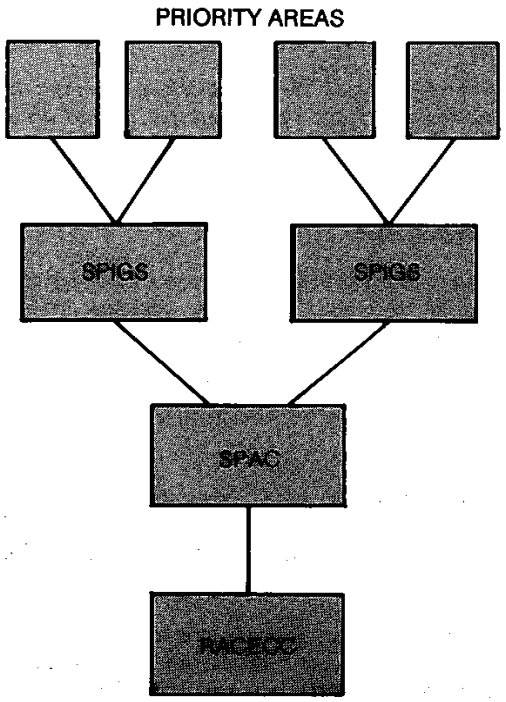


FIGURE 17 — Salinity Program Management Framework

The Shepparton Irrigation Region comprises five irrigation areas and one Irrigation District. Detailed planning for catchment specific salinity control activities has already commenced in the Campaspe West area and is the subject of the Campaspe West Salinity Management Plan.

The size of the Shepparton Irrigation Region means detailed planning and implementation of the catchment specific salinity activities cannot occur over the entire Region immediately. SPPAC have therefore identified a number of criteria under which a priority Irrigation Area has been selected for detailed work. The criteria used were:

- the current extent of salinity problems;
- agricultural intensity;
- range of management type areas represented;
- the availability of required technical data;
- the environmental implications; and
- current activity/interest by the community in salinity control.

After due consideration of these criteria, SPPAC has recommended both Rodney and Tongala Irrigation Areas establish Salinity Program Implementation Groups to commence detailed planning in 1989/90. The resources required to allow commencement have been identified in the five year program. There are good reasons why these two SPIG's ought to be combined, given their proximity and the interlinkage between the channel and drainage systems of the Irrigation Areas.

SPPAC would expect other SPIG's to be established during the first three years of the implementation process and resources are identified for this to occur.

7.1.4 Roles and Responsibilities

The Land and Water Salinity Management Plan presented by SPPAC has been designed to respond to community interest and activity. Key decision making will be by people living within the Region. Works are to be implemented where there is a majority decision to proceed by the affected community. Where it is clear that individuals or groups are not prepared to undertake works which are consistent with the Plan and result in wider community benefit, the SPIG will have authority to refer the issue to SPAC for a decision to proceed.

The decision making process involves local, area and Regional communities. SPIG's may receive submissions or deputations from landholder groups, individuals, municipalities or DCFL on behalf of conservation interests, and apply to SPAC for endorsement and funding (Section 7.2).

To have an effective community driven salinity control program in the Shepparton Irrigation Region, SPPAC encourages the more active involvement of local government in the financing, administration and organisation of salinity control activities within each locality.

The Rodney Shire commissioned "Role of Local Government in Salinity Control" study has identified and recommended a number of activities to the Region's municipalities in tackling salinity control. SPPAC endorses this study, and has recommended in this Plan the following roles and responsibilities for salinity control between the landholder, the Regional community (via local government) and the State and Federal Governments.

The Roles and Responsibilities recommended by SPPAC are listed in Table 25. In preparing this summary SPPAC recognises that each group benefits from reversing the current high watertable and salinity situations, and therefore must be prepared to act now.

7.1.5 Groundwater Management

The Plan relies very heavily on sub-surface drainage by both private and public groundwater pumping with local reuse of groundwater. Activities to encourage private pumping and reuse are a major cost within the Plan. SPPAC has therefore welcomed the recent announcement by the Minister for Water Resources that groundwater charges to individual irrigators within

TABLE 25: Roles and Responsibilities for Salinity Control Implementation

ACTIVITY	FUNDING	INVESTIGATION/ DESIGN	CONSTRUCTION	CONSTRUCTION MANAGEMENT	OPERATION/ MAINTENANCE	COMMUNITY SUPPORT	ENVIRONMENT
FARM:							
Whole farm plan	Landholder/ State Govt.	Priv. design consultants	—	—	—	DARA	DCFL
Lasergarding/ landforming & drainage	Landholder/ State Govt.	Priv. design consultants	Contractors	Landholder/Shire Planning Scheme	Landholder	DARA/RWC	DCFL
Drainage reuse	Landholder/ State Govt.	Priv. design consultants	Contractors	Landholder	Landholder	DARA/RWC	DCFL
Farm trees	Landholder/ State Govt.	Priv. design consultants/DCFL	Landholder/ landcare group	Landholder	Landholder	DARA/RWC	DCFL
Private g/water	Landholder/	Contractors	RWC/Contractor	Landholder	Landholder	DARA/RWC	
Pump tile drains	State Govt.						
SURFACE:							
RWC drains	State/Federal/ Municipal	RWC Consultants DCFL	RWC Private contractors	RWC	RWC	RWC	DCFL
Community drains	Landholder/ State/Federal/ Municipal	Private design consultants RWC/Municipality	Contractors Municipality Landholders	Municipality Consultants Landholder group	Landholders Municipality	DARA/RWC Municipality	DCFL
Water harvesting	Landholder State/Federal/ Municipal	RWC Consultant Municipality	Contractor Municipality	RWC	Landholder Municipality	RWC/DARA Municipality	DCFL
D.C.D.'s	Landholder/ State/Federal/ Municipality	RWC Consultants	Landholder RWC Municipality	RWC	Landholder Municipality	RWC Municipality	DCFL
SUB-SURFACE:							
G/water pumps	State/Federal	RWC	RWC/Contractor	RWC	RWC	RWC	DCFL
Tile drains	State/Federal	RWC	RWC/Contractor	RWC	Landholder	RWC	DCFL
ENVIRONMENTAL:							
Drain outfalls	State/Federal	RWC/DCFL	RWC/Contractors	RWC	RWC	RWC/DCFL	
Wetland protection	State/Federal	RWC/DCFL Consultant/DCFL	RWC/Contractors	RWC/Municipality	Landholders Municipality	RWC/DCFL Municipality	DCFL
Wetland enhancement	State/Federal	DCFL/Landholder	Landholder	Landholder	Landholder	DCFL	DCFL
Stream protection	State/Federal	DCFL/Landholder Municipality	Landholder Municipal	Landholder/DCFL Municipal	Landholder Municipal	DCFL	DCFL

salinity control areas will be waived, and that the costs of managing groundwater resources will be met from the salinity budget.

SPPAC looks forward to continuing consultation with the RWC and the Salinity Bureau to further develop a policy for managing groundwater within the Region, SPPAC believes that this will require the declaration of appropriate Groundwater Conservation Areas for which the issues of surface water management, groundwater resource management, sub-surface drainage and salt disposal can be effectively co-ordinated. These are likely to be based on the Murray, Goulburn-Broken, and Campaspe valleys, and will require advisory committees with effective representation of all water users and relevant government departments. These issues are beyond the scope of this Management Plan and will also affect areas outside both the Management Plan and SPPAC's geographical base. However, a high priority must be given to the development of appropriate policies and an effective management and advisory structure which does not unnecessarily duplicate other existing and proposed arrangements.

7.1.6 Other Management Issues

The drainage program preferred by SPPAC is to be implemented in accordance with the priorities and standards which will be determined by local communities. About 80% of the area to be drained will be served by drainage systems which will be planned, constructed, operated and maintained by these local communities. Similarly there is a significant number of works in the sub-surface program which require the co-operation and goodwill of many communities of landowners. There is therefore need for legislative support for a number of issues involved with SPPAC's preferred program. Some of these issues are as follows:

(a) Community Groups

It is proposed that many surface and sub-surface works will involve interlinked works on a number of properties.

Community groups of up to about 20 landowners would be formed to manage these schemes. Each group would have a smaller management committee elected from its membership. These groups will not remain intact by goodwill alone; they may be disrupted when properties change hands or when local conflict occurs. Therefore legislation is required to:

(i) give legal standing to the group and its committee;

(ii) give the committee the right to carry out the operation and maintenance activities associated with the drain and be able to recover the cost from the benefiting landowners;

(iii) ensure that the agreements are registered with or via the title to the land and are passed onto successors in title; and

(iv) ensure that agreements to protect the environmentally sensitive areas as part of a condition of Government (or Regional) funding are honoured in the long term.

(b) Municipal Planning Controls

Municipal planning controls are required to protect all drainage lines to ensure that each property in the Shepparton Region has access via its natural drainage lines to an outfall point.

Landforming is altering the slope of irrigation land in northern Victoria and in many instances leads to substantial losses of native trees (woodlands) which have often taken over half a century to grow.

In a substantial number of cases drainage patterns are being altered and landforming is being carried out without installing drainage systems or giving due regard for the effect of the works on others. Under SPPAC's program it is proposed that no landforming or lasergrading should be carried out without a Municipal Planning Certificate and all such works must be complemented by either:

(i) a farm drainage system outfalling to a RWC or community drain; or,

(ii) a farm drainage system leading to a significant water reuse or water harvesting system where RWC drainage is not available.

These planning controls would also address the environmental requirements of wetlands and woodlands protection.

(c) Level of Service

Implementation of the preferred program would be significantly enhanced if the RWC was not legislatively forced to maintain the currently stipulated standard of service. SPPAC strongly supports the introduction of legislation which would remove this requirement.

(d) Discharge into RWC Channels

Under SPPAC's preferred program it is proposed that some 4% of the area be served by community drains leading to water harvesting systems which will discharge into RWC channels by pumping. At present it is understood that there is no straightforward legislation which will allow the RWC to charge a fee to recover costs under these circumstances. The community based water harvesting system with channel discharge also relies heavily on the RWC having the power to control discharge to its channel system. The present legislation is not especially geared to provide this power nor to facilitate the prosecution of offenders.

It is therefore proposed that appropriate legislation be enacted to give the RWC power to control and manage discharges to its channel system stemming from the preferred program and similar schemes throughout the State. This legislation would also provide for the imposition of the necessary charges and for penalties for illegal discharges.

7.1.7 Water Price Structure and Salinity Control

In some sectors of the community, there is a belief that a change in the water price structure would not only improve water use efficiency onfarm, but overcome the salinity problem. SPPAC believes water pricing has a role to play in salinity control, but is aware of the many impacts, particularly economic and social which occur when the cost of any farm input is altered.

Water pricing is obviously a very sensitive issue with both the irrigation community and with government policy makers.

Currently irrigators pay a flat rate for all irrigation water provided from the RWC channel system. The flat price applies to both water right and the "sales" allocation. Any surface drainage charges or groundwater control charges (e.g. Phase A) are recovered from irrigators by way of a drainage levy against water right only.

The result of these two policies is that the total cost of "sales" water ($12.10/ML in 1988/89) is less than the cost of water right (an average of $14.91/ML in 1988/89). This is termed a "falling" price structure which results in the last units of water used being cheaper than the first.

SPPAC believes there is scope to change the existing pricing structure to improve irrigation water use efficiency without affecting farm financial performance. This would

be achieved through a water pricing formula which provides reward for improved water use efficiency.

The following types of changes to the water pricing structure are recommended by SPPAC:

(i) Drainage and Extra Drainage Rates should be charged against total water used, rather than against water right on a per farm basis as is currently the case. This recognises that each megalitre of water used has a drainage and groundwater accession component regardless of whether it be water right or sales water.

(ii) The water pricing structure should be reviewed to provide incentive for irrigators to use water more efficiently.

(iii) In reviewing water pricing structures, a "rising" pricing structure should be investigated provided it meets the following criteria:

- it remains price neutral up to 150% sales allocation; and,

- it is equitable across and within the various enterprise groups.

(iv) Any change to the water pricing structure should only be undertaken after detailed community consultation across all water user groups.

7.1.8. Finance for Farm Salinity Control Activities

There are currently three main sources of finance for landholders undertaking farm development works which aid salinity control. These are:-

- private capital
- commercial lenders
- Rural Finance Corporation (Water Management Loans).

During the development of the Management Plan, SPPAC has identified concern with the RFC water management loan scheme. These concerns predominately relate to the security arrangements being required by the RFC for the loan. Many landholders are opting for commercial loans as a result, and necessarily carrying out less work due to the consequent interest rates.

SPPAC believes an expanded interest subsidy scheme ought to be applied to identified salinity control activities being undertaken onfarm. This scheme would see landholders borrowing from the normal commercial lenders and receiving an interest subsidy back from the RFC to reflect a capital contribution to the works as identified in Section 7.2.1.

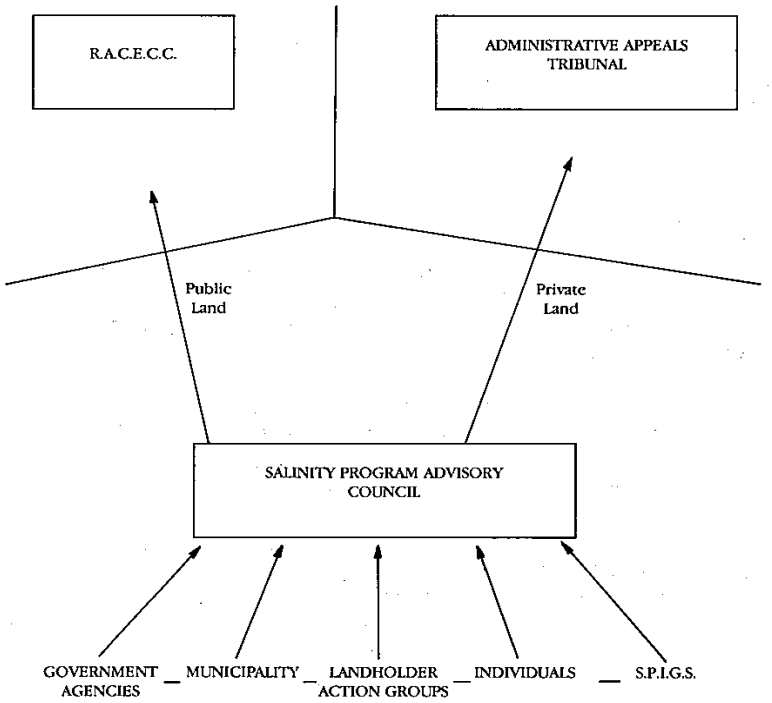
Such a scheme would enable landholders to deal with a single financial institution of their choice rather than dealing with a number of institutions as is currently the case.

7.1.9. Conflict Resolution

In implementing the Land and Water Management Plan there will be occasions where conflicts develop between individuals, groups, municipalities, SPIG's, Government agencies and special interest groups.

SPPAC believes there must be a process in train to resolve these conflicts, and proposes the resolution processes identified in Figure 18. At each stage there is potential to achieve resolution. However, the final decision must either lie with RACECC for public land disputes or the Administrative Appeals Tribunal for disputes which involve private land and drainage issues.

FIGURE 18 — Conflict Resolution Process



SPPAC is particularly concerned to make sure there is provision to resolve conflicts which will arise where community schemes e.g. drainage schemes, are stopped because individuals won't participate, even though the project will result in an overall community benefit. Representation along these lines has been made to the Minister for Water Supply to include legislation in the Water Act 1989 to deal with this situation.

Part 1003 of the First Draft Bill (Access Over Lands) now deals with this situation. Where an owner of land who seeks and is denied access for drainage, water supply or salinity mitigation purposes over land owned by another person, he may apply to the Minister for the appointment of an authority to decide the issue. A review of the decision can occur on application to the Administrative Appeals Tribunal which may make any order it thinks fit for the payment of compensation. Where salinity control activities are the subject of dispute the Salinity Program Advisory Council might logically be the authority appointed by the Minister to decide an issue.

Other disputes may arise over the construction of RWC drains which may impact negatively on wetlands. If compromises cannot be reached at the Regional level by the Salinity Program Advisory Council after consultation with the Regional Management of the Government Agencies concerned, the RACECC should resolve the issue.

7.1.10 Reviewing and Modifying the Management Plan

SPPAC acknowledges that the Management Plan presented here will continually need reviewing to ensure the most effective land and water salinity protection measures are adopted.

The Plan is necessarily one developed with knowledge available to SPPAC at this time. In the future, changes in technology, technical information and community awareness and preparedness to act will occur.

As these changes occur, then the Management Plan will have to be modified; that is one of the roles of the Salinity Program Advisory Council. The SPAC must review the Plan implementation from time to time to ensure effective use of Regional, State and Federal resources.

7.1.11 Research, Investigation and Monitoring

Development of the Plan has highlighted the need for further research and investigation in many key areas. Some of these needs have been highlighted in the various sub-programs of Section 6. The Plan proposes a significant Research and Investigation program in the five year works program (Section 7.3.1.) costing $11.6M.

SPPAC recommends a review be undertaken within the next two years of the R & I requirement for this Region. Given the enormous amount of work that has been undertaken to research this Plan, SPPAC believes the R & I program can be reduced in the medium term and funds channeled to implement the works identified in the Plan.

To ensure implementation of the Plan achieves the objectives identified by SPPAC for salinity control in the Region without generating unexpected negative effects, a major monitoring program is included in the Research and Investigation Program. The monitoring program relates particularly to salt loads in streams, channels and drains,and watertable behaviour in both protected and unprotected areas. Adoption rates of particular activities by Regional landholders are to be monitored on an ongoing basis.

7.1.12 Community Education Program

The five year program includes an extension of the Community Education Program which is necessary to implement the salinity Management Plan. The Community Education Program has been in place for three years and much has been achieved in creating awareness of the salinity problem. The Program will need to change direction and attempt to channel this awareness into on ground action.

A Community Education Officer is required to continue and develop the Awareness Program, promote good practices, encourage implementation of the Plan and support Landholder Groups. The Education Program will continue the School's Community Education Program and co-ordinate the joint CFL/DARA Salinity Grants and Saltwatch Programs in the Goulburn-Broken Region. This five year work program will cost $345,000.

7.1.13 Extension Support Activities

The Plan provides for a large amount of activity to be undertaken on farms by landholders and community groups. Most of these activities need to be undertaken by groups working in a co-ordinated manner to obtain maximum benefit. The DARA, RWC and DCFL have the major responsibilities in the Plan for providing high quality extension support to landholders and community groups (see Table 23 p.124).

The Salinity Program Advisory Council and the Salinity Program Implementation Groups must also be resourced with qualified staff from the Departments to ensure a high level of activity and a consistent approach to implementing the Plans.

The Plan proposes a five year extension support program (Section 7.3.1) costing $3.4M to be provided by Government. The Plan proposes a continuation of the current advisory services in the Region and requires an increase in critical areas to ensure that implementation of the Plan proceeds as required.

7.2 COST SHARING ARRANGEMENTS

7.2.1 Beneficiaries of the Plan

The State Salinity Control Strategy "Salt Action:Joint Action" states:

> *"While the State Government has an important role to play in providing resources for salinity control, regional and local communities must be prepared to help themselves. Construction by communities at regional and local levels should reflect both the extent to which these communities derive benefit from salinity control and the relative inputs of local farming, water management and disposal systems to the worsening of the salinity problem".*

SPPAC endorses these statements which adopt a "beneficiary pays" approach to salinity control. The Management Plan developed here relies heavily on the local and regional communities acting now in collaboration with individuals and Governments to protect the Regional environment and its productive capacity.

In many cases action by the community now has to overcome the actions of past generations of landholders and governments, current actions of landholders and governments in order to protect the Region for future landholders and governments. This will not happen overnight, it will not be easy, and it will be expensive.

If the objectives of this Management Plan are to be achieved, all sectors of the community must be involved. Table 26 shows groups identified by SPPAC as beneficiaries in what way they benefit and the organisation through which they can play their part.

It has been the usual practice to consider irrigators to be the only beneficiaries of irrigation, drainage and salinity control. This Plan has already demonstrated (Sections 4.4, 5.2, 5.3 and 5.4.) that the beneficiary group from actions proposed in this plan is much wider than irrigators. The following discussion identifies who benefits, and who does not, from the Plan.

(a) Irrigators

Provided the Plan offers all irrigators the potential for reasonable access to the proposed actions, then all irrigators are beneficiaries. Equal access to technical options for salinity control can never be achieved due to the complex hydrogeological processes of the Region, but the Plan offers programs in which every irrigator is able to participate if he or she wishes.

Notwithstanding the present uncertainty in relation to the C Type management areas where sub-surface drainage is difficult, this Plan is put forward on the basis that all irrigators are potential beneficiaries and therefore all irrigators pay a share of the costs.

This concept is fundamental to the Plan, if at any time the community or the Government change this basic concept, the whole Plan and the agreements based on the Plan are negated.

TABLE 26: Groups Benefiting from Salinity Control

BENEFICIARY GROUP	IDENTIFIED BENEFITS FROM SALINITY CONTROL	RESPONSIBLE ORGANISATION
Individual Landholders	Productivity protection Productivity increase through reclamation of currently saline areas Maintenance and in some cases enhancement of property values Maintenance of landscape and environmental values Improved social harmony	Individual
Regional	Maintenance of employment opportunities Reduced road maintenance costs Maintenance of social welfare Maintenance of environmental values to Region Maintenance of municipal rate base Reduced transport costs Improved input to community activities	Local Government
Victorian Community	Maintenance of environmental value to Victorians Reduction in road maintenance costs Maintenance of the Region's population and employment growth rates (R.E.V. policy) Containment of social welfare, family health and law enforcement costs Maintenance of state revenue from industries, and businesses established in the Region River bank protection Reduced agency support required in the longer term	Victorian Government
Murray Darling Basin and National Community	Maintenance of the environment Offsetting major increases in the need for social welfare, unemployment and health benefits resulting from regional unemployment Contribution toward stabilising the "Greenhouse Effect" Maintenance of tax revenue to Governments through income security and related taxation payments Offsetting a range of unquantifiable health and psychological costs to individuals, families and communities.	Federal Government
Murray River Community	Controlled rather than unchecked salt disposal to the River Murray System	Federal Government

(b) Regional Community

The analysis reported in Section 4.4 has shown the dairy and horticultural industries as receiving less than one third of the benefits from salinity control. More than two thirds accrue to the processors and other dependent industries. If the Plan were not implemented, the corollary is that the processors and dependent industries would lose twice as much as farmers.

The surface drainage benefits as presented in Table 18 (p.91) indicate that more than 50% of the measurable benefits result from savings in road construction and maintenance. The benefits are received directly by the Regional community, the people of Victoria and to some extent, the people of Australia.

The maintenance of the environment within the Region benefits all who live in the Region and where the environmental features are of state, national and world significance, the people of these communities also benefit. Many of the

environmental features of the Shepparton Region have significance beyond the local level and some of the wetland features have significance at the national level.

The conclusion has been drawn that the Regional community, represented by local government municipalities in the Shepparton Irrigation Region, are major beneficiaries of the Plan and should share the costs equally with irrigators.

(c) Victorian and National Community

Sections 5.2 to 5.3 describe the impacts of a "do-nothing" approach to salinity control in the Shepparton Irrigation Region. A very productive, vibrant and developing region will move to one of decline within a very short time period. The social, environmental and economic consequences of this are difficult to comprehend.

It is estimated that over 3,500 jobs will be lost to the region, the economic and social cost of this is enormous. It would not be correct to expect the farmer to be responsible for ensuring this does not happen.

Social welfare, Regional decentralisation and maintenance of the country's natural resources are Commonwealth and State Government responsibilities, although Regional communities have a part to play in implementing these policies. The social cost of losing some 3,500 jobs is around $40M per annum in social welfare payments (with a similar amount foregone in taxation revenue). The Commonwealth Government should therefore be interested in seeing this plan implemented for this reason alone.

Also, as outlined under (b) above, some of the wetland and natural features of the Region have environmental significance at the national level.

In summary, the wider community, as represented by Government, has a clear responsibility to help meet the deferred costs of overcoming the problems of land and water degradation resulting from past policies and practices. The Federal Government has indicated its acknowledgement of its responsibilities in accepting the Murray Darling Basin's Natural Resource Management Strategy.

7.2.2 Sharing the Costs -Applying the Beneficiary Pays Concept

SPPAC has identified four types or classes of beneficiary. They are the Federal Government, State and local government (as representatives of the Regional community) and the irrigators. SPPAC considers that the most appropriate policy is for the beneficiaries to share equally the "Public Sector" component of the costs. Landholders will continue to pay for the major proportion of the required farm activities. This has been the case historically, and will continue to be so.

In promoting a cost sharing proposal, SPPAC have been mindful of the need to have an administratively simple arrangement, and one which is realistic. The financial objective of the Plan clearly focuses on the need for an affordable program of works for all beneficiaries.

SPPAC argues that the cost shares identified on a project by project basis in Table 27 would be appropriate given the proportion of wide community benefit resulting from the works.

In determining the cost sharing percentages for particular projects, SPPAC has used a number of criteria. Wherever possible, the level of cost share is related to the level of benefit received by each beneficiary group.

TABLE 27: Plan Costs and Cost Shares ($M)

PROJECT		CAPITAL				CAPITALISED O & M				
	TOTAL	FG*	SG*	LG*	LH*	FG*	SG*	LG*	LH*	TOTAL
ENVIRONMENTAL PROTECTION										
1. River Bank Protection	2.2	1.1	1.1							
2. Wetland Protection	10.0	5.0	5.0							
3. Stream Protection	15.0	7.5	7.5							
SUB TOTAL (2)	27.2	13.6	13.6							
ON-FARM PROGRAM										
4. Whole Farm Plans	5.8		2.9		2.9					
5. Landforming & Farm Drainage	137.3		13.7		123.6				57	57
6. Drainage Reuse	13.2		4.0		9.2				35	35
7. Farm Tree Program	45.6		13.7		31.9					
8. Private G/W Pumps and Tiles	14.3		2.9		11.4				2	2
9. Groundwater Pump Incentives	2.2		2.2						3.5	3.5
10. Exploratory Drilling Service	4.2		3.3		0.8				(1)	
SUB-TOTAL (2)	222.6		42.7		179.8				97.5	97.5
OFF-FARM PROGRAM										
11. New RWC Drains	117.3	35.2	35.2	17.6	29.3	2.4	2.4	1.2	2.0	7.9
12. Upgrading RWC Drains and Outfalls	28.8	8.7	8.6	4.3	7.2	0.3	0.4	0.2	0.3	1.2
13. New Community Drains	47.3	11.4	11.4	5.7	18.9				10.1	10.1
14. Water Harvesting	17.9	6.6	6.6	3.1	1.6				5.6	5.6
15. Drainage Course Declarations	11.1	3.9	5.0	1.5	0.7		0.1	0.4	0.2	0.7
16. Priority Project Sub-surface Prog.	61.9	15.5	15.5	15.5	15.4	27.6	27.6	27.6	27.6	110.4
17. Channel Seepage Control	6.0	3.0	3.0							
18. Murray Darling Works	10.2		10.2					4.3	4.4	8.7
SUB TOTAL (2)	300.5	84.3	95.4	47.6	73.1	30.3	30.4	33.7	50.2	144.6
19. Extension/Advisory Program	20.4	10.2	10.2							
20. Research/Investigation/ Monitoring	66.0	33.0	33.0							
21. Environmental/Inv/ Monitoring	8.7	4.4	4.4							
SUB-TOTAL (2)	95.1	47.6	47.6							
GRAND TOTAL (2)	645.4	145.5	193.4	47.6	252.9	30.3	30.4	33.7	147.7	243.1
% SHARE		22.5	30.9	7.4	39.2	12.5	12.5	14.0	61.0	

* FG — Federal Government
SG — State Government
LG — Local Government
LH — Land Holder

Note:
(1) These costs only counted to year 20
(2) Numbers may not match totals because of rounding errors.

(a) The farm program cost shares have been determined after:

(i) consideration of the level of accession reduction resulting from the works e.g. landforming results in a 10% reduction in accession, therefore 10% of capital is provided by the State Government.

(ii) consideration of the effectiveness of current incentive/assistance schemes at getting the required works implemented e.g. current assistance of 10% (approx.) toward groundwater pump installation is not achieving the required activity, SPPAC has recommended this be lifted to 20%.

(iii) assessment of where current assistance schemes where effective these have been continued e.g. whole farm planning @ 50% support.

(b) The surface drainage program cost sharing has been determined after identifying the beneficiary groups. These are landholders (through productivity benefit and maintenance), local government (through road construction and mainitenance benefit) and Government (through environmental and social benefits.)

Local government has not been a traditional financial contributor towards surface drainage in the Region, so historic cost sharing arrangements cannot be directly used.

Attempts have been made to quantify the degree of benefits resulting from each type of drainage system proposed in the Plan.

New RWC drains have been cost shared on a beneficiary pays bases where 50% of the benefit accrues to the agricultural and road construction and maintenance areas. The local government benefit approaches 15%, landholders 25% and the remaining 60% State and Federal governments.

Community drainage has been continued at the current DARA assistance rate of 40% landholder contribution. However instead of the State meeting the remaining 60% as in the case at present it is proposed that this proposition be shared on a 40:40:20 basis between the Federal, State and local governments. The landholders pay the operation and maintenance costs.

Water harvesting works have been funded on a 10%/18%/36%/36% cost share to landholders, local government, State and Federal governments after considering the level of assistance required to ensure the scheme is financially attractive for landholders to implement. As with Commission drains the cost share between the other three beneficiaries has been divided according to the cost sharing arrangements already operating for Federal Water Assistance Program Flood Plain Management Works. Landholders pay the operation and maintenance costs. Similarly for Drainage Course Declaration works the capital cost in excess of the 50% currently met directly by landholders should be shared on the same 40:40:20 with the annual maintenance costs being met by the asset owners.

(c) The benefits of Public scale sub-surface drainage works are large, but difficult to attribute to any group or beneficiaries. In the Plan, SPPAC has adopted an equal four way cost share between landholders, local governments, State and Federal governmnent for both capital and operation and maintenance costs.

Sub-surface drainage beneficiaries have been identified as Federal/State/local government and landholders in a four way split. The cost share has been applied to public works, similar cost shares to the farm program incentives apply.

(d) Environmental projects have been traditionally Government funded and will continue to be so.

Table 27 indicates the total capital ($645.2M) and Capitalised O & M (242.2m) costs of the Plan is $887.4M. With the proposed cost shares identified by SPPAC, the overall percentage of this cost is to be recovered from beneficiaries in 20/26/9/45 percent for the Federal/State/local government/landholder respectively. This approaches a cost share of 50% Government and 50% Regional community.

7.2.3 Meeting the Costs of River Murray Salt Disposal

The Murray Darling Basin Ministerial Council has agreed to build two salt interception schemes to reduce River Murray salinity and adopted a salinity and drainage strategy for the Basin. This strategy provides the framework for managing River salinities and specifically salt disposal.

By contributing to the cost of the salt interception schemes, Victoria will earn salt disposal rights which will enable it to implement a number of land protection schemes.

The cost of the Salinity and Drainage Strategy are considered in two parts; the costs of reducing River Salinity and the cost of earning salt disposal entitlement.

(a) Cost Sharing to Reduce River Salinity

The Victorian Government has agreed to meet the capital costs of reducing river salinity of $4.28M on the condition that the Northern Victorian community meets the operation and maintenance costs of $0.22M per year. SPPAC believes it is not in a position to allocate costs to Northern Victoria and have not included these costs in the Plan. SPPAC believes little consultation with the Northern Victorian community has occured on this matter.

(b) Cost Sharing for Salt Disposal Entitlements

The Victorian Government has not determined the method by which the costs of salt disposal entitlement are to be shared. The Government requires the various Salinity Management Plans to identify a process.

The Shepparton Irrigation Region Land and Water Salinity Management Plan proposed by SPPAC requires a salt disposal Entitlement of 19.4EC when fully implemented. The annualised capital and annual operation and maintenance cost of each EC of salt disposal is $24,450 and $21,000 respectively.

SPPAC have identified four beneficiaries of the Plan, the State, Federal and local government and landholders. SPPAC would argue that 50% of the costs of salt disposal entitlements should therefore be met by the Region and 50% by the State and Federal governments (in line with other public works cost sharing proposals in the Plan).

Under this cost sharing arrangement, the most practical approach is for Government to cover the annualised capital contribution of $476,775 and the Regional community $405,500 of operation and maintenance. The latter contribution is included in the cost sharing proposals in Table 27 and is split equally between the landholders and local government.

7.2.4. Cost Sharing - A Practical Proposal

As for the implementation arrangements, the financing arrangements for the Plan have been divided into two categories. These relate to farm activities on a region wide basis, with public works programs and some farm works being implemented on a priority project. Basis across the Region. The proposed financing for both components assumes no basic changes to existing State level budgeting processes, co-ordinative functions or financing arrangements.

1. Regionwide Farm Activities

These activities are to be financed by farmers with incentives payments being provided from the State Government for beneficial works being undertaken onfarm via its Departmental Agencies of DARA, RWC and DCFL. The level of incentive has been determined after consideration of the accession reduction being achieved from the activity and the current level of adoption relative to that required.

The activities are to be promoted and administered by Departmental advisory staff and annual reviews of the various incentive schemes will be undertaken by the Salinity Program Advisory Council to ensure the levels of incentive are appropriate and that the activities are being adopted at the required rates.

2. Public Works Program

The Regional activities of sub-surface and surface drainage are proposed to be financed by the State and Federal government, local government and landholders.

It is proposed that finance is made available by the Government and the beneficiaries repay their share of the total cost of the works. When the State Government provides finance to Public works programs of this nature it has determined that current cost accounting policies are to be used to identify the "full cost" of the works.

The policy requires Government Authorities (the RWC in this case) to establish rates and charges to generate a rate of return (currently 4% in real terms) on the current value of their portfolio of assets, after covering depreciation and all their operating costs. For existing assets of the RWC rates and charges of the RWC therefore need to:

- recover all operating costs such as fuel, labour, maintenance etc;
- recover all capital cost i.e. current cost depreciation plus a real rate of return on the current value of assets in service;
- adjust the real rate of return on capital to move toward the target rate of return to 4% at the corporate level (where this is not already being achieved).

It must be noted that the RWC is currently achieving a negative rate of return and is working toward a target Rate of zero over the next twenty years. A deadline to achieve the required 4% rate has not been specified.

The Plan as proposed will see a major increase in the RWC asset register, particulary through an expansion in the surface drainage and groundwater control works.

The Plan proposes that the beneficiaries of the public works program share the costs of such a program. As demonstrated in Section 7.2.1, the beneficiaries are far wider than irrigators (who under a user pays policy have borne the costs of salinity control works that the RWC have constructed in the past).

If the works programs outlined in the Plan were implemented and paid for by the beneficiary groups as identified in Table 27, the capital costs would be split equally between the State/Federal Government and the Regional community (landholders and local government). The annual operating costs would be paid mainly by the landholder (61.7%) but the Government would also pay significant operating costs. Although this cost sharing arrangement has been established on

beneficiary pays principles and precedent where it was difficult to identify beneficiary percentages, the administration of such a financial arrangement for the public works component of the Plan would be unworkable.

SPPAC therefore proposes a pragmatic solution to the financing of the Plan.

For Region Wide Activities, SPPAC proposes the financing arrangements already identified for farm activities, community drainage (Table 28), water harvesting and Drainage Course Declarations be adopted.

For public works, SPPAC proposes that the State and Federal Governments cover all capital costs including all financing charges and depreciation incurred by the RWC based on Government financing guidelines. The region in turn is to cover the annual operation and maintenance costs of the works.

For Traditional Government Activities of extension, Research and Environmental Protection, SPPAC proposes these continue to be financed by government.

TABLE 28: SPPAC Cost Sharing Proposal

ACTIVITIES	COSTS TO BE RECOVERED ($M)	
	GOVT	REGION
REGION WIDE ACTIVITIES		
Farm Program	42.7	179.8
Community drainage	22.8	24.5
Waterharvesting	13.2	4.7
Drainage Course Declaration	8.9	2.2
Operation and Maintenance (1)	0.1	113.0
SUB-TOTAL	87.7	325.0
PUBLIC WORKS ACTIVITIES		
R.W.C. Drainage Works	146.1	
Sub-surface drainage	61.9	
Channel seepage	6.0	
Murray Darling Works	10.2	8.7
Operation and Maintenance (2)		119.5
SUB-TOTAL	224.2	128.2
Extension	20.4	
Research	74.7	
Environment	27.1	
SUB-TOTAL	122.1	
GRAND TOTAL	433.8	453.3

Notes:
(1) Includes all operation and maintenance costs for Region wide activities.
(2) Includes operation and maintenance costs for RWC drainage and sub-surface drainage works.

The financing arrangement is administratively simple, does not require ongoing annual O&M being met by the Government, and is compatible with the financing arrangements already operating funded for the Region's irrigation infrastructure.The proposal does however identify local government as beneficiaries of salinity control and proposes that 17.5% of the O & M costs be recovered from the Regional community through local government.

Table 28 identifies the cost sharing proportions if the SPPAC pragmatic approach is taken. Costs are apportioned for the Region wide activities on a capital share basis as before whilst the public works activities are funded by Government, and the total O & M is paid by the Regional community on a 17% and 83% share between local authorities and landholders. In Table 30 O & M has been capitalised at 4% over 50 years for the completed project.

Under this approach the total cost share is $433.9M to State and Federal government and $451.2M to the Regional community. The costs of extension/research and environmental protection have been traditional roles for Government and will continue to be so.

Under the Plan the Rural Water Commission will construct drainage works with a total capital value of $181.1M ($146.1M for surface drainage and channel upgrading and channel upgrading and $35M for sub-surface drainage). This cost will be borne by Federal and State Governments. In terms of the State Government's general rate of return requirements for Government Authorities, this means that capital will be provided as required, but neither the 4% target rate of return nor depreciation will be recovered from the Regional community. If RWC are required to account for these items it will be necessary for the State Government as a beneficiary under the Plan to provide these payments. Table 29 indicates what this will mean in terms of annual payments for the first 5 years of the Plan.

TABLE 29: Rate of Return Analysis for RWC Assets (1989-1994)

YEAR	SURFACE DRAINAGE CAPITAL INPUT (1)	SUB-SURFACE CAPITAL OUTPUT (1)	TOTAL COST (100% GOVT.) (2)
1989/90	2500	130	70.71
1990/91	3300	1043	276.96
1991/92	3700	1391	581.46
1992/93	5050	1652	993.37
1993/94	7150	1652	1498.52
TOTAL	21,700	5,868	3421.02

Notes:

(1) Depreciation charges assume Investigation and Designs has a 100 year life and construction 40 years for sub-surface and 70 years for surface drainage works.

(2) Includes recommended inflation factors of 6.4, 6.3, 5.5, 5.5, 5.5% per year respectively.

Two factors need to be recognised in relation to this approach. The first is that half of the capital is to be provided by the Federal Government, which does not require 4% rate of return from the State. The second is that payment of depreciation would be equivalent to 0% rate of return on drainage assets at a time when the RWC is achieving a negative rate of return on its water supply assets. The arrangement proposed by SPPAC therefore :

- is consistent with the fact that part of the capital will be provided by the Federal Government;

- is consistent with the present situation in relation to RWC assets in general;

- avoids a situation where the cost of drainage to the user would be greater than the cost of water supply works.

The Regional community share of the cost is in two forms, the region wide activities relate particularly to the farm program. Individual landholders will be responsible for contributing toward farm activities as they already do. Local Government has a contribution to make toward their share of community drainage water harvesting and Drainage Course Declaration works.

For these Region wide activities, local government will be required to contribute the required capital share as works are being undertaken.

The O & M of the public works program however is to be split between landholders and the Regional community on a beneficiary pays approach. The identified split is 17% local government and 83% Landholder. The $128.2M capitalised figure represents an annual cost of $5.97M, which if split on the above basis requires a $0.99M Local Government and $4.97M Landholder contribution.

The cost recovery methods being proposed by SPPAC for the Public works program O & M are as follows:

(a) The Landholder component is to be recovered by way of a salinity control rate being applied to all irrigators by way of a charge per megalitre of RWC water used (both water right and sales). This rate would vary across the region depending upon the:

(i) level of service of the surface drainage system. Those landholders with access to RWC drains or relying either directly or indirectly upon RWC works for outfall will pay a higher rate than those with lesser forms of drainage (community, DCD scheme), as is currently the case.

(ii) level of groundwater reuse being undertaken onfarm. Where landholders are protecting their own properties through private groundwater pumping and reuse, they will be able to apply for a rebate off the sub-surface drainage rate. The level of rebate will depend on the amount of groundwater use and the ability to use groundwater. Those landholders in difficult to pump areas (C type) are to pay the minimum sub surface drainage rate.

Existing works will be included in this proposal (i.e. Phase A, RWC drains in use).

The impact of this scheme (when fully implemented over 30 years) is expected to see an average salinity control rate of $3.10/ML applied across the region (cost calculated using a figure of 1.6M megalitres of water use).

The guidelines for the differential rating system have not yet been developed, but are to be a high priority for the Salinity Program Advisory Council.

(b) The local government component of the annual O & M charge is proposed to be levied on the Regional Community by way of a general Salinity Control Rate applied across municipalities on a N.A.V. basis. The Current N.A.V. rate basis for each local authority in the Shepparton Irrigation Region are listed in Table 30.

The impact of a fully implemented program is expected to see a 4.3% of 1989 revenue rate being committed to Salinity Control across the region. (This level of expenditure would not be achieved until year 30).

The mechanism for the exchange of finance between local government and the RWC (for the public works components) have not yet been developed, this matter is to be addressed by the Salinity Program Advisory Council in consultation with the local government.

TABLE 30: Rate Bases and Revenues for Local Government Municipalities in the Shepparton Irrigation Region

MUNICIPALITY	NET ANNUAL VALUATION (1) $M	1989 RATE REVENUE $M
Cobram	8.999	1.38
Deakin	10.853	1.74
Echuca	25.115	1.59
Kyabram	8.011	1.05
Nathalia	8.104	0.85
Numurkah	12.879	1.18
Rochester	18.770	1.97
Rodney	26.233	3.05
Shepparton City	60.345	6.37
Shepparton Shire	28.333	1.92
Tungamah	9.027	0.82
Waranga	11.650	1.20
TOTAL	228.319	23.12

Notes:
(1) N.A.V. figure have been determined using valuations as at September 1988 provided by the municipalities and equalized using factors provided by the Valuer General's Department.

For further information on this section refer to the following Background Papers:

PL4 - Implementation Arrangements for the Shepparton Irrigation Region Land and Water Salinity Management Plan - October 1988
PL5 - Identifying a Priority Irrigation Area for Detailed Implementation - June 1988
PL6 - Finance for Onfarm Salinity Control - July 1988
PL7 - Financing of Salinity Works in the Shepparton Region - October 1988
PL11 - Regional Responses to SPPAC CHAT Issues Paper - April 1989
PL12 - Role of Local Government in Salinity Control - Rodney Shire Study - 1989
SE6 - Water Pricing and Salinity Management - October 1988
SE7 - Implementation of Works Study - October 1988
SE9 - Pumping for River Murray salinity Improvements - July 1989

7.3 WORKS PROGRAM

7.3.1 Five Year Program

The proposed five year works program is listed below.

TABLE 31: Five Year Work Program ($000's)

PROJECT	89/90	90/91	91/92	92/93	93/94	TOTAL
FARM PROGRAM						
1. Whole Farm Plans	100	160	200	200	200	860
2. Landforming & Drainage	409	1033	2079	4172	4265	11958
3. Drainage Reuse	153	265	461	563	608	2050
4. Agroforestry	—	572	572	572	572	2288
5. Shelterbelt	100	165	335	1086	1086	2772
6. G/W Pump Instal.	105	765	1016	1271	1276	4428
7. G/W Pump Incent.	471	419	368	368	368	1994
8. Explor. Drilling	282	300	300	300	300	1482
SUB TOTAL	1620	3674	5331	8532	8675	27832
ENVIRONMENTAL PROTECTION						
9. Floodplain Wetland Protection	25	100	200	300	300	925
10. River Bank Protection	—	—	100	200	300	700
11. High Value Wetlands	—	100	200	300	400	1000
12. Stream Protection	—	200	300	400	500	1400
13. Invest. & Monitoring	125	690	450	390	263	1918
SUB TOTAL	150	1090	1250	1590	1763	5943
SUB-SURFACE DRAINAGE						
14. RWC Capital Assets						
Construction	—	652	870	1044	1044	3610
Invest. & Design	130	391	521	608	608	2258
O & M	—	23	47	70	93	233
15. Low B3 Private Pumps						
Capital	—	218	305	435	435	1393
O & M	—	172	346	518	692	1728
16. Channel/Drain Maint.						
O & M	—	38	77	115	153	383
17. Support Activities	301	424	424	400	350	1899
18. G/W Management of Private Pumps	200	260	270	85	99	914
19. Murray Darling Costs	27	54	81.	107	134	403
20. Surface Dge. Diversion	—	186	312	438	563	1499
SUB TOTAL	658	2418	3253	3820	4171	14320

TABLE 31: Five Year Work Program ($000's)

PROJECT	89/90	90/91	91/92	92/93	93/94	TOTAL
SURFACE DRAINAGE						
21. Wyuna Horticultural	600	650	850	1150	1125	4375
22. Ardmona Horticultural	625	700	200	650	1150	3325
23. Lockington	325	325	125	50	25	850
24. Rodney Ext.	125	125	200	200	400	1050
25. Shepparton Drain 3	350	525	525	500	100	2000
26. Mosquito Dep. D.C.D.	525	575	450	250	—	1800
27. Wyuna Pastoral	100	150	850	1175	1200	3475
28. Ardmona Outfall			Included in item 24			
29. Millewa	75	75	75	60	700	975
30. Mullers Creek	50	75	150	175	625	1075
31. Harston	75	200	200	400	800	1675
32. Mosquito Depression		175	225	300	525	1225
33. Mosquito Trib.			Included in item 32			
34. Stanhope Depression			Included in item 31			
35. Cobram South			Included in item 36			
36. Muckatah			125	200	225	440
37. Cornella Creek			50	50	25	125
38. M.V. Drain II				100	200	300
39. Barmah Forest	50	150	—	—	—	200
40. Community Drainage DARA Grants	525	825	1225	1630	2035	6240
41. Misc.	100	100	—	—	—	200
42. General Support	360	410	340	340	445	1945
43. Operation & Maintenance	0	10	30	60	100	200
SUB TOTAL	3885	5070	5620	7330	9580	31585
DARA						
44. Farm Advisory Services	2648	2648	2648	2648	2648	1324
45. Farm Advisory Trainee	25.2	25.2	25.2	25.2	25.2	126
46. Community Education Program	69.0	69.0	69.0	69.0	69.0	345
47. Group Salinity Program	35.3	35.3	35.3	35.3	35.3	176.5
48. Implementing the Plan	66.8	66.8	106.8	106.8	106.8	454
49. Groundwater Pump Incentives	50.7	50.7	50.7			152.1
R.W.C.						
50. Drainage Advisory	30	30	20	20	20	120
51. Plan Implementation	21.5	80	90	90	90	371.5
52. Groundwater Pumping Officer	40	40	40	40	40	200
53. Design of Drainage CADD systems	30	30	30	30	30	15
DCFL						
54. Agroforestry Officer	40	40	40	40	40	200
	673.3	731.8	771.8	721.1	721.1	3619.1

TABLE 31: Five Year Work Program ($000's)

PROJECT	89/90	90/91	91/92	92/93	93/94	TOTAL
RESEARCH AND INVESTIGATION						
55. Effect of Saline Water on Crop Yields	180.9	180	180	180	180	900.9
56. Intrusion of Saline Water on Soils	27.9	28	28	28	28	139.9
57. Increasing Plant Salt tolerance	25.5	50	50	50	50	225.5
58. Analytical Services	65.5	65	65	65	65	325.6
59. Farm-based Salinity Management System	28.09	280	280	280	280	400.9
60. Nodulation/N-fixation of Legumes	3.2	5	5	5	5	23.2
61. Reducing Accessions under Horticultural Crops	40.4	40	40	40	40	200.4
62. Saline Groundwater Use Trial	21.4	21	21	21	21	105.4
63. Tongala Groundwater Re-Use Project	74.9	75	75	75	75	374.9
64. Impact of Dryland Salinity on Irrigation Water	50	100	10	10	100	270
65. Investigate Campaspe/Goulburn Deep Leads	90	105	100	80	—	375
66. *Complete Groundwater Monitoring Grid	130	190	150	120	—	590
67. Vertical Accession Studied	—	100	100	100	100	400
68. Salinity/Nutrient Aquifer Movement	50	100	100	80	100	430
69. Map useable G/W Resources	—	50	50	50	50	200
70. Effectiveness of S/surface Drainage	120	150	80	80	80	510
71. Channel Seepage Studies	110	60	30	—	—	200
72. Channel Sealing Trials and Review	35	120	20	20	—	195
71. Water Harvesting Effectiveness/design	—	100	50	20	20	190
72. Evap. Basin Performance/design	23	27	20	20	—	90
73. *Monitoring G/W Level/useage	166	300	300	300	300	1366
74. *Data Base (s/surface) Establishment	—	50				50
75. Drain Runoff/salt/nutrient Studies	50	150	150	100	100	550
76. *Monitoring Salt Loads in/out	200	200	200	150	150	900
77. *Data Base (surface) Establishment	—	50				50
78. Develop Design Criteria for Private Works	25	5	5	5	5	45
79. Review Govt. Works Design Criteria	—	25	5	5	5	40
80. Management Plan Support	280	280	280	280	280	1400
81. Riverine Plain Invest	22.7	23	23	23	23	114.7
82. Integrated Surface and G/W Investigation	8.9	9	9	9	9	44.9
SUB TOTAL	2081.2	2939	2396	2196	2046	11,657
* (Monitoring Components)	496	790	650	570	450	2956
GRAND TOTAL	8978	15807	18442	23949	26761	93936

The eighty two (82) projects listed for action in the five year work program represents the scale of activity required in the Shepparton Irrigation Region to address high watertables and salinity seriously.

SPPAC believes the Plan as presented is realistic and affordable. The first year program has been bid for through 1989/90 Victorian Salinity budget to allow works to commence.

For further information on this section refer to the following Background Papers:

RI1 - Groundwater and Surface Water Research Investigation and Monitoring Request for the SIRLWSMP - October 1988
RI2 - Agronomic/Economic Research Priorities - October 1988
RI3 - Environmental Research and Investigation Needs - October 1988

APPENDIX A - BACKGROUND PAPER

"THE PLAN" SERIES (PL)

CODE	TITLE
THE PLAN	
PL 1	Guidelines and Criteria for Evaluation of Proposals - October 1987.
PL 2	Preliminary Review of Options for Salinity Control - October 1987.
PL 3	Policies for Areas Without High Yielding Low Salinity Aquifers - July 1988.
PL 4	Implementation Arrangements for the Shepparton Irrigation Region Land and Water Salinity Management Plan - October 1988.
PL 5	Identifying a Priority Irrigation Area for Detailed Implementation - June 1988.
PL 6	Finance for onfarm Salinity Control - July 1988
PL 7	Financing of Salinity Works in the Shepparton Region (Financial Model) - October 1988
PL 8	Reliability of Projections - (July 1989?)
PL 9	Stream Salinities and Salt Loads in the Goulburn and Broken River Catchments
PL 10	Goulburn Dryland Salinity Management Plan - July 1989
PL 11	SPPAC CHAT and Responses Issues No. 1 to 5 - April 1989
PL 12	Role of Local Government in Salinity Control - Rodney Shire Study - 1989.
DISPOSAL	
DS 1	Guidelines to Manage Channels and Drain Salinities for Environmental Purposes - July 1988
DS 2	Salt Disposal to the Murray River in Relation to the SIRLWSMP - January 1989
DS 3	Simulation of Channel and Drain Salinities - January 1989
DS 4	Regional Salt Balance - July 1989

Oct. 99,

ENVIRONMENTAL

EN 1 Environmental Considerations by DCFL - 1989

GROUNDWATER

GW 1 Hydrogeological Mapping of the Upper Shepparton Formation - February 1989

GW 2 The Shepparton Irrigation Region - A Regional Hydrogeological Perspective - January 1989

GW 3 Riverine Plain Groundwater Usage Survey. Summary Report - November 1988

GW 4 Solute Transport Aspects of Groundwater Pumping - 1989

GW 5 Modelling of Sub-Surface Drainage Options in Pumpable Areas - August 1988

GW 6 The Role of Deep Lead Pumping for Salinity Control and Resource Development Within the Shepparton Region - March 1989

GW 7 Groundwater Accession Reduction Benefits - November 1988

GW 8 Development of Sub-Surface Drainage Plan - (Papers A,B,C,D). - 1989

GW 9 Groundwater Control by Private Pumping Systems.

GW 10 Review of Farm Exploratory Drilling Service

FARM SERIES

FM 1 Quantification of onfarm Options for Salinity Control - August 1988

FM 2 Development of Farm Program - 1989

FM 3 Effects of Landforming and Surface Drainage on Accessions (Papers A & B). - 1989

RESEARCH AND INVESTIGATION

RI 1 Groundwater and Surface Water Research Investigation and Monitoring Request for the SIRLWSMP - October 1988

RI 2 Agronomic/Economic Research Priorities - October 1988

RI 3 Environmental Research and Investigation Needs - October 1988

SURFACE DRAINAGE

SD 1 Draft Surface Drainage Strategy - 1989

SD 2 A Model for Determining the Quantifiable Economic Benefits of Surface Drainage - 1989

SOCIO-ECONOMIC

SE 1 Salinity Monitoring Survey - June 1987

SE 2 Farm Socio-Economic Survey - October 1987

SE 3 Future Rural Household Incomes - February 1988

SE 4 Costs and Benefits of the Plan - July 1989

SE 5 Regional Economics - August 1988

SE 6 Water Pricing and Salinity Management - October 1988

SE 7 Implementation of Works Study - October 1988

SE 8 The Shepparton Region in the "Do Nothing" Case - August 1988

SE 9 Paying for River Murray Salinity Improvement - July 1989

ACKNOWLEDGEMENTS

The Goulburn Broken Region Salinity Pilot Program Advisory Council wish to formally thank Irene Taverner, Pam Collins and Gillian Payne for their skill and patience in preparing this document and Kath Harper for her editing skills.