Goulburn Broken Dryland Salinity Management Plan

1995-2001 Review

Second Generation Salinity Management Plan

Contents

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Foreword

In 2002, the Goulburn Broken XXXXXX Working Group was formed to develop a draft Goulburn Broken Dryland Salinity Management Strategy for the Goulburn Broken Catchment Management Authority (GBCMA) as part of the Regional Catchment Strategy review and the preparation of second generation salinity management plans.

The Goulburn Broken catchment was identified as one of three highest priority catchments targeted by the Murray Darling Basin Ministerial Council's xxxxxx.

Reference to funding levels in the strategy, are only indicative. The specific level of government investment is contingent on budgets and government priorities.

Acronyms

CEP	Community Education Program
COFFI	Co-operative farm forestry investment
DWT	Depth to water table
EC	Electrical conductivity, a measure of salt concentration
EPFL	Eastern plantations forestry limited
FFORNE	Farm forestry North East
GBCMA	Goulburn Broken Catchment Management Authority
GBD	Goulburn Broken Dryland
GBDSMP	Goulburn Broken Dryland Salinity Management Plan
IC	Implementation committees
LAP	Local Area Plan
MDB	Murray Darling Basin
MDBC	Murray Darling Basin Commission
MDBMC	Murray Darling Basin Ministerial Council
MGBIC	Mid Goulburn Broken Implementation Committee
RMP	Regional Management Plan
SIR	Shepparton Irrigation Region
UGIC	Upper Goulburn Implementation Committee

Chapter 1 Introduction

This document is part of the review of the Goulburn Broken Regional Catchment Strategy. The risk posed by dryland salinity has been revealed to be much larger than previously thought. It will not be possible to protect large areas of the catchment from degradation and so it is important the Goulburn Broken Dryland Salinity Management Plan focuses on the identification and protection of key assets. The protection of these assets will require a radical shift in the way works are delivered and in the community's participation in identifying and working towards the appropriate natural resource management outcomes.

The salinity plan is built on the interim end of valley targets set by the Murray Darling Basin Commission. These targets are that salinity and salt loads be maintained within 100% of current levels in the Goulburn River at Goulburn Weir and within 136% in the Broken River at Casey's Weir. To go any way to meeting these targets will require massive landscape change, at scale not seen since the 1840's.

This document deals with the issue of dryland salinity, there are other natural resource issues in the dryland that need to be managed. The protection of assets will be used to develop a more integrated approach to catchment management over the next three years.

1.1 The Goulburn Broken Dryland Salinity Management Plan

This Review of the Goulburn Broken Dryland Salinity Management Plan forms part of the Goulburn Broken Regional Catchment Strategy (RCS). The RCS sets the overall strategic direction for natural resource management in the catchment. This Dryland Salinity Management Plan deals specifically with the issue of dryland salinity.

This Review is timely. It provides the opportunity to draw on the experience of the past twelve years of salinity plan implementation, and to shape our response to the newly recognised challenges posed by dryland salinity. In the last five years there has been a significant increase in our understanding of the threat posed by dryland salinity. Our understanding of the processes by which salt is mobilised in the landscape now allows us to more effectively target where works are required, and recommend the type of works required.

The Goulburn Broken Dryland Salinity Management Plan (GBDSMP) was first prepared in1989 as part of a co-ordinated State response to the salinity problem as recognised then. In 1990 the Victorian Government endorsed the Plan, and implementation commenced. The original Plan was based on knowledge available at the time, and it assumed that the works identified would restore a hydrological balance in the catchment. In hindsight, this was never achievable.

After 12 years of implementation, dryland salinity remains a major concern for the catchment community. Recent projections (DNRE, 1999) indicate that a significant proportion of the catchment, particularly on the Broken and Goulburn Plains, is likely to become affected by high watertables and salinity over the next 100 years. Revised estimates from the Murray Darling Basin Commission (MDBC, 1999) indicate that an additional 165,000 tonnes of salt per year will be generated from dryland salinity in the Goulburn Broken catchment within a 100 year timeframe.

This additional salt threatens the condition of the Murray River downstream, a water resource of critical importance. The increase in dryland salinity also threatens important assets within the catchment including water quality, productive land, urban infrastructure, heritage sites and biodiversity.

The strategic approach to salinity management has been greatly enhanced by the recent establishment of end of valley targets by the MDBC, with the agreement of State Government. These targets have been set so as to limit increases in the salinity of the Murray River, as measured at the benchmark site at Morgan in South Australia. End-of-valley targets have been set for the Goulburn and Broken Rivers, and these now provide the context for salinity management within the catchment.

Addressing the problem of increased salinity across the Goulburn Broken Dryland will require a radical shift in land use in key parts of the catchment. It is essential that the catchment community is engaged in discussions concerning the future condition of the catchment, and in negotiating their response to the challenges of dryland salinity. Responses to the dryland salinity problem will need to encompass the aspirations and regional development objectives of the catchment community.

1.2 About the catchment

The Goulburn Broken Dryland covers 1.8 million hectares, of which 600,000 hectares is forested, mainly in the southern and eastern parts of the catchment.

At present, approximately 260,000 tonnes of salt is generated annually in the Dryland. Of this, some 94,000 tonnes enter the Shepparton Irrigation Region, and over 22,000 tonnes are diverted to irrigation regions further west. The balance of over 143,000 tonnes reaches the Murray River and contributes to the salinity downstream. The salt leaving the catchment accounts for around 23 EC units in the Murray River at Morgan.

For the purposes of salinity management, the Dryland catchment is divided into five sub regions: Goulburn Highlands, South West Goulburn, Goulburn Plains, Broken Highlands and Broken Plains (Figure 1).

Goulburn Highlands

The Goulburn Highlands varies from flat alluvial valleys and undulating foothill country, to very steep mountainous country in the south and east. It covers an area of 8,380 square kilometres, approximately 50% of which is cleared. Rainfall varies from 650 mm in the north-west to more than 1200 mm in the east and south. The Goulburn Highlands is the major source of good quality water in the Goulburn River (over 3,000,000 ML/yr). The main land use is grazing with an increasing occurrence of hobby and lifestyle farms.

South West Goulburn

The South West Goulburn covers and area of 2,973 square kilometres with only 20% remaining forested. Rainfall varies from 600 mm in the north to over 900 mm in the south. The dominant land use is grazing. The area has a high proportion of absentee landowners and is increasingly dominated by small hobby farms and lifestyle properties. This area generates the highest salt loads of anywhere in the catchment (on average 31 tonnes of salt per km^2 per year).

Goulburn Plains

The Goulburn Plains covers an area of 1,798 km^2 of which 87% has been cleared for mixed grazing and cropping. There are also significant areas of high value viticulture and a growing thoroughbred horse industry. Annual rainfall across the area varies between 500 and 600 mm.

Broken Plains

The Broken Plains lies mostly north of the Broken River and (along with the northern section of the Goulburn Plain) is the area at highest risk of future salinisation. It covers an area of 1,164 km^2, of which only 8% remains uncleared. Rainfall varies from less than 500mm/yr in the north-west to just under 800 mm in the south-east. The main land use is mixed cropping and grazing, with small irrigation developments in the north around Yarrawonga and surrounding Lake Mokoan.

Broken Highlands

The Broken Highlands is an area of high relief, covering 3,036 km^2. It is reasonably well forested, with 34% remaining uncleared. Rainfall ranges from 800 mm in the north to over 1200mm on the eastern boundary. The area is mostly used for grazing, although there are some small horticultural and viticultural developments in the area.

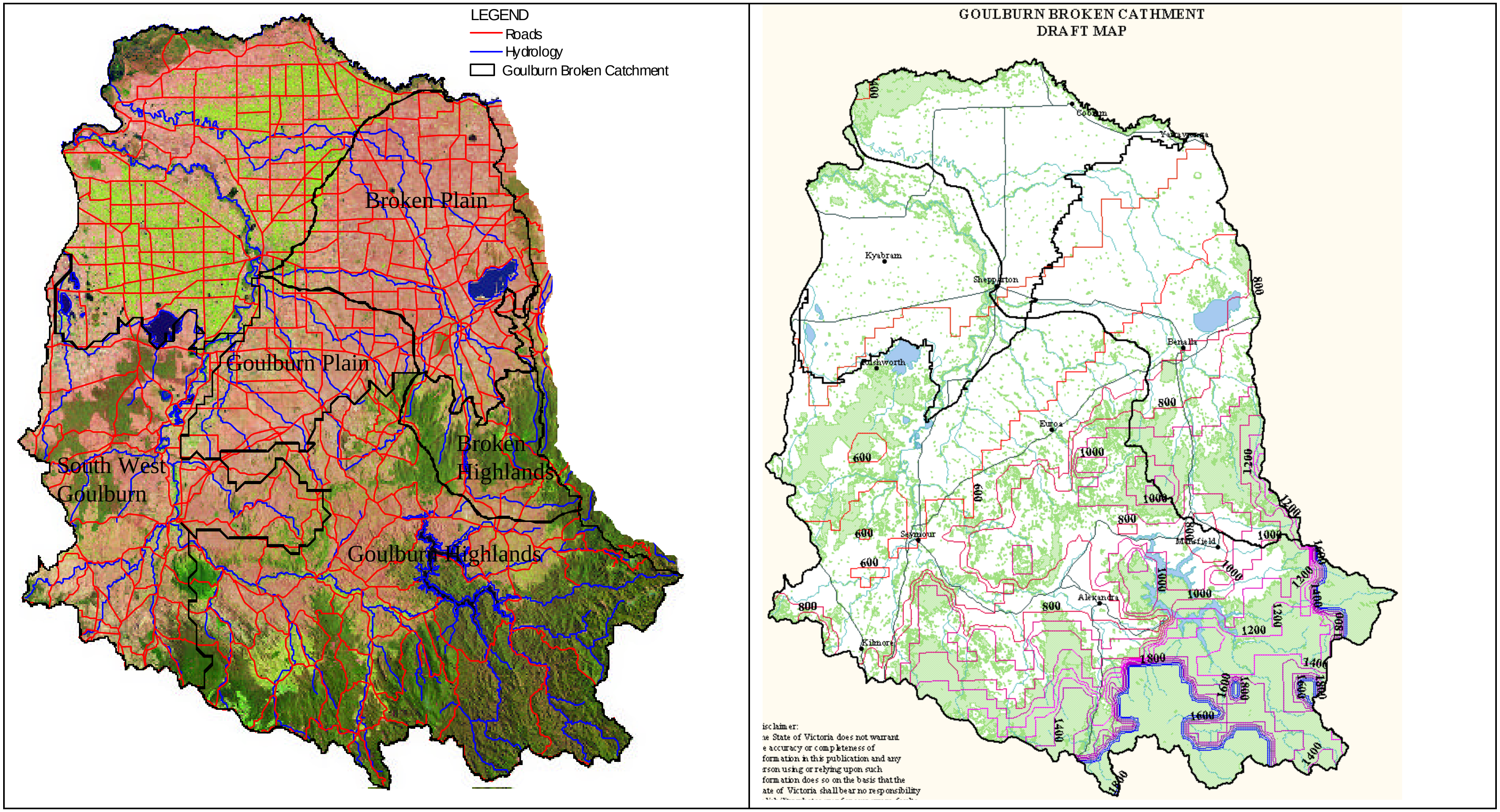


Figure 1 Goulburn Broken Salinity regions and rainfall isohyets

1.3 Policy context

Murray Darling Basin Salinity Management Strategy (2001-2015)

The objectives of the Basin Salinity Management Strategy (MDBC, 2000) are to:

- maintain the water quality of the shared water resources of the Murray and Darling Rivers for all beneficial uses - agricultural, environmental, urban, industrial and recreational
- control the rise in salt loads in all tributary rivers and, through that control, protect their water resources and aquatic ecosystems at [community] agreed levels
- control land degradation and protect important terrestrial ecosystems and productive farm land, cultural heritage, and built infrastructure at [community] agreed levels
- maximise net benefit s from salinity control across the Basin

The Basin Salinity Management Strategy (BSMS):

> "…establishes the framework for State salinity management strategies, catchment management strategies and Land and Water Management Plans to work together to achieve common objectives. It sets out a process to identify key community values and assets at risk, develop targets to protect them, and establish a 15 year program of works and landscape change…"

An important step in this process has been the establishment of interim end of valley targets for salinity. These targets define the limits to acceptable increases in salinity and average salt loads, over the period 2001 to 2015, for each of the major catchments within the Murray Darling Basin. End-of-valley targets are measured at defined points near the downstream ends of each catchment. For the Goulburn Broken Dryland these targets are:

> Goulburn River at Goulburn Weir – salinity and salt loads to be maintained within 100% of current levels
>
> Broken River at Casey's Weir – salinity and salt loads to be maintained within 136 % of current levels

The Ultimate Salt Loads study (DNRE, 1999) provided the background information on Victorian catchments for the Murray Darling Basin Salinity Management Strategy. In this study, the Goulburn Broken was recognised as the Victorian catchment most at risk from dryland salinisation.

The State and Federal Governments have jointly agreed to work towards meeting the interim end of valley targets. Much work needs to be done to determine exactly how targets can be met, and putting in place the necessary infrastructure and policies to support the changes that are necessary. This will coincide with continued implementation of catchment works and the expansion of downstream salt interception works. Interception works are seen as "*the program of engineering works needed to 'buy time' and short term relief from salinity to the shared rivers*".

It is recognised in the BSMS that, in the longer term, the more cost-efficient solutions to dryland salinity rest with major land use change. Balancing the twin approaches of land use change and engineering works is an important focus of the BSMS.

State Salinity Strategy

The Victorian Government also recognises that management of the salinity problem "…will require a mix of strategic measures" and again emphasises the need to achieve this, in part, through major land use change. To achieve this will require the development of improved co-operative arrangements with communities.

The document **Salinity Management in Victoria: Future Directions** (Victorian Government, 1999) identifies State salinity targets for the next 15 years. They are:

- By 2015, there will be a real reduction in the environmental and economic impacts of salinity.
- By 2005, critical recharge zones within catchments will be identified, with 40 to 60 per cent of these critical areas revegetated by 2015.
- By 2005, a quarter of agricultural production will be produced from natural resources that are managed within their capacity. By 2015, this will increase to half the value of agricultural production.

In order to achieve this, the State has identified the key steps in the process as being:

- the development of partnerships for integrated catchment management;
- improving the understanding catchment processes;
- developing appropriate actions for particular landscapes;
- building skills and the capacity for change; and
- underpinning new initiatives with an adherence to the principle of increasing water use efficiency.

Regional context

The Goulburn Broken Catchment Management Authority (GBCMA Priorities Document, 2002) has recognised that the major degradation issues facing the catchment are:

- dryland and irrigation salinity;
- water quality;
- river and floodplain management;
- pest plants and animals;
- declining biodiversity;
- soil acidity and sodicity; and
- other non-environmental issues.

It is further recognised that *"the impacts of unchecked watertable rises and salinity (in both the dryland and irrigation areas) are of significant economic, environmental and social concern".*

The GBCMA has set a high priority on developing and implementing Best Management Practices throughout the catchment and across industries in recognition that *"the continued viability of the dryland region is threatened by the continuation of unsustainable practices."*

The objectives of the Goulburn Broken Catchment Management Authority are to integrate across natural resource issues and to balance the needs of the dryland and irrigation zones with particular reference to water quality and water supply.

The CMA recognises that improved management of natural resources needs to be considered in conjunction with continued economic development of the region. It is critical that natural resource outcomes are achieved along with social and economic outcomes for the community.

1.4 Integrated catchment management

This document deals mainly with the issue of dryland salinity. Because the proposed solutions are aimed at large scale landscape change it is important that other issues are captured, in particular the likely impact on biodiversity and ecosystem function. The means of doing this is still to be developed but will be built on a model of assessing assets, their values and the risks posed to those values. In the first instance this will be done at the program scale and later applied to the sub catchment scale and finer where appropriate. At the same time other issues of water quality, water supply, soil acidification, soil erosion and pest plants and animals will be incorporated.

1.5 Community Consultation

Community consultation has been a major factor throughout the development and implementation of the Goulburn Broken Dryland Salinity Management Plan. Continued community consultation will be vital for the successful implementation of this Plan Review. It is expected that even stronger community engagement processes will need to be established as Plan implementation develops.
The GBCMA has established a robust system for community involvement in natural resource management across the catchment, centred on the Implementation Committees of the CMA.
This Draft Review document has been developed with the assistance of community input through the GBCMA Implementation Committees, and reflects broad community involvement in the salinity program.
Comments on the document are now invited and will be used to further refine the direction of dryland salinity management in the Goulburn Broken Dryland into the future.

Chapter 2 The Issues

The three key issues in the Goulburn Broken dryland are:

- *area of land affected by high water tables,*
- *stream salt loads, and*
- *stream salinities.*

High water tables will affect large areas of the Goulburn and Broken plain, with the Broken plain worst affected. Across the dryland, over the next 100 years, up to 135,000 hectares of land will be affected by dryland salinity. It is expected that the greater part of this will remain in the landscape.

High stream salinities are an ephemeral problem in the catchment, with a few streams of high EC, usually late in summer.

A major task in the next three years is to identify the natural and built assets at risk from the threatening process of dryland salinity and the probable impact on asset values given the projected increases in dryland salinity and the resilience of the assets.

In the Goulburn system mean EC is expected to increase by 24 EC units if nothing is done to manage the problem. In the Broken the expected increase is 133 EC, a doubling of current levels. There is limited capacity to manage these EC levels using dilution flows. The primary task, then, is to prevent the salt reaching the streams, either by lowering recharge rates or intercepting salt before it reaches the streams.

The dominance of regional groundwater flow systems in the Broken Plain means it will be very difficult to counter the expected increases in dryland salinity and stream salt loads in this area. Managing salt in the landscape will become an important part of land management in the future in this area.

Most gains in reducing salt loads will be made in areas such as the south west Goulburn and Broken Highlands where there is a predominance of local and intermediate groundwater flow systems.

The management of dryland salinity influences and is influenced by other key natural resource issues. These include water quality, soil acidity, water supply, native vegetation and biodiversity, and pest plants and animals. The integration of planning and work activities will be improved over the next three years to ensure that multiple benefits are realised and key assets across the catchment are protected and, where possible, improved.

2.1 Dryland salinity in the Goulburn Broken Catchment

The salinity problem can be defined in three ways:

1. The area of land affected by high watertables and groundwater discharge, or land salinised as a result of salt accumulating in the surface layers of the soil. This is mostly a concern to the affected landholders and the catchment community. High water tables are where groundwater is within 2 metres of the soils surface.
2. Stream salinity, or the concentration of salt in waterways and water resources. Stream salinity is of principal concern to the catchment community, as it directly affects their use and enjoyment of the water resource. Stream salinity is measured by EC units, a measure of the electrical conductivity of the water which increases as the sal t content increases.
3. Salt loads, or the total amount of salt exported from the catchment. Salt loads are more relevant to downstream communities and water resource users, because of implications for the condition of the River Murray. Salt loads are measured in tonnes of salt passing a given point over a given time-usually days or years.

2.2 High Watertables and Dryland Salinisation

The original Goulburn Broken Dryland Salinity Management Plan predicted that the area of salt affected land in the Dryland would increase from an estimated 3,500 ha in 1989, to 38,000 ha over a 30 to 50 year timeframe. The broader impacts of high watertables and waterlogging were not identified. It is now estimated that more than 6,000 km^2 will be affected by high water tables in the Goulburn Broken catchment by the year 2100. Slightly more than 80% of this will occur on the Riverine Plains. High water tables will lead to waterlogging, salinisation of low parts of the landscape, and increased salt accession to streams.

The major problem will be in the Broken and Goulburn Plains, with at least 20% and up to 40% of the area potentially affected by water logging. This will reduce agricultural productivity and limit production options, further reducing the viability of farms. Increased waterlogging will also lead to higher maintenance costs on roads and drainage, and affect buildings and infrastructure around towns, including Yarrawonga, Violet Town, Benalla and Euroa.

High water tables and waterlogging will affect native vegetation and biodiversity values across the lower-lying areas of the Plains. In particular, the hydrological regimes of wetlands will be altered, with a consequent changes in their function and values.

Much work is still required to determine which parts of the landscape affected by high watertables will eventually become salinised. A conservative estimate would see between 15,000 and 20,000 hectares of land highly salinised, equivalent to 7.5% of the arable cropping and grazing country in the Riverine Plains area being rendered unsuitable for any form of conventional production.

Saline groundwater will cause accelerated depreciation of infrastructure, including roads, bridges and culverts as well as buildings. Townships in the Plains area, including Yarrawonga, Violet Town, Euroa and Benalla are already at threat. Remnant vegetation on the riverine plains has a high intrinsic value because it is already highly depleted. The maintenance of existing stands of native vegetation are a high priority for the environmental value they serve. Much of this remaining vegetation is along watercourses and floodplains where the risk of salinisation is greatest.

The condition of the Murray River and the supply of water to Adelaide is measured at Morgan in South Australia. At present salt loads from the GB catchment are around 260,000 tonnes a year which is responsible for an increase of 24 EC in the Murray River at Morgan. This is up from the original estimate in 1989 of 186,000 tonnes and 15 EC.

2.3 Impacts of Salinity on Assets in the Goulburn Broken Dryland

Natural assets

Soils

The structure and function of soils is severely altered by waterlogging and high salt content. Both conditions can induce physical and chemical changes to the soil.

Water logging is currently a seasonal problem across large areas of the Riverine Plains, particularly in cropping country. With the projected expansion of high watertable areas across the Plains, water-logging will become more prevalent. This will affect soil structure and aeration, and reduce agricultural productivity. Water-logging will also lead to compaction, reduce trafficability, and increase surface runoff.

Once soils can no longer be flushed of excess salts, their productive capacity is severely reduced and they are rendered useless for conventional production activities. More than 15,000 hectares of land is likely to be severely salt affected. This has the potential to greatly increase soil erosion, and salt and water run off to streams. Saline throughflow and interflow in dispersive soils will increase gully and tunnel erosion, and destabilise stream banks, leading to increase sediment loads and siltation in waterways.

Waterways

It is projected that an additional 165,000 tonnes of salt per year will be mobilised in the catchment. Much of this increased salt load will reach the region’s waterways, either directly by groundwater baseflow into streams, or through surface wash-off. Many seasonal streams will flow for longer periods as they become dominated by saline groundwater, with likely severe impacts on aquatic biodiversity. Groundwater seepage will increase the risk of destabilisation of stream banks, leading to increased sediment loads and siltation.

The waterways at greatest risk are those on the Riverine Plains, and those flowing through the Plains-Upland interface along the foot of the Strathbogie Ranges. These are the areas where the risk of dryland salinity is highest and where most salt will be mobilised in the future. Many of the streams in this zone already suffer from seasonally high salinities. More work is required to fully understand the impacts of increased salinities and shifts in timing of flows on aquatic ecosystems and stream condition.

Many of the waterways in the upper-mid catchment that flow in local and intermediate groundwater flow systems are unlikely to degrade severely. However, there is some potential for reduction in runoff (dilution flows) to streams through extensive revegetation in these zones.

Biodiversity

The magnitude and potential extent of the salinity problem in the Goulburn Broken Dryland threatens to have a major impact on the biodiversity of the more seriously affected areas of the catchment, leading to a reduction in the complexity, diversity and functions of ecosystems.

Much of the remnant vegetation across the Riverine Plains is of severely depleted vegetation types. Remnant vegetation on the lower-lying parts of the landscape, on the floodplains, in wetlands, and along waterways, is particularly at risk from rising watertables. This will affect stream condition and further accelerate the degradation of aquatic habitats. Further loss of vegetation and biodiversity in the Plains zone will degrade the capacity of natural ecosystem to support essential landscape functions.

In the upland areas where dryland salinity is more localised, biodiversity impacts will be less severe.

Economic assets

All investors in the catchment and its infrastructure are likely to be affected by changes wrought by salinity. The rise in dryland salinity will force more resources to be channelled into maintenance costs for buildings, roads, bridges and utility services. In the more seriously affected areas, it will force

wholesale change in land use or lead to highly degraded environment with flow on impacts to other natural assets and infrastructure. Areas of the Riverine Plains are likely to be most affected, including the towns of Euroa, Violet Town, Yarrawonga and Benalla.
The efficiency of investment in the catchment will be reduced as funds are diverted from otherwise more productive options to compensate for accelerated depreciation of infrastructure.
There will be as yet unrealised benefits as the emerging problems brings about innovative solutions and alternative land uses that would otherwise not be considered or justified. These include salt harvesting and saline aquaculture. There will also be benefits from alternative forestry and farming systems adapted to changed soil conditions and focussed on more effective use of ground and surface water.

Social assets

Regional communities are currently under enormous pressure from global and national forces. These include continued decline in terms of trade, changing employment patterns, migration of young people to urban centres, enhanced lifestyle expectations, and a steady reduction in Government and business services to regional areas (affecting schooling, banking and the quality of service delivery by utilities).
Natural resource degradation has a marginal impact within this broader context. It adds to the pressures facing rural communities, particularly where it:

- reduces the opportunities for enterprises to continue to improve production;
- adds to the costs of production or service delivery;
- diminishes service availability as population diminishes; or
- forces unwanted change in land use and lifestyle, either directly by reducing enjoyment of lifestyle or landscape, or indirectly through changed community standards for ‘accepted’ land management practices.

Dryland salinity will increase the costs of maintaining infrastructure and service delivery to regional communities. It will exacerbate the current problem of the declining condition of road networks and associated infrastructure. By reducing productivity in some areas, it will reinforce the need for off-farm employment, and further reduce the viability of medium- to smaller-sized farms, adding to family pressures. The threat of dryland salinity is likely to affect land values in some areas. It will lead to increased rates and charges by local government required to recoup the additional costs of infrastructure maintenance. The rate burden on the urban population will increase. Such increases in costs will have a ripple effect on the provision of other services, as resources are increasingly allocated to maintain the status quo.

2.4 Stream salinity and salt loads

For the purposes of salinity management, the Goulburn Broken Dryland can be sub-divided into five sub regions.

Goulburn River catchment:

1. Goulburn Highlands - from the headwaters upstream of Lake Eildon to Trawool
2. South West Goulburn - from Trawool to the Goulburn Weir
3. Goulburn Plains - from Goulburn Weir to the River Murray

Broken River catchment:

4. Broken Highlands - from the headwaters upstream of Lake Nillahcootie to Casey’s Weir
5. Broken Plain - from Casey’s Weir to the Goulburn River at Shepparton.

Goulburn Highlands

The Goulburn Highlands above Lake Eildon remains mostly forested. The major tributaries downstream of Eildon are the Rubicon, Acheron, Yea and Murrindindi Rivers and the King Parrot Creek. It is an area of high runoff and moderate salt generation rates. On average, each hectare generates 14 tonne/km^2 of salt and current stream salt loads are 114,000 tonne/yr.

South West Goulburn

The South West Goulburn includes the reach from Trawool to the Goulburn Weir at Nagambie. The main tributaries in this section are Dabyminga, Sugarloaf, Sunday, Gardiners, Mollison and Whiteheads Creeks.
The area is predominantly cleared (80%) with thin granitic soils and high salt stores. Salt generation rates are very high (31 tonne/km^2) and around $1/3^{rd}$ of the salt in the Goulburn Broken system originates in this sub region. Current stream salt loads are 92,000 tonne/yr.

Goulburn Plains

At present, the Goulburn Plains contributes only low to moderate salt loads into the Goulburn River. Salt load generation rates are around 11 tonne/km^2 and current stream salt loads are 19,000 tonne/yr.

This reach includes the influences of events at the interface between the Strathbogie Ranges and the Goulburn Plains. The main tributaries are Hughes, Creightons, Castle, Seven and Honeysuckle Creeks. Projections suggest the area is likely to generate very high saltloads from rising watertables, particularly at the interface between the Plains and the Strathbogie Ranges. The Goulburn Plains includes the Heartlands study area.

Broken Plains

The Broken Plains currently generates comparatively little salt to the Goulburn-Broken system. Salt generation rates are 7 tonne/km^2 and the current stream salt load averages out at 22,000 tonne/yr. It produces, at present, the lowest amount of salt per square kilometre in the whole catchment. This area was identified in the work by SKM (DNRE 1999) as the sub region likely to generate most of the increased salt loads over the next 100 years, as watertables rise to within 2 metres of the surface over between 20 and 40 per cent of the area.

Broken Highlands

The Broken Highlands remain moderately afforested. This, and the comparatively low flows, mean that the area is not a major source of salt. Over the next 50-100 years there will be increased salinisation in valley floor and break of slope locations in some landscapes. The average salt generation rate is 11 tonne/km^2 and the average stream salt load is 13,000 tonne/yr.

Table 1 Flow and salt load data, saltload generation rates, and impact on EC at Morgan, for Goulburn and Broken catchments and sub regions

Sub Region	**Area of catchment km^2**	**Area cleared %**	**Mean Flow ML/yr**	**Total stream saltload (tonne/yr)[1]**	**Mean salinity in catchment EC**	**Salt load generation rates Tonne/km^2**	**EC impact at Morgan EC units[2]**
Goulburn Highlands	8,388	50	3,298,452	114,043	72	14.0	10.15
South West Goulburn	2,975	80	445,302	91,704	430	31.0	8.48
Goulburn Plain	1,798	87	265,877	18,933	149	11.0	3.02
Broken Plains	3,036	92	241,868	21,104	169	7.0	2.60
Broken Highlands	1,798	66	248,457	13,232	98	11.0	3.19
Total Goulburn	13,161	62	4,009,631	224,680	117	17.43	18.44
Total Broken	4,834	82	490,325	35,336	133	8.49	4.18
TOTAL	**17,995**	**67**	**4,499,956**	**259,016**	**90**	**15.03**	**22.62**

[1] Data from GBD Catchment Salt and Water Balance study (SKM 1996)

[2] Estimated from relationship used in Ultimate Salt load study (SKM 1999)

2.5 Trends

An analysis of trends in stream salinities and salt loads provides the background information on which the appropriateness of end of valley and within valley targets can be analysed. The South West Goulburn, Goulburn Highlands and Broken Highlands are dominated by local and intermediate groundwater flow systems, and so it would be expected that they would have reached hydrologic equilibrium, or be very near to in the case of the slower-responding intermediate systems. In contrast, the Goulburn and Broken Plains are dominated by regional groundwater flow systems, and it may be many decades before hydrologic equilibrium is reached.

Goulburn Catchment

Above Eildon

Salt loads at Eildon are around 20 tonnes/day at 45-50 EC. There is no clear trend in the data as might be expected for heavily afforested catchments. Even the dry period from 1995 has not shown up in the trends.

There is limited data on tributaries in this section of the river. What data is there shows high variability with high salinities and low flows.

Eildon to Trawool

Salt loads past this section are 250-300 tonnes/day at 60-75 EC. There is little variation in the salinity and residual salinities of around 10 EC indicate the base flow contribution by tributaries. Flows from Eildon make up between 10 and 100% of the flows at Trawool and the salinity regime reflects this. The highest salinities correspond to periods of low release (winter) when salinities in tributaries are lower because of the effect of dilution.

Trawool to Murchison

This reach has shown a decrease in loads since 1990, down by 80 tonnes/day to 200 tonnes/day or 50 EC in that time. There is a complex area with diversions at Goulburn Weir and inputs from the South West Goulburn. Flow regimes at Trawool are up to 40 times greater than at Murchison, largely because of the diversions at Goulburn weir. The complexity means that the loads and concentrations are poorly correlated and are highly variable. Around to 6-25% of loads originate as base flow or from the tributaries of the South West Goulburn. The proportion increases as loads at Murchison decrease which supports the view that tributaries at higher reaches have the greater effect on stream EC.

Murchison to McKoys

This reach receives flows from the Strathbogie ranges and the Goulburn plains. It also passes through the Shepparton Irrigation Region (SIR) with the consequent impact of drainage returns. Estimated mean load increase from between 200-280 tonnes/day at Murchison to 540-400 tonnes/dayay at McKoys. The data shows a downward trend, probably commencing around 1989.

Tributaries

The gauging stations are not well placed to describe processes in this reach of the river. All come under the influence of other processes further back from the main stem. The figures indicate that this area is not a major contributor of salt to the Goulburn at present. In the future the dryland part of this area will be strongly influenced by outbreaks of salinity in the Plain-upland interface

Broken Catchment

Mean stream salinity increases along the river from Moorngag to Rice’s weir by about 20 EC. The decrease in EC between Katamatite and Rice’s weir is caused by irrigation drainage returns.

Salt loads increase along the length of the system. The high salt loads at Gowangardie are likely to result from the local influence of irrigation. The situation at Katamatite arises when water is diverted from higher up in the system and returned in irrigation drainage below Katamatite

Moorngag to Casey’

The smoothed salinity trend at Moorngag has stayed constant since 1983 following a decline in the preceding six years. At Casey’s weir the salinity has increased since 1990.

There has been an increase in the salinity difference between Moorngag and Casey’s of 10 EC from the mid 1970’s to 80 EC in the late 1980’s. Analysis shows that the salt load at Moorngag is not a good predictor of the salt load at Casey’s weir.

Casey’s Weir to Katamatite

While salinity at Casey’s weir has been increasing the trend at Katamatite is stable. Since the late 1980’s these has been a decrease in salinity from Casey’s weir to Katamatite. Diversions between the two stations means there is little correlation between the loads or stream salinities. The flow at Casey’s is greater that that at Katamatite for long periods of time

Katamatite to Rice’s Weir

There is little difference between the salinities in this reach of the system although the time series analysis shows that there can be very large differences, with salinity in the upstream section frequently higher than that lower down.

Mean flow at Rice’s Weir is significantly higher than mean flow at Katamatite, the result of drainage returns from the irrigation region. This leads to salt loads at Rice’s Weir being much higher than at Katamatite.

2.6 Projections

The potential extent of the dryland salinity problem is described in the report “Prediction of the Ultimate Salt Load from Victorian Dryland Catchments to the Murray River (DNRE, 1999), otherwise referred to as the Ultimate Salt Loads study. The projected increase in area affected by dryland salinity and impact on stream saltloads from this study can be considered a worst case scenario.

The total area of high water tables in the catchment is anticipated to increase from 1,170 km^2 at present to 6,600 km^2 by the year 2100.

There are two areas of primary concern - the Riverine Plains and the Plains-Upland interface along the foot of the Strathbogie Ranges. The area of the Riverine Plains with high water tables is predicted to expand from 0 to 2,800 km^2. The area of high water tables in the Plains-Upland interface is projected to increase from around 130km^2 to 350 km^2 (Figure 2).

Across the dryland, 135,000 ha will be severely salt affected. A further 500,000 ha will be moderately to severely affected. This increase in dryland salinity will result in an additional 160,000 tonnes of salt being mobilised to the land surface (MDB Audit, 1999). Much of this salt will be retained in the landscape.

The salt that does reach the streams will cause:

- an increase in stream salinity in the Goulburn River at the Goulburn Weir by 20 EC (up from 120 EC currently to 140 EC by 2100),
- a doubling in the Broken River at Casey's Weir (up from 130 EC currently to 270 EC by 2100), and
- an increase in the Murray River of 100 EC (up from 130 EC currently to 230 EC by 2100).

The management of these projected changes in the condition of the catchment will be the focus of the Goulburn Broken Dryland Salinity Management Plan for the foreseeable future.

It has to be recognised at the outset that there is little that can be done to manage the development of discharge on the Riverine Plains area. The very large area involved, and the slow response time of the regional groundwater flow systems, mediate against any effective action to control watertable rise other than engineering options. Such measures can only be justified to either protect high value assets or as part of a Basin-wide strategy of salt interception works. Work in this area needs to concentrate on living with salt and developing profitable farming systems that complement a vastly altered landscape.

The management of stream salt loads will need to focus on the South West Goulburn and the Plains-Upland interface, and to a lesser extent the Broken Highlands.

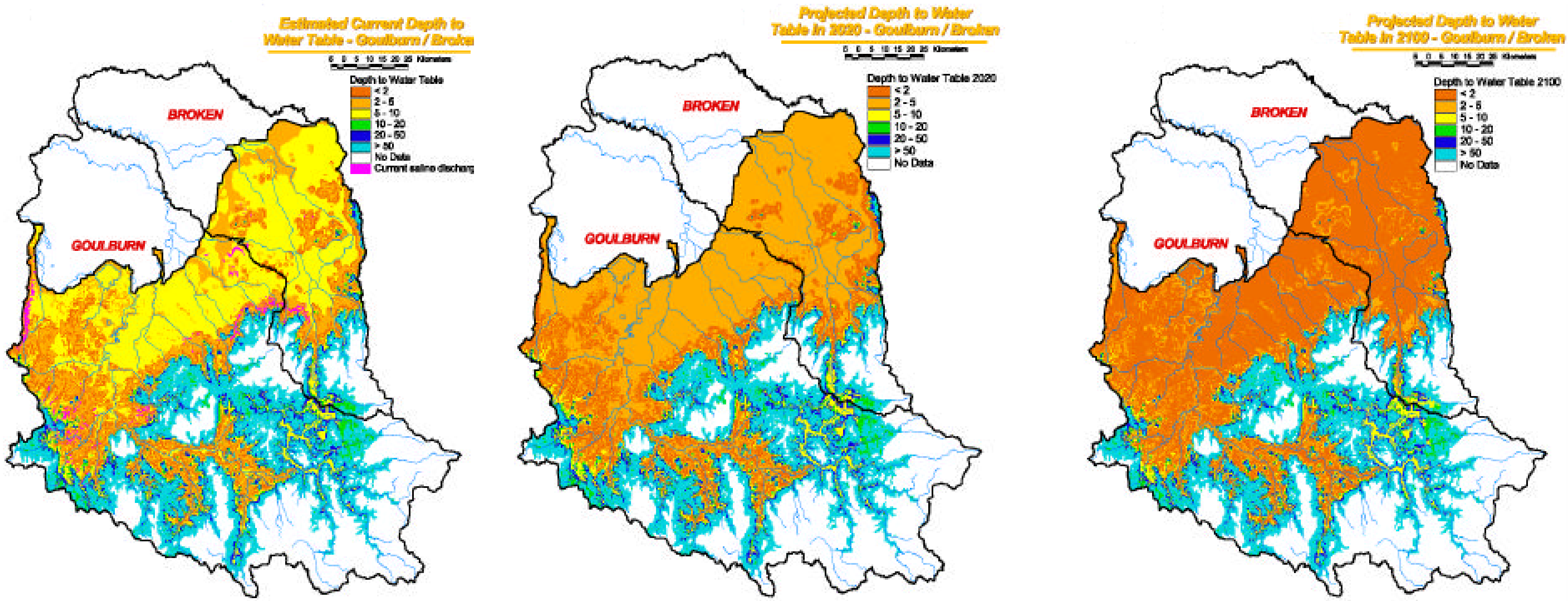


Figure 2 Change in depth to water table to the year 2100 (SKM, 1999)

2.7 Relationships to other Natural Resource Management issues

Water quality

Excess salt is clearly a water quality issue. It adversely affects in-stream habitat for many aquatic and riparian species. Dryland salinity also impacts on waterway health by increasing rates of soil erosion in catchments, and along stream banks and beds.

The effectiveness of recharge management for improving in-stream condition depends largely on the connectivity between the recharge zones and the streams, and will vary across the catchment. Work is currently underway to provide a better understanding of connectivity across the landscape, and the impact of salinity on aquatic ecosystems.

Salinity mitigation works to reduce salt accession to streams (eg. revegetation of stream buffer strips) will have obvious benefits for other water quality issues. Areas where priority zones for salinity and waterway health are likely to correspond include the Goulburn and Broken Highlands and the South West Goulburn. The association between waterway health and salinity priority zones will be investigated over the next 18 months.

Soil acidity

Soil acidity has already had a significant impact on the salinity program in the Broken Highlands by limiting the area suited to lucerne and perennial pastures. This is likely to be an increasing problem with the area of low pH soil projected to increase significantly over the next 50 to 100 years. It is of particular concern where low pH soils are expected to expand into the lower rainfall zones of the catchment, since these areas are where pasture-based solutions are more likely to be adopted than the option of high density trees.

The major challenge for management of low pH soils is the insidious nature of the problem. Plant water use efficiency can be severely reduced before the more obvious signs of soil acidity, such as the emergence of indicator species, present themselves. This has implications for the effectiveness of proposed solutions for the salinity problem based on high water use by vegetation. Much of the high priority area along the Plains-Upland interface has naturally acidic soils with low buffering capacity. There is a tendency to further acidification, even under native vegetation, albeit at much lower rates than under high-risk practices such as annual pastures, cropping and horticulture. It is important to make an assessment of the risk posed to the successful management of dryland salinity by acidification of the landscape.

Water supply

Management of water supply is equally as important as water quality. The impact of large-scale land use change on water supply for downstream irrigated agriculture or environmental flows need to be considered carefully. The implications of revegetation on catchment water yield are being investigated as part of the National Action Plan for Salinity and Water Quality, for each sub catchment in the dryland area. This issue will be an integral part of the community planning process for setting salinity management targets. By necessity, such planning will extend to the irrigation community through the agency of the GBCMA.

The supply of water in the Goulburn catchment is dominated by catchment yield upstream of Eildon, an area not targeted for salinity remediation works. Most of the area targeted for extensive revegetation occurs in the lower rainfall areas, where runoff is much lower, and reduction in runoff following revegetation is less. Because of this, it is unlikely that revegetation works carried out in the catchment for salinity control will seriously threaten downstream flows. The main concern from revegetation in this instance is some localised impacts on stream salinity, as a result of short-term loss of dilution flows. The GB Salinity Program will link to the work carried out under the Catchment Characterisation project to estimate the effects of revegetation on stream salinity and salt loads.

Native Vegetation and Biodiversity

There are already close associations between biodiversity programs and the salinity program in the Goulburn Broken Dryland. The Environmental Management Grants system determines rates of incentives for revegetation and vegetation protection works based on combined salinity and biodiversity priority criteria. All non-commercial plantings are carried out within the guidelines

specified in the Goulburn Broken Revegetation Guide. It is anticipated that the Salinity Plan will also utilise information developed from the Bioregional Planning process wherever possible.
The Plan is also working towards the integration of biodiversity principles into commercial plantings, including the strategic placement of corridors and buffers of native vegetation within commercial plantations.

Pest Plants and Animals

The management of pest plants and animals is an important issue for the catchment community. Areas of native vegetation can be harbours for weeds and vermin, if not managed appropriately. Rabbits can severely limit the success of revegetation and natural regeneration. There is considerable scope to manage pastures throughout the region for the combined objectives of productivity, weed control and recharge management. Appropriate rotational grazing systems, which promote the spread of perennial species, can be a highly efficient weed control strategy.
There is a need to better integrate Pest Plant and Animal Programs with the Salinity Program, to ensure that high priority weeds are effectively managed. Requirement for pest control could be integrated into the conditions of grants, in the case of on-farm plantings, and into contractual agreements, in the case of commercial plantings where the CMA or agencies are involved. Details will be worked out with staff over the next 12 months.

Chapter 3 Achievements

Perennial pastures (exotic grasses and lucerne) have been the mainstay of the program, accounting for over 70% of all works completed. Around 200 ha/yr of high density tree plantings, as revegetation, break of slope or protection of discharge areas, have been completed since 1996.

Trends in area planted annually are very responsive to seasonal influences, more so because of the high proportion of pastures that make up the works activities.

It is now understood that the targets set in 1989 and modified in1995 were inadequate for dealing with dryland salinity. It will require at least a twenty-fold increase in on-ground work activities to meet the end of valley targets.

Much of the extension and education activities of the Plan have focussed on the traditional landholder base. There is a need to adapt the plan to a changing community structure across the catchment.

The importance of pastures has already been emphasised. Perennial pastures are no longer promoted for recharge management, in areas where the annual rainfall is over 650 mm. Where they abut onto remnants landholders are also required to keep a 20m buffer between the pastures and the remnant.

In the past five years closer links with farm forestry and plantation ventures have been developed. This has culminated in the development of decision aids to allow investors, processors and growers to evaluate the opportunities for commercial tree growing activities in the catchment.

The cropping program is no longer supported by the salinity program. This is due to increasing costs of program support and the recognition that improved cropping practices offer only small gains in control of recharge when compared with other perennial vegetation options.

Community education has been an important part of the SMP since it began. The community education program has been highly successful in raising the level of awareness of salinity. The challenge throughout the life of the plan has been to convert this awareness into action. In recent years, through work by Curtis (2000) and others, we have developed a better understanding of the change process and the pressing need to move away form voluntarism to more equitable business based solutions.

After 12 years there s still many questions that need to be answered. High on the list is the processes by which salt reaches the streams or is discharged to the landscape; this is important information for effective targeting of works. Other notable issues include identifying assets, beyond water quality, and the threats posed to those assets.

Local Area Planning has been heavily promoted in the last three years as one way to involve the community more in the processes of natural resource management. Local area plans in their simplest form have been developed for the whole of the dryland catchment.

Making sure that costs of natural resource management are shared equitably has been an important plank of the GBDSMP to date. The cost share arrangements have undergone constant revision as the need to capture multiple benefits has grown.

In 2000 a new grant system was developed-the Environmental Management Grants. These combined salinity, biodiversity and soil management outcomes in assessing the value of government contributions to and the conditions placed on grants. The purpose was to maintain equitable cost sharing arrangements while at the same time ensuring that works were properly targeted and reflected the priorities of funding agencies

3.1 Priority Activities

Since the original Goulburn Broken Dryland Salinity Management Plan (SPAC, 1989) was developed, the focus of implementation has remained the establishment of vegetation on high recharge areas. These include:

- high density trees,
- low density trees on land with less than 600mm annual rainfall,
- lucerne, and other deep-rooted perennial pasture.

Discharge sites were also to be protected using suitable salt tolerant species. The 1995 Review of the salinity program led to some changes in the type of works promoted.

- the use of perennial pastures as a recharge control option was limited to areas with an average annual rainfall of 650mm or less.
- break of slope tree planting was promoted as a groundwater interception option in appropriate landscapes.
- tree planting in 'potential discharge areas' was promoted through the establishment of high-density tree plantations in areas close to active discharge sites. The aim was to prevent further spread, using similar principles to those behind Break of Slope plantings.
- Groundwater pumping was also recommended, but was limited to on-site groundwater use due to the lack of salt disposal entitlements for dryland areas.

The option of '*living with salt'* was not accepted by the Salinity Program Advisory Committee (SPAC), nor has it formally been accepted since by the Implementation Committees of the CMA. It is now clear that it is unrealistic to continue to ignore the living with salt option.

The original GBDSMP divided the catchment into 13 Land Management Units (LMU's). These LMU's (see Figure 3) were defined by their hydrogeological characteristics and potential salinity risk, and were used to prioritise where works would be carried out in the catchment.

The priorities and proposed actions for the various LMU's are reported in the 5 year review.

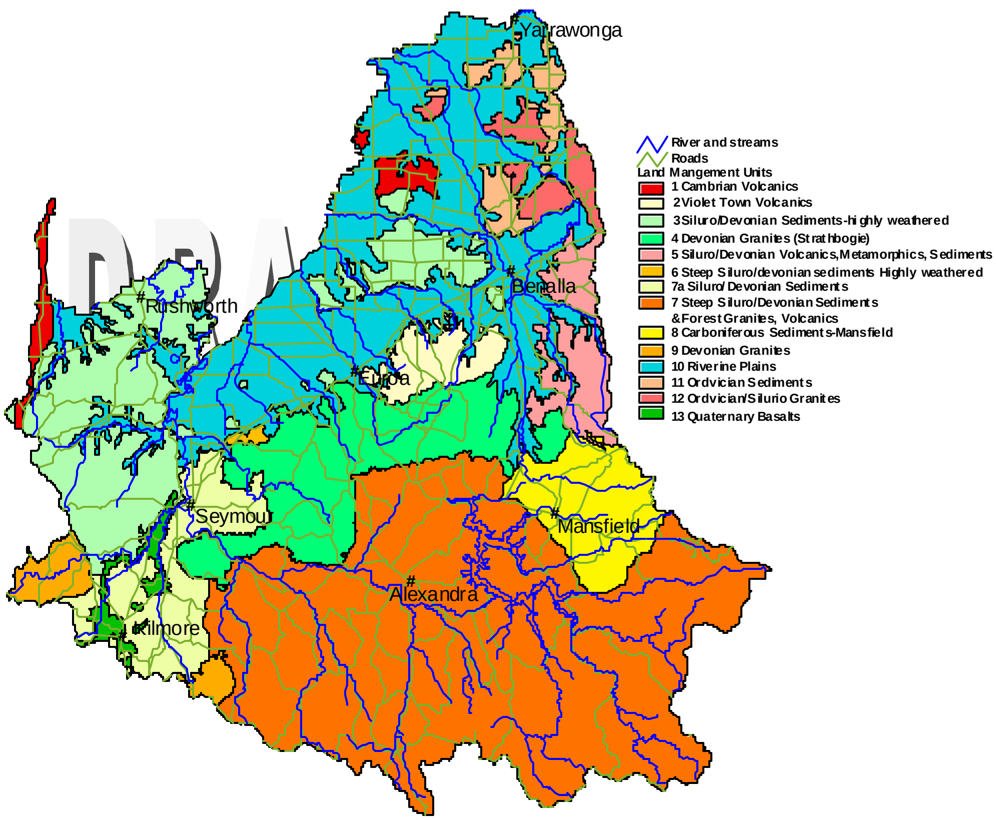
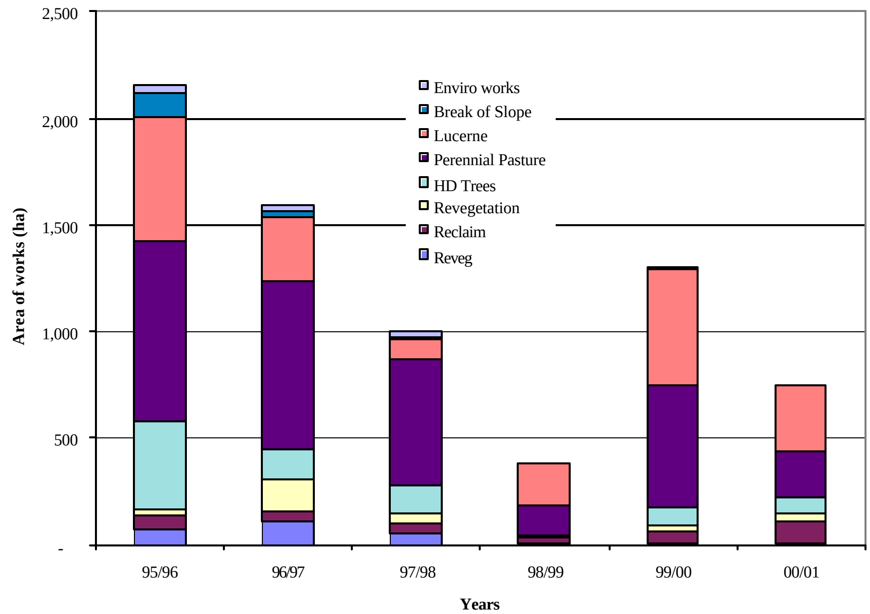


Figure 3 Land management units in the Goulburn Broken Dryland

3.2 Achievements against targets 1995 -2001

The original GBDSMP established targets for works in the different LMU's. These were amended in the 1995 Review to reflect what could be achieved given the level of investment by Government in the Salinity Program. The targets set in 1995 are shown in Figure 5. The major changes were:

- the reduction of targets for low density trees
- the doubling of targets for the area of high density trees
- a five fold increase in targets for the area of lucerne



Overall achievements are shown in Figure 4. It clearly shows that perennial pasture and lucerne have been the mainstay of the works program (see table 2 and Appendix1)..

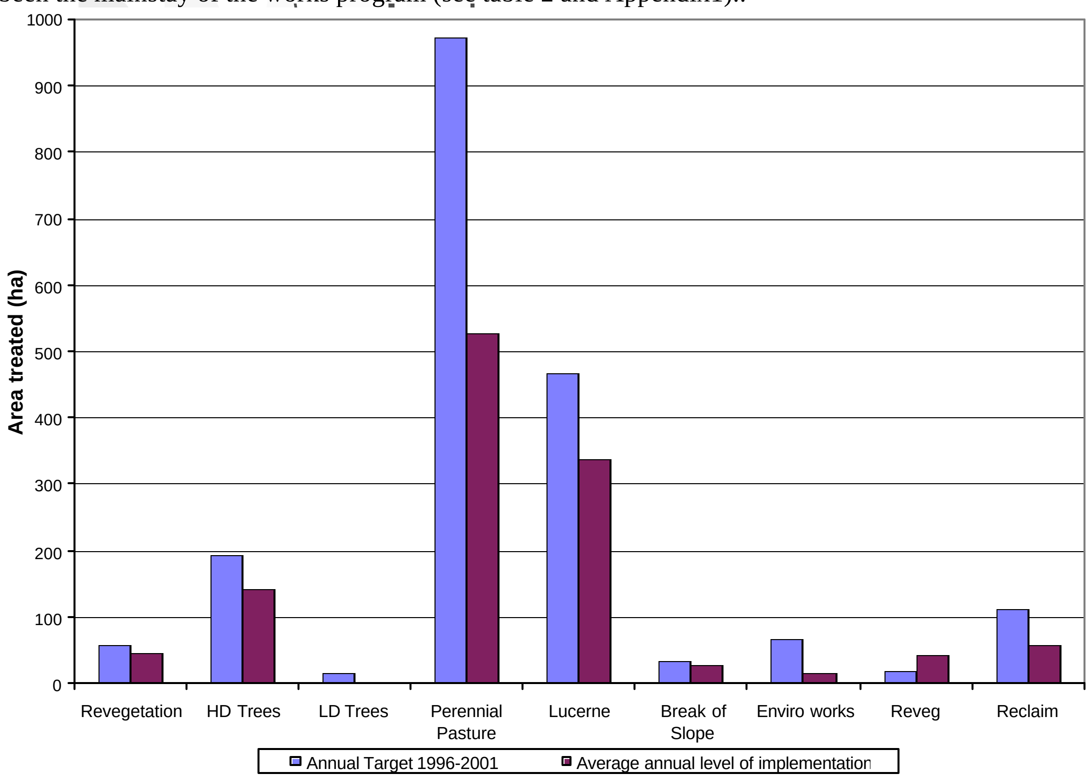


Figure 4 Average annual works compared to annual targets 1995-2000

Table 1shows the variability in annual works which is characteristic of natural resource programs. High variability is due to changing seasonal and market conditions. There is some evidence of a slow down in the overall rate of works with time which may reflect a waning interest or falling capacity on the part of the community to participate in works programs.

Table 1 Variability in annual works program 1995-2001

	Recharge							Discharge		
	Reve-getation	HD Trees	LD Trees	Perennial Pasture	Lucerne	Break of Slope	Native vegetation protection	Reve-getation	Reclaim	GW Pumps
95/96	24	420	10	839	586	111	38	72	66	1
96/97	150	135	-	798	291	32	27	109	50	1
97/98	48	132	-	588	94	12	28	58	44	3
98/99		7	-	141	197	-	*	7	27	
99/00	23	92	-	568	548	10	*	5	61	#
00/01	43	68	0	224	305	-	*	6	102	#
Total	287	855	10	3,157	2,020	165	94	256	350	5

Over the years since the 1995 Review, there have a been several changes in the emphasis of works including a:

- decline in the role of perennial grass pasture because of questions over its capacity, in high rainfall areas, to affect recharge significantly and the threat that grasses such as phalaris pose to environmental values
- reduction in the investment in discharge treatment, mainly in response to budget cuts to the programs
- increased emphasis on the protection of remnant native vegetation

The average area treated per year over the first five years of Plan implementation (1,220 ha/yr) is very similar to that achieved in the following 6 years (1,199 ha/yr) (see Figure 5).

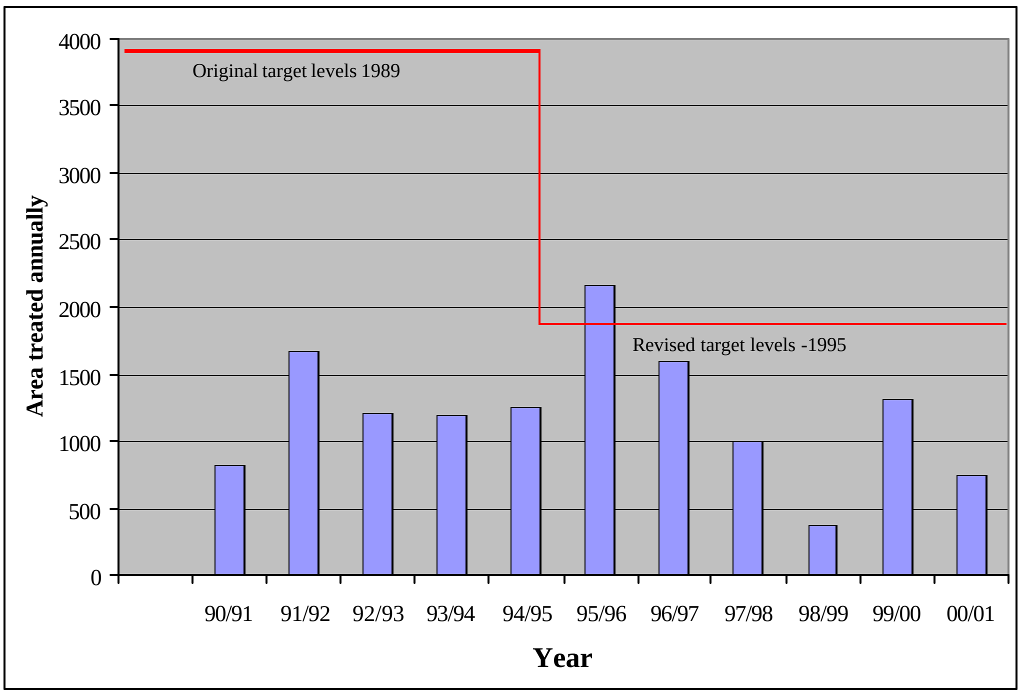


Figure 5 Area treated annually

Achievements by LMU

As expected the level of achievement has varied across the catchment. This has in part been a result of funding, location of staff, enterprise differences, seasonal conditions, and priority placed on the various work activities. Table 2 shows achievement for the six-year period for each of the LMU's, along with the percentage of 1995 target achieved.

Of the total works, 74% of the area has been treated by pasture of one type or another. Of this, 26% has been treated by perennial grass pasture, a control option that has since fallen out of favour.

Of the total area treated, 18% was using high-density trees. This equates to 1,200 ha over 6 years, or an average of 200 ha each year.

The number of grants approved has remained steady at around 300 per year, which suggests that the interest in salinity control works has not altered. However, there has been a decline in the number of approved grants actually undertaken and completed, which points to a growing perception that cost-share arrangements were not equitable, and that other demands on landholder time and labour were affecting their capacity to do the works required.

Table 2 Works achieved for each LMU between 1995-6 and 2000-01. **Figures in brackets are percentage of target achieved**

	High and moderate recharge							Discharge	
LMU	Native Revegetation Ha	High Density trees ha	Low density trees ha	Perennial Pasture ha	Lucerne Ha	Break of Slope ha	Enviro works	Revegetation ha	Reclamation ha
1a	-	2 (2)	-	74 (25)		-	-	8	37 (62)
1b	-	43 (72)		331 (46)	385 (58)	-	-	6	10 (33)
2	46 (153)	42 (28)	10 (33)	26 (9)		139 (77)	-	11 (37)	18 (20)
3	43 (72)	89 (148)	-	199 (41)	310 (65)	-	2	49 (408)	6 (14)
4	-	12	-	-	-	-	-		-
5	116 (193)	147 (98)	-	129 (43)	45 (150)	26 (87)	-	27 (225)	45 (75)
6	32 (107)	89 (40)	-	595 (38)	200 (67)	-	24 (29)	6	112 (49)
7a	20 (28)	40 (33)	-	284 (33)	-	-	-	1	50 (56)
7b	-	114 (127)	-	658 (110)	-	-	-	33	58
8	-		-		-	-	-	-	-
10a	2 (17)	19 (24)	-	104 (36)	323 (43)	-	50 (93)	29	5
10b	1 (8)	7 (23)	-	48	502 (418)	-	-	-	1
10	5	37	-	3.53	225	-	-	27	14 (233)
11	-	31 (129)	-	26 (29)		-	-	-	1 (17)
13	-	12 (33)	-	6 (3)	-	-	-	-	-
LMU not recorded	-	22	-	196	31	-	-	-	7
Total	265 (77)	706 (60)	10 (11)	3029 (53)	2021 (71)		76 (19)	206 (181)	364 (52)
Annual targets 1996-2001	57	195	15	973	765	35	67	19	112

Environmental Management Grants

In 2000, steps were taken to change the cost-share arrangements with landholders, so that they reflected the true cost of undertaking works. These were managed through the new Environmental Management Grants scheme (EMGs). Although it is too early to be sure about the impact of the new grant system, there has been a slight increase in the number of grants written, buta large increase in grants being completed. Also the average area of works of each grant is greater. By the end of March 2002, there have already been 300 ha of high-density revegetation works, and 200 ha of remnant vegetation protection works, completed for the financial year.

Adequacy of targets

It is now clear that the targets set in 1989, and modified in 1995, were not adequate to address the salinity problem. This, coupled with the difficulties of reaching those targets, points to the need for a radical shift in the delivery of the program and its focus on on-farm works. This issue will be taken up in Chapter 4.

3.3 Extension program

The model of extension applied in the GBDSMP has essentially remained unchanged over the 12 years of its implementation. It is largely based on the philosophy of agricultural extension, using a combination of one-on-one and group extension techniques where appropriate. For the most part the aim has been to convince landholders of the appropriateness of better natural resource management and assist them to implement the works. Various attempts have been made to prove the profitability of preferred management practices, usually without a full understanding of the financial consequences (including peak debt, pay back period and borrowing requirements) or a proper recognition of the difficulty of changing long held practices or beliefs. Barr (1999) has analysed the process of change and it is notable that for the most part the extension agencies deal with only a small part of the process of change (see Community Education section).

A major difficulty in assessing the achievements of the extension program has been the lack of any suitable measure of success. Measures to date have been limited to the uptake of grants. Two crucial questions that need to be addressed in the short term are: 'To what extent the SMP relies on on-farm works program to achieve its goals?' and 'How does it best maximise the effectiveness of service delivery to the community?'

Community Links Officers

In 2000, and in response to the need to lift implementation rates, a program was developed to employ local community representatives to work within their communities as salinity extension officers. This was designed to provide a known contact person, and to overcome the problems of transient agency staff being unable to develop a rapport with local communities. Three part-time Community Links Officers were employed originally; this has since been expanded to six. Their role is to contact landholders, provide information on revegetation or remnant protection works, to prepare grant submissions, and to provide follow-up advice and support. The program has been very successful in expanding networks within local communities. It is believed that this closer link to the community is one of the reasons for the higher conversion rates. It has allowed a more pro-active approach to generating interest in works, more consistent follow-up on expressions of interest by landholders in grants, and the provision of information which is more specific to individual landholders' needs and interests. This closer contact with the community, along with the EMG's, is the reason for the improved rate of conversion of grants to works.

Communication Strategy

Effective communication with the regional community is essential for the successful implementation of the GBDSMP. However effective and efficient communication processes have proved to be difficult to achieve. A communication strategy was prepared with the objective of improving information flows to the community, and establishing protocols for communication between agencies. The plan was accepted by the Implementation Committees, but never formally implemented. It has since been replaced by other strategies of similar intent. The number of communication strategies, and the on-going call for better communication processes, points to:

- an as-yet unresolved definition of the true problem of communication within the catchment;
- a failure to properly identify the objective of a communication strategy; or
- a lack of commitment by service agencies to adapting to changed circumstances and changes in target groups.

This remains an important issue for the community groups and agencies to resolve. Any such attempts should focus on reviewing and, where appropriate, implementing what already exists (see Community Education Program).

3.4 Community education program

As a result of the Five Year Review of the Salinity Program, the objectives for Community Education program were broadened to:

- raise awareness of salinity and related Landcare issues within the community, particularly those communities directly affected by salinity in the Goulburn Broken Dryland;
- increase the community understanding of salinity and related land degradation issues;
- motivate the community to implement works recommended in the Goulburn Broken DSMP; and
- provide education programs to community groups and schools.

The review also flagged that the development of a Communications Strategy was a high priority, and that this strategy should develop programs for:

- Farming community
- Community groups
- Local government
- River Management Authorities
- Schools and other educational institutions
- NRE Staff
- C&LPB (now CMA)
- Water boards
- General Community

Successful programs such as the Community Salinity Grants Program, Saltwatch, Waterwatch and Watertable Watch would continue.

Achievements 1995-2001

The achievements for the Community Education Program for years 5 – 12 of the GBDSMP are as follows:

- Field day displays, tours, brochures, newsletters, television commercials and newspaper articles
- Development of a Communications Strategy for the Dryland in 1998
- Commencement Links Landcare support in 1999
- Development of Landcare Management Guidelines in 1999
- Community Liaison Position in the Upper catchment
- Survey of Landowners in 2000 to explore the willingness and capacity to manage dryland salinity
- Workshop on communication of NRM issues in 2000
- Development of an educational video
- Saltwatch in 2001, included 18 schools and 400 children
- Local Area Plan development
- Development of a Weed Booklet
- Education Kit for schools in conjunction with the Landcare Networks (in progress)
- Production of a resource booklet for NRM in the dryland catchment (in progress)
- Developing a information kit for Local Councils to send out with rates notices or when land changes hands (in progress)

The Community Education Program has been subsumed by the Landcare Support positions in the last two years. To the extent that Landcare plays a key role in the generation and transfer of information, this is a natural progression. When the support for Landcare is coupled to the work in schools and the development of education kits, we have a program that looks very much as it did 10 years ago.

It has been shown that awareness of salinity is high in the catchment, at greater than 90%, although there is no clear description of what the 'awareness' means. It could mean anything from being aware that there is a salt problem somewhere 'out there' to a full understanding of how salt is released into the landscape, the implications of that salt release and the appropriate means to deal with it.

Work by Curtis *et al* (2001) has also shown that land managers are unlikely to be concerned about salinity unless they have direct experience of its impacts. Curtis, when asking land managers about best management practices for salinity management, reported that landholders felt they had sufficient information or knew where to get information if they so required it. This suggests that efforts to provide information to landholders have been successful insofar as they appreciate the problem, but probably not as successful in convincing landholders and the community in general of the extent or severity of the problem.

The Community Education Program, as it was originally conceived, has been successful. It has created a wide awareness of the problem, developed close associations with school programs through Saltwatch and Waterwatch, has been instrumental in the on-going support for landcare, and has been largely responsible for the heightened appreciation of social issues in the dryland.

There are some unique characteristics of natural resource programs that have been glossed over in the development of extension and education programs. These are:

1. the reliance on altruism at the expense of self-interest. There is an expectation that landholders should be prepared to sacrifice some part of their lifestyle in support of 'green' values.
2. the high level of community investment associated with natural resource programs. This brings with it a different set of accountabilities compared to industry funded programs more typical of agricultural extension programs.
3. the cause and effect relationships between actions and outcomes is far more tenuous in natural resource issues than other production issues. This increases the uncertainty about the appropriateness of actions being promoted to protect natural resources. It is well established that landholder interest in action wanes as the uncertainty of what they are being asked to do increases.

The assumptions now and then are listed in **Table 3**.

Table 3 Assumptions supporting the GBDSMP (MacFarlane 2002)

Assumptions at the start of the GBDSMP	Now
Awareness of a problem leads to action	• Awareness of a problem does not always lead to actions due to other social and economic priorities.
Most people recognise and understand the problem	• Very few people understand the problem and its causes in any detail.
Information leads to action	• The information required by individuals and parts of the community varies enormously. • Action is the result of a long chain of processes and information gathering is but one part of that process
Our information is sufficient	• Most of our information is technical. The key information on financial and social impacts is rarely considered • The available technical information is rarely sufficient to compel land managers to act
Land managers are homogenous	• No two land managers are the same in attitude, education, experience, business demands or aspirations
Our solutions are profitable and adaptable	• With few exceptions most of the proposed solutions have high financial risk and require new skills and changes to farming systems
Everyone wants to do their utmost to protect the natural resources of the catchment	• Most people are driven by short-term demands or have long term aspirations that do not take into account the condition of natural resources.
Salinity is a problem that can be managed with a strong on-farm focus	• Current information suggests that the scale of works required to remedy the problem of dryland salinity precludes relying on existing farming systems.
There will be sufficient support to landowners who want to protect natural resources	• There is neither sufficient support in terms of dollars or technical expertise to support all landowners who want to protect natural resources
By educating Landcare members we will be educating the rest of the community	• Landcare members are only a small part of the community and the program needs to include other groups.
Management of salinity in dryland areas can largely be accomplished using vegetation options	• The dryland salinity problem is amenable to control using vegetation in some parts of the landscape. Other parts of the landscape cannot be protected. Engineering solutions are an important part of the management of the impacts of dryland salinity in the short term

Our understanding of the assumptions behind the Plan have grown enormously over the past five years. This change is an example of how Plans develop and change with time. The challenge is what to do with the improved understanding.

It needs to be recognised that the changed assumptions have two important implications. First, and most obviously, are the implications for how we manage the Plan and how we interact with land managers. The second, and probably more important, is how we define and then work with an expanded target audience.

3.5 Pasture Program

The pasture program has been responsible for the majority of the area treated over the last 6 years (5,177 ha), through grants for the establishment of lucerne and perennial grass pasture. Much of this was effectively targeted to the Riverine Plains area and within the high priority LMU’s 6 & 7a.

Lucerne

The water use of lucerne has been assumed to be similar to that of trees, and lucerne pastures were assumed to remain in place for 30 years or more, with no fall-off in water use. For pastures to be retained this long, requires a very high level of management, and there are few land managers who can, or want, to retain a lucerne pasture for so long. For the most part, lucerne is grown in rotation. The practice of intercropping lucerne is not widespread. This means lucerne is, at best, similar to perennial grass pasture in its water use patterns (GBCMA, 1995), and most likely only 40 to 50 % as effective as trees as an on-farm water use system. Nevertheless, lucerne remains an attractive option for producers in the catchment. As stated earlier, it is the one of the few management options showing an increase in implementation. rates.

Perennial Grass Pastures

The establishment of perennial grass pastures (particularly Cocksfoot and Phalaris) was a major focus of the original GBDSMP. Assistance for establishment of perennial grass pastures is now only provided in areas receiving less than 650mm annual rainfall. This is because their effectiveness in creating a large enough water deficit over the summer-autumn period is hampered by restricted root development in acid soils, with shallow A horizon. These are common characteristics of higher rainfall areas in the Goulburn Broken. In any event, their potential to create a soil water deficit under grazing is somewhat less than first thought at the inception of the Plan.

The Implementation Committees, in response to concerns raised by environmental groups, has placed restrictions on the use of exotic perennial grasses. In order to prevent the spread of Phalaris and Cocksfoot into remnant native vegetation areas, a 20 metre buffer is now required between perennial grass pasture and areas of remnant vegetation on roadsides.

Native Grass Pastures

The Salinity Program has investigated the potential role of native grasses in salinity management. It has been found that native grasses, on their own, did not increase water-use sufficiently to be considered a viable recharge management option, particularly in the higher rainfall areas. However, it is recognised that a well-managed native pasture with a good cover of perennial grass species such as Kangaroo Grass (Themeda), Wallaby Grass (Danthonia), or Weeping Grass (Microlaena) will be much more effective for recharge control than a weedy or annual pasture.

The management of existing native pastures to promote the spread of the surviving perennial species needs to be encouraged. Research and experience has shown that management of native pastures, through appropriate rotational grazing systems, can quickly lead to the spread of native grass species. It is likely that this is the most effective way to promote native grasses. At present, the cost of native grass seed and its low availability make the sowing of native grass pastures uneconomic.

Low-input management of remnant native pasture can be a cost-effective salinity treatment option where perennial pasture establishment or revegetation is either not economic, or not desired by the landholder. This approach appears particularly well suited to cleared high recharge hill country, on steeper slopes or where soils are shallow or stony.

It was also recognised that native grasses have a role in other issues beyond salinity management including the preventing soil erosion and maintaining or enhancing biodiversity.

Management

The water-use of all pastures is influenced by how they are managed. In general, management which optimises productivity can also optimise recharge control benefit, since water-use is directly related to pasture growth.

Set-stocking practices, or heavy grazing pressure over the summer-autumn period, compromises the effectiveness of pastures for recharge control, by reducing the leaf area and hence the transpiration potential. More intensive pasture management systems, such as the cell-grazing approach and appropriate lime and fertiliser applications, will increase the cover and vigour of perennial species, leading to increased productivity and increased water use. To date, this approach has not been widely adopted. This is due, in part, to the costs of additional fencing and stock water points, and its demands for continual and intensive monitoring and management.

3.6 Farm Trees Program

Trees are the most effective biophysical agent for controlling recharge, when planted at a sufficiently high density. The 1995 review recommended that the density of tree planting funded by the Program be increased to 500 stems to the hectare. This was subsequently adopted and implemented.

The review also recommended that a farm forestry/commercial forestry strategy be developed, as it was necessary to greatly increase the area planted under trees. Since then, considerable interest in farm forestry has developed as a result of work carried out by the Farm Forestry North East Program. Commercial hardwood plantations have been established by Eastern Plantations Forestry Limited, and significant progress has been made towards the establishment of a plantation hardwood industry. Plantations of Blue Gums and other hardwood species totalling several thousand hectares have been established across the North East.

In 1999-2000 a trial was undertaken in co-operation with the Co-operative Farm Forestry Initiative program to establish 10 farm forestry sites of 10 hectares or more in priority salinity areas in the below 650 mm rainfall zone. This now stands as a model for future development of farm forestry in the lower rainfall zones.

Our understanding of the effectiveness of trees for recharge control has developed significantly. Examples include the Break of Slope plantings, and investigations into where in the landscape plantations can best be located to maximise salinity benefit whilst still providing commercial return.

3.7 Cropping Program

The cropping program is no longer supported by the salinity program in the Goulburn Broken because of shifts in priorities of DNRE. It is highly unlikely that improved cropping management can significantly reduce recharge, unless new perennial crops are introduced or new techniques developed to manage recharge during fallow periods. However, improved management of crops in an altered landscape will be necessary across the Riverine Plains as part of an overall package of better management practices. The integration of lucerne into the cropping-pasture rotations remains a responsibility of the pasture extension component of the Plan.

3.8 Saline Agriculture Program

In the 1995 review it was considered that saline agriculture would never be a significant part of the Plan and was ranked a low priority. While there is no immediate urgency, the saline agriculture program will become an important component of the Plan in the future.

3.9 Saline discharge and groundwater management program

Groundwater pumping and reuse has been trialed as a salinity control measure by the GBDSMP in the Nagambie, Tatong, Lurg, Dookie and Colbinabbin areas. Pumped groundwater has been used for irrigation of lucerne, pasture, grapes and timber plantations. Investigations have been carried out on where to best target groundwater pumping for salinity control, and incentives are available for test drilling and groundwater pumping developments in priority areas across the dryland. There is currently a moratorium on further pumping from deep lead aquifers in the Nagambie area until sustainable yields are determined.

Generally, this can be an effective approach where groundwater yields and salinities are suitable, and where a sufficiently high value use of the water makes it an economic investment. Typically, it is the economic and social issues, rather than technical feasibility, which limit the application of this approach.

Since the dryland has never had access to any Salt Disposal Entitlements (SDE's), there has been no capacity to dispose saline groundwater to streams in the dryland. This still remains the case.

A set of possible conditions that, if met, would allow disposal of saline groundwater or diversion of saline surface or sub-surface water, was to be set out in the proposed Dryland Drainage Strategy. The completion of a Dryland Drainage Strategy was seen as a high priority in the 1995 Review. At the time of writing, the preparation of this strategy has been subsumed into the wider Floodplain Management Strategy, which is currently at a draft for comment stage. There is still a need to establish the rules by which salt disposal in the dryland can be managed, within the requirements of the MDBC SDE cap.

It was also suggested that the formation of a salt credit market might allow trading of SDE's into the dryland. Such market structures are still some way off.

3.10 Environmental program

The integration of the salinity program with the biodiversity and native vegetation management programs in the catchment is now all but complete. The Environmental Management Grants scheme combines environmental and salinity management outcomes in one assessment and prioritisation process. Funds from biodiversity and salinity programs are combined to ensure multiple benefits. The bioregional planning approach will be integrated with the EMG system when it is finalised.

The priorities of the Environmental Program of the GBDSMP have been superseded by the priorities under the Regional Native Vegetation Plan. The Salinity Program will continue to support the principles established under Victoria's Native Vegetation Management Framework.

There will need to be further co-ordination of monitoring data in the future, to better understand the threats and risks posed to biodiversity by dryland salinity. For example, it is highly unlikely that a significant level of expenditure can be justified to protect or enhance native vegetation in areas of the Riverine Plains where the predicted expansion of salinity and waterlogging makes that vegetation unviable.

3.11 Monitoring Program

Works monitoring

The past 6 years have seen substantial advances in the monitoring of works. The catchment developed its own program for monitoring works, the New Incentive Tracking System (NITS), which enabled monitoring of the progress in grants, from the initial site visit through to completion of works. The advantages of NITS were that it made data-entry easy, and compiled information on a central database.

This concept was then picked up in a Statewide initiative under the Regional Data Net project, where the role of NITS was supplanted by the Catchment Activity Monitoring System (CAMS). While still supplying the functionality of NITS, CAMS is a web-based monitoring system able to be deployed Statewide.

Groundwater monitoring

The groundwater monitoring program was reviewed by CLPR (Cheng, 1999) which made a number of recommendations on improving the efficiency and cost-effectiveness of the program. The objective of the study was to improve the existing bore monitoring network and identify any shortcomings. This analysis included whether sites, or bores within sites, were required or redundant, their suitability to improving our understanding of groundwater processes, and the recommended frequency of bore readings.

The data has been used in several major studies (SKM, 1996; SKM, 1999; ANU, 2001; CLPR, 1999). A comprehensive report and analysis of bore trends was also produced by CLPR (Cheng, 2001).

Major gaps identified in the review, and since confirmed in the study by ANU (ANU, 2001), still exist at the Plains-Upland interface and in the upland area of the South West Goulburn. The recommendations required a significant increase in expenditure on monitoring which was agreed to by the Implementation Committees.

Stream monitoring

Two reports were produced by SKM on stream monitoring (Sinclair Knight Merz, 2000a, Sinclair Knight Merz, 2000b). They reported on the suitability of sites for monitoring stream salinity and flows, and made recommendations on filling in data gaps. The stream salinity monitoring data has been the basis of a number of important studies in the catchment, particularly the reports on catchment salt and water balance by SKM and ANU (Sinclair Knight Merz, 1996; Australian National University, 2001).

Environmental monitoring

Environmental monitoring continues in a modified form. At present, the environmental condition of Shire Dam Swamp, Dowdles Swamp, and Tahbilk Lagoon are regularly monitored and information forwarded to Water Ecoscience.

The monitoring of the condition of remnant vegetation stands now falls under the Regional Native Vegetation Plan. Development of appropriate measures for the extent and quality of native vegetation is progressing.

Discharge monitoring

The catchment continued to participate in the Statewide discharge monitoring program, coordinated by CLPR. The GB Dryland rejected a request to expand the program, because of concerns over the value of information generated. A subsequent review of the program led to a trial assessment in the summer of 1999/2000 of a more generalised mapping of discharge areas. Whilst the trial was successful, there have been no further resources allocated to discharge monitoring. This situation will have to be reviewed in light of the projected increase in dryland salinity in the catchment, and the Broken and North Goulburn Plains areas in particular.

Community input

A second community input study was carried out in 1997 (DNRE, 1997). The results of the study confirmed the previous work by Madden (1992) that the amount of works (high-density trees and perennial pastures) completed by the community was 7-10 times the level of work supported by the natural resource programs of Government. The method followed did not allow us to identify the extent to which the additional works corresponded to priority areas, but it can be assumed that the effectiveness of these additional works is something less than 7-10 times because they are not necessarily well targeted.

3.12 Research and Investigations Program

The outcomes of the Research and Investigations Program have been used to develop much of the current strategic thinking in the Salinity Program, and as such are reported throughout this document. A short summary of the main developments follows.

Pastures

It is now generally accepted that perennial grass pastures in high rainfall areas (above 650 mm) have little advantage over annual pastures, especially under grazing. This is also exacerbated by:

- high pH soils in parts of the catchment which restricts root development, and
- thin soils on much of the highlands, which further limits the potential to create a sufficient soil water deficit to buffer against winter recharge.

As a consequence a decision was taken to no longer provide support for pasture establishment in areas where annual rainfall exceeds 650 mm.

Sub catchment hydrology

Priorities

Cheng (1999) and SKM (1999) developed a method to prioritise catchments according to their salinity levels and salt load levels, and risk of dryland salinity. This work was subsequently modified to provide a separate prioritisation by stream salinity and salt load, which will form the basis of priority setting in the future.

Catchment Characterisation

Under the Tools for Managing Salinity Project, the national catchment classification system was adapted to the Goulburn Broken catchment (Dyson, *unpub*). This defines the characteristics of 13 groundwater flow systems in the catchment, according to such qualities as aquifer properties, time to reach equilibrium, likely response to treatment, salt stores, risk and probable location of dryland salinity, and recharge risk areas. When combined with the priority sub-catchments, it provides a method for targeting works within high-risk groundwater flow systems, in high priority sub-catchments.

Goulburn Broken Salt and Water Balance Study

SKM (1996) provided a comprehensive analysis of salt and water balances for the five sub-regions of the catchment. It was this work that first highlighted the emerging problem of rising groundwater on the Riverine Plains. The study, in its efforts to partition salt fall and rainfall between the different components at a sub-regional level, also highlighted the difficulty of trying to extract too much information from too little data.

Salt and Water Balance (ANU, 2001)

Because of the difficulties encountered during the SKM work in 1996, and with the availability of improved methods of trend analysis, a study was commissioned to review the hydrologic status of the upland areas and stream trends across the catchment. The study differed in some areas from the 1996 work, particularly concerning stream trends, and in its estimates of recharge rates in the South West Goulburn area. It also highlighted the effect of lack of data in key areas (the Plains-Upland interface and the South West Goulburn). However, the conclusions support the general acceptance of high salt loads emanating from the South West Goulburn and high risks of dryland salinity in the Riverine Plain.

Broken and North Goulburn Plains Study

As a result of the coarse analysis on the Ultimate Salt Loads study and the Salt and Water Balance Study, further work was carried out on the Plains area of the catchment deemed to be at high risk of dryland salinity. The purpose of this study was to better estimate where dryland salinity would occur in the landscape, and what measures, if any, could be taken to control it. At the time of writing no results have been published.

Farm forestry

CLPR (2000) reported on the suitability of a range of different species for commercial forestry across the dryland. It showed that much of the catchment was suited to different species, but did not include an analysis of growth rates and hence commercial prospects. Commercial forestry potential on the Riverine Plains is limited to those areas overlying groundwater of low salinities. A spin-off from the study was an estimate of the area that was at risk of high water tables. It provided a somewhat less dramatic, though still alarming, estimate of area at risk than that produced by SKM (SKM, 1996; SKM, 1999).

Heartlands

The National Heartlands program selected a site in the Honeysuckle Creek catchment for long-term monitoring of salinity control programs. The site was selected as being representative of the low rainfall mixed cereal-livestock farming system in the Murray Darling Basin. The program has included extensive use of airborne geophysical sensing of sub-surface salt and water stores. Whilst not a high priority area in the Goulburn Broken dryland, the project offers the opportunity to explore some cutting edge science and trial a multi–disciplinary approach to landscape change.

Break of Slope Analysis

An analysis of the effectiveness of Break of Slope plantings was completed (CLPR, 1999) which showed that there was an effective drawdown up to 100 metres from the plantation at one site, but far less impact at another site. More work is required to determine the appropriate density and management of Break of Slope plantings to maximise their water use.

Engineering

3.13 Plan Co-ordination

Geographic Information Systems

The past 6 years has seen an enormous growth in the application of GIS technology to salinity management. This has enhanced our capacity to visualise the problems, and to integrate across issues such as water quality, native vegetation, and pest plants and animals. Spatial analysis has allowed us to predict the impact of reforestation on catchment yield, and better estimate the areas available to tree planting. It will also allow us to develop, for the first time, a catchment-wide recharge map as part of the overall priority setting process.

Local Area Planning

The need to integrate the Regional Management Planning process with community engagement processes is being met through the Local Area Planning project. This is designed to directly involve local communities in the management of natural resources. Twenty-one individual LAP's have been prepared, covering most of the Dryland. These have been combined into six collective Local Area Plans.

Local area planning in the dryland has particular challenges that are not well recognised by decision-makers. These include the vast area, the difficulties of engaging large segments of the population, the general decline in service delivery to the dryland and the attendant social problems, and the complexity of the issues that need to be dealt with. Nevertheless, there now exists a framework for negotiation with local communities on resource allocation to, and priorities in, the Local Area Plans.

The next stage is to link the LAP's to the Regional Management Planning process, and to then extend the LAP's to include other issues of importance to the community, either through direct action or by establishing links with other community initiatives. Local Area Planning needs to evolve into an ongoing communication process with local communities.

Economics/Sociology

Several studies were completed on the economic and social conditions in the catchments. Lavis (1997) reported on the true cost of establishing perennial pasture in the catchment, which showed there was a very wide range of costs (from $80/ha to over $300/ha), with a mean of $180/ha. As a consequence, the cost-share arrangements were adjusted to reflect the higher rate (increased from $120/ha to $180/ha).

A study was done through Charles Sturt University (Curtis *et al,* 2000) to evaluate landholder attitudes to natural resource management. It was a valuable and wide-ranging study, which included an analysis of the characteristics of the catchment population. In common with many other studies, it showed the catchment to be ageing (average age 58), with a concern for, but limited capacity to address, salinity issues. Only landholders directly affected by salinity recognised the magnitude of the problem and, by and large, landholders are not swayed by problems on other people's properties. Succession planning is still a major issue, with very different perceptions between generations on the fate of the family farms. Time and money are major constraints to any additional on-farm works, with more than two-thirds of the land holder population involved in some form of off-farm work. Rates of turnover of land ownership are very high, at 10% per year, particularly in the south of the catchment. At the same time, in other parts of the catchment, older members of the community are trapped on their farms, unable to sell their property, and unable to run it successfully as a commercial enterprise. There is at present a tendency to reduce cropping on the Riverine Plain because of the high costs of cropping and the low viability of many farms.

The report pointed to the need to better manage the transition of property ownership, because the most likely place to effect a change in the conditions of land use is at the point of sale. The report also highlighted the difficulty many landholders have had, and will have, is making time or resources available to carry out on-farm works, as well as limited community perceptions of the severity of the salinity problem.

Staff

The 5-year review recommended that staff levels need to be better managed, particularly through the identification and retention of core positions with longer-term contracts than were then on offer. Changes in Government policy have largely superseded this issue, but there is still a need to recognise the core services that need to be maintained.

3.14 Cost share

The Land Protection Incentive Scheme (LPIS) which assisted landholders to rehabilitate their land was well-developed at the commencement of the GBDSMP in 1990. The LPIS scheme was developed by the Soil Conservation Authority in the 1960's. It was established as an incentive undertake works; it was not based on any cost sharing principles.

Developments between 1989 and 1995

Several significant changes to grants and cost-sharing were approved by Government in the period 1989 to 1995.

These were:

- A change in the cost-sharing for the establishment of perennial pasture on high recharge areas.
- Break of Slope Planting.
- Groundwater pumping at Nagambie – including generic guidelines to expand groundwater pumping to other parts of the Catchment.

Perennial Pasture

The original incentive rates for perennial pasture establishment on high and moderate recharge were based on an average cost of establishing pasture of $120/ha. The cost share arrangments agreed to in the Government response to the GBDSMP were:

Very high priority Land Management Units 6 & 7a	50% ($60/ha)
other LMUs	25% ($30/ha)

The higher incentive rate for LMU 6 & 7a was based on the high salt loads emanating from these areas and their impact on downstream users.

The Goulburn Broken Salinity Program Advisory Council (SPAC) became concerned with the low uptake of grants for perennial pasture in LMUs other than 6 & 7a. In resposne to this a rate equal to that for LMU 6 & 7a was approved for all high recharge areas in the catchment.

Break of Slope Plantings

The concept of interception of groundwater flow rather than direct interception was accepted in 1994 as an option for a few specific areas in the catchment. Incentive rates to encourage initial plantings to enable field assessment were endorsed by SPAC.

Groundwater Pumping

Groundwater pumping was not included in the initial Plan, due to a lack of information. Detailed studies since 1990, particularly of the groundwater levels in the Goulburn Deep Lead, led to the encouragement of groundwater pumping in the Nagambie area and the investigation of its relevance in other areas. Grants were made available to encourage this approach. The value of the grant was based on the equivalent salinity benefits to what high-density trees would cost.

The new rates at this time are shown below.

Table 4 Incentive rate in the Goulburn Broken dryland

New Incentive Rates	High Recharge	
	Public	Private
Break of Slope tree establishment	75	25
Pasture establishment (Incl. Lucerne)	50	50
Groundwater Pumping	$90/ML Max 80% & $13500	

Developments between 1995 and 2001

In the last five years, there has been a continuing change to the incentive/grant program and the concepts of cost sharing.

Major improvements have been made so that incentive rates reflect the current real costs of the implementation of works, and to better value the benefits of the works by looking at multiple benefits. Detailed salinity investigations have led to some modification of programs so that some works are now not eligible for incentives. These works include:

- Establishment of perennial pasture is now not approved as a salinity control measure in areas with an annual rainfall over 600mm.
- Additional groundwater pumping in the Nagambie area is now suspended until further investigation is made of the Permissible Annual Value (PAV) of the deep lead aquifer

Cost share principles

The concept of cost share was developed in the late 80's and early 90's with the implementation of the salinity management plans. It was through these that cost-sharing based on the share of benefit derived from the works was first used in the Goulburn Broken.

The argument for sharing the cost of works in proportion to their benefit is now accepted widely in the community. The difficulty has been, and remains, the identification of costs and benefits to be included in cost share arrangements along with the lack of commonly agreed principles for such arrangements.

The GBCMA recognises the following cost share principles:

Duty of care – natural resource users and managers have a duty of care to ensure that they do not damage the natural resource base. They are responsible for making good any damage incurred as a result of their actions.

Beneficiary pays – when it is not possible to attribute damage, then primary beneficiaries should pay. Existing and future users are expected to pay for activities which provide private benefits. Contributions from secondary beneficiaries will be negotiated with the primary beneficiaries.
Government contributions for public benefit – government contributes primarily for activities which produce public benefits. Governments may contribute to land and water management activities that have a private benefit, where the cumulative uptake of these activities provides significant public benefit and government support is required to facilitate this uptake.
The Authority has identified four groups of beneficiaries. They are, the Federal Government, State and Local government (as representatives of the regional community) and the landholders. The Authority considers that the most appropriate policy is for the beneficiaries to share equally the "Public" component of the costs. Landholders will continue to pay for the major proportion of the required farm activities.
The costs of undertaking works, which includes capital costs, opportunity costs, maintenance costs and operating costs, has been identified as a major impediment to implementation.
These additional costs can almost double the cost of works (see Chapter 6) and are borne solely by the landholder. In most cases the landholder does not receive an equivalent benefit; the work is carried out in the expectation that the wider community does receive at least an equivalent benefit.
Environmental Management Grants system
As a result of a review of the incentive schemes a new Environmental Management Grants system (EMGs) was developed. EMGs combine three important principles
1. The cost share is based on the true capital cost of works for fencing and pasture or tree establishment. This costing is reviewed annually.
At this time the additional contribution of landholders from lost opportunity costs, replacement costs or depreciation and maintenance costs within fenced sites are not recognised in the cost share arrangements.
2. The benefits are assessed on multiple outcomes, including salinity, biodiversity and water quality
The use of a multiple benefit approach to incentives was pioneered in the Goulburn Broken Catchment, initially for GBCMA Parthership Grants (Waterway Grants). This approach has allowed the additional benefits of the proposed works to be taken into account in determining incentive rates. The development of the EMG system is the result of an integrated approach, at the on-ground level, for management of natural resource programs.
3. The benefits are assessed on the basis of catchment plans
To ensure that the community benefit is maximised the level of grants offered to landholders reflects the importance of the work to overall condition of the catchment. This is based on the priorities established through the action plans which underpin the Regional Catchment Strategy.
The implementation of EMG's has led to a large increase in the number of grants being taken up in 2001-2002. More time is required to properly evaluate whether or not the new system will attract a larger number of applications for assistance with works. The evaluation criteria for the EMGs are shown in Appendix 2.

Chapter 4 The Second Generation Strategy

The objectives of the revised salinity management plan are:

- *deliver an integrated program to protect and enhance natural resources within the catchment*
- *develop a high level of community responsibility and accountability.*
- *control land degradation and protect important terrestrial and aquatic assets.*
- *maintain water quality for all beneficial uses, including agricultural, environmental, urban, industrial and recreational.*

The end of valley targets, as proposed by the MDBC and agreed to in principle by the State Government are only the start of the target setting process. Ultimately it will be the community that decides how much degradation they are prepared to accept and how much on-ground works they are willing to do. Any targets set at the catchment level will have to:

- *reflect community attitudes*
- *be technically feasible and economically efficient*
- *be equitable across different sectors of the community*

It is necessary to put the targets in a way that is more readily understood if the community is to participate in negotiating outcomes. To this end estimates are made of the area of land that needs to be treated in order to achieve the desired reduction in salt reaching the streams. These then become the targets for annual works programs as well as a measure of the overall area that needs to be treated.

On currently available information around 300,000 ha of land would need to be planted to high density trees (more than 500 stems to the hectare), or its equivalent, to meet the proposed end of valley targets. Both the Upper Goulburn Implementation Committee and the Mid Goulburn Broken Implementation Committee recognise that this is an unacceptable burden on the community and have instead opted for an overall target of 150,000 ha to be treated. A consequence of reducing the area to be treated is that the amount of salt entering the streams will be higher than is desired under the end of valley targets. The Goulburn Broken Catchment Management Authority will work with the Department of Natural Resources and Environment, the State and Federal Governments and the Murray Darling Basin Commission to identify how else the stream salt loads can be managed using salt interception works or other engineering options.

The areas to be targeted are firstly those sub catchments that contribute high salt loads into the Goulburn and Broken rivers. Within these sub catchments some areas contribute more salt than other or are more responsive to treatment. These areas have been identified using the groundwater flow systems within the sub catchments. The highest priority areas are those:

- *with high salt stores at risk of being mobilised*
- *with high groundwater salinities and zones of high recharge*
- *that are likely to respond to treatment options*
- *where the time it takes for the effect of treatments to be expressed are reasonable*

The actions taken to reduce dryland salinity and salt reaching the streams will depend on the suitability of different areas for those treatments. In the Goulburn and Broken plains, lucerne pasture in combination with high density trees offers some scope for slowing rising groundwaters. Over time more consideration will be given to living with salt options, as areas become salinised. In the higher rainfall areas high density trees will be promoted, particularly where there are likely to be commercial returns or where multiple benefits are most likely. Groundwater pumping is well suited to some areas of the catchment and will be used where it can be shown to provide a clear salinity benefit and where current or proposed land use is complemented by the availability of groundwater.

4.1 Objectives and Principles

The objectives of the original 1989 Goulburn Broken Dryland Salinity Management Plan were to:

- Reduce rainfall accessions to the groundwater system, by planting areas of high or moderate infiltration (recharge areas) with high water using trees, pastures and crops.
- Establish vegetation cover on denuded salt land, and to control erosion from these areas.

The Plan aims were to:

- Reduce long-term economic loss.
- Reduce the environmental and land degradation impacts of salinity.
- Reduce increasing salt loads to the Shepparton Irrigation Region and the Murray River.
- Reduce the social impact on landholders and regional communities.

Whilst these are still relevant today, the Plan needs to reflect the changed emphasis on community involvement and on the negotiation of trade-offs between interest groups that make up the catchment community. The Plan also needs to adapt to the increased emphasis on integrated catchment outcome and links between in-catchment activities and outcomes at the State and Murray Darling Basin scale.

The objectives of the GBDSMP in 2002 and beyond are to:

- deliver an integrated program to protect and enhance natural resources within the catchment, and to manage salt loads across the Basin.
- develop a high level of community responsibility and accountability for the setting and management of within valley and end of valley targets for salinity management.
- control land degradation and protect important terrestrial ecosystems, productive farmland, cultural heritage and built infrastructure. at community agreed levels.
- maintain water quality, within community agreed limits, in the Goulburn and Broken for all beneficial uses, including agricultural, environmental, urban, industrial and recreational.

4.2 Target Setting

Salinity management plans are simple in their basic concept. There are only two primary activities - managing saline discharge and salt loads, and living with the consequences of not doing the first one with 100% efficiency. The first activity has historically attracted community support through Government investment, and was the focus of the first 10 years of implementation of the GBDSMP. The community had refused to recognise the need to live with salt and was intent on implementing the Plan to control discharge through recharge management. The passing of time, and with it, improved knowledge, have made it clear that we cannot manage a reduction in salt loads with 100% efficiency, and so ‘living with salt’ is inevitable for large areas of the catchment. Targets therefore must be built by deciding how much salt can be prevented from reaching the land and streams, based on what level of degradation the community is prepared to accept and is willing to pay for.

Principles of target setting

The principles of setting targets are:

- targets must reflect and be responsive to community attitudes,
- they must be technically feasible and economically efficient, and
- they must be equitable across different sectors of the community.

Targets to reduce salt loads can be achieved through a combination of land use change and engineering approaches. For the catchment community, and the Implementation Committees in particular, the challenge is to identify that part of the target which can be achieved through land use change and, if there is a shortfall between what can be done and community expectations, to then investigate alternative options. Usually the alternative will be some form of salt interception works, either in or out of the catchment.

In order to assess the validity of a target, we need something more tangible than the required tonnes per year of salt load reduction. A more suitable measure is to estimate the area of land that needs to be treated to achieve the desired salt load level. Such a measure has the advantage of allowing decision makers to better envision what is being asked of them. This approach also links more easily to other natural resource programs, such as water quality management and native vegetation management. It is also the unit on which costs of program delivery are calculated.

The presentation of targets has to be done in such a way as to better facilitate community involvement in the target setting process. To this end, a number of options will be presented. It is envisaged that the process of setting targets will be an on-going process, as better information becomes available and as the community becomes more aware of the issues involved.

The size of the problem

The first step is to describe the size of the problem. The best available definition of the long-term dimensions of the salinity issue in the Goulburn-Broken Dryland comes from the Ultimate Salt Loads Study (SKM, 1999), which projects, within a 100 year timeframe, a salt load increase of 165,000 tonnes per year. A starting point for the establishment of targets to deal with this threat is provided by MDBC interim end-of-valley targets. An estimate of the area that needs to be treated, using high-density trees, to meet these interim targets is presented in Table 5.

Table 5 Estimate of saltload reduction required to meet EOV targets and area required to be treated for sub-regions of the Goulburn Broken

Sub region	**Area of catchment (ha)**	**% land uncleared**	**Saltload reduction required (tonne/yr)**	**Areas to be treated (ha)**	**% land treated to meet targets**
Goulburn Highland	838,800	50%	22,886	16,767	2%
South West Goulburn	297,500	20%	18,403	193,284	65%
Goulburn Plain	179,800	13%	3,799	35,409	20%
Broken Plain	303,600	8%	14,237	15,805	5%
Broken Highland	179,800	34%	8,522	49,029	27%
Total	**1,799,500**		**67,847**	**310,294**	

This shows that around 70,000 tonnes of salt has to be prevented from reaching the Goulburn River at Goulburn Weir and the Broken River at Casey's Weir each year. To do this will require treating the equivalent of 300,000 ha. The bulk of this would need to occur in the South West Goulburn area because:

a. it is an area with a predominance of high and moderate priority salinity areas, and
b. it is the area with the highest salt load generation rates (at 31tonne/km$^{2)}$, and so the area where the biggest gains can be made for the least cost, all other things being equal.

To achieve this salt load reduction would require a further 30% of land to be treated in the Broken Highlands, 20% in the Goulburn Plains, and a massive 65% in the South West Goulburn. It is possible to share the burden across different areas of the catchment more equitably, but such action would mean that more area in total would have to be treated, at a higher cost. The time required for the hydrological system to reach a new equilibrium would be greatly extended as a consequence. Clearly, there would be considerable resistance to this level of land use change from significant sectors of the community. With the exception of the Plains country, most of the treatment options centre on revegetation, with perhaps some groundwater pumping in areas with suitable aquifer properties. To treat this much land would require an investment of around $240m to $270m in works alone. To this can be added an additional $120m in support and infrastructure costs and $200m in costs incurred by landholders in maintaining the sites where works are completed and opportunity costs. Such an investment could only be achieved if spread over a very long time, of the order of 50 years or more.

4.3 Options

The refinement of targets will be an on-going process that accommodates community aspirations and includes better information as it becomes available. That part of the EOV target that cannot reasonably be achieved through land use change, in a reasonable time period, will need to be managed by other means, probably salt interception works selsewhere in the Murray Darling Basin.

Table 6 shows the effect of reducing these catchment targets. Each time the targets are reduced, a shortfall is generated between the required salt load reduction (EOV) targets, and the salt load reduction achieved. It will be important to establish how any shortfalls in salt loads will be dealt with, whether it be within the catchment, within the State or somewhere within the Murray Darling Basin.

Table 6 Analysis of scenarios for recharge reduction and estimation of shortfall in meeting EOV targets

Option	1		2		3	
Sub region	25% reduction below target		50% reduction below target		75% reduction below target	
	Area treated (ha)	Saltload reduction achieved (t/yr)	Area treated (ha)	Saltload reduction achieved (t/yr)	Area treated (ha)	Saltload reduction achieved (t/yr)
Goulburn Highlands	12,575	4,218	8,384	2,812	4,192	1,406
South West Goulburn	130,756	44,978	87,272	30,038	43,788	15,098
Goulburn plains	27,256	2,998	19,103	2,101	10,950	1,205
Broken plain	12,310	862	8,815	617	5,321	372
Broken Highlands	36,799	4,048	24,569	2,703	12,339	1,357
Total	219,697	57,104	148,143	38,271	76,590	19,439
Shortfall in target load (t/yr)		**10,743**		**29,575**		**48,408**

Cost ($m)	**222.5**		**150.0**		**77.6**	
Annual targets 30 year timeframe	**7,323**		**4,938**		**2,553**	
Annual targets 50 year timeframe	**4,394**		**2,963**		**1,532**	
Annual targets 100 year timeframe	**2,197**		**1,482**		**766**	

Historically, the rates of implementation achieved by the GBDSMP have been around 75% less than that required to meet the interim EOV targets (equivalent to option 3). If this rate of implementation is sustained into the future, then there will be a need to deal with around 50,000 tonnes of salt each year through salt interception or other engineering options.

4.4 Preferred Option

The GBCMA has to strike a target for treatment works that reflects the target setting principles (see section Target Setting). The actual targets agreed to with different communities across the catchment will range between all three options. However, the catchment-wide outcome is still likely to be an area treated that is less than that required to meet the interim end-of-valley target solely from land use change.

It is recommended that the target levels for the catchment be set at 50% of the area required to meet the end-of-valley targets (ie. option 2). This is suitably challenging, requiring a prolonged investment and substantial land use change, whilst still accommodating different demands across the catchment. In effect, to achieve this over a 50 year time-frame requires the catchment community to increase the rate of revegetation with high-density trees achieved previously through the GBDSMP (an average of 200 ha per year) by some 15 times. Extensive establishment and management of perennial pastures, and widespread uptake of groundwater pumping options, will reduce the areas required for revegetation.

The implications of this target for each sub-catchment are presented in Appendix 4. Note that these are notional figures only. The target level in any one sub-catchment depends on all other sub-catchments achieving the required level of works.

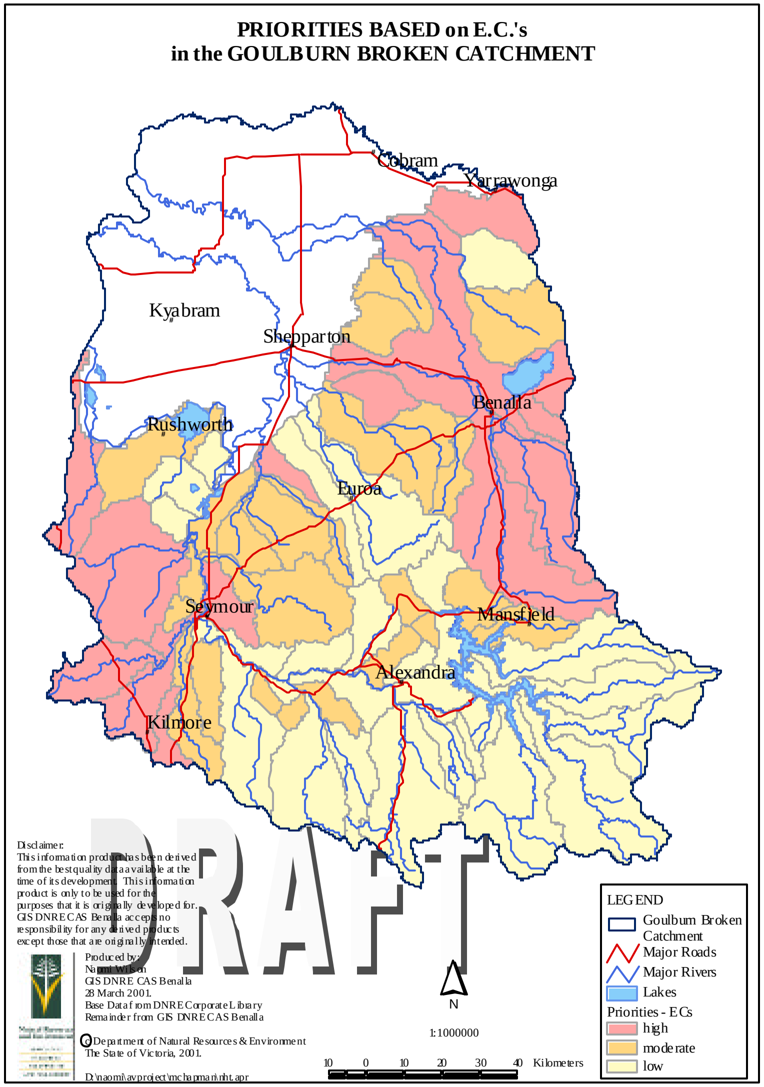
4.5 Priorities

A priority setting framework

In 1999, two studies were produced that categorised each sub-catchment in the Goulburn Broken Dryland according to the severity of salinity problems, the risk of future saline discharge, and the adequacy of current monitoring (Cheng, 1999; SKM, 1999).

The outcome was a ranking of the salinity risk for each sub-catchment on a three-point scale (high, moderate, low), which was then used to indicate where implementation programs should be targeted. The analysis was subsequently modified to define the priorities according to whether the dominant issue was stream salt load or stream salinity (Cheng, unpub). The outcomes are presented in Figure 6.

As noted earlier in Chapter 2, whilst stream salinity is an issue for the catchment community, it is salt loads that dominate the inter-governmental agreement and justifies the participation of the MDBC and investment through the National Action Plan for Salinity and Water Quality. For these reasons, it is recommended that the sub-catchment priorities based on salt loads be used to establish priorities for the GBDSMP.



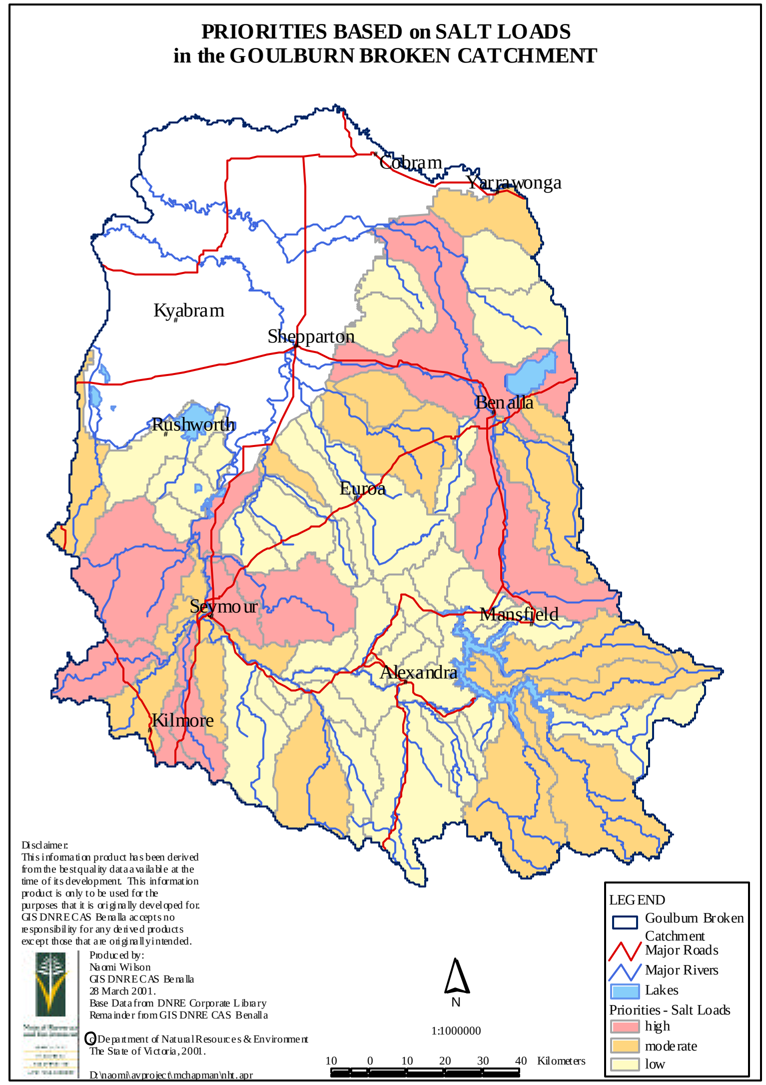


Figure 6 Sub-catchment priorities for the Goulburn Broken catchment based on stream salinity and salt loads

4.6 Groundwater Flow Systems and Sub-catchment Priorities

The sub-catchment priorities are a first step in the targeting of works. To ensure works are effective and efficient, more information is required on which parts of the sub-catchments are likely to best respond to the different control options, and in what timeframe. Thirteen groundwater flow systems have been identified in the Goulburn Broken. They are shown in Figure 7.

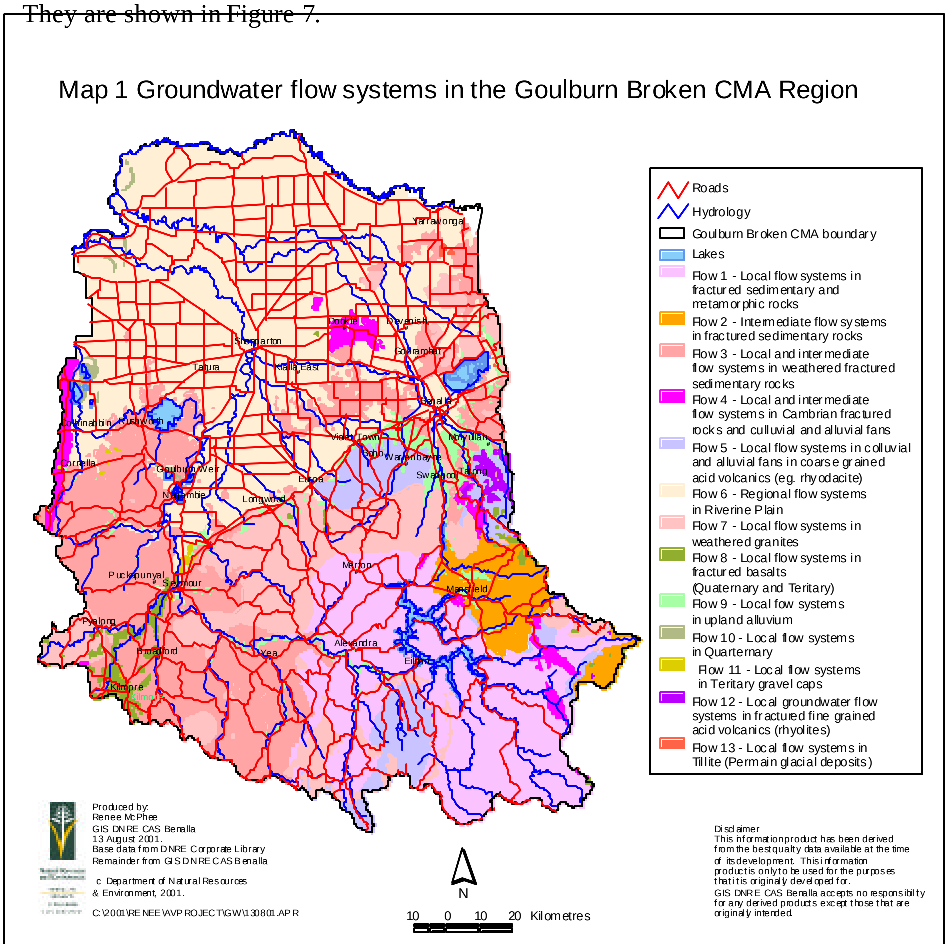


Figure 7 Groundwater flow systems for Goulburn Broken catchment

The key features of each of these groundwater flow systems is described in the appendix. This information, combined with the priority sub-catchments, allows us to target high priority areas with specific salinity control options. The highest priority areas are those:

- with high salt stores at risk of being mobilised,
- with high groundwater salinities and zones of high recharge,
- that are likely to respond to treatment options,
- where salinity occurrence and salt accession process (baseflow or washoff) allow effective treatment, and
- where the equilibrium response time (the time over which the system is likely to respond to treatment) is reasonable.

Information on the groundwater flow systems within each high and moderate priority sub-catchment is presented in Table 7. The table includes information on the percentage of the total sub catchment area occupied by each groundwater flow system, the areas best targeted for salinity control works, and the recommended salinity management options.

Table 7 High and moderate priority sub catchments in the Goulburn Broken catchment, zones to be targeted and the priority actions for each

Sub-catchment	GFS	Targeting area	Recommended salinity management options
South West Goulburn			
High priority			
Dry Ck	3(80%), 8(10%), 1(10%), 9(>1%)	Discharge sites and high watertable are widespread at the lower slopes and valley floor. Hill slopes have been extensively cleared. High recharge may occur along gentle cleared slopes (GFS 3).	High-density trees targeted at recharge area (e.g. gentle slopes of weathered sedimentary hills) would be the most effective. Perennial pasture along would not be effective to control recharge due to high rainfall, but incorporation with low-density trees would be more effective. Opportunities for groundwater pumping may be limited due to high salinity of groundwater and low yield in the fractured rock aquifer. Establishing salt tolerant grasses and saltbush at discharge area would increase productivity and reduce salt wash-off.
Hughes Ck	7(78%), 3(15%), 9(4%), 6(2%), 1(1%)	Discharge sites and high watertables mainly occur on the valley floor and along drainage lines at the upper Hughes Ck (GFS 3). Salinity risk is believed to be relatively low.	High-density trees targeted at recharge area (e.g. gentle slopes of weathered sedimentary hills) would be the most effective. Perennial pasture along would not be effective to control recharge due to high rainfall, but incorporation with low-density trees would be more effective. Opportunities for groundwater pumping may be limited due to high salinity of groundwater and low yield in the fractured rock aquifer. Establishing salt tolerant grasses and saltbush at discharge area would increase productivity and reduce salt wash-off.
Kurkurac Ck	3(44%), 9(25%), 1(24%), 8(7%)	Discharge sites and high watertables mainly occur on the valley floor and along drainage lines in the sedimentary country (GFS 3). It is believed that high recharge occurs on along gentle cleared slope of sedimentary hills.	High density trees targeted at recharge area (e.g. gentle slopes of weathered sedimentary hills) and along drainage lines would be the most effective. Perennial pasture along would not be effective to control recharge due to high rainfall, but incorporation with low-density trees would be more effective. Opportunities for groundwater pumping may be limited due to high salinity of groundwater and low yield in the fractured rock aquifer. Establishing salt tolerant grasses and saltbush at discharge area would increase productivity and reduce salt wash-off.
Majors Ck	3(52%), 1(31%), 9(14%), 6(3%)	Discharge sites and high watertable are widespread at the lower slopes and valley floor, particularly in the southern part of the sub-catchment where hill slopes have been extensively cleared. High recharge may occur along gentle cleared slopes (GFS 3).	High density trees targeted at recharge area (e.g. gentle slopes of weathered sedimentary hills) and along drainage lines would be the most effective. Perennial pasture along may be effective to control recharge due to high rainfall, but incorporation with low-density trees would be more effective. Opportunities for groundwater pumping may be limited due to high salinity of groundwater and low yield in the fractured rock aquifer. Establishing salt tolerant grasses and saltbush at discharge area would increase productivity and reduce salt wash-off.

Mollisons Ck	7(67%), 3(19%), 1(7%), 9(4%), 8(3%)	Discharge sites and high watertables mainly occur on the valley floor and along drainage lines in the sedimentary country (GFS 3). Small patches of discharge and high watertables also occur at valley floor in the granites country. It is believed that high recharge occurs on along gentle cleared slope of weathered sedimentary rocks and granites.	High density trees targeted at recharge area (e.g. gentle slopes of weathered sedimentary hills) and along drainage lines would be the most effective. Perennial pasture along may be effective to control recharge due to high rainfall, but incorporation with low-density trees would be more effective. Opportunities for groundwater pumping may be limited in the sedimentary country due to high salinity of groundwater, but granites country may provide some opportunities. Establishing salt tolerant grasses and saltbush at discharge area would increase productivity and reduce salt wash-off.
Sunday Ck	3(72%), 1(12%), 7(10%), 8(6%)	Discharge sites and high watertable are widespread at the lower slopes and valley floor. Hill slopes have been extensively cleared. High recharge may occur along gentle cleared slopes (GFS 3).	High-density trees targeted at recharge area (e.g. gentle slopes of weathered sedimentary hills) would be the most effective. Perennial pasture along would not be effective to control recharge due to high rainfall, but incorporation with low-density trees would be more effective. Opportunities for groundwater pumping may be limited due to high salinity of groundwater and low yield in the fractured rock aquifer. Establishing salt tolerant grasses and saltbush at discharge area would increase productivity and reduce salt wash-off.
Whiteheads Ck	3(52%), 9(18%), 6(12%), 1(9%), 7(4%), 11(4%)	Discharge sites and high watertable are widespread at the lower slopes and valley floor. High recharge may occur along gentle cleared slopes (GFS 3).	High-density trees targeted at recharge area (e.g. gentle slopes of weathered sedimentary hills) would be effective. Tree belts along the streams would form a effective buffer to reduce groundwater/surface water interaction (may reduce baseflow into the surface water system. Perennial pasture incorporated with low-density trees would be also effective. Opportunities for groundwater pumping may be limited due to high salinity of groundwater and low yield in the fractured rock aquifer. Establishing salt tolerant grasses and saltbush at discharge areas would increase productivity and reduce salt wash-off.
Moderate priority			
Dabyminga Ck	3(64%), 7(25%), 1(9%), 9(2%)	Discharge sites and high watertable occur at the lower slopes and valley floor. High recharge may occur along gentle cleared slopes (GFS 3). Forest is well retained at the upper part landscape.	High-density trees targeted at recharge area (e.g. gentle slopes of weathered sedimentary hills) would be the most effective. Perennial pasture along would not be effective to control recharge due to high rainfall, but incorporation with low-density trees would be more effective. Opportunities for groundwater pumping may be limited due to high salinity of groundwater and low yield in the fractured rock aquifer. Establishing salt tolerant grasses and saltbush at discharge area would increase productivity and reduce salt wash-off.
Sheepwash Ck	3(43%), 6(26%), 1(23%), 9(7%), 8(1%)	No discharge is reported. High watertables may occur in places. Stream/groundwater interaction may be active.	Tree belts along Goulburn River would form a effective buffer to reduce groundwater/surface water interaction (may reduce baseflow into the surface water system.

Stony Ck	3(44%), 1(38%), 9(12%), 8(5%), 6(1%)	Small discharge sites are reported. High watertables may occur in places. Stream/groundwater interaction may be active.	Tree belts along the streams would form a effective buffer to reduce groundwater/surface water interaction (may reduce baseflow into the surface water system.
Trawool	7(36%), 3(35%), 9(20%), 1(9%)	Small discharge sites are reported. High watertables may occur in places. Stream/groundwater interaction may be active.	Tree belts along the streams would form a effective buffer to reduce groundwater/surface water interaction (may reduce baseflow into the surface water system.
Upper Goulburn			
High priority None			
Moderate priority			
Big R	1(88%), 5(8%), 9(2%), 10(2%)	Low salinity risk -no discharge site reported, well-retained forested and low stream salinity	Low significance for reduction of salinity risk
Delatite Ck	2(43%), 1(32%), 7(16%), 9(5%), 5(3%), 4(>1%)	Salinity risk is low in general. Maybe some potential risk in the lower part of the sub-catchment due to extensively cleared land	Tree belts along stream may act as buffers and reduce salinity input into the stream, but low significance for reduction of salinity risk is expected due to high rainfall.
Yea R	3(52%), 1(33%), 9(9%), 7(4%)	Salinity risk is low in general. High watertables may occur at the lower part of the sub-catchment. Salt export is relatively high.	Tree belts along Goulburn River. Retention and re-introduction of native vegetation are also recommended.
West Goulburn			
High priority None			
Moderate priority			
Cornella Ck	4(30%), 3(26%), 1(18%), 6(17%), 9(7%)	Widespread high watertable along foothills, high recharge on hill slopes of Cambrian fractured rocks and colluvial and alluvial fans. However, off-catchment impact may be insignificant due to low stream flow.	High-density trees, particularly moderate water-use species such as sugar gum, would be suitable in most high recharge areas. Well-managed perennial pasture would be suitable at mid and lower slopes. There are some opportunities for groundwater pumping fresh groundwater from fractured rock aquifers to irrigate horticulture or farm forestry. Saline agronomy would be suitable at lower slope where watertable is high.

Goulburn Plains			
High Priority			
Lower Goulburn	6(93%), 3(5%), 1(2%)	The area with high watertable is not significant, but along Goulburn River and probably contribute significant salt load to the river	Tree belts along Goulburn River and Goulburn Weir would form an effective buffer to reduce groundwater/surface water interaction.
Moderate priority			
Honeysuckle Ck Plain	6(68%), 9(16%), 3(15%), 1(1%)	High watertables occur at the BOS and lower of the sedimentary rises, and the area near irrigation area and drainage lines	Alley faming with perennial pasture at the lower slope. Low density tree planting along slopes of sedimentary rises.
Honeysuckle Ck Upland	5(81%), 9(15%). 1(3%), 3(1%)	High watertables are widespread at the BOS, lower slope, valley floor and along drainage lines. High recharge probably occurs along gentle colluvial slopes (GFS 5)	High-density plantings along colluvial slopes may be the most suitable options, particularly Break of Slope plantations. Salt tolerant vegetation is also warranted at the lower and valley floor where watertable is high and saline. There may be some opportunities for groundwater pumping in the colluvium. Perennial pasture is generally unsuitable due to relatively high rainfall and acid soil.
Sheep Pen Ck Plain	6(98%), 3(2%)	Shallow watertables are widespread and saline across the sub-catchment. Discharge occurs along drainage lines and the plain/upland interface.	Wider adoption of salinity management protases is necessary due to influence of regional groundwater system. Widespread establishment of relatively salt tolerant perennial pasture (e.g. lucerne) is warranted. Improved management of traditional crops and pastures would reduce deep drainage, particular in low and moderate recharge area. The majority of the catchment area is not suitable for tree plantations due to shallow and saline watertables. There may be some opportunities along the plain/upland interface for moderate water-use tree species (e.g. red ironbark). The use of engineering options may be limited due to saline groundwater and problem of its disposal. Some opportunities for establishment of salt tolerant grasses in the areas with high watertables.
Sheep Pen Ck Upland	3(64%), 6(20%), 1(16%)	Shallow watertables are widespread at the lower slope, BOS and valley floor. Watertables are generally deep and rising steadily below hills. Groundwater is generally saline, but fresh shallow groundwater occurs in places. It is believed that high recharge occurs along fault zones where weathered sedimentary rocks are highly fractured.	High-density trees along the fault zones may be effective to control recharge. There may be some opportunities for farm forestry (e.g. alley farm) on the gentle slopes. Some opportunities for pumping fresh groundwater from plaeochannels. Some opportunities for establishment of salt tolerant grasses at the lower slope and BOS.

Broken Highland			
High Priority			
Broken R upland	2(31%), 7(31%), 9(24%), 5(6%), 1(5%), 3(1%), 4(1%)	High watertables are widespread at the BOS, lower slope, valley floor and areas along the river. High recharge probably occurs along gentle colluvial slopes (GFS3 and GFS 5)	High-density plantings along colluvial slopes may be the most suitable options, particularly Break of Slope plantations. Tree belts along the creek would form an effective buffer to reduce groundwater/stream interaction. Salt tolerant vegetation is also warranted at the lower and valley floor where watertable is high and saline. There may be some opportunities for groundwater pumping in the colluvium and fractured rocks. Perennial pasture is generally unsuitable due to relatively high rainfall and acid soil.
Moderate priority			
Four and Sevens Ck	1(37%), 9(32%), 3(13%), 6(12%), 7(6%)	High watertables are widespread at the lower slope and valley floor, but the total area is insignificant. High recharge probably occurs along gentle slopes of weathered sedimentary rocks (GFS3)	High-density plantings along slopes (GFS3) may be the most suitable options, particularly Break of Slope plantations. Retain native vegetation in ridge and upper slope areas. Salt tolerant vegetation is also warranted at the lower and valley floor where watertable is high and saline. There may be some groundwater pumping opportunities in the fractured rocks. Perennial pasture is generally unsuitable due to relatively high rainfall.
Holland Ck	9(33%), 5(29%), 12(10%), 2(8%), 1(6%), 4(4%), 6(4%), 3(2%), 7(2%),8(2%)	High watertables are widespread at the BOS, lower slope, valley floor and areas along the creek. High recharge probably occurs along gentle colluvial slopes (GFS3 and GFS5)	High-density plantings along colluvial slopes may be the most suitable options, particularly Break of Slope plantations. Tree belts along the creek would form an effective buffer to reduce groundwater/stream interrelation. Retain native vegetation in ridge and upper slope areas. Salt tolerant vegetation is also warranted at the lower and valley floor where watertable is high and saline. There may be some opportunities for groundwater pumping in the colluvium. Perennial pasture is generally unsuitable due to relatively high rainfall and acid soil.
Broken Plain			
High Priority			
Lower Broken R (Kialla East-Pine Lodge South)	6 (97%), 3 (3%), 1(1%)	Entire catchment area due to widespread shallow watertable, high groundwater salinity and active groundwater/stream interaction. Recharge occurs across majority of the sub-catchment.	Wider adoption of salinity management practices is necessary due to influence of regional groundwater system. Widespread establishment of relatively salt tolerant perennial pasture (e.g. lucerne) is warranted. Improved management of traditional crops and pastures would reduce deep drainage, particular in low and moderate recharge area. The majority of the catchment area is not suitable for tree plantations due to shallow watertables and high groundwater salinity. Some of sandy rises and area along Broken River and near irrigation area may offer some opportunities for moderate water-use tree species (e.g. red ironbark). The use of engineering options may be limited due to high groundwater salinity and problem of its disposal. Some opportunities for establishment of salt tolerant grasses at discharge area.

Moderate priority			
Congupna Ck Upland	4 (73%), 6(14%), 3(7%), 1(6%)	Widespread high watertable along foothills, high recharge on hill slopes of Cambrian fractured rocks and colluvial and alluvial fans	High-density trees, particularly moderate water-use species such as sugar gum, would be suitable in most high recharge areas. Well-managed perennial pasture would be suitable at mid and lower slopes. There are some opportunities for groundwater pumping fresh groundwater from fractured rock aquifers to irrigate horticulture or farm forestry. Saline agronomy may be the most suitable at lower slope where watertable is high.
Muckatah Ck	6(78%), 3(20%, 1(1%), 13(1%)	Widespread high watertable in the northern part of the sub-catchment. High watertables also occur at lower slope of sedimentary rises (GFS3) in the southern part of the sub-catchment	High-density trees along the irrigation boundary (as interception and recharge control) and hill slopes of sedimentary rises (as recharge control only). Widespread establishment of perennial pasture is warranted across the catchment area. Limited opportunities for groundwater pumping or drainage

Chapter 5 Catchment Standard practice

It is very important that the RCS and the plans that support it adhere to recognised operating procedures and management principles.

Chief among these is the need to help the community to build their capacity to adapt to changed circumstances and to influence the direction that change takes. Catchment standards are built on:

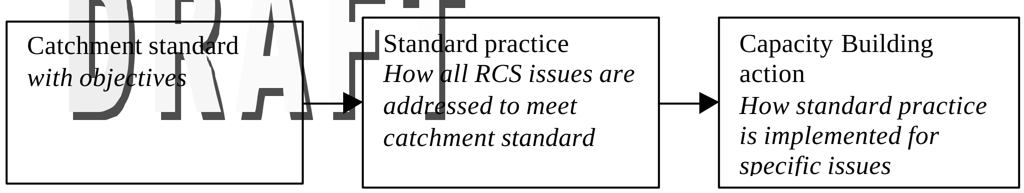
- *developing relationships between communities and organisations,*
- *establishing financial arrangements which are fair between communities and over time and*
- *providing for the security of all stakeholders in a changed working environment*

The environment in which these plans will be implemented is subject to significant change in objectives and resources over time. Recognising and valuing the assets in the catchment, analysing the risks posed to those assets and developing contingency plans is central to preserving the impetus that the plan(s) aim to create. If the RCS is to be implemented and the supporting plans are to be successful then management will have to become more adaptive.

Measuring and evaluating progress is essential for adaptive management. It includes monitoring of changes in the biophysical condition of the catchment as well as evaluating the effectiveness of management arrangements and processes that drive implementation.

5.1 Building capacity and Catchment standards

Achieving the goals of the GBDMP can only happen if the community has the determination, inclination and capacity to do so. The GBCMA has adopted a set of "Catchment Standards" with "Standard Practices" for managing all issues. These Standards underpin the actions that build and maintain capacity.



These Standards and objectives include all "Best Practice Standards" as listed in the National Action Plan Agreement (2001).

Building and maintaining capacity comes at a cost. The cost of actions are presented in chapter 6.

Table 8 is a summary of the Catchment Standards and the actions that need to be taken in support of them. The MGBIC and UGIC are responsible for overseeing the implementation of all capacity building actions

Table 8 Capacity building actions to achieve catchment standards in the Goulburn Broken Dryland

Catchment Standard	**GBD Standard practice**	**GBDSMP Capacity building action**
1. Partnerships fostered	Involve agency and community stakeholders in key decision making forums	MGBIC and UGIC represent community to oversee implementation of DSMP. Support provided by DST
	Tailor RCS actions for inclusion in community organisations and government agency plans	Local Govt involved in IC policy development and implementation
		DNRE, GMW, DSRD and DOI and Commonwealth involved in DSMP and accommodate views and policy and practice
	Include private industry in natural resource management	Facilitate development of markets and management through Vegetation Bank
		Support regional development with appropriate information on opportunities and best practice standards and benchmark

		information
	Develop targeted awareness campaigns of NRM issues	Implement communication strategy of Community engagement Program
2. Priorities rigorous	Priorities based on the best available scientific, economic and sociological information.	Utilise sub-catchment scale maps and targets
3.	Priorities for works will consider risks and multiple benefits.	Undertake risk assessment on other assets beyond EOV targets
	Integrate resource allocation with community priority setting process	Annual priority settign prosess through UGIC and MGBIC to prepare RMP
	Check feasibility of proposed actions by risk assessment and adapt management processes accordingly	Assess asset and risk and the impact of current management strategies on long term condition
Costs shared fairly	Develop cost sharing arrangements by identifying costs and polluters and benefits and beneficiaries	Review cost sharing arrangements annually
		Continue to monitor quantified and unquantified costs of dryland salinity
	Develop inventory of assets, threatening processes and risks	Compile inventory of dryland assets
		Utilise current known risks and identify information shortfalls to assess threat to assets and probable impact
Focus on large scale	Implement remediation works through commercial agreements	
		Work with Local Government and DOI to address important planning issues
	Link outcomes of DSMP to improved regional condition	Work in partnership with DSRD, DOI and local Government and industry bodies to develop regional capacity for sustainable growth
Cultural Heritage	Aboriginal and non-Aboriginal cultural values will be factored into all decisions.	Include cultural heritage values in risk assessment and evaluation of suitability of management practices
Accountabilities clear	Define roles and responsibilities of all partners	Review operating agreements
		Abide by spirit and intent of operating agreements
	Establish targets and appropriate actions according to National and State guidelines	IC to monitor evaluate and modify works projects and research projects directly related to implementation, including prepare annual works program and have an input into relevant IC works programs
	Produce progress reports that clealry state situation and progress and link to regional	Quarterly and annual reporting

	State and national targets	
		5 yr Review
	Identify duty of care for mad and water managers and recommend changes where legislation lags community expectations	
Adaptive management systems at all scales	LAPs	Reposnsiveness
	Partnership development	Breadth of issues
		On-going analysis of responsibilities and resource allocations
	Develop of BP	

Roles and Responsibilities

The Goulburn Broken CMA has had an Operating Agreement with DNRE for the last three years. The CMA is currently reviewing what Operating and Service Level Agreements are required. This will formalise what has been agreed to in the RCS and Sub-strategies including the GBDSMP.

To date roles and responsibilities have largely been implied and understood through the Implementation Committee and the various working groups that implement the works programs.

5.2 Community consultation and involvement-the implementation committees

The community, through the Implementation Committees and their predecessors, has driven the development and implementation of the GBDSMP. Community involvement has been integral to the management of natural resources in the catchment. The involvement of the IC is further enhanced through a number of special task groups set up under the Dryland Support Team to provide recommendations to the full IC and the GBCMA Board on matters arising in the dryland.

Dryland Support Team

The Dryland Support Team, or DST, provides specialist advice to the IC's on issues requiring more detailed consideration or explanation. The DST membership comprises technical staff and community members. Where it is necessary to set up small groups to deal with issues in detail there the special task group comprises members with technical skills and expertise relevant to the task, as well as community members with responsibility to the IC on the task at hand.

Priority setting and reporting

The IC's are responsible for the priority setting processes that occur both at the strategic and implementation levels: These include the

- 5 year review of strategic directions
- annual review of implementation programs
- preparation of the Regional Business Plan and
- quarterly review of progress

Priority setting is based upon using the best available technical information to describe the extent of the problem and the risk posed to assets and to then supplement this with economic assessment and/or review of cost share implications. The social dimension of priority setting is currently done informally through the IC: this is a component of the analysis that needs to be strengthened.

The IC's ensure that priorities match with the RCS objectives and community aspirations.

Full scale community consultation

In circumstances where there are significant changes in strategic directions, as is the case with this review, the IC's require broader consultative process with the community, including special interest groups and through public forum. This is one way to ensure that the community is aware of the implications of the strategic directions in natural resource management and have the opportunity to amend , accept or reject the proposed changes.

5.3 Business management principles

Application of adaptive management to Catchment management

Catchment management is a complex undertaking. It involves " defining the key ecological variables, processes, and inherent characteristics of the system" (Coleman et al). To this is coupled the web of social and economic values which are an integral part of the solution to catchment management issues. Adaptive management is needed to respond to the inherent variability of social, economic and environmental systems. The goal of adaptive management is to build resilience into the environmental, economic and social systems. Resilience requires that we adapt to change and not seek to maintain stability for its own sake.

Through adaptive management the management system itself is seen as a system with its own uncertainties and unknowns; conditions which become more evident in the face of change. The adaptive approach embraces the uncertainties of system responses and sees management actions as 'experiments' from which learning is a critical product.

Uncertainty does not mean that we do not make decisions, only that we combine the precautionary principle with the need to make decisions and move forward. We cannot hope to understand all the components of the system, or how they link. As a result there will always be failures in management as new, unforseen problems arise. An adaptive management culture is one that accepts there will be failure as a normal part of the operating process and uses that constructively to develop better, more resilient management systems. For this reason the reliance on on-going and comprehensive evaluation of progress and management performance coupled to risk assessments is essential.

The delivery of natural resource programs in the dryland will be continue to be rooted in sound business management principles. These include risk management, contingency planning, evaluation and monitoring, and review.

Risk management

The Goulburn Broken Catchment Management Authority has put in place a strategy that will ensure appropriate management of risks. Effective risk management depends on a sound knowledge of the assets at risk, along with a clear understanding of stakeholder expectations.

The Goulburn Broken CMA, in conjunction with the Department of Natural Resources and Environment and its other partners, has established a consistent approach to assessing and managing risk that is based on the Australian/New Zealand Standard for Risk Management. The Goulburn Broken CMA's risk management approach has six key features:

- identifying objectives – these objectives are related to projects, activities and programs;
- pinpointing the risks to achieving these objectives;
- assessing the likelihood and consequence of the risks;
- implementing 'controls' and a risk management treatment plan to deal with these risks in order to achieve the desired objectives;
- ranking and treating risks and
- monitoring and reviewing the process.

The risk management process is cyclical and ongoing. The main risks identified to date are described in the following table:

Specific risk	**Description of risk**	**Likelihood of risk emerging**	**Consequence for natural resource assets**
Implementation / Management	Participation rates are lower than expected	Moderate	High
	Uptake of rebates /incentives are lower than expected	Moderate	Moderate
	Stakeholders not identified	Low	High
	Stakeholders expectations not captured	Low-Moderate	Moderate-High
	Project activities are not completed using agreed methods or to expected levels	Low	High
	Adequate trading models are not developed in next 10 years	Moderate	High
	Efforts to induce private market involvement in NRM are unsuccessful	Moderate	High
Biophysical	Information incomplete, insufficient	Low to	Moderate

	understanding of processes	Moderate	
	Assets not properly identified and risk not quantified	Low	High
Environmental	Compromise resource condition	Likely	Moderate-Low
	Inadequately define ecosystem services	Moderate	Moderate
Social	Community awareness low	High	High
	Community not accept solutions	High	High
Heritage	Implementation of strategy does not account for impact on heritage values	Moderate	High
Economic	Compromise regional development	Unlikely	High
	Community unable to afford implementation	Likely	High

Contingency planning

Contingency Planning is identifying the range of risk control options for a project, evaluating them, selecting preferred treatment and implementing the appropriate risk treatment plan. The GBCMA will adopt the DNRE risk management model which requires they:

- develop a continuous improvement process and put in place contingency plans to address the identified risks.
- build flexibility into project management to allow for new or innovative approaches that demonstrate potential at any stage during the project.
- develop a range of management and evaluation products, addressing different situations and needs, using learning techniques and different levels of complexity in order to maximise participation rates.
- keep the community informed of changes to investments (particularly short term) and the expected impacts.

Some of the planned activities are innovative, with potential political implications at both regional and state level. Such changes will be dealt with sensitively and carried through only where there is high level support.

Cultural Heritage

As part of the business planning and risk management process DNRE and the GBCMA will undertake to improve the integration of cultural heritage issues into the planning and implementation phases of the RCS.

Heritage assessments in all areas of major works will be crucial. Implementation staff will work with Aboriginal Affairs Victoria, land councils (Taungurung, Wurundjeri and Yorta Yorta) and local aboriginal communities to identify sites of significance or importance to the local community and agree on the measures to ensure their preservation.

The Plan will also support the presentation of training and awareness programs to staff and community on landscape features and the significance protecting our cultural heritage.

Monitoring

It is important to monitor the implementation of the strategy to assess whether or not the results are being achieved. It is also important to be able to report to stakeholders on the success of strategy implementation by assessing progress against targets for individual actions.

Monitoring involves collecting information and reporting on indicators of changes in the condition of catchment assets. The information collected needs to undergo a continuous evaluation to ensure that:

- it informs our decision making and risk assessments and
- the models that connect data flows and our comprehension of the systems and how it works are tested

The key indicators to be monitored as part of this strategy are stream EC and flows, area of dryland salinity and adoption of best management practices.

Extensive water quality monitoring is conducted under the Victorian Water Quality Monitoring Network, through GMW as part of their monitoring of the condition of major storages, the dryland salinity program and the EPA.

There is a need to monitor not only the quality of water, but also the impacts of that water quality, for example, the ecological impacts. The impact of changes in stream salinity regimes on the health of aquatic ecosystems will be assessed and management strategies developed accordingly. The index of stream condition (ISC) provides a useful framework for this. The ISC gives a summary of hydrology, physical form, riparian zone, water quality and aquatic life. The water quality information needed to compute the chemical sub-index of water quality for the ISC requires monthly monitoring of pH, electrical conductivity, turbidity and total phosphorus.

Evaluation framework

Evaluation will occur over different geographic and time scales. This framework describes evaluation on three fronts:

1. accountability, to what extent the objectives and targets of the strategy are met
2. improvement, of processes, to deliver a more effective and efficient program
3. condition, the improvement or deterioration in condition that requires a new response.

For evaluation to be successful it is important to know and articulate the assumptions that connect the outcomes and outputs between the RCS and the supporting sub strategies. From there, the sequence of steps to complete the evaluation matrix is as follows:

- identify the key stakeholders for each of the RCS and the sub strategies
- establish their requirements
- determine what success would look like if those requirements are met
- select appropriate measures or indicators to gauge progress towards meeting those requirements
- define the method to be followed for data capture (spatial and temporal collection, data sources, capture processes)
- set agreed levels for each measure or indicator
- identify who will collect, collate and analyse data
- establish processes to review and analyse the information generated and provide feedback to allow changes to be made to the strategy or plan if required..

Evaluation Review

There has to be a commitment to the evaluation process to create the appropriate environment to support adaptive management. An annual review of the evaluation process should be conducted to ensure:

- the evaluation is doing justice to stakeholders views/values
- the program learns from what it is doing
- the evaluation is useful to those involved
- it is persisting through implementation
- it remains relatively simple and effective

Chapter 6 Investment Analysis

The annual costs of works is up to $7m. For the preferred option, which aims to achieve 50% of the proposed end of valley targets it is $3.5m. It is likely that the costs to the public can be reduced substantially by enabling more private investment and aiming for work sites to be on a larger scale (more than 10 ha). If we do nothing then the disbenefits to the community will exceed $10m annually or an NPV of around $250m. However we cannot prevent all disbenefits occurring. Even if we reach 100% of end of valley targets the community will still suffer disbenefits of around $3.5m a year. At 50% of end of valley target the disbenefits incurred are over $6.5m. At the same time the benefits of implementing the plan are $3.8m annually. The additional benefits that accrue from carbon sequestration, reduced phosphorous inflow into streams, soil stabilisation, aquatic and terrestrial ecosystem services and multiplier benefits of investment in the region by government and private industry have not been included. These additional benefits, coupled to reductions in public costs with increased private industry participation will ensure that the benefits of implementing the plan exceed the costs.

Cost share arrangement with those doing the works will be governed, at least in the short term, by the principle of beneficiary pays. While it is usually preferable to make the polluter pay there are problems in instances such as dryland salinity identifying the polluter. There are also issues of equity in that the cause of dryland salinity and salinisation of streams, clearing of native vegetation, were often the result of government inspired programs.

Cost share arrangements have to be built on a proper estimate of the costs incurred by each party. Traditionally many of the costs incurred by landholders have either not been recognised or if they were recognised have not been properly valued. Estimates of costs to landholders from depreciation costs, site maintenance costs and lost opportunity costs are between 24% and 53% of the up front costs of site establishment. It is also recognised that if the community is to enter into cost share arrangements that take into account the additional costs to landholders then there needs to be some form of guarantee that the works will remain in place or that sites will be maintained to an agreed standard.

There is a pressing need to enhance financial investment analysis, built on biophysical inputs and outputs, with a more comprehensive social and political analysis. The debate on the natural resource management is in fact a debate on the well being of communities. Such debates cannot be held and the appropriate trade-offs identified if the information is not available.

Historically Governments and landholders have borne the costs of natural resource management programs. The task of combating the rise in dryland salinity will outstrip the capacity of both these groups very quickly. There is both a need and an opportunity to involve private industry and the investment markets in natural resource management. If done properly, this will provide the resources for land stewardship payments and large scale investment in plantation and farm forestry and regional development. The need and opportunity should be a catalyst for the reform of institutional arrangements that support regulation of land use, the roles of the market in public good projects and the role of government in monitoring land use and instigating and monitoring the activities of the market in public good projects.

6.1 Annual cost of works

The annual cost of implementing the program is shown in Table 9. The cost of completing works is based on the establishment of high density trees. The costs of delivering the works program through extension, plan support etc. is about half of the cost of the works program. No estimate is made of the engineering costs that are presumably incurred as a result of not reaching the End-of-Valley target, because neither the scale nor the scope of such works has yet been defined. While it is assumed that the costs of implementing the plan are incurred at around the same rate each year the same cannot be said for the benefits that accrue, which tend to increase over time. In order to compare the costs and benefits the annual costs are also shown as the net present value calculated over 50 years at 4%.
The cost of works is based on current arrangements, working with landholders to establish small scale plantings across a wide area of the catchment, in high and moderate priority areas. A major drawback of this approach is the high proportion of fencing to area revegetated or protected. This means that fencing costs comprise much of any cost share arrangements, adding to costs to both the community and individual landholders. Larger scale plantings, of more than 10ha, are far more efficient in this

regard and it is in the community's long term interest to develop more appropriate mechanisms to drive large scale change.

Table 9 Annual combined community (government and non government) investment in the implementation of the GBDSMP for different levels of EOV target.

	Total	**Works**	**Infra-structure**[1]	**Community capital**[2]	**Community maint and depreciation**[3]	**Opportunity cost**
100	$6,917,725	$3,666,889	$1,821,435	$1,214,278	$215,122	$511,110
75	$5,188,294	$2,750,167	$1,366,076	$910,709	$161,341	$383,333
50	$3,458,862	$1,833,445	$910,718	$607,139	$107,561	$255,555
25	$1,729,431	$916,722	$455,359	$303,570	$53,780	$127,778
Net present value of costs over 50 years at 4%						
100	$148,607,840	$78,772,797	$39,128,410	$26,085,346	$ 4,621,288	$10,979,764
75	$111,455,880	$59,079,598	$29,346,307	$19,564,009	$ 3,465,966	$8,234,823
50	$74,303,920	$39,386,398	$19,564,205	$13,042,673	$ 2,310,644	$5,489,882
25	$37,151,960	$19,693,199	$9,782,102	$6,521,336	$ 1,155,322	$2,744,941

[1]These are the costs of supporting works programs, and limited to additional costs incurred by service agencies
[2]This is the in-kind and cash contribution by land managers to the implementation of works
[3] The on-going maintenance of works sites, estimated at 1%of the capital value of the works

Community capital is the direct cost of establishing sites and completing the works paid for by the landholder. The maintenance and depreciation costs are those that are incurred after the work sites have been established. They are the hidden costs, paid by landholders to protect the sites from weeds and pest animals and to maintain fences.

The area of works required and so the costs of those works depend on where they are carried out in the catchment. The most efficient area to locate works, from a technical viewpoint, is the south west Goulburn because it is the area with the highest salt generation rates. The figures in Table 9 are based on nearly half the required works being carried out in the South West Goulburn. This minimises the total area of works for salinity mitigation. All other things being equal, works done outside the south west Goulburn require a greater area to be treated (and so incur a higher cost) to get the same reduction in salt load.

6.2 Benefits and Disbenefits

The total costs of dryland salinity is separated into those that are avoided as the result of implementing the SMP, and those that are still incurred. As more of the Plan is implemented, more disbenefits are avoided. The disbenefits that accrue from dryland salinity are shown in Table 10.

Table 10 Net present value of disbenefits from dryland salinity in the Goulburn Broken dryland

Known disbenefits						
Percent of EOV targets	**Cost of increased load external**	**Loss to salinised land**	**Loss to water logged land**	**Annual cost to local Govt**	**Annual cost to domestic and industrial**	**TOTAL**
100	$4,963,721	$11,799,135	$32,700,549	$22,412,369	$10,325,193	$82,200,967
75	$7,146,394	$16,987,512	$47,079,804	$32,267,651	$14,865,440	$118,346,801
50	$9,874,735	$23,472,982	$65,053,872	$44,586,755	$20,540,749	$163,529,094
25	$12,603,076	$29,958,453	$83,027,940	$56,905,858	$26,216,059	$208,711,386
Do nothing	$15,501,939	$36,849,266	$ 102,125,387	$69,994,905	$32,246,075	$ 256,717,572

Even if the targets are met in full, it is expected there will be an increase in disbenefits of $82m. More than half of this cost ($44m) will be the result of lost production due to high water tables or dryland salinity. Annual costs to local government make up a further 25% of the costs. The net present value of disbenefits if we do nothing is estimated at $257m.

The benefits from implementation of the SMP are shown in Table 11.

Table 11 Net present value of benefits from prevention of further degradation from dryland salinity in the Goulburn Broken dryland

Known benefits						
Per cent of EOV targets	**Cost of increased load external**	**Loss to salinised land**	**Loss to water logged land**	**Annual cost to local Govt**	**Annual cost to domestic and industrial**	**TOTAL**
100	$10,538,218	$25,050,131	$ 69,424,838	$47,582,537	$21,920,881	$ 174,516,606
75	$8,355,545	$19,861,754	$ 55,045,584	$37,727,254	$17,380,634	$ 138,370,771
50	$5,627,204	$13,376,283	$ 37,071,516	$25,408,151	$11,705,325	$ 93,188,479

25	$2,898,863	$6,890,813	$ 19,097,447	$13,089,047	$6,030,016	$ 48,006,186

The net present value of reaching 100% of end of valley targets is $175m. For the preferred option of 50% of end of valley targets the figure is $93m.

As a consequence of reaching only 50% of the end of valley targets as recommended by the Murray Darling Basin Commission there will be shortfall in the level of salt that needs to be prevented from leaving the catchment. The costs of doing this has not been included here, nor have the disbenefits been calculated. The process for dealing with this shortfall is still to be developed. It may include salt interception works, either inside or outside of the catchment or the purchase of salt credits or other mechanisms yet to be identified. Until such time as they are known there likely costs and impacts cannot be included in the investment analysis.

Downstream - External

These are estimated from the ABARE study, and are calculated from a downstream disbenefit of $27/tonne leaving the dryland area. The disbenefits calculated here are from the expected increase in salt leaving the catchment over the next 100 years.

Production losses

These are based on the opportunity cost of land affected by high water table (Trapnell *unpub*). Land affected by salinity was assumed to fall in production potential by 50%, land affected by high water table but not salinity was assumed to fall in productive potential by 10%. These estimates are net changes after land managers have adapted to changed conditions. They do not include the transition costs or the multiplier effects of a shift in the investment strategy of land managers as a result of altered circumstances.

Local Government

The costs to local government are taken from the report by Wilson and Ivey ATP.

- Additional repairs and maintenance on roads, culverts and bridges
- Building new infra-structure
- Preventative works
- Community education, research and extension

The original data was estimates of current costs. These were adjusted on a pro-rata basis for the projected increase in salt loads to give a total cost in the future. The rate of increase in dryland salinity was assumed to follow the projected increase in dryland salinity (SKM, 1999).

Disbenefits to industrial and domestic water users

These figures were also taken from the Wilson and Ivey ATP report. The calculations include:

- domestic saline town water costs
- industrial saline water costs

The rate of change was calculated in as for the costs to local government.

Unquantified benefits

There are a multitude of benefits not accounted for in this analysis because they have yet to be quantified. These include additional water quality benefits, and improved function of terrestrial and aquatic ecosystems because of salinity remediation works. The focus on high-density trees also means there is a benefit accruing from carbon sequestration which is not calculated.

No estimate is made of the benefit or disbenefit of changing land use. In some cases, such changes may yield a net increase in returns (plantation forestry, saline aquaculture) and in other cases it may result in a net loss (saline agriculture, saline aquaculture).

Avoidable losses

The losses that can be avoided by implementing the plan are not the total costs or disbenefitsof dryland salinity. The plan is built on the assumption that some further degradation of the environment and increase in salt loads in streams is unavoidable.

The probable disbenefits are calculated as the change resulting from dryland salinity. Estimates do not include the current costs of salinity as these have already been incurred. The future work is aimed at preventing further degradation, not restoring what has already occurred.

6.3 Cost Benefit Analysis

The analysis of costs and disbenefits are given in **Figure 8**. Known benefits are less than the cost of implementing the plan up to 100% of the EOV targets. The costs of implementation do not include any costs associated with managing the shortfall between targets achieved and EOV targets required. The implications of any shortfall in achieving targets have not been made clear; nor is it known which parties are responsible for managing any shortfalls. It would be premature to build such costs into a regional analysis at this stage.

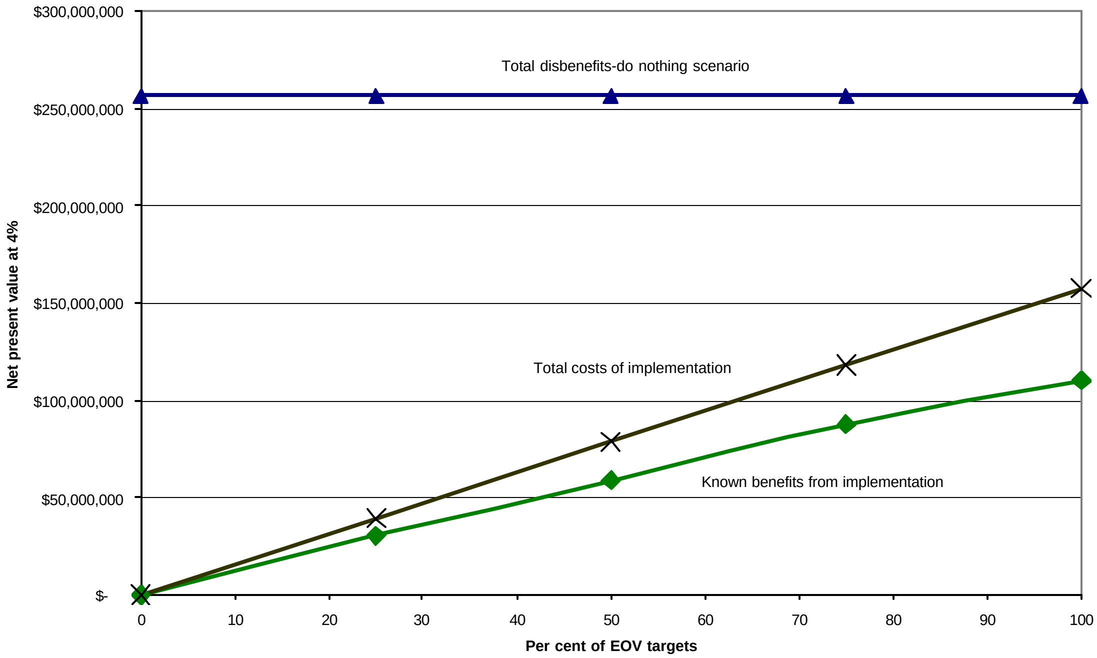


Figure 8 NPV of costs of implementation and known benfits from implementation of the DSMP in the Goulburn Broken

The benefit cost ration (BCR) is shown in Table 12. There is a slight increase in the BCR at lower levels of the EOV targets. This is because the marginal value of implementation increases with lower levels of implementation. The likelihood of returning a net benefit to the community, as is required under government policy, depends on the value of the unquantified benefits that would result from implementation of the SMP

Table 12 Benefit cost ration for different levels of EOV targets for implementation of the GBDSMP

	Percent of EOV targets			
	100	**75**	**50**	**25**
Benefit Cost Ratio	0.70	0.74	0.75	0.77

Quantifying the unquantified

While it is not possible, yet to quantify many of the other benefits it is possible to estimate what value they would need to be to return a net benefit to the community.

Table 13 Estimated value of unquantified benefits required to return a net benefit to the community from implementation of the GBDSMP

	Percent of EOV targets			
	100	**75**	**50**	**25**
Difference between known benefits and costs of implementation	$47,050,655	$30,538,630	$19,761,682	$8,984,735
Annuity of difference at 4% over 100 year	$1,920,043	$1,246,220	$806,435	$366,649

For the overall benefits to equal or exceed the costs of implementing the plan the additional benefits from carbon sequestration, reduced phosphorous inflow into streams, soil stabilisation, aquatic and terrestrial ecosystem services and multiplier benefits of investment in the region by government and private industry would need to total around 25-30% of the estimated salinity benefits.

For a target of 50% of EOV the unquantified benefits would have to be greater than $20m over 100 years. This is equivalent to an additional annual benefit of $0.8m a year. More work is required to value these benefits but by any measure they are likely to be worth at least this amount.

6.4 Sensitivity Analysis

The magnitude of disbenefits from dryland salinity depend very much on the projections of increased salt load from the Ultimate salt loads study. The projections reported by SKM and used to develop the Basin Salinity Management Strategy are at the upper end of likely outcomes. If it comes to pass, with new information, that the estimates are curtailed, it is worth looking at the implications for the GBDSMP (see figure 8).

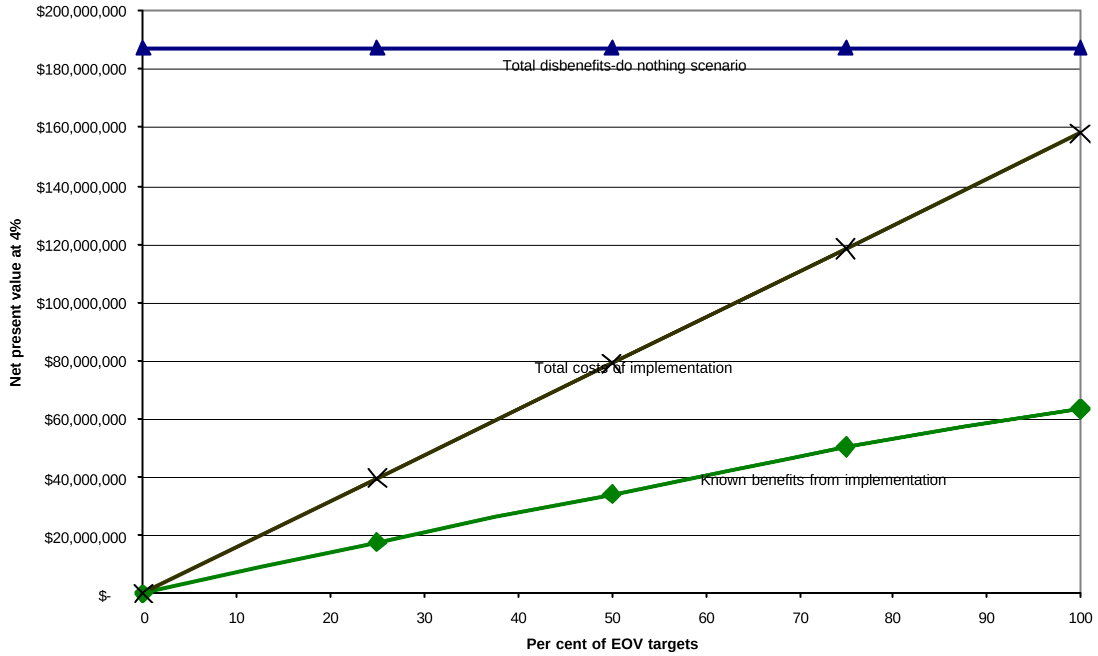


Figure 9 NPV of costs of implementation and known benfits from implementation of the DSMP in the Goulburn Broken at half the projected increase in dryalnd salinity in BSMS

The estimated total known costs is now $187m, down from $256m. The costs of implementing the Plan exceeds the known benefits at all levels of targets.

If the community opts for a EOV target level of 50%, it needs to decide if the size of other unquantified benefits are sufficient to justify the proposed level of expenditure. For a target of 50% of EOV the unquantified benefits would have to be greater than $45m over 100 years (or $1.8m/yr at 4%).

	Percent of EOV targets			
	100	**75**	**50**	**25**
Difference between known benefits and costs of implementation	$94,288,139	$67,992,299	$44,985,582	$ 21,978,865
Annuity of difference	$3,847,710	$2,774,630	$1,835,772	$896,914

The model is sensitive to the assumptions about the impact on production from high water tables and dryland salinity. A conservative value was put on the likely lost production. Increasing the anticipated loss from either or both of these increases the disbenefits whilst keeping the costs of implementation the same, making the investment more attractive.

6.5 Cost Sharing

Cost sharing, is a way for both the community and the landholder to share the cost of improvements to natural resources. Cost-share is usually defined either as ‘polluter pays’ or ‘beneficiary pays’.

The ‘polluter pays’ principle applies where there is a clearly identified polluter, more usually associated with point source pollution. Under these circumstances it would be expected that the ‘polluter’ would pay to repair or improve the value of the assets back to a community-agreed standard. For issues such as dryland salinity the sources of pollution are diffuse and it is very difficult to identify the ‘polluter’. In this case, cost-share arrangements are built on the ‘beneficiary pays’ principle. ‘Beneficiary pays’ is where that sector of the community that benefits from remediation works that restore environmental values pay for that work. The major difficulty with this method is adequately quantifying the benefits and apportioning them equitably amongst the sectors of the community. Cost share arrangements are slowly becoming a mix of both polluter pays and beneficiary pays. This reflects a greater awareness of what constitutes inappropriate land management coupled to an improved understanding of the processes that lead to pollution in the case of dryland salinity.

Principles

In addition to identifying polluters where possible it is also expected that the rate of Government contribution should only be such that the expected benefits outweigh the costs.

There are a number of other general principles that directed the use of Government contributions in other programs and areas such as regional development, social behaviour and protection of community assets.

The Government (community) contributes to developments in a limited number of situations. These are where:

- there is a public benefit derived from the development where the beneficiary can not be easily identified
- where there are threats to public goods (such as the environment) which require intervention to protect them
- to encourage a change in behaviour for the public good
- to encourage regional development for the broader community's benefit

6.6 Landholder contributions

Most current government grant schemes provide for a percentage of the initial capital cost. In many cases this is only a minor part of the total cost. Many of the real costs are not considered, or are deemed to be the responsibility of landholders. The failure to acknowledge these costs distorts the balance of costs and benefits, and makes it more difficult to achieve the community's natural resource goals.

Actual Costs

In the past, landholders have borne a much higher proportion of the costs than is recognised. The main costs ignored are:

1) maintenance costs,
2) replacement costs, and
3) lost opportunity costs of works (both time and money).

The accrued value of these costs makes them prohibitive for many landholders.

In the last two years, the GBCMA through DNRE, have reviewed the costs of works, with a view to adjusting the amount paid to landholders. The GBCMA has adopted a policy of using current local costs in their assessment of grants, and has undertaken to review these costs annually and to publish the results. This will make it easier for landholders to understand and accept the grants process.

Maintenance Costs

Maintenance costs are not normally included in the overall costing of environmental works projects and yet these costs can be considerable. By their very nature, maintenance of the fence that suffers stock pressure from one side only is substantially greater than for a 'normal' subdivisional fence. To this can be added the additional maintenance for pest plant and animal control. An O&M cost of approximately 1% of the establishment costs would be applicable for fencing located specifically for protection of vegetation. This is equivalent to around 10% of the capital value if paid up front.

Replacement Costs - Depreciation

Replacement of the fencing is also not included in the costing. There is an expectation that once the works are completed they will be there forever; although this is not the case. When a fence falls into disrepair, the groundcover and shrubs that are critical to biodiversity can rapidly disappear. An up-front payment for future replacement would be between 50 and 70% of the initial capital cost. Such payment for future replacement poses a high risk to the community. At present there is no compulsion for land managers to replace the fence, so there is no guaranteed return on any investment the community makes. This applies generally, but is particularly significant to environmental programs that rely on creating a diversity of structure within revegetated or protected areas. In the case of salinity, the establishment of high-density trees poses less of a risk since they are unlikely to be 'grazed out', and there already exists controls on land clearing. Nevertheless, consideration needs to be given to making the controls robust enough to guarantee that the community's investment in land management is protected better.

Opportunity Costs

Opportunity costs are incurred when the 'opportunity' to earn income in an area is foregone by putting that area to another use. For the most part, revegetation for environmental purposes means that the land is effectively retired from productive use, and the landholder incurs a cost by way of lost opportunity. While it is clearly a case of lost opportunity to the landholder, it cannot be assumed that it is the same for the community at large. In the process of changing land use, other benefits arise which are insignificant to the landholder but must be assumed to be significant in aggregate across a large number of landholders. Currently, opportunity costs vary between $122/ha in the Goulburn Highlands to $199/ha in the Broken Plains (Trapnell *pers comm*).

In summary the unaccounted for costs to landholders are shown in **Table 14**.

Table 14 Estimated maintenance, replacement and opportunity costs for 100m of fencing in the Goulburn Broken Dryland

Cost	Estimated annual cost	Net Present Value at 8%
Maintenance	$4.20	$45
Replacement[1]		$177
Opportunity cost[2]	$122-199/ha	$104-$170
TOTAL		$326-$392

[1] Depreciation calculated using straight line depreciation method and assuming a life span of 25 years and a salvage value of 1% of initial cost

[2] Opportunity cost converted from $/ha to $/m assuming each 100m of fence protects 0.08ha of land. This will vary according to the width and shape of the area fenced.

This means that depending on whether an area is simply fenced, or fenced and revegetated, the unaccounted-for costs are between 40-90% of the identified costs.

In the case of properties that are managed for lifestyle, the opportunity costs are not nearly as large, if they are considered at all. In this latter case, the additional costs are between 24-53% of the identified costs.

Under present arrangements, it is expected that the landholder will bear all of this additional cost. If nothing else, it is important to recognise the costs borne by landholders when they complete works as part of defining the overall contributions to works.

6.7 Identifying trade-offs

Managing salinity will require the community to make trade-offs between social, environmental and economic outcomes. Trade-offs occur all the time but they are not necessarily explicit, and in fact, while they are small or inconsequential, they may not matter. However, in the face of far-reaching change, it is vital that the trade-offs are well understood and well communicated.

Typical trade-offs might include

Social	Willingness to pay/participate
	Lifestyle opportunities and aesthetic value
	Lifestyle and stress on environmental assets
	Plantation development and aesthetic values/quality of life
	Duty of care and Right to farm
Environmental	Plantation development and biodiversity
	Recharge reduction and catchment yield
	Recharge and discharge management
Economic	Capacity to pay/participate
	Growth and protection
	Infrastructure protection and Environment protection
	Infrastructure at risk from salinity and infrastructure that needs to be improved/maintained

Any failure to address this issue means the community is implicitly accepting a certain but unknown level of degradation of natural resources and infrastructure.

There is, at present, no clearly identified mechanism that allows these trade-offs to be explored and judgements made on their appropriateness.

Almost by definition, trade-offs require that what is 'being traded' can be measured somehow. As part of an on-going process, we need to develop measures of key trade-offs, along with systematic ways to process the information. An important tasks is to develop a set of catchment indicators that can be used to measure progress of the program.

Market-based Systems

The long-term viability of the GBDSMP depends on attracting private investment into the catchment. Such involvement can be purely altruistic or delivered through philanthropic trusts. However, if we have the long-term in mind, then businesses need to invest in the catchment for commercial gain. The commercial opportunities for plantation forestry are well established. In this enterprise the level of Government involvement can be well defined and is restricted to investments where there is a high likelihood of the environmental benefits being greater than the costs of investment and where the outcomes are clearly defined.

Investment in environmental works needs to be greatly supplemented if the targets are to be increased 15-fold. Success in attracting future investment in capital works for salinity control in the catchment will require the development of new investment approaches. One possibility is the development of the land stewardship payment approach. In order to manage land stewardship payments, the payments themselves have to derive from returns on investment and not the capital itself. This requires that sufficient funds be invested in the appropriate institution (eg. vegetation bank). For example, a long term goal of 10,000 hectares under stewardship payments, assuming that such payments are 50% of the opportunity cost, would need a capital investment of between $6-12m depending on how the stewardship payments were distributed across the catchment.

There is still much to be done to develop concepts like the vegetation bank and land stewardship payments. Other possible approaches such as credit trading mechanisms (eg. carbon credits, salt credits or biodiversity credits) are currently being considered at an international and national level.

The GBCMA will continue to support the development of new investment approaches which ensure equitable outcomes for both land managers and the wider community, and lead to improvements in the condition of the natural assets of the catchment.

Institutional Reform

In a report on institutional reform options, the Virtual Consulting Group (2001) wrote that "…the management of dryland salinity will involve the provision of:

Information to allow stakeholders to understand the nature of the problem and its possible solutions at the farm, catchment and national scapes.

A priority setting process. to determine how public resources should be allocated to deal with dryland salinity in an a manner that is in the national interest this will require the establishment and support of mechanisms to consult effectively with the community at the catchment level.

An investment and cost sharing partnership which provides an agreed basis for mobilising investments and sharing costs in dryland salinity management among landholders, the community, state and federal governments.

A consistent whole-of-government approach to ensure that all government activities are in support of actions appropriate to improves management of dryland salinity.

A supporting operating environment in which market and other signals encourage appropriate behaviour. Together with the investment and cost sharing partnership, the operating environment must provide adequate incentives for appropriate behaviours by all parties".

These are common sense provisions, but ones that require a restructuring of our current operating environment and the way we analyse problems and determine actions.

The success of managing dryland salinity in the Goulburn Broken catchment, and the Murray Darling Basin in general, depends on how well we can manage change in institutional support. The options available can be defined as:

1. Regulation
2. Market base
3. Government investment.

For the most part, Government investment has been the mainstay of salinity programs to date. The advantage of Government investment, through such mechanisms as subsidies, is that they can be well-targeted, often have lower transaction costs than alternative mechanisms and, in principle, are equitable.

Other options include tradeable permits, taxes, regulation and management agreements.

Tradeable permits

The GBCMA can do little more than support the development of tradeable permits. Opportunities in the short to medium term lie with water trading for dilution flows, and carbon credit trading. Other opportunities in the longer term are trading in salt credits, either for salt loads generated or recharge prevented, and biodiversity credits.

Taxes
Taxes, unless well targeted, can be inequitable. Improved targeting requires investment in gathering more information. The more broadly the tax or levy is applied, the more difficult it is to ensure that the proceeds are used eqitably. This is because the uses to which they can be put and the beneficiaries of those uses vary greatly in their circumstances and so the system becomes more iniquitous or inefficient. Levies or taxes at the catchment or local government scale do provide a means for more efficient and equitable targeting, and therefore lower transaction costs, but would also mean that local communities explicitly pick up those transaction costs. The GBCMA and local government need to investigate the mechanisms of local levies or taxes that best capture the principles of fairness and cost effectiveness.

Regulation
The success of regulatory measures will depend on having the legislative backing supported by appropriate information. There is a high degree of uncertainty in our understanding of salinity processes, particularly at the individual landholder level. There needs to be a clearly established and defined Duty of Care, and an expectation of what constitutes land management practices that are generally accepted by the community. There is obvious scope for work within the catchment to further develop a culture supportive of regulatory initiatives, as well as defining a reasonable Duty of Care.

Management agreements

Management agreements have largely been voluntary to date, and carry little legal significance. They may play an important role in the future when used in concert with other measures. It will be critical to work out ways, with local government and other state departments, to lower the monitoring and compliance costs which are, at this stage, prohibitive. It is also important to recognise the true costs to landholders of entering into management agreements.

Chapter 7 Implementation details

Implementation needs to focus more on large-scale landscape change. The challenge in such change is to get broad community understanding of the issues and a clear idea about what level of change they are prepared to accept. This can only be achieved by creating better opportunities for community participation in the management of the problem. It is important to recognise that the salinity problem can act as a catalyst for community involvement in the wider issue of regional development. As an issue in its own right salinity, and any other single natural resource management issue, will not galvanise the community to action. The emphasis will shift to regional development and the greater involvement of private markets in overcoming the problems of degradation of natural assets. The salinity program will deliver this via five sub programs: community engagement, plan support, on-farm, commercial and engineering. Each sub program will have its own targets and timeframes for implementation.

Improved community engagement is essential for the success of the plan. There needs to be better identification of 'the market' and a move away from sole reliance on landcare to bring about the change required. Recent work has underscored the need to better understand the process of change and the attitudes of the community to change and to use this to change the way the program is delivered. Plan support will focus on filling information gaps, integrating activities across different programs and adapting the program to the changed circumstances. The commercial sub program will develop partnerships between government, industry and investors. The aim is to ensure that the communities resources are used effectively to protect and enhance natural assets while creating opportunities for the economic growth of the region and the improvement service delivery to local communities. Engineering options, within or outside the catchment , are the surest means to manage salt loads in stream in the shortest time. The key question is to what extent the community wishes to invest in engineering works to protect important assets in the near future. Engineering will also provide opportunities to promote regional development and at the same time reduce salt loads entering streams in some areas of the catchment. The on-farm sub program will focus on maximising water use on farm , combining production s and protection at the whole of farm scale. Landholders can select from a number of options to manage water use on their farm with a view to reaching as yet to be defined benchmarks to attract support to establish more sustainable farming systems.

The implementation of the SMP will require an annual investment of around $4.6m annually. Such a level of investment needs to combine government and private market support; this is the significant challenge for natural resource management in the future.

7.1 Dryland salinity –the need for change

The solution to the emerging problem of dryland salinity will entail a massive change in land use and management. Change of the magnitude suggested will only happen if the community as a whole is in agreement and wants to embrace the change.

There are two problems when engaging the interest of the community. First is the relative importance of dryland salinity as a natural resource issue. Dryland salinity is one of a number of natural resource issues. It is arguable whether it is the most important environmental issues compared with climate change, sustainable energy use or population management.

The second problem is that the community also faces many more challenges than environmental ones. These include- provision of services by government or utilities and banks, employment, migration of the young people to cities and health. This diversity of interests and concerns makes it very difficult to inspire the sort of change that is necessary to manage the dryland salinity problem if it is promoted as a single issue.

Management of dryland salinity, at the scale described in this strategy, is only going to be accepted, and so made possible, if the outcomes from improved salinity management are clearly seen to improve condition of the whole community. For salinity to be dealt with at an appropriate community scale it needs to be more clearly linked to the broader success of the region and to be part of a holistic response to the issues that beset local regional communities. The actions required to combat salinity need to be aligned with objectives that are seen to better meet the needs of communities. As Peter Elyard observed in his address to a workshop on the future of communities,

> "…An action which achieves ecological sustainability … while totally wrecking the economic and social sustainability of a community … is not working towards sustainable development."

It is necessary to implement natural resource protection programs in a broader regional development context. Dryland salinity is a regional development issue. As such the focus needs to be on the protection of key assets that enhance or maintain the economic, social and environmental sustainability of the region.

At present there are no clearly identified bodies in the dryland catchment to provide the support to link natural resource management to regional development. At the same time there are a number of committees or steering groups in the catchment with the potential to catalyse a broader regional development initiative in a way that encompasses the major environmental issues. Such a forum would be needed to help facilitate institutional change in support of community inspired initiatives.

It is well accepted that development is contingent on trade-offs between different demands. Elyard (2001) wrote:

> "… there would need to be trade-offs between ecological, economic,, social and cultural goals. To allow for this most policy makers have also advocated open, consensus based planning processes to ensure that the necessary compromises required to accommodate these trade-offs did not result in any form of irreversible environmental change, and that any accommodations which were made also had broad community support."

Explicit recognition and management of the trade-offs needs to be built into the Program and the most appropriate way to achieve this is through an increased emphasis on community involvement. For the GBDSMP to be successful the community needs to draw together the supporting infrastructure that would facilitate institutional change.

7.2 Sub-Programs

The sub programs that make up the salinity program also need to reflect the challenges for the future and the way that the protection and enhancement of natural resources is to be managed and paid for. Currently there are eleven sub programs in the GBDSMP which largely describe the activities of the program. It is proposed to reduce the number of programs to five that better capture the focus of the Program in the future. The five proposed programs are Community Engagement, Plan Support, On Farm, Commercial and Engineering.

Each program encompasses the following:

Community engagement	Local Area planning
	Local Government
	Regional development
	Landcare support
	Schools program
Plan Support	Research and Investigation
	Monitoring
	Policy and planning
	Vegetation bank
	Adaptive management
On-farm	HD trees, farm forestry, BOS
	Pastures
	Discharge management
	Living with /Saline agriculture
	Whole farm planning
Commercial	Plantation forestry
	Investment development
	Regional development
Engineering	Salt interception
	Salt disposal
	Groundwater pumping
	Regional development

Each sub program needs a clear focus and plan of action with targets and timeframes for implementation. Each sub program should have a specific leader, a person delegated to take responsibility for coordinating implementation of the sub-program and reporting on progress. Some functions, such as regional development cross sub-programs. Equally it is expected that staff function's will also cross sub–programs. This will work to ensure that the implementation of the Plan is properly integrated.

Community engagement sub program

The success of the management plan hinges on the success of engaging the entire catchment community. This in itself will require a more sophisticated model of operating than used in the past.

Proper recognition will have to be given to the implications of the work of Curtis *et al* (2000) and Barr (2001) and how their conclusions influence our approaches in the future. In particular both identify that a reliance on altruism and voluntarism limits the capacity to deliver the level of works required to deal with the problem. Of equal importance is how the service agencies respond to directions set by the community. The future will require an adaptive style of management, one that is capable of responding to directions from a community with a different perspective to that which pervades natural resource agencies. To work, the ethos of adaptive management needs to be adopted at senior management levels in the key agencies, notably DNRE and the CMA.

The elements of the community engagement sub-program are:

Local Area planning

Natural resource management programs must place more emphasis on the role of Local Area Planning (LAP) as a process to identify the most suitable way forward in resource protection and regional development. The Regional Catchment Strategy describes the desired approach to natural resource management across the catchment and is limited in its influence. The development of LAP's needs to meet the needs of those charged with the responsibility of managing natural resources. They also need to provide the means to engage with the community on inter-related issues.

Local Area planning is a vehicle to support greater community participation in natural resource management. In the short term the LAP process needs to link issues identified through community forums with current priorities and resource allocations. In the medium and longer term LAP's need to encompass a wider range of issues and capture the interest of a greater part of the community. Sometimes this may mean building on LAP's, at other times it will mean incorporating outcomes and processes from the LAP's into other community initiatives.

The effectiveness of LAP's will be determined in part by the ability of decision makers in the service agencies to adapt to the demands that arise from community. At the same time unless the service agencies themselves, as members of the community, have a clear vision for the future their responses will as likely be ad hoc and increasingly reactive and ineffective.

Local Government

Local government plays a critical role in the future of resource management on two accounts. First they are the elected representatives of the community and are responsible for many issues that are of more commonplace concern than natural resource management. As such the responsiveness of local councils to environmental matters is a measure of the progress towards a more environmentally aware or concerned community. Second, through the Planning and Environment Act, they are a major influence on what is deemed appropriate land use. The use of planning overlays is critical to describing suitable development and land uses and proscribing unsuitable developments or land use. Third local government has a key role in promoting regional development initiatives. As described previously the management of the dryland salinity problem is dependent on the community pursuing a common vision for regional development, one which addresses the environmental, social and economic aspirations of the community.

It will be important to develop a three way partnership with Local Government, the Department of Infrastructure and natural resource service agencies. Due consideration needs to be given to the expected role of each organisation and the type of support required for them to participate.

Regional development support

If we are to participate in regional development then we need to provide appropriate support by providing information and analysing the implications of different initiatives. The GBCMA can play a lead role in convening and supporting a forum that enacts the vision of "double the production off half the land".

Such a forum needs to bring together relevant Government departments, industry and community interest groups to provide ideas and influence to improve the productivity and resource condition of the catchment.

Schools program

Close liaison with schools is important in forming public opinion and influencing cultural change in the community. The Saltwatch and Waterwatch programs have been highly successful in introducing natural resource management concepts into schools and the community. In the recent past this has been enhanced with the development of additional curriculum materials for schools. If such programs are to be successful and adopted by schools then their presentation also needs to be supported.

Social and economic condition

Measuring progress via the 'triple bottom line' has become a mantra for strategies and government policy in recent times, without anyone being able to clearly articulate what exactly is to be measured. It is generally true that agencies such as the CMA and DNRE do not have the breadth of skills to undertake social analysis. Economic analysis is also hamstrung because of the difficulties of analysing issues of inter-generational equity and properly defining scarcity of resources.

The catchment needs to develop a set of indicators of catchment health and well being spanning across the environmental economic and social qualities that mark progress. Although there have been a number of efforts to do this in the past at the State and National level they have all floundered on the problems of definition and compromise. A set of catchment indicators for Regional, rather than State or Basin, analysis is being developed in the North East region. This may catalyse action at a broader scale but more importantly it will provide the basis for deciding what we, as a regional community, deem important and help devise the measures of progress towards our goals.

Community support

Landcare support has been a major part of the extension and community education role of the Plan in the past 12 years. This needs to be strengthened and broadened to explicitly include a wider audience. This will entail a considerable change in the way we approach the task because we are no longer communicating to an aware and receptive audience. A different approach is required for that sector of the community that has shown scant interest in natural resource matters in the past. This emphasises the value of putting the salinity problem in a broader regional development context.

As well as providing information and assisting the devolved grant process, this part of the program needs to develop a network throughout the community that supports increased community participation in regional development.

Plan support sub program

Adaptive management

The GBDSMP needs to establish benchmarks of performance in responding and/or managing community aspirations. The mechanisms to achieve this need to be part of the normal business planning cycle.

Land stewardship

Land stewardship requires that the appropriate infrastructure be put in place to manage financial and advisory support to land managers that allows them to manage land for ecosystem services, including salinity abatement. Investment by the community in such schemes needs to be safeguarded with management and cost share arrangements that are equitable and ensure that there is a net gain for the community through the investment. The principles upon which stewardship is based are well established in the Goulburn Broken. The implementation of more sophisticated methods of land management is a natural progression and closely linked to instituting a vegetation bank.

Integration across programs

The integration of priority setting processes and planning across programs is the key to integrated catchment management. Further work is required to more closely align bioregional planning initiatives with the environmental component of the Plan. At the same time there is mutual benefit to be gained from co-ordinating works activities near streams to establish buffers against salt and nutrient flows to streams. The development of erosion risk maps will also provide the means to identify where management of erosion and recharge and discharge management coincide.

Research and Development

After twelve years there are still some significant gaps in our knowledge. The following are areas where further investigation is required:

- **Accurate identification of recharge areas across the catchment** – Currently recharge maps across the catchment are incomplete. The techniques used to map the recharge areas were not consistent and the accuracy of these maps varies. It is necessary to develop a more scientifically sound and cost-effective technique (using a combination of existing soil data, digital elevation model data, soil radiometric data and bore data) to map potential recharge areas across the catchment.
- **Movement of salt in the landscape and accession processes in priority areas.** In the past 20 years, a comprehensive network of sites for groundwater and surface water monitoring has been established. Groundwater, surface water and dryland salinity processes have been extensively studied in the Goulburn Broken Dryland Catchment. Many previous studies (Allan, 1994; SKM, 1996, 1999; Cheng, 1999) have shown that dryland salinity has caused significant degradation and is posing an increasing threat to land and streams in the catchment. However, these studies were mainly based on point data. The spatial distribution of salt and its historical change have hardly been studied due to the unavailablity of technology. Because of this, development of catchment models (conceptual and numerical) has been a very difficult task. Airborne geophysical technology, in conjunction with other datasets, offers the prospect to revolutionise the way we

develop catchment models and, ultimately, the tools that we use to help manage catchment issues such as salinity, water quality and resources in general.

- **Assessment of the effectiveness of salinity management options**. Over the past ten years, many salinity control techniques have been employed to combat dryland salinity problems in the catchment, particularly in the areas where salinity is visible and there is active community involvement. These approaches include remnant vegetation retention, establishment of high-density tree plantations, lucerne, perennial pastures, break-of-slope tree plantations, and groundwater pumping. These programs need to be monitored and assessed for their impact and cost-effectiveness on watertable control. The use of the Catchment Assessment Tool to validate the assumptions that underpin the Plan will be an important task.
- **Perennial vegetation management systems.** Vegetation management systems, involving the incorporation of perennial vegetation (pastures or/and trees) into either the crop rotation, or onto the cropland itself, could be effective for salinity management. Further investigations are required to look at the potential application of these systems in the Goulburn Broken Dryland Catchment. The Program also needs to support investigations into alternative crop types for saline land and for the management of recharge in low rainfall areas.
- **Engineering options**. Engineering approaches have been widely used in irrigation regions for salinity control, but are often considered to be too expensive for dryland area. Although investigations to identify and delineate groundwater resources have been undertaken in some areas (eg. Mt. Camel Range, Dookie and Nagambie), groundwater pumping options have not been widely adopted. Investigation should be expanded to a wider area including paleao-channels on the Broken Plain. New technology (eg. airborne geophysical sensing techniques) may be needed.
- **Impact on streams.** Several studies (Earl, 1988; SKM, 1996; ANU, 2001) identified the South-West Goulburn to be the catchment's greatest contributor of salt to the Goulburn River, on a tonnes per hectare per annum basis. However, the salt release processes, including the relative significance of salt wash-off and base flow, remain unclear. To address this we need to:
  - identify high-risk salinity areas and the key processes,
  - prioritise high-risk areas for targeting implementation strategies (including on-ground works, research, capacity building) on the basis of technical, environmental, social and economic considerations,
  - develop a data acquisition program to address data deficiencies, and
  - develop a management decision support system for later use in testing different management options in the identified priority areas.
- **Risk posed by acidification of the landscape**

The success of biological solutions to dryland salinity is compromised by acidification of the landscape. The risk that such acidification poses is not well understood. More information is required to understand the processes of acidification, the areas likely to be affected and the impact on reforestation and pastures as well as terrestrial and aquatic ecosystems.

- **Discharge risk in the priority areas of the catchment.** Requirements include:
  - Location - which areas are at risk
  - Extent - what is the probable area to be affected over time
  - Rate of spread - how quickly is it likely to occur.

Geographic Information Systems Support

The use of GIS has been instrumental in the priority setting process, and support for the grants scheme, as well as for spatial analysis of impacts of reforestation on catchment yield. This needs to continue into the future with tasks including:

- Accumulation and integration of critical data sets
- Spatial analysis of responses to recharge and discharge control options
- Local Area Plan support
- Regional development support
- Asset identification and risk assessment
- Land use options
- Natural and built assets at risk

End of Valley targets and progress

An analysis by SKM (2002) confirmed the suitability of the End of Valley sites at Goulburn Weir and Casey's Weir. The analysis of trends at Goulburn Weir will be supported by results from stream salinity monitoring at Trawool. Between these two data sets there will be indicative information on responses to works carried out in the South West Goulburn. The major issue of concern is accounting for diversions at the Weir. In the Broken system, there is less need to compartmentalise the response to increased salinity. The focus of work in this region will be on managing the higher water tables rather than stream salinity for its own ends.

Surface water

Stream salinity monitoring in the catchment is adequate for the purposes of describing the overall condition of the catchment. There will be a need from time-to-time to enhance the network as our understanding of the salt accession processes improves.

Groundwater

A review of groundwater monitoring was carried out by CLPR (Cheng, 1999). The recommendations of that review have been implemented. It will be important to improve the network in the vicinity of the Plains-Upland interface to allow us to understand more clearly what is happening in this area and how the problem of dryland salinity is likely to express itself.

Discharge

Discharge monitoring has been a low priority of the GBDSMP in the past, in part a recognition of the refusal to accept the living with salt option. Any discharge monitoring has been largely carried out under the mandatory environmental monitoring.

The situation has changed enormously with the projections of the Ultimate Salt Loads study and the Murray Darling Basin Salinity Management Strategy. It is essential to establish a formal discharge monitoring program to:

- Validate or otherwise the projected increase in areas of dryland salinity.
- Provide data to support changes to the Plan in the future, according to the actual rise in groundwater and salinisation of the landscape.

A trial discharge monitoring project established in 2000 the protocol for mapping salinity areas. This should provide the framework for future discharge monitoring programs, primarily in the Riverine Plain and the Plains-Upland interface, with additional work in the South West Goulburn.

CMA/IC support

Continued support to the IC and CMA to ensure the Partnership develops and provides appropriate service levels to the community

Commercial sub program

Meeting the targets will require a substantial investment by private industry or other investors. In the short term, significant opportunities are offered by an expansion of the plantation timber industry in the catchment. The region is well suited to the growth of the plantation industry. However, development of a hardwood chip or pulp plantation base is at present hamstrung by distance to port or other markets. Development of a hardwood plantation sawlog industry is dependent on sufficient quantity and quality of resource base being established.

Government support for the establishment of timber plantations is justified where there are clear public benefits. In areas where there is a mutual public and private benefit, Government investment could allay the risk to investors arsing from extra costs, and at the same time increase the area under plantation. The principle of Government investment in plantations for salinity benefit and timber production is similar to that which justifies support for individual landholders. It is likely that the level of Government investment on behalf of the community, on an area basis, would be far less than that which is presently paid to individual landholders. Government involvement would also enable the community to set standards for plantation development that reflected the broad needs of the community. This would include such things as better biodiversity outcomes, managing perceived fire hazards, maintaining social structures, and balancing reductions in salt accessions with maintenance of catchment yield for downstream users and the environment.

No such investment should occur without full consideration of the long-term benefits to the environment, and the development of equitable cost-share arrangements. The guiding principles of any investment should be that the market knows best what it will invest in, and the community, through the Government, should only invest where the public costs are outweighed by the expected benefits.

In the longer-term, there is a range of opportunities built around better practice management within emerging industries. For example, the budding horse racing industry in the catchment could distinguish itself in the market through its commitment to the environment. Likewise, with other intensive industries that see ‘being green’ as a marketing opportunity rather than an external cost.

Engineering

Engineering options will become increasingly important in the implementation of the Plan for the foreseeable future.

Drainage
The increase in area affected by high water table will create a demand for the drainage of affected land across substantial areas of the Riverine plain and the Plains-upland interface. At present there is no scope to undertake works in the dryland to dispose of saline water into waterways or drainage lines. It will be critical to develop a comprehensive dryland drainage strategy before events overtake us.

Groundwater pumping
This also applies to groundwater pumping where there is a need to develop a clear set of guidelines that describe the conditions under which groundwater pumped to the surface can be allowed to flow to the waterways, and manage the impact of groundwater pumping and use on catchment yield.

As part of the broader program, it will be important to establish where groundwater pumping is most likely to:

- Provide adequate yields of suitable quality that support commercial development
- Provide a benefit by reducing the risk of salt reaching waterways or the area of salt affected land

The development of industries around groundwater use needs to be supported through the extension effort of DNRE and CMA, and as part of the regional development focus.

Salt interception
Salt interception schemes provide the most effective means to meet end of valley target level in the proposed timeframe of 15 years. After factoring in time for implementation and for land use change to be fully functioning salt interception also provides the most suitable and effective option for at least the next 30 years.

To reach the end of valley targets will require a combination of land use change coupled to salt interception works either in the catchment or outside of the catchment.

Consideration will be given to salt interception schemes where appropriate but it needs to be established whether these are best placed in the catchment, or outside of the catchment as part of a joints work program.

Dilution flows
Another option for management of stream condition is the provision of dilution flows. The Goulburn River already has low salinity levels due to the impact of releases from Eildon over the summer period. Any increase in dilution flows will come at the expense of diversions for irrigation use and so would need to provide a clear benefit either to overcome the production foregone or to protect important environmental values. Any plan to increase dilution flows has to be part of a broader consideration of water supply management and water use efficiency, particularly in the irrigation region.

On-farm program

There are six components to this sub program-pastures farm forestry, environmental planting, discharge management, saline agriculture and whole farm planning.

The central theme to the program is optimising water use on farms and entails a whole farm approach to managing the water regime of farms. Optimal water use can be achieved through a range of actions, from tree planting, pasture development, groundwater pumping for irrigation and saline aquaculture. How any one land manager achieves better water use should be left to them. The role of Government and the GBCMA is to establish clear benchmarks on the expected water use on-farm and to then support land managers in achieving an agreed level of increased water use using endorsed activities or management practices.

Linked to community engagement and adaptive management

Pastures
Pastures will remain an important part of the Plan. Whilst perennial pastures are not as effective as high-density trees, they are accepted more widely by land managers, and provide potential for improvement in recharge control across much of the landscape. They also play an important role in the stated aim of the GBCMA to ‘double the production off half the land’. Increased emphasis will be placed on promoting the management of pastures, whether exotic or native, to increase water-use and salinity benefit, as well as to improve profitability, weed control and biodiversity benefits.

In recent times, there has been increasing interest in the use of native grasses for recharge management. There is no doubt that remnant native grasses have an important role in integrated catchment management, but it is difficult to see how the large-scale reintroduction of native grasses into areas where they have been lost can be promoted. There is no suitable native grass seed producing industry at present, and the costs of available seed currently make sowing of native pastures not commercially viable. The most effective option open to Government support is the promotion of pasture management practices which will encourage the spread of remnant native grasses.

Farm forestry

The options for farm forestry, at this time, are still limited by a lack of institutional support and markets. A decision to ban all collection of firewood on public land would create a demand for a firewood industry very quickly. Such an industry would be at least greenhouse gas neutral while serving to provide a high density vegetation option for recharge control in low rainfall (<650mm) areas.

Experience in the FFORNE project indicates there is an opportunity to establish between 600 and 1000ha of high density farm forestry plantings each year.

Revegetation

Environmental plantings have been the mainstay of the high density tree planting in the salinity program for the past 12 years. This part of the program is heavily dependent on the altruism of landholders for its success. Environmental plantings are best targeted to those areas where there is depleted or rare EVC's or where additional plantings can improve habitat for rare and endangered species. Historically around 200ha of high density trees have been established each year over the last 12 years. This target needs to be lifted to 400-500ha.

Additional support through land stewardship arrangements will be essential for the long term expansion of this project to break the dependence on the altruism of land owners.

In recent times there has been more interest in the use of native grasses for recharge management. There is no doubt that native grasses have an important role in integrated catchment management. Financial support for the establishment of native grasses depends on there being a seed producing industry and a substantial reduction in the price of commercially available seed. The most effective option open to the GBCMA and regional DNRE, in the short and medium term, is the promotion of better practices to encourage the spread of native grasses.

Remnant Vegetation Management

The protection and enhancement of existing remnant native vegetation, and the promotion of management practices which encourage natural regeneration are another effective approach to salinity control. A wide range of programs are directed at protecting native vegetation across the catchment, and promoting more effective management. These programs have been successfully integrated into the GBDSMP Program, through initiatives such as the Environmental Management Grants system and Whole Farm Planning. Efforts to integrate remnant vegetation and biodiversity management into the Program will be sustained.

Additional support through land stewardship arrangements will be essential for the long-term expansion of this sub-program.

Discharge management

Management of discharge sites is as important as management of recharge in many landscapes, particularly those dominated by overland flow processes. Preventing salt accession to streams, once it is mobilised, is part of the management strategy to 'buy time' so as to allow other landscape change options to take affect.

There are two components to this activity. First is the management of active discharge sites, to reduce their spread, to stabilise them against erosion by providing some groundcover, and to provide some limited production options. The second is to intercept saline overland flow before it reaches waterways. By buffering streams, the rate at which salt gets to the streams is reduced. This program will be developed in conjunction with the Waterways Program to ensure that maximum benefits are gained from works undertaken.

Saline agriculture

Saline agriculture is about the productive use of salt-affected land, about making opportunities from otherwise adverse conditions. The development of profitable options for living with salt is reactive by definition. It can only be promoted where there are existing salt outbreaks. The role of Governments in such circumstances is to undertake research and demonstration, to promote desirable approaches and provide information, and to remove impediments to innovative approaches. At the same time, service agencies need to ensure that all planning controls are adhered to and that no additional risk is posed to the environment or built infrastructure from saline agriculture.

In the regional groundwater flow systems of the Riverine Plains (GFS 6), it is likely that the most suitable long-term option is living with salt. The onset of high watertables, with subsequent salinisation, of large areas of land cannot be avoided for many areas. It will be important to develop links with programs such as OPUS and PUR$L to ensure that landholders have the opportunity to learn from the past experiences of other landholders, and to have access to the latest information.

Whole farm planning

Whole Farm Planning provides the means to encourage the widespread adoption of better management practices for sustainable farming. There are two distinct client types in the Goulburn Broken dryland: those who manage their land primarily for production, and those who own land for the lifestyle they enjoy as a result. The WFP sub-program needs to provide for the different requirements of each client group.

Where managers are concerned with deriving a substantial part of their income from the land, the problem is one of business viability, not merely enterprise or activity viability, nor even environmental viability. Better management practices should lead to more informed decision-making on:

- What to invest in
- Where and when to invest
- How to maintain debt-servicing capacity
- Risk assessment
- The link between desired lifestyle and capacity of the business to deliver it

In this case, better management practices will only lead to better natural resource management if the planning horizon is long-term. Short-term demands will often force businesses to over-utilise natural resources, because there are no appropriate market signals to suggest otherwise. This is difficult to manage, and relies on the existence of a market for the social goods that reward better management practices. The appropriate market signals may be in property values, commodity prices or lending rates from financial institutions. Whole Farm Planning can assist this process by being the starting point for accreditation under various possible Environmental Management Systems (EMS) banners.

The second client group is better served by the conventional model of Whole Farm Planning because they are less concerned with the trade-offs between productive land and amenity or service revegetation. In fact, additional environmental works will normally enhance the value of the land for this group. They are a very important group because they are starting to dominate land ownership, if not by number, then certainly by influence on land prices in the highlands and foothills where many of the environmental problems are found or arise.

The challenges in working with this group are their availability, often confined to weekends, their limited understanding of biological and agricultural systems, and the high rates of turnover of land. It is the last point that should define the way the program is delivered. There is no merit in investing resources in skilling this group in soil science, agronomy and forest science. It is sufficient they know there are differences, and necessary they know that the differences are important. This information is easily delivered nowadays using GIS overlays. There is potential to provide benefit to these landholders if they prepare a long-term Environmental Farm Plan, and show progress in its implementation, by way of rate rebates or other benefits that can be transferred from one owner to the next.

Community Links Officers

The Community Links Officers approach to program extension has proved to be a cost-effective way to deliver services to the community, and it will be important to expand this approach in priority areas. In addition to the current activities of Links Officers, there is a need to provide greater assistance with the coordination and implementation of works, particularly for landholders where time is a major constraint on their participation in environmental programs.

Table 15 Priority tasks and implementation framework for GBDSMP 2001-2015

	Annual cost	Task	Target and Timeframe	Primary/ Secondary responsibility	Priority
Community engagement					
Local Area Planning	$40,000	Adopt as a vehicle for business plan development	Complete natural resource component of LAP.Establish operating procedure to engage with community at grassroots level and adapt programs as needed- 2 years	CMA/NRE	High
Support annual priority setting process	$45,000	Annual priority setting process-input from key program leaders	Extend priority setting process to local communities and other key stakeholders as part of developing Regional Business planOn-going	CMA/NRE	Moderate
	$85,000	Liase with community	Establish and maintain community network to each of 6 LAP areas for information exchange, priority setting and problem definition On-going	CMA/NRE	High
			Integrate LAP's with other community initiatives	CMA/NRE	Moderate
	$12,000	Adaptation of LAP triennially	Review status and progress with LAP- On -going	CMA	
Schools program	$60,000	Implement schools program , support curriculum presentation	Support Salt watch and Waterwatch programs and continue to develop and assist the delivery of CSF material On -going	NRE/CMA	Moderate
Community support	$50,000	Information provision to key stakeholders and priority setting with community groups and landholders	On -going.Annual priority setting process for seasonal works	NRE/CMA	High
		Assist groups with devolved grants	Provide direction and advice to groups on funding opportunities On -going		Moderate
Local Government	$50,000	Assist local government to deliver improved environmental management controls throughplanning scheme	Establish relationship with each Local Government and work through data and information requirements to support planning overlays	NRE/CMA	Moderate
			Enhance planning overlays, with emphasis on new developments and planning permits in co-operation with DOI and local municipalities	NRE/CMA/ Local Govt/ DOI	High
Regional Development	$30,000	(Initiate and) support regional development forum.Includes planning and administrative support	2 years to develop appropriate forum and then on-going admin support subject to negotiation with participatinggroups	NRE/CMA	High
			Develop common vision for sustainable use and development of natural assets within 12 months	CMA	High

Social and economic condition	$80,000	Develop benchmark indicators for condition and change in condition of key social and economic indicators	In co-operation with evaluation section and through GBCMA develop set of indicators to measure change in the social well being and economic performance of the dryland region Within 3 years	CMA/	Moderate
				CMA	High
sub TOTAL	$ 452,000				
Plan support					
Adaptive management	Not costed	Co-ordinate response to community input to business planning cycle and incorporate new information into implementation program	2 years to develop benchmarks and institute management cyclethat is responsive to community and Government aspirations		High
Technical support	$35,000	DST support to community groups	On-going provision of technical support and advice to IC and special interest groups	NRE/CMA	High
Research and Investigation	$45,000	Identify salinity risk areas in high priority zones	Extend SWGinvestigation to other high priority areas of the catchment 3 years	NRE	Moderate
	$72,000	Assess risk posed to salinty and biodiveristiy	from acidification of landscape in high priority areas		
	$ 150,000	Develop model of response time and processes for salt accession to land and streams	Complete SWG investigations on accession processes and response function 18 months	NRE	High
	$ 100,000	Further develop priority setting process for plan management	Develop priority setting process to encompass other assets, particularly built infrastructure and significant environmental assets 18 months	NRE/CMA	High
	$5,000	Support for CRCCH, CRCPBS and other research initiatives	Continued support for national and state initiatives On-going		Low
Monitoring	$45,000	Monitor spread of discharge in key areas of Riverine plain and Plains-Upland interface	Contribute to enhanced statewide discharge identifying andmonitoring of active sitesand assess against projected increase in discharge area -On-going	NRE	Moderate
	$34,000	Continue to monitor groundwater program and enhance network in key areas of South West Goulburn and Plains-Upland interface	Maintain and log 430 bores of monitoring programs and report to community on changes On-going	GMW/NRE	High

	$40,000	Surface water(including new sites required for WIV monitoring)	Establish 2 new sites for WIV monitoring andat Trawool and Broken Weir and support maintenance of existing sites Jun 2003	GMW	High
Nature Conservation Co-ordinator	$80,000	Provide technical advice on integration of biodiversity principles into all work programs	Establish biodiversity risk management protocols for all work areas by Dec 2003		
		Implement strategic and tactical environmental planning into work programs	Priority settign in salinity enhanced with assessment of risk and recommendations for conservation and improvement of ecosystem function		
Plan co-ordination	$85,000	Promote ICM through improved decision making and data assessment capability	Integrate CAT along with other DSS tools for biodiversity management and management of social, economic and environmental tradeoffs	NRE/CMA	Low
		Quarterly reporting planning assistance and technical advice	Specialist advice to community IC's on ICM issues and planning needsOn-going	NRE	Moderate
GIS support	$85,000	Support planning, reporting and priority setting activities of the plan	Provide spatial analysis, mapping support and data acquisition support for on-farm, commercial programand general plan supportOn-going	NRE/CMA	Moderate
sub TOTAL	*$776,000*				
Commercial					
Vegetation bank	$33,000	Establishment and management of vegetation bank	Establish principles and operating agreement for vegetation bank in partnership with funders and fund manager and implementation projects	CMA	High
Plantation forestry	$40,000	Develop investment portfolio for investment partners, detailing the conditions and extent of investment for natural resource benefits	In partnership with Regional Development program and industry develop investment portfolio	CMA/NRE	High
	$16,000	Construct likelihood maps for investment opportunities	Analysis of suitability of land for plantation and farm forestry in high and moderate priority areas 6 months	NRE	High
Fund manager	$80,000	Develop fund portfolio from private industry and philanthropic trusts	3 years to establish $1 million of non government support for catchment management and then on-going management, self supporting at 10% of funds captured	CMA	Moderate

		Establish management and cost share arrangements for stewardship program	Develop management arrangement for land stewardship integrating across On-farm and community engagement programs		
			Link to fund manager to develop capital fund to support land stewardship payments on 200 ha/yr each year of high priority land, at an annuity equal to maintenance , replacement and management costs of land under stewardship		
	$ 240,000	Develop investment fund to support sustainable development in plantation industry	Assist the establishment of 1200 ha, long term average, of plantation forestry in high and moderate priority zones on agreed cost share basis -on-going	CMA/NRE	High
sub TOTAL	*$409,000*				
Engineering					
Plan support	$15,000	Provide policy and technical advice to Plan co-ordinator and IC	On-going	GMW	High
Dryland drainage	$30,000	Complete dryland drainage strategy	Provide clear direction to GBCMA and Local Government through guidelines for management of drainage and groundwater bought to the surface-12 months	GMW	High
Irrigation options	$40,000	Integrate into extension program and regional development plans	Develop dryland irrigation management plan for water use, water requirement and disposal. 3 years	GMW/NRE/ CMA	Moderate
Salt interception	$35,000	Planning	Analysis of suitability of areas in GBC for salt interception or other large scale salt mitigation works 18 months	GMW	Moderate
	$ 120,000	Farm exploratory drilling program	Continue farm drilling program in high and moderate priority areas in co-operation with On-farm program. On-going	GMW	Moderate
sub TOTAL	*$240,000*				
On farm					
Pastures	$ 195,000	Integrate pasture planting in low rainfall area into tree planting and land stewardship programs	In co-operation with WFP project develop optimal water use plans with land managers On-going	NRE	Low
			Assist the establishment of 500 ha/yr of native and perennial pasture species in high and moderate priority area, including sub-divisional fencing		

Farm forestry	$ 980,000	Develop farm forestry industry in low rainfall zone to compliment regional development initiatives to expand market for farm forestry products	Plant 800 ha/yr to low rainfall farm forestry in high and moderate priority areas -on-going	NRE	High
Environmental	$1,280,000	Maintain integration of protection and enhancement of native vegetation with salinity recharge and discharge plantings	Establish 500 ha/yr of environmental plantings inhigh and moderate priority areas including protection of existing remnants	NRE	Moderate
Discharge	$ 120,000	Protect high risk areas by reducing salt export and, in partnership with waterways program undertake stream buffering program in critical areas	Protect 80 ha active discharge sites annually in high and moderate priority areas posing high risk to streams and other assets	NRE	High
Saline agriculture	$75,000	Support the implementation of OPUS and PUR$L programs into the riverine plains of GB dryland	Establish and maintain 4 PUR$L sites in co-operation with grower community	NRE	Low
Whole farm planning	$75,000	Develop a system for wide scale adoption of whole farm planning and link to grants scheme			
	$45,000	Complete preliminary Farm planning course with 60 landholders and evaluate against participation in remediation work and efficiency of grant servicing12 months.In co-operation with education providers promote on farm service to assess business viability as part of regional development strategy*	Provide training and consultingopportunities for 60 landholders/yr	NRE	Moderate
sub TOTAL	*$ 2,770,000*				
Overall TOTAL	***$ 4,647,000***				

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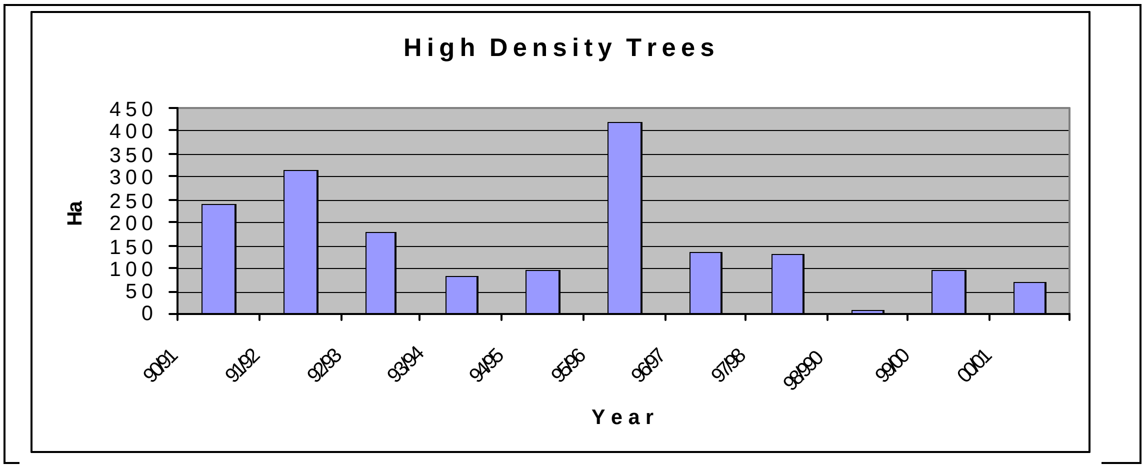
Appendices

Appendix 1

Areas treated for each activity



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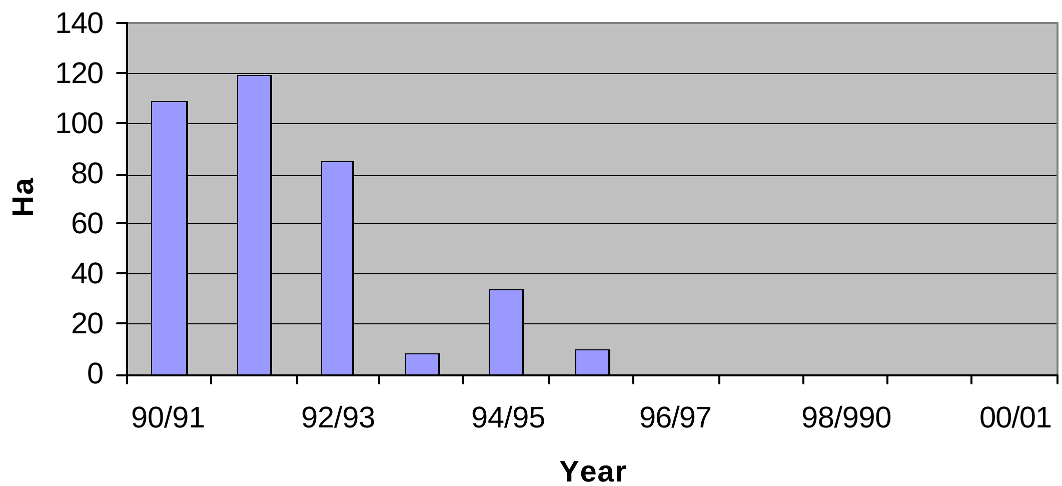

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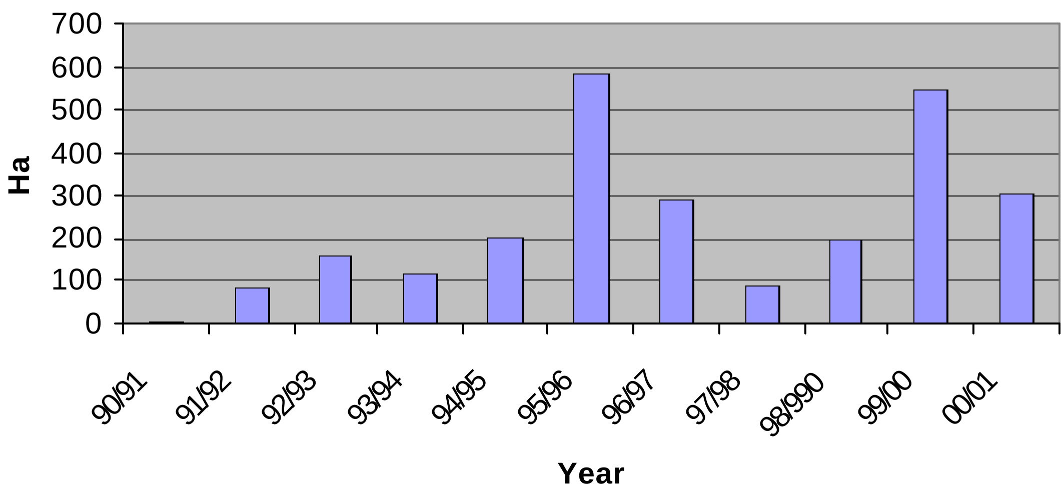

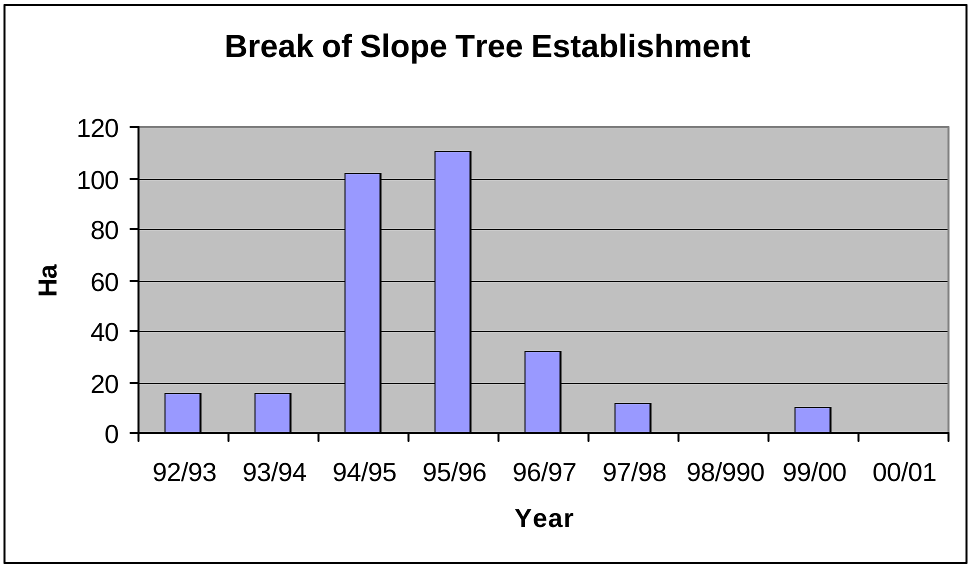

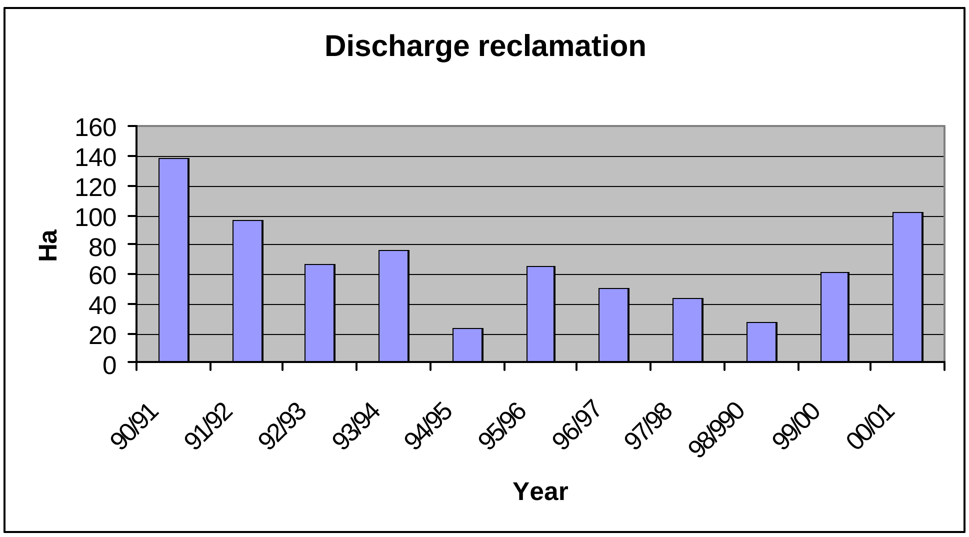

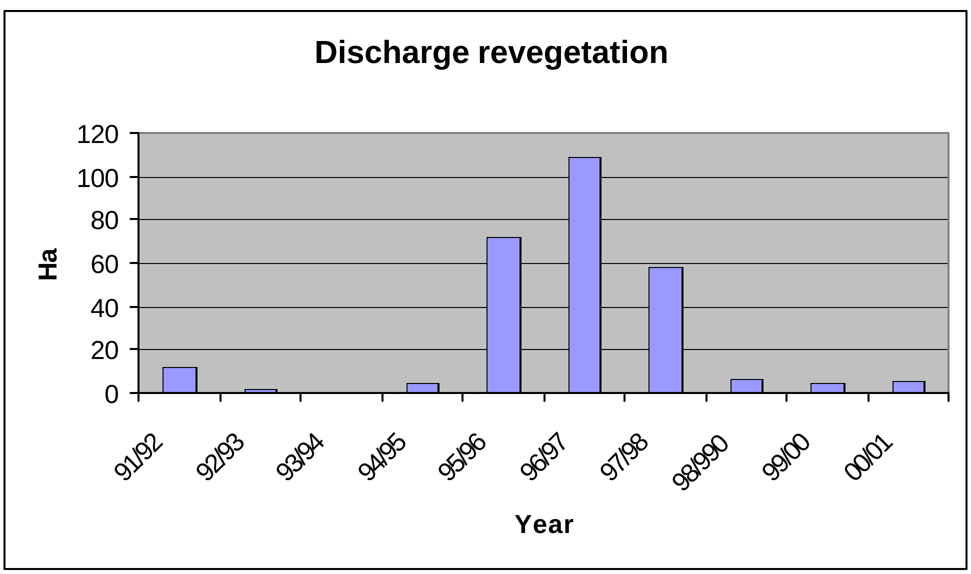

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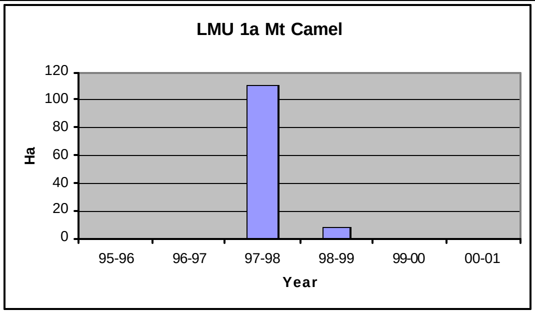
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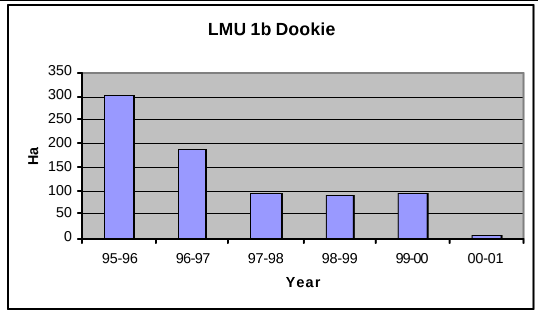
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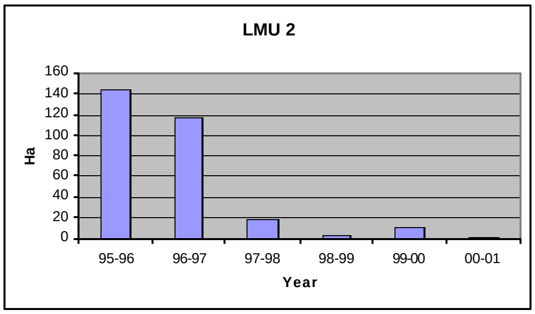
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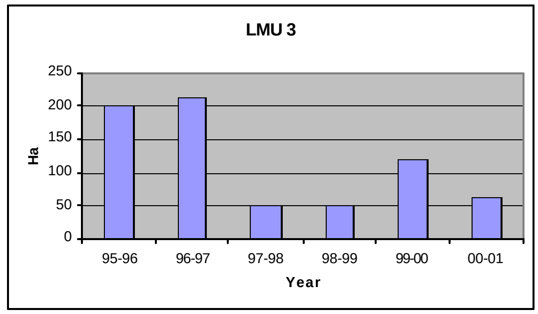
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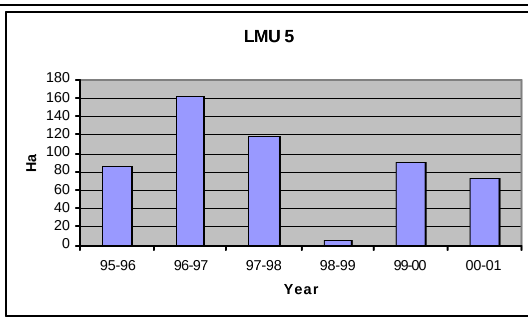
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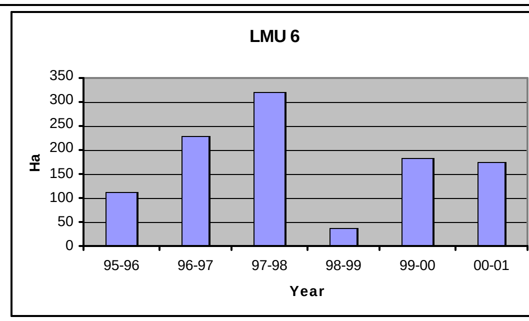
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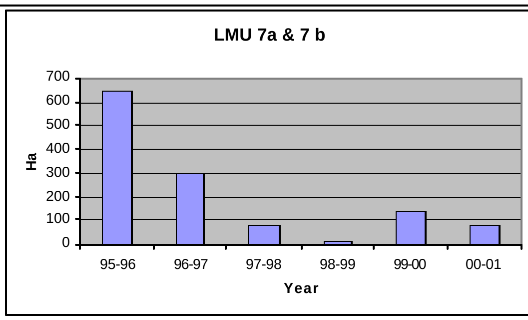
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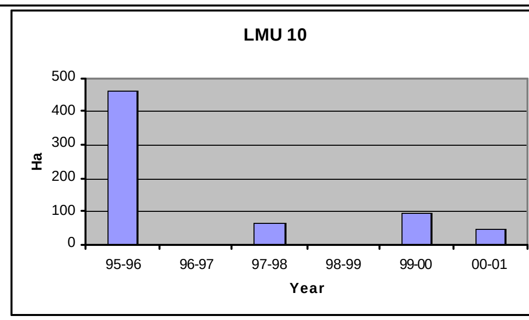
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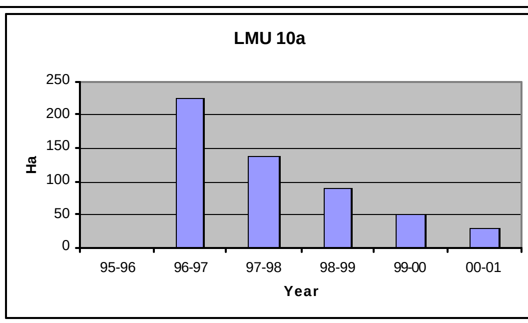
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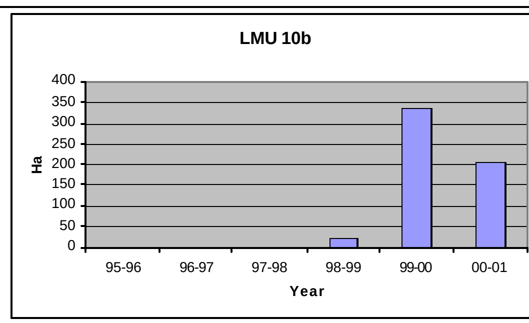
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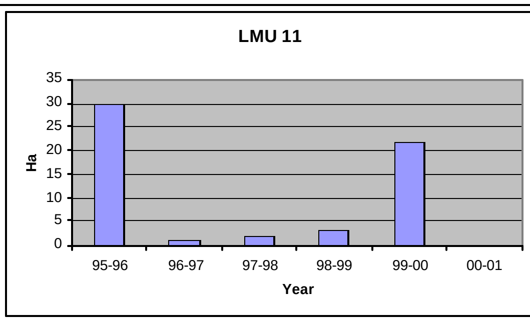
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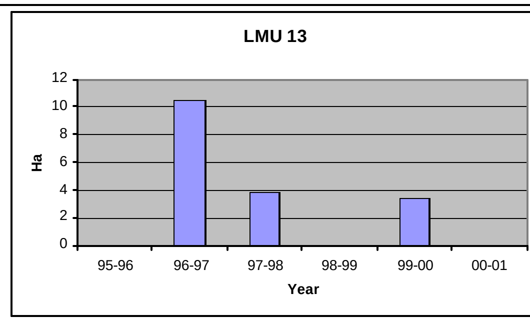
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Appendix 2

Evaluation criteria – Environmental Management Grants

Criteria	Parameter	Value	Score	Comments
1. Area of Works (ha)	1.0 - 2.0 2.0 - 3.0 3.0 - 5.0 above 5.0	**1** **2** **3** **5**		Minimum of 1 ha. Minimum total width is 40 m (can be 20 m private land + 20 m vegetated roadside Area of fencing or revegetation.
2. Proximity (distance) to nearest good quality remnants (metres)	> 1000 500 –1000 100 – 500 < 100	**2** **3** **4** **5**		Officer's discretion of "good quality". Need to think about size ie .1 ha, presence of understorey, health of remnant etc.
3. Conservation status of Ecological Vegetation Class (EVC)	Least Concern Depleted Vulnerable Endangered / Rare	**1** **3** **4** **5**		Conservation status of EVC in the particular Bioregion of the Goulburn Broken Catchment.
4. Works type	Revegetation Remnant protection and enhancement	**4** **5**		Revegetation is for all revegetation other than remnant Protection and remnant protection and Enhancement.
5. Salinity priority	Discharge Potential discharge Recharge	**3** **5** **10**		If map not yet mapped, officer's discretion.
6. Farm Natural resource Plan	Normal	**1**		EVC Map, Aerial Photograph, Landsat Image or Topographical Map.
		Total		
		% Grant rate		

Criteria Score and Grant Rate

Criteria Score	% Grant Rate
12 – 14	55 %
15 – 18	60 %
19 – 22	65 %
23 – 27	70 %
28 - 31	75 %

Grant rates are calculated using the following capital costs:	
Fencing:	Total cost = $6.50/m for standard fence, $4.00/m for electric fence
Planting:	Total cost = $1500/ha for 500 plants/ha
Direct Seeding:	Total cost = $650/ha

NOTES

1. All grants that meet the minimum criteria will be at least 55%
2. 70% maximum grant rate if grant is fencing only ($4.55 per metre)
3. Grant rates above 55% are estimates only and may alter due to funding constraints

Appendix 3

Features of groundwater flow systems in the Goulburn Broken (Dyson et.al. 2000)

	GFS	Salt store	Salinity Occurrence	Temporal distribution of recharge	Spatial distribution of recharge	Baseflow/ washoff	Equilibrium response time	Groundwater salinity dS/m
1	Local flow systems in fractured sedimentary & metamorphic rocks	low	break of slope & valley floor (small areas)	seasonal	hill crest & upper slopes (some valleys)	baseflow	fast	0.5 to 2
2	Intermediate flow systems in fractured sedimentary rocks	low (higher than local)	valley floor (in stream)	seasonal	tabletops	baseflow	slow to moderate	0.5 to 2
3	Local & intermediate flow systems in weathered fractured sedimentary rocks	high	valley floor	seasonal & episodic at lower r/f	general, higher where rock outcrops	baseflow in SWG & washoff (SPC)	slow to moderate	up to 20
4	Local & intermediate flow systems in fractured Cambrian fractured rocks and colluvial and alluvial fans	moderate	break of slope & gullies	seasonal & episodic	higher on ridges and upper slopes, also high under red soils	washoff (some baseflow)	moderate to (fast)	<3 (lower on upper slopes)
5	Local flow systems in colluvial and alluvial fans in coarse grained acid volcanic rocks	low to moderate	break of slope & valley floor	seasonal	upper parts of colluvial fans	washoff	fast	0.5 to 5
6	Regional flow systems in Riverine Plain	low to high	drainage lines and depressions	seasonal & episodic	general & higher in alluvial fans & rivers and prior streams	washoff & baseflow	slow	<1 in Calivil <15 in Shepp.
7	Local flow systems in weathered granites	low	drainage lines and break of slope	seasonal	general & upper fans	washoff & some baseflow	fast	<3
8	Local flow systems in fractured basalts (Quaternary and Tertiary)	low	drainage lines adjacent basalt	seasonal	general	baseflow	moderate to fast	<2
9	Local flow systems in upland alluvium	low	n/a	seasonal	general (in part related to river flow)	baseflow	fast	<1
10	Local flow systems in Quaternary lunettes	high	footslopes, interlunette depressions, wetland interface	seasonal	general	baseflow/lateral flow, washoff	moderate to fast	5 to 20
11	Local flow systems in Tertiary gravel caps	moderate	n/a	seasonal	general	n/a	moderate to fast	<4
12	Local flow systems in fine grained acid volcanics (e.g. rhyolites)	moderate to high	break of slope & valley floor	seasonal	upper slopes	baseflow/lateral flow, washoff	moderate	1 to 15
13	Local flow systems in Tillite	moderate	valley floor	seasonal	general	washoff	moderate - fast	3 to 5

Appendix 4

Priority areas and recommended management options for all sub catchmenets in the Goulburn Broken

Sub-catchment	GFS	Targeting area	Recommended salinity management options
South West Goulburn			
High priority			
Dry Ck	3(80%), 8(10%), 1(10%), 9(>1%)	Discharge sites and high watertable are widespread at the lower slopes and valley floor. Hill slopes have been extensively cleared. High recharge may occur along gentle cleared slopes (GFS 3).	High-density trees targeted at recharge area (e.g. gentle slopes of weathered sedimentary hills) would be the most effective. Perennial pasture along would not be effective to control recharge due to high rainfall, but incorporation with low-density trees would be more effective. Opportunities for groundwater pumping may be limited due to high salinity of groundwater and low yield in the fractured rock aquifer. Establishing salt tolerant grasses and saltbush at discharge area would increase productivity and reduce salt wash-off.
Hughes Ck	7(78%), 3(15%), 9(4%), 6(2%), 1(1%)	Discharge sites and high watertables mainly occur on the valley floor and along drainage lines at the upper Hughes Ck (GFS 3). Salinity risk is believed to be relatively low.	High-density trees targeted at recharge area (e.g. gentle slopes of weathered sedimentary hills) would be the most effective. Perennial pasture along would not be effective to control recharge due to high rainfall, but incorporation with low-density trees would be more effective. Opportunities for groundwater pumping may be limited due to high salinity of groundwater and low yield in the fractured rock aquifer. Establishing salt tolerant grasses and saltbush at discharge area would increase productivity and reduce salt wash-off.
Kurkurac Ck	3(44%), 9(25%), 1(24%), 8(7%)	Discharge sites and high watertables mainly occur on the valley floor and along drainage lines in the sedimentary country (GFS 3). It is believed that high recharge occurs on along gentle cleared slope of sedimentary hills.	High density trees targeted at recharge area (e.g. gentle slopes of weathered sedimentary hills) and along drainage lines would be the most effective. Perennial pasture along would not be effective to control recharge due to high rainfall, but incorporation with low-density trees would be more effective. Opportunities for groundwater pumping may be limited due to high salinity of groundwater and low yield in the fractured rock aquifer. Establishing salt tolerant grasses and saltbush at discharge area would increase productivity and reduce salt wash-off.
Majors Ck	3(52%), 1(31%), 9(14%), 6(3%)	Discharge sites and high watertable are widespread at the lower slopes and valley floor, particularly in the southern part of the sub-catchment where hill slopes have been extensively cleared. High recharge may occur along gentle cleared slopes (GFS 3).	High density trees targeted at recharge area (e.g. gentle slopes of weathered sedimentary hills) and along drainage lines would be the most effective. Perennial pasture along may be effective to control recharge due to high rainfall, but incorporation with low-density trees would be more effective. Opportunities for groundwater pumping may be limited due to high salinity of groundwater and low yield in the fractured rock aquifer. Establishing salt tolerant grasses and saltbush at discharge area would increase productivity and reduce salt wash-off.

Mollisons Ck	7(67%), 3(19%), 1(7%), 9(4%), 8(3%)	Discharge sites and high watertables mainly occur on the valley floor and along drainage lines in the sedimentary country (GFS 3). Small patches of discharge and high watertables also occur at valley floor in the granites country. It is believed that high recharge occurs on along gentle cleared slope of weathered sedimentary rocks and granites.	High density trees targeted at recharge area (e.g. gentle slopes of weathered sedimentary hills) and along drainage lines would be the most effective. Perennial pasture along may be effective to control recharge due to high rainfall, but incorporation with low-density trees would be more effective. Opportunities for groundwater pumping may be limited in the sedimentary country due to high salinity of groundwater, but granites country may provide some opportunities. Establishing salt tolerant grasses and saltbush at discharge area would increase productivity and reduce salt wash-off.
Sunday Ck	3(72%), 1(12%), 7(10%), 8(6%)	Discharge sites and high watertable are widespread at the lower slopes and valley floor. Hill slopes have been extensively cleared. High recharge may occur along gentle cleared slopes (GFS 3).	High-density trees targeted at recharge area (e.g. gentle slopes of weathered sedimentary hills) would be the most effective. Perennial pasture along would not be effective to control recharge due to high rainfall, but incorporation with low-density trees would be more effective. Opportunities for groundwater pumping may be limited due to high salinity of groundwater and low yield in the fractured rock aquifer. Establishing salt tolerant grasses and saltbush at discharge area would increase productivity and reduce salt wash-off.
Whiteheads Ck	3(52%), 9(18%), 6(12%), 1(9%), 7(4%), 11(4%)	Discharge sites and high watertable are widespread at the lower slopes and valley floor. High recharge may occur along gentle cleared slopes (GFS 3).	High-density trees targeted at recharge area (e.g. gentle slopes of weathered sedimentary hills) would be effective. Tree belts along the streams would form a effective buffer to reduce groundwater/surface water interaction (may reduce baseflow into the surface water system. Perennial pasture incorporated with low-density trees would be also effective. Opportunities for groundwater pumping may be limited due to high salinity of groundwater and low yield in the fractured rock aquifer. Establishing salt tolerant grasses and saltbush at discharge areas would increase productivity and reduce salt wash-off.

Moderate priority

Dabyminga Ck	3(64%), 7(25%), 1(9%), 9(2%)	Discharge sites and high watertable occur at the lower slopes and valley floor. High recharge may occur along gentle cleared slopes (GFS 3). Forest is well retained at the upper part landscape.	High density trees targeted at recharge area (e.g. gentle slopes of weathered sedimentary hills) would be the most effective. Perennial pasture along would not be effective to control recharge due to high rainfall, but incorporation with low-density trees would be more effective. Opportunities for groundwater pumping may be limited due to high salinity of groundwater and low yield in the fractured rock aquifer. Establishing salt tolerant grasses and saltbush at discharge area would increase productivity and reduce salt wash-off.
Sheepwash Ck	3(43%), 6(26%), 1(23%), 9(7%), 8(1%)	No discharge is reported. High watertables may occur in places. Stream/groundwater interaction may be active.	Tree belts along Goulburn River would form a effective buffer to reduce groundwater/surface water interaction (may reduce baseflow into the surface water system.
Stony Ck	3(44%), 1(38%), 9(12%), 8(5%), 6(1%)	Small discharge sites are reported. High watertables may occur in places. Stream/groundwater interaction may be active.	Tree belts along the streams would form a effective buffer to reduce groundwater/surface water interaction (may reduce baseflow into the surface water system.

Trawool	7(36%), 3(35%), 9(20%), 1(9%)	Small discharge sites are reported. High watertables may occur in places. Stream/groundwater interaction may be active.	Tree belts along the streams would form a effective buffer to reduce groundwater/surface water interaction (may reduce baseflow into the surface water system.

Upper Goulburn
High priority None

Chapter 8 Moderate priority

Big R	1(88%), 5(8%), 9(2%), 10(2%)	Low salinity risk -no discharge site reported, well-retained forested and low stream salinity	Low significance for reduction of salinity risk
Delatite Ck	2(43%), 1(32%), 7(16%), 9(5%), 5(3%), 4(>1%)	Salinity risk is low in general. Maybe some potential risk in the lower part of the sub-catchment due to extensively cleared land	Tree belts along stream may act as buffers and reduce salinity input into the stream, but low significance for reduction of salinity risk is expected due to high rainfall.
Yea R	3(52%), 1(33%), 9(9%), 7(4%)	Salinity risk is low in general. High watertables may occur at the lower part of the sub-catchment. Salt export is relatively high.	Tree belts along Goulburn River. Retention and re-introduction of native vegetation are also recommended.

Chapter 9 Lo
w Priority

Acheron Ck	1(55%), 5(28%), 9(9%), 7(8%)	Low salinity risk -no discharge site reported, well-retained forested and low stream salinity	Low significance for reduction of salinity risk
Boundary Ck	3(80%), 1(16%), 9(4%)	Relatively high stream salinity, maybe some watertables at the lower slope. High recharge may occur along cleared gentle slopes (GFS3)	High-density trees along cleared gentle slopes, but low significance for reduction of salinity risk is expected due to small size of the sub-catchment and high rainfall.
Brankeet Ck	7(50%), 1(47%), 9(3%)	Low salinity risk -no discharge site reported, reasonably well retained forested, high rainfall, low stream salinity and steep country (GFS 1 and 7).	Low significance for reduction of salinity risk
Coles Ck	1(95%), 9(5%)	Salinity risk is low in general. Maybe some potential risk due to extensively cleared land (84%) and relatively low rainfall (rain shallow)	Low significance for reduction of salinity risk is expected due to small size.
Dairy Ck	3(66%), 1(19%), 9(15%)	Relatively high stream salinity, maybe some watertables at the lower slope and along drainage lines. High recharge may occur along cleared gentle slopes (GFS3)	High-density trees along cleared gentle slopes, but low significance for reduction of salinity risk is expected due to small size of the sub-catchment and high rainfall.
Ford Ck	2(50%), 1(28%), 9(18%), 4(2%)	Salinity risk is low in general. Maybe some potential risks due to some high watertables at the lower slopes, relatively high stream salinity and extensively cleared land (99 %).	High-density trees along cleared gentle slopes, but low significance for reduction of salinity risk is expected. Retention and re-introduction of native vegetation are also recommended.
Home Ck	1(80%), 9(12%), 7(8%)	Salinity risk is low in general. Maybe some potential risks due to some high watertables at the lower slopes, relatively high stream salinity and extensively cleared land (81 %).	Tree belts along stream may act as buffers and reduce salinity input into the stream, but low significance for reduction of salinity risk is expected. Retention and re-introduction of native vegetation may also reduce recharge.
Homewood	1(60%), 9(29%), 3(11%)	Salinity risk is low in general. Maybe some high watertable at the lower landscape.	Low significance for reduction of salinity risk
Howqua R	1(67%), 2(10%), 4(7%), 5(6%),	Low salinity risk - no discharge site reported, well-retained forestry (94%), low stream salinity with no trend, steep country.	Low significance for reduction of salinity risk

	7(5%), 9(5%)		
Jamieson R	1(61%), 2(24%), 4(9%), 5(4%), 9(2%)	Low salinity risk - no discharge site reported, well-retained forestry (97%), low stream salinity (34 EC) with no trend, steep country.	Low significance for reduction of salinity risk
Jerusalems	1(83%), 5(12%) 7(3%), 9(2%)	Low salinity risk - no discharge site reported, well-retained forestry (97%), low stream salinity (>40 EC) with no trend, steep country.	Low significance for reduction of salinity risk
Johnson Ck	1(91%), 6(9%)	Salinity risk is low in general. Relatively high stream salinity (250 EC) indicates that there may be some salinity at the lower part of the sub-catchment.	Low significance for reduction of salinity risk
King Parrot Ck	3 (66%), 7(21%), 1(8%), 9(5%)	Salinity risk is low in general. Relatively high stream salinity (250 EC) indicates that there may be some salinity at the lower part of the sub-catchment.	Low significance for reduction of salinity risk
Limestone Ck	1(80%), 9(9%), 3(8%), 7(2%)	Salinity risk is low in general. High watertables may occur at the lower part of the sub-catchment.	Low significance for reduction of salinity risk
Merton Ck	1(89%), 9(8%), 7(3%)	Moderate salinity risk due to extensively cleared land (89%), high watertable and relatively high stream salinity (200+ EC). But insignificant off-catchment impact due to low flow.	High-density trees along cleared gentle slopes, but low significance for reduction of salinity risk is expected. Retention and re-introduction of native vegetation are also recommended.
Murrindindi R.	7(44%), 1(42%), 5(5%), 3(5%), 9(3%)	Low salinity risk - no discharge site reported, well-retained forestry (79%), low stream salinity (>40 EC) with no trend, steep country.	Low significance for reduction of salinity risk
Rubicon R	5(76%), 1(15%), 9(8%), 7(>1%)	Low salinity risk - no discharge site reported, well-retained forestry (79%), low stream salinity (>20 EC) with no trend, steep country.	Low significance for reduction of salinity risk
Scrubby Ck	1(67%), 9(24%), 3(2%), 7(1%)	Salinity risk is low in general. High watertables may occur at the lower part of the sub-catchment.	Tree belts along Goulburn River
Snobs Ck	5(91%), 1(5%), 7(2%), 9(2%)	Low salinity risk - no discharge site reported, well-retained forestry (96%), low stream salinity (>30 EC) with no trend, steep country.	Low significance for reduction of salinity risk
Spring	1(89%), 9(11%)	Moderate salinity risk due to extensively cleared land (93%), high watertable and relatively high stream salinity (250 EC). But insignificant off-catchment impact due to low flow.	High-density trees along cleared gentle slopes, but low significance for reduction of salinity risk is expected. Retention and re-introduction of native vegetation are also recommended.
Switzerland	7(70%), 3(17%), 9(7%), 1(5%)	Salinity risk is low in general. High watertables may occur at the lower part of the sub-catchment.	Tree belts along Goulburn River
Tallangalook Ck	1(75%), 2(9%), 9(7%), 7(6%), 4(3%)	Salinity risk is low in general. High watertables may occur at the lower part of the sub-catchment.	Low significance for reduction of salinity risk
Upper Goulburn R	1(98%), 9(1%)	Low salinity risk - no discharge site reported, well-retained forestry (99.6%), low stream salinity with no trend, steep country.	Low significance for reduction of salinity risk
West Eildon	1(88%), 9(12%)	Salinity risk is low in general. High watertables may occur at the lower part of the sub-catchment.	Tree belts along Goulburn River. Retention and re-introduction of native vegetation are also recommended.
Wightmans	1(50%), 9(36%),	Low salinity risk - no discharge site reported, well-retained forestry	Low significance for reduction of salinity risk

	7(11%), 5(3%)	(90%), low stream salinity with no trend, steep country.	
West Goulburn			
High priority None			
Chapter 10 Moderate priority			
Cornella Ck	4(30%), 3(26%), 1(18%), 6(17%), 9(7%)	Widespread high watertable along foothills, high recharge on hill slopes of Cambrian fractured rocks and colluvial and alluvial fans. However, off-catchment impact may be insignificant due to low stream flow.	High-density trees, particularly moderate water-use species such as sugar gum, would be suitable in most high recharge areas. Well-managed perennial pasture would be suitable at mid and lower slopes. There are some opportunities for groundwater pumping fresh groundwater from fractured rock aquifers to irrigate horticulture or farm forestry. Saline agronomy would be suitable at lower slope where watertable is high.
Chapter 11 Lo w priority			
Back	3(44%), 6(33%), 1(16%), 9(2%), 10(2%)	Salinity risk is low in general. High watertables may occur at the lower part of the sub-catchment.	Tree belts along Goulburn River. Perennial pasture and low density trees would be also effective to control recharge.
Buffalo Ck	3(68%), 6(21%), 1(11%)	Low salinity risk due to deep watertable and reasonably well-retained forest	Low significance for reduction of salinity risk
Sandy Ck (South)	6(58%), 3(19%), 7(17%), 1(4%)	Low salinity risk due to deep watertable and reasonably well retained forest. High watertable may occur at the lower slopes where have been cleared, but not evidenced.	Low significance for reduction of salinity risk
Wanalta Ck	3(57%), 1(14%), 6(14%), 9(1%)	Moderate salinity risk due to high watertables in places and high potential recharge along cleared gentle slopes	Low-density tree incorporated with well-managed perennial pasture would be suitable for recharge control at mid and lower slopes.
Goulburn Plains			
High Priority			
Lower Goulburn	6(93%), 3(5%), 1(2%)	The area with high watertable is not significant, but along Goulburn River and probably contribute significant salt load to the river	Tree belts along Goulburn River and Goulburn Weir would form an effective buffer to reduce groundwater/surface water interaction.
Chapter 12 Moderate priority			
Honeysuckle Ck Plain	6(68%), 9(16%), 3(15%), 1(1%)	High watertables occur at the BOS and lower of the sedimentary rises, and the area near irrigation area and drainage lines	Alley faming with perennial pasture at the lower slope. Low density tree planting along slopes of sedimentary rises.
Honeysuckle Ck Upland	5(81%), 9(15%). 1(3%), 3(1%)	High watertables are widespread at the BOS, lower slope, valley floor and along drainage lines. High recharge probably occurs along gentle colluvial slopes (GFS 5)	High-density plantings along colluvial slopes may be the most suitable options, particularly BOS plantation. Salt tolerant vegetation is also warranted at the lower and valley floor where watertable is high and saline. There may be some opportunities for groundwater pumping in the colluvium. Perennial pasture is generally unsuitable due to relatively high rainfall and acid soil.

Sheep Pen Ck Plain	6(98%), 3(2%)	Shallow watertables are widespread and saline across the sub-catchment. Discharge occurs along drainage lines and the plain/upland interface.	Wider adoption of salinity management protases is necessary due to influence of regional groundwater system. Widespread establishment of relatively salt tolerant perennial pasture (e.g. lucerne) is warranted. Improved management of traditional crops and pastures would reduce deep drainage, particular in low and moderate recharge area. The majority of the catchment area is not suitable for tree plantations due to shallow and saline watertables. There may be some opportunities along the plain/upland interface for moderate water-use tree species (e.g. red ironbark). The use of engineering options may be limited due to saline groundwater and problem of its disposal. Some opportunities for establishment of salt tolerant grasses in the areas with high watertables.
Sheep Pen Ck Upland	3(64%), 6(20%), 1(16%)	Shallow watertables are widespread at the lower slope, BOS and valley floor. Watertables are generally deep and rising steadily below hills. Groundwater is generally saline, but fresh shallow groundwater occurs in places. It is believed that high recharge occurs along fault zones where weathered sedimentary rocks are highly fractured.	High-density trees along the fault zones may be effective to control recharge. There may be some opportunities for farm forestry (e.g. alley farm) on the gentle slopes. Some opportunities for pumping fresh groundwater from plaeochannels. Some opportunities for establishment of salt tolerant grasses at the lower slope and BOS.

Chapter 13 Low priority

Branjee	6(99%), 3(1%)	In general, salinity risk is low across the sub-catchment. High watertable occur along the irrigation boundary and the upper part of the sub-catchment (GFS3), but the area is small.	Low significance for reduction of salinity risk
Castle Ck	6(64%), 7(28%), 9(6%), 1(1%)	Low salinity risk in general, some hill slopes of weathered granites (GFS 7) may have some moderate salinity risk	Low significance for reduction of salinity risk
Creightons Ck	7(53%), 6(32%), 9(13%), 1(1%), 3(1%)	In general, salinity risk is low across the sub-catchment. High watertable occur at the BOS and lower slopes of weathered granites (GFS7) and valley floor (GFS 9), but the area is small.	Low significance for reduction of salinity risk
Pranjip Ck Plain	6(54%), 7(33%), 9(11%), 3(1%)	Watertable is generally deep. Some high watertables occur along drainage lines	Tree belts along creeks
Pranjip Ck Upland	same as above	High watertables occur at the lower slopes of weathered granites, but total area is insignificant. High recharge probably occur at the mid and upper slopes. On the alluvial plain, watertables are generally deep.	High density trees at the mid and upper slopes. Groundwater pumping?
Seven Ck Plain	6(80%), 9(11%), 3(5%), 5(4%)	Low salinity risk on plain area due deep watertable, some hill slopes of weathered volcanics (GFS 5) northern part of the sub-catchment may have some moderate salinity risk	High density plantings along colluvial slopes may reduce recharge. Salt tolerant vegetation is also warranted at the lower and valley floor where watertable is high and saline. Perennial pasture is generally unsuitable due to relatively high rainfall and acid soil.

Seven Ck Upland	7(68%), 5(28%), 9(2%), 1(1%), 8(1%)	High watertables are widespread at the BOS, lower slope, valley floor and along drainage lines. High recharge probably occurs along gentle collouvial slopes (GFS 5)	High-density plantings along colluvial slopes may be the most suitable options, particularly BOS plantation. Tree belts along the creek would form an effective buffer to reduce groundwater/stream interaction. Salt tolerant vegetation is also warranted at the lower and valley floor where watertable is high and saline. There may be some opportunities for groundwater pumping in the colluvium. Perennial pasture is generally unsuitable due to relatively high rainfall and acid soil.
Wormangal	6(55%), 7(16%), 9(12%), 3(11%), 1(6%)	There may be some high watertables along the plain/upland interface and valley floor in the upland area. But the total area may not significant	Farm forestry along the gentle slopes of sedimentary hills (GFS 3)
Broken Highland			
High Priority			
Broken R upland	2(31%), 7(31%), 9(24%), 5(6%), 1(5%), 3(1%), 4(1%)	High watertables are widespread at the BOS, lower slope, valley floor and areas along the river. High recharge probably occurs along gentle colluvial slopes (GFS3 and GFS 5)	High density plantings along colluvial slopes may be the most suitable options, particularly BOS plantation. Tree belts along the creek would form an effective buffer to reduce groundwater/stream interaction. Salt tolerant vegetation is also warranted at the lower and valley floor where watertable is high and saline. There may be some opportunities for groundwater pumping in the colluvium and fractured rocks. Perennial pasture is generally unsuitable due to relatively high rainfall and acid soil.
Chapter 14 Moderate priority			
Four and Sevens Ck	1(37%), 9(32%), 3(13%), 6(12%), 7(6%)	High watertables are widespread at the lower slope and valley floor, but the total area is insignificant. High recharge probably occurs along gentle slopes of weathered sedimentary rocks (GFS3)	High density plantings along slopes (GFS3) may be the most suitable options, particularly BOS plantation. Retain native vegetation in ridge and upper slope areas. Salt tolerant vegetation is also warranted at the lower and valley floor where watertable is high and saline. There may be some groundwater pumping opportunities in the fractured rocks. Perennial pasture is generally unsuitable due to relatively high rainfall.
Holland Ck	9(33%), 5(29%), 12(10%), 2(8%), 1(6%), 4(4%), 6(4%), 3(2%), 7(2%),8(2%)	High watertables are widespread at the BOS, lower slope, valley floor and areas along the creek. High recharge probably occurs along gentle colluvial slopes (GFS3 and GFS5)	High density plantings along colluvial slopes may be the most suitable options, particularly BOS plantation. Tree belts along the creek would form an effective buffer to reduce groundwater/stream interrelation. Retain native vegetation in ridge and upper slope areas. Salt tolerant vegetation is also warranted at the lower and valley floor where watertable is high and saline. There may be some opportunities for groundwater pumping in the colluvium. Perennial pasture is generally unsuitable due to relatively high rainfall and acid soil.
Chapter 15 Low Priority			
Five Ck	5(49%), 9(39%), 7(6%), 6(2%), 3(3%), 1(1%)	High watertables are widespread at the BOS, lower slope and valley floor, but the total area is insignificant. High recharge probably occurs along cleared colluvial slopes (GFS5)	High density plantings along colluvial slopes may be the most suitable options, particularly BOS plantation. Salt tolerant vegetation is also warranted at the lower and valley floor where watertable is high and saline. There may be some opportunities for groundwater pumping in the colluvium. Perennial pasture is generally unsuitable due to relatively high rainfall and acid soil.

Chapter 16 Broken Plain			
High Priority			
Lower Broken R (Kialla East-Pine Lodge South)	6 (97%), 3 (3%), 1(1%)	Entire catchment area due to widespread shallow watertable, high groundwater salinity and active groundwater/stream interaction. Recharge occurs across majority of the sub-catchment.	Wider adoption of salinity management practices is necessary due to influence of regional groundwater system. Widespread establishment of relatively salt tolerant perennial pasture (e.g. lucerne) is warranted. Improved management of traditional crops and pastures would reduce deep drainage, particular in low and moderate recharge area. The majority of the catchment area is not suitable for tree plantations due to shallow watertables and high groundwater salinity. Some of sandy rises and area along Broken River and near irrigation area may offer some opportunities for moderate water-use tree species (e.g. red ironbark). The use of engineering options may be limited due to high groundwater salinity and problem of its disposal. Some opportunities for establishment of salt tolerant grasses at discharge area.
Moderate priority			
Congupna Ck Upland	4 (73%), 6(14%), 3(7%), 1(6%)	Widespread high watertable along foothills, high recharge on hill slopes of Cambrian fractured rocks and culluvial and alluvial fans	High-density trees, particularly moderate water-use species such as sugar gum, would be suitable in most high recharge areas. Well-managed perennial pasture would be suitable at mid and lower slopes. There are some opportunities for groundwater pumping fresh groundwater from fractured rock aquifers to irrigate horticulture or farm forestry. Saline agronomy may be the most suitable at lower slope where watertable is high.
Muckatah Ck	6(78%), 3(20%, 1(1%), 13(1%)	Widespread high watertable in the northern part of the sub-catchment. High watertables also occur at lower slope of sedimentary rises (GFS3) in the southern part of the sub-catchment	High-density trees along the irrigation boundary (as interception and recharge control) and hill slopes of sedimentary rises (as recharge control only). Widespread establishment of perennial pasture is warranted across the catchment area. Limited opportunities for groundwater pumping or drainage
Chapter 17 Low priority			
Boosey Ck Plain	6(95%), 1(2%), 3(1%), 7(1%), 9(1%)	Low salinity risk in general	Low significance for reduction of salinity risk
Boosey Ck Upland	7(48%), 6(16%), 9(13%), 3(12%), 1(11%)	Hill slopes formed by weathered fractured sedimentary rocks (GFS 3) and weathered granites (GFS 7)	High density trees targeted at recharge area and BOS plantation in granitic country (where GW is fresh) would be most effective. Well-managed perennial pasture would also be effective. Groundwater pumping may have some potential in weathered granites. Establishing salt tolerant grasses at discharge area would be the best options of living with salinity
Broken Ck Plain	6(71%), 3 (11%), 1(6%), 9(6%), 7(4%), 4(2%)	Generally low salinity risk due to deep watertable and relatively low recharge on plain area, moderate salinity risk along foothills at Devenish-Goorambat, Tarnook (GFS3) and Dookie (GFS4)	Low significance for reduction of salinity risk

Congupna Ck Plain	6(95%), 4(4%), 8(1%)	Low salinity risk in general, high watertables occur along interface of GFS6/GFS4	Low significance for reduction of salinity risk due to pobabaly strong influence of GFS4 in the upland area
Nine Mile Ck	6(92%), 4(6%), 2(2%)	In general, salinity risk is low across the sub-catchment. Moderate risk along the boundary with Congupna Ck Sub-catchment	Trees planting and establishing perennial pasture on the hill slopes (GFS 4)
Sandy Ck (Nth)	6(58%), 3(19%) 7(17%), 1(4%), 9(1%), 13(1%)	High watertables occur at lower slopes of sedimentary rises, but total area is insignificant. On the alluvial plain, watertables are generally deep.	Trees planting at the upper and mid slopes, and establishing perennial pasture at the lower slope would be effective for salinity control