

**CURRENT WATER AUTHORITY STRATEGY
FOR SALINITY REDUCTION
IN CLEARING CONTROL CATCHMENTS**

**REPORT No. WS149
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PREFACE

This report is a compilation of the strategies currently being used by the Water Authority in working towards its objectives for stream salinity reduction in the Clearing Control Catchments. It is intended as a reference for Water Authority staff who are implementing the strategies, and for other people who wish to be informed about the Water Authority's strategies.

With the new Water Resources Commission and water utility organisation soon to be established, some operational details may need modification to be compatible with a new management and legislative structure. Consequently, now is not a good time to seek broad public input on how the strategies could be improved. By making this report available now, interested people may examine the current strategies and be prepared to make constructive suggestions when given the opportunity as soon as possible after the new organisations are established. However, if anyone wants to discuss this report or make comments about it to the authors, they are welcome to do so at any time. Any input received will be considered when reviewing the strategies.



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OVERVIEW OF STRATEGY

This strategy applies to the Clearing Control Catchments, namely Wellington Dam Catchment (Collie River), Mundaring Weir Catchment (Helena River), Denmark River Catchment, Kent River Water Reserve, Warren River Water Reserve and Harris River Catchment Area. The locations of these catchments are shown in Figure 1.

Within this report, each topic has some background information, a statement of the management objective, and a list of strategies to achieve the objective. The statement of the management objective for each topic has been copied here to give a brief overview of the complete strategy.

Clearing Control Legislation

Maintain the extent of uncleared land and minimise loss of native vegetation on private property within the Clearing Control Catchments so that the area of land which contributes to present and future salinity is not increased.

Protection of Remnant Vegetation

Improve the effectiveness of remnant vegetation for salinity control in the Clearing Control Catchments.

Management of Water Authority Land

Ensure that management of Water Authority owned land is a model of the practices advocated by the Water Authority for all privately owned land in the Clearing Control Catchments.

Management of Crown Land

Maintain the salinity protection characteristics of native forest on Crown land.

Management of Cleared Land on Private farms

Salinity reduction treatment on private farms is to be voluntarily integrated into farm planning to meet management objectives of individual farms.

Commercial Reforestation

Maximise the commercial use of reforestation for salinity mitigation on the Clearing Control Catchments by private commercial treeplanting contracts.

Financial Assistance for Salinity Treatment

Minimise direct financial involvement of the Water Authority in salinity treatments on private farms, while allowing the Water Authority to be a last resort to prevent financial problems impeding treatment.

Targets for Salinity Reduction

Be able to advise on the degree of salinity reduction required in each catchment at any time, in terms of percentage reduction in deep groundwater discharge needed, and priority areas for treatment, so that the adequacy of salinity treatment in farm plans can be assessed.

Coordination of Government Advice

Ensure that advice from the Water Authority for farmers is integrated with their normal agricultural advice, and that both government and private agents who provide advice are well informed and supportive of Water Authority strategies.

Demonstration of Treatment Principles

Ensure that successful examples of proposed treatments are known, or establish them as soon as possible, to give greater credence to advice on salinity reduction.

Investigation and Research

Ensure that management strategies have a sound technical basis, both in availability of information and in the understanding of personnel who are to apply the strategies.

Implementation of Strategy

Ensure that resourcing to implement this strategy is sufficient to enable catchment rehabilitation to be achieved by the time the water resource is scheduled for development.

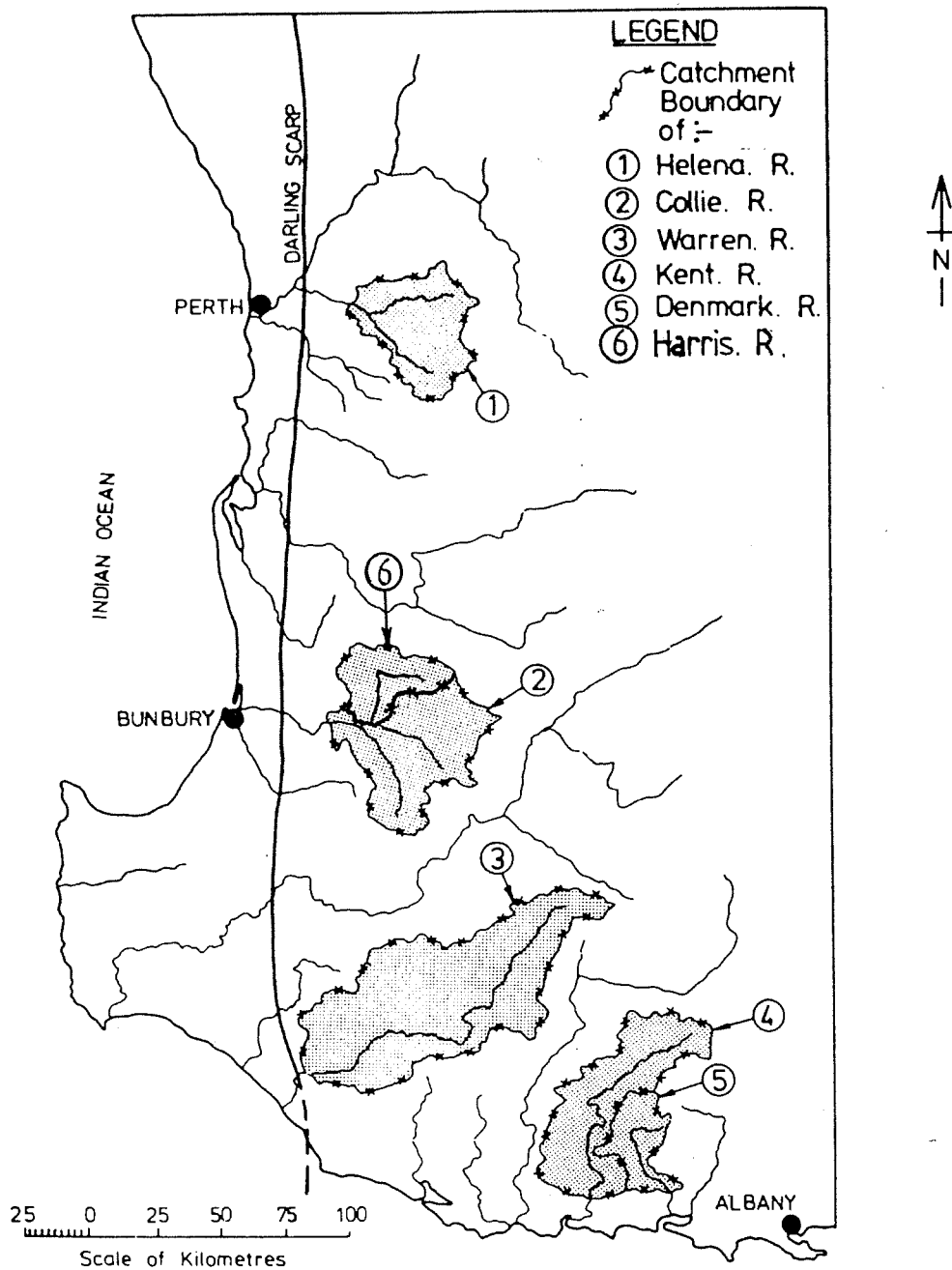


Figure 1: Location of Clearing Control Catchments (from Sadler & Williams, 1981)

1. INTRODUCTION

This strategy is to guide the Water Authority's activities which have the objective of salinity reduction in the Clearing Control Catchments. While generally in accordance with the State Salinity Strategy, it is directed to the particular conditions in these catchments as future potable water sources, and as a consequence some strategies are expressed differently

Part IIA of the Country Areas Water Supply Act is known as 'Clearing Control Legislation'. Catchments proclaimed under the Clearing Control Legislation are:

- Wellington Dam Catchment Area (catchment of the Collie River)
- Harris River Catchment Area (a tributary of the Collie River)
- Mundaring Weir Catchment Area (catchment of the Helena River)
- Denmark River Catchment Area
- Kent River Water Reserve
- Warren River Water Reserve

Figure 1 shows the locations of these catchments.

The salinity of the rivers from these catchments had begun to rise noticeably during the 1960's and 70's. Clearing native vegetation for agriculture was recognised as the cause of the increase in salinity. There were still large areas of private land not cleared and potential for large losses of the water resource value if there was no action to limit increases in salinity.

Enacting the Clearing Control Legislation was a major step in protecting these water resources by limiting salinity increases. Wellington Dam Catchment Area was proclaimed in November 1976. At that time it included the catchment of the Harris River. The other catchments were proclaimed in December 1978. The proclamations effectively stopped further large scale clearing in the high salinity hazard zones of these catchments. However, further salinity increase was to be expected because deep groundwater discharge was still increasing as a result of the clearing undertaken prior to proclamation. Figure 2 shows the record of salt output from all the catchments except Mundaring Weir. It is evident that, despite climatic variation, there is a tendency for an increasing rate of salt output in all cases, up to the present. It is still too early to be confident that treatment for salinity is having the expected effect of reduced rates of salt output, because the projected reduction at this time is small compared to the climatic variation. Thus decisions on courses of action for the future must still rely on professional judgement as to the expected impacts and benefits of treatment programmes. The judgement on which this strategy is based indicates that programmes should proceed as planned.

The catchments with highest priority for treatment were Wellington and Denmark, where the rise in salinity was making current town water supplies unsatisfactory. Programmes were commenced with the long term aim of reducing salinity in these catchments. In the case of Wellington, land was acquired by the Water Authority as a consequence of arrangements for compensation of landowners under the Clearing Control Legislation and by purchase on the open market. An initial target was set of 8000 ha to be planted with trees over about 10 years. In 1988, on the Upper Denmark catchment the Water Authority entered into a cooperative project with Department of Agriculture and Department of Conservation and Land Management to encourage farmers to implement farm plans (Schofield et al, 1989). The plans included planting trees for commercial value as well as salinity control. In both these catchments, treatment for salinity has not progressed rapidly enough to avoid the need to find alternative supplies for the towns for which they were sources.

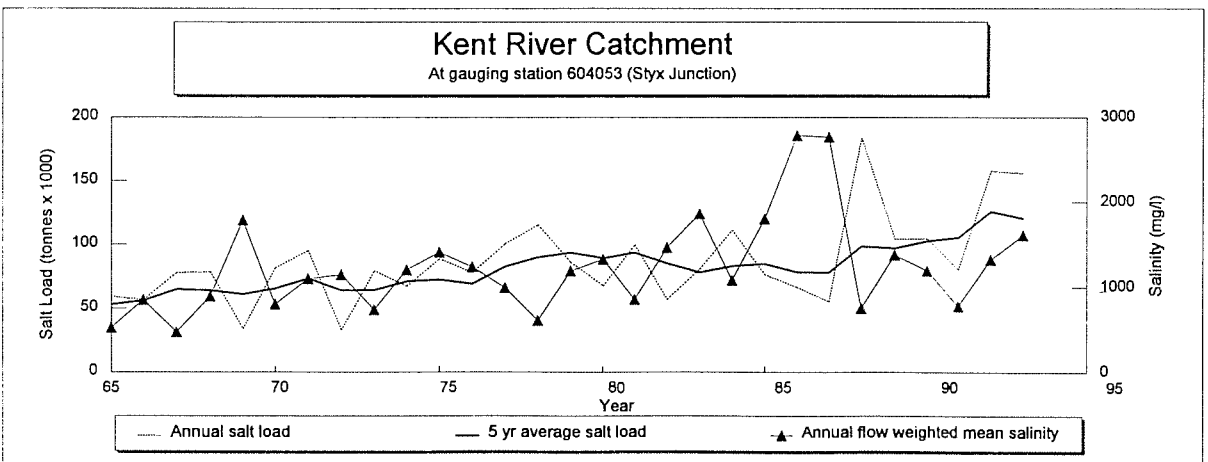
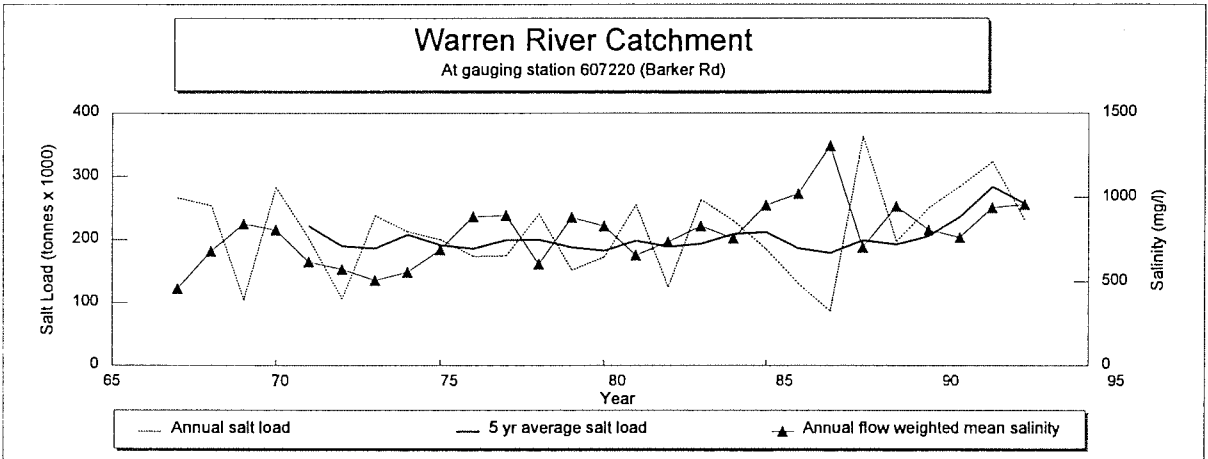
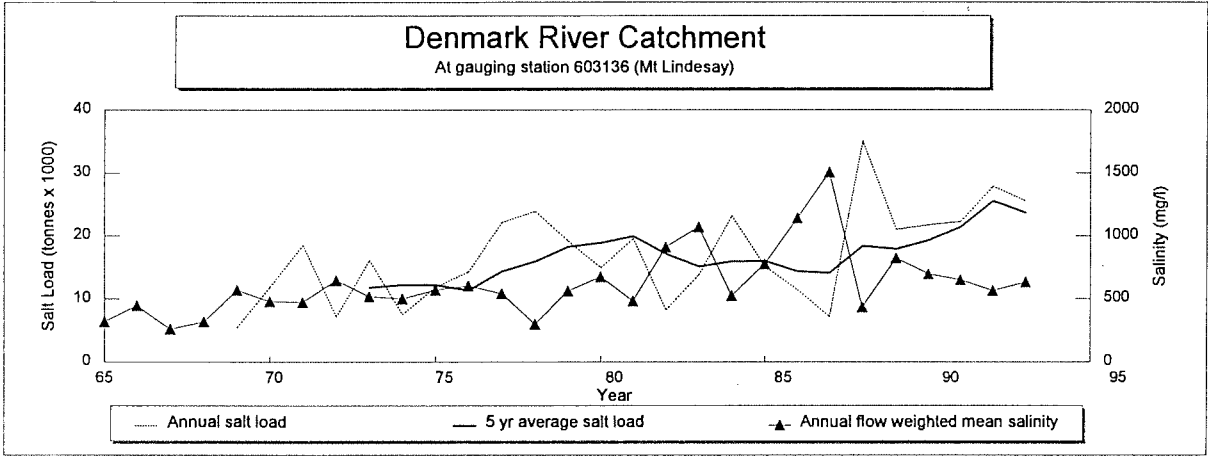
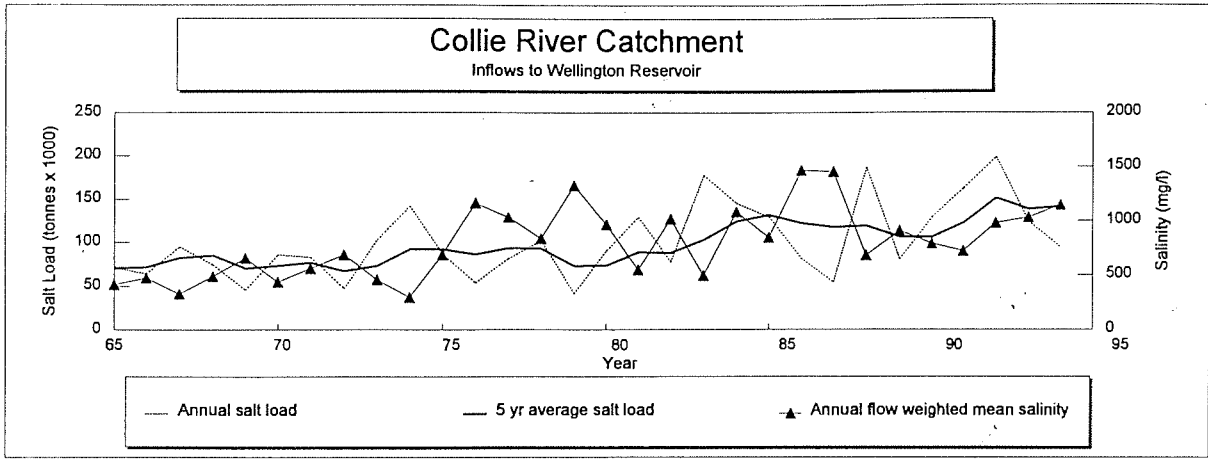


Figure 2: Historical Salt Output From Clearing Control Catchments

The Harris River Dam was built as an alternative source for the Great Southern Towns Water Supply scheme. In 1991 after construction of the Harris River Dam, the catchment of the Harris river was excised from Wellington Dam Catchment Area and then reproclaimed as a separate Catchment Area. In the interests of the environment and the long term source for public supply, the environmental approval for the Harris River Dam included a commitment by the Water Authority to reduce the salinity of Wellington Reservoir (Water Authority, 1991). Thus the programme to treat salinity on the catchment must continue until the salinity level of the Collie River is such that the quality of water supplied from Wellington Reservoir is suitable for domestic water supplies. The initial strategy of planting 8000 ha was estimated to be not sufficient for this objective, and development of a strategy for further salinity reduction was required.

The Denmark River used to be the main source of water for the town of Denmark. When salinity increased, Scotsdale Brook was used as an alternative. However, the Scotsdale often dried up in summer, forcing the Water Authority to use the Denmark River for Denmark again at a time of year when the salinity was highest. The Quickup River Dam was built to overcome this problem by storing water on a fresh tributary. Despite having no immediate demand for additional water, active treatment of the Upper Denmark needs to continue as a demonstration that integration of trees with farming can restore the quality of the water resource while improving farm productivity. The success of treatment will make a significant resource of water available in the Albany region to meet future demands.

On the other proclaimed catchments, where the compensation process has resulted in the Water Authority purchasing land, the usual action has been to retain uncleared areas. Purchased cleared land has either been sold on the open market, or sold to landowners with a compensation claim to reduce the amount of cash compensation paid. By gaining cleared land in exchange for uncleared land, a farm's viability could be improved. Only in exceptional cases has the Water Authority retained cleared land for tree planting.

The costs incurred by the Water Authority on compensation and reforestation to the end of 1994 are shown in the following table. The Commonwealth Government has provided a 50% subsidy, up to a limit of \$2 million per year, for these costs except where noted. To date, the total subsidy has been one third of costs. Additional costs have been incurred on investigations and monitoring in the catchments, and in constructing the Harris River and Quickup River Dams.

	<u>COMPENSATION</u>		<u>REFORESTATION</u>	
	\$		\$	Ha
Wellington	5 365 000		16 468 000 ¹	6 743
Denmark	1 418 000		171 000	302 ²
Warren	13 948 000		-	-
Kent	8 664 000		50 000	268 ³
Mundaring	1 309 000		55 000 ⁴	n/a
TOTAL	30 704 000		16 523 000	7 313

¹ Includes net cost of land acquisition.

² Commercial and non-commercial plantings undertaken by the Water Authority on private land as investor.

³ Includes areas of planting on Water Authority land under CALM sharefarming agreements.

⁴ No Commonwealth subsidy.

In terms of their present importance as water resources, the Water Authority ranks the catchments in the following order:

1. Wellington Dam Catchment (including the Harris Dam Catchment), because the dams exist and there are existing uses for the water.
2. Denmark River Catchment, because it is within reach of industrial development in the Albany region.
3. Mundaring Weir Catchment, important as the source for G&AWS, but where inflow from salt affected areas is a relatively minor contribution from the whole catchment.
4. Warren River catchment, because it is a large source for the future which has not deteriorated as much as some others.
5. Kent River catchment, because although relatively close to Albany, it is the most degraded.

Planning studies suggest that a contribution of potable quality water from these catchments could be important around 2020 (excepting Mundaring Weir and Harris Dam, which should not be allowed to deteriorate to less than potable quality). This is not based on projections of current local demand. Significant development of the region would be required to realise such demands. However, 2020 is a time horizon in which proposed salinity treatment strategies should be effective. Consequently, programmes in the strategy are generally targeted to between 2010 and 2020.

Salinity reduction of the required degree will need the cooperation of private landowners to manage their land in somewhat different ways to current conventional practice. General acceptance of new practices depends on having demonstrations that teach other farmers of the value of the practices. In the interest of establishing as many examples of appropriate treatment as possible, the Water Authority should cooperate with any individual or catchment group who want to plan or implement salinity treatment within these catchments. This cooperation should not be dependent on the water resource priority of the catchment.

Since the late 1960's, the body of data and research results to support management decisions concerning salinity in these catchments has been growing steadily. This has improved the understanding of the problem and solutions that may be feasible. The technical and agricultural industry environment has also been advancing, creating new opportunities to treat the problem efficiently and to turn treatment costs into economic gains wherever possible.

Working in this environment with other government agencies and farmers, the Water Authority has developed a draft strategy which could apply in all the Clearing Control Catchments. The draft strategy is stated in this document to allow review by any other interested parties. Subsequently, the strategy will take account of feedback from such review.

2. CLEARING CONTROL LEGISLATION

The prime purpose of the Clearing Control Legislation is to prevent additional sources of salinity being created within the Clearing Control Catchments. It requires landowners to obtain a licence for any clearing within the catchment. Guidelines have been prepared to define policies where the Water Authority had discretion, setting out the normal decisions of the Water Authority for different categories of clearing. The guidelines assist Water Authority officers in consistency of approach, enable quicker processing of licence applications, and guide landowners when making applications so as not to have unrealistic expectations. In general, small scale, essential clearing for farm management may be

licensed, while large scale agricultural development will not be permitted, particularly in zones of high salinity hazard.

The guidelines were recently updated after extensive consultation with agricultural communities. The documents are available in the Water Authority's Policy Library. The updated guidelines are more flexible in allowing planted trees to replace scattered paddock trees, but recognise the importance of protecting understorey from grazing in uncleared land if native vegetation is to survive in the long term.

When refused permission to clear, farmers can claim compensation for their inability to develop their land. The bulk of costs to implement the Clearing Control Legislation are associated with paying compensation. The liability will be finished when compensation or the equivalent had been paid on all eligible land. To date, it is believed that about 90% of eligible landowners have received compensation. The Water Authority is undertaking a review to estimate the liability of areas not yet compensated. If the amount is relatively minor, the Water Authority will develop a proposal to modify the legislation to set a date beyond which eligibility for compensation would cease. The controls on clearing would still remain.

The Clearing Control Legislation has been effective in limiting additional clearing in the catchments. Some shortcomings in its application have been addressed by updating the Guidelines, resulting in a useful tool for maintaining uncleared land on private property within the catchments. Review of the Clearing Control Legislation is needed to allow appropriate action to be taken when use of remnant vegetation on farms is causing severe degradation or loss of the native plants.

Management Objective

Maintain the extent of uncleared land and minimise loss of native vegetation on private property within the Clearing Control Catchments so that the area of land which contributes to present and future salinity is not increased.

Strategy

1. Continue clearing controls on all the Clearing Control Catchments.
2. Control clearing by licensing in accordance with Clearing Control Guidelines (Refer to policy document in Water Authority Policy Library).
3. Review whether a date should be set after which compensation for refusal of a licence to clear would not be available. Continue payment of claims for compensation in the meantime.
4. Review Clearing Control Legislation to ensure it has appropriate powers to protect the quality of vegetation on uncleared land.
5. Apply conditions on future compensated land so that understorey is protected from grazing.
6. Ensure that areas planted in lieu of clearing scattered paddock trees are satisfactory to the Water Authority for salinity control, including assurance that the land will be permanently used to grow trees.

3. PROTECTION OF REMNANT VEGETATION

An inter-departmental committee was established to consider State Government policy on protection of remnant vegetation in the agricultural regions. It found that severe degradation was and is occurring, primarily by continued livestock grazing. Grazing removes understorey species and tree seedlings which are required to replace old trees. Increased soil nutrients, invasion by exotic plants and soil compaction also occur in disturbed remnants, further reducing their sustainability. Degraded remnants that are not permitted to regenerate are generally deficient in deep rooted plants needed for salinity control, and ultimately all trees will be lost. Fencing to enable stock to be excluded is necessary to allow a remnant to regenerate. However, planting and other active rehabilitation is also commonly needed for badly degraded remnants to restore their sustainability.

In many remnants near streamlines, it has been noticeable that trees have died due to the waterlogging and salt discharge effects of upslope clearing. Treatment of cleared saline waterlogged areas is possible, and similar methods should be employed to protect remnants in this situation.

If the objectives of Clearing Control are to be achieved, the condition of remnants needs to be kept sustainable so they remain in place indefinitely, and in a healthy state so their water use at a site is at a maximum.

Management Objective

Improve the effectiveness of remnant vegetation for salinity control in the Clearing Control Catchments.

Strategy

1. Prepare a submission to the Board of the Water Authority to gain approval for the proposed Remnant Vegetation Fencing Strategy.
2. Encourage farmers to restore the natural ecosystem in remnants by fencing remnants (i.e. excluding stock), planting endemic species and controlling invasion by exotic flora.
3. Encourage farmers to increase vegetation cover to maximise sustainable water use.
4. Where waterlogging is threatening to degrade remnants, encourage farmers to protect them by planting high water use vegetation upslope. Appropriate drainage could also be effective in diverting shallow groundwater flows away from remnant vegetation.
5. Establish demonstration sites to give practical proof that proposed treatments are effective.

4. MANAGEMENT OF WATER AUTHORITY LAND

The Water Authority owns significant areas of freehold land in the Clearing Control Catchments as a result of the compensation process of the Clearing Control Legislation. The land is either natural bush, i.e. remnant vegetation, or has been planted with trees for salinity control. Some parts of valley floors bought by the Water Authority are still unable to sustain vegetation. As the landowner, the Water Authority has the same responsibilities for protection of remnant vegetation and management of planted areas that it claims lie with all landowners in the catchments. That it accepts these responsibilities should be evident in all its dealings with its land. The planted areas also present opportunities to test and demonstrate management strategies such as species selection, and harvesting for commercial returns.

Management Objective

Ensure that management of Water Authority owned land is a model of the practices advocated by the Water Authority for all privately owned land in the Clearing Control Catchments.

Strategy

1. Clearly assign responsibility for management of Water Authority land to well-informed staff positions in the Authority.
2. Maintain an inventory of all parcels of Water Authority land, showing the management objective of each and any currently planned actions.
3. Retain ownership to ensure the land continues to serve its function of salinity control.
4. Continue management of Water Authority land. Include timber harvesting and other activities where appropriate to demonstrate that such uses are compatible with salinity control. Realise commercial opportunities where possible.
5. Review effectiveness of plantings and recommend supplementary planting if needed.

5. MANAGEMENT OF CROWN LAND

State forest and other Crown land is managed as a native forest resource by the Department of Conservation and Land Management. Normal forestry activities are not considered to have a serious impact on salinity. However, guidelines have been developed to minimise the slight increases that monitoring has shown are associated with clear-felling techniques.

As part of management of State forest, CALM occasionally wants to rationalise its boundaries by swapping 'islands' of Crown land, or irregularly shaped Crown land that protrudes into private land, with similar plots of private land within or intruding into Crown land. Frequently the vegetation on the Crown land is degraded or cleared, and the private land is still uncleared, so the swap would have benefits of protecting remnant vegetation. In accordance with a decision of the State Government Cabinet in 1982, alienation of any Crown land in the Southwest of Western Australia must have the approval of the Executive Director Water Resources. If the Crown land was in the Clearing Control Catchments and was substantially uncleared, then such approval would be unlikely. But if approval was given, any application to clear the land after the swap would be treated in the same way as any other application for clearing private land.

Crown land sometimes needs to be cleared to provide infrastructure e.g. powerlines. When the power supply agency is responsible, the Water Authority requests it to arrange for an equivalent area in Zone A (as defined in the Clearing Control Guidelines) of the Wellington Catchment to be planted with trees, possibly by purchasing private land. When other agencies are responsible (such as the Main Roads Department), they are required to contribute financially to the reforestation programme on the Wellington Dam Catchment.

Management Objective

Maintain the salinity protection characteristics of native forest on Crown land.

Strategy

1. Cooperate with government agencies responsible for managing Crown land, in development of management guidelines which are effective in preventing increases in salinity due to forestry activities.
2. Ensure that where land is cleared for government infrastructure in any Clearing Control Catchment, an equivalent area is planted in Zone A of the Wellington Catchment to compensate.

6. MANAGEMENT OF CLEARED LAND ON PRIVATE FARMS

Cleared land on private farms is the predominant source of salinity derived from deep groundwater discharge in the Clearing Control Catchments. Treatment of this land must happen if salinity levels are to be reduced in the long term. However, the Water Authority considers that suitable treatment can be integrated with other farm planning and catchment management objectives so that more benefits than salinity reduction may be achieved. Improving economic returns is a most important objective. Where trees are planted for treatment, accounting should recognise indirect returns resulting from the sheltering effects of trees as well as direct returns from harvesting trees.

The dominant form of treatment is expected to be planting trees to use deep groundwater before it discharges into soils used by shallow rooted vegetation. If commercial trees do not perform this function satisfactorily, a two-tier treatment may be needed where commercial trees (or perennial pasture, or drainage) remove most of the shallow, low salinity water upslope from deep-rooted, salt-tolerant trees which are thus forced to draw the deep groundwater for a longer period of the year. Other treatment strategies may be appropriate in some circumstances, but for the Water Authority to support the concept, it will be important for the Water Authority to understand how the proposed treatment will reduce salinity of the rivers.

Advantages of addressing treatment on the basis of individual farms are:

- many people are involved in the management of the land for salinity reduction, working for their own good as well as community benefit.
- the rural community structure is maintained, as farms continue to be viable economic enterprises.

The success of meeting salinity reduction objectives will depend on convincing as many as possible of the farmers in the catchments that some change is needed and is desirable for the farmers, and for them to implement appropriate change.

Management Objective

Salinity reduction treatment on private farms is to be voluntarily integrated into farm planning to meet management objectives of individual farms.

Strategy

1. Reduce discharge of deep groundwater on private farms by planting suitable trees in suitable locations, supplemented by other treatments if necessary or desirable.

2. Encourage landowners to undertake appropriate farm treatment. Incentives will include:
 - a) Referring the landowner to commercial schemes for growing timber on farms with the object that economic output of farm will increase.
 - b) Providing maps to farm planner (farmer or timber scheme adviser) to show areas of highest priority.
 - c) Advice on minimising planted areas while meeting salinity control objectives, if farmer's aim is to minimise planting.
 - d) Promoting concepts of salinity control in LCDC catchment management planning.
3. Promote integration of treatment for salinity with other water management objectives. e.g. vegetation strips beside streams to reduce turbidity and nutrients.
4. Promote integration of tree planting with other farm management objectives. e.g. shelter belts. Concepts of alley farming are likely to be very compatible with salinity control planting strategies.

7. COMMERCIAL REFORESTATION

During the late 1980s, the potential for Tasmanian bluegums to supply a superior wood chip product gained momentum. Environmental pressure against clearfelling native hardwood products directed attention to plantations on private land. CALM's major venture into Tasmanian bluegum plantations on farmland commenced in 1988 when 2000 hectares of Tasmanian bluegum broadscale plantations were established in the south west.

In 1988, CALM started to develop the option of integrating commercial plantations into farmland for both wood production and other land benefits. By 1991 the Timberbelt Sharefarming Scheme (TBSFS), as it was known, had sufficient status for the Water Authority to invest in it as a means of establishing trees on private farmland in the upper Denmark catchment for salinity control. The Scheme also allowed for the planting of other species where the Tasmanian bluegum is not appropriate due to the unsuitable growing conditions posed by saline soils. In these cases, expenditure incurred by the investor to establish areas of "non-commercial" plantings is offset against an increased investor share in the commercial areas. However, there is the danger that non-commercial plantings financed in this way may suffer through a lack of incentive to ensure successful establishment and survival.

By 1995, investor interest in Tasmanian Bluegum plantations has grown considerably such that landowners have a number of financial options offered by different companies. In addition to CALM's agent relationship with foreign investors in the south coast and the Wellington Dam catchment, there are a number of private companies seeking to establish Tasmanian bluegum plantations on purchased or leased farm land. The landowner is provided the choice whereby trees can be incorporated into existing farming operations to provide multiple returns or land can be sold or leased for broadscale plantation establishment.

The Clearing Control Catchments largely lie within the region of rainfall greater than 600mm where Tasmanian bluegums can be successfully grown. This means that trees planted for land degradation benefits have a commercial return in addition to other benefits on and off the farm.

Management Objective

Maximise the commercial use of reforestation for salinity mitigation on the Clearing Control Catchments by private commercial treeplanting contracts.

Strategy

1. On Water Authority land which has been identified for replanting, use treeplanting contracts with bona fide private companies or their agents, to maximise commercial returns for reinvestment in salinity control.
2. In areas where the Water Authority expects tree planting to reduce salinity, or where more examples will assist community acceptance of trees in such areas, encourage private landowners to exploit commercial opportunities which are available in the catchment area for growing timber on farms.
3. Provide advice to private tree planting companies on how suitable trees in suitable locations may reduce salinity, and the community benefits of salinity reduction which may help promote their products.
4. Encourage private tree planting companies to incorporate the means of financing the planting of salinity tolerant species in their contractual arrangements with landowners.
5. Improve establishment and survival rate of non-commercial salinity tolerant species by promotion and advice to tree planting companies on their importance for salinity reduction.

8. FINANCIAL ASSISTANCE FOR SALINITY TREATMENT

While a revised farm plan may have potential to improve productivity, any subsidy that could be obtained would obviously improve returns. It has been suggested that the Water Authority should be prepared to contribute due to the benefit it expects from having good quality water sources available. In response: If the Water Authority is to contribute because of the expectation of a future return, it must have security for the benefit it is paying for. This is difficult to achieve for general items in a farm plan, but can be done in relation to tree planting on specific areas of land on the farm. The preferred arrangement is for an agreement to reserve being memorialised on the land title, so that there is a guarantee that the area of land will remain planted with trees indefinitely. Such agreements have also been used by the Water Authority as consideration for allowing some clearing of existing trees to facilitate commercial tree planting. In the extreme, the Water Authority would purchase the land to be planted, as has happened in the reforestation programme for Wellington Dam Catchment. This is not totally desirable as it limits the possibilities of adjusting areas of treatment in the future, incurs more demands on Water Authority resources to manage the land, and disrupts the local community by displacing farmers from the land.

If capital is lacking to establish commercial trees and associated treatment, and the various investor schemes now available are not satisfactory, the Water Authority is prepared to be the investor in the Timberbelt Sharefarming Scheme promoted by CALM.

Management Objective

Minimise direct financial involvement of the Water Authority in salinity treatments on private farms, while allowing the Water Authority to be a last resort to prevent financial problems impeding treatment.

Strategy

1. Only where other opportunities are not available to a farmer, allow the Water Authority to invest in commercial tree planting on his farm through a recognised investment scheme such as CALM's Timberbelt Sharefarming Scheme.
2. If essential areas of non-commercial trees will not be planted due to lack of financial incentive, the Water Authority may pay for establishing the areas, provided there is security that the areas will remain planted in perpetuity. Security should be provided by an agreement to reserve being memorialised on the land title, but, as an option not preferred by the Water Authority, the Water Authority could purchase the required area. The agreement to reserve may need to include areas which may be used for commercial tree planting, to ensure the survival of essential non-commercial areas.

9. TARGETS FOR SALINITY REDUCTION

While it is desirable to reduce salinity levels, the aims of water resource protection do not require total cessation of deep groundwater discharge. The question is thus "How much reduction is required?", and then "How much treatment is needed to achieve this?". The water resource managers need to be able to answer these questions where a landowner is trying to optimise the mix of his management objectives. Analysis of hydrologic records, and catchment modelling are equipping the Water Authority with answers to these questions. To date, analysis and mapping of priority sites for treatment have been completed for the Upper Denmark and Wellington Catchments. Analysis of the Kent Catchment is in progress.

The target for a whole catchment may be set in terms of potable quality. Flow-weighted mean salinity is an appropriate measure because it represents the mix of all the river flow over a period of time. The period may be 3 or 4 years if the water is stored in a large reservoir, or may be longer if the effects of variations in climate are to be ignored. Other statistics of interest, for example median or 90th percentile salinities, can be approximately inferred from the flow-weighted mean. From analysis of salinity records, the target of flow-weighted mean salinity can be converted into a target of percentage reduction in deep groundwater discharge. A target to reduce deep groundwater discharge can be used as a guide for planning an appropriate degree of treatment at specific sites.

Some treatments may exceed the catchment average target, while others may not achieve it. Monitoring of treatments applied is thus important to determine how well the overall salinity reduction objective is being achieved. Such monitoring can indicate where any campaigns for more treatment should be focussed. Overall effectiveness should be evident in the river's salinity record, but the effects will lag planting by a number of years, and may be masked by climatic variation from year to year.

Management Objective

Be able to advise on the degree of salinity reduction required in each catchment at any time, in terms of percentage reduction in deep groundwater discharge needed, and priority areas for treatment, so that the adequacy of salinity treatment in farm plans can be assessed.

Strategy

1. Amount of reduction to be estimated using targets of flow-weighted mean salinity at nominated points in stream. Continue monitoring of flow and salinity at the nominated points as a measure of the overall effectiveness of treatment.
2. Use hydrologic analysis to identify discharge sites and assess benefits of existing and proposed treatment.
3. Monitor progress of tree planting. If inadequate planting is achieved after 5 years, consider other incentives for farmers.

10. COORDINATION OF GOVERNMENT ADVICE

The Water Authority has the information and motivation to address reduction of salinity in the Clearing Control Catchments. But if the Water Authority offers advice to farmers directly, this may not integrate well with advice they receive from their normal agricultural advisers. The Water Authority should first convey its message to the agricultural advisers, and then be prepared to support the advisers in their discussions with farmers.

Similarly, other government agencies need to be aware of and support the Water Authority's strategies in these catchments. Agencies with particular interest are Dept of Agriculture, CALM, Dept of Resources Development, Waterways Commission and CSIRO.

All these agencies and the Water Authority need to work cooperatively to ensure that farmers are made aware of the issues that need to be addressed and the means of addressing them. Consistent information should be provided by educational material in pamphlets and news articles, advisers to groups engaged in catchment-based planning, and advice given to farmers individually.

Management Objective

Ensure that advice from the Water Authority for farmers is integrated with their normal agricultural advice, and that both government and private agents who provide advice are well informed and supportive of Water Authority strategies.

Strategy

1. Brief relevant interdepartmental coordinating committees (e.g. ICMCG, WAWRC) about the Water Authority strategies and request appropriate support.
2. Brief Dept of Agriculture advisers and CALM advisers for the Timber Belt Share Farming Scheme about Water Authority findings and strategies for salinity treatment.
3. Contact relating to farm planning between Water Authority officers and farmers should be coordinated through the farmer's normal agricultural adviser.
4. Water Authority analysts to interact informally with advisers to appreciate practical limitations of treatments, and assist with more information from hydrologic analyses.

11. DEMONSTRATION OF TREATMENT PRINCIPLES

Principles of salinity treatment which have been deduced from research results and computer modelling should have full scale demonstrations established to give tangible proof

that advice is sound. Any such demonstrations need to be appropriately monitored to support claims of its function.

The new aspects of the treatment being advocated in this strategy mean that existing demonstration sites only partly satisfy this need. As much data as possible should be extracted from them, but new sites should also be established which are designed to show all features.

Management Objective

Ensure that successful examples of proposed treatments are known, or establish them as soon as possible, to give greater credence to advice on salinity reduction.

Strategy

1. Look for opportunities for establishment of a demonstration of current advice on salinity treatment. Experimental catchments totally managed by the Water Authority could be considered for this purpose as soon as their demonstration of the development of salinity is complete. However, an immediate site for a demonstration should be sought with a cooperative landowner.
2. Document evidence from existing demonstration sites which shows how physical principles are acting, even if desirable outcomes of salinity reduction are not being achieved.

12. INVESTIGATIONS AND RESEARCH

A number of investigations and research projects have been conducted, and a number are still in progress, to provide information on which management strategies are founded. Most Water Authority investigations have been based in the Wellington Dam Catchment, but an important project is being undertaken on the Denmark River Catchment.

A current research project with a study area close to Wellington Dam Catchment is being run by Murdoch University. It is examining the role of geological structures in salinity processes and how vegetation may be used for salinity management in relation to geology. This is typical of projects which generate new information which can be valuable.

A number of relevant research projects are also expected to commence, because the National Salinity Strategy has selected the Kent River Catchment as a focus for research under the LWRRDC in the immediate future.

The main areas of investigation conducted by the Water Authority have been:

- Hydrologic demonstrations to show how salinity develops after clearing. A pair of forested experimental catchments in high rainfall (Salmon and Wights), and a group of three in low rainfall (Lemon, Dons and Ernies) were initially monitored in the Wellington Dam Catchment. Wights was then totally cleared, Lemon completely cleared over its western half, and Dons had a number of styles of clearing. Salmon and Ernies remained uncleared as controls. Monitoring of groundwater changes and salt output in the streams has been continuing. An incomplete phase of the investigation is where a computer model is used to simulate the small catchment's responses to clearing.
- Vegetation management, to determine the capabilities of different tree species for water use and salinity tolerance, and to determine techniques for successful planting in sites affected by waterlogging and salinity.

- Hydrologic impacts of tree-planting. Three experimental catchments have been set up just outside the Denmark River Catchment, each of which had been cleared for many years. After initial monitoring, one was totally planted with trees, one was planted according to a farm plan which the farm owner agreed to, and the third is left as a control. It is too early for the subsequent monitoring to show the expected effects yet.
- Analysis of all hydrologic records on a whole-of-catchment basis to extract performance characteristics such as trends in salt output from the catchment.
- By digital computer modelling of geographic information, identification of critical areas for treatment, with recommendation of areas for tree planting to meet salinity reduction objectives. Development of analysis techniques for this purpose has also increased the Water Authority's capabilities for generating such information and contributed to understanding of hydrologic processes.

Management Objective

Ensure that management strategies have a sound technical basis, both in availability of information and in the understanding of personnel who are to apply the strategies.

Strategy

1. Maintain projects which monitor performance of treated areas and whole catchments, with periodic review and update of information.
2. Continue the programme to set up digital models of all Clearing Control Catchments to identify critical areas for treatment and assess the total effect for a catchment of proposed treatment strategies. Also assess treatments that are implemented to confirm their contribution to salinity reduction.
3. Allow organisations or individuals who are involved in salinity treatment, to have access to data and software that is controlled by the Water Authority, to facilitate their investigations and analysis.
4. Support research projects which have potential to contribute to the knowledge base of salinity processes and treatment strategies. Incorporate such knowledge into catchment modelling and into advice on treatment strategies, as it becomes available.
5. Maintain a group of staff in the Water Authority who have the ability to supervise and undertake investigation projects in accordance with these strategies.

13. IMPLEMENTATION OF STRATEGY

The work covered by this strategy in 1995/96 has been organised as projects, and application is being made to the National Landcare Program for subsidy. These projects commit 8.5 Full Time Equivalents of Water Authority staff, spread over 18 individuals in various parts of the organisation. The continuation of the strategy after 1995/96 is expected to require a similar commitment to maintain the current rate of progress. However, the rate of progress on some aspects of the strategy may not be fully satisfactory at this level of resourcing. For example, strategies which require 'encouragement' and 'promotion' would be best serviced by a full time officer engaged on extension activities. Without adequate resources, the areas appropriately planted with trees may not increase at a rate needed to be effective in reducing salinity by the time the water resource is required. Work plans need to be reviewed to ensure that all aspects of the strategy are being addressed, and progress on projects needs to be monitored with a view to adjusting resourcing if management objectives are not being achieved quickly enough.

Reorganisation of the Water Authority as from 1st January 1996 can be expected to have some impacts on this strategy. The main features of the reorganisation are that Water Authority will be split into two organisations, one of which will be the water utility business. The other will be responsible for water resources management, and will amalgamate with the Waterways Commission and Hydrogeological Branch of the Geological Survey of W.A. This latter organisation is referred to as the Water Resources Commission, although the name is not yet finalised. Responsibility for this salinity strategy will be with the Water Resources Commission. There will be modifications to legislation to enable the new organisations to function and to be resourced. Until decisions have been made on areas of responsibility, staffing and financing, it cannot be assumed that all aspects of the current salinity strategy will be sustainable. Accordingly, the salinity strategy should be brought forward for review very early in the operation of the new Water Resources Commission.

The principles expressed in this strategy could be beneficial if applied in other salinity-affected catchments. While information and advice are freely available from resources managing Clearing Control Catchments, any requirement for substantial resources for other catchments must be allocated through normal budgetting processes.

Management Objective

Ensure that resourcing to implement this strategy is sufficient to enable catchment rehabilitation to be achieved by the time the water resource is scheduled for development.

Strategy

1. Review programme of projects relating to salinity control to ensure that all aspects of the strategy are addressed.
2. Ensure that projects are managed to meet targets related to timely rehabilitation of catchments, especially by monitoring the adequacy of resources being applied.
3. Review the complete salinity strategy as soon as possible after operation of the new Water Resources Commission commences, to ensure compatibility with new organisational structure and resources.

14. REFERENCES

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