ENVIRONMENTAL DEGRADATION IN THE MURRAY-DARLING BASIN : AN EVALUATION OF SOME OPTIONS

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INTRODUCTION

Environmental degradation in the Murray-Darling Basin has been a source of major concern (see MDBMC, 1987b, RMC) and has been a significant force underlying the establishment of the Murray-Darling Basin Ministerial Council.

Irrigation and land clearing have been identified as major causes of environmental degradation in the Murray-Darling Basin (see MDBMC 1987a). The resulting salinity impacts associated with rising groundwater levels have in turn imposed substantial damage costs on users of the Basin's resources. Recent estimates (see MDBMC 1988) indicate that agricultural production losses in major irrigation areas from land salinisation and waterlogging amount to $65m per year. Damage costs of river salinity on urban, industrial and agricultural water users are estimated to amount to $37m per year. In the absence of measures to address these costs of over $100m per year, then by 2015, production losses are estimated to increase to $95m and costs to water users to $75m.

A substantial proportion of the production losses and damage costs to water users represents external diseconomies from land clearing and irrigation. Virtually all of these costs are attributable to non point sources. Intervention is a necessity for measures to be introduced which effectively address the problems.

To address the land salinisation and waterlogging problems in irrigation areas a range of on-farm and off-farm measures has been proposed. The latter include a number of indicative land protection schemes based on surface and sub-surface drainage. For river salinity, a number of salt-interception schemes have been proposed. A point of note is that land protection may involve disposal of salt to the river, and the question to be resolved is the extent to which this can be accommodated without prejudicing the impact of the measures to reduce river salinity.

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* The author is an officer in the Department of Primary Industries and Energy Canberra. The views presented in this paper represent those of the author only. The paper is a revised version of Young 1988a.

+ Grateful acknowledgement is made for the use of Murray-Darling Basin Commission (formerly River Murray Commission) computing facilities for the calculation of present values in the evaluation analyses, and for helpful comments from Terry Roberts.

It is of note that the Ministerial Council at its most recent meeting in December agreed in principle to a salinity and drainage strategy which incorporates these proposals. In addition Council decided as a matter of priority to proceed with the implementation of three salt interception schemes, subject to final approval on environmental grounds. These three schemes (Woolpunda, Mallee Cliffs and Mildura/Merbein/Buronga) form key components of the strategy and are included in the present evaluation.

The purpose of this paper is to present estimates of benefits and costs for the various proposed projects which address river salinity and irrigated land problems in the Basin.

ESTIMATION OF BENEFITS AND COSTS

The analysis uses a conventional benefit cost framework. Estimates of the costs of implementing the various works and measures together with the corresponding benefit estimates in the form of reduced salinity damage and production losses due to land salinisation and waterlogging are discounted to net present values at a common point in time. If the present value of the benefits exceeds the present value of the associated project costs, then the project is viewed as worthwhile from an economic efficiency point of view. For present purposes the focus will be restricted to net present values as the criterion for decision choice, on the basis that this criterion has advantages over other criteria (see for example Mishan, pp 226-234).

The analysis assumes that each project has a life of 30 years and that the implementation of the projects and the generation of benefits over time occur as outlined in Tables 1 and 2.

A social discount rate, or social time preference rate, of 5% is assumed to be appropriate. However a sensitivity test using a 10% discount rate is also undertaken.

In estimating the benefits of proposed measures the basic approach was to compute two sets of estimates, one for River salinity damage and one for the impact of salinisation and waterlogging on irrigated land, and then to combine these.

River Salinity:

The estimation of benefits is based on the assessed reduction of current and future salinity damage. Estimates of River salinity damage are derived from the River Murray Commission Salt Flow computer model. The average value of one EC change in river salinity is estimated to be of the order of $70,000 in 1986, $90,000 in 2001, and $100,000 in 2016, all in 1986 dollars. The trend increase over time reflects the projected increase in Adelaide population, which more than offsets declines in agricultural production losses associated with adoption of new irrigation technology. The actual values used for each scheme are based on the impact at Morgan of estimated salt flows originating from relevant points upstream. Because the impacts at Morgan for a given EC reduction will vary with the distance of the point of origin upstream from Morgan, the actual values vary between schemes. The data for salt interception schemes in Table 1 relating to EC benefit and the value of that benefit for each scheme illustrate this point.

Land Salinisation and Waterlogging:

Eight sub regions were selected and a package of measures designed for drainage and salinity mitigation were identified for each sub region.

The options in each package of works were:

Berriquin, Wakool, Shepparton, Campaspe and Barr Creek - surface and subsurface drainage, improved irrigation management such as land relayout and irrigation scheduling, and infrastructure refurbishment as necessary to maintain the current productivity potential.

NSW and Victoria Sunraysia, Riverland - improved irrigation practices namely undertree piped irrigation, design and operation advice and infrastructure refurbishment as required.

The basic approach employed for assessing the value of damage due to salinity and waterlogging rested on the premise that additional production losses would result as the incidence of salinity and waterlogging became more widespread over time in association with rising watertables. These losses, together with losses already recorded, could be reversed by implementing programs of works, and would accordingly represent the benefits of such programs.

The estimation of these losses required estimates of the incidence of waterlogging and salinity over the specified time horizon of 30 years, and the formulation of a damage function representing the relationship between salinity and waterlogging and losses in agricultural production, together with data on current levels of production in each sub-region. Estimates were also made for the production losses that had already occurred as a result of salinity and waterlogging.

To estimate the value of losses associated with land management measures, 1985-86 market prices were used. Total benefits are computed as the sum of future losses plus losses already incurred. Conceptually, this is shown in Figure 1 in which production losses already recorded are represented by AB, expected losses at 30 years are represented by BC. Total loss is computed as the sum of the two, i.e. AC.

An estimate of the net productivity gain has been made by subtracting the difference between production costs associated with non salinised land compared to salinised land from the increased value of production from the same land.

The costs of the various activities such as on-farm works, surface drainage, subsurface drainage and interception schemes were developed for each of the sub-regions based on experience with each of the options within each sub-region. Factors such as agricultural enterprises, topography and the types of aquifers are the principal causes for any differences between sub-regions.

Estimates of increased operating and maintenance costs (O&M) were made for the different activities. In some cases, such as the interception schemes and groundwater pumping in the irrigation areas, reasonable estimates exist from previous studies. The O&M costs of the other activities were estimated as a percentage of the capital cost of the scheme, based on experience and judgement. These were 1% for on-farm works and 2% for drainage works. Costs estimated in this way are likely to overestimate the net change in O&M costs where there is existing infrastructure since existing works will already have O&M costs of this order.

It has to be recognised that major data limitations remain, particularly for works for which there are no current plans or for which an implementation timetable has not been determined. In this sense, the analyses are illustrative and indicative rather than definitive. More detailed analysis, particularly of the benefits and costs of changes in agricultural practices in different districts will be required at a later stage. Currently these data are not available. In addition, some differences exist between Victorian and New South Wales data since Victorian production losses from salinised land are based on current regional production, whereas New South Wales losses are based on the production now being achieved by above average farmers.

Further details of data sources and derivation are available in Lyle et al.

A summary of the estimated present values of costs and benefits and of net benefits for each project is presented in Table 3.

The estimates in Table 3 indicate that some of the projects are not economically justifiable on the basis of the present specification of costs and benefits. In the case of the salt interception schemes, the results confirm earlier estimates (see MDBMC 1986; MDBMC 1987a, Table 10) and there are no surprises. In the case of land protection measures, perhaps the most notable outcomes are the apparent viability of Barr

Creek, the consistency of the estimates for Sunraysia for NSW and Victoria, and the clear viability of the Riverland, Shepparton and Berriquin Phase A schemes.

It should also be noted that the estimates of benefits and costs ignore environmental and social costs of increasing salinisation and waterlogging, and that other options for addressing these problems are not evaluated. In addition no account is taken of equity effects of implementing the various projects, it being assumed that a positive net present value of benefits equates to an increase in social or national welfare.

SALT INTERCEPTION SCHEMES

The results for the selected schemes are based on the premise that flow regulation measures (flushing of Lake Victoria, drawing on Menindee Lakes before Lake Victoria and the surcharging of Menindee Lakes) are already in place.

The average EC reduction associated with each scheme together with estimates of the present value of net benefits and the ratio of the present values of benefits and costs are shown in Table 4. Given that the MDBC (formerly RMC) interim salinity target at Morgan is expressed in terms of an EC level for 95% of the time, the corresponding EC reduction for 95% of the time is also presented.

The schemes are ranked by benefit/cost ratio in Table 4 and this ordering is used as the basis for Figure 2 which shows the relationship between EC reduction and the magnitude of the present value of net benefits.

Given an objective of maximising the present value of net benefits the graph indicates this occurs at a value of just over $24m with the inclusion of the first five schemes in Table 4. The average EC reduction associated with this maximum totals to 79.4 EC, and the corresponding 95% of the time estimate is 212.3 EC.

LAND PROTECTION MEASURES

The streams of benefits and costs relating to the package of measures in each zone assumes implementation of the measures in equal annual amounts. Like the salt interception schemes a project life of 30 years is assumed.

The area in each zone over which the benefits from each package of measures are generated is shown in Table 5 together with the average net impact on river salinity at Morgan and the estimated present values of net benefits and ratio of benefits and costs. The estimates of average net EC impact indicate that for some zones the measures are complementary to river salinity mitigation works while for others which impose a net increase, there is a trade-off. With the exception of the two Sunraysia zones, each zone generates net positive benefits.

The land protection zones were ranked by benefit/cost ratio, as was done for the salt interception schemes, and the present value of net benefits plotted against area. This relationship is shown in Figure 3.

The maximum present value of net benefits amounts to $265m which is associated with a benefit area of 380,000 ha, and an overall net average EC impact of 1.3. That is the implementation of land protection measures for those zones which have positive present values of net benefits will marginally increase river salinity although the estimates for EC change for 95% of the time indicate that the impact of Riverland will more than offset the impact of the other zones and that there will be a net EC reduction of some significance.

From an overall viewpoint therefore, there is essentially no trade off at an aggregate level between the land protection and river salinity mitigation measures. At an individual zone level, however, and at points on the River Murray upstream from Morgan, there will be a trade off involving those zones for which there is a net average EC addition to river salinity ie for all zones other than Riverland and Barr Creek.

A BASIN PERSPECTIVE

To a limited degree, a Basin perspective can be developed on the basis of the results presented above. This may be achieved by combining the results for the salt interception schemes and the land protection measures, and focussing on the variables of interest viz present value of net benefits, which is the objective being maximised, and the net average EC impact which represents the trade-off variable.

The estimates shown in Table 6 indicate that the maximum net benefits value amounts to just under $290m, and the net total EC reduction corresponding to this maximum is 78 EC. To achieve this benefit would require implementation of the projects listed in Table 6 down to and including Waikerie. The projects listed below Waikerie in Table 6 incur costs which exceed the benefits and are not economically viable on the basis of the costs and benefits specified. The implementation of the viable projects would involve a cost of $350m and the generation of benefits valued at $640m in 1986 dollars in present value terms.

It may also be of interest to examine the relationship between net benefits and costs across all projects. This is shown in Figure 4 which confirms a maximum net benefit present value of some $290m and an associated present value cost figure of $350m.

RANKING OF PROJECTS

Intuitively, it seems logical to select the project which generates the largest expected net benefits. In a situation where more than one project may be implemented and there is no budget constraint, it may be appropriate to use the absolute benefits (B) minus costs (C) present value criterion appearing in column 1 of Table 7. However more realistically with limited funds for investment, there will be a preference to select those projects which give the greatest return per dollar invested.

This leads us to the relative criteria of B/C or (B-C)/C appearing in columns 3 and 5 of Table 7. These criteria give the gross and net value of benefits per unit value of costs in present value terms and those projects which have the highest ratio would be selected. Since the difference between the two relative criteria is unity they give the same ranking as is apparent from Table 7.

It needs to be remembered that these decision criteria represent a condition to be met, and as such are a guide to decision making. The underlying objective of the project may well lead to a decision which selects a project which is economically viable ie (B-C) 0 but which does not have the highest B/C ratio. For example, if the aim is to replace or install infrastructure in a given zone, then the question of ranking projects across zones by a present value criterion may not be relevant, and assessment of viability may be sufficient. On the other hand to the extent that States have responsibility for infrastructure and on-farm measures and also have limited budgets it may be relevant to rank intrastate projects across zones and give priority to implementing those yielding the greatest net benefit, as well as encouraging on-farm measures which are most profitable.

In terms of getting the best return on dollars of expenditure it seems clear that the three salt interception schemes at the top of the B/C ranking are some way ahead of the others. Mildura, Chowilla and Mallee Cliffs can achieve an EC reduction of 75.3 for 95% of the time for a cost of $9.99m or $0.13m per EC. By contrast, the corresponding per EC present value cost for Woolpunda is $0.24m and for Waikerie $0.32m.

THE DISCOUNT RATE

In the analysis so far, it has been assumed that the appropriate discount rate is 5%. The justification for this choice is based on an approximation to the long term bond rate less the rate of inflation. There are however arguments based on opportunity cost which suggest a higher rate is more appropriate (see Mishan for example).

The fact that land protection measures consist of a mixture of private and public expenditure, with on-farm capital expenditure accounting for some 47% of the total capital expenditure on the viable land protection schemes (see Table 2) indicates that consideration should be given to the corresponding private sector rate. It might be argued that if due account is taken of this aspect, a rate of 10% may be more appropriate.

While the selection of a discount rate is inevitably somewhat arbitrary, estimation of present values using a discount rate of 10% has been undertaken for illustrative purposes. The results are shown in Table 8 together with corresponding estimates using the 5% rate.

Use of a 10% rate causes the Woolpunda and Waikerie salt interception schemes, and the Wakool land protection scheme to become non-economic in the sense that the present value of costs exceeds the present value of benefits.

Given that the salt interception schemes will be publicly funded whereas Wakool will contain a significant private component (over 60%), the economic feasibility of Wakool would appear to be marginal and require further investigation.

A second question relating to choice of discount rate is the issue of intergenerational transfers. The point at issue is that long life projects which yield net benefits across generations are discriminated against by use of a positive discount rate for computing present values, since net benefits extending beyond say 50 years add little or nothing to the present value of the project. Such an approach amounts to ignoring the interests of future generations and a myopic concern with the interests of the present generation. That is, the issue is one of equity rather than efficiency (Young 1988b).

Because it has been assumed that each project being evaluated has a life of 30 years, this issue is of only marginal relevance in this exercise, and will be ignored. However for other aspects of the resource management strategy concerned with projects with longer lives, consideration should be given to the development and application of a more appropriate methodology.

PROJECT LIFE

The assumed project life of 30 years is based on a scenario determined by expectations regarding the incidence of shallow watertables and associated soil salinity and waterlogging together with implementation of works and their resulting benefits.

The range of capital assets associated with the salt interception and land protection measures is wide and correspondingly, the expected life of these assets also varies by type of asset

It would be expected that structural items such as bridges, pipelines, earthworks and evaporation disposal areas would have a project life of 50 years or more given a continuation of assumed maintenance expenditures beyond 30 years. In addition, the operating and maintenance estimates include allowance for replacement of items with a life of less than thirty years.

In view of this, it seems reasonable to assume that a project life of 50 years would be just as valid as one of 30 years. Accordingly, the benefit and cost estimates were recomputed using a 50 year project life assuming that the levels of O and M costs and of benefits remained constant from year 30 through to year 50. Selected results are presented in Table 9 together with corresponding estimates for a 30 year project life.

The data in Table 9 indicate that the longer project life is associated with a substantial increase in net benefits. Projects such as Lindsay River and Victoria Sunraysia which with a 30 year project life were assessed to be uneconomic have under a 50 year life become marginally economic. Wakool which was a marginal project under a 30 year life becomes much less so. On the other hand, NSW Sunraysia remains uneconomic.

Because the land protection schemes have a significant private component, it is appropriate to reassess the Victoria Sunraysia and the Wakool projects at a higher discount rate. Victoria Sunraysia which has become marginally economic has an on-farm component amounting to 74% of total capital expenditure, whilst Wakool, which has become less marginal has a 61% on farm component. Assuming a 50 year life, the estimates for these two projects were recalculated using a 10% discount rate. The results appear in Table 10. Wakool remains a marginally viable project whereas Victoria Sunraysia returns to non-viability.

Rather than evaluating an extended project life, it may be argued that if improved efficiency in irrigation water use, and revegetation in recharge areas has an impact on salinity which is sooner rather than later then a shorter project life for salt interception schemes may be a more appropriate assumption. Comparison of present value estimates for a 20 year and 30 year project life for salt interception schemes are shown in Table 11.

As expected, the NPV of benefits is reduced with a shorter project life. Woolpunda becomes marginal and Waikerie becomes non-economic.

An alternative approach to extending the project life is to assume a salvage value at the end of the 30 year project life. For purposes of illustration, present value estimates were computed for the salt interception schemes with a salvage value at the end of thirty years equal to 50% and 100% of capital cost. These are shown in Table 12 and compared with the original estimates which assumed a zero salvage value. The results do not significantly change with the inclusion of salvage values, with the main change being to increase the benefit cost ratio marginally to make the Lindsay River scheme marginally economic.

DAMAGE ESTIMATES

The estimates of benefits achieved by reducing river salinity are based on values per EC change which increase over time, as specified earlier but which average about $80 000 per EC change in 1986 dollars. This estimate is derived from a study by Dwyer Leslie and represents an average of what were assumed to be upper and lower bound estimates of salinity damage incurred by urban water users.

To allow for the possibility that the estimates of salinity damage may be overstated or understated the analysis was redone using EC damage values representing approximately the lower bound and upper bound values identified by Dwyer Leslie. These are respectively $50 000 and $110 000 per EC. The results appear in Table 13.

Because the estimated EC impact of the land protection schemes was minor in relation to estimated annual benefits, being less than 10 per cent in each case with the exception of Barr Creek for which the proportion was just over 15%, these revised estimates are presented only for the salt interception schemes.

The results in Table 13 indicate that regardless of the potential errors which may characterise the 'best bet' estimates the three most viable schemes remain viable even under the lower bound unit EC value.

On the basis that the average used by Dwyer Leslie may be an underestimate, since irrigated agriculture other than horticulture is ignored, as are the social and environmental impacts of salinity, then the upper bound may be a more appropriate value to use. In this case, only the Sunraysia scheme is assessed to be non-economic, and Lindsay River becomes a viable project.

Given the relatively high degree of uncertainty which characterises the data for the land protection measures, there would appear to be merit in applying similar upper and lower bounds to the estimated benefits for each zone. To the extent that estimated costs may be represented as negative benefits, then such an application may be viewed as encompassing errors in the cost as well as the benefit estimates.

For convenience as well as for purposes of illustration and comparison with Table 13, the upper and lower value bounds for unit EC values ie $50th and $110th respectively were divided by the average unit EC value ie $80th to generate two ratio factors (0.625 and 1.375) which could be used to compute similar arbitrary bounds for the land protection zones. The results are presented in Table 14.

These results indicate that with the exception of Wakool which has already been identified as marginal, the estimates for the specified land protection measures are relatively insensitive to substantial changes in the value of the benefits, in the sense that the majority of the schemes remain economically viable over the sensitivity range. Although Victoria Sunraysia becomes viable at the upper end of the range, the use of a higher discount rate to reflect the private component is likely to render this scheme non-economic, as was shown in Table 10.

SOME ISSUES

In conducting and reporting on the analysis of benefits and costs, a number of issues relevant to the estimates of net benefits have not yet been considered. These include tax efficiency aspects, the changing economic environment and the high degree of uncertainty characterising some of the data. These will now be reviewed briefly more with the aim of flag waving than resolving them. The point is that subsequent evaluations undertaken prior to implementation of works programs should address these issues before a final decision is made on public investment.

If public investment is financed by taxation revenue, a welfare loss will be involved in addition to the direct funding cost. The premise underlying this argument is that taxpayers would be better off if taxation revenue was not raised. Thus a program of public expenditure will be efficient only if the benefits exceed the direct costs by at least as much as the additional welfare cost of the funds (see Findlay and Jones). Estimates made by BAE indicate that the costs of raising revenue can be substantial. The implication of this tax efficiency argument is that the B/C ratio should be significantly above unity if the project is to proceed. On the other hand, if tax efficiency gains associated with the benefits of the project are significant then the welfare loss may be more than offset. In the context of the present exercise the only income generating benefits are associated with the elimination of agricultural production losses, and these would form a basis for assessing marginal tax gains.

The changing economic environment is an issue particularly relevant to the estimation of benefits and costs associated with infrastructure and on-farm measures. In the analysis it is implicity assumed that regardless of enterprise change in irrigated farming, prices received and paid by farmers will remain constant in real terms over the next thirty years. Experience tells us that this will not be the case. The long term deterioration in farmers' terms of trade is likely to continue and to require more productivity gains and structural adjustment for farm units to remain viable. One persons vision of the structure of irrigated farming in 30 years is likely to be as good as another's, and it has been assumed for convenience that this too will remain unchanged. Once again experience tells us otherwise. These assumptions are particularly critical for investment in infrastructure. With the introduction of transferable water entitlements and economic water pricing policies, expenditure on infrastructure may be highly risky. If water demand shifts from one district to another, the demand for infrastructure services will also change.

A simple solution would be to argue that infrastructure is an integral part of irrigated farming, that the irrigation farmers are the principle beneficiaries and users of infrastructure services and therefore they should not only pay for these services but should also pay for and own the infrastructure as well in a corporate district sense. A problem is that infrastructure is a utility which achieves peak efficiency when it exploits economies of size and is of a capacity to meet peak demands of the district as a whole. The investor in infrastructure will therefore wish to know what the likely return on infrastructure is going to be and this will depend on an assessment of future demand for water. This in turn will depend on the outlook for relative profitability of different products and the profitability of products which can be grown in one district relative to another, the expected viability of districts and a number of related factors. Such an assessment is complex and subject to many uncertainties. But given the apparent need for infrastructure investment, it is unavoidable, if public investment is determined as necessary and is to be accountable.

CONCLUDING COMMENTS

Uncertainty is a characteristic of much of the data which have been used in the analysis. The degree to which key variables may be subject to error can be overcome to some extent by sensitivity analysis and subsequently by adopting a conservative approach to selecting which projects to implement. In other words, because of the high degree of uncertainty characterising the data, the risk of making a wrong decision is increased, and hence the next step in the evaluation process would be either to reduce the degree of uncertainty and/or restrict the choice of projects to those which are clearly viable on an economic basis.

There also remains considerable uncertainty about the dynamics of Basin hydrogeology and interactions with surface activity. It is not clear according to BMR, what the likely impact of more efficient water use by irrigation farmers, and resulting reduced accessions to groundwater will have on aquifer pressures or on discharges to the river or to land areas. There is a risk of confusing symptoms and causes.

In addition, two options for salinity mitigation which have not yet been evaluated are the withdrawing of ground water from aquifers (a possible option identified by BMR) and the revegetation of key recharge areas.

Accordingly, it should not be concluded that all of the projects which are identified as contributing positive net benefits to social welfare should be implemented immediately. The results do, however, indicate a positive probability of scope for significant gains to the community.

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Figure 1:

Estimated Production Losses Due to Land Salinisation and Waterloggong

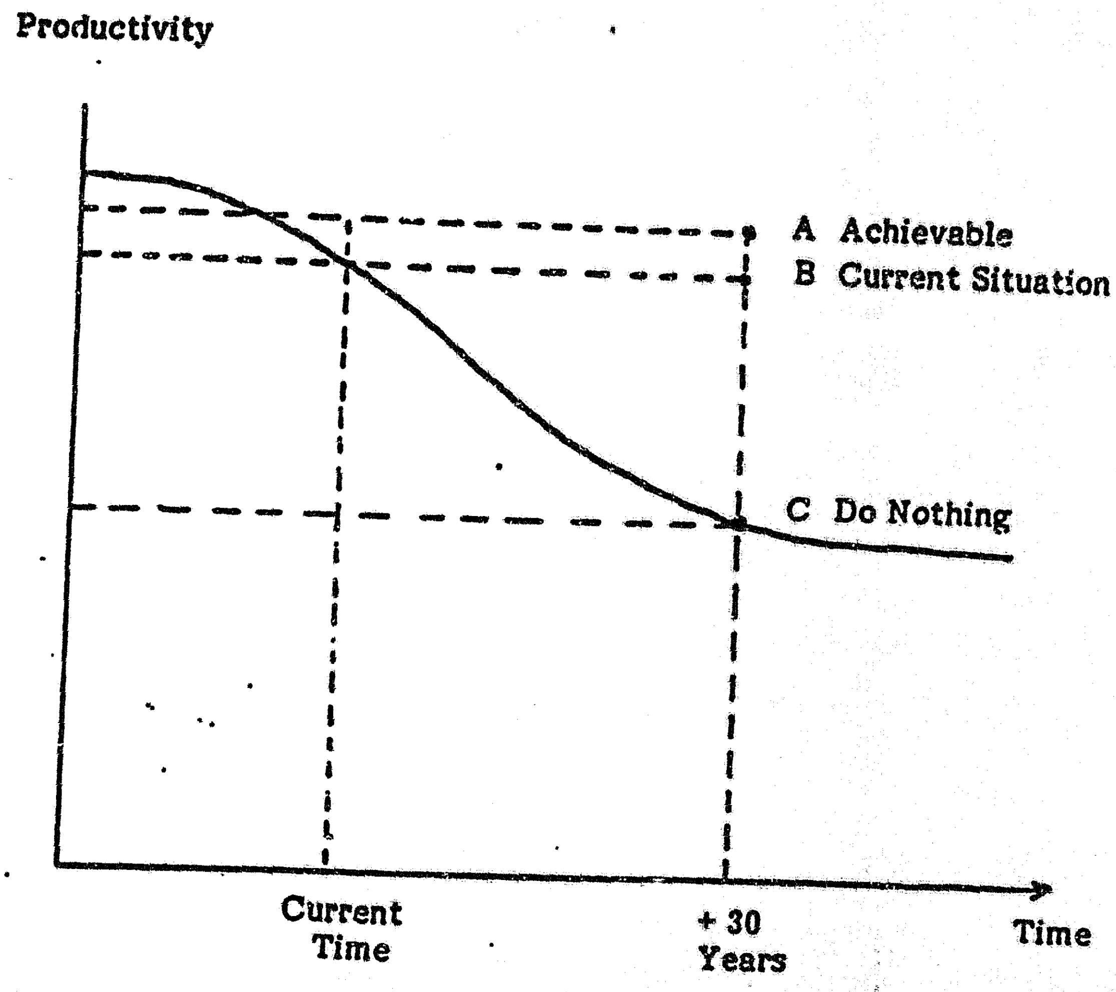

FIGURE 2 : SALT INTERCEPTION SCHEMES

NPV OF BENEFITS AND AV EC REDUCTION

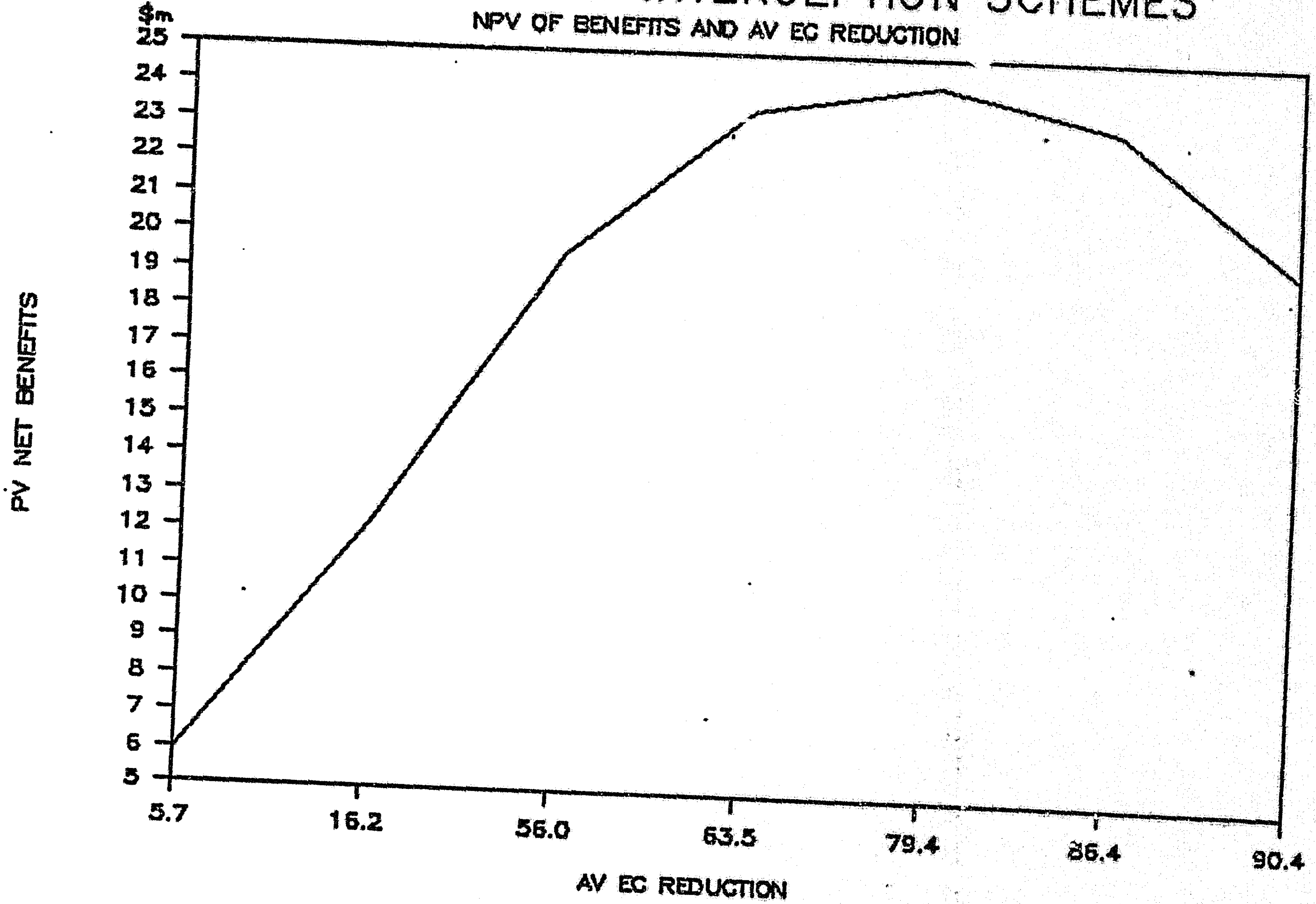

FIGURE 3 .: LAND PROTECTION SCHEMES

VALUES OF NET BENEFITS AND AREA

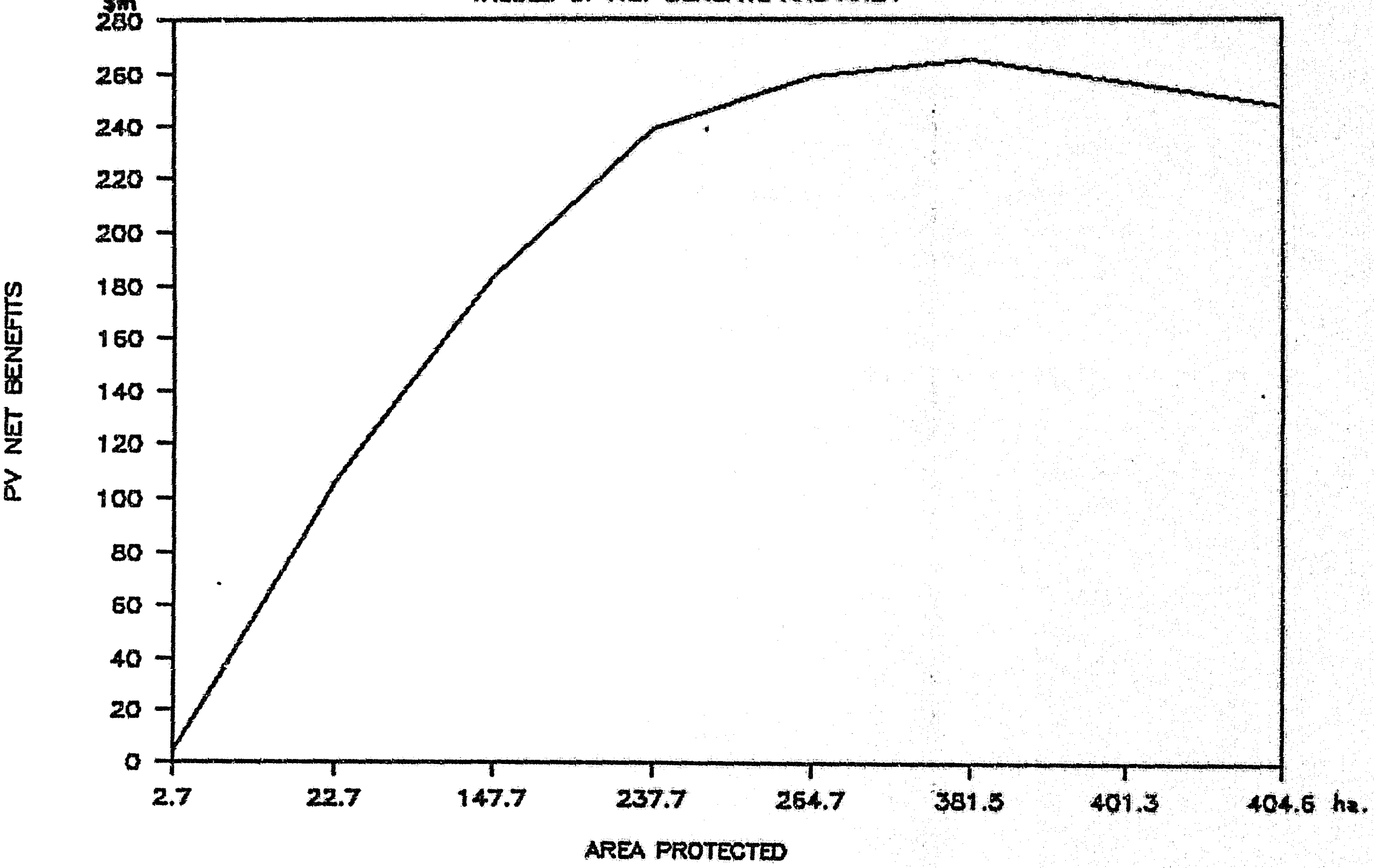

FIGURE 4 : PV NET BENEFITS AND COSTS

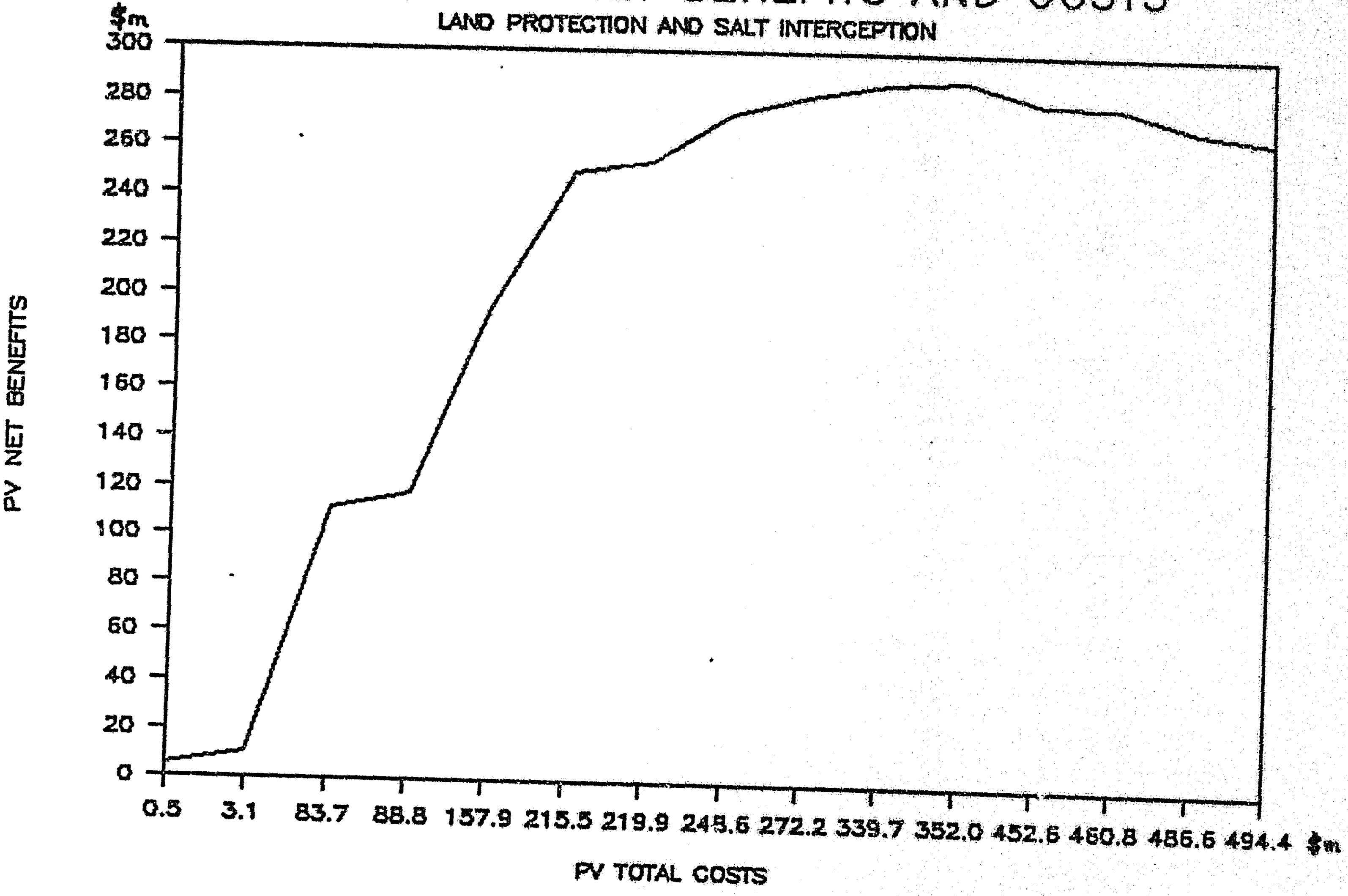

TABLE 1: SALT INTERCEPTION SCHEMES CURRENTLY UNDER INVESTIGATION
EFFECT OF SCHEMES AFTER ADOPTION OF REVISED RIVER OPERATING PROCEDURES

DETAILS CURRENT AT DECEMBER 1986

Description of Project	Estimated Capital Cost $M	Estimated Average Annual O&M Cost $1000's	Salinity Benefit at Morgan for				Capital Exp. $M				
			EC	$1000's 1986	$1000's 2001	$1000's 2016	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5
Improved Mildura Merbein/Buronga	0.25	20	5.7	386	458	529	0.25				
Chowilla	4.0	100	10.5	700	854	1008	2.0	2.0			
Mallee Cliffs	3.0	120	7.5	488	636	734	1.0	2.0			
Woolpunda	12.2	1070	39.8	2079	2638	3135	3.0	4.0	4.0	1.2	
Waikerie	8.0	400	15.9	833	1058	1256	3.0	3.0	2.0		
Sunraysia	6.0	180	7.0	455	595	686	2.0	2.0	2.0		
Lindsay R	8.0	75	4.0	260	340	392	2.0	4.0	2.0		

Discount Rate 5%

Project Life 30 Years (ending Year 2016) Project Benefits Examined by modelling 10 year Period 1975 to 1985.

* Revised operating procedures for Menindee Lakes and Lake Victoria as per RMC Technical report 86/3.

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TABEL 2: LAND PROTECTION SCHEMES: COSTS AND BENEFITS SUMMARY 1985-86

	DRAINAGE		ON-FARM		
	TOTAL CAPITAL $m	ANNUAL O+M AT YEAR 30 $000	TOTAL CAPITAL $m	ANNUAL O+M AT YEAR 30 $000	ANNUAL BENEFITS AT YEAR 30 $m
WAKOOL+	41.0	2330	63.0	630	12.0
BERRIQUIN 'A'	21.5	770	28.5	285	13.0
NSW SUNRAYSIA*	18.0	-	16.4	1050	2.7
SHEPPARTON+	45.6	2480	52.5	525	24.0
CAMPASPE+	1.5	129	-	-	0.7
VIC SUNRAYSIA*	31.0	-	90.0	6320	15.0
BARR CREEK*	27.0	-	9.0	27	4.3
RIVERLAND*	56.9	-	17.6	4000	22.4

\+ ANNUAL O+M COSTS INCLUDE EC ADDITION TO RIVER SALINITY

* ANNUAL BENEFITS INCLUDE EC REDUCTION.

TABLE 3: ESTIMATES OF PRESENT VALUES OF SALT INTERCEPTION SCHEMES AND LAND PROTECTION MEASURES

1986 $MILLION

PROJECT	PV OF COSTS		PV OF BENEFITS	PV OF NET BENEFITS
	CAP	O+M		
SALT INTERCEPTION SCHEMES				
MILDURA	0.24	0.29	6.44	5.92
CHOWILLA	3.72	1.35	11.33	6.26
MALLEE CLIFFS	2.77	1.62	8.29	3.90
WOOLPUNDA	10.93	12.65	30.98	7.39
WAIKERIE	7.31	5.06	13.15	0.78
LINDSAY R	7.26	0.95	7.08	-1.13
SUNRAYSIA	5.45	2.28	4.05	-3.68
LAND PROTECTION ZONES				
WAKOOL	53.34	14.16	73.60	6.10
BERRIQUIN A	43.29	14.29	111.82	54.23
NSW SUNRAYSIA	17.68	6.44	16.37	-7.75
SHEPPARTON	50.27	18.91	147.20	78.01
CAMPASPE	1.15	1.44	7.53	4.94
VIC SUNRAYSIA	61.95	38.64	92.00	-8.59
BARR CREEK	28.31	0.38	49.14	20.45
RIVERLAND	46.73	33.83	181.45	100.89

PROJECT LIFE = 30 YEARS; SOCIAL DISCOUNT RATE = 5%

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TABLE 4: SALT INTERCEPTION SCHEMES: PRESENT VALUES OF BENEFITS/COSTS; $MILLION 1986

SCHEME	EC REDUCTION		PRESENT VALUE OF NET BENEFITS	PVB/ PVC
	Average	95%		
MILDURA/MERBEIN/ BURONGA	5.7	17.5	5.92	12.23
CHOWILLA	10.5	32.2	6.26	2.23
MALLEE CLIFFS	7.5	25.5	3.90	1.89
WOOLPUNDA	39.8	98.3	7.39	1.31
WAIKERIE	15.9	38.2	0.78	1.06
LINDSAY RIVER	7.0	-	-1.13	0.86
SUNRAYSIA	4.0	-	-3.68	0.52

TABLE 5: LAND PROTECTION MEASURES BY ZONE: PRESENT VALUES OF BENEFITS/COSTS; $MILLION 1985/86

ZONE	EC IMPACT		AREA 000 ha	PRESENT VALUE OF NET BENEFITS	PVB/ PVC
	Average	95%			
WAKOOL/ TULLAKOOL/ DENIBOOTA	+10.9	+28.4	116.8	6.10	1.09
BERRIQUIN A	+4.0	-	90.0	54.23	1.94
SUNRAYSIA NSW	-2.0	-	3.3	-7.75	0.68
SHEPPARTON	+13.5	+12.4	125.0	78.01	2.13
CAMPASPE	+0.8	+0.8	2.7	4.94	2.91
SUNRAYSIA VIC	-2.0	-	19.8	-8.59	0.91
BARR CREEK	-6.5	+0.3	27.0	20.45	1.71
RIVERLAND	-21.4	-60.2	20.0	100.89	2.25

TABLE 6: COMBINED LAND PROTECTION AND SALT INTERCEPTION PROJECTS: CUMULATIVE NET BENEFITS AND EC IMPACT

PROJECT	AVERAGE EC IMPACT	CUMULATIVE EC IMPACT	PV OF NET BENEFITS	CUMULATIVE NET BENEFITS	PVB/ PVC
MILDURA	-5.7	-5.7	5.7	5.92	12.2
CAMPASPE	+0.8	-4.9	4.94	10.86	2.91
RIVERLAND	-21.4	-26.3	100.89	111.75	2.25
CHOWILLA	-10.5	-36.8	6.26	118.01	2.23
SHEPPARTON	+13.5	-23.3	78.01	196.02	2.13
BERRIQUIN A	+4.0	-19.3	54.23	250.25	1.94
MALLEE CL	-7.5	-26.8	3.90	254.15	1.89
BARR CREEK	-6.5	-33.3	20.45	274.60	1.71
WOOLPUNDA	-39.8	-73.1	7.39	281.99	1.31
WAKOOL	+10.9	-62.2	6.10	288.09	1.09
WAIKERIE	-15.9	-78.1	0.78	288.87	1.06
SUNRAYSIA (VIC)	-2.0	-80.1	-8.59	280.28	0.91
LINDSAY R	-7.0	-87.1	-1.13	279.15	0.86
SUNRAYSIA (NSW)	-2.0	-89.1	-7.75	271.40	0.68
SUNRAYSIA	-4.0	-93.1	-3.68	267.72	0.52

TABLE 7: RANKING OF VIABLE PROJECTS

NET PRESENT VALUE CRITERION

	B-C	RANKING	B/C	RANKING	$\frac{B-C}{C}$	RANKING
SALT INTERCEPTION SCHEMES						
MILDURA	5.92	8	12.23	1	11.23	1
CHOWILLA	6.26	6	2.23	4	1.23	4
WOOLPUNDA	7.39	5	1.31	9	0.31	9
MALLEE CLIFFS	3.90	10	1.89	7	0.89	7
WAIKERIE	0.78	11	1.06	11	0.06	11
LAND PROTECTION ZONES						
WAKOOL	6.10	7	1.09	10	0.09	10
BERRIQUIN 'A'	54.23	3	1.94	6	0.94	6
SHEPPARTON	78.01	2	2.13	5	1.13	5
CAMPASPE	4.94	9	2.91	2	1.91	2
BARR CREEK	20.45	4	1.71	8	0.71	8
RIVERLAND	100.89	1	2.25	3	1.25	3

TABEL 8: COMPARISON OF ESTIMATES OF PRESENT VALUES OF NET BENEFITS USING 5% AND 10% DISCOUNT RATES
$MILLION 1986

	PRESENT VALUE OF NET BENEFITS	
	5%	10%
SALT INTERCEPTION SCHEMES		
MILDURA	5.92	3.30
CHOWILLA	6.26	2.00
WOOLPUNDA	7.39	-0.65
MALLEE CLIFFS	3.90	1.08
WAIKERIE	0.78	-2.50
LAND PROTECTION ZONES		
WAKOOL	6.10	-4.76
BERRIQUIN 'A'	54.23	12.50
SHEPPARTON	78.01	29.54
CAMPASPE	4.94	2.31
BARR CREEK	20.45	3.00
RIVERLAND	100.89	39.81

TABLE 9: COMPARISON OF PV's WITH 30 YEAR AND 50 YEAR PROJECT LIFE

	PV OF NET BENEFITS		PVB/PVC	
	30yr	50yr	30yr	50yr
SALT INTERCEPTION SCHEMES				
MILDURA/MERBEIN/BURONGA	5.92	7.39	12.23	13.64
CHOWILLA	6.26	9.14	2.23	2.71
WOOLPUNDA	7.39	13.36	1.31	1.50
MALLEE CLIFFS	3.90	5.66	1.89	2.20
WAIKERIE	0.78	3.26	1.06	1.24
LINDSAY RIVER	-1.13	0.27	0.86	1.03
SUNRAYSIA	-3.68	-3.27	0.52	0.60
LAND PROTECTION ZONES				
WAKOOL	6.10	34.04	1.09	1.46
BERRIQUIN 'A'	54.23	88.68	1.94	1.46
SHEPPARTON	78.01	138.08	2.13	2.76
CAMPASPE	4.94	6.52	2.91	3.18
BARR CREEK	20.45	32.91	1.71	2.14
RIVERLAND	100.89	153.00	2.25	2.66
SUNRAYSIA - NSW	-7.75	-5.52	0.68	0.81
SUNRAYSIA - VIC	-8.59	16.49	0.91	1.14

TABLE 10: COMPARISON OF PV's FOR MARGINAL LAND PROTECTION PROJECTS WITH 50 YEAR LIFE USING 5% AND 10% DISCOUNT RATES

SCHEME	PV OF NET BENEFITS		PVB/PVC	
	5%	10%	5%	10%
WAKOOL	34.04	-0.04	1.46	1.00
SUNRAYSIA - VIC	16.49	-8.66	1.14	0.85

TABLE 11: SALT INTERCEPTION SCHEMES - COMPARISON OF PV ESTIMATES
20 YEAR AND 30 YEAR PROJECT LIFE

SCHEME	PV of Net Benefits 20 year	 30 year	PVB/PVC 20 year	 30 year
MILDURA/MERBEIN/BURONGA	4.50	5.92	10.61	12.23
CHOWILLA	3.73	6.26	1.78	2.23
MALLEE CLIFFS	2.21	3.90	1.55	1.89
WOOLPUNDA	1.85	7.39	1.09	1.31
WAIKERIE	-1.52	0.78	0.86	1.06
LINDSAY RIVER -	2.54	-1.13	0.68	0.86
SUNRAYSIA	-4.08	-3.68	0.43	0.52

TABLE 12: SALT INTERCEPTION SCHEMES - COMPARISON OF PV ESTIMATERS USING ZERO, 50% AND 100% OF CAPITAL COST AS SALVAGE VALUES AT END OF 30 YEAR PROJECT LIFE

SCHEME	PV OF NET BENEFITS			PVB/PVC		
	0%	50%	100%	0%	50%	100%
MILDURA/MERBEIN/ BURONGA	5.92	5.94	5.97	12.23	12.29	12.34
CHOWILLA	6.26	6.70	7.14	2.23	2.32	2.41
MALLEE CLIFFS	3.90	4.23	4.56	1.89	1.96	2.04
WOOLPUNDA	7.39	8.73	10.08	1.31	1.37	1.43
WAIKERIE	0.78	1.66	2.54	1.06	1.13	1.21
LINDSAY RIVER	-1.13	-0.24	0.64	0.86	0.97	1.08
SUNRAYSIA	-3.68	-3.01	-2.35	0.52	0.61	0.70

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TABLE 13: SALT INTERCEPTION SCHEMES - COMPARISON OF PV ESTIMATES USING UNIT EC VALUES OF $50,000, $80,000 and $110,000; $million

SCHEME	UNIT EC VALUE					
	$50,000		$80,000*		$110,000	
	NPV	PVB/PVC	NPV	PVB/PVC	NPV	PVB/PVC
MILDURA/MERBEIN/ BURONGA	3.5	7.6	5.9	12.2	8.3	16.7
CHOWILLA	2.0	1.4	6.3	2.2	10.5	3.1
MALLEE CLIFFS	0.8	1.2	3.9	1.9	7.0	2.6
WOOLPUNDA	-4.2	0.8	7.4	1.3	19.0	1.8
WAIKERIE	-4.2	0.7	0.8	1.1	5.7	1.5
LINDSAY RIVER	-3.8	0.5	-1.1	0.9	1.5	1.2
SUNRAYSIA	-5.2	0.3	-3.7	0.5	-2.2	0.7

* Estimates taken from Table 4.

TABLE 14: LAND PROTECTION MEASURES - COMPARISON OF PV ESTIMATES USING LOWER (0.625) AND UPPER (1.375) BOUNDS FOR ESTIMATES OF BENEFITS

LAND PROTECTION ZONE	LOWER BOUND		"BEST BET"*		UPPER BOUND	
	NPV	PVB/PVC	NPV	PVB/PVC	NPV	PVB/PVC
WAKOOL	-21.5	0.7	6.1	1.1	33.7	1.5
BERRIQUIN A	12.3	1.2	54.2	1.9	96.2	2.7
SHEPPARTON	22.8	1.3	78.0	2.1	133.2	2.9
CAMPASPE	2.1	1.8	4.9	2.9	7.8	4.0
BARR CREEK	2.0	1.1	20.5	1.7	38.9	2.4
RIVERLAND	32.8	1.4	100.9	2.3	168.9	3.1
SUNRAYSIA - NSW	-15.6	0.4	-7.8	0.7	-3.3	0.9
SUNRAYSIA - VIC	-43.1	0.6	-8.6	0.9	25.9	1.3

* Estimates taken from Table 5

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