Little River Catchment Best Management Options: Cost Benefit Analysis

Prepared for

Little River Landcare Group

Prepared by

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P R O J E C T R E P O R T

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GLOSSARY & ABBREVIATIONS

BMO	Best Management Option.
DSE	Dry Sheep Equivalents.
ha	Hectare.
LMU	Land Management Unit.
LR	Little River.
LRLG	Little River Landcare Group.
GIS	Geographic Information System.
Gross Margin	Gross income from an enterprise less the variable costs incurred in achieving this income. Variable costs are directly attributable to an enterprise and vary with the size of the enterprise. Gross margins are normally quoted per hectare.
ML	Megalitre.
NCB	Non-Calcic Brown Land Management Unit.
NPV	Net Present Value.
PV	Present Value.
SS	Siliceous Sands Land Management Unit.
RBE	Red Brown Earth Land Management Unit.
RP	Red Podzolics Land Management Unit.
WTP	Willingness to Pay. A majority of environmental goods are not bought and sold in a market so there is no price derived for these 'goods'. Price is an indicator of value. Values can be ascertained by estimating an individual's willingness to pay for an environmental good. There are a number of techniques that try to put a monetary measure on environmental benefits.

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EXECUTIVE SUMMARY

This report is provided to assist the Little River Landcare Group make decisions regarding management options to address and avoid degradation in the Little River catchment. The report considers the economic costs and benefits of actions or Best Management Options identified by the Community and the Committee in Stage Two of the Little River Catchment Planning process.

Purpose of the Cost Benefit Analysis

It is hoped that this report will assist in three ways:

- Give an understanding of the magnitude of costs associated with various Best Management Options;
- Provide a first estimate of the impact at a farm level of options so that the required level of incentives to adopt BMO's can be estimated; and
- Assist in addressing the priorities of the Plan given funding, local capacity and social constraints.

The Analysis

A multi-criteria analysis was used to identify issues in Stage Two of the Catchment Plan. Using this framework, local knowledge and technical expertise, a number of priority Land Management Units (based on soil type) were identified. On each of these, the actions or Best Management Options (BMO's) are recommended.

The Committee asked that the analysis be conducted on the key or priority BMO's on priority Land Management Units (LMU's). As such the Cost Benefit Analysis is not carried out on the whole range of actions detailed in the Plan.

The purpose of a Cost Benefit Analysis is to provide a framework to take into account the financial and wider costs and returns of an action or the Plan as a whole. The approach allows estimates of future expenditure and returns to be made. This can be a reality check of a list of actions that need to be prioritised when faced with a limited budget. Where possible a Cost Benefit Analysis will also indicate where the best opportunity for effective expenditure occurs.

Decisions should not be based on the benefit costs analysis alone. This is especially true with catchment planning as many of the actions have uncertain outcomes at a farm or paddock scale, let alone on a catchment scale.

The Treatment of Benefits in the Analysis

Inclusion of non-financial benefits flowing from many of the BMO's identified in the Plan is not carried out in this analysis. To estimate the value of these benefits (in most cases losses avoided) requires a detailed knowledge of the impacts of the BMO's on regional recharge, salinity, erosion and bio-diversity. The fact that these benefits are not detailed in dollar terms does not mean they do not exist. Where direct agricultural benefits can be estimated at a large enough scale these estimates are included. Where benefits are uncertain it is important for local and/or technical expertise to estimate whether the benefits derived are likely to outweigh the costs involved with an action. It may be that no action will have a positive economic return. If this is the case then the decisions become ones of cost effectiveness between options.

Impacts of the Plan and Recommendations

The costs of full implementation of the Plan are large. The up front and opportunity costs of various actions and the targets specified will impact on the short-term returns from farms. Opportunity costs are defined as foregone potential returns from activities adopted under the Plan to protect the long-term environment and productivity of the catchment.

The three largest BMO's in terms of up front costs are:

- Matching Landuse to Land Capability;
- Strategic Tree Planting and Forestry; and
- Soil Ameliorants.

To fully implement these three BMO's would cost approximately $87 million over the 10 years of the Plan. Approximately $10 million of this cost is income lost as a result of the land use change targeted for areas that are currently used for cropping. It can be argued that change is necessary for long run productivity but this does not mean that this income is not lost in the shorter term.

The benefits from these actions are in not always felt directly on-farm. Two options that will have direct productive benefits at a paddock scale in most cases are the use of soil ameliorants and the adoption of strategic grazing. The recharge benefits from these BMO's are difficult to quantify though it is generally accepted that they have positive effects by increasing water use. Given the possibility for private benefit these BMO's are likely to be adopted at a faster rate than others that result in benefits only at a catchment scale.

Given the nature of the Little River Catchment and the on-farm costs associated with implementation of the options, it is likely that the best combination of BMO's will involve:

- Improvement of grazing management;
- Increased levels of liming; and
- Targeting specific problems and opportunities in the riparian zone and for remnant vegetation conservation.

These options have direct positive benefits to the individuals asked to implement the actions, as well as having a wider potential to improve the environment in large areas of the catchment. Targeting specific problems can be approached with a combination of direct incentives and education, which relative to other options, will require less investment for more tangible and visible results.

1. INTRODUCTION

1.1 The Task

Hassall & Associates Pty Ltd have been asked by the Little River Landcare Group to provide a cost benefit analysis of selected Best Management Options (BMO's) described in the Catchment Management Plan developed for the area. Stage 1 of the plan have profiled the Little River Catchment and provided BMO's and specified an implementation Plan for the next ten years.

This report provides a description of Hassall & Associates' understanding of each BMO, an analysis of the direct costs and benefits to landholders of implementing the BMO, and an estimate of costs across the region associated with implementation of each BMO and the targets specified for the catchment in the Stage 2 report.

This report will assist decision making by the Little River Landcare Group as to where efforts should be concentrated into the future. The economic information is one element that should be incorporated into a strategy for funding and implementation. Other considerations include social constraints, likely adoption rates of actions, the economic situation of individuals in the catchment and their capacity to pay. These latter issues have been dealt with in part by Watson *et. al.* (2001) in "Sustainability Profile for the Little River Catchment" as part of the TARGET project.

1.2 Cost-Benefit Analysis (CBA)

CBA is a technique used to rank and assess investment projects. A CBA adds up all the benefits and costs over the chosen period. If the forecast benefits exceed the costs, the project is considered to be profitable. The major limitation of CBA is that only the benefits and costs that are financially measurable can be included in the analysis. However by conducting a CBA you can gain some indication of the value that needs to be generated from these non-financial benefits (such as environmental benefits) in order for the project to breakeven. It is then the decision of the landholder or community in general, to determine if the non-financial benefits compensate adequately for any financial loss incurred.

Opportunity costs are included in this CBA. Opportunity costs occur if any income is foregone as land is used for an alternative enterprise to its current use. A number of the actions identified in Stage 2 have the potential to incur opportunity costs. There are others that in the medium to long term may have a higher return than current landuse. This of course will vary with individual situations and across the diverse range of individual management skills. However, it is essential that opportunity costs (along with any direct costs) are considered for each BMO as they will impact on adoption rates.

Agricultural opportunity costs can be measured by:

- the present value of the potential future stream of net revenue associated with a BMO minus initial capital costs; or

All costs and benefits (where currently available as a financial estimate) are reported over the life of the implementation stage of the Plan (a period of 10 years). The figures are reported as Net Present Values (NPV) so that the timing of benefits and expenditure can be accounted for. A discount rate of 7% is used in the analysis[1]. More information on Cost Benefit Analysis is presented in Appendix One.

[1] In line with NSW Treasury guidelines.

1.3 Best Management Options (BMO)

The analysis has focused on the fourteen BMO's which are highlighted in Table 1. The Little River Landcare Group selected these BMO for analysis from the 20 detailed in Stage 2.

Table 1 List of Best Management Options

Best Management Options Analysed			
1	Matching land use to land capability	**11**	Vegetation conservation
2	Reduce fallow length	**12**	Ameliorants
3	Crop-pasture rotations	**13**	Earthworks*
4	Conservation farming	**14**	Engineering for Salinity*
5	Strategic grazing	**15**	Salt land agronomy*
6	Perennial mixed pastures	**16**	Cooperative pest control*
7	Native pastures	**17**	Buffer strips
8	Diversity	**18**	Water extraction*
9	Forestry	**19**	In-stream management
10	Strategic tree planting	**20**	Urban pollution*

* Not included in this analysis

The majority of the Best Management Options are implemented on farm. This emphasises the need to examine the on-farm consequences of each action and the need to have strategies that will bring about adoption of the options by landholders.

2. FARMING SYSTEMS IN THE LITTLE RIVER

A number of sources including local agency staff, benchmarking studies and budget information from NSW Agriculture have been used to describe farming systems across the Little River Catchment. Four typical farm situations have been developed based on geographic and enterprise distinctions.

2.1 Catchment level information

From benchmarking data:

- the average farm size is approximately 900 ha;
- the majority of farms are mixed farms with cropping and grazing enterprises;
- approximately 25% of farm area is cropped in any one year;
- wheat, canola and oats are the dominant crop enterprises; and
- merino sheep production is the dominant stock enterprise in terms of frequency as an enterprise and number of head.

From conversations with Hassall & Associates[1] and DLWC staff, the split between farm types has been estimated in Table 2. These are considered 'typical'. Profiling work conducted by Watson et al (2001) indicate a high degree of variability in farm size within the Little River Catchment. It was reported that approximately 35% of properties were below 500 ha in size.

Table 2 Breakup of farming systems in the Little River catchment

Farming System Description	Percentage of Farms in the LR Catchment	Typical Size of a Farm (ha) and range
Cropping & Stock (Sheep)	50%	800 (500-1,600)
Cropping & Stock (Sheep & Cattle)	20%	800 (500-1,600)
Sheep Only (+10% fodder crop)	20%	1,500 (1,000-3,000)
Cattle Only (+10% fodder crop)	10%	1,500 (1,000-3,000)

[1] Personal Communication, March 2002. Glenn Shepherd, Agronomist - Hassall & Associates, Dubbo.

Across the catchment we see that cropping is more prevalent in the east of the Little River catchment. Table 3 shows that Yeoval, Suntop and Cumnock areas have 35 – 42% of farmers under cropping enterprises, whereas the area used for cropping in the Baldry area is approximately 8%.

Table 3 Landuse statistics – 1988 (ha)

Landuse	Baldry	Yeoval	Cumnock	Suntop/ Arthurville	Total
Cropping	8,647	15,200	14,348	24,549	**62,743**
Mining	19	8	17	8	**52**
Pasture	68,843	20,965	28,288	36,838	**154,935**
Timber	33,625	47	1,335	5537	**40,544**
Urban etc		45	2	0	**47**
TOTAL	111,134	36,266	43,989	66,933	**258,322**

Source: Donaldson (2000).

More recent comprehensive landuse statistics are not available however, Watson *et*. *al*. (2001) reported that on average 70% of total property area was devoted to pasture. It is likely that there has been a move towards more cropping but the figures in Table 3 do indicate the relative differences in landuse between the sub-catchments within the Little River catchment.

2.2 Typical farms in each sub-catchment

Currently there is no information available that provides a concrete estimate of the number of farms within the Little River Catchment. An estimate of 350 farms has been provided in the Stage 2 report. The following section attempts to classify a typical farm enterprise mix, rotation and size for each of the sub-catchments in the Little River catchment.

2.2.1 Suntop-Arthurville

Suntop is characterised as a mixed cropping and grazing area. The typical farm size ranges from 500-1,000 ha.

	Notes		Details
Number of Farms	Estimated by percentage of area of total catchment by farm numbers weighted for farm size		130
Farm Type	Mixed Cropping and Grazing		
Farm Size	Typical		800 ha
Enterprise Mix	30% cropping		
Typical LMU's	Red Brown Earths, Euchrozems		
Cropping Options	Wheat, Barley, Oats, Canola		
Rotations & Gross Margin	Pasture Phase 3-4 years, cropping 2-4 years PPPPWCWC PPPP		 $220/ha $55/ha
Stocking Rate	Varies with farmers risk attitude		8 DSE/ha
Typical Price & Yield			
Wheat	Varies with stage in rotation	$160/t	3.5 t/ha
Canola		$270/t	3.0 t/ha

Pastures are both improved and native. The percentage of improved pastures on properties in the Central West is reported to range from 28 to 68% (Patton & Mullen 2001). The TARGET project reported that on average 70% of the total property area was devoted to pasture (Watson *et al* 2001) with perennial pasture making up half of the total pasture area.

2.2.2 Yeoval

Yeoval has the highest proportion of cropping in the 1988 land use mapping. Approximately 42% of the area was used for cropping.

	Notes		Details
Number of Farms	Estimated by percentage of area of total catchment by farm numbers weighted for farm size		55
Farm Type	Mixed Cropping and Grazing		
Farm Size	Typical		1,000 ha
Enterprise Mix	40% cropping		
Typical LMU's	Red Brown Earths, Non-Calcic Browns		
Cropping Options	Wheat, Barley, Oats, Canola		
Rotations & Gross Margin	Pasture Phase 3-4 years, cropping 2-4 years PPPPWCWC PPPP		 $175/ha $55/ha
Stocking Rate	Varies with farmers risk attitude		8 DSE/ha
Typical Price & Yield			
Wheat	Varies with stage in rotation	$160/t	3.0 t/ha
Canola		$270/t	2.5 t/ha

2.2.3 Cumnock

The Cumnock area has a higher percentage of mixed cropping farms in the northern area of the sub-catchment. In the higher areas to the south there is a shift toward cattle grazing. These cattle only properties have been estimated to comprise approximately 20% of the farms in the sub-catchment.

	Notes		Details
Number of Farms	Estimated by percentage of area of total catchment by farm numbers weighted for farm size		70
Farm Type	Mixed Cropping in North and cattle grazing		
Farm Size	Typical		1,000 ha
Enterprise Mix	30% cropping		
Typical LMU's	Non-Calcic Browns, Red Podzolics		
Cropping Options	Wheat, Barley, Oats, Canola		
Rotations & Gross Margin	Pasture Phase 3-4 years, cropping 2-4 years PPPPWCWC PPPP		 $145/ha $90/ha
Stocking Rate	Varies with farmers risk attitude		7.5 DSE/ha
Typical Price & Yield			
Wheat	Varies with stage in rotation	$160/t	2.5 t/ha
Canola		$270/t	2.0 t/ha

2.2.4 Baldry

The Baldry sub-catchment can be characterised as a grazing area. The typical farm size is larger than the rest of the Little River catchment. In the sub-catchment 62% of the area is under pasture, 30% is under timber with only 8% cropping.

	Notes		Details
Number of Farms	Estimated by percentage of area of total catchment by farm numbers weighted for farm size.		95
Farm Type	Mainly grazing for sheep and some cattle with small areas of cropping		
Farm Size	Typical		1,500 ha
Enterprise Mix	Stock (mainly sheep)		
Typical LMU's	Siliceous Sands, Red Podzolics, Red Solodics		
Cropping Options	Wheat, Barley, Oats, Canola		
Rotations & Gross Margin	PPPP A small amount of cropping for fodder		$35/ha
Stocking Rate	Varies with farmers risk attitude		5 DSE/ha
Typical Price & Yield			
Wheat	Varies with stage in rotation	$160/t	2.5 t/ha
Barley	Fodder		

Table 4 Assumed gross margins for typical rotations

Area	Rotation	Annual Gross Margin ($/ha)
Mixed Cropping - East	PPPWCWC	220
Pasture - East	PPPP	55
Pasture Cumnock - Cattle	PPPP	90
Pasture Baldry - Sheep	PPPP	35

3. COSTS OF THE PLAN AND OVERHEADS

There are a number of activities detailed in the Catchment Plan that are general in nature and cannot be assigned to a BMO. Amongst the costs are:

- Little River Landcare Group Officer expenses;
- annual Committee costs;
- preparation of farm management plans;
- establishment and monitoring of a groundwater monitoring network; and
- remote sensing and analysis.

These general Plan costs will be borne by both landholders (e.g. preparation of Farm Management Plans) and by public resources. The costs of agency staff identified in specific tasks for each BMO has not been included in these Plan costings.

The Net Present Value (NPV) is reported over a period of 10 years and at a 7% discount rate. The NPV will ultimately represent the sum of total costs less the value of benefits over the life of the plan and uses discounting to account for the timing of any expenditure and benefits. **The NPV reported here does not include non-financial, environmental benefits derived from the Plan.**

Net Present Value of Plan Overheads (10 years)	**-$1,700,000**

Individual Components	$
LR Landcare Officer	$632,000
Committee Costs	$56,000
Groundwater Network Costs	$115,000
Remote Sensing Costs	$9,800
Development of Farm Management Plans	$861,000

4. ECONOMICS OF REDUCED FALLOW LENGTH

4.1 Understanding of the BMO

Current cropping practices in the catchment are based on 2 to 4 year cropping phases, often involving long fallowing. The Stage 2 Plan proposes the following systems, in order to address salinity, by making use of all the available rainfall, in all but the wettest years.

a) Intercropping / companion farming (crops sown into existing lucerne or other perennial pastures), which means that plants are growing and using moisture throughout the year.
b) Delaying the removal of pasture prior to return to the crop phase until summer, to avoid deep drainage during bare fallow.

The high priority LMU's for Reduced Fallow length are:

- Red Brown Earth; and
- Non-Calcic Brown.

4.2 Costs and benefits

The cropping area in the two priority LMU's has been estimated at approximately 40,000 ha (35% of the two LMU's). The impacts of various rotations are difficult to estimate given the interactions between the pasture phase and subsequent yields of the cropping phase. It is likely that intercropping and delaying the removal of pasture in fallows will decrease the returns of subsequent cropping phases. The two variables that will affect the magnitude of the loss are the yield impacts and the relative crop and pasture gross margins.

An additional pasture phase may result in a reduced gross margin over the period of the rotation. This result is dependent on commodity prices. At this coarse level of analysis there is some slight loss though this may be offset by increased yields in the medium to long term.

On-farm benefits	On-farm costs
A reduction in recharge. Extra livestock carrying capacity.	Lost income. Additional chemical costs.
Off-farm benefits	**Off-farm costs**
Improved water quality for downstream through decreased discharge. Reduced area of salinised land on neighbouring farms.	

4.3 Barriers to adoption

The reduction in fallow length is likely to have a direct effect on subsequent crop yield. The full benefits of this practice have to be taken into account with a more detailed analysis of the impact of the pasture phase on subsequent crop yield.

4.4 Net Present Value

If we assume an adoption rate or target rate of 50% of the total cropped area with reduced fallow length, the direct costs to farms over 10 years are in the order of 1.4 million dollars through opportunity cost of lost income. As mentioned this needs to be tempered by any offset in yield over time.

BMO Net Present Value (10 years)*(Note: no valuation of non-financial benefits included)*	**-$1,400,000**

5. ECONOMICS OF CROP/PASTURE ROTATIONS

5.1 Understanding of the BMO

Part of recommended crop management practice in the plan is the increased use of crop-pasture rotations, which offer many advantages for increased water use and nutrient cycling, and improving soil health. It is important to manage the pasture phase to produce high growth rates, high water use, and improved financial returns.

Further benefits of improved crop agronomy – including crop rotations – are improved plant growth and hence water use, water use efficiency, and profits.

The priority LMU's for Crop/Pasture Rotations are:

- Red Brown Earth;
- Non-Calcic Brown; and
- Red Podzolics.

The recommended length of the crop and pasture phases that should minimise deep drainage for the LMU's examined are:

LMU	Suggested Rotation
Red Brown Earth	Equal length crop and pasture phases acceptable and profitable if cereals rotated with canola, and associated with strategically planted trees.
Non-Calcic Brown	3 yrs crop / 5-8 years pasture if conventional farming systems used.
Red Podzolics	Maximum 2 yrs crop / 8-10 yrs pasture.

These rotations are suggested only. It is realised that seasonal factors, farming techniques and management skills will mean that these vary across the catchment and across time.

5.2 Costs and benefits

The rotations above are major changes from the common rotations used in the Little River Catchment. For this analysis it is assumed that a 4-year cropping, 4-year pasture rotation is used.

LMU	Assumed changes required to rotation	Opportunity Cost/ha
Red Brown Earth	One extra year of pasture	$13
Non-Calcic Brown	Two extra years of pasture	$22
Red Podzolics	Currently used little for cropping so assume no change (Stage 2 Report).	$0

There are potentially large costs associated with increasing the pasture phase in rotations. Work conducted by NSW Agriculture (Patton & Mullen 2001) showed for the Central West that a rotation with a pasture phase of five years provided maximum returns. This result is dependent on the range of commodity prices examined, though it was found to be robust to these changes. Further work in this area is currently underway in an area more specific to the Little River.

On-farm benefits	On-farm costs
Increased livestock carrying capacity Improved soils Reduce salinisation potential	Foregone crop income Labour costs of landholder

Off-farm benefits	Off-farm costs
Improved water quality downstream through reduced recharge Reduced area of salinised land on neighbouring farms	

5.3 Barriers to adoption

The barriers to adoption are mainly economic. Changing prices and therefore return from cropping enterprises will have an overriding impact on rotations. It is likely that smaller farm sizes will also mean that rotations are adopted that are not optimal in terms of water use as the pressure to remain viable will mean a higher proportion of the land will be devoted to cropping.

5.4 Net Present Value

If we assume an adoption rate or target rate of 50% of landholders adopting recommended rotations, the direct costs to farms over 10 years are in the order of $1,300,000 through lost income. It must be remembered that these figures are based on a partial analysis from the current situation and do not take into account yield benefits that may be derived in the medium term from the longer pasture phase. These results are also sensitive to commodity prices. If relative prices for livestock enterprises increase the opportunity costs may be little or zero.

Preliminary BMO Net Present Value (10 years)	**-$1,300,000** ***(Note: no valuation of non-financial benefits included)***

6. ECONOMICS OF CONSERVATION FARMING

6.1 Understanding of the BMO

Conservation farming includes a range of farming practices that aim to improve infiltration, reduce erosion hazard and improve soil structure and biology. These include:

- reduced or zero tillage;
- direct drill;
- controlled traffic;
- contour farming; and
- stubble retention.

Adoption is restricted by the need to modify machinery in most cases. Retaining stubble though, increases need for applied nitrogen and attention needs to be given to the trade-off with chemical usage and the effects on water quality and/or soil health.

The priority LMU's for Conservation Farming are:

- Red Brown Earth; and
- Non-Calcic Brown.

6.2 Costs and benefits

The adoption of conservation farming requires machinery conversions or purchase. The Plan calls for funds for purchase/conversion to minimum tillage machinery and the promotion of conservation farming including the formation of a conservation farming group.

The costs of converting conventional machines ranges from $5,000 - $15,000. A self-made conversion kit is the cheapest option for around $5,000. This cost is used to estimate the costs for the farmers in the Little River catchment.

The number of landholders that do not practice reduced tillage and use chemicals is close to zero. Watson *et al* (2001) report that 22% of respondents use conventional tillage practices.

It is estimated that approximately 10% of croppers are involved in zero till/direct drilling (another 20% would have made some sort of adaptations to their machinery) [1]. It is assumed that 60%of mixed farms would need to upgrade machinery over the next five years to fully adopt conservation farming practices.

[1] Personal Communication, March 2002. Glenn Shepherd, Agronomist, Hassall and Associates, Dubbo.

On-farm benefits	On-farm costs
Improved soils	Capital costs
Improved farm biodiversity	Increased chemical use
Decreased labour requirements	Maintenance costs
	Increased management skills

Off-farm benefits	Off-farm costs
Improved water quality for downstream	
Reduced area of salinised land in neighbouring farms	

6.3 Barriers to adoption

The main barriers to adoption of conservation farming are the cost of machinery conversion and more importantly the required change in management skills.

6.4 Net Present Value

The cost of machinery conversion for conservation farming is approximately $500,000 across the catchment. This is based on this adoption being taken up over the first five years of the Plan.

Preliminary BMO Net Present Value (10 years)	**-$490,000** ***(Note: no valuation of non-financial benefits included)***

7. ECONOMICS OF STRATEGIC GRAZING

7.1 Understanding of the BMO

Strategic grazing can be used to describe different grazing strategies. These are high density stocking under rapid rotation, short duration grazing and rotational grazing.

The Plan recommends a grazing strategy of one third eaten, one third trampled (groundcover and litter) and one third left standing. This method is most effective when paddock sizes are small and herd/flock sizes are large, which may require additional fencing and watering points, and some adjustment to herd/flock management. The thrust of the BMO is to move away from set-stocking and continuous grazing.

Currently in the Little River catchment, there is an approximate break-up of different grazing systems as follows.

Table 5 Grazing systems in the Little River catchment[1]

System	Proportion of farms practising	Notes on fencing requirements	Paddock Rotation
Set Stocking Grazing	25%	No change to paddocks	NA
Limited Rotational Grazing	40%	Wheat/sheep rotations, perennials – lucerne.	3-4 month
Rotational Grazing	30%	No change	1-2 weeks
Intense Grazing Systems	5%	Involves higher levels of sub-divisions.	1-2 days

The priority LMU's for strategic grazing are:

- Siliceous sands; and
- Riparian grazing

7.2 Costs and benefits

The strategy to change the grazing management of farmers in the Little River Catchment involves Education programs and support for fencing, particularly in the riparian zone. It is also likely to be tied to efforts to increase the levels of treatment of acidity with the Little River catchment. The catchment Plan recommends that all LMU's should be fenced according to land capability and this will have a considerable bearing on the costs of fencing and water for the strategic grazing BMO. Costs of fencing for the Riparian Zone are reported here as an indication of costs of implementing the strategic grazing BMO. There is likely to be double counting for the Plan as a whole as these costs would also be reported in the Buffer Strips BMO.

It is assumed that only 25% of the riparian zone would be utilised for strategic grazing during the first 10 years of the Plan[2]. The costs associated with fencing the Riparian zone and provision of alternative watering points are estimated at $6,000/km. Implementation time is ten years.

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[1] Personal Communication, April 2002. Allan Nicholson (DLWC Wellington) and Ron Hacker (NSW Agriculture, Trangie).

[2] Based on a target landuse of 50% pasture in the Riparian Zone and adoption in 50% of the LMU area.

Assumptions are also made for moving towards strategic grazing in areas where Siliceous Sands are found. It is estimated that 60 farms are dominated by this LMU. A proportion (estimate 35%) of these would already practice some rotational grazing so up to 40 farms would require changes in terms of grazing management and fencing to allow more strategic, rotational grazing. Costs for a typical farm for reducing paddock size from an average 50 ha to 25 ha are estimated at $42,000 per farm for additional fencing and watering points.

Regional benefits from this BMO come mainly in the form of a reduction in salinised land in the area and reduced in-stream salinity. Hydrological work is required to estimate these benefits from a change in landuse across the catchment.

On-farm benefits	On-farm costs
Reduction in salinised land. Reduction in waterlogging. Reduction in erosion. Potential increased stocking rate. Potential improved farm capital value.	Fencing and stock water costs. Labour costs of landholder. Maintenance costs.
Off-farm benefits	**Off-farm costs**
Improved water quality for downstream. Reduced area of salinised land in neighbouring farms.	

7.3 Equity Considerations

The majority of Siliceous Sands are present in the west of the Little River catchment and any change in grazing management will be primarily targeted in this area.

7.4 Barriers to adoption

As with other strategies that involve changes in management, the barriers to adoption of strategic grazing are partly economic and partly social. Effective education and transfer of knowledge is essential. It may be argued that as strategic grazing practices are widespread in the region further actions other than education are warranted to bring about change.

7.5 Net Present Value

It is estimated that the fencing of the Riparian and Siliceous Sands LMU's will cost approximately $2.2M. It must be remembered that this is based on fencing only a small component of the total riparian zone. Land use targets for the Riparian LMU also mean there is a reduction in the overall area of grazing in the Riparian LMU.

Preliminary BMO Net Present Value (10 years)	**-$2,200,000** ***(Note: no valuation of non-financial benefits included)***

8. ECONOMICS OF PERENNIAL PASTURES

8.1 Understanding of the BMO

This BMO aims to increase the proportion of land under perennial pastures, substituting for annuals. Perennial mixed pastures, with their deep roots and continual growth pattern throughout the year, have a far greater capacity to use rainfall and prevent deep drainage. They also provide better ground cover, increased litter onto the ground and improved organic matter.

The major aim of the inclusion of perennial pastures into a farm's enterprise mix is to combat leakage and control the spread of dryland salinity. There are also benefits from a more stable year round feed supply for grazing animals.

The priority LMU's for perennial mixed pastures are:

- Red Brown Earth;
- Non-Calcic Brown;
- Siliceous Sands
- Riparian; and
- Red Podzolics.

All five LMU's analysed are affected by the strategy to increase the areas of perennial pastures. There are slight differences in the implementation of the BMO in each LMU. RBEs have lucerne recommended in the mix of perennials and require liming. SSs on the other hand are mainly natives and production levels are lower.

8.2 Costs and benefits

Establishment costs are estimated at $300/ha (Walpole & Lynch 2002).

The following summarises the costs and benefits associated with perennial pastures.

On-farm benefits	On-farm costs
Reduction in salinised land	Sowing costs
Reduction in waterlogging	Labour costs of landholder
Reduction in erosion	Maintenance costs
Potential increased stocking rate	
Potential improved farm capital value	
Off-farm benefits	**Off-farm costs**
Improved water quality downstream	
Reduced area of salinised land in neighbouring farms	

8.3 Barriers to adoption

The barriers to the introduction of deep-rooted perennials are likely to be economic. That is, their introduction will depend on their performance relative to current systems. Bathgate and Pannell (2002) examined the economics of perennials at a farm level for an area of Western Australia. The farm was analysed as final decisions regarding changes to practices will be made at this level. The decision is also not one of, are perennials profitable, but are they more profitable than current pastures?

The profitability of perennial systems will drive adoption of what is a major enterprise change. Further detailed work for the Central West is currently underway.

The adoption of perennials will also be constrained by factors such as soil type, constraints on machinery and labour, initial costs of establishment and risk preferences of farmers. Changes in grazing management, such as increased strategic grazing, may also be required to optimise the benefits of perennials and to avoid the costs of re-sowing perennial pastures.

8.4 Net Present Value

Currently perennial pastures comprise approximately 50% of pastures in the Little River catchment (Watson *et al* 2001). Incentives are suggested in Stage 2 to promote the establishment of perennial pastures however specific targets are not set regarding adoption of perennial pastures other than the generic targets for adoption of BMO's which may already be met if the estimates of pasture areas are correct.

Preliminary BMO Net Present Value (10 years)	**NA**

9. ECONOMICS OF NATIVE PASTURES

9.1 Understanding of the BMO

The physical characteristics of native pastures, particularly their ability to adapt to poor quality soils with nutrient "imbalances" and which receive marginal rainfall, illustrate the suitability of these species especially on to the Siliceous Sands LMU. The use of native pastures is also encouraged in the Riparian Zone and the Red Podzolics. This is due to the plants ability to perform where fertilizer application would be discouraged and also the minimal impact that native species litter has on the aquatic ecosystem as compared to non-native plant species.

The proportion of native plant species on Siliceous Sands LMU is assumed to increase through regeneration and changed grazing management and therefore should not incur any additional direct costs. The only cost that may be experienced is in the assessment of the land class area to confirm the non-feasibility of alternative enterprise options. The natural regeneration of native species of plants in the riparian zone will not result in any establishment direct costs, though grazing management may have to change to optimise native pasture regeneration.

The priority LMU's for native pastures are:

- Siliceous Sands;
- Riparian; and
- Red Podzolics.

9.2 Costs and benefits

The direct cost of native pasture regeneration is assumed to be zero in the Siliceous Sands and the Riparian Zones. NSW Agriculture gives a range of stocking rate estimates for native pasture of 1.5 to 3.0 DSE per ha, native pasture plus clover and superphosphate 3–12 DSE per ha, and sown perennial grass/legume pasture 6-14 DSE per ha.

On-farm benefits	On-farm costs
Stock grazing Opportunity for income diversification Improved farm biodiversity	Foregone grazing Maintenance costs
Off-farm benefits	**Off-farm costs**
Improved water quality for downstream Reduced area of salinised land in neighbouring farms	

The Catchment Plan does not specify any target adoption of native pastures. Therefore it is not possible to assess the costs associated with the BMO.

10. ECONOMICS OF DIVERSITY

Increased biodiversity in soils, flora and fauna enrich and improve ecosystem functioning, which helps maintain processes that provide for a healthy landscape. Increased bio-diversity improves habitat value and helps plant communities withstand climatic variability. Plant species diversity provides a wide range of rooting depths (better utilise soil moisture before it drains into water tables or ground water system) and in agricultural systems, provides greater integrated control of pests and diseases.

The priority LMU for diversity is:

- Riparian;

There is target of 25% of remaining native vegetation preserved for biodiversity. The key factor is the extent of native vegetation remaining in the Riparian Zone. If we assume approximately 50% (as typical in other catchments) then the area to be preserved is approximately 325 ha.

10.1 Benefits

Many of the public benefits of environmental 'goods' such as bio-diversity do not show up in markets and thus may be unpriced, though they are valued by people. Economists have developed the following specific economic valuation techniques to measure these community benefits. Various studies (see Gillespie Economics, 2000) have estimated that people are willing to pay:

- $1.69 per NSW household per percentage increase in population size of non-threatened species (i.e. $3.4 M per percentage increase in population size of non-threatened species)

- $11.39 per household per endangered species protected (i.e. $22.8 M per endangered species protected). It should be noted that the valuation per endangered species protected relates to fauna species moving from "endangered" to a less vulnerable status of "threatened".

The protection of species and native vegetation is important to society as a whole as indicated by various studies and arguably the pressure that is now applied through political forums to manage the environment.

On-farm benefits	On-farm costs
Possible reduced incidence of pests and diseases. Production benefits from wind protection. Fodder reserves.	Foregone grazing. Labour costs of landholder. Additional labour costs. Maintenance costs.

Off-farm benefits	Off-farm costs
Improved water quality for downstream. Reduced area of salinised land in neighbouring farms. Non-financial benefits to the community.	

10.2 Net Present Value

It is difficult to conduct a cost benefit analysis on this BMO. It is likely that the works required in the Riparian Zone to achieve improvement in terms of biodiversity will be conducted to achieve other goals (fencing, strategic grazing, buffer strips etc). As a stand alone action targeting 25% of the Riparian Zones for biodiversity has costs associated with foregone income. These are offset against the benefits that are estimated for the community.

BMO Net Present Value (10 years)	**$32,000**

11. ECONOMICS OF AGRO-FORESTRY AND STRATEGIC TREE PLANTING

11.1 Understanding of the BMO

Agro-forestry and plantation forestry have been identified as potential alternative enterprises which may also achieve some of the environmental goals of the Catchment Plan.

Agro-forestry: For agro-forestry exotic species have been recommended over native species for their hydrologic benefits over a shorter time span, positive economic benefits for the farms and the region and potential benefits through carbon and salinity credits. Species for agro-forestry will normally be faster growing.

Strategic Tree Planting: Refers to areas of forestry included the farm layout to achieve a number of natural resource management objectives. These include a decrease in recharge to the water table, provision of shelter, enhanced bio-diversity, restoration of riparian zones and provide some harvestable timber. Strategic tree plantings would use mainly native species.

11.2 Impact on each Land Management Unit

Every LMU has a target of an increased area of trees. For the five included in this analysis the percentage of increased area of trees is shown in Table 6.

Table 6 Land use change targets - trees

	LMU Area (% of LR)	LMU Area ha	Current Tree Cover %	Target Hectares (% change)
Red Brown Earth	23	59,400	Approx 1	5,350 (+10%)
Non-Calcic Brown	22	56,800	7	6,650 (+13%)
Siliceous Sands	17	43,900	8	9,880 (+25%)
Red Podzolic	9	23,250	4	5,230 (+25%)
Riparian	1	2,500	Approx 1	1,050 (+45%)
TOTAL				28,160

1 The target percentages are a change of the total area not an increase in the current percentage of tree cover. The figures are also adjusted for a 90% adoption rate assumed in Stage 2 of the Plan.

Strategic tree planting applies to the RBEs, NCBs, SSs, and Riparian LMU. Agro-forestry has been identified as a potential production enterprise for the Red Podzolic LMU. The focus of this activity would be in the areas that would see the replacement of the existing cropping and annual pastures with farm or agro-forestry.

11.3 Assumptions for Regional Costs and Benefits Investment

There are a number of actions identified at the Plan level to encourage forestry and strategic tree planting. Actions include:

- research;
- investigation of the economics of agro-forestry;
- investigation of the social implications of changing landuse from agriculture to timber; and

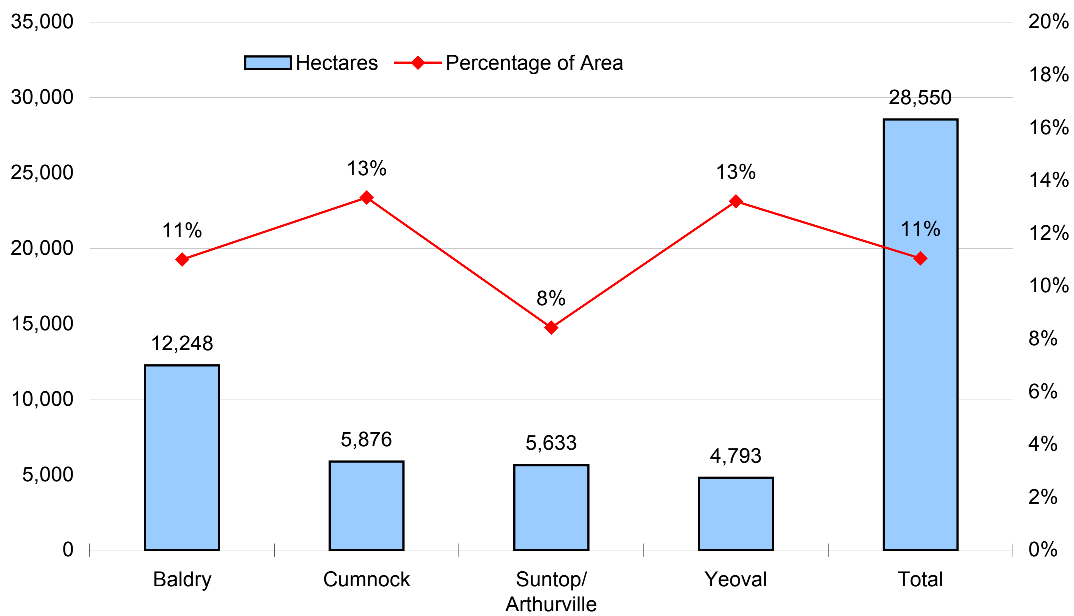
- investigate / develop trading in carbon and salinity credits.

11.4 Equity Considerations

An analysis of tree planting in relation to each sub-catchment reveals that there are differences in the proportion of each sub-catchment that will be targeted for change.

Figure 1 Proposed areas of tree planting in each Sub-catchment

ha **%**



From this initial analysis we see that 11% of the Little River area is targeted to be planted with trees, whether they be for agro-forestry or added to the landscape as belts or scattered woodland. The Cumnock and Yeoval sub-catchments have the largest targeted increases in tree plantings as a percentage of sub-catchment area. The Baldry sub-catchment has the highest in terms of hectares but is in the main establishment of scattered woodland on the SSs LMU.

It is likely that the establishment of agro-forestry will also not be equal across farms in the areas that have the Red Podzolic LMU. This relates to the average size of wood lots that would be profitable. It is assumed there are approximately 70 farms in the Cumnock sub-catchment. The target hectares of agro-forestry is 1,444 ha and on a proportional basis (on area of Red Podzolics) for the Cumnock sub-catchment this is 670 ha or an average of a 10 ha wood lot per farm. The minimum size for hardwood plantations with agreements with State Forests is 100 ha and for softwood 40 ha. To reach this minimum size, farmers would have to devote substantial proportions of total farm area to agro-forestry.

11.5 Costs and benefits

Cost estimates for establishing trees range from $400/ha (Walpole and Lynch 2002) to $1,350/ha[1]. For agro-forestry, establishment costs for a 20 ha planting have been estimated at $2,000/ha (Walpole & Lynch, 2002) with management costs of $600/ha over 5 years.

On-farm benefits	On-farm costs
Opportunity for income diversification	Foregone grazing
Income received for timber and thinnings	Capital costs
Fuel wood production	Labour costs of landholder
Carbon credits?	Additional labour costs
Dryland salinity mitigation	Maintenance costs
Ag productivity benefits on proximate land	
Biodiversity	
Off-farm benefits	**Off-farm costs**
Improved water quality for downstream	
Reduced area of salinised land in neighbouring farms	
Biodiversity	

Currently there is no dollar value determined for carbon credits.

Plantations can make effective windbreaks for surrounding paddocks. Studies showed that well-designed shelterbelts can increase yields by 20-30% over a distance of 10 to 12 times the height of the trees in the cropping and higher rainfall (over 600mm) areas of southern Australia. ('Getting Started in Farm Forestry: Plant Trees for Profit', p.17).

11.6 Barriers to Adoption

There are a number to barriers to achieving the target change in the area planted to trees within the catchment. These relate to opportunity costs, the very high costs of establishment and for agro-forestry the uncertainty of achieving economically viable returns in associated low to medium rainfall areas. This section will concentrate on these barriers within the Little River catchment.

11.6.1 Strategic Tree Planting

The barriers to tree planting are economic. That is there is a high cost associated with establishing trees and in most LMU's, a high opportunity cost.

[1] Personal Communication, May 2002. Allan Nicholson, DLWC Wellington.

11.6.2 Agro-forestry

State Forest preferences - Softwood

1. At least 40 hectares of plantable land;
2. Good local access;
3. Soils which are moderately fertile, well drained, and at least 50cm deep;
4. A long-term average annual rainfall greater than 700mm;
5. Less than 18 degrees slope;
6. Not on broken country; and
7. Less than 80-100 km from the main market for timber products, although this may vary with the value of the products, the size of the plantation and road quality.

State Forest preferences - Hardwood

1. A high quality site with rainfall over 1,000 mm/year;
2. A road haulage distance of no more than 80-100 kms to the main market;

Livestock must be fenced out of the plantation area until the young trees are established. When the trees are around two metres high, which may be as early as 3-4 years after planting, stock can graze in the area. Grazing is an important plantation management tool because it reduces fire risk.

What is needed for a forestry industry?

Trees are faster growing in areas with higher rainfall and are therefore more likely to be viable, based on a desirable Mean Annual Increment (MAI) of about 16 to 20m³. Based on rainfall within the Little River, growth rates would not be very high, with an MAI of around 8 to 12m³ over a life of about 35-40 years.

The rainfall in the Little River Catchment will be a limiting factor given the current requirements for State Forest involvement in private forestry.

Table 7 Average annual rainfall

Centre	Average Annual Rainfall (mm)	Source
Dubbo	588	Donaldson 2001, p.4.3
Wellington	614	op cit.
Obley	646	op cit.
Yeoval	583	op cit.
Cumnock	644	op cit.
Orange	1098	Bureau of Meteorology 2002

There is the need for a large resource base for a timber processing infrastructure to be viable. For example, in the Bombala district, 30,000ha is considered not really enough. Viability is also affected by the need to have a fairly even distribution in the age class of trees in order to ensure a reasonably continuous supply. In order to get an industry started the Little River and surrounds would require 50,000 to 60,000 ha of plantable land[1]. Current plantations exist near Oberon (80,000 ha State and around 20,000 ha in private hands) and Tumut (85,000 ha state and 25,000 ha private). The closest softwood plantations are located at Oberon, where there are also the required sawmill and processing operations (owned by CSR), approximately 185 km from the Little River. Currently the nearest mill for State Forests use is 250 kms away at Oberon,

[1] Personal Communication, April 2002. Hugh Dunchue, NSW State Forests.

which is a softwood mill. There is no commercial hardwood mill in the Orange area. In conversations with forestry staff ,Little River is seen as a high risk area.

11.7 Net Present Value

Given the above factors, the direct benefits from timber production are unlikely to be profitable for landholders. To be profitable for the individual, sources of income from carbon, salinity and bio-diversity credits are likely to be required.

At this stage only the establishment costs of strategic tree planting and for the target area of forests are reported. No opportunity costs are reported as it is examined in the matching land use to land capability section. The benefits from trees are not included at this stage as there is no market and the returns from agro-forestry are outside of the 10 year analysis period.

Agro-forestry BMO Net Present Value (10 years)	**-$7,500,000** ***(Note: no valuation of non-financial included)***
Strategic Tree Planting BMO Net Present Value (10 years)	**-$20,700,000**

12. ECONOMICS OF NATIVE VEGETATION CONSERVATION

Only a very small percentage of the catchment outside of Crown land remains under native vegetation and the majority of this is highly degraded.

Clearing of native vegetation is controlled by the Native Vegetation Conservation Act (1997). There are additional actions in the Catchment Plan which target select areas.

The priority LMU's for native vegetation conservation are:

- Siliceous Sands;
- Riparian.
- The steeper Red Podzolics.

12.1 Costs and benefits

Cost estimates for fencing and reduced grazing on a 20 ha remnant vegetation site are $500 per ha (Walpole & Lynch 2002).

Direct use values include shelter benefits for adjoining crops and pasture growth, shelter benefits for stock, increased farm productivity, timber for firewood, fencing and brushwood, honey and bees wax production, seed collection, aesthetic benefits, habitat for animals to help control pests, medicinal and perfume resources, improved riverine recreation experiences etc. Direct use values may accrue to the landholder and/or some members of the wider community. For instance, the salinity use values from revegetation may accrue to the landholder undertaking the plantings/management action as well as neighbouring or downstream landholders (BDA Group and Gillespie Economics 2001).

The benefit transfer technique is also sometimes used to value non-market community benefits of environmental services. The technique borrows values from other studies and applies these values to the study site in question.

A study by Lockwood and Carberry (1998) found a willingness to pay of $3.80 per household for every 10,000 ha of native vegetation conserved with an extra willingness to pay of $1.69 per household for every extra native plant and animal species conserved (this value is conditional on the success of an action. If the conservation actions do not add to the number of species conserved in the region then only part of this value can be attributed to the action).

There has been some work carried out on the direct benefits of native vegetation when used as wind breaks (Reid & Thompson 1999). An economic analysis was conducted using experimental data as a basis for assumptions. The windbreaks used translated into a 12% higher stocking rate in the Armidale area. The report does not attempt to find whether the difference is through increased pasture production or the shelter of the animals. They found that investment in windbreaks costing less than $2,000/ha was justified economically when an increase in stocking rate of 10% results.

Further modeling work of a farm in the Gunnedah area (Walpole 1999) found that native vegetation would have a positive impact on pasture productivity. The optimum level for proportion of tree cover that produces maximum pasture output was estimated at 34%. There were large increases in the value of pasture as the proportion moved from 0-20%, a flattening of response between 20-30% before a decrease after 35% of the farm was covered by dry woodland area. It must be remembered these results only looked at the benefits to pasture productivity.

12.2 Net Present Value

The costs of conservation of remnant vegetation are slightly more than the benefit that has been placed on this conservation by the community. These results are dependent on the actions within the Plan successfully conserving native vegetation and reflect the value society places on native vegetation, not a direct financial return to a landholder.

Preliminary BMO Net Present Value (10 years)	**-$40,000**

It must be remembered that there may be issues with double counting of costs with other BMO's (particularly Diversity) when examining this action. This will depend on the overlap of targets for each.

13. Economics of Matching Land Use to Land Capability

13.1 BMO impacts

Matching land use to land capability is seen as a best management option and also an outcome of a number of other best management options that have been analysed previously in this report.

Table 8 Current land use and land use change targets (ha)

	Crop (ha)	Change (ha)	Pasture (ha)	Change (ha)	Trees (ha)	Change (ha)
Red Brown Earth	32,420	-5,347	26,230	-	500	5,347
Non-Calcic Brown	19,880	-5,115	32,944	-1,534	3,976	6,649
Siliceous Sands	1,756	0	38,632	-9,881	3,512	9,881
Red Podzolic	1,860	0	20,460	-5,231	930	5,231
Riparian	725	-697	1,775	-349	0	1,046
	56,891	**-11,159**	120,541	**-16,995**	8,418	**28,155**

For the 5 LMU's examined (which cover 72% of the Little River Catchment) the approximate targets are:

- 11,000 ha decrease in the area cropped;
- 17,000 ha decrease in the area currently under pastures; and
- 28,000 ha increase in the area of trees (open woodland, tree belts and/or agro-forestry).

The priority LMU's for matching landuse to land capability are:

- Red Brown Earth;
- Non-Calcic Brown;
- Siliceous Sands;
- Red Podzolics; and
- Riparian.

13.2 Costs and benefits

On-farm benefits	On-farm costs
Stock grazing	Foregone income
Opportunity for income diversification	Labour costs of landholder
Improved farm biodiversity	Additional labour costs
Potentially improved farm capital value	Maintenance costs
Off-farm benefits	**Off-farm costs**
Improved water quality for downstream	
Reduced area of salinised land in neighbouring farms	

13.3 Equity considerations

From the land capability map and conversations with agency staff there is a general change in the mix of enterprises as we move from east to west in the catchment. In the east cropping is more prevalent than in the west where grazing and timbered country are more dominant. These differences largely reflect differences in the proportion of soil types (LMU's) which make up each region.

This will mean that the impact of recommended changes in land use will vary across farms and sub-catchments. The graph below gives a breakup of each sub-catchment by the LMU's that are relevant to the study.

Figure 2 LMU Percentage in Sub-catchments of Little River

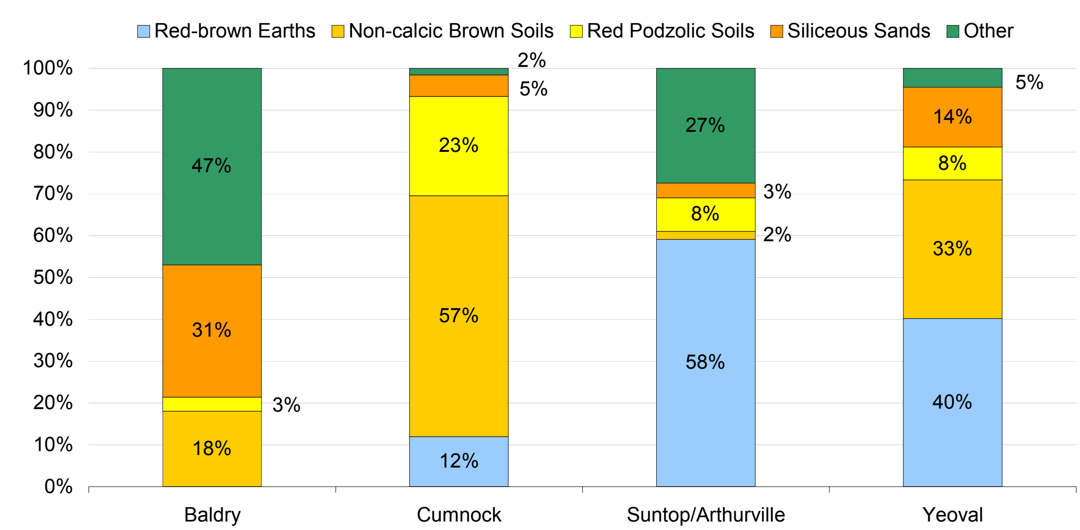


Figure 2 indicates where the impacts of targeted landuse change are likely to be felt. The Yeoval (73%), Cumnock (69%) and Suntop (60%) areas have the largest areas of RBEs and NCBs. Therefore these sub-catchments will feel most of the effects and costs of the recommended reduction in cropping areas. The two LMU's with large increases in the areas of trees are the Red Podzolics and Siliceous Sands. These in the main exist in the Baldry (34%) and Cumnock (28%) sub-catchments.

This means that we will see differences across the Little River catchment in terms of opportunity costs borne by farmers and also in terms of up-front investment costs for tree planting.

13.4 Barriers to adoption

There are a number of barriers to the adoption of widespread change in landuse.

There are considerable investment costs involved with changing landuse. These include the high costs of tree planting which is a major upfront investment. This level of investment will depend on the type of tree planting required. If the planting is also expected to yield benefits through agro-forestry operations, then a higher level of investment will be required. The change in landuse will require investment in acquiring skills and knowledge of agro-forestry operations.

The high level of investment is likely to be unappealing to those farmers who are in an older age bracket. Increased levels of debt and a return that is uncertain and delayed are major disincentives.

13.5 Net Present Value

The costs arising from widespread landuse change recommended in the Plan change are large. This NPV does not take into account loss of production if nothing is done. Benefits from reduced rates of salinisation, erosion and other production benefits and positive impacts on bio-diversity and other community benefits will offset the upfront and opportunity costs.

BMO Net Present Value (10 years)	**-$38,500,000** ***(Note: no valuation of non-financial benefits included)***

The cost averaged over the estimated 350 properties in the Little River sub-catchment is approximately $110,000 (a discounted figure over the next 10 years).

Another way of looking at this cost is that the production benefits of increased tree cover (tree belts, open woodland, agro-forestry) on land degradation and bio-diversity in the Little River has to match this figure to pay-off.

To achieve a positive 'return' the gross margin on each hectare needs to increase approximately $17 per year. This increase can be an increase over current production or future lost income from land degradation that is now avoided as a result of the landuse change. There are estimates of loss from future salinity. The key question is then what impact does the land use change have on the current and future levels of salinity.

Ivey ATP (2001) estimates the cost of salinity at $1.13/ha/year across the Macquarie-Bogan catchment. Income foregone on areas affected by salinity is in the order of $160/ha/year with a known area of salinity sites of 3,887 ha.

14. ECONOMICS OF AMELIORANTS

14.1 Understanding of the BMO

Acidification occurs due to the natural (geology based) acidification process and farming impacts. Liming has been recommended as a regular management practice before topsoil acidification becomes severe, or subsoil acidity develops. Other ameliorants include fertilisers and also gypsum to combat sodicity though these are not explicitly included in any plan targets.

The targets are:

- By 2004 – no further increase in area of land with topsoil pH < 4.5
- By 2007 – Less than 15% of the catchment with topsoil pH < 4.5
- By 2010 – Average pH > 5.0

The reporting process from different Landcare groups has meant that there is not a consistent range of pH categories used to classify soils across the Little River catchment. A number of the categories overlap as displayed in Table 10. The six categories have been grouped into three categories – very severe, severe and at risk.

Table 9 Categorisation of soil pH levels

pH Level	Category
<4.5	Very Severe
>4.25<5.0	Very Severe
>4.25<5.5	Very Severe
>4.5<5.5	Severe
>5.5	At Risk
>5.0<6.0	At Risk

To calculate areas we use the GIS calculations of hectares affected by acidity to find the proportion of each LMU affected and apply this proportion to the LMU total area adjusted for the inclusion of a Riparian Zone LMU.

Table 10 Approximate areas affected by acid soils in each priority LMU

Topsoil Acidity	Red Brown Earth	Non Calcic Brown	Siliceous Sand	Riparian	Red Podzolic
<4.5			18,711		
>4.25<5.0			2,381		9,611
>4.25<5.5	917				
>4.5<5.5	57,911	56,800	22,807		3,406
>5.5	573				
>5.0<6.0					10,233
TOTAL	59,400	56,800	43,900	0	23,250

Source: Little River Catchment GIS.

From Table 10 the following percentage of the priority LMU's area (72% of the LR catchment) can be classed as:

- 17 % is very severely affected by acidity (31,054 ha);
- 77 % is severely affected by acidity (142,202 ha); and
- the remainder of the catchment (6 %) is at risk.

To calculate the actions required to reach the targets established in the Stage 2 report, assumptions also have to be made regarding the rate of increase of acidity in the Little River Catchment if no additional liming and other works to combat acidity are undertaken.

14.2 Costs and benefits

The costs and benefits per ha to undertake liming activities to ameliorate acidity are summarised in Table 11.

Table 11 Liming assumptions

	Cost/tonne	Cartage & Spreading	Application Rate (t/ha)	Percentage GM Response[1]
Severe	$32	$21	2.5	Wheat +25% Canola +25% Pasture +25%
Very Severe	$32	$21	3.7	Wheat +50% Canola +50% Pasture +50%

[1] Hassall & Associates (1998).

The liming rates shown in the analysis are assumed to increase pH by 1 (severe) to 1.5 (very severe) pH units. The responses will depend on the initial pH of the area in question.

The following summarises the costs and benefits associated with liming.

On-farm benefits	On-farm costs
Reduction in acid affected land Potential increased stocking rate Increased crop yields Reduction in salinised land through reduced recharge Reduction in waterlogging Reduction in erosion	Costs of lime and application
Off-farm benefits	**Off-farm costs**
Improved water quality for downstream Reduced area of salinised land in neighbouring farms	

14.3 Equity Considerations

An analysis of where the major areas of acid soils are located is shown in Table 12.

Table 12 Little River areas affected by acid soils in each sub-catchment (ha)

Acidity of Topsoil	Baldry	Yeoval	Cumnock	Suntop/ Arthurville	Total
<4.5	29,615	1,805		967	32,388
>4.25<5.0	12,335	3,345	6,633	9,635	31,948
>4.25<5.5				907	907
>4.5<5.5	64,580	29,636	32,115	41,898	168,228
>4.6<6.0	258			1,922	2,180
>5.0	596	746	310	4,278	5,930
>5.5			359	6,039	6,398
>5.0<6.0	3,843	734	4,569	1,198	10,343
TOTAL	**111,227**	**36,266**	**43,986**	**66,844**	**258,322**

All areas have a high proportion of acid affected soils. Baldry has a higher percentage classed as very severe though this may be more an indication of the categories used than a real difference. That is, different pH ranges were used to define categories for reporting across the Little River catchment. Differences between farming systems may mean that the benefit from liming will differ through less of a return to pasture country due to lower gross margins and the lack of incorporation of line.

14.4 Barriers to adoption

The high initial cost of liming is a barrier to adoption of this practice. Farmers often purchase lime according to a budget constraint each year[1]. The costs of achieving the target rate of liming are in the order of $18,000,000. The benefits are large but are sensitive to the response rate assumed to the liming.

The adoption rates that are given as targets and are used in the analysis indicate an approximate annual budget of $5,000/farm in the Little River catchment (assuming 350 farms and an even distribution of acidity problems across the catchment).

14.5 Net Present Value

Net Present Value (10 years)	**$39,700,000** *(Note: no valuation of non-financial benefits included)*

[1] Personal Communication, April 2002. Richard Hazelton, Hazelton Ground Spread, Cumnock.

15. ECONOMICS OF RIPARIAN ZONE MANAGEMENT (BUFFER ZONES & IN-STREAM MANAGEMENT)

15.1 Understanding of the BMO

There are two BMO's that relate directly to the Riparian LMU. These are the establishment of Buffer Strips and In-stream Management.

The specific aim is to maintain buffer areas between human activity and water sources. These areas are vital in helping to maintain water quality, and should be managed separately from the surrounding landscape, in such a way as to enhance their role as a buffer zone, as well as a unique part of the landscape.

Actions required to manage the riparian zone include:

- fencing to ensure adequate control of grazing pressure;
- establishing alternative watering points;
- provision of shade away from streams;
- prevention of cropping in riparian zones and wetlands;
- preventing further clearing within the riparian zones;
- protecting actively eroding banks;

In-stream management of the river involves attention to:

- the extent and placement of large woody debris;
- stability of the stream bank (deep rooted species);
- extent of aquatic vegetation;
- presence of non-native fish.
- revegetation of banks and gullies;
- removal of invasive weeds and willows; and
- enhancing habitat for native fish particularly through woody debris and aquatic vegetation.

15.1.1 What is the Riparian Zone?

There are a number of definitions of the Riparian zone. It can be defined in landform, vegetative, legislative and functional terms. Several Australian States Acts refer to a set width (usually 20 – 40 m). A functional definition is "any land which adjoins, directly influences or is influenced by a body of water" (LWRRDC 1998). There is no one definition of the width of a buffer strip and it is likely to change between regions, stream type and from one end of a system to the other.

For the purposes of this economic analysis an estimation of average riparian zone width is made for use with the GIS. This is not a recommendation of the width of a buffer zone, as it will vary between each landscape and with different management objectives. The riparian zone in this case is defined as:

- *That land which is 40 metres either side of the middle of a stream or watercourse.*

The width of riparian land that needs special management will range from very narrow or non-existent, through to a wide, densely-vegetated corridor.

There are specific targets for management of the riparian zone within the Stage 2 report (Donaldson 2001).

Table 13 Riparian zone targets

2004	2007	2010
15% riparian land is managed separately from surrounding paddocks.	35% riparian land is managed separately from surrounding paddocks.	60% riparian land is managed separately from surrounding paddocks.

15.2 Impact on each Land Management Unit

The BMO only affects the Riparian LMU. This is not defined as a specific zone in the Little River GIS. The Riparian zone for the sake of the targets is defined as 3rd order streams or larger.

Table 14 Little River riparian zone statistics

	Length of river (km)	Buffer Zone (ha)[1]
Macquarie	29.7	120
Little	123.5	742
Other Creeks	431.5	3,670
Total	584.7	4,533

[1] Assumes a buffer zone of 40 m either side of the middle of the stream.

From Table 14 we see that there are approximately 585 km of streams in the Little River catchment.

Buffer zones of 40 m either side of the middle of the river have been specified in the GIS to calculate the area of land affected by the targets relating to managing the Riparian zone separately to surrounding paddocks. The figure of 40 m is a combination of information from a range of sources.

A buffer zone of 40 m means that approximately 4,500 ha have to be managed separately from surrounding land if there is 100% adoption of buffer zones.

Year	Target (%)	Stream Length (km)	Area of Buffer Zone (ha)
2004	15	88	680
2007	30	175	1,360
2010	60	350	2,720

15.3 Costs and benefits

A number of cost assumptions are made for a range of management activities in the Riparian zone. There are also associated opportunity costs.

Specific targets for the Riparian zone are:

- a 30% decrease in cropping (697 ha);
- a 15% decrease in pasture (349 ha); and
- a 45% increase in trees in the landscape (1,046 ha).

On-farm benefits	On-farm costs
Stock grazing e.g. controlled access or drought reserve Opportunity for income diversification e.g. farm forestry Reduced mustering time Improved watering points for stock Improved nutrient recycling on pasture Improved water quality for stock Minimise streambank erosion Aesthetics Improved farm biodiversity	Foregone grazing (possible loss of permanent access) Capital costs (fencing, alternative watering points) Labour costs of landholder Additional labour costs Maintenance costs
Off-farm benefits	**Off-farm costs**
Improved water quality for downstream landholders' stock Aesthetics Improved biodiversity Reduced sedimentation Improved river function	Catchment level incentive schemes for riparian fencing

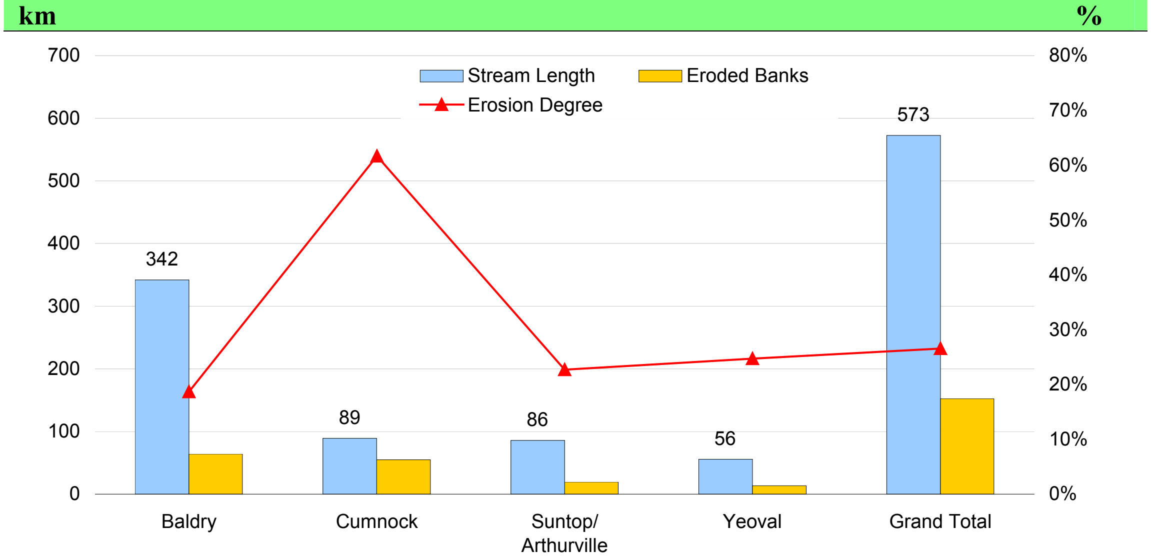
Two detailed economic analyses of case studies have been carried out. One was conducted in the Blackwood Catchment in Western Australia and another in the Bega Valley of the South Coast NSW.

The Blackwood catchment study (Blackwood Basin Group 2001) found that all but one of the riparian works carried out in their area were not financially viable. That is, no financial return was made on the investment over the analysis period.

15.4 Equity Considerations

If we assume that the actions will be targeted to areas that are most affected by streambank erosion the Cumnock area is likely to be targeted for action. Figure 3 shows that Baldry has the highest length of streams, however Cumnock has the highest degree of streambank erosion.

Figure 3 Stream length by Sub-catchment



15.5 Barriers to adoption

The main barrier to riparian works is the lack of economic benefits to the landholder.

15.6 Net Present Value

The costs of fencing the riparian zone are in the order of $2,700,000. The figure consists of opportunity costs associated with a decrease in the stocking rates in the riparian zone and costs associated with fencing and provision of watering points. There could be double counting with other BMO's.

BMO Net Present Value (10 years)	**-$2,700,000** *(Note: no valuation of non-financial benefits included)*

16. SUMMARY OF BEST MANAGEMENT OPTIONS COSTS

The following table summarises the cost estimates of the BMO's analysed.

Table 15 List of Best Management Options analysed

BMO No.	BMO	PV Costs	PV Benefits
1	Matching Land Use To Land Capability	-41,200,000	2,800,000
2	Reduce fallow length	-1,400,000	nf
3	Crop-pasture rotations	-1,300,000	nf
4	Conservation farming	-490,000	nf
5	Strategic grazing	-2,200,000	nf
6	Perennial mixed pastures	na	nf
7	Native pastures	na	nf
8	Diversity	-140,000	172,000
9	Forestry	-7,500,000	nf
10	Strategic tree planting	-20,700,000	nf
11	Vegetation conservation	-2,450,000	2,410,000
12	Ameliorants	-17,500,000	57,000,000
17	Buffer strips	-2,700,000	nf
18	In-stream management	-800,000	nf

nf: no financial benefit estimated.

The total costs of implementing the Plan are in the order of $100 million over ten years. This estimate assumes full adoption of the BMO at the target levels specified in the Plan. It also includes a number of actions and investments that are currently being undertaken by some landholders, for example conversion to conservation farming methods, liming and changing grazing management systems.

There are benefits that have been associated with BMO's. Only a small number of these have been included in the analysis due to uncertainty associated with assigning financial values to many of the benefits. The major benefit that can be quantified is the response to liming, as there are observable, on farm benefits associated with that activity. That other benefits are not included in the analysis does not mean that there are no benefits but the lack of data means that an estimate and financial valuation of benefit cannot be made. This is particularly so of matching land use to land capability as no returns from any agro-forestry are included at this stage due to uncertainty over markets and the fact that returns if they occur will fall outside the analysis period of 10 years.

16.1 Sensitivity Analysis

In a NPV framework the discount rate chosen has an influence on the total costs of the Plan. There are differences in the NPV estimates, however assumptions within the analysis will have a greater effect than the discount rate, particularly those associated with land use change and ameliorants.

Table 16 Sensitivity analysis of NPV results to discount rate

Discount Rate	NPV	NPV $ per ha
Base case (7%)	-37,400,000	-145
4%	-39,600,000	-153
10%	-35,400,000	-137

17. CONCLUSIONS

From a local point of view, the Little River Landcare Group faces the challenge of identifying which BMO's ought to be targeted as priorities for implementation of the Catchment Plan. A suggested initial framework for assessing the priorities for implementation could be based on the following criteria:

(a) is implementation of the BMO to the targeted level achievable, given the skills, attitudes, risks and level of advisory support available to landholders?

(b) is implementation of the BMO affordable through direct landholder investment and the capacity of the group to attract "outside", government funds on behalf of the whole community?; and

(c) implementation of which BMO's will have the most tangible, on-farm and off-farm benefits?

(d) Is this action consistent with the priorities of the Central West Catchment Blueprint?

An intuitive assessment of all priority BMO's against this framework is provided below.

Best Management Option	Achievable	Affordable	Tangible Benefits	Consistent with CMB properties
1. Match land use to land capability	✓	✓	✓	✓✓
2. Reduce fallow length	✓✓	✓✓	✓	✓
3. Crop-pasture rotations	✓	✓	✓	✓✓
4. Conservation farming	✓✓	✓✓	✓	✓✓✓
5. Strategic / rotational grazing	✓✓	✓✓	✓✓	✓✓
6. Perennial mixed pastures	✓	✓✓	✓✓	✓✓✓
7. Native pastures	✓	✓✓	✓	✓
8. Diversity – native conservation and habitat enhancement	✓	✓	✓	✓✓
9. Farm forestry / agroforestry	✓	✓	✓	✓
10. Strategic tree planting	✓✓	✓	✓✓	✓✓
11. Vegetation conservation	✓✓	✓✓	✓✓	✓✓
12. Ameliorants (eg: liming)	✓✓	✓	✓✓✓	✓✓
13. Buffer strips for riparian zones	✓✓	✓✓	✓	✓✓
14. In stream management	✓	✓	✓	✓✓

On the grounds of this analysis, the following BMO's appear to offer the best outcomes in terms of costs, benefits and achievability:

- Use of soil ameliorants;
- Strategic / rotational grazing;
- Native vegetation conservation;
- Conservation farming;
- Perennial mixed pastures;
- Strategic tree planting; and
- Buffer strips in Riparian zone.

These options have direct positive benefits to the individuals asked to implement the actions, as well as having a wider potential to improve the environment in large areas of the catchment. Targeting specific problems can be approached with a combination of direct incentives and education, which relative to other options, will require less investment for more tangible and visible results.

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APPENDIX ONE: LIST OF PEOPLE CONTACTED

Contact	Organisation	Location
Richard Hazelton	Hazelton's Ground Spread	Cumnock
Ron Hacker	NSW Agriculture	Trangie
Allan Nicholson	DLWC	Wellington
Col Mullen	NSW Agriculture	Dubbo
Glenn Shepherd	Hassall & Associates Pty Ltd	Dubbo
Philip Blowes	Farmer	Yeoval
Shaun Martin	RCS	
John Press	Regional Plantation Committee	Orange
Terry Ramien	Ramien's Timber Co.	Dubbo
Dhyan Blore	NSW Agriculture Trees on Farms Program Coordinator	Orange
Don Nicholson	State Forests	Dubbo
Hugh Dunchue	State Forests (Softwood) Investment Services	
Jonathan Clark	Office of Private Forestry	Sydney

APPENDIX TWO: DISCOUNTING AND NPV

The costs and benefits reported in this study are discounted over 30 years. A brief description of the rationale behind discounting and the calculation of a NPV is provided.

To recognise the time preference of money, future cash streams were discounted using a standard discount rate of 7%[1].

Discounting recognises that there is value in receiving an amount of money today, as opposed to receiving it in, say, 5 years. The discount rate also recognises the uncertainty of receiving an amount of money in 5 years – in the analysis of projects in a highly speculative environment, a higher discount rate may be used (although, the rate should always be consistent between projects being compared). The sum of the discounted costs and benefits in a cash stream is the Net Present Value (NPV) of the cash stream – that is, the net value of the cash stream over its life, in today's dollars.

Net Present Value can be expressed as:

$$NPV = \sum_{n=0}^{N} \frac{B_n - C_n}{(1+r)^n}$$

where B_n = benefits in year n expressed in constant dollars
C_n = costs in year n expressed in constant dollars
r = real discount rate
N = number of years that costs and/or benefits are produced

NPV of a plan provides an indication of the benefits accruing, regardless of the level of investment. As such the NPV provides an indication of the quantum of net benefits. Where analysis indicates a negative Net Present Value, threshold analysis can be employed to determine whether indirect[2] or unvalued benefits (such as environmental benefits for which there is no basis for valuation) are of the order of magnitude required for the investment to break even.

Distribution of Benefits

Cost Benefit Analysis does not explicitly identify the stakeholders to whom the costs or benefits of a Plan will accrue. In many cases the stakeholders to costs or benefit will be easily identifiable. This is particularly true where there are a small number of stakeholders.

[1] 7% is the standard central discount rate used by NSW Treasury. NSW Treasury recommend the use of sensitivities at 4% and 10% when using this rate.
[2] Indirect benefits can be identified for consideration in addition to the direct benefits modelled in cost benefit analysis, however should not be included in indicators which are determined. They are considered to be 'secondary' and are excluded on a consistent basis.

APPENDIX THREE: LIST OF ASSUMPTIONS FOR EACH BMO

Plan Overheads	
LR Landcare Group Officer	An annual wage of $45,000 is assumed with a multiplier of 2.0 for overheads and expenses.
Annual Committee Costs	Eight committee members meeting 6 times a year.
Farm Management Plans	250 farm plans to be completed over the first five years of the Catchment Management Plan.
Groundwater Network	$100,000 in establishment costs for a network and annual monitoring of 2 weeks per year.
Remote Sensing & Analysis	Conducted every third year with two weeks allowed for analysis.

Reduced Fallow Length	
Target LMUs	RBE, Non-Calcic Brown
Change required	20,442 ha
Income forgone b/w rotations	$13/ha/year

Crop/Pasture Rotations	
Current typical rotation	4-years Pasture, 4 years Cropping
Change required	RBE - One extra year of pasture NCB - Two extra years of pasture
Current typical Gross Margin	$175/ha
New typical Gross Margin	$162/ha $153/ha
Targets	25% of crop land. Current crop land approximated at 48,661 ha (i.e. 35% of area). Targets relating to RBE and NCB Land Management Units mean a target change of 10,221 ha.

Conservation Farming	
Costs of Machinery Change	$5,000 per farm
Farms Not Practising Conservation Farming	200 farms out of 350 in LR Catchment
Target	Over 5 years

Strategic Grazing	
Target LMU	Riparian and Siliceous Sands
Number of Farms – Riparian	175 with a target adoption rate of 25%
Length of Bank per Farm	1.46 km
Number of Farms – SS	39 with adoption rate of 85%
Additional costs per farm	$42,000 based on an additional 7km of fencing and watering provision of watering points
Cost / km for fencing & watering points (no contract labour)	$6,000

Diversity	
Target LMU	Riparian - 2,583 ha
Target	25% managed for diversity over 10 years
Fencing costs	$500/ha
Income foregone	$55/ha/year staged over 10 years
Willingness to pay	A once off $760/ha

Agro-forestry & Tree Planting		
Agro-forestry target LMU	5,550 ha in the Red Podzolics	
Costs of establishment	$2,000/ha	
Rate	Over 5 years	
Strategic Tree Planting LMUs	Red Brown Earths, Non-Calcic Brown, Siliceous Sands, Riparian	
Targets	Red Brown Earths	5,940 ha
	Non-Calcic Brown	7,550 ha
	Siliceous Sands	11,110 ha
	Riparian	1,100 ha
Costs of Tree Planting	Red Brown Earths	1,350
	Non-Calcic Brown	$1,350
	Siliceous Sands	$500
	Riparian	$1,350

Native Vegetation Conservation	
Land Management Units	Siliceous Sands, Riparian, Steeper Red Podzolics
Targets 5%	Siliceous Sands 2,196 ha Riparian 129 ha Steeper Red Podzolics 1,162 ha
Fencing Costs	$500/ha
Income foregone	$55/ha/year staged over 10 years
Willingness to Pay	A once off $760/ha

Land Capability & Land Use Matching	
Land use Change	As per table in main document
Opportunity Costs	Cropping - $172/ha Pasture - $56/ha ($28/ha on SS and RP Land Management Units)
Tree Planting Costs	Red Brown Earths - $1,350/ha Non-Calcic Brown - $1,350/ha Siliceous Sands - $500/ha (revegetation only) Red Podzolics – 2,000/ha (establishment for forestry) Riparian - $1,350/ha

Ameliorants	
Land Management Units	RBE, Non-Calcic Brown, Siliceous Sands, Red Podzolics
Liming Rates	3.7 t/ha for very severely affected areas 2.5 t/ha severely affected areas
Costs per ha	$196 /ha for very severely affected areas $133/ha for severely affected areas
Target	Area treated over 10 years
Average Benefit over 10 years	Severe - $28/ha/year Very severe - $51/ha/year

Riparian Zone Management	
Lengths of Creeks	Little River 123 km Macquarie River 30 km Creeks 432 km
Targets	2004 - 15% 2007 - 35% 2010 - 60%
Costs of Large Woody Debris	$2,000 km
Removal of willows	$1,000 km