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Setting targets for resource condition in Yilliminning catchment

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Acknowledgements

Andrew Huffer from Andrew Huffer and Associates facilitated and evaluated the workshops.

Natalie Lees, NRMO from Narrogin/Williams helped to organise the workshops.

The project is an initiative of the South West Catchments Council funded jointly by the Australian Government and the Government of Western Australia under the National Action Plan for Salinity and Water Quality.

Summary

The Department of Agriculture and Food (DAFWA) was commissioned by the South West Catchments Council (SWCC) to set resource condition targets for land salinity and native vegetation in the portion of the South West Natural Resource Management Region with less than 600 mm mean annual rainfall. In the South West we believe that **realistic** and **achievable** targets can only be set by involving the landholders who will need to make the changes on their land to cope with and manage salinity.

The Department of Agriculture and Food (Keipert *et al*. in prep.) developed a process involving two half-day workshops combining the latest scientific information and simple models with local knowledge of salinity and its management to set long term targets for salinity and native vegetation.

The title for the first Yilliminning catchment workshop was:

Linking science with local aspirations

At this workshop, a hydrologist from the Department provided the latest information on current and future groundwater and salinity levels as well as the likely impact of a range of recharge management scenarios. All available management options were discussed and the group nominated three management options for further modelling to be presented at the second workshop.

The title for the second Yilliminning catchment workshop was:

Setting targets for action

The results of the modelling were presented and the impacts of the different management options discussed. The group considered these options and then finalised the following resource condition targets for the Yilliminning catchment.

The landholders in Yilliminning agreed to the following resource condition targets:

~ No more than 10% of the Yilliminning catchment affected by salinity in 2028. (Landholders estimated that 8% of the catchment is currently affected by salinity and the full-risk by 2028 was estimated as 12-15% of the catchment.)

~ No further degradation or loss of natural assets by 2028.

Contents

1. Introduction

The South West Catchments Council (SWCC) commissioned the Department of Agriculture and Food to set land salinity and native vegetation resource condition targets in seven catchments in the portion of the South-west NRM region that has a mean annual rainfall of less than 600 mm. This followed the successful completion of a pilot project that involved five catchments in 2006. These targets were a requirement for investment under the regional natural resource management (NRM) strategy. The project is an initiative of the South West Catchments Council funded jointly by the Australian Government and the Government of Western Australia under the National Action Plan for Salinity and Water Quality.

The project's Community and Stakeholder Reference Group initially identified 31 catchments to test a process for linking science with local aspirations and knowledge in setting realistic resource condition targets. The list of 31 catchments was re-evaluated and seven catchments in the low and medium rainfall areas of the Blackwood and Murray River basins were invited to collaborate with the Department of Agriculture and Food in setting measurable targets for dryland salinity.

The Yilliminning catchment group was invited to take part in the target setting workshops because of the group's history of active involvement in Landcare. The process was assisted locally by Natalie Lees, Natural Resource Management Officer (NRMO) for the Shires of Narrogin and Williams.

1.1 Yilliminning catchment

The Yilliminning catchment is named after Yilliminning Rock and the surrounding nature reserve; it covers approximately 25,000 ha and falls within the Shire of Narrogin. It is located about 13 km east of the Narrogin townsite. The Yilliminning catchment falls within the Southern Zone of Rejuvenated Drainage. The upper catchment is characterised by irregularly undulating terrain with occasional areas of rock outcrop and gravelley ridges and crests. The valleys in the upper portion range from narrow and flat-floored valleys surrounded by short, steep slopes to v-shaped with well-incised natural drainage. The bottom of the catchment consists of broad valley flats and alluvial plains 1.5 to 4.5 km wide, with some small lakes and associated lunettes, dunes and swales. Basic descriptions of the soil-landscape units mapped in the Yilliminning catchment are presented in Appendix 4 and further information is presented in the Rapid Catchment Appraisal report for the area (South West NRM Region Appraisal Team 2005).

The long-term mean annual rainfall is 400 to 425 mm. An analysis of rainfall trends for the study area by Raper *et al*. (in prep.) showed that the mean annual rainfall since 1975 for Narrogin is not statistically different to the pre-1975 rainfall. This is in contrast to most centres in the study area where mean annual rainfall has decreased between 8 and 15% since 1975. Average May to October rainfall at Narrogin, however, has decreased from 401 to 353 mm since 1975, a fall of 12%.

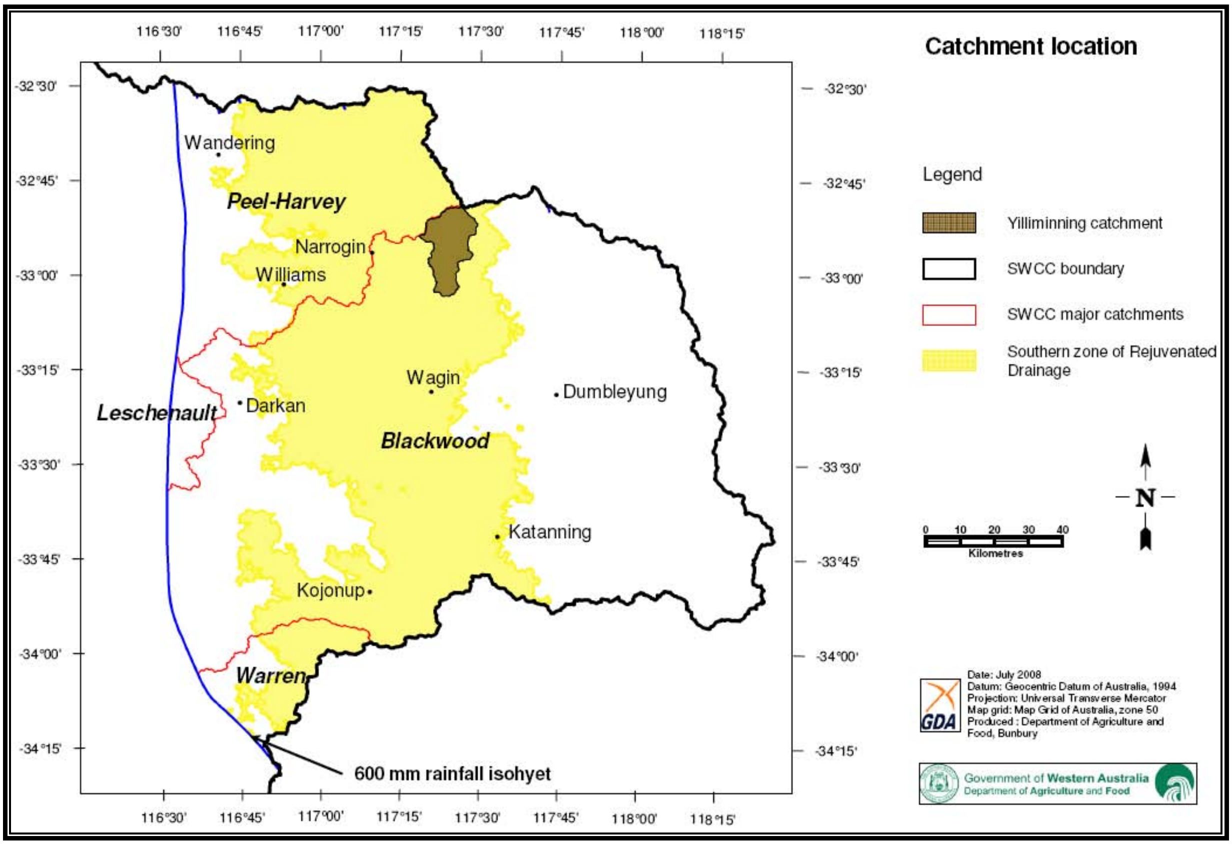

Figure 1: Location of the Yilliminning catchment within the South West Natural Resource Management Region.

1.2 Workshop aims

The aims of the workshops were to:

- Determine the landholders' perceptions of the salinity risk to the catchment **and their aspirations** for its management (i.e. to incorporate landholder views on the likely future extent of salinity on their properties and in their catchment).
- Present catchment information on **current salinity impacts, trends for the future** and **an assessment of the likely impact of two levels of salinity management effort.**
- Identify **salinity management options** of interest to the landholders.
- Provide **an estimation of the likely impact of the salinity management options favoured by the landholders.**
- Agree to a **catchment resource condition target (20 year) for land salinity** and **native vegetation.**
- Identify and prioritise five-year management action targets.

1.3 Current salinity – local view

The landholders identified the current salinity status of their properties. It was agreed that the works implemented over the last 20 years have led to a slowing down or stabilisation of salinity on individual properties within the catchment. Concerns were expressed regarding salinity expanding in the lower reaches of the catchment where the valley floors are flat and broad, as well as along some creeklines.

1.4 Local aspirations

At the first workshop, the landholders' aspirations for the control of salinity in their catchment were explored using a continuum (Figure 2). The following criteria were used:

- **Full risk** - allowing salinity to increase with no additional intervention (do nothing scenario).
- **Containment** - keeping salinity within the catchment to current levels.
- **Full recovery** - returning currently saline land back to previous level of agricultural production.

Full risk **Containment** **Full Recovery**

↑↑ ↑ ↑

Figure 2: Continuum of landholder initial aspirations

2. Current salinity impacts and future trends

During the first workshop landholders were presented with regional and catchment-scale information on groundwater trends, salinity status and future salinity risk. The limitations and scale issues associated with each information source were discussed and the landholders were then invited to provide feedback from their local knowledge.

2.1 Groundwater trends

Regional groundwater trends have been analysed for each of the main soil-landscape zones in the low and medium rainfall zones of the South West NRM region. Yilliminning Catchment lies in the Southern Zone of Rejuvenated Drainage and due to the lack of any groundwater data for the catchment these regional trends were the only groundwater data that could be presented to the group. The groundwater trends for this zone are presented in Table 1. A small majority (18 of 33) of bores in lower slope and valley floor positions indicate that some watertables have reached equilibrium, a significant number (13 of 33) indicate that groundwaters in areas of salinity risk are still rising at an average rate of 0.15 m/yr.

Table 1: Regional groundwater trends (Raper *et al*. in prep.)

Landscape Position	Average trend	Southern Zone of Rejuvenated Drainage		
		Number of bores	Average rate of change (m/yr)	Mean depth to water (m)
Upper slope	*Rising*	11	0.40	-9.7
	Equilibrium	4	_	Dry
Mid slope	*Rising*	21	0.20	-5.3
	Equilibrium	5	-	-4.5
Lower slope	*Rising*	11	0.15	-1.4
	Equilibrium	10	-	-1.4
	Falling	1	-0.05	-1.9
Valley floor	*Rising*	2	0.05	-0.3
	Equilibrium	8	-	-0.6
	Falling	1	-0.10	-0.9

2.2 Current salinity impacts

The Land Monitor project used high resolution digital elevation data and remotely sensed vegetation health data to map salt-affected land and to produce an estimate of the maximum possible future extent of salinity in the south-west agricultural region (McFarlane *et al.* 2004). Land Monitor (2001) estimated that 1,550 ha (6%) of the Yilliminning catchment was salt-affected in 1998 (Wallace 2002) with 2,750 ha (11%) remnant vegetation in the catchment (Figure 3).

The Land Monitor estimate of current salinity has limitations that can affect the precision of the mapping. The reported accuracy of the Land Monitor mapping for the west Blackwood zone, within which Yilliminning sits, was 96% (Wallace 2002). A field visit prior to the workshops indicated Land Monitor significantly underestimated the extent of salinity. It picked up only the most severely degraded areas and it did not include saline areas covered in samphire. At workshop 1, landholders agreed that Land Monitor underestimated the extent of current salinity, but also pointed out that some current salinity had appeared since 1998 and could therefore not be detected during the Land Monitor project. The average rate of expansion of salt-affected land, as mapped by Land Monitor within the Narrogin Shire between 1990 and 1998 was 5.8% or 0.7% per annum (Wallace 2002). These rates of expansion of salt-affected land cannot be used as a direct indication of the likely rate of expansion in the Yilliminning catchment because, unlike a catchment, a shire is an administrative area. The landholders were given the opportunity to mark areas that they identified as currently salt-affected over the Land Monitor salinity map and any discrepancies were noted. They estimated that salinity currently affected 8% of the catchment (2,000 ha).

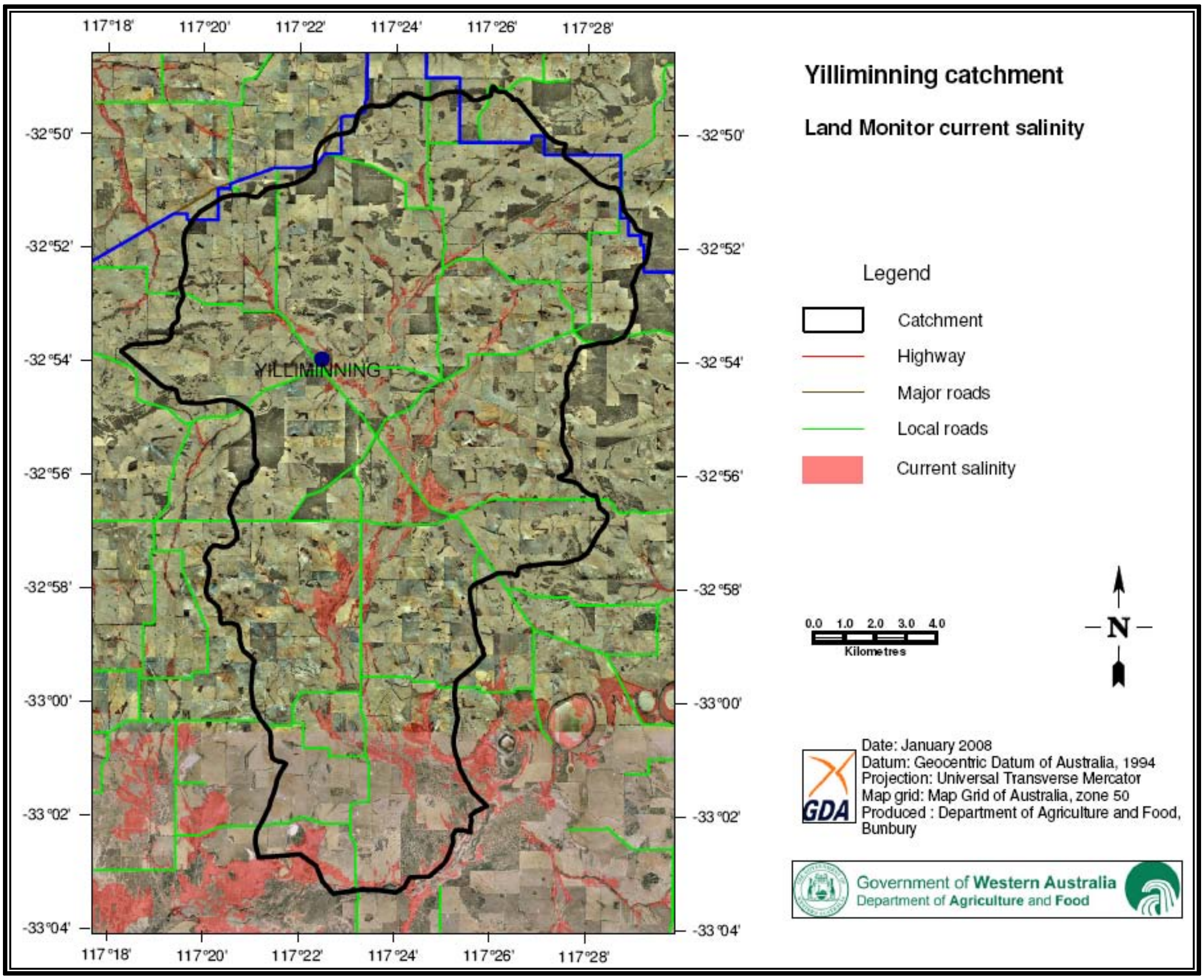

Figure 3: Current salinity in Yilliminning (Land Monitor 2001)

2.3 Valley floor hazards

Salinity hazard is best thought of as an area of land, usually on the valley floor, where the watertable may, at sometime in the future, approach the ground surface and give rise to dryland salinity. Valley floor hazard, from the Land Monitor (2001) information for low-lying areas, shows areas which have the highest risk of waterlogging, flooding, shallow groundwater and salinity (Figure 4).

It is **important to note** that not all these areas will become saline. Variations in topography and soil type are critical factors in determining their susceptibility to salinity. Furthermore, the valley floor hazard mapping does not imply any particular time-frame for the realisation of salinity risk. It can only therefore be used to provide an estimate of salinity risk required to assist in the setting of a 20-year resource condition target.

Land Monitor used digital elevation modelling to derive valley floor hazard. This was reported as the area of valley floor within a specified elevation of the main streamline. Table 2 presents this information as cumulative areas at four classes: 0-0.5 m; 0-1.0 m, 0-1.5 m and 0-2.0 m. The areas in the 0-2.0 m class are almost certainly an overestimate of the salinity hazard for the Yilliminning catchment. The 0-0.5 m class offers a better estimation of the area at risk of becoming saline if land use remains largely unchanged (McFarlane *et al*. 2004).

Given the current extent of salt-affected land in the catchment, the reported rates of groundwater rise and landholders' local knowledge, the landholders initially estimated that 14 to 16% of the catchment is likely to be salt-affected in 2028 if no further action is taken. They later revised this estimate to 12 to 15% at the second workshop.

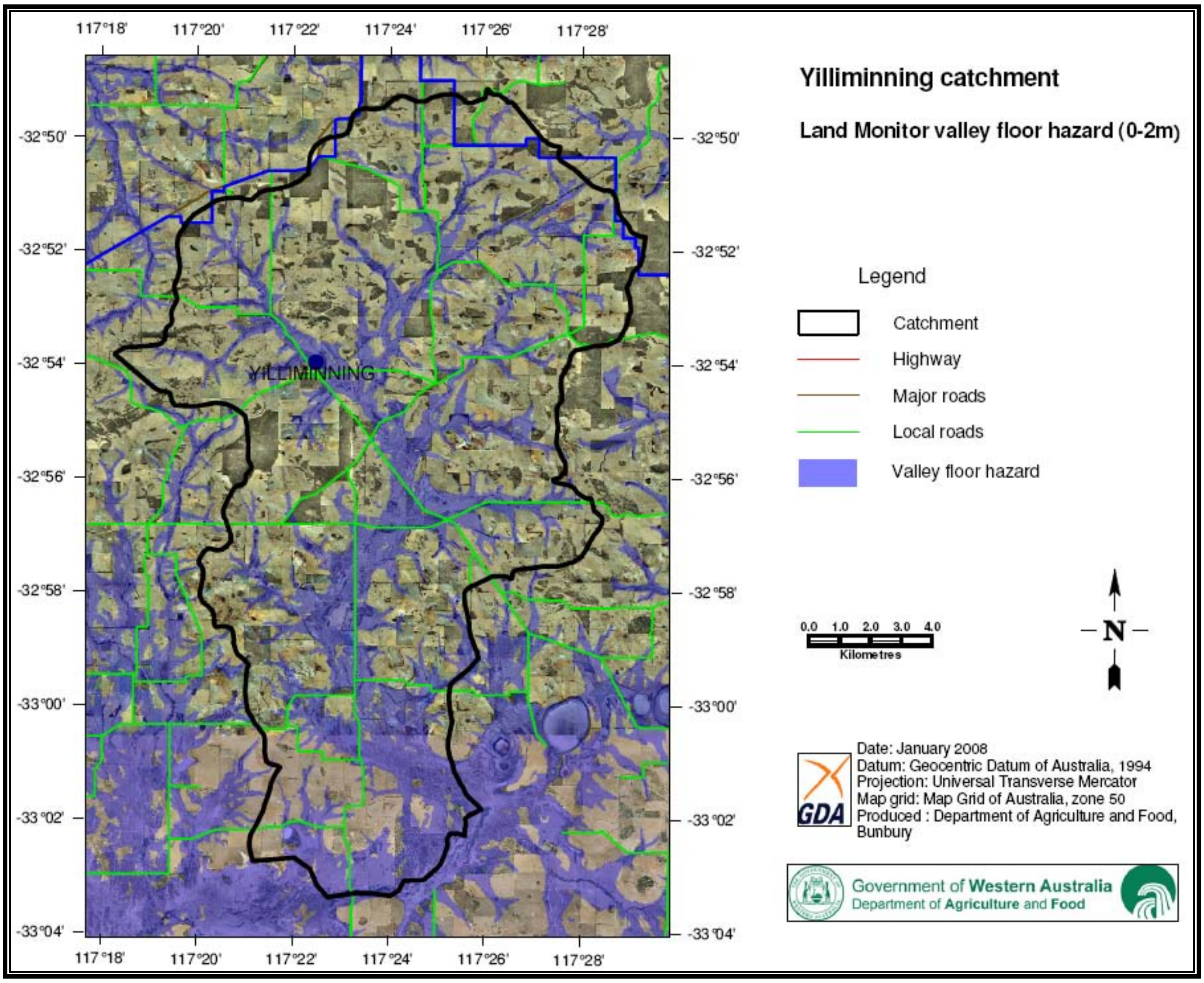

Figure 4: Valley floor hazard in Yilliminning (Class 0-2m Land Monitor 2001)

Table 2: Valley floor hazards in Yilliminning (Source: Land Monitor 2001)

Yilliminning	Total area (ha)	% of catchment	Remnant vegetation (ha)	% of catchment	% of remnant vegetation
Catchment	25,001		2,769	11	-
Land Monitor valley floor hazard at different elevations above the main stream line					
0- 0.5 m	6,051	24	457	1.8	16.5
0 - 1.0 m	7,509	30	585	2.3	21.0
0 - 1.5 m	7,901	32	624	2.5	22.5
0 - 2.0 m	7,911	32	625	2.5	22.5

2.4 Predicted impact of recharge reduction strategies

The Flowtube model (Argent 2005) was used to assess the likely impacts of three levels of recharge control on shallow watertables and therefore salinity risk, for all catchments involved in the project. Flowtube is a simple two-dimensional model which simulates the position of the watertable over time along a groundwater flow line, either down a hillslope or down the main drainage line of the catchment. A limitation of this type of model is that the proportions of the catchment with shallow groundwater for different scenarios must be estimated from the length of the flow line saturated. However, because the model simulates the position of the watertable through time, an estimate at the end of the 20-year time frame required for this exercise is possible.

There are no groundwater data available for the Yilliminning catchment so modelling could not be done. The East Yornaning catchment, located 8 km north of Yilliminning, was used as a case study. The model predicted that reducing recharge by 25%, 50% or 75% across the catchment would have a limited impact on the area at risk from shallow watertables and would not greatly change the area at risk of becoming salt-affected (see Table 3). Note that percentage areas presented in Table 3 are quoted to one decimal place. This is to show the very small differences in the areas calculated and is not a reflection of the accuracy of the modelling.

Table 3: Predicted salinity risk under three levels of recharge control for the East Yornaning case study catchment

Scenario	Percentage of catchment with shallow watertable
Current practice	15.7
25% recharge reduction	15.6
50% recharge reduction	15.2
75% recharge reduction	14.7

3. Salinity management options

The Yilliminning landholders identified works that they had undertaken over the last 20 years to manage salinity. This is shown in the timeline in Figure 5. They also identified management actions that they were considering implementing to manage salinity in the future. These are captured in the mind-map in Figure 6. The mind-map shows the key areas for action (e.g. trees) and shows the linkages between some of the options identified.

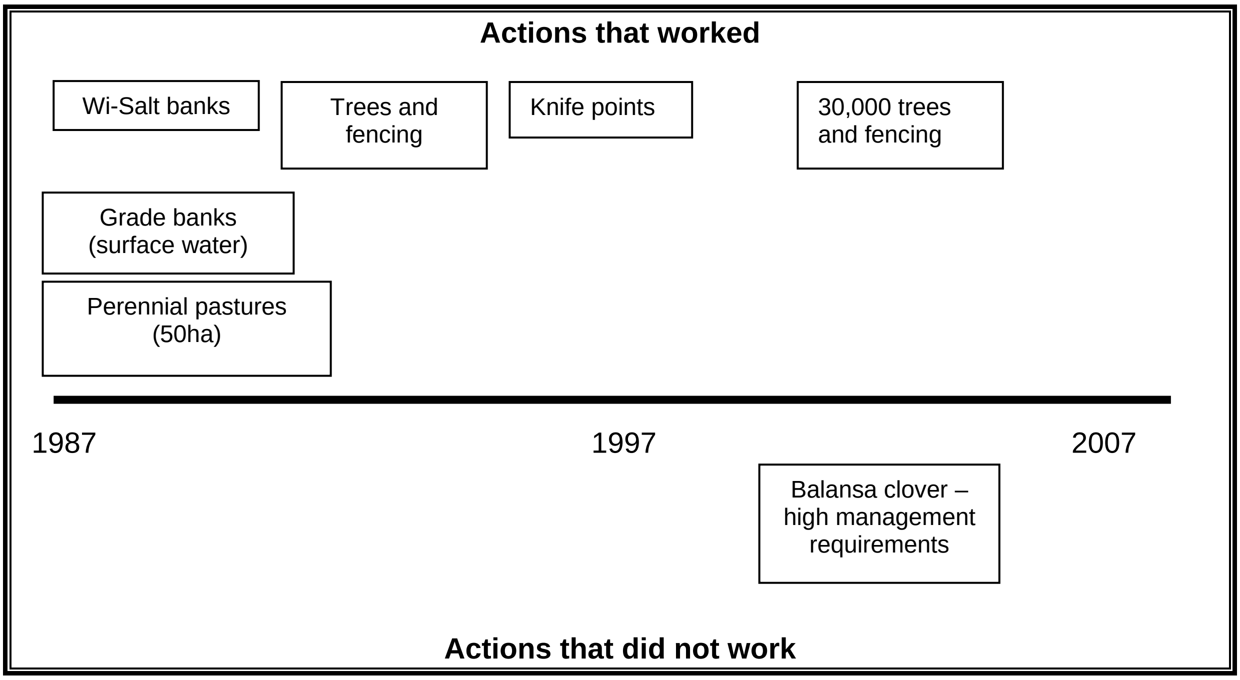

Figure 5: Works undertaken in Yilliminning catchment

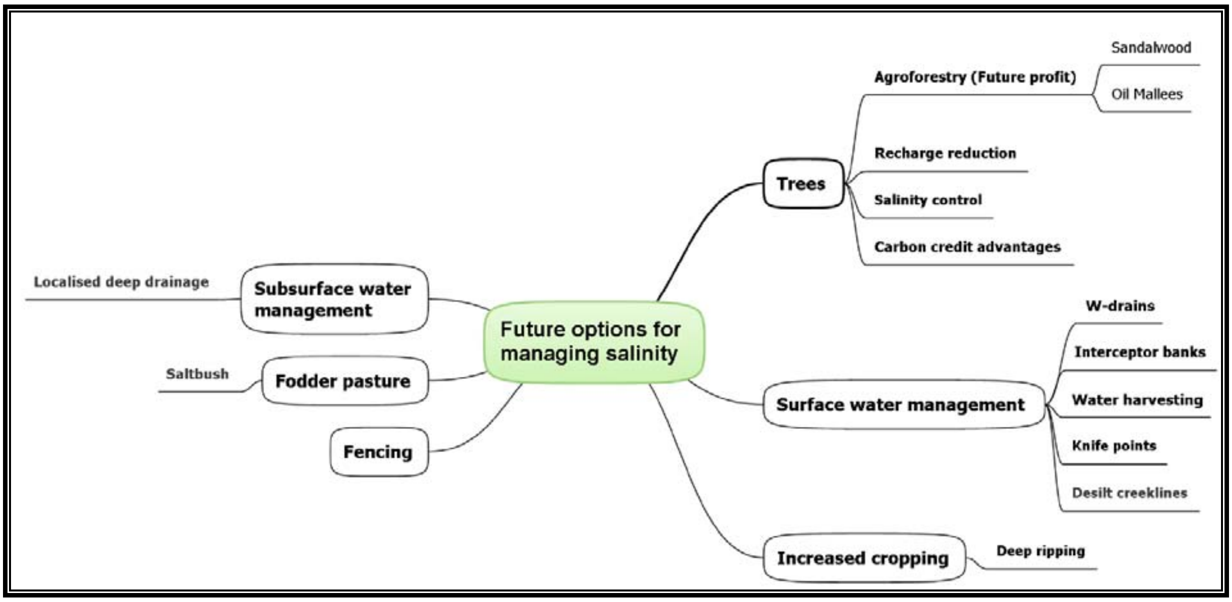

Figure 6: Potential options for managing salinity in the Yilliminning catchment

4. Modelling

The landholders chose three scenarios from the salinity management options identified in Figure 6 to model their impact on salinity risk. The most appropriate modelling tool available for the simulation of each scenario was chosen; the choice being dependent on the nature of the management option to be simulated and the availability of data to support the modelling. Case studies from other catchments were used where no data were available for the Yilliminning catchment. The following management options were nominated:

- Trees along drainage lines and in block plantings
- Deep drainage in bottom third of the catchment
- Surface water management.

4.1 Scenario 1 ~ Trees along drainage lines and in block plantings

The Flowtube model was chosen to simulate the likely impact of trees on catchment salinity risk. The East Yornaning catchment was again chosen as a case study.

Assumptions

- The magnitude of the groundwater response to tree planting at East Yornaning is indicative of the likely response to similar treatments in the Yilliminning catchment, which is a realistic assumption given the similarities in soil-landscape units between the catchments.
- All trees are healthy and effective regardless of depth and salinity of groundwater.
- The zero recharge scenarios were based on the assumption that trees would reduce recharge to zero under the area planted, but not access groundwater, which is most likely where groundwater is brackish or saline.
- The discharge scenarios are based on the assumption that the trees access groundwater to the level indicated.

Impact

Different scenarios for trees were modelled and the results are summarised in Table 4.

Table 4: Tree planting scenarios (East Yornaning data used)

Scenario	Percentage of catchment with shallow watertable
Base case	15.7
Tree all drainage lines – zero recharge	15.7
Tree all drainage lines – 50 mm/year discharge	15.6
Tree all drainage lines – 100 mm/year discharge	15.6
Block planting mid to lower catchment – zero recharge	13.6
Block planting mid to lower catchment – with discharge	12.5

4.2 Scenario 2 ~ Deep drainage in bottom third of the catchment

The impact of deep drainage was estimated using GIS (Geographical Information System) tools. A network of arterial drains through the currently salt-affected and adjacent areas at risk was digitised on the valley floors roughly parallel to the natural drainage (Figure 7). Drains were marked up to the south side of Yilliminning Road, the main road between Narrogin and Harrismith which cuts east-west through the catchment. The area hypothetically drained includes most of the salt-affected area except for an area north of the road on the valley floor adjacent to intersection with Cannell Road.

Areas impacted by the hypothetical drains were calculated from drain length and assumed lateral impacts only, not from an explicit simulation of drainage impacts on the groundwater system. Therefore, the results are only indicative of area of impact and the reduction in shallow watertables and do not represent an expected outcome from deep drainage. Soil-landscape units likely to be dominated by soils with poor drainage characteristics were identified (Department of Agriculture and Food 2008); the main characteristics considered were permeability and stability for drain construction. Two estimates of the potential 2028 extent of salinity in the Yilliminning catchment, 14 and 16%, were used as benchmarks for this exercise in line with the landholders' estimates reported above.

Assumptions

- Safe disposal of drainage effluent is available
- 40 km of feeder & arterial drains
- Lateral impact ranges from 25 to 200 m either side of drain
- 200 m lateral impact required to make drain cost effective at 75% efficiency
- Sodic subsoils likely to restrict lateral impact of drains.

Impact

The estimated impact of deep drains is based on a main drain with feeder drains to a total length of 40 km as shown in Figure 7. Table 5 presents a range of lateral impacts from 25 to 200 m. It includes estimates based on assumed drainage efficiency of 75 and 100%. The most likely impact is a reduced area of shallow watertables of between 420 ha (1.7%) and 840 ha (3.4%), assuming a lateral impact of 70 to 140 m at 75% drain efficiency because of the presence of unstable or low permeability subsoils on the valley floors.

Table 5: Impact of deep drains on shallow groundwater in Yilliminning catchment

Total drains (km)	Lateral impact (m)	Area impacted (ha)	% catchment salt affected (estimate 1)	% catchment salt affected (estimate 2)
No drains			14.0	16.0
40 km at 75% efficiency	25	150	13.4	15.4
	70	420	12.3	14.3
	140	840	10.6	12.6
	200	1,200	9.2	11.2
40 km at 100% efficiency	25	200	13.2	15.2
	70	560	11.8	13.8
	140	1,120	9.5	11.5
	200	1,600	7.6	9.6

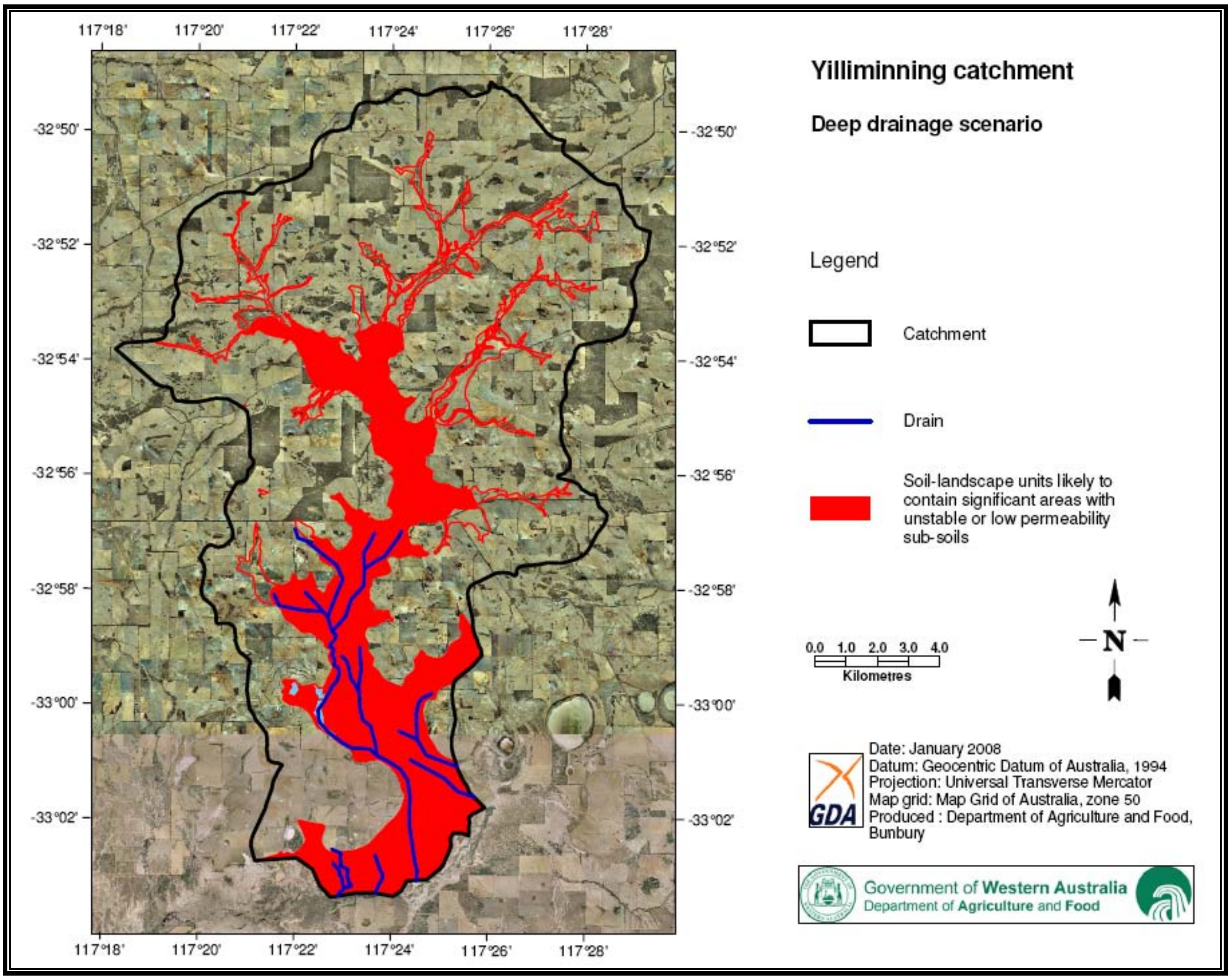

Figure 7: Deep drainage scenario (only indicative placement to calculate total drain length)

4.3 Scenario 3 ~ Surface water management

The MODFLOW distributed groundwater flow model (McDonald and Harbaugh, 1988) was used to simulate the likely outcome of surface water management on lower slopes and valley floors. The model was setup for the 8,600 ha Queerfellows Creek catchment, about 40 km south of Yilliminning, also in the Southern Zone of Rejuvenated Drainage. The Queerfellows modelling was used as a case study because it provided explicit information on the impact of surface water management options, designed and implemented by landholders in a catchment with some soil and morphological similarities. The mean annual rainfall in the Queerfellows Creek catchment is 425 to 450 mm, which is very similar to that of the Yilliminning catchment that has a mean annual rainfall of 400 to 425 mm. The Queerfellows Creek landholders included 34.2 km of surface water control structures and drains on their farm plans in 2000 and the impacts of these planned works were simulated. Most of the planned works have now been installed for several years. Simulations were also performed for surface water control structures installed at twice and three times the density indicated on the farm plans (Keipert *et al.* in press). The model predicts the equilibrium depth to groundwater given annual recharge and the impacts of drainage; the results are therefore not time-bound and the time required to reach a new equilibrium is not determined.

Assumptions

- Queerfellows Creek data are applicable to Yilliminning
- Banks and drains at twice and three times the density specified in the Queerfellows Creek farm plans
- Recharge is reduced by 50% for 100 m downslope of drain.

Impact

A range of scenarios are presented for surface water control (Table 6). Modelling predicted that the area at risk from shallow watertables would be reduced from 26% to 23% of the catchment with a doubling or trebling of the length of surface water management structures as proposed on the farm plans. Trebling the length of surface water management structures resulted in a predicted area at risk not significantly different to a doubling of the length of surface water management structures because a doubling covered almost all of the high risk areas. It should be noted that because an equilibrium model was used, the time required to reach the estimated area with shallow groundwater is not determined and may be different under each management option modelled.

Table 6: The impact of surface water management with shallow watertables in Queerfellows Creek catchment

Scenario	% of catchment with shallow watertables
Base case	26
Farm plans – double surface water control	23
Farm plans – triple surface water control	23

Surface water control has two main benefits in relation to salinity management. The first is recharge reduction which is simulated in the MODFLOW model and second, a reduction in waterlogging and inundation which cannot be explicitly modelled. Reduction in waterlogging will have a positive impact on the surface condition and productivity of the area treated; this is not quantifiable and is therefore not reflected in the results presented in Table 6.

5. Assets and targets

5.1 Assets at risk to salinity

The Yilliminning landholders nominated that in addition to agricultural land the following assets are at risk or are already affected by salinity:

- Yilliminning Rock Reserve - seepage is affecting the corner area of the reserve and negatively impacting upon wildlife and vegetation (including orchids)
- Yilliminning townsite - is at the confluence of a number of waterways, with substantial inflows of water that can potentially impact negatively on remnant salmon gums
- Block areas of remnant vegetation on private land at risk from rising watertables
- Yilliminning River.

5.2 Yilliminning catchment targets

The landholders in Yilliminning agreed to the following resource condition targets:

~ No more than 10% of the Yilliminning catchment affected by salinity in 2028. (Landholders estimated that 8% of the catchment is currently affected by salinity and the full-risk by 2028 was estimated as 12-15% of the catchment.)

~ No further degradation or loss of natural assets by 2028.

6. Future options to manage salinity and native vegetation

The landholders identified salinity management options that they considered appropriate for them to implement in the short to medium term and these are summarised in Appendix 3. Further Management Action Targets (MATs) were discussed during workshop 2 and then prioritised according to the group's and/or individuals' ability to implement the action and the potential impact on the likelihood of achieving their agreed land salinity resource condition target (Figure 8).

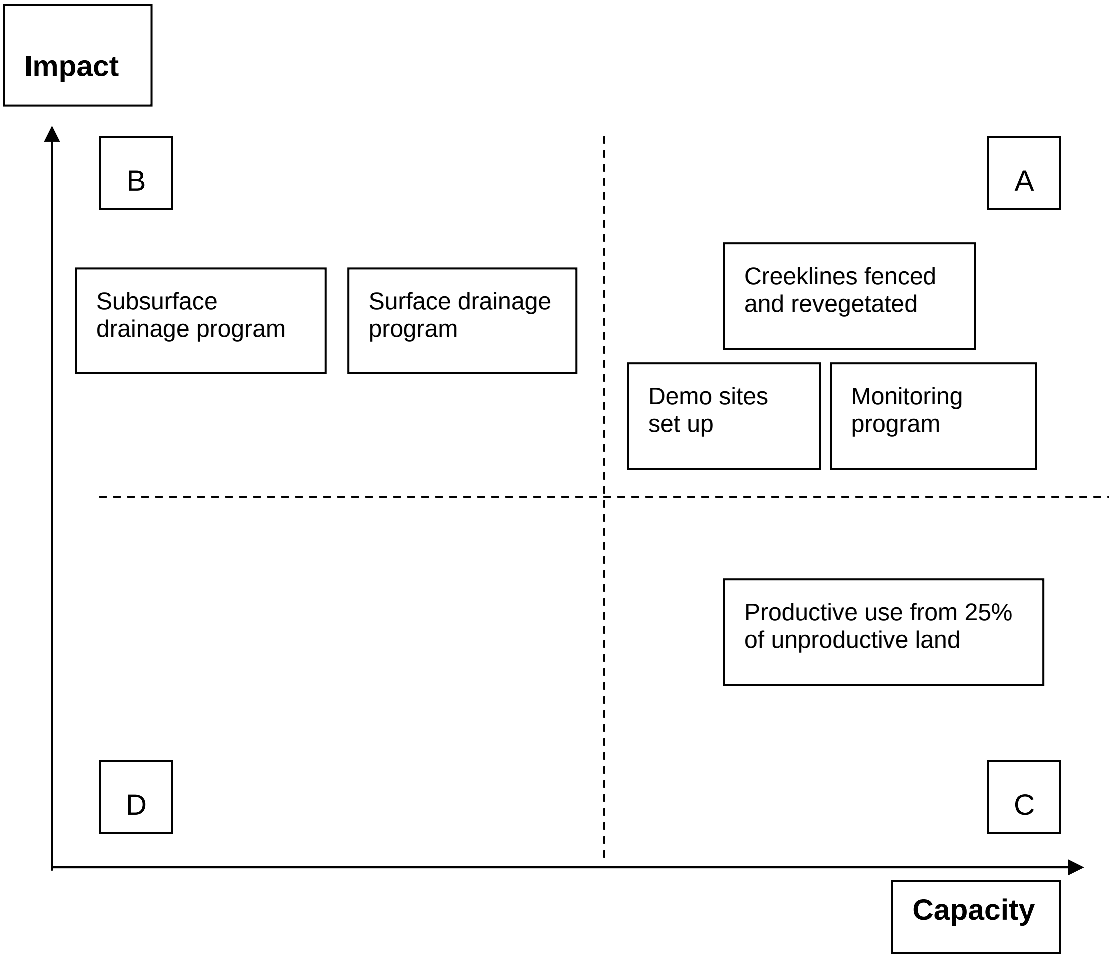

Figure 8: Prioritised management actions based on impact of action and capacity to implement

Each of the nominated management actions was discussed to determine if it will have a low or high impact on achieving the agreed land salinity resource condition target. The group then decided if members had a low or high capacity to implement the action. This determined the quadrant in which the management action was placed (A, B, C or D). The quadrant in which an action is placed indicates its priority and timeline for implementation.

A = Immediate (0-3 years) action (high impact and high capacity)

B = Longer or medium-term action (needs more resources – high impact and low capacity)

C = Short-term action (a small win can help build confidence – low impact and high capacity)

D = Needs to be reviewed in future to see if priority or circumstances have changed (low impact and low capacity)

The different MATs and the initial actions to implement the targets are summarised in Table 7.

Table 7: Initial actions for Management Action Targets

Target	Priority	Initial action
All creeklines fenced and revegetated	A	▪ Identify sources of private funding
Set up demonstration sites highlighting a combined approach to salinity management (trees, banks, drainage, water harvesting)	A	▪ Utilise existing sites throughout the catchment
Establish a monitoring program to more clearly identify saline and non-saline land	A	▪ Utilise existing sites ▪ Undertake individual property identification of salt affected land using aerial photos ▪ Identify individual bore sites ▪ Identify opportunities to establish bores
Start a subsurface drainage program	B	▪ Initiate a field investigation ▪ Identify effluent disposal options
Start a surface drainage program	B	▪ Utilise existing sites ▪ De-silt Yilliminning Creek ▪ Conduct field day or tour ▪ Develop control program to manage weeds in creek

7. Conclusion and recommendations

The Yilliminning landholders were presented with information on the extent of salt-affected land in the catchment derived from remotely-sensed data under the Land Monitor project. The data suggested that over 1,500 ha (6%) of the catchment was salt-affected in 1998. The landholders mapped salt-affected land and determined that 2,000 ha (8%) was currently affected. The area of salt-affected land has increased from 1998 to the present.

The Land Monitor valley floor hazard mapping suggests that the maximum area at risk from salinity within the Yilliminning catchment is 20%, but this estimate is not time-bound and the landholders estimated that between 12 and 15% of the catchment is likely to be salt-affected within 20 years if no further action is undertaken.

The Yilliminning landholders nominated three scenarios for modelling to assist them in setting time-bound, achievable resource condition targets for land salinity:

- Trees along drainage lines and in block plantings
- Deep drainage in the bottom third of the catchment
- Surface water management.

The Yilliminning catchment landholders set a 20-year, land salinity resource condition target to contain the extent of salt-affected land to 10% of the catchment area and to prevent any further degradation or loss of natural assets by 2028.

The modelling of potential salinity management actions suggested by the catchment group shows that the resource condition target agreed to by the landholders is optimistic but achievable. The modelling suggests that large-scale drainage works and or large-scale revegetation may deliver the agreed target. In the case of the proposed drainage works, most of the salt-affected valley floors are likely to be dominated by soils with poor drainage characteristics due to either low permeability or potential slumping. Extensive site investigations would be required prior to detailed planning of any proposed drainage network. Furthermore, significant issues concerning the safe and legal disposal of the drainage effluent would require resolution before any detailed planning could be started.

The Yilliminning landholders prioritised the following salinity management actions in support of their agreed land salinity resource condition target:

- All creeklines fenced and revegetated
- Set up demonstration sites highlighting a combined approach to salinity management (trees, banks, drainage, water harvesting)
- Establish a monitoring program to more clearly identify saline and non-saline land
- Start a subsurface drainage program
- Start a surface drainage program.

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9. Appendices

Appendix 1: Workshop dates and attendees

Workshop 1: Linking science with local aspirations

Friday 8 February 2008. DAFWA offices, Narrogin

Attendees

Landholders: Andrew Borthwick, Tim Shepard, Chad Mead and Lindsay MacDougall

Support team: Paul Raper, Leon van Wyk, Natalie Lees and Andrew Huffer

Workshop 2: Setting targets for action

Friday 22 February 2008. DAFWA offices, Narrogin

Attendees

Landholders: Andrew Borthwick, Chad Mead, Lindsay MacDougall, Dane Sieber and Michael Lange

Support team: Paul Raper, Leon van Wyk, Natalie Lees and Andrew Huffer

Appendix 2: Workshop feedback

What was worthwhile?	What should be changed?
▪ Maps ▪ Data ▪ Seeing the problem we have ▪ Seeing the scientific basis for the different scenarios ▪ Finding out what others think ▪ Good time of year for the workshop ▪ 2 x ½ day format works well ▪ Discuss and agree on priorities ▪ Able to get information from experts ▪ Information from the modelling ▪ Focus and revitalisation of the group ▪ Will help with funding	▪ More people ▪ Field tour to look at options

Appendix 3: Future methods of managing salinity in the Yilliminning catchment

Management options	Name	Please specify (type, approx when)
1. Deep-rooted perennial species to increase water use		
• Woody shrubs and trees	Lindsay McDougal Tim Shepherd	Salt tolerant trees to finish creeklines in 2009 Various trees 2008 onwards
• Commercial tree crops (e.g. pines, oil mallees)	Tim Shepherd Andrew Borthwick	Oil mallees 2008 to 2009 Continue with oil mallees
• Land conservation (add to existing remnant vegetation)	Andrew Borthwick	Where possible
• Forage crops (e.g. tagasaste)	Andrew Borthwick	Or as new crops become available
2. Plant crops and pastures to increase water use		
• Increase productivity of saline lands (e.g. balansa, tall wheatgrass or saltbush)	Tim Shepherd Chad Mead Andrew Borthwick	Tall wheatgrass in 2009 Saltbush along creeklines and salt-affected areas As land comes back into possible production
• Perennial pastures (e.g. lucerne)	Tim Shepherd	Puccinellia to spread between trees
• Summer crops		
• Improved agronomy of annual pastures and crops	Lindsay McDougal	Higher breakout pressure on tines

Appendix 3: Continued

3. Collect, reuse and dispose of surface water		
• Surface earthworks (e.g. grade backs, inceptor banks, W-drains)	Lindsay McDougal Tim Shepherd Chad Mead Andrew Borthwick	Grade banks and fence along banks in 2009 Surface drains through gullies in 2009 More banks for water collection into dams On-going as funds are available (own)
• Other strategies (e.g. woody perennials)	Andrew Borthwick	On-going
4. Drain or pump, reuse and disposal of groundwater		
• Deep drains	Andrew Borthwick	On-going
• Pumps		
• Aquaculture		
• Siphons and relief wells		
5. Protect and manage remnant native vegetation		
• Protective fencing	Tim Shepherd Chad Mead Andrew Borthwick	Fencing of remnant bush in 2009 Fence newly planted trees On-going as needed
• Rehabilitation	Andrew Borthwick	On-going as needed
• On-going management (e.g. weed control)		

Appendix 4: Soil-landscape units of the Yilliminning catchment (DAFWA 2008)

Mapping unit	Area (ha)	Proportion of catchment (%)	Landform	Soils
257Ar_1	990	4	Broad valley flats and alluvial plains (1.5-4.5 km wide)	Grey shallow duplex, often alkaline, deep sandy duplex and saline wet soils
257Ar_1ns	170	1	Valley flats, largely unsalinised (at the time of mapping)	Shallow and deep sandy duplexes, sometimes alkaline and sodic, loamy duplexes and deep alluvial sands, minor saline wet soil
257Ar_1sal	70	0	Salinised valley flats	Saline soil, wet and semi-wet soil, minor shallow and deep sandy duplexes, calcareous loamy earths
257Ar_2	830	3	Broad valley flats and alluvial plains (1.5-4.5 km wide)	Saline wet soils with alkaline grey shallow sandy duplex and grey deep sandy duplex
257Ar_2ns	1,680	7	Valley flats, largely unsalinised (at the time of mapping)	Deep and shallow sandy duplexes, minor deep alluvial sands and clay soils
257Ar_2sal	1,220	5	Salinised valley flats	Saline soil, wet and semi-wet soil, minor shallow and deep sandy duplexes, calcareous loamy earths
257Ar_4	60	0	Lakes and swamps with associated lunettes, dunes and swales	Salt lake soil and saline wet soil with minor grey sandy duplex, often alkaline, and brown deep sand
257Ng_1	810	3	Remnants of detrital laterites often forming prominent mesas. Larger remnants have long, gentle, colluvial slopes	Shallow gravel, sandy gravel, deep loamy gravel, deep pale and yellow sand
257Ng_1s	70	0	Small depressions located on the mid & lower uniform to concave backslopes of lateritic terrain	Deep pale sands and minor yellow sandy earths.
257Ng_2d	420	2	Irregularly undulating country where rocks outcrop. Gravelly ridges forming in well drained places.	Rock outcrop, soils comprise red & brown clay loams & shallow gravely rises on well drained positions
257Ng_2g	380	2	Irregularly undulating country where rocks outcrop	Rock outcrop, coarse granitic sands, gradational brown loams & duplexes further downslope. Weakly developed gravely rises on well drained positions
257Ng_2r	190	1	Rock outcrop/s within irregular terrain	Rock outcrop, minor coarse granitic sands and gradational red and brown loams
257Ng_2sal	420	2	Saline seeps in upper "V" shaped valleys and on hillsides, often controlled by bedrock highs downslope	Wet soil, semi-wet soil, saline soil (often secondary salinity) expressing on sandy and loamy duplexes

Mapping unit	Area (ha)	Proportion of catchment (%)	Landform	Soils
257Ng_2u	6,070	24	Upper to lower slopes on irregularly undulating terrain, largely devoid of rock outcrops	Colluvial & fresh rock soils, comprised of gradational red & brown loams, clay loams & loamy duplexes with minor sandy duplexes & gritty shallow sands
257NgNB	130	1	Long gentle and undulating hillslopes and divides	Yellow/brown deep and shallow sandy duplexes, brown loamy earths, grey sandy duplexes and sandy gravels
257Wb_1	1,240	5	Mid to upper slopes and crests	Sandy gravels with minor areas of loamy gravels and pale deep sands.
257Wb_1s	0	0	Lower to upper slopes and drainage lines	Pale deep sand with minor gravely pale deep sand and yellow deep sand
257Wb_2	700	3	Lower to upper slopes and crests including low rises adjacent to river flats	Grey sandy duplex soils, often with alkaline subsoils and duplex sandy gravels on low rises
257Wb_2d	10	0	Rises and low hills	Red deep and shallow loamy duplex soils, often with alkaline subsoils, Red/brown non-cracking clays, minor gravely ridges
257Wb_2g	20	0	Rises and low hills, with minor irregular rock & silcrete outcrop	Grey shallow duplexes, often hardsetting, some grey deep sandy duplexes & deep sands, minor granite & silicified granite saprolite outcrop
257Wb_2r	0	0	Irregular rises and low hills, with rock & silcrete outcrop	Rock outcrop, sandy duplexes and deep sand
257Wb_2sal	80	0	Vales & depressions within rises and occasional low hills	Saline wet soils, often formed from recently salinized grey shallow & deep sandy & loamy duplexes
257Wb_2u	5,280	21	Rises and low hills	Grey deep and shallow sandy duplex soils, often with alkaline subsoils. Minor gravely soils on ridges & crests
257Wb_3	270	1	Lower to upper slopes and crests	Grey deep and shallow sandy duplex soils, rock outcrop and red duplex soils, often alkaline
257Wb_3d	340	1	Irregularly undulating rises and low hills	Rock outcrop, soils comprise red and brown clay loams and shallow gravely rises on well drained positions
257Wb_3g	550	2	Irregularly undulating rises and low hills	Minor rock outcrop, surrounded by coarse granitic sands, becoming gradational brown loams and duplexes further downslope. Shallow gravely rises on weathered granite.
257Wb_3r	120	0	Rock outcrop/s within irregularly undulating rises and low hills	Granite rock outcrop with minor skeletal soils of shallow coarse granitic sands.

Mapping unit	Area (ha)	Proportion of catchment (%)	Landform	Soils
257Wb_3u	1,850	7	Largely colluvial undulating rises and low hills surrounding irregularly undulating rocky terrain	Sandy and loamy duplexes with minor rock outcrop, shallow sands and gradational loams
257Wb_4	740	3	Footslopes. Lower slopes and valley flats	Grey shallow and deep sandy duplex, and grey and yellow/brown shallow loamy duplex
257Wb_4sal	290	1	footslopes and narrow valley floors	saline soil, semi-wet soil, sandy duplexes, loamy duplexes
Total	**25,020.0**			