Modifying storages to save water

The cost of water saved through storage structural modifications

A summary of 15 case study scenarios investigating the costs and benefits of storage structural modifications to reduce seepage and evaporation losses

Key Points

- The cost of saving water was reasonable using either cell division or wall height strategies, with an average cost in the order of $150/ML/yr
- The cost was as low as $15/ML/yr for cell division and $59/ML/yr for wall height increase
- Larger water volumes were saved through wall height increases, although the capital cost was also much higher
- When dividing a storage into cells, the optimum size of each cell will depend on the typical water availability

A range of measurement work conducted as part of the Cotton Catchment Communities CRC project *"Measurement to Improve the Water Efficiency of On-Farm Storages in the Cotton Industry"*, has demonstrated that 5% to 45% of all on-farm water can be lost from storages. Whilst there are various methods available for reducing these losses, it can be difficult to determine the most cost effective approach. Furthermore, the range of water losses measured suggests that individual solutions might be economically applied in some situations, but not in others.

This document summarises the results from 15 case studies of potential storage structural modifications so that their cost effectiveness can be assessed. Structural modifications were chosen as they have been identified in previous studies as the solution most likely to be economical for cotton farms, where water supply is typically very irregular. Such modifications can include dividing a storage into cells, or raising the height of the storage wall. In either case, the modification serves to reduce the surface area available for evaporation and seepage for a given volume of water.

The 15 potential strategies were analysed using the Evaporation and Seepage Ready Reckoner (readyreckoner.nceaprd.usq.edu.au), an existing tool for economic evaluation of evaporation and seepage solutions.

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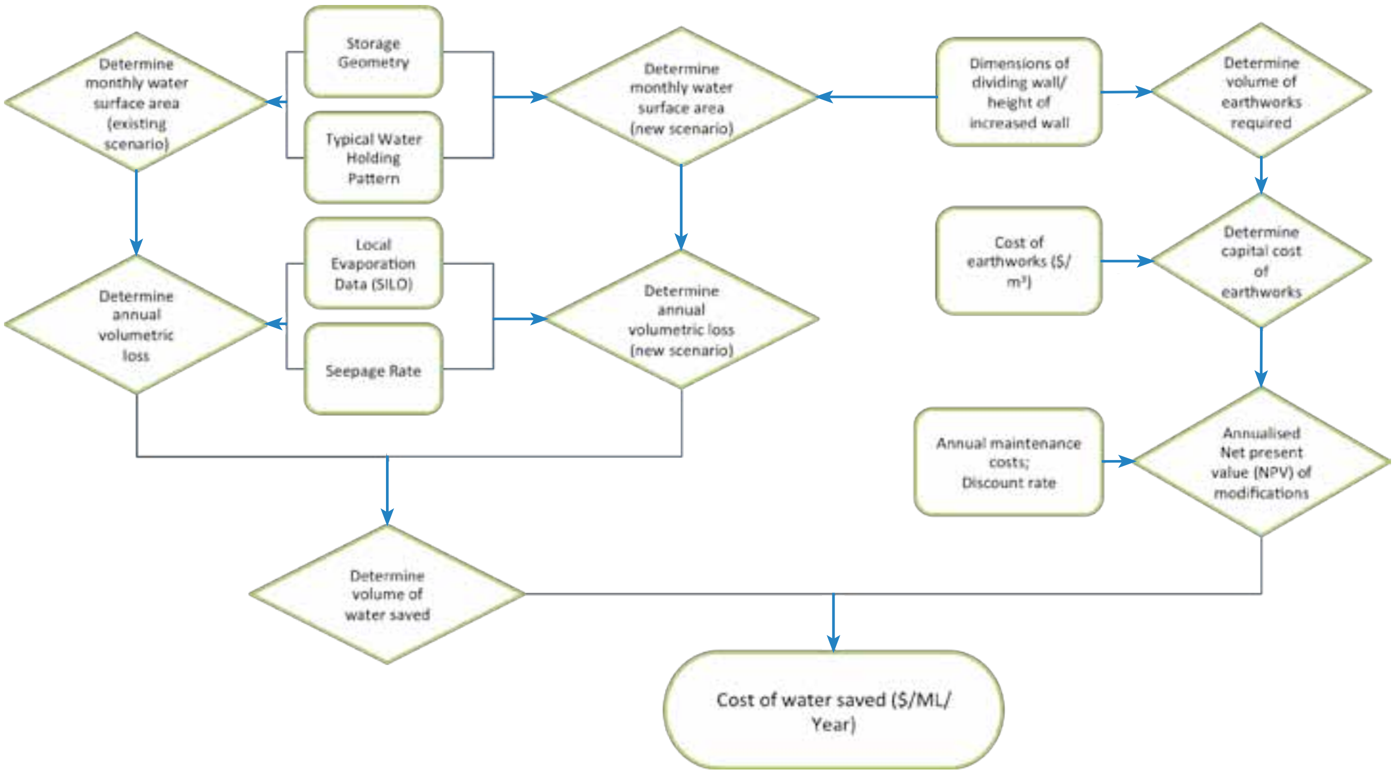
Analysis procedure

The Evaporation and Seepage Ready Reckoner analysis procedure is outlined in the flowchart below. Broadly, the characteristics of the existing storage and proposed modification are used to determine the typical volume of water that could be saved annually. The net present value (NPV) of the upfront and ongoing costs of the proposed modification is calculated and then annualised over the lifespan of the works. The annual water savings are then compared to the annual cost to provide the cost of the water saved.



For the structural modifications used in these analyses, a number of parameters were consistent across each case study.

Annual maintenance cost of the new wall	**$500 pa**
Cost of earthworks	**$3 per m^3**
Discount rate	**5% pa**
Lifespan of earthworks	**60 years**

For the cell division strategies, the relative size of the cells was determined using the Ready Reckoner to calculate which sizes provided the most cost effective water savings. In determining the location of the new wall, the position of current infrastructure such as pump stations was taken into account so that it would not need to be relocated. Most split cell scenarios analysed involved a 50:50 splitting of the existing storage, however it is important to note that this is not necessarily the optimum ratio for all storages. Some storages were also split at a ratio of 25:75.

It should be noted that the method for determining the relative proportion of cells was quite simplistic, in that a particular cell was nominated to always be the first to receive water. A more complex analysis which allows the transfer of water between cells might yield different optimum cell size ratios, and would most likely further decrease the cost of water saved.

The wall height strategies typically included analysis of two existing storages, where the capacity of one of the storages was increased by raising the wall height so that the water from the second storage could be accommodated. However the case study for Farm 12 investigates an existing proposal to increase storage capacity by building a new storage. The analysis in this case considers an alternative proposal of amalgamating, modifying and raising existing adjacent storages so that the overall water volume was the same as under the existing proposal, but without significantly increasing surface area. Furthermore, the case study for Farm 15 involves building a new wall to reduce the storage footprint by around 40% whilst simultaneously raising the wall height by 1 metre so the stored volume remains the same.

Both cell division and wall height increases were investigated on farms 14 and 15.

Economic analysis under the wall height scenarios cannot be performed directly with the Ready Reckoner tool, so the tool was used to estimate the water savings and the economic analysis was conducted separately. However, the economic analysis methodology and assumptions were identical to those used within the Ready Reckoner.

The typical water holding pattern is required by the Ready Reckoner to determine the storage water losses, and it consists of two characteristics:

- For each month, the typical proportion of years that the storage holds water; and
- For those months when water is held in storage, how full is the storage (as a % of the full volume).

The typical water holding patterns of the storages being investigated varied considerably, with some storages holding water quite regularly, whilst others had very low reliability. The typical water holding capacities for each storage is indicated in the following figures.

Results and Conclusions

The results indicated that the cost of water saved was often attractive when compared with the value of water available from temporary transfer markets. Having said this, only individual growers will be able to determine an acceptable cost for water saved under their particular conditions.

The average cost of water saved for both cell division and wall height strategies was around $150/ML/year. Whilst the maximum cost of water saved was $350/ML/year for cell division strategies and $300/ML/year for wall height strategies, the cheapest savings were only $15/ML/year and $59/ML/year respectively. This range of results demonstrates the importance of analysing individual storages to determine where particular solutions can be most cost effectively applied.

Although larger volumes of water were saved through wall height strategies, implementation is often limited by the high total cost (due to the availability of capital) and the practicality in some situations, particularly where the necessary wall would be unacceptably high.

Cell Division Strategies

Farm Number	Cell Split Ratio	Storage Volume (ML)	Storage Area (ha)	Water Saved (ML)	Capital Cost	Cost of Saved Water ($/ML/year)
1	50:50	1200	22	31.8	$162,150	$285
2	50:50	3963	130	1011	$278,050	$15
3	25:75	350	7.5	37.7	$111,780	$170
4	50:50	1000	34.5	52.3	$161,595	$173
5	50:50	1100	29.4	40.1	$161,595	$225
6	50:50	1500	27	234.8	$269,541	$63
7	50:50	350	11.5	15.5	$93,150	$350
8	25:75	450	10.7	94.3	$123,750	$75
13	50:50	3000	97.3	201	$547,000	$143
14	50:50	963	25.7	98.8	$105,450	$56
15	50:50	12000	337	1404	$390,000	$15
Average		**2352**	**67**	**293**	**$218,551**	**$143**

Wall Height Strategies

Farm Number	Storage Volume (ML)	Storage Area (ha)	Water Saved (ML)	Capital Cost	Cost of Saved Water ($/ML/year)
9	780	29.9	549	$1,685,000	$161
10	3850	74	2065	$6,252,756	$159
11	900	23.1	585	$1,800,000	$163
12	265	6.5	611.8	$3,499,500	$302
14	963	25.7	211.7	$234,838	$59
15	12000	337	2929	$3,412,500	$62
Average	**3126**	**82.7**	**1159**	**$2,814,099**	**$151**

***Table 1** – Water savings and costs for all case studies*

Appendix – Typical water holding patterns for individual farms

Average percentage of years that the storage contains water

Month	Storage Number 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Jan	30	90	80	30	30	95	60	80	80	75	90	90	50	100	75
Feb	25	70	70	25	25	90	50	70	80	75	90	90	50	100	75
Mar	0	60	5	0	0	60	30	5	80	75	90	90	50	100	75
Apr	0	40	0	0	0	50	20	0	80	75	90	90	50	100	75
May	0	30	0	0	0	10	5	0	80	75	90	90	50	100	75
Jun	0	20	0	0	0	10	5	0	80	75	90	90	50	100	75
Jul	0	30	0	0	0	10	5	0	80	75	90	90	50	100	75
Aug	0	50	0	0	0	10	10	0	80	75	90	90	50	100	75
Sep	10	60	0	10	10	60	10	0	80	75	90	90	50	100	75
Oct	10	70	5	10	10	80	20	5	80	75	90	90	50	100	75
Nov	25	80	80	25	25	90	40	80	80	75	90	90	50	100	75
Dec	30	90	80	30	30	95	50	80	80	75	90	90	50	100	75

Average amount of water stored per month (% of total storage volume)

Month	Storage Number 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Jan	30	50	25	30	30	50	80	25	80	30	80	40	40	63	60
Feb	20	30	15	20	20	30	70	15	100	20	50	30	30	53	50
Mar	0	10	0	0	0	10	50	0	100	10	30	20	20	43	40
Apr	0	5	0	0	0	5	20	0	90	50	20	100	100	40	40
May	0	0	0	0	0	0	10	0	80	80	20	100	100	35	100
Jun	0	0	0	0	0	0	10	0	60	80	50	100	97	70	100
Jul	0	0	0	0	0	0	10	0	40	80	100	100	95	69	100
Aug	0	5	0	0	0	0	20	0	30	75	100	90	95	68	100
Sep	20	10	0	20	20	10	40	0	30	70	100	80	91	67	100
Oct	50	20	15	50	50	30	50	15	40	60	100	70	88	66	90
Nov	50	40	25	50	50	40	70	25	60	50	95	60	75	65	80
Dec	10	50	25	40	40	50	70	25	80	40	90	50	50	64	70

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