FINAL DRAFT

Lake Mokoan Study

Volume 5 – Benefit Cost Analysis: Addendum

GOULBURN BROKEN CATCHMENT MANAGEMENT AUTHORITY

Prepared for

Goulburn Broken Catchment Management Authority

By

URS

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Statement

Volume 5 should be read in conjunction with Volumes 1 to 4. It was commissioned because of concerns expressed about the capital costs of implementing a spit option and the offsets required to maintain water supply reliability. There are still concerns that the capital costs for the spit options are understated. To address this the Consultants have been asked to prepare a sensitivity analysis which will be included as an Appendix to Option 5 when it is completed.

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On consideration of the results presented in Volume 2 (Option Assessment) of the Lake Mokoan Study, the Goulburn Broken Catchment Management Authority, as project manager, commissioned further and more detailed analysis of the alternative offsets for Option 1 and spit bank construction costs used in the analysis. The main revisions include:

1. The original Option 1 offset option (Eildon to Nillahcootie Link) achieved current water security on the Broken System, but at a high cost. A number of further offsets were developed, which also maintain water security on the Broken System at considerably lower cost;

2. The capital cost of undergoing Spit Bank works for Option 2B3 was revised by Sinclair Knight Mertz (SKM, 2004), which revealed that it would be more expensive to construct a spit bank than was assumed in Volume 2. The new construction costs result in a change in the total costs of the option and hence, the net present values; and

3. Following a review of the modelling results, additional water savings of 3GL per year were identified. These additional water savings affect the present values of water savings and, therefore, the net present values for each option. The amendments to Volume 2 associated with options 2B1, 3B1 and 3B3 have been presented as an errata in Appendix A.

This report provides an addendum and errata to Volume 2 of The Lake Mokoan Study. Most sections of the original analysis remain unaffected by the revisions to the figures and offset alternatives. Therefore, this volume only documents those amendments to Options 1 and 2B3 that result from revisions 1 and 2 (listed above). The section numbering corresponds with the relevant sections in Volume 2 and should be read in conjunction with Volume 2. Other alterations to the figures for all options are presented in Appendix A (Errata for the Final Report of The Lake Mokoan Study, Volume 2), while all amended figures in the economic analysis have been captured in the summary table in Section 11.

2.3.3 Options and offsets

Reducing the storage capacity of Lake Mokoan may reduce the reliability of the Broken River system.

In November 2002, the (then) Minister for Environment and Conservation guaranteed that there would be no adverse impact on the security of irrigators' existing water entitlements. This was confirmed by the Minister for Water in a letter to the Victorian Farmers Federation dated 18 March, 2003. Therefore a number of alternatives have been examined that reduce or eliminate any reduction of reliability in the system.

The alternatives for lessening the reduction in reliability are reducing the demand on the system, providing more efficient storage within the system, or diverting water from alternative sources. An 'offset' is defined as a physical work or an action undertaken to reduce the additional shortfall created by a water saving. The offsets previously considered were:

- piping of Casey's Weir and Major Creek Waterworks District (Tungamah) system;
- supply Lake Mokoan diverters from Ovens or King Rivers;
- link Lake Eildon to Lake Nillahcootie;
- harvesting spills from Lake William Hovell in Lake Nillahcootie; and
- raising Lake Nillahcootie.

Additional offsets now being considered include:

- supply Tungamah system (above) from the Murray;
- implement new total channel control system (TCCS) technology on the Broken River and Creek;
- supply private diverters on the Broken River from the East Goulburn Main Channel; and
- pipeline East Shepparton Water Works District.

3.3 Supply Issues (Offsets)

Altering the configuration of Lake Mokoan will alter the ability to supply some customers and the reliability of existing water entitlements. The Government has indicated that "options for the future management of Lake Mokoan will have no adverse impact on the security of irrigator's existing water entitlements".

The partitioning of the lake with a bank across the spit will cut off water supply access to the diverters at the eastern end of the lake. The reinstatement of supply to existing customers will be a direct cost to the implementation of the option. The cost of works to enable diverters to continue to take their water supply at the existing location is included in the option cost. These works would include a pumping station at the lake, rising main, balancing storage and supply pipelines.

The cost of decommissioning Lake Mokoan (Option 1) will include the cost of providing a water supply to the Lake Mokoan diverters from the Broken River. The works required include a pumping station on the Broken River, rising main, balancing storage and supply pipelines. The estimated capital cost of providing the water supply is $6million. The annual cost of operating and maintaining the water supply system is $70,000.

Maintaining the security of the system requires either a reduction in the demand, the further harvesting of water resources within the valley or drawing supply from alternative resources, preferably where there will be a negligible impact on the reliability of that source. These options for maintaining the reliability of supply are the offsets and will be considered separately, although ultimately they will form part of the overall option cost.

The offsets that will reduce the demand on the Broken River system are:

- replacement of the Casey's Weir and Majors Creek open channel domestic and stock water supply (Tungamah) system with a pipeline system;
- supply the pipelined Tungamah system from the River Murray;
- supply the Lake Mokoan diverters from the Ovens or King Rivers; and
- implement TCCS in the Broken River and Creek.

A further option to reduce the demand is to purchase entitlement on the Broken system, an option that was raised as a possibility in The Green Paper – Securing Our Water Future. Unlike infrastructure offsets, purchasing entitlement is not necessary to maintain system reliability. The practicality of purchasing entitlement on the Broken system will depend on the volume required and the preparedness of customers to sell. This is difficult to assess, hence only the physical offsets have been considered. Entitlement purchases on the Goulburn and Murray systems, however, have been considered as a means to reduce shortfalls in these systems either to replace the additional demand or small reduction in regulated supplies.

The only offset that involves the further development of the water resources of the Broken River catchment is the raising of Lake Nillahcootie.

The offsets that draw on alternative supplies are:

- linking Lake Eildon to Lake Nillahcootie;
- harvesting Lake William Hovell spills in Lake Nillahcootie; and
- supply private diverters on Broken River from the East Goulburn Main Channel.

Obviously drawing supplies from an alternative source will have an impact on the reliability of supply in that system.

3.3.1 Pipelining of Casey's Weir and Major Creek Waterworks District (Tungamah) System

The Casey's Weir and Major Creek Waterworks District (Tungamah) System supplies water from the Broken River system to grazing and cropping properties in the Broken, Major and Boosey Creeks catchments where it is used for domestic and stock purposes. It also supplies water to the North East Regional Water Authority for the townships of Devenish, St James and Tungamah.

The water is delivered over the period from December to June each year by gravity through a network of natural waterways and constructed channels to fill excavated dams on the properties or in the case of the towns, raw water storages. The system is not efficient and investigations are currently being undertaken to replace the channels with a pipeline system supplying all year round to farm distribution systems comprising tanks, pipelines and troughs. The pipeline system will significantly reduce the demand on the Broken River system.

The replacement of the open channel system with pipelines also has the advantage of allowing the supply to be taken from the River Murray at Yarrawonga, further reducing the demand on the Broken River system.

The estimated costs for the pipelining of the Casey's Weir and Major Creek Waterworks District System for both supply from the Broken and Murray Rivers are given in Table 3-1. The estimated capital cost ($2.0 million) to supply the Tungamah system from the Murray River includes the purchase of 792ML of permanent entitlement on the Murray system.

Table 3-1: Casey's Weir and Major Creek Waterworks District (Tungamah) System Pipeline Costs

Option	Capital Cost $million	Annual Cost $'000
Supply from Broken Creek	12.5	82
Supply from River Murray	14.5	120

It is possible that the pipelining of the Tungamah system will proceed as a water savings project irrespective of decisions on the future of Lake Mokoan. In this case the water savings will remain as water that has to be supplied from the Broken River system. Where pipelining the Tungamah system is required to maintain the reliability of supply in the Broken River system then the cost would be a part of the Lake Mokoan project. It will therefore be necessary to assess offsets without the benefit of pipelining the Tungamah system. In the event that an option requires an offset drawing supply from an alternative source then that source would supply the changed demand direct.

3.3.3 Raising Lake Nillahcootie

In the original analysis (Volume 2), it was assumed that the existing Lake Nillahcootie spillway capacity meets ANCOLD requirements. A recent design review has since revealed that it does not meet ANCOLD requirements, which means that the construction cost of this offset will be higher than originally estimated, at $6.5 million.

3.3.6 Implement TCCS on the Broken River and Creek

Implementation of total channel control (TCCS) on the Broken Creek is expected to reduce water losses by 3GL per year on average. TCCS on the Broken River is expected to improve the operational efficiency in the River and reduce shortfalls in supply by 1GL per year. The estimated costs of implementing TCCS on the Broken River and Creek is $5.7million with an annual operation and maintenance cost of around $186,000.

3.3.7 Supply private diverters on the Broken River from the East Goulburn Main Channel

This offset will supply private diverters on the Broken River downstream of the East Goulburn Main Channel (EGM) from the Goulburn System. Works will need to be undertaken at the existing outfall structure at an estimated cost of $250,000. Annual operation and maintenance costs are assumed to be $5,000 per year. For this option, an upper limit of 866ML of permanent entitlement can be purchased from the Goulburn System to enable 866ML of entitlement for Broken diverters to be supplied from the Goulburn system, therefore, allowing a reduction in the shortfall in the Broken system.

Option 1 - Return to Winton Swamp

In Volume 2, the only offset that maintained Broken system security was the Eildon to Nillahcootie Link offset at a high cost, which also caused a shortfall in the Goulburn system. A number of further offsets have been developed , that when used in combination with some of those previously investigated, maintain system security at a more reasonable cost.

5.2 Offsets

The additional offset scenario, to maintain the reliability of the Broken River system, consists of 7 individual offsets as described in the following:

Option 1 – Return to Winton Swamp with Tungamah and Broken system offsets

	Offset
1	**Pipeline Tungamah D&S** Saving of losses in Broken Creek and D&S system will reduce commitment within the Broken system.
2	**Supply Tungamah D&S from Yarrawonga** Supplying the D&S from Murray system will reduce commitment within the Broken system.
3	**Install Total Channel Control technology in Broken Creek** Improved efficiency of delivery along Broken Creek will reduce losses thereby reducing the commitment within the Broken system.
4	**Pipeline East Shepparton Water Works District (WWD)** Saving of losses in East Shepparton Water works District will reduce commitment within the Broken system.
5	**Supply private diverters on Broken River below East Goulburn Main from the EGM** Supplying these diverters from Goulburn system will reduce commitment within the Broken system.
6	**Install Total Channel Control technology Broken River** Improved efficiency of delivery along Broken River will reduce losses thereby reducing the commitment within the Broken system.
7	**Raise Nillahcootie 1.0 metre to increase capacity by 5.3 GL** Increased storage capacity will improve ability of the Broken system to supply commitments.

5.3 Modelling

Impact on Broken In-Valley Users

The Winton Swamp option provides water savings of 37GL/year.

The key impacts are summarised in Table 5-1.

Option 1 - Return to Winton Swamp

Table 5-1: Water Savings and Impacts on Broken In Valley Users – Winton Swamp Option

	Water Savings	Increase[1] in av. annual shortfalls	Prob. allocation of 170%LV occur	Prob. allocation of > 100%LV occur	Increase[1] in av. annual Broken outflows to Goulburn	Increase[1] in av. annual Broken supply to Murray
	(GL)	(GL)	(% years)	(% years)	(GL)	(GL)
Without offsets	37	5 (0 - +22)	5	26	49	-7
With Tungamah & Nillahcootie offsets	40	1.6 (-3 – +17)	40	69	48	-6
With Tungamah & Eildon to Nillahcootie Link (max annual transfer 20.6GL/yr) offsets	47	0 (-8 – +8)	45	79	58	-7
With Eildon to Nillahcootie Link (max annual transfer 30GL/yr)offsets	44	0 (-8 – +10)	74	82	55	-5.5
With Tungamah & Broken system offsets	44	-0.5 (-10 – +8	76	81	52	-7
Base case	-	-	66	80	-	-

Note: [1] Compared to NRE Base Run. Values in brackets are the shortfall range.

As previously stated, Option 1 without offsets achieves high water savings (37GL/year), the impacts on the Broken In-Valley users are substantial without offsets. The Lake Eildon to Lake Nillahcootie link offset is expensive and causes a shortfall on the Goulburn System. An alternative which eliminates the shortfall and minimises the impact on Broken reliability includes a combination of Tungamah pipeline and a new set of Broken River offsets. The latter alternative is now preferred and has been assessed in this section.

The impacts on reliability of the option without offsets and with the Tungamah and Broken System offsets are shown in Figure 5-1.

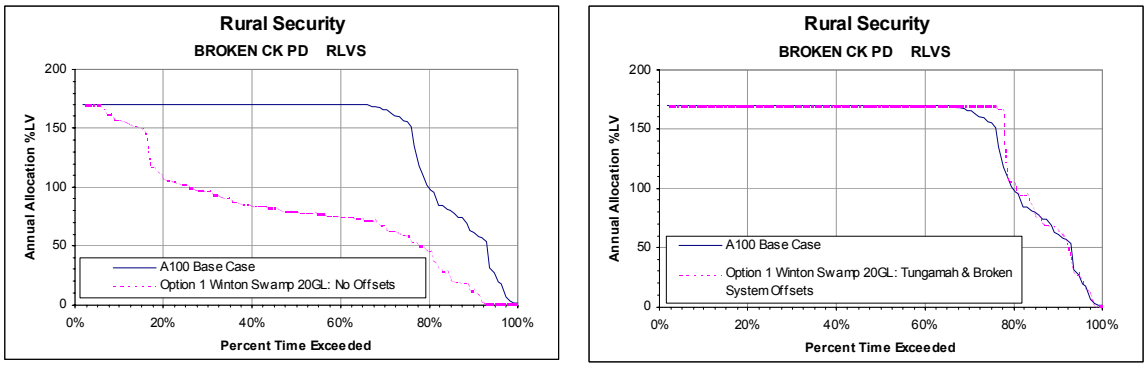

Figure 5-1: Impact of Option 1 on reliability without offsets and with the Tungamah and Broken System offsets

Impact on Goulburn

The impact on the Goulburn has been determined to increase the average annual shortfall by 0.8 GL, however, there will be additional impacts on the Goulburn due to the Broken Creek offsets (refer offsets 1,2 and 3 in Section 5.2) which cannot be quantified by the model as it does not simulate the lower parts of the Broken Creek. The agreed impacts on the Goulburn (including all offsets) will be to increase the average annual shortfall by around 3.4 GL. The modelled impact on reliability in the Goulburn System is shown in Figure 5-2.

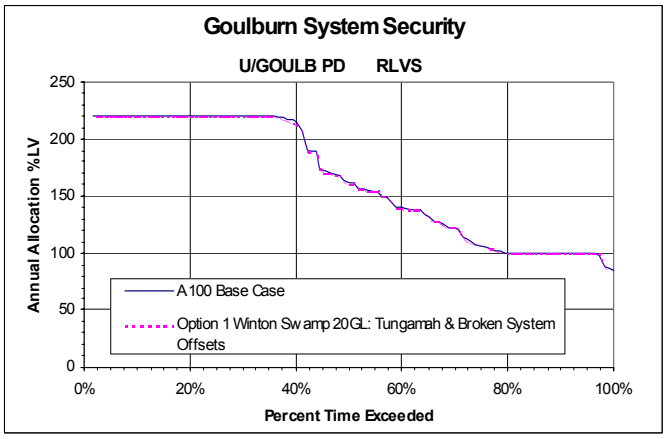

Figure 5-2: Impact of Option 1 on reliability in the Goulburn System

Impact on Murray

Some impacts on the Murray system are expected with the Tungamah and Broken System Offsets. Purchase of Murray system entitlement, associated with the Tungamah offset, has been included in the cost estimates for that offset, however, the impacts on the Murray system of the Broken system offsets will be very small and subject to a separate study, therefore, have not been assessed in this study.

Full Uptake of Licence Volume

For this option, with the Tungamah and Broken System offsets, full uptake of licence volume has no effect on the water savings, however, it causes the average annual shortfall to increase by 2.3 GL. The impact on the reliability is shown in Figure 5-3.

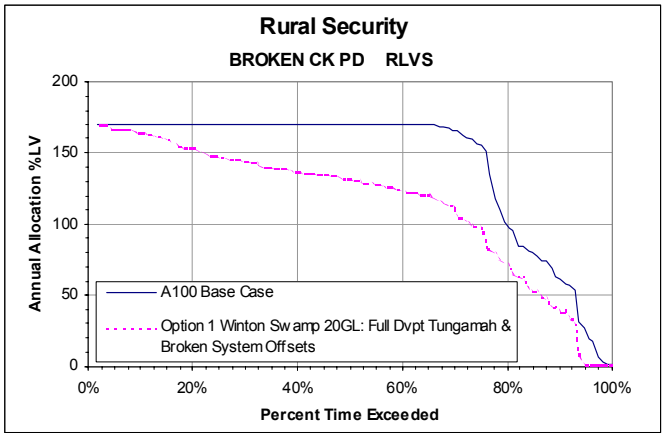

Figure 5-3: Impact of Option 1 on reliability with the Tungamah & Broken system offsets and uptake of full licence volume

5.4 Cost

The estimated cost of decommissioning Lake Mokoan and re-establishing Winton Swamp is $48million with ongoing annual costs of $496,000-$511,000 as shown in Table 5-2.

Table 5-2: Option 1 Costs

Description	Capital Cost $million	Annual Cost $'000
Decommission Lake Mokoan works and provide alternative water supply to lake diverters	14	135
Environmental Works	1	15-30 depending on year
Broken System Offsets[1]		
Pipeline Tungamah D&S	12.9	80
Supply Tungamah D&S from Yarrawonga	2.3	40
TCC on Broken Creek and River	8.1	186
Pipeline East Shepparton WWD	1.8	35
Supply Private Diverters on Broken River from EGM	1.25	5
Raise Lake Nillahcootie	6.5	0
Total for Broken System Offsets	33	346
Total	48	496-511

[1] Some of these offsets require the purchase of entitlement on the Goulburn System to maintain the reliability of supply on that system. The capital cost of purchasing this entitlement (assumed at $1,200/ML) has been added to the total capital costs for implementing each offset, except those not requiring the purchase of entitlement on the Goulburn system, namely, pipelining East Shepparton WWD and raising Lake Nillahcootie.

5.8 Benefit-cost analysis

Table 5-3: Benefits and costs of Option 1

Benefits resulting directly from Option 1		
Item	**PV at 4% ($m)**	**PV at 8% ($m)**
Water savings (44,000ML @ $70/ML/year)	66.2	37.7
Commercial land use (based on agriculture)	1.8	0.3
Savings in cost of water treatment in Shepparton	1.3	0.7
Savings in costs of algal blooms	6.0	3.3
Costs associated with current operation not incurred under Option 1		
Current management and operation costs avoided	12.5	7.1
Total quantified benefits	***87.8***	***49.1***

Costs resulting directly from Option 1		
Item	**PV at 4% ($m)**	**PV at 8% ($m)**
Benefits of current operation given up under Option 1		
Loss of net economic value of recreation activities	4.3	2.9
Extra costs associated with Option 1		
Capital costs of works	13.5	13.0
Annual costs of works	2.8	1.5
Capital costs of offsets	31.6	30.5
Annual costs of offsets	7.1	3.9
Drainage costs	0	0
Bank rehabilitation costs	0	0
Wetland establishment costs	0.2	0.2
Buffer establishment costs	0.7	0.6
Wetland and buffer maintenance costs	0.4	0.3
Total quantified costs	***60.6***	***52.9***
Net Present value	**27.2**	**-3.8**

Unquantified benefits

The recreation use benefits (such as, walking, and bird watching), the indirect use benefits (such as nutrient assimilation), and any non-use benefits of a large area of re-instated wetland. If the value of all other benefits (including the unpriced value of a re-instated wetland) were higher than assumed here they would increase the margin of 'profit' of the option at 4 per cent. At 8 per cent, however, all benefits other than water savings would need to have a combined present value of $3.8million for the option to breakeven. This is equivalent to an annual value of $310,000 per year for 50 years.

5.8.1 Selected sensitivity analyses

Value of water savings

The above results were generated for a value of $70/ML/year – corresponding to a capitalised value at 4 per cent (8 per cent) of $1,500 ($850). The breakeven values of water savings, that is, the value at which the present value of benefits would equal the present value of costs (net present value equals zero) would be around $41ML/year at 4 per cent and $77/ML/year at 8 per cent. These correspond to capitalised values (over 50 years) of $888/ML at 4 per cent and $944/ML at 8 per cent.

Option 2B3 Spit Bank, Permanent Storage, Shallow

Review of the constructability of the proposed spit bank (SKM, 2004) has indicated that coffer dams and additional foundation works may be required. This has resulted in the estimated cost of works to increase. This section documents the necessary amendments to Volume 2 associated with the revised cost of works and the additional water savings identified.

7.1 Descriptions

This option proposes maintaining the current Lake Mokoan operating rules, lowering the lake full supply level (FSL) to EL 164.0 and reducing the lake capacity and surface area to 97GL and 3,080ha respectively by the construction of a partitioning bank. The location proposed for the partitioning bank is on the natural ridge that separated Winton Swamp from Green Swamp. This minimises the height of the bank and makes use of a natural ridge that extends into the lake from the southern shoreline, referred to as the spit, to reduce the length of the bank. The deepest part of the lake is maintained and the shallow eastern end of the lake is removed from the storage. The lowering of the lake FSL also removes the shallow south western corner of the lake from the storage.

The lower lake FSL allows the use of an excavated channel to pass the runoff from the upstream catchment around the smaller lake. The proposal is to construct the channel through the spit and around the southern side of the lake and discharge to the lake outlet channel. The channel will require the breaching of the existing embankment, a structure to prevent back flow from the outlet channel, a subway under the extended inlet channel and three subways to maintain the natural catchment inflow to the lake. The material excavated from the channel may be used to construct the embankment, if suitable, which could significantly reduce the cost.

The option will also require:

- the extension of the inlet channel to the lower lake FSL;
- the rehabilitation of the area removed from the storage;
- the provision of water supply to the Lake Mokoan diverters at the eastern end of the lake; and
- the partial rehabilitation of the existing lake embankment.

7.3 Modelling

Table 7-1: Water Savings and Impacts on Broken In Valley Users – 97GL Current Operation

	Water Savings	Increase[1] in av. annual shortfalls	Prob. allocation of 170%LV occur	Prob. allocation of > 100%LV occur	Increase[1] in av. annual Broken outflows to Goulburn	Increase[1] in av. annual Broken supply to Murray
	(GL)	(GL)	(% years)	(% years)	(GL)	(GL)
Without offsets	30	0.8 (0 - +19)	63	79	36	-4.5
With Nillahcootie offset	30	0.4 (-3 - +15)	76	81	34	-3.2
With Tungamah offset	34	-0.6 (-7 - +10)	75	84	38	-3.3
Base case	-	-	66	80	-	-

Note: [1] Compared to NRE Base Run. Values in brackets are the shortfall range.

7.4 Cost

The estimated cost of partitioning Lake Mokoan at a FSL of EL164 and operating it with current rules is $59.5million with ongoing annual costs of $680,000 to $690,000 as shown in Table 7-2.

Table 7-2: Option 2B3 Costs

Description		Capital Cost $million	Annual Cost $'000
Partition Lake Mokoan		27	40
Inlet channel extension		1	4
Water supply to lake diverters		3	20
Existing Embankment, Weirs and Channels		0	516
Embankment Rehabilitation Cost	Year 5 Year 10	1.5 4.5	0
Natural catchment drainage works		9	10
Environmental Works		1	10-20 depending on year
Offset – Pipeline Tungamah system		12.5	80
	Total	59.5	680-690

7.8 Benefit-cost analysis

Table 7-4: Benefits and costs of Option 2B3

Benefits resulting directly from Option 2B3		
Item	**PV at 4% ($m)**	**PV at 8% ($m)**
Water savings (34,000ML @ $70/ML/year)	51.1	29.1
Estimated remaining benefits of Tungamah pipeline	7.3	4.8
Commercial land use (based on agriculture)	0.05	-0.2
Savings in cost of water treatment in Shepparton	1.0	0.5
Savings in costs of algal blooms	1.5	0.8
Costs associated with current operation not incurred under Option 2B3		
Current management and operation costs avoided	11.3	6.4
Total quantified benefits	***72.2***	***41.4***
Costs resulting directly from Option 2B3		
Item	**PV at 4% ($m)**	**PV at 8% ($m)**
Benefits of current operation given up under Option 2B3		
Loss of net economic value of recreation activities	3.2	2.4
Extra costs associated with Option 2B3		
Capital costs of works	29.8	28.7
Annual costs of works	11.9	6.6
Capital costs of offsets	12.0	11.6
Annual costs of offsets	1.6	0.9
Drainage costs	8.9	8.5
Bank rehabilitation costs	4.3	3.1
Wetland establishment costs	0.1	0.1
Buffer establishment costs	0.3	0.3
Wetland and buffer maintenance costs	0.3	0.2
Total quantified costs	***72.4***	***62.4***
Net Present value	**-0.2**	**-21.0**

7.8.1 Selected sensitivity analyses

Value of water savings

The above results were generated for a value of $70/ML/year – corresponding to a capitalised value at 4 per cent (8 per cent) of $1,500 ($850). The breakeven values of water savings, that is, the value at which the present value of benefits would equal the present value of costs (net present value equals zero) would be about $70/ML/year at 4 per cent and about $120/ML/year at 8 per cent. These correspond to capitalised values (over 50 years) of $1,500/ML at 4 per cent and $1,470/ML at 8 per cent.

Without dam rehabilitation costs

If dam rehabilitation costs are removed, the net present value at 4 per cent (8 per cent) is plus $4.0million (minus $17.8million). The breakeven value of water savings at 4 per cent (8 per cent) falls to about $65/ML/year ($112/ML/year). These correspond to capitalised values over 50 years of $1,386 (4 per cent) and $1,380 (8 per cent).

Table 11-1 summarises the likely water savings, costs and socio-economic implications of the options. The present values referred to in the table are discounted over a period of 50 years and are shown for a discount rate of 4 per cent (8 per cent).

Table 11-1: Summary of Water Savings, Costs and Socio-economic Implications of the Options

Item	Option 1 Return to Winton Swamp (with Tungamah & Broken System Offsets)	Option 2B1 Spit bank, permanent storage, deep	Option 2B3 Spit bank, permanent storage, shallow	Option 3B1 Spit bank, annual storage, deep	Option 3B3 Spit bank, annual storage, shallow	Option 4 Revised operating rules for Lake Mokoan
Water Savings (ML)	44,000	25,000	34,000	29,000	40,000	-1,400
Estimated present value of cost, including lost recreation and dam rehabilitation costs ($m)	60.6 (52.9)	106.3 (92.6)	72.4 (62.4)	93.9 (80.8)	106.1 (93.6)	25.4 (20.6)
Estimated present value of cost per ML saved ($/ML)	1,377 (1,202)	4,252 (3,704)	2,129 (1,835)	3,238 (2,786)	2,653 (2,340)	n.a.
Estimated present value of benefits ($m)	87.9 (49.1)	51.5 (29.1)	72.2 (41.4)	55.1 (31.2)	72.7 (41.2)	-1.4 (-0.8)
Estimated present value of net benefit, including dam rehabilitation costs ($m)	27.2 (-3.8)	-54.8 (-63.5)	-0.2 (-21.0)	-38.8 (-49.6)	-33.4 (-52.4)	-26.8 (-21.4)
Estimated breakeven present value of water savings ($/ML)	888 (944)	Approx. 3,700 (3,396)	Approx. 1,500 (1,470)	2,842 (2,569)	2,340 (2,170)	n.a. (n.a.)
Estimated present value of net benefit excluding dam rehabilitation costs ($m)	n.a. (n.a.)	-40.6 (-53.1)	4.0 (-17.8)	-24.6 (-39.3)	-29.2 (-49.5)	-12.5 (-10.9)
Estimated range of change in local expenditure by recreationists ($)	-32,000 to -200,000 (mid-point -116,000)	+37,000 to + 47,000 (mid-point + 42,000)	-40,000 to +44,000 (mid-point –2,000)	-60,000 to +9,000 (mid-point – 26,000)	-80,000 to -238,000 (mid-point –158,000)	+16,000 to +48,000 (mid-point +32,000)
Storability of water savings	A range of limited opportunities exist	As for Option 1	As for Option 1	As for Option 1	As for Option 1	n.a.

Item	Option 1 Return to Winton Swamp (with Tungamah & Broken System Offsets)	Option 2B1 Spit bank, permanent storage, deep	Option 2B3 Spit bank, permanent storage, shallow	Option 3B1 Spit bank, annual storage, deep	Option 3B3 Spit bank, annual storage, shallow	Option 4 Revised operating rules for Lake Mokoan
Implication for possible Warby Ranges development	Increases the present value cost of supply for Stage 1 by $36million for the peak supply rate and $19million for the average supply rate and Stage 2 by $27million and $16million respectively	Increases the present value cost of supply from Lake Mokoan to Stage 1 at the peak rate by $10million and at the average rate by $6million. The present value cost for supply to Stage 2 will increase by $2.7 and $1.4million respectively	As for Option 2B1	As for Option 2B1	As for Option 2B1	This option has no implications for the Warby development.
Heritage effects	Relative small effects due to minor disturbance; immediate effects of exposure and drying on waterlogged archaeological deposits (eg cracking of mound clays, vertical movement of artefacts); and rotting of exposed scarred trees.	As for Option 1, plus significant damage to the lunette, resulting in destruction of unquantified but predictably significant archaeological deposits – possibly burials	As for Option 2B1	As for Option 2B1 plus there would be some effects of cycles of wetting and drying which would further destabilise archaeological deposits.	As for Option 2B1 plus there would be continued effects of cycles of wetting and drying which would further destabilise archaeological deposits and probably cause ongoing erosion such as occurs at other inland lakes used for periodic water storage. These effects can result in severe damage to archaeological material.	There would be essentially no change under this option relative to current. Continuation of any current impacts, for example, waterlogging of archaeological deposits and features, and death and destruction of cultural scar-bearing trees.

References

SKM, 2004, Lake Mokoan – Spit Embankment Pre-Feasibility Study: Lake Mokoan – Spit Embankment Option 2B3 Construction Study. Draft Report, January 2004.

Appendix A

Errata for the Final Report of The Lake Mokoan Study, Volume 2

Errors in figure presented in Volume 2 arise from:

a) the change in spit bank construction costs; and

b) changes in water savings.

The errata has only reported errors arising from the re-estimated water savings for Options 2B1, 3B1 and 3B3, however, the change in spit bank construction costs will cause the net present value for these options to be more negative.

1. Errata Section 5 Option 1 – Return to Winton Swamp

Errata Section 5.3 Modelling

The following changes apply to the water savings figures in the first column of Table 5.1.

- With Tungamah and Nillahcootie offsets – water savings figure changes from 36 GL to 40 GL.
- With Tungamah and Eildon to Nillahcootie offsets – water savings figure changes from 37 GL to 47 GL.
- With Eildon to Nillahcootie offset – water savings figure changes from 38 GL to 44 GL.

The following sentence replaces the first sentence under the sub heading 'Impact on Goulburn':

- The impact on the Goulburn will be to increase the average annual shortfall by 6.1 GL for the option with Tungamah and Eildon to Nillahcootie link offsets or 6.9 GL for the option with Eildon to Nillahcootie offset and reduces the reliability of sales allocations.

Errata Section 5.4 Cost

The following changes apply to Table 5-2.

- Insert row before 'Total' and include in the following columns:
  - Description – 'Purchase Entitlement on the Goulburn System (6.9GL @ $1,200/ML)'.
  - Capital Cost $million – 8.
  - Annual Cost $'000 – 0.
- In last row, Total Capital Cost ($million) changes from 67 to 75.

Errata Section 5.8 Benefit-cost analysis

The following changes apply to Table 5-5.

- Water Savings for 4% (8%) changes from 57.1 (32.5) to 66.2 (37.7).

- Total quantified benefits for 4% (8%) changes from 78.6 (43.9) to 87.7 (49.1).
- Capital costs of offsets for 4% (8%) changes from 50.0 (48.1) to 57.7 (55.6).
- Total quantified costs for 4% (8%) changes from 75.7 (68.8) to 83.4 (76.3).
- Net Present Value for 4% (8%) changes from 2.9 (-24.9) to 14.6 (-27.2).

The following sentences replace the last two sentences under the sub heading 'Unquantified benefits':

- At 8 per cent, however, all benefits other than water savings would need to have combined present value of $27.2million for the option to breakeven. This is equivalent to an annual value of $2.2 million per year for 50 years.

Errata Section 5.8.1 Selected sensitivity analyses

The following sentences replace the last two sentences under the sub heading 'Value of water savings':

- The breakeven values for water savings, that is, the value at which the present value of benefits would equal the present value of costs (net present value equals zero) would be $66/ML/year at 4 per cent and $120/ML/year at 8 per cent. These correspond to capitalised values (over 50 years) of $1,410/ML at 4 per cent and $1,475/ML at 8 per cent.

2. Errata Section 6 Option 2B1 – Spit Bank, Permanent Storage, Deep

Errata Section 6.3 Modelling

The water savings figure in Table 6-1 for the With Tungamah offset run should be changed from 22 to 25.

Errata Section 6.8 Benefit-cost analysis

The following changes apply to Table 6-4.

- Water Savings for 4% (8%) changes from 33.1 (18.8) to 37.6 (21.4).
- Total quantified benefits for 4% (8%) changes from 57.5 (33.2) to 51.5 (29.1).
- Net Present Value for 4% (8%) changes from –49.1 (-59.4) to –54.8 (-63.5).

The following sentences replace the last two sentences under the sub heading 'Unquantified benefits':

- If the value of all benefits other than water savings (including the unpriced value of a re-instated wetland) were higher than assumed here, they would need to have combined present value of $54.8million at 4 per cent or $63.5million at 8 per cent for the option to breakeven. These present values are equivalent to an annual value at 4 per cent (8 per cent) of $2.6million per year ($5.2million) for 50 years.

Appendix A

Errata Section 6.8.1 Selected sensitivity analyses

The following sentences replace the last two sentences under the sub heading 'Value of water savings':

- The breakeven values for water savings, that is, the value at which the present value of benefits would equal the present value of costs (net present value equals zero) would be $172/ML/year at 4 per cent and $278/ML/year at 8 per cent. These correspond to capitalised values (over 50 years) of $3,696/ML at 4 per cent and $3,396/ML at 8 per cent.

The following paragraph replaces the paragraph under the sub heading 'Without dam rehabilitation costs':

- If dam rehabilitation costs are removed, the net present value at 4 per cent (8 per cent) is minus $40.6million (minus $53.1million). The breakeven value of water savings at 4 per cent (8 per cent) decreases to $146/ML/year ($244/ML/year). These correspond to capitalised values over 50 years of $3,126/ML (4 per cent) and $2,982/ML (8 per cent).

3. Errata Section 7 Option 2B3 – Spit Bank, Permanent Storage, Shallow

Errata Section 7.3 Modelling

The water savings figure in Table7-1 for the With Tungamah offset run should be changed from 31 to 34.

4. Errata Section 8 Option 3B1 – Spit Bank, Annual Storage, Deep

Errata Section 8.3 Modelling

The water savings figure in Table 8-1 for the With Tungamah offset run should be changed from 25 to 29.

Errata Section 8.8 Benefit-cost analysis

The following changes apply to Table 8-4.

- Water Savings for 4% (8%) changes from 37.6 (21.4) to 43.6 (24.8).
- Total quantified benefits for 4% (8%) changes from 49.1 (27.8) to 55.1 (31.2).
- Net Present Value for 4% (8%) changes from –44.8 (-53.0) to –38.8 (-49.6).

The following sentences replace the last two sentences under the sub heading 'Unquantified benefits':

- If the value of all benefits other than water savings (including the unpriced value of a re-instated wetland) were higher than assumed here, they would need to have combined present value of $38.8million at 4 per cent or $49.6million at 8 per cent for the option to breakeven. These present values are equivalent to an annual value at 4 per cent (8 per cent) of $1.8million per year ($4.1million) for 50 years.

Errata Section 8.8.1 Selected sensitivity analyses

The following sentences replace the last two sentences under the sub heading 'Value of water savings':

- The breakeven values for water savings, that is, the value at which the present value of benefits would equal the present value of costs (net present value equals zero) would be $132/ML/year at 4 per cent and $209/ML/year at 8 per cent. These correspond to capitalised values (over 50 years) of $2,842/ML at 4 per cent and $2,569/ML at 8 per cent.

The following paragraph replaces the paragraph under the sub heading 'Without dam rehabilitation costs':

If dam rehabilitation costs are removed, the net present value at 4 per cent (8 per cent) is minus $24.6million (minus $39.3million). The breakeven value of water savings at 4 per cent (8 per cent) decreases to $109/ML/year ($180/ML/year). These correspond to capitalised values over 50 years of $2,350/ML (4 per cent) and $2,212/ML (8 per cent).

5. Errata Section 9 Option 3B3 – Spit Bank, Annual Storage, Shallow

Errata Section 9.3 Modelling

The following changes apply to the water savings figures in the first column of Table 9-1.

- With Tungamah and Nillahcootie offsets – water savings figure changes from 33 GL to 37 GL.
- With Tungamah and Eildon to Nillahcootie offsets – water savings figure changes from 34 GL to 42 GL.
- With Eildon to Nillahcootie offset – water savings figure changes from 35 GL to 40 GL.

The following sentence replaces the first sentence under the sub heading 'Impact on Goulburn':

- The impact on the Goulburn will be to increase the average annual shortfall by 3.6 GL for the option with Tungamah and Eildon to Nillahcootie link offsets or 5.9 GL for the option with Eildon to Nillahcootie offset.

Errata Section 9.4 Cost

The Capital cost for Offset - Lake Eildon to Lake Nillahcootie Link figure in Table 9-2 should be changed from 49 to 56.

Errata Section 9.8 Benefit-cost analysis

The following changes apply to Table 9-4.

- Water Savings for 4% (8%) changes from 51.1 (29.1) to 60.2 (34.3).
- Total quantified benefits for 4% (8%) changes from 63.6 (36.0) to 72.7 (41.2).
- Capital costs of offsets for 4% (8%) changes from 47.1 (45.4) to 53.9 (51.9).

- Total quantified costs for 4% (8%) changes from 99.3 (87.1) to 106.1(93.6).
- Net Present Value for 4% (8%) changes from –35.7 (-51.1) to –33.4 (-52.4).

The following sentences replace the last two sentences under the sub heading 'Unquantified benefits':

- If the value of all benefits other than water savings (including the unpriced value of a re-instated wetland) were higher than assumed here, they would need to have combined present value of $33.4million at 4 per cent or $52.4million at 8 per cent for the option to breakeven. These present values are equivalent to an annual value at 4 per cent (8 per cent) of $1.6million per year ($4.3million) for 50 years.

Errata Section 9.8.1 Selected sensitivity analyses

The following sentences replace the last two sentences under the sub heading 'Value of water savings':

- The breakeven values for water savings, that is, the value at which the present value of benefits would equal the present value of costs (net present value equals zero) would be $109/ML/year at 4 per cent and $178/ML/year at 8 per cent. These correspond to capitalised values (over 50 years) of $2,340/ML at 4 per cent and $2,170/ML at 8 per cent.

The following paragraph replaces the paragraph under the sub heading 'Without dam rehabilitation costs':

- If dam rehabilitation costs are removed, the net present value at 4 per cent (8 per cent) is minus $29.2million (minus $49.5million). The breakeven value of water savings at 4 per cent (8 per cent) decreases to $104/ML/year ($171/ML/year). These correspond to capitalised values over 50 years of $2,234/ML (4 per cent) and $2,094/ML (8 per cent).