Decommissioning Lake Mokoan Program

MINI LAKE MOKOAN — MODELLING OF WATER SAVINGS AND RELIABILITY AND COMPARISON WITH MODIFIED LAKE MOKOAN AND FULL DECOMMISSIONING

- Final 1
- 7 December 2007

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1. Introduction

Sinclair Knight Merz (SKM) has been commissioned by the Department of Sustainability and Environment (DSE) to simulate a storage proposal which is being considered as an offset to ensure existing reliability of supply is maintained when Lake Mokoan is decommissioned. The storage proposal involves creating a 20 – 30GL storage in the area of Sergeants Swamp within the existing Lake Mokoan area. This storage has been modelled as part of this project and compared to the modified Lake Mokoan Proposal and the decommissioning scenario.

1.1 The study area

The Broken River and Broken Creek are located in North East Victoria. The Broken River flows into the Goulburn River at Shepparton, which then flows into the Murray River. The Broken Creek flows into the Murray River upstream of the Murray's confluence with the Goulburn River. Two major storages currently service the Broken River and Broken Creek systems: Lake Nillahcootie and Lake Mokoan.

Lake Mokoan is an off-stream storage in the Broken River valley near Benalla. It has a capacity of 365,000 ML, a surface area of about 7,880 ha and a maximum depth of 7.3 m. Lake Mokoan was formed in 1972 by the construction of an embankment to inundate a series of wetlands, the largest being Winton Swamp.

1.2 The Decommissioning Lake Mokoan Program

In 2004, New South Wales, Victoria, South Australia, the Australian Capital Territory and the Commonwealth Government signed an intergovernmental agreement to address water over-allocation in the Murray-Darling Basin. The Victorian Government formulated its commitment to returning water to the Murray (and Snowy) River in 2004, with its White Paper *Securing Our Water Future Together: Our Water Our Future* (DSE, 2004). This commitment included decommissioning Lake Mokoan.

A major works program has been commissioned to reduce losses, provide alternate sources of supply and increase the operating efficiency of the Broken basin water supply system (DSE, 2004). This program to maintain security of supply to Broken System irrigators has been termed the "Offset Package". The Project to decommission Lake Mokoan is being implemented by Goulburn-Murray Water (G-MW).

The Government's commitment is for the offset package to achieve a reliability of supply of at least 91%. Four offset package options, that achieve this requirement, are currently under consideration and these are detailed on the Lake Mokoan web site (www.lakemokoan.com – Fact Sheet 11, Attachment 1 – ref: G-MW, 2006).

1.3 Modified Mokoan Proposal

A group of local irrigators are claiming existing reliability of supply is 97% and have presented an alternative proposal for a modified Lake Mokoan to achieve this claim. The proponents are claiming that the Modified Lake Mokoan proposal will provide considerable water savings and a reliability of supply that is acceptable to Broken River irrigators.

The Modified Lake Mokoan proposal consists of a storage on Winton Swamp created by two major embankments. The proposal also includes the following:

- Associated infrastructure including an outlet channel, flood pumping from Greens Swamp into the storage, outlet and overflow structures;
- Supply pipelines and channels servicing diverters directly from Lake Mokoan;
- committed offsets that are common to the Lake Mokoan decommissioning proposal, including Tungamah domestic and stock pipeline, Mawsons/Burnbrae entitlement purchase, improved system monitoring and, the rain rejection storage;
- Mid-Murray Storage;
- Limited works decommissioning (breaching embankment and removal of existing outlet structure); and,
- Entitlement purchase for Murray/Goulburn reliability requirements.

The Modified Lake Mokoan design uses the natural contours of the Lake Mokoan site, and constructed embankments, to confine the water storage to the former Winton Swamp area. The former Sergeants Swamp area, west of the storage would be drained and the former Greens Swamp, to the east of the storage would be rehabilitated as a natural feature.

Water is proposed to be transferred into the Wetlands Storage from the existing Lake Mokoan inlet channel and from Greens Swamp via flood pumping.

This proposal was modelled by SKM for DSE (SKM, 2007) with the exception of modelling the proposed offsets described above.

1.4 Mini Lake Mokoan

The Mini Lake Mokoan proposal involves the construction of an additional embankment which will separate an area of Sergeants Swamp from the rest of the Lake Mokoan area. Consideration was given to a storage with a capacity in the range of 20 – 30GL with an inlet channel in the range of 500 to 1,000 ML/day. The proposal also includes the committed offsets that are common to the Lake Mokoan decommissioning proposal, including:

- Tungamah domestic and stock pipeline;
- Mawsons/Burnbrae entitlement purchase; and,
- improved system monitoring.

2. Water Resource System Modelling

Water resource modelling was undertaken to simulate the hydrology of the Mini Lake Mokoan proposal, including the offsets and compare this with the Modified Lake Mokoan and Decommissioning Mokoan scenario. As part of this project, it was necessary to include the offsets in the Modified Lake Mokoan simulation to enable it to be compared with both the other scenarios which include modelling of offsets.

2.1 Background

2.1.1 The Broken River System

Overview

Operation of the regulated Broken system for in-valley requirements is based on meeting commitments to the primary entitlement holders and minimum flow rules defined in the Broken System Bulk Entitlement (BE).

The water resource available to primary entitlement holders is derived assuming:

1. Maximising harvesting from Broken River and Holland's Creek to Lake Mokoan subject to:
   - Tributary inflows downstream of Lake Nillahcootie;
   - Channel capacity constraints;
   - Minimum flow requirements as defined by the BE; and,
   - Maximum rate of rise of the lake.

2. Satisfying demand downstream of Casey's Weir from Lake Mokoan resources, subject to resource availability and operational constraints (refer below for detail).

Lake Mokoan Current Operational Constraints

Lake Mokoan was commissioned in 1971 and is currently operated to supply irrigation demands in the Broken River valley and to supplement the Lower Goulburn and River Murray. Rules have been implemented to limit the rate of rise and fall of the storage to maintain water quality and thereby reduce likelihood of blue-green algae (BGA) blooms. At times when BGA outbreaks occur, releases from the Lake are not made. At these times the Broken River allocation is reviewed and adjusted downwards if there is insufficient resource available to meet the announced allocation.

Goulburn and Murray Supplements

Resources from Lake Mokoan have been used to supplement flow requirements downstream of Shepparton and/or downstream of McCoy's Bridge in the Goulburn system. Releases from the storage have also been used to alleviate channel capacity problems and to boost water availability in the Murray system. This additional supply from Lake Mokoan is available if regulated licence and sales entitlement in the Broken System are already met in that season.

Allocation Policy

The allocation policy for the private diverters in the Broken system is based on the total available resource, assuming Lake Mokoan is either on or off line.

Bulk Entitlement Minimum Flow Requirements

Bulk entitlement minimum flow requirements are specified at Moorngag, Broken Weir, Holland's Weir and Gowangardie Weir.

2.1.2 The GSM Model

G-MW and DSE maintain a monthly model of the irrigation supply system on the Goulburn River called the Goulburn Simulation Model (GSM). GSM is a REALM (**RE**source **AL**location **M**odel) model. REALM is a water supply system simulation package. Any water supply system can be configured in REALM as a network of nodes and carriers representing reservoirs, demand centres, waterways, pipes, etc. System changes (e.g. new operating rules, physical stream modification) can be quickly and easily configured and investigated in REALM. The GSM simulation period is 1891-2005.

The base case against which the proposed Mini Lake Mokoan and the Modified Lake Mokoan proposal has been compared is the system operation as described above. This relates to system operation prior to the commissioning of the new Tungamah domestic and stock pipeline system. It includes rules which limit the rate of rise and fall of the lake and simulates lake closure due to BGA constraints.

2.1.3 Modelling Method for Mini Lake Mokoan

A new storage was added which represents the Sargeants Swamp Area. The existing Lake Mokoan storage was altered to represent the proposed Mini Lake Mokoan storage with a capacity of either 20GL or 30GL for different scenarios. Inlet channel capacities of 500 to 1,000 ML/day were considered but only the 500 ML/day capacity was taken through to final assessment.

A volume-area-level rating table was provided for the proposed storage. The rating table for the remaining Winton’s & Greens Swamp was prepared using a geographical information system to calculate the area and volume inundated at 0.1 metre intervals.

Offsets were required to be modelled which involved:

- Adding an additional demand node on the East Goulburn Main to represent supply to the Tungamah D&S pipeline and reducing the commitment to supply Tungamah D&S(including associated losses) from Broken River at Casey's Weir;
- Reducing the entitlement and demand for the Lower Broken Diverters demand node to represent the Mawsons/Burnbrae entitlement purchase.
- Altering the operational loss formula to reflect the reduction expected in operational loss due to improved system monitoring.

The assumptions of the modelling of Modified Lake Mokoan are summarised in Table 1 below.

Table 1 Assumptions included in the GSM model to simulate the Mini Lake Mokoan proposal.

Model component	Assumptions of the model
Green's & Winton Swamp	- Full Supply Volume of 21,122ML with surface area of 2,350ha - No planned diversion in or out, other than flows above full supply volume passed downstream to the Broken River - 100% of natural flows to Lake Mokoan directed to the combined Greens & Winton Swamp area
Mini-Mokoan Storage	- Full Supply Volume of 20,000 ML or 30,000ML with surface area of 664 ha or 685ha respectively - 0% of natural flows to Mini Lake Mokoan storage - Planned diversion via inlet channel limited to 500ML/day - No BGA rules assumes unrestricted response to demand - No rise/fall limit forced - Annual storage (no planned carry over)
Other Offset(s)	- Tungamah D&S pipeline, Mawsons/Burnbrae entitlement purchase and improved system monitoring
EGM supply	- No supplement to the EGM

2.1.4 Modelling Method for Modified Lake Mokoan

The process of adding the offsets to the simulation of the Modified Lake Mokoan proposal was to use the previous model simulations as described in SKM (2007) and make changes to simulate the offsets. This involved:

- Adding an additional demand node on the East Goulburn Main to represent supply to the Tungamah D&S pipeline and reducing the commitment to supply Tungamah D&S (including associated losses) from Broken River at Casey's Weir;
- Reducing the entitlement and demand for the Lower Broken Diverters demand node to represent the Mawsons/Burnbrae entitlement purchase.
- Altering the operational loss formula to reflect the reduction expected in operational loss due to improved system monitoring.

The assumptions of the modelling of Modified Lake Mokoan are summarised in Table 2 below.

Table 2 Assumptions included in the GSM model to simulate the Modified Lake Mokoan proposal.

Model component	Assumptions of the model
Green's Swamp	- Full Supply Volume of 3,833 ML with surface area of 678 ha - No planned diversion in or out, other than flows above full supply volume passed to Wetland Storage - 48% of natural flows to Lake Mokoan directed to Greens Swamp
Wetland Storage	- Full Supply Volume of 62,040 ML with surface area of 2,096 ha - 52% of natural flows to Lake Mokoan directed to Wetland storage - Planned diversion via inlet channel limited to channel capacity and no release below dead storage of 13,029 ML - Receives flow from Greens Swamp via flood pumping - No BGA rules assumes unrestricted response to demand - No rise/fall limit forced - Annual storage (no planned carry over)
Sergeants Swamp	- No evaporation or losses from Sergeants Swamp has been assumed
Other Offset(s)	- Tungamah D&S pipeline, Mawsons/Burnbrae entitlement purchase and improved system monitoring - Rain rejection storage
EGM supply	- No supplement to the EGM

2.1.5 Model Results

2.1.5.1 Net Evaporation

The changes in evaporation losses for Mini Lake Mokoan proposal, the Modified Lake Mokoan proposal and Decommissioning and are summarised in Table 3 below.

- **Table 3 Change in Net Evaporation.**

Waterbody	Decommissioning Mokoan (GL/year)	20GL Mini Mokoan Proposal (GL/year)	30GL Mini Mokoan Proposal (GL/year)	Modified Mokoan Proposal (GL/year)
Removal – reduction in evaporation				
Existing Lake Mokoan Storage	-47.8	-47.8	-47.8	-47.8
Addition - increase in evaporation				
Winton Swamp	+14.4	+12.3	+12.3	+13.8
Greens Swamp				+3.4
Sergeants Swamp		+4.0	+4.5	0.0
Lake Nillahcootie	+0.1	+0.5	+0.6	+0.6
Net Change	**-33.3**	**-30.9**	**-30.4**	**-30.0**

As shown in Table 3, the major changes are:

- **For Decommissioning** the complete removal of Lake Mokoan as a storage results in an average reduction of 47.8 GL/year in evaporation. However, the remaining wetland (Sergeants, Winton and Greens Swamp) has an average evaporation of 14.4 GL/year resulting in net reduction in evaporation of an average of 33.3 GL/year.
- **For the 20GL Mini Lake Mokoan proposal**, the removal of Lake Mokoan as a storage results in an average reduction of 47.8GL/yr in evaporation. However there is an increase in evaporation due to the new storage of 4.0GL/yr and 12.3GL/year in the remaining Winton and Greens Swamp wetland. Also, Nillahcootie evaporation increases by 0.5GL/year as it will operate on average at higher levels. This results in net reduction in evaporation of an average of 30.9GL/year.
- **For the 30GL Mini Lake Mokoan proposal**, the removal of Lake Mokoan as a storage results in an average reduction of 47.8GL/yr in evaporation. However there is an increase in evaporation due to the new storage of 4.5GL/yr and 12.3GL/year in the remaining Winton and Greens Swamp wetland. Also, Nillahcootie evaporation increases by 0.6GL/year as it will operate on average at higher levels. This results in net reduction in evaporation of an average of 30.4GL/year.

- **For the Modified Lake Mokoan proposal**, the removal of Lake Mokoan as a storage results in an average reduction of 47.8GL/yr in evaporation. However there is an increase in evaporation due to the new storage of 13.8GL/yr and 3.4GL/year in the remaining Greens Swamp wetland. Also, Nillahcootie evaporation increases by 0.6GL/year as it will operate on average at higher levels. This results in net reduction in evaporation of an average of 30.0GL/year.

2.1.5.2 Total Water Savings

Total water savings are defined based on change in flow in the Goulburn River at McCoy's Bridge. The results of the modelling incorporating the offsets is presented below in Table 4. The difference in water savings for the 20GL and 30GL Mini Lake Mokoan is 10.2GL/year and 10.9GL/year respectively less than the 47.5GL/year water savings achieved by decommissioning Lake Mokoan.

Table 4 Change in total water savings

Decommissioning Lake Mokoan (GL/year)	20GL Mini Mokoan Proposal (GL/year)	30GL Mini Mokoan Proposal (GL/year)	Modified Lake Mokoan Proposal (GL/year)
47.5	37.3	36.6	36.0

2.1.5.3 Reliability

The reliability of the simulated Mini Lake Mokoan Proposal including offsets was calculated to be 92% and 93% for the 20GL and 30GL options respectively. The inclusion of offsets in the simulation of the Modified Lake Mokoan resulted in a reliability of 94% without consideration of any blue-green algae problems.

The occurrence of blue-green algae blooms in the Mini Lake Mokoan or Modified Lake Mokoan would reduce the reliability of supply. The closure of the storage arising from blue-green algae outbreak reduces the ability to meet demand and also increases evaporation in the idle reservoir. A comparison of reliability for each scenario is presented in Table 5 below.

Note that the previous estimate of reliability of supply of 96% was an approximation only. The 94% specified above represents a more accurate calculation of reliability.

Table 5 Comparison of reliability

Decommissioning Lake Mokoan (GL/year)	20GL Mini Mokoan Proposal (GL/year)	30GL Mini Mokoan Proposal (GL/year)	Modified Lake Mokoan Proposal (GL/year)
91%	92%	93%	94%

2.1.5.4 Proposed 80/20 Sales Sacrifice

The 80/20 sales sacrifice which the proponents have suggested would yield 3,500 ML for the Modified Lake Mokoan proposal has not been included in the modelling. The maximum historical usage of sales is 3,800 ML. 20% of this volume is 760ML/yr. Based on current usage of sales in the Broken River system, an estimate of the likely available long term average is around 400ML/yr (pers comm. Barry James, DSE, 2007). Hence, the equivalent water savings benefit of this proposed sales sacrifice is 0.4 GL/year. Note that this has not been modelled, so additional water savings of 0.4GL/year may be possible in addition to the results presented in the section above, if this sales sacrifice volume was saved.

2.1.5.5 Goulburn and Murray Entitlement Reduction

This has not been modelled within the scope of this project. The figure of 4,500 ML entitlement purchase would need to be confirmed with additional modelling.

3. Conclusions

The water savings of the Mini Lake Mokoan proposal has been compared to the Modified Lake Mokoan proposal and the Decommissioning scenario. The findings of this assessment are presented in Table 6 below.

Table 6 Summary of Results

Item	Decommissioning Lake Mokoan (GL/year)	20GL Mini Mokoan Proposal (GL/year)	30GL Mini Mokoan Proposal (GL/year)	Modified Lake Mokoan Proposal (GL/year)
Evaporation Savings	33.3	30.9	30.4	30.0
Total Water Savings	47.5	37.3	36.6	36.0
Reliability	91%	92%	93%	94%

4. References

DSE, 2004. *Securing Our Water Future Together. Our Water Our Future.* Victorian Government Department of Sustainability and Environment, Melbourne, June 2004.

SKM, 2007 *Review of Modified Lake Mokoan proposal* for the Department of Sustainability and Environment