SINCLAIR KNIGHT MERZ
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River Murray Catchment Water Management Board

# The basis for the River Murray Catchment Plan Farm Dam Volume Limits

- Final, Revision 1
- 20 September 2004

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# 1. Introduction

The River Murray Catchment Water Management Plan for the River Murray in South Australia (RMCWMB, 2003) includes policies for the control of water affecting activities. One of the specific policies includes setting limits on farm dam development within a sub-catchment and for individual allotments.

This report provides the background for derivation of this policy. It includes a copy of the rule (Section 2) and supporting information for the rule (Section 3). Conclusions drawn from available research are presented in Section 4, followed in Section 5 by a list of references used to prepare this report.

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# 2. The 30% rule

## 2.1 Development rules in South Australia prior to the 30% rule

At the time of developing the policies that might apply to water affecting activities in the River Murray catchment (in accordance with the *Water Resources Act 1997*), farm dam development in South Australia was only controlled through the *Development Act 1993* and specific provisions relating to development in the Mount Lofty Ranges (MLR) Watershed. The *Development Act 1993* came into force where dam walls were greater than 3 metres in height or 5 ML in volume. The provisions applying in the MLR watershed allowed landholders to capture 50% of the run-off generated from their properties, which was the so-called '50% Rule'.

## 2.2 The 30% rule

The relevant rules specified in the Catchment Plan are as follows (RMCWMB, 2003). The essence of these rules is to limit the farm dam volume on an allotment or in a sub-catchment to 30% of the mean winter (May to November) runoff.

**Section 13.2.1, Principle No. 2**

"…the surface water sub-catchment zone limit of all dams within a surface water sub-catchment zone has been determined by the following calculation:

> The surface water sub-catchment zone limit of all dams (megalitres) = 0.3 (30% of) X area of the surface water sub-catchment zone (sq. km) X long term average rainfall between the months of May and November (mm) X runoff coefficient…"

**Section 13.2.1, Principle No. 4**

"With the exception of stock and domestic dams, the total dam volume allowed on an allotment will be calculated as follows:

> b) If the current total volume of dams in the surface water sub-catchment zone containing the allotment is below that surface water sub-catchment zone limit defined in Principle 2, then the allowable dam volume (megalitres) is the lower volume derived from the application of the following:
>
> i) 0.3 (30%) X the area of the allotment (sq. km) X long term average rainfall between the months of May and November (mm) for the locality X runoff coefficient OR
>
> ii) The surface water sub-catchment zone limit, defined in Principle 2, for the surface water sub-catchment zone containing the allotment minus the current total volume of dams in the surface water sub-catchment zone containing the allotment."

**Section 13.2.1, Principle No. 5**

"Where a dam ('the new dam') is to be constructed on an allotment created by a land division (or series of divisions) of a larger allotment ('the original allotment') that contains a dam or dams ('the old dam'), the combined capacity of the new dam (or dams) and the old dam (or dams) shall not exceed 30% of the long-term average runoff from the original allotment for the period May to November.

# 3. Supporting Information for the Rule

## 3.1 Perceptions of farm dam development

Perceptions of excessive development of farm dams in Eastern Mount Lofty Ranges (MLR) suggested that more stringent controls were required to avoid degradation of water dependent ecosystems and impacts on existing catchment water users. As noted in BC Tonkin (1998), the Marne River and surrounding region was the focus of several farm dam investigations, including those by Good (1992), McMurray (1996), EPA (1998), Thatch Environmental Consultancy (1998) and French and Daniell (1997), as well as subsequent investigations by BC Tonkin (1998) and Nathan et.al. (2000). This list of references highlights that there was significant energy and investment being placed into understanding the downstream effect of farm dams in this region. Almost all of these studies concentrate solely on the hydrologic impacts of the dams, which was the first step towards understanding their impact on downstream water users, including the environment. Only BC Tonkin (1998) examined the links between farm dams and downstream ecology and concluded that farm dams may cause negative impacts on the life cycles of many stream plants and animals in the Upper Marne River and the Marne Gorge.

## 3.2 A comparable indicator of farm dam development

The cause of concern for catchment managers throughout south-east Australia is not the volume or even the density of farm dams per se, but rather the potential downstream impact on other water users, including the environment (eg in Sinclair Knight Merz, 1999). For the purpose of standardising farm dam impacts across Australia and comparing between catchments, a useful indicator of this impact is the volume of farm dams in a catchment relative to its mean annual flow.

## 3.3 Farm dam development in the Marne relative to other areas of Australia

Studies completed throughout Australia (ICAM/SKM 1999; SKM, 2000a, 2000b) indicated that the level of farm dam development in the Marne River catchment is at the upper end of the spectrum in terms of the total farm dam volume as a proportion of mean annual flow. At the time of developing the 30% rule, farm dam hydrologic impact studies had been completed in the Marne River catchment (Nathan et.al. 2000), in the Hawkesbury-Nepean River catchment in New South Wales (SKM, 2000a) and in selected catchments in Victoria and Queensland (ICAM/SKM, 1999, SKM 1998, 2000b, 2000c, 2000d). The volume of farm dams relative to mean annual flow for these catchments is shown in Table 3-1.

Many of the catchments in Table 3-1 were selected for previous study because they were in areas of perceived high farm dam development. That is, catchment managers allocated funds to investigate farm dams in these areas rather than other areas where farm dams were considered to be less of a threat to ecological values and downstream water users. It can be seen that the Marne River has the second highest proportion of farm dam volume relative to streamflow (37% of mean annual flow). This was a strong indicator that the Marne River catchment was already experiencing a very high level of impact from farm dams by Australian standards and that taking a precautionary approach to farm dam management in the Marne River catchment was justifiable until further information became available. This precautionary approach was supported by the work in BC Tonkin (1998) that suggested that farm dams may be affecting ecological values, as discussed in Section 3.1.

A Statewide study in Victoria (SKM, 2003), undertaken after the 30% rule was established, has confirmed that the Marne River is relatively unique in its very high level of farm dam development. With a farm dam volume greater than 30% of mean annual flow, the Marne River catchment would fall into the top 3% of catchments in Victoria in terms of its level of farm dam development relative to mean annual flow. This comparison is based on a very large sample size of around 1500 study catchments.

- **Table 3-1 Farm dam volumes ranked by Dam Volume / Mean Annual Flow**

| Site no. | Catchment name | State | Catchment Area ($km^2$) | Total Dam Volume (ML) | Mean Annual Flow (ML/yr) | Dam Volume / Mean Annual Flow |
|---|---|---|---|---|---|---|
| 416317 | Broadwater Ck | QLD | 108 | 3600 | 6000 | 0.60 |
| **426529** | **Marne R at Cambrai** | **SA** | **238** | **2558** | **6845** | **0.37** |
| 410090 | Yass R u/s Gundaroo | NSW | 388 | 6650 | 20588 | 0.32 |
| 226409 | Ten Mile Ck at Delburn | VIC | 46 | 2383 | 8188 | 0.29 |
| 212320 | South Ck at Mulgoa Rd | NSW | 90 | 3790 | 17460 | 0.22 |
| 212244 | Werriberri Ck at maugers | NSW | 101 | 2160 | 19404 | 0.11 |
| 212048 | South Ck from Mulgoa Rd to Great Western Hwy | NSW | 179 | 4821 | 50952 | 0.09 |
| 212053 | Stone Quarry Ck at Picton | NSW | 85 | 740 | 8784 | 0.08 |
| 2122725 | Mulwaree R at the Towers | NSW | 493 | 2700 | 36384 | 0.07 |
| 212009 | Wingecarribee R from Berrima to Greenstead | NSW | 374 | 3250 | 47928 | 0.07 |
| 229208 | Arthurs Ck at Arthurs Ck | VIC | 105 | 657 | 10127 | 0.06 |
| 212340 | Eastern Ck at Bridge | NSW | 26 | 350 | 5556 | 0.06 |
| 212040 | Kialla Ck at Pomeroy | NSW | 93 | 530 | 10236 | 0.05 |
| 419045 | Peel R at Chaffey Storage | NSW | 407 | 2706 | 53059 | 0.05 |
| 212272 | Wingecarribee R from Sheepwash Bridge to Berrima | NSW | 69 | 1330 | 40452 | 0.03 |
| 229618 | Diamond Ck | VIC | 299 | 740 | 23589 | 0.03 |
| 415245 | Mt Cole Ck at Crowlands | VIC | 158 | 452 | 16097 | 0.03 |
| 212020 | Tarlo R at Swallowtail crossing | NSW | 590 | 1920 | 69204 | 0.03 |
| 212014 | Blackheath Ck at Mt Boyce | NSW | 20 | 76 | 2784 | 0.03 |
| 229215 | Woori Yallock Ck at Woori Yallock | VIC | 323 | 2523 | 94381 | 0.03 |
| 419054 | Swamp Oak Ck at Limbri | NSW | 391 | 900 | 33333 | 0.03 |
| 419076 | Warrah Ck at Old Warrah | NSW | 150 | 215 | 9348 | 0.02 |
| 405238 | Wattle Creek u/s Navarre | VIC | 161 | 310 | 15594 | 0.02 |
| 212280 | Nattai R at the Causeway | NSW | 435 | 1090 | 55872 | 0.02 |
| 405217 | Yea R | VIC | 830 | 1790 | 109000 | 0.02 |
| 419054 | Duncans Ck at Woolomin | NSW | 93 | 177 | 11800 | 0.02 |
| 402204 | Yakamdamdah Ck @ Osbornes | NSW | 255 | 798 | 57778 | 0.01 |
| 229224 | Hoddles Ck | VIC | 33 | 96 | 6974 | 0.01 |
| 212274 | Caalong Ck at Maugers | NSW | 6 | 59 | 5532 | 0.01 |
| 2122051 | Nepean R from Macguires Crossing to Nepean Dam Inflow | NSW | 78 | 180 | 18240 | 0.01 |
| 212028 | Wolgan R at Newnes | NSW | 234 | 140 | 33456 | 0.00 |
| 402206 | Running Ck at Running Ck | VIC | 126 | 126 | 36681 | 0.00 |
| 212019 | Mangrove Ck from d/s dam to Mangrove Mountain | NSW | 111 | 104 | 35220 | 0.00 |
| 212013 | Megalong Crk at Narrow neck | NSW | 26 | 9 | 7932 | 0.00 |
| 402203 | Kiewa River @ Mongams Bridge | VIC | 552 | 242 | 495153 | 0.00 |
| 212021 | MacDonald River at Howes Valley | NSW | 295 | 5 | 30756 | 0.00 |

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## 3.4 Mechanism for farm dam impacts

The mechanism by which farm dams reduce streamflows is well understood (SKM, 2000b). Water in the dam evaporates and is drawn upon for consumptive use. When runoff flows into the dam, it is prevented from reaching downstream areas if the dam is not full. As discussed in Section 3.2, farm dam impact on streamflow is best described relative to the flow in the river. In perennially wet catchments, the dams are often full and inflows spill from the dams with minimal downstream impact relative to the pre-dam conditions in the stream. In dry catchments, when dams are often less than full, small to moderate flow events can be completely or mostly captured in the dams, significantly changing the downstream flow regime. Farm dams have the greatest effect on low flows, particularly during isolated runoff events in summer/autumn and for the first few runoff events at the start of winter. Ideally, an indicator of farm dam impact would be the farm dam volume relative to a low flow indicator, such as the flow exceeded eighty percent of the time. However, $80^{th}$ percentile flows were not readily available and nor are they easily calculated for the practical application of a farm dam policy.

Farm dam volume relative to the mean winter flow was adopted as a reasonble indicator of downstream hydrologic impact. In the Eastern Mount Lofty Ranges, the majority of runoff occurs in the May to November period. Runoff from December to April is highly variable from year to year and the long-term mean summer flow is dominated by isolated storm events of high flow magnitude. The adoption of a mean annual runoff, which includes these summer storm events, would allow farm dam limits to be appropriately set for only a small number of years with high summer flow. In most years, when summer runoff was negligible, more water would be diverted in winter than would otherwise be sustainable. For this reason, a limit on farm dam volume was set relative to the mean winter flow in preference to the mean annual flow.

## 3.5 Linking hydrologic impacts to ecological impacts

Links between farm dam development (and water use in general) and ecologic stress are currently not well investigated or documented on a regional scale (MDBC, 2004). The majority of information, if available, tends to be anecdotal, catchment-specific and related to a broad range of catchment characteristics, such as degree of land clearing, water quality and flow regulation, as well as the volume of water extracted from the catchment. A number of projects are currently underway which will help to better define links between water use and hydrologic and ecologic stress at a regional scale. These include the Sustainable Rivers Audit, soon to be applied across the Murray-Darling Basin, and the Flow Stress Ranking project in Victoria.

The Sustainable Diversion Limit (SDL) project was undertaken in Victoria (SKM, 2003) for the Victorian Department of Sustainability and Environment, with specific linking of the SDL to farm dam impacts in Sinclair Knight Merz (2004). The purpose of the SDL project was to define the limit at which further diversions will result in an unacceptable risk of causing degradation to the environment. Unacceptable risk was defined by an expert panel with reference to a wide range of hydrologic and ecological information (Nathan et.al. 2002). This project determined farm dam volume, mean annual streamflow and a range of other information for over 1500 catchments with unregulated streamflows.

Farm dam impacts were analysed for a subset of SDL catchments in the Upper Wimmera River catchment, which anecdotally has similar hydrologic properties to the Eastern Mount Lofty Ranges. They are both regions with ephemeral streams subject to similar average annual rainfall and evaporation conditions (Bureau of Meteorology, 2001a,b) and both regions rely predominantly on farm dams as their source of water supply. By analysing data in the Upper Wimmera catchment for this report, it was found that:

- The SDL is typically in the order of 5-10% of the mean annual flow.
- For every megalitre of farm dam storage, the average annual reduction in mean annual flow is around 70% of the dam volume.
- This means that for the observed upper value (10%) in the Upper Wimmera, the SDL is reached when the farm dam volume in a catchment is equal to 14% of the mean annual flow (ie. 10% of mean annual flow / 0.7 ML reduction in flow per ML of farm dam = 14% of mean annual flow).
- A value of 14% of the mean annual flow is approximately equivalent to 21% of the mean winter flow (Nathan et.al, 2004).

This means that based on an expert panel approach, there is an unacceptable risk of degradation to the environment in catchments that are hydrologically and climatically similar to the Eastern Mount Lofty Ranges when the level of farm dam development is equal to 21% of the mean winter flow.

Estimates of the SDL are based on regional information that is conditioned by site-specific attributes. As such the estimates need to be inherently conservative (Nathan et.al. 2002). Rather than being viewed as a fixed upper limit on diversion, the SDL is intended to be used as a trigger for undertaking more detailed studies of environmental water requirements.

It could be argued that 21% is the level at which farm dams pose an unacceptable risk to the environment. This was not known at the time that the 30% rule was formulated. However given that the SDL process is deliberately precautionary and that the 30% rule is already in place, it would appear reasonable to retain the rule in its current form.

On this basis, the 30% rule is not inconsistent with the limit indicated by the SDL approach. The 30% rule provides an appropriate trigger beyond which it would need to be demonstrated that new developments do not cause further degradation of the downstream environment. This is a risk

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based method for managing the impacts of farm dams and is considered appropriate in the absence of specific detailed links between hydrologic and ecologic impacts in the Eastern Mount Lofty Ranges.

# 4. Conclusions

Based on this review of the 30% rule for farm dams, it is concluded that:

- Catchments with a level of farm dam development of greater than 30% of mean annual flow have a very high level of farm dam development by Australian standards.
- This high level of farm dam development warranted a precautionary approach to management of the riverine environment when the 30% rule was established.
- Based on an expert panel approach, there is an unacceptable risk of degradation to the environment in catchments that are hydrologically and climatically similar to the Eastern Mount Lofty Ranges when the level of farm dam development is greater than around 21 % of the mean winter flow.
- It could be argued that 21% is the level at which farm dams pose an unacceptable risk to the environment. This was not known at the time the rule was formulated. However given that the SDL rule is deliberately precautionary and that the 30% rule is already in place, it would appear reasonable to retain the rule in its current form.
- This is a risk based method for managing the impacts of farm dams and is considered appropriate in the absence of specific detailed links between hydrologic and ecologic impacts in the Eastern Mount Lofty Ranges. The 30% rule provides an appropriate trigger beyond which it would need to be demonstrated that new developments do not cause further degradation of the downstream environment.

Information to be prepared as part of the Flow Stress Ranking project in Victoria and the Sustainable Rivers Audit project in the Murray-Darling Basin is expected to provide additional regional information about levels of farm dam development and ecologic stress. Based on the work undertaken to date, these additional studies are not expected to result in a significant departure from the 30% rule in the Eastern Mount Lofty Ranges.

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