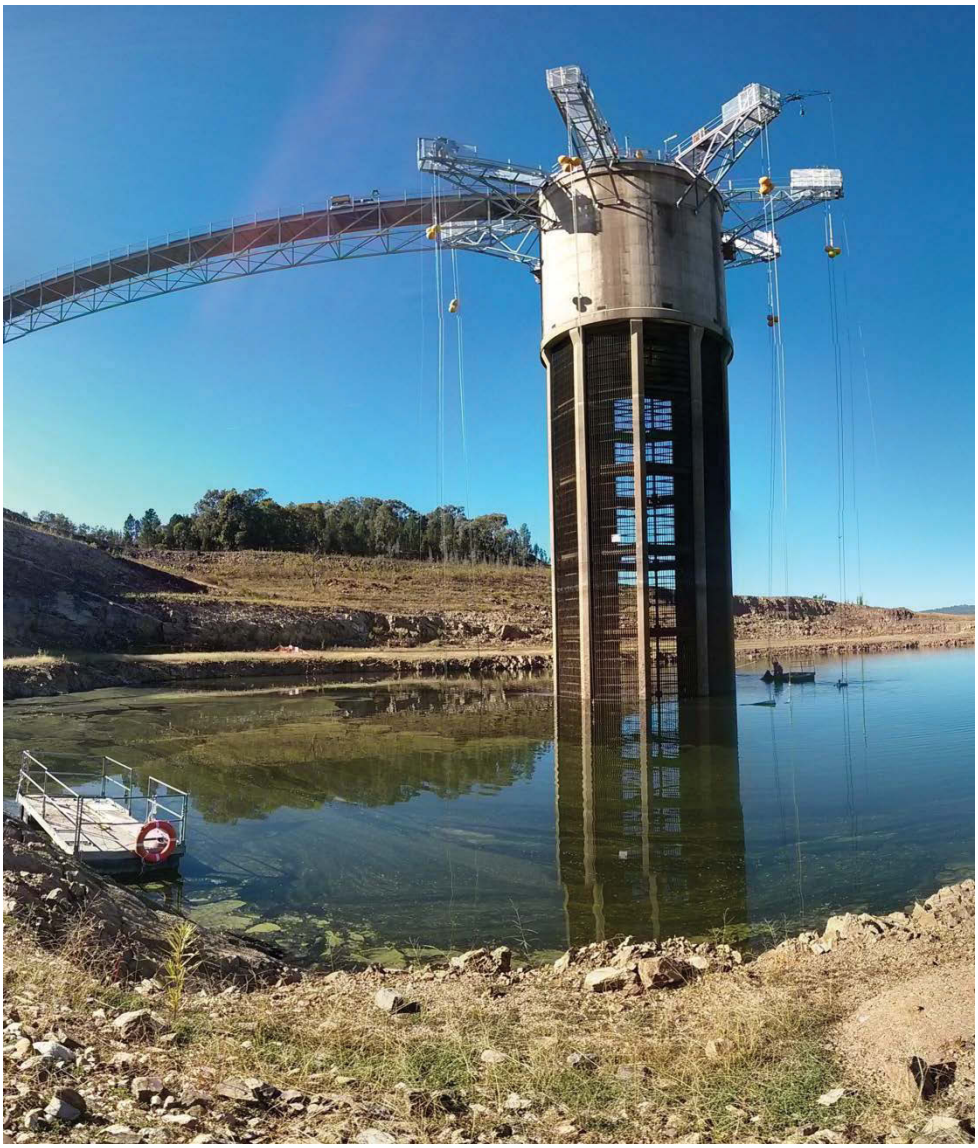
Effectiveness of cold water pollution mitigation at Burrendong Dam using an innovative thermal curtain



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This thesis has been written in the style of a journal. Each chapter has been written as stand-alone chapters, in the style of journal articles so some repetition unavoidably occurs.

Certificate of Original Authorship

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree except as fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

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Rachel Gray

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Abstract

Many dams in Australia are known to create thermal pollution in rivers, often for hundreds of kilometres downstream of the dam wall. Low-level releases from a reservoir during periods of thermal stratification disrupt the downstream thermal regime by supressing the water temperature and reducing the diel variation. Low-level releases have also been linked to elevated nutrient concentrations and altered phytoplankton density and community structure downstream from the dam. To reduce the problem, Burrendong Dam has been fitted with an innovative thermal curtain that directs warmer surface water to the low-level off-take.

This study set out to quantify the magnitude and extent of cold water pollution along the Macquarie River downstream of Burrendong Dam before and after the curtain was implemented. It also aimed to quantify the effect of the dam on nutrient concentrations and phytoplankton density (indicated by chlorophyll *a* concentrations) and community structure before and after thermal curtain operation. This was achieved through analysis of time-series data from temperature loggers installed within the impoundment, upstream and downstream in the Macquarie River, prior to the installation of the thermal curtain. Water samples for analysis of nutrients, phytoplankton concentrations (chlorophyll *a*) and community structure were collected within the reservoir and upstream and downstream of the dam.

CWP was shown to be a long-term problem in downstream river reaches, caused by the release of hypolimnial waters from the dam. Epilimnial releases with use of the curtain improved the thermal regime (mean daily and mean monthly temperature, and

diel temperature range) below the dam so that it more closely resembled the upstream thermal regime with an improvement of approximately 2°C. Fluctuations in nutrients occurred in the hypolimnion of Burrendong Dam during thermal stratification, probably due to the development of an oxycline and subsequently low oxygen concentrations in the hypolimnion. Nutrient concentrations increased at the outlet as a result of hypolimnial releases, with the concentrations breaching the trigger values outlined by ANZECC which indicate ecological disturbance. This study found a substantial increase in the cell count of cyanobacteria at the dam outlet, which may lead to water quality issues in the Macquarie River downstream of the dam. The results of this study will be useful to assist in the management routine of the thermal curtain at Burrendong Dam, to maximise the efficiency of CWP mitigation, whilst not compromising the downstream ecological health in terms of nutrient and cyanobacteria concentrations.