THE BENEFITS OF SHADECLOTH COVERS FOR POTABLE WATER STORAGES

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ABSTRACT

East Gippsland Water participated in a joint venture project with Gale Pacific, CSIRO and SuperSpan which explored the overall benefits of covering water supply storages with shadecloth as an alternative to replacement with covered tanks, solid covers or floating covers. The project ran from 2004 to 2006 with four storages (two raw water and two clear / treated water) monitored for one year uncovered and one year covered. Two control storages (raw and treated) were monitored for two years uncovered. At the end of the study it was shown that the incidence of algal blooms was dramatically reduced. Water fowl and wind-borne organic materials were less likely to enter the water storages. Aquatic plants could longer grow at the bottom of the storages, reducing maintenance costs. Evaporation rates were reduced by approximately 90%. This drop in evaporation loss is highly significant and, in circumstances where alternative water supplies are not available, potentially valuable. The improved water quality and reduced risk of algal blooms and other contamination provided by the covers offers a valuable enhancement in security of water supply.

KEY WORDS

Shadecloth, Algae, Evaporation, Covers, Storages

1.0 INTRODUCTION

This project was a joint venture between Gale Pacific (manufacturers of shadecloth), CSIRO (responsible for design and implementation of monitoring program and interpretation of the data), East Gippsland Water and SuperSpan (design, installation and maintenance of the shadecloth covers). At each site there was a number of monitoring devices installed including weather stations, evaporation pans, flow monitors and multiparameter probes (Algae / Chlorophyll, pH, Temperature, Salinity, Specific conductivity, Turbidity and Depth).

Each of the water storages had a different layout, operation and water source. Storage locations and details are shown in Table 1. All the storages were being monitored from April 2004. Four of the six storages were covered between May and August 2005. Two storages remained uncovered for the whole study to act as controls.

Table 1: ***Storage Properties at Each Site.***

Covered Sites	Water type	Treatment	Capacity (ML)
Cann River	Raw	Disinfection only (hypo)	3
Mallacoota	Clear	Full water treatment	22.8
Omeo	Clear	Full water treatment	5.2
Swifts Creek	Raw	Disinfection only (chlorine dioxide)	4
Control Sites			
Orbost	Clear	Full water treatment	53
Sarsfield	Raw	Disinfection only (Cl gas)	160

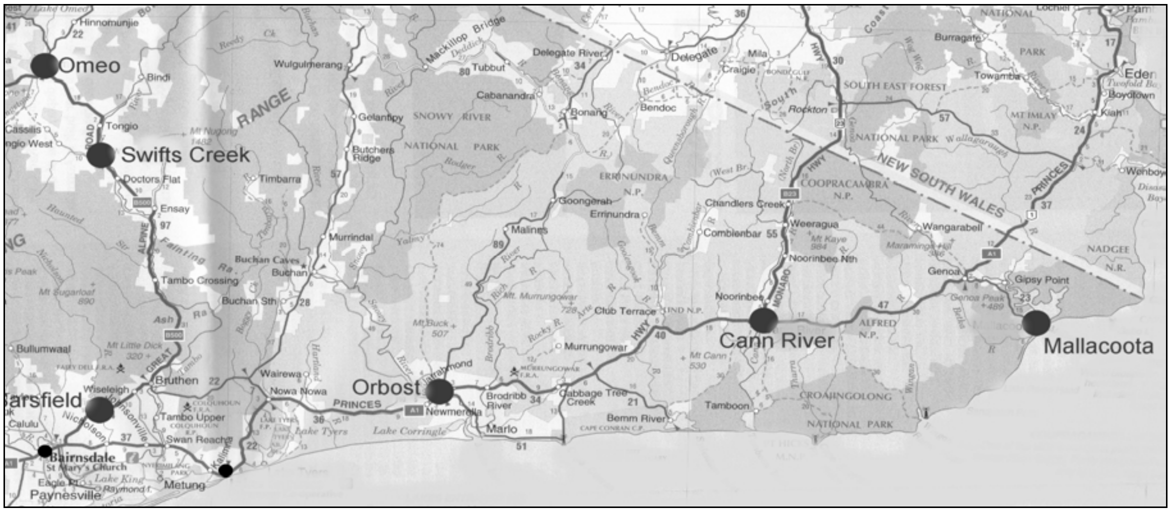


Figure 1: ***Storage Sites Map***

1.1 Shadecloth Structures

The covers for the storages are tensioned architectural structures designed and installed by SuperSpan. The fabric used in the structures was Commercial 95 shadecloth manufactured by Gale Pacific. A tented structure design was used at the storages to allow for access to the water surface at the request of East Gippsland Water. The covers were suspended from steel cables from galvanised steel posts bolted to concrete footings.

Figure 2: ***Swifts Creek Storage – Shadecloth Cover***

2.0 DISCUSSION

2.1 Evaporation

Evaporation rates were significantly reduced. Annual evaporation rate estimates ranged from 870 mm to 1060 mm per year across the sites. At Mallacoota, the largest covered storage, the estimated evaporative loss was equivalent to 8.5 ML of water per year. Air speed under the covers was effectively zero when the skirts were properly fitted and so normal wind surface evaporation was prevented.

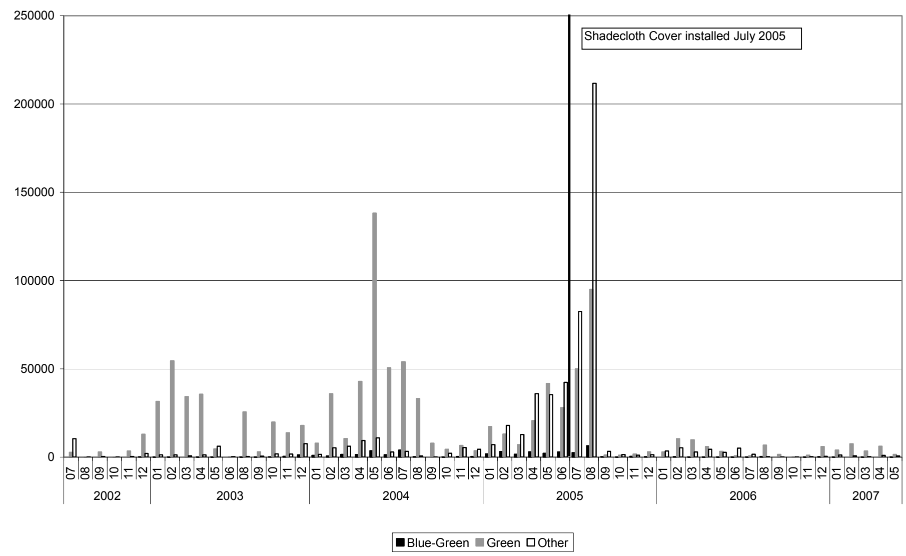
The evaporation rate was estimated to have been reduced by at least 90% by the covers. Evaporation reduction, while not the primary motivation for covering storages, is highly significant and in circumstances where alternative water supplies are not available potentially valuable.

Due to the limited space for this paper only summary data for Mallacoota (covered clear water storage) and Orbost (uncovered clear water storage) is reported. Full details of all storages and calculations can be obtained from the CSIRO report (see References).

2.2 Algae and Bacteria

Mallacoota Clear Water Storage

The Mallacoota water supply is sourced from the Betka River. The water undergoes full water treatment. The storage is a clay-lined, rock beached turkey nest design. Historically the Clear Water Storage experienced high algal numbers during Summer / Autumn. This resulted in 'tainted' water being delivered to customers with incidences of turbidity, taste and odour being recorded. This effectively negated the benefits gained via full water treatment.
Error! Reference source not found. Figure 3 and Figure 4 below show the impact of covering the storage – reduced numbers of algal species and abundance as well as reduced bacterial levels indicating that reduced recontamination of the water after treatment has been achieved.



<u>Figure 3:</u> ***Mallacoota algal abundance, shows a dramatic reduction in algal blooms after covering.***

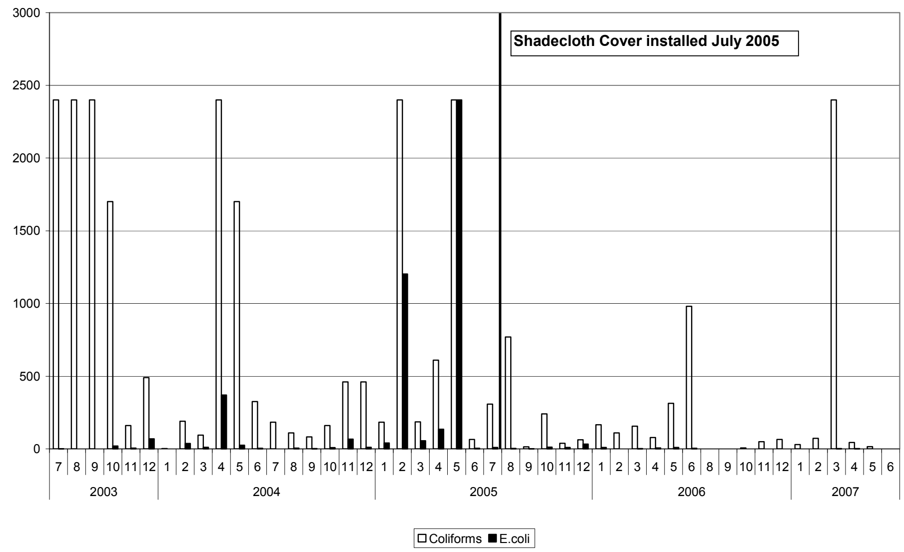


Figure 4: ***Mallacoota bacterial test results. Covering has reduced the frequency of bacterial contamination; probably due to the exclusion of water birds.***

Orbost Clear Water Storage

The township of Orbost is supplied with water harvested from the Brodribb River and Rocky River. This water undergoes full water treatment. Orbost was used as a control site and remained uncovered for the whole study. **Error! Reference source not found.** and Figure 6 show the variations and levels of algae and bacteria in this storage over the period of the study.

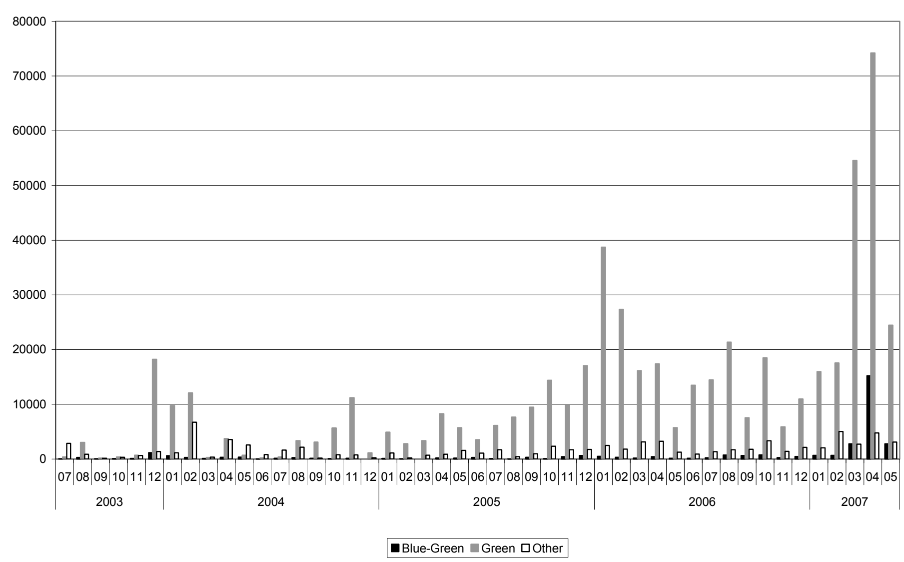


Figure 5: ***Orbost Algal abundance.***

Orbost was relatively free of algal blooms in the first year of the study but showed higher levels in the summer of the second year.

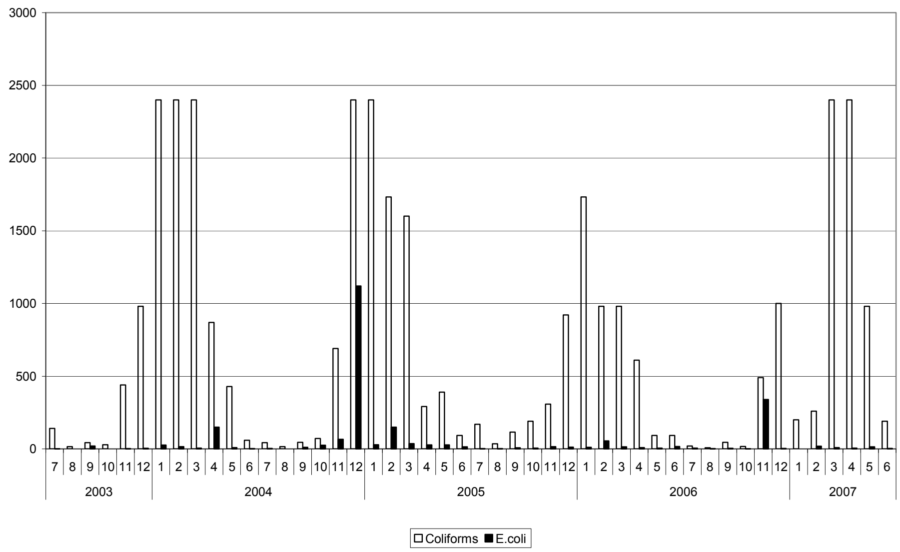


Figure 6: ***Orbost Bacterial test results.***

Bacterial levels at Orbost showed a strong seasonal effect. While not strict controls, the presence of similar or higher levels of algae and bacteria in the uncovered storages during the second year of the study suggested that the reduced levels in the covered storages were not just seasonal variations. This is reinforced by the similar weather and water conditions for the two years of the trials.

2.3 Plant Growth

The four storages to be covered were videoed using a remote controlled robotic camera to assess the amount of aquatic plant growth. These storages were videoed before and after covers were installed. The videos after covering showed that no re-growth of aquatic plants had occurred except in small areas where light leaked through openings in the covers.

2.4 Depth Profiles

Temperature layers (stratification) of the water column was shown to occur at various times in both covered and uncovered storages during hot weather. The temperature gradients appear to be more persistent but smaller in magnitude in covered storages due to reduced evaporation (and therefore reduced evaporative cooling) and to the insulating effect of the covers. When the storage is covered with shadecloth the direct radiation is reduced by approximately 98%. Before the storages were covered the solar radiation during the day penetrated into the water heating the surface layers up to 2 or 3°C warmer than the deeper waters. Although large temperature gradients can be generated in uncovered storages they do not last for long as heat is quickly lost and temperatures equilibrate. Rapid cooling of the surface could also result in a reversal of the temperature gradient that will then result in a 'turnover' of the warmer water and mixing of the layers and can also lift sediments. One effect of the cover is to slow down the speed with which water temperature changes occur and so this type of undesirable event is unlikely to occur in a covered storage.

3.0 CONCLUSIONS

This study has shown that the incidence of algal blooms is significantly reduced by the presence of the shadecloth covers. Access to the storages by animals or windblown contaminants was severely curtailed. Plants no longer grow at the bottom of the storages because of the lack of light, reducing maintenance costs. In the case of raw water storages the frequency of adverse bacterial events was not as greatly reduced as for clear water storages. Minor algal events occurred at the raw water storages after covering. However, the algae introduced into these storages did not readily multiply / grow due to the lack of light. Since covering the storages no remedial action with respect to algae, such as algaecide dosing or draining of the storage, has been required.

The air speed under the covers is effectively zero when the storages are covered and skirts are properly fitted and so normal turbulent surface evaporation isn't possible. Evaporation from covered storages was estimated to be reduced by 90%.

Some practical design issues occurred with the covers and support structures themselves, including abrasion against rock-beaching and objects under the covers and problems with the entrances and skirts. These will be rectified and improvements incorporated into future designs.

The problems with the covers discussed here are, however, minor issues compared to the successes seen since their installation. The improved water quality and massively reduced risk of algal blooms and other contamination provided by the covers offers a valuable enhancement in security of water supply. Evaporation reduction, while not the primary motivation for covering storages, is highly significant and in circumstances where alternative water supplies are not available, potentially valuable.

Shadecloth covers are expected to have advantages over alternative covers in terms of costs, maintenance and ease of operation. Sealed suspended covers carry a risk of growing biofilm on their moist inner surfaces and because they block 100% of the light and seal in gases they pose potential health and safety risks for operators when working inside them. Floating covers require drainage infrastructure for rain capture and also grow potentially problematic biofilms on their inner surfaces. They also do not allow staff access or readily allow visual assessment of the water storage.

4.0 ACKNOWLEDGEMENTS

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5.0 REFERENCES

Finn, N; Barnes, S., "The Benefits of Shade-Cloth Covers for Potable Water Storages", CSIRO Publications, 2007. *This report can be downloaded from the CSIRO publications website :* http://www.csiro.au/resources/Shadeclothcovers.html