



*16th Annual Conference of Small Enterprise Association of Australia and New Zealand,
28 September – 1 October 2003*

Evaporative Control Systems A Case Study In Innovation

*A paper for the Small Enterprise Association of Australia and New Zealand 16th Annual Conference, Ballarat, 28
Sept-1 Oct, 2003.*

Professor Ian Scarman
University of South Australia
North Terrace Adelaide, 5000
Email: ian.scarman@unisa.edu.au

Evaporation Control Systems

NECESSITY – THE MOTHER OF INVENTION

Control of evaporation on farm dams has been called the Holy Grail of irrigation research. It's something people have chased but its never been satisfactorily captured. Evaporative losses from farm dams have always been known to be large but the cost of the solution has always been considered far higher than the value of the water saved. However, over the last few years new materials, and inventive solutions for applying those materials, have come along which have reduced the costs of potential solutions. At the same time the value of water has risen considerably and it is possible that a balancing point has now been reached.

One of those solutions, and one which has just won an important award, was developed by Warwick Hill, a sheep farmer in SE Queensland. Warwick, who is a Commerce and Education graduate from Melbourne University, was a former schoolteacher and university lecturer in economics, accounting and contract law, and he co-authored books on contract law. Teaching and writing was a career he pursued for nearly twenty years, but all through that time he sustained a boyhood dream of becoming a farmer. It never seemed very likely to be possible given the high cost of farming land in Victoria, but a suggestion that he look at cheaper land that was being newly opened up in Queensland, led to a revival of that dream.

In 1977 Warwick and his wife, Diane, found a neglected and therefore cheap property in the western Darling Downs, five hours from Brisbane. The property needed re-clearing but at 4,250 acres it was possible to turn it into a viable sheep property. Warwick and Diane succeeded in doing this over the next few years only to be hit by a three-year drought in 1980. By 1982 they had run completely out of stock water on their property and Warwick had to cart bore water from a town twenty kilometres away to keep his sheep alive. It became obvious to him that he was losing most of the water not down the sheep's throat, but through evaporation.

THE LONG GESTATION

Better rainfall in subsequent years made a solution to the dam evaporation problem less urgent, but it did not escape Warwick Hill's mind, and so began a long gestation period to a solution. He discovered that good data on dam evaporation did not exist in the public domain so he began his own evaporation measurement tests, which confirmed general beliefs, but of course, were not independent.

Another multi-year drought in the mid-90's increased the urgency for finding a solution and Warwick began seriously seeking information. He was steered in the direction of the CSIRO, which had done a big study on water evaporation for the government of Botswana. The study was wide-ranging and looked at many possible solutions to the evaporation problem. One of the suggestions was to use liquid film on the top of the water. Warwick decided to try this approach and used sump oil in a successful small-scale test. However, when he attempted to use it on a 4,000 square metre surface, it didn't last 24 hours. The wind simply blew it away over night without a trace. Similarly, other ideas in the report proved impractical or made only a small difference.

Inspired by watching Gladwrap-covered soup in a microwave oven his thoughts moved on to floating plastic sheet. Warwick had some left over 'bubble-wrap' that he tried on a small tank on his own property. It worked well in terms of stopping evaporation, but this was no surprise, as effective swimming pool covers made from similar materials had been around for some time. It still did not tell him if the idea could be successfully scaled up to dam size. As well, it did not seem likely that ordinary clear bubble-wrap would stand the test of time against harsh UV rays.

Warwick later attended a farming Trade Exposition in Southeast Queensland. When talking through his ideas and seeking advice concerning possible materials to use, he was strongly advised to make contact with Sealed Air Australia. Sealed Air's parent company invented and developed bubble-wrap packaging, and the firm prides itself on its "consultative sales approach" which involves working very closely and listening intently to its potential customers. He also made another important contact at the expo. He managed to interest Max Brady, the proprietor of Darling Downs Tarpaulins, in his dam cover ideas, and later Max joined Warwick in his consortium.

Warwick was very confident by now about the design and type of material that he wanted, and some long discussions with the sealed air technical people ensued. Eventually one of the Sealed Air engineers began to think that a product they had developed for another purpose, but which did not sell well, might suit Warwick's needs. That was how it turned out – a nice win-win, with the additional bonus that Sealed Air had recently re-engineered all its bubble products for greater strength and longer life.

Warwick was also by now confident that he had a business that he could develop. He registered Evaporation Control Systems in 1999 as the corporate vehicle for commercialising his ideas. He eventually put together a working Consortium with Sealed Air Australia, for the manufacture of the jointly developed material used in the covers, and with Darling Downs Tarpaulins, for their fabrication and installation. It is a collaboration defined by a series of written agreements, not a jointly owned company or joint venture. Warwick is happy with the way this has worked. Warwick himself holds the two patents covering the intellectual property in the operation. The patents protect "the method and the system for the construction and deployment of large-scale self-supporting, evaporation control membrane covers and the specialised equipment that allows the construction of the cover on water".

The end product, which came out of this collaboration, can be described as a floating cover made from specialised black and white polyethylene bubble material. The upper surface of white UV stabilised material reflects the sun's heat, while the black underside prevents the penetration of light into the water underneath, thus retarding biological action. This unique multi-layered, polyethylene membrane is 450 microns thick and contains its own buoyancy cells. The bubbles are needed to give enough prominence above the water so the water doesn't tend to come up through the drainage holes and lie on the surface which would cause even greater evaporation than without it. The drainage holes admit into the storage all rainwater than falls on the cover and emit any dangerous gas build-up which may occur from decaying organic matter in the stored water. There is an optimal pattern and spacing for the holes. The design also allows for variation in water level.

The material is environmentally safe – polyethylene is commonly used in food storage – and can be recycled at the end of its usefulness as a cover whenever that may be. It is nearly 100% effective in reducing evaporation from open storages and it brings with it a number of ancillary benefits. It reduces algal and weed growth in the stored water and minimises salt build-up. It reduces wave action that causes bank erosion on un-lined storages, and the reduced wave action in turn lowers the turbidity of the stored water.

Warwick had realised earlier that he would need help with the construction of the dam covers and in Max Brady he had someone with all the necessary skills and experience. They quickly found that smaller covers up to and including the fairly common 20m by 20m farm dam could be put together in Max's factory and transported to the site. But to cover very large areas of dam surface was clearly going to involve a lot of onsite work. Whilst Max had considerable experience in installing dam liners, this was different. Larger covers needed to be put in place when the dam was full, and since the product came in 6m wide rolls, the only feasible way to construct a large cover was to float the pieces onto the dam surface and join them on the water. A large cover needs many rolls of material and the problem of joining all the pieces while floating on the surface of a large dam is not a trivial matter.

JOINT DISASTER

Warwick's next headache, therefore, was to find an effective and economic way to join the pieces to create large covers. Several experts (including Max Brady) advised Warwick that plastic could not be welded when wet and that it was very dangerous in any case to use electricity on water. So he began to consider and try many other ways of joining the polyethylene sheets. He eventually settled on aluminium aeronautic rivets. This choice was workable in that it could be relatively easily done but it would lead to some serious practical problems later on.

The rivets were totally imported and supply chain interruptions occurred several times. They were used on the first major project ECS undertook, and were partly responsible for the disastrous failure of this first attempt. Although workable they probably were not the ideal joining solution in the first place and with less than the desired number on hand due to supply problems, they were spaced too far apart. This allowed the wind to get under the joins and tear away the connections. An overnight windstorm blew the nearly completed cover off the dam and damaged the material seriously. This disaster left Warwick Hill shattered and almost exhausted his determination and persistence. The experience also put a serious squeeze on his financial resources. The disaster cost the three partners almost \$200,000.

This first large-scale project was installed in September/October 2001 at Moonrocks, the St. George, Queensland property owned by the Moon family, and home of the famous Moonrocks rockmelon products. These top quality products are successfully marketed throughout the eastern seaboard. With a high value crop to protect, the chance to absolutely guarantee the security of their water meant they were willing to be the first to take a risk on an unproven system (on this scale), and invest a large sum - \$250,000 – in order to guarantee their water supply.

BACK ON THE HORSE

Eventually Warwick recovered his enthusiasm and set about finding a superior method about joining the sheets. Clearly if the 'big tarp' idea, as it was being called in the media, was going to work another method for joining the rolls had to be devised. The moons were still keen, despite the first failure, because of the value to them of water security. Sealed Air was still keen and offered free material for a second attempt. Max Brady was also still keen and was willing to work with Warwick and contribute to the further development of his ideas.

Welding was actually Warwick's first choice for joining the pieces, and in fact, Brady had already used it successfully on the cover material converting Sealed Air's 1.4m rolls into 6m welded rolls in his Toowoomba factory. Now they began to re-think and reconsider onsite welding, which with plastic essentially means heating, melting, and fusing together the edges of the plastic sheets. Warwick had already developed and built a floating raft-like construction for the earlier riveting process. Now, with some help from Max Brady and his engineer son Lachlan, developed his now patented welding technique. They discovered that if the material is kept very clean, it can be welded when wet, and they had already found ways to remove the risks of using electricity whilst floating on the water. Warwick then successfully converted his floating riveter into a floating welder, which he has likened to a large floating sewing machine, pulling together the two pieces of bubble-wrap cover like two pieces of cloth going through a sewing machine and sealing them together on the way through.

They were now ready, five months later, to have a second attempt at the Moonrocks project. Eight semi-trailers delivered 20 tonnes of what was now being called E-VapCap. The rolls were gently floated out across the dam and they were welded together on the water rather than riveted. Despite some nervousness following another overnight windstorm, the second attempt succeeded. In doing so they established the basis on which the ECS business could be built. The Moonrock's dam cover is believed to be the largest of its kind in the world. The dam surface at Moonrocks is 40,000 square metres, or two times the surface of the MCG. As the Moon's like to put it, their dam holds 230 megalitres, equivalent to

230 Olympic swimming pools. Some current possible customers, however, are interested in much larger projects with much larger surface areas.

COSTS AND BENEFITS

Warwick Hill's commerce degree had equipped him with the skills to develop a base case costing of \$6.50 per square metre (plus GST) for E-VapCap covers. However, the total cost is very site specific and depends upon the remoteness of the site and other issues such as whether the top edge of the dam has been graded for easy vehicular access. The cover has an estimated lifespan of 10 years and probably can be depreciated over 5 years. It has a 5-year pro rata warranty.

From the customers point of view the value of water saved (not the cost) is the crucial issue. Jeff Moon from Moonrock's, as a high-value crop producer has correctly summed up this viewpoint:

The E-VapCap cover has, quite literally, meant we can grow grapes this season. Without the cover, we may well have lost our table grape and rock melon crop we were losing in the vicinity of 2.0 – 2.5 metres each year, better than half our water. The E-VapCap cover, which effectively covers our entire dam, has meant we have now eliminated water loss. While spot water prices can be as high as \$250 per megalitre, getting access to that water is becoming increasingly difficult. With the loss of an entire crop at stake, water is literally worth the value of that crop – in some cases, millions of dollars. The cost of an E-VapCap cover can therefore have a very quick payback.

For high value crops such as sweet potatoes, rock melon, table grapes, and avocados the financial arithmetic of a dam cover is therefore pretty simple. Those growing lower value crops are probably not potential customers for ECS and in fact may not survive coming water price increases. They may simply better off selling their water rights (see appendix A).

The question of access to water for irrigation farmers and its cost is now a major commercial and environmental issue, involving the whole nation. A recent ABC Four Corners programme (14/07/03) was devoted to this very issue, and illustrated how uncertain both access to, and the price for, allocated irrigation water has become. From the economic viewpoint of an individual irrigation farmer, security is probably even more important than its cost. As we now know accurately the amount of water lost to evaporation in an open irrigation system can be as much as 90%. Water allocations by various government bodies are becoming tighter and tighter in many areas, and so individual farmers must begin seriously to look more closely at saving as much of whatever water allocation they get (see appendix B). This, of course, bodes well for the long run business success of Evaporation Control Systems, particularly if federal government efforts to solve the nation's water problems includes some incentives, (tax incentives or grants) for farmers to use dam covers as part of the solution.

THE PRESENT

Marketing efforts have been low key and low cost. They include ads in local papers, a presence at trade shows, Sealed Air's brochures, and ECS's web site. The web site has been the most successful generator of new contacts, particularly after the ABC's Landline programme in early March this year featured the successful Moonrock's 'Big Tarp'. There is essentially no competition at present, and Warwick does have some patent protection. However, he is nervous about his financial capacity to defend his patents.

Currently around Australia the ECS consortium has constructed about 20 E-VapCap covers covering 20m by 20m water storages (Turkey's nests). The covers are proving suitable for agriculture, horticulture, aquaculture, live stock storages, and sewerage systems. The defence department has installed a cover on its water supply at a remote radar station. A coal mining operation, which needs water for its coal washing process, but because of its location has to use water from a sewerage treatment plant, is installing a large cover. A particularly interesting application is at Stanthorpe State High School in Queensland. They have covered their recycled water storage to reduce algal growth that was restricting the efficiency of the drip irrigation system to their orchards and vineyard. Prior to the installation of the cover the filter on the irrigation system required cleaning every 20-30 minutes because

of algal clogging. Three weeks after the installation the reduction in algae meant that the filter only needed to be cleaned once a week.

THE FUTURE

While the small-scale projects provide a solid underpinning for the Consortium, the prospects for some very large installations are looking good. A major power station is concerned about the security of the water it uses in its cooling tower. Their water comes from a sewerage treatment plant and if they proceed they will need a cover twice the size of the Moonrock's installation. Alcoa is also concerned about the quality and security of the water it uses for cooling at its aluminium smelter in Pinjarra, W.A.. They will need a cover 10 times the size of Moonrock's. Warwick Hill has admitted to them that he does not really know if the Consortium can build one that size at this stage. Equally he knows that it is very important to find out.

Sinclair Knight Merz (SKM), the large and diversified Australian engineering design company¹, has also become interested in large-scale water projects and their world-wide potential. They recently approached ECS to join them in an application for a A\$250,000 Federal Government research grant to study the engineering requirements of the construction of very large E-VapCap covers. Despite an earlier failure to get a Federal Government Farm Innovations Programme grant for the development of his ideas (not innovative enough he was told) Warwick is confident that through SKM they will succeed this time. If they succeed the study is expected to take 4 months to complete. If very large-scale covers are proved to be feasible, then an international market of mining, power companies, and environmental projects, opens up for ECS through SKM's world-wide structure and connections. The World Bank has already registered its interest in attempting such a project in Ethiopia. The long gestation of a simple but powerful innovation, may be about to transform ECS into a national and possibly international force.

¹ Sinclair Knight Merz is the largest Australian owned multi disciplinary environmental and engineering consulting firm with over 30 offices in Australia, Asia, the Americas and Europe. It has annual revenues of over A\$350 million and is ranked in the top 100 by BRW's survey of the top 500 private companies. SKM is perhaps best known for its work on the engineering design of Stadium Australia – Sydney's Olympic Stadium.

Appendix A

What the water's used for

Land use	Water returns, in \$/megalitres	Water use, in megalitres/ha	Percentage-of total water used
Vegetables	1295	3	2.6
Fruit	1276	7	4.4
Grapes	600	8	5.2
Cotton	452	7	15.5
Coarse grains	116	3	3.5
Dairy	94	7	39.5
Rice	31	11	11.3
Sugarcane	21	7	8.0
Beef	14	4	7.2

Source: National Land and Water Resources Audit

Appendix B

Excerpt from “Since the Algae, Efforts to Save Water Run Deep” from The Australian 17/07/03

Asa Wahlquist

The way Australians see water is rapidly changing. Once water was cheap, subsidized and often wasted, and the rivers regarded as little more than delivery channels and sewers.

But all that changed when, in late 1991, more than 1000km of the Darling River was infected with toxic blue-green algae.

In 1994, the Council of Australian governments introduced its water reform agenda, in which the states agreed to allocate water to the environment, to change the full price of water, and to trade water separately from land.

The following year, the Murray Darling Basin Commission capped water extractions at 1993-94 levels. Under natural conditions the Murray mouth experienced severe drought conditions one year in twenty; at the time of the imposition of the cap it was headed for severe drought three years in four.

Now the basin community is considering increasing environmental flows by 350 gigalitres (one Gl is a billion litres), 750 Gl or 1500Gl. Federal opposition leader Simon Crean has promised to return 1500 gigalitres over a 10-year period.

Dan Luscombe has watched the water trade from the beginning, first as a banker and now as a water broker. “what we have seen is prices move from around \$250 per megalitre (one million litres or about the volume of an Olympic swimming pool) to \$1500/Ml (in South Australia). In that period we have seen a couple of significant jumps in price and we have also seen some quite spectacular drops over short periods of time.”

The water trade is complex, because each state has a different system, and water in the eastern states can be traded both on a temporary and permanent basis.

Allocations vary with the season. The 2003-4 drought saw some valleys with zero allocations. With many dams in the southern Murray-Darling basin at unprecedentedly low levels, the 2003-04 year has started out with low allocations.

The water authority, Goulburn Murray Water, has announced there will be no opening allocations for Goulburn system irrigators, while irrigators on the Murray system will receive just 16% of their entitlement.

South Australia is going into the new water year its first-ever cut in allocations – of 35 per cent.

Governments can also cut allocations, usually in favour of the environment. Compensation for such cuts is one of the most contentious issues in rural Australia today.