Once the system has been established the additional upkeep is non-existent or negligible.

The Council of Australia Governments has stated for many years that water from the environment will be given to the most profitable use. Top nurseries are reporting $60,000 gross sales per megalitres of water. However, when a nursery recycles water and procures only 2 ML of water from outside, the payback on the water can easily be as high as $250,000 per megalitres.

LITERATURE CITED

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Water Saving, More Than Just Recycling©

Garry Heyne
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ACKNOWLEDGEMENT

I will begin by acknowledging Lance Gladigau of Irritech. He infected in me enough of his passion for water conservation to encourage me after his death to continue his work. The result of which has been several Awards in Environmental Excellence for our wholesale nursery.

INTRODUCTION

Heyne's Nurseries Pty Ltd is the oldest registered nursery in Australia. It was first established in Norwood, an Eastern Suburb of Adelaide, South Australia (SA), in 1869 and has played a prominent role in the development of the SA's nursery industry. High quality stock and good customer service have been our company's main aims since its beginning. The challenge of the 1990s was to produce this high quality stock economically, with minimal impact on the environment. In doing so the company aimed to increase water usage efficiency and to investigate the feasibility of recycling its runoff water. In 1995 our company received an $11,800 grant from the Cleaner Industries Demonstration Scheme to supplement its research.

This paper will provide information on the system of recycling water from the wetlands that Heyne's Wholesale Nursery has set up in conjunction with Salisbury Council. But more importantly, it will supply information on some of the in-house procedures taken to improve water-use efficiency and decrease pollutants.

HISTORY

In 1845 Ernest Bernhard Heyne migrated from Germany. He was a learned man with degrees, including a Diploma in Botany from Leipzig University. These, his experience gained as an employee of Dresden Botanical Gardens along with his ability to write five languages and speak seven, soon landed him the job as head draughtsman at the Royal Botanic Gardens Melbourne and Personal Secretary to Von Mueller, the director. In 1869 after trying several other ventures E.B. Heyne moved to Adelaide where he established a nursery in Bond Street, Norwood, and a

Figure 1. An extensive system of windbreaks had to be erected at the wholesale site.

shop in Rundle Street, Adelaide. After his death his wife continued to operate the business until their son Carl F. Heyne graduated from Roseworthy College. In 1924 Carl F. established a nursery/retail outlet on land he had purchased on the Parade at Beulah Park. His son Franz W. Heyne (Wally) joined him in, and continued to expand, the garden centre on that same site. Sons Roger and Garry Heyne became the fourth generation to become involved in the nursery and in 1984 a 9.4-ha section of land was purchased north of Adelaide (wheat country) at the intersection of Bolivar and Waterloo Corner Roads, Burton. Garry Heyne established a wholesale production nursery on this site. Both of his sons, Carl and Adam, work with him and Roger's son, Michael, works at the Garden Centre.

HEYNE'S WHOLESALE NURSERY

Customer Base. The Wholesale Nursery supplies both retailers and the landscaping industry, the latter requiring a large range of species and container sizes in and out of season. This has made irrigation more difficult and has resulted in much in house research into improving irrigation practices.

Environment. The site was flat and unprotected, so a 3-m-wide windbreak of native dry-land trees were planted around the initial 4 ha to minimize wind damage

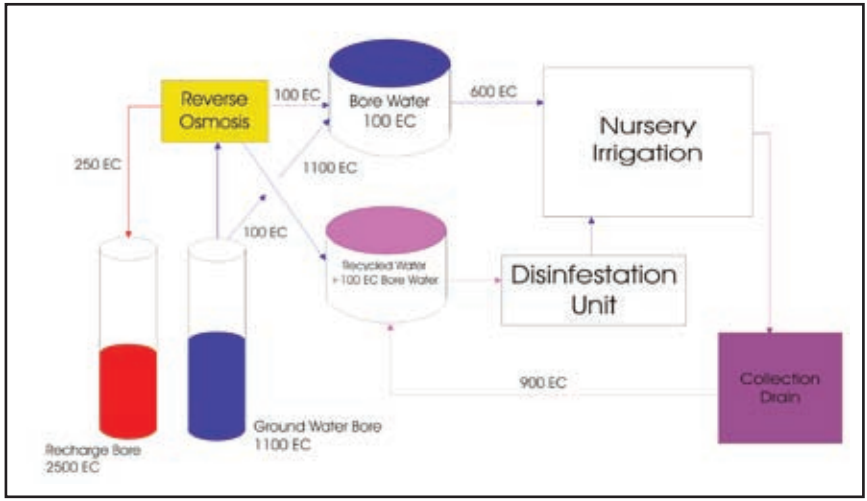

Figure 2. Flow diagram of alternative irrigation system.

and to reduce water loss from excessive transpiration and evaporation from the potting soil and gravel. A network of 2.7-m-high windbreaks covered in 50% mesh has also been erected to increase the wind protection within the nursery (Fig. 1).

Possible In-House Recycling. When the nursery was established, large amounts of clay filling were transported in to allow all the runoff water to be directed to one particular point with a view to recycling. Some areas were raised by up to 1.5 m. Lance and I first looked at recycling the runoff water in 1994 but due to the salinity of the mains supply the runoff water reached unacceptable salinity levels (Dec. 1994 — electrical conductivity (EC) 1340 $\mu S \cdot cm^{-1}$). Reverse osmosis (RO) of the water was not viable because of the suspended fine particles (20-micron filtration allowed 40% UV penetration). It was decided to look at the feasibility of RO treatment of bore water (EC 1100 $\mu S \cdot cm^{-1}$) and use the EC 100 $\mu S \cdot cm^{-1}$ portion produced to dilute the runoff water (the uncontaminated remaining bore water to be placed in a more saline aquifer). The usable water would then possibly be disinfected with chlorine dioxide (Fig. 2).

SUPPLY FROM KAURNA PARK WETLANDS

In 1995 discussions were held with Salisbury Council with a view to being supplied with winter stormwater from Kaurna Park Wetlands. This was to be the first commercial use of water from the vast network of Salisbury Council planned wetlands.

Water Collected at Kaurna Park Wetlands.

Quality. Electric conductivity approx 260 $\mu S \cdot cm^{-1}$, pH 7.4–7.8, the water has a very low level of contaminants and undesirable pathogens (the principle of wetlands disinfestation is similar to that of slow sand disinfestation). The Salisbury Council uses aquifer recharge water for sprinkler irrigation of parks without treatment or signage.

Storage. The water is gravity fed via a bore into the T2 aquifer. When this becomes impractical due to pressure build up in the filling aquifer, the recharging is

enhanced with a pump (40 $L \cdot s^{-1}$). The sandy nature of the aquifer allows injected water to displace the original bore water (high EC) in an orderly fashion forming a fresh water "bubble" allowing approximately 80% to be retrieved without saline contamination. Water is retrieved on demand and pumped at 12 $L \cdot s^{-1}$ to the nursery site, treated, and stored in 3 × 160,000 L tanks.

Treatment. Sulfuric acid (67%) is injected into the water, changing the pH to approximately 6.5. This assists plant growth and keeps the calcium bicarbonate from precipitating and blocking drippers. The result is a max EC of 330 $\mu S \cdot cm^{-1}$. The water is filtered by two sand filters and then passes through an ultraviolet disinfestation system before entering the storage tanks. Turbidity, pH, EC, and UV are monitored constantly. Any failures will shut supply down and solenoids then fill tanks from two 50-mm potable mains water meters.

Use. The water is distributed through two variable speed pumps. One supplies the sprinkler system running sections of Antelco Roto Rains® at 150 Kpa and the other supplies a vast system of Antelco® drippers and shrubblers at 110 Kpa.

Savings. In the last financial year, the nursery used 124,000 kL of water at a cost of $45,000 including pumping and associated chemicals. The same amount purchased from the South Australian water authority would cost about $125,000.

Comments on the System.

- A UV disinfestation treatment was chosen because the turbidity of my water was suitable, it was economical to run, proven, and with the right equipment safe and simple to maintain.
- In the near future the old float switches will be replaced with a pressure transducer, as it is more reliable and easier to access information via a computer.
- Because the UV has no residual effect, the tanks and irrigation lines are periodically treated with a disinfectant.
- Not realising at the planning stage how much the pH of recharged aquifers would vary, a fixed rate, manually adjustable acid-injection unit was installed. This will be replaced with a self-monitoring variable injection system.

Water Saving and Chemical Reduction. Recently, we have investigated the possibility of recycling our runoff water. As a result of the cost and the need to use disinfectants, we have decided to continue to allow the water to run back into the wetlands, where the treatment is far more environmentally acceptable. Regardless of where this runoff ends up, it is essential that it have minimal contaminants. Irrigation efficiency is a major part of this, as excessive wetting of the foliage causes an increase in pesticide use, and leaching of the potting mix has a direct effect on the amount of these contaminants. (NB: There are frogs and yabbies in our nursery drains and the ducks in the wetlands where we deposit our runoff water are as happy as the ones at Kaurna Park where we source our water.)

DRIP IRRIGATION

The majority of the 20-cm containers and all larger containers are watered by drip irrigation. We will be installing more drip irrigation and will be looking seriously at capillary for the smaller pots. In our nursery, cells of fresh potted 20-cm pots

are irrigated in the same cycle as the more established plants adjacent to them. We found that the water drained through the fresh potting mix quickly without reaching the sides. We did not want to alter the mix, as the older plants were fine. We assumed that in time, with compaction, composting, and the extra root growth in the mix, these pots would behave the same as the older. We set up a trial. Two trolleys were set up to be watered by drip and have the ability to collect any drained water individually from each plant for measuring. Trolleys were used so that the trial could be moved to avoid rain. One of the trolleys was pulse watered. Wetting agents were added to the surface of selected pots. Results showed that pulse watering had some benefits, wetting agent added to the surface had the most effect, and the combination of the two was the best. Further testing allowed us to determine the optimal amount of applied water. The juvenile plants could then be made to fit with the watering cycle of the nursery.

AQUAMISER®

A persistent Lance Gladigau kept coming up with ideas that intrigued me. He was determined that the need to irrigate a nursery was directly proportional to the evaporation rate from a container. We installed a "V" notch weir on our runoff drain and connected it to a chart recorder. The volume of water over the weir was constantly recorded. We were able to plot the volume of water retained in the nursery (mains water — runoff water) on a graph. Concurrently we were able to record water transpiration from a class A pan on a graph. The two graphs were virtually identical. We have installed Aquamisers® to control irrigation in the nursery. We are about to install them on beds containing low-water-use plants and will adjust them to higher evaporation rates before operating.

SPRINKLER DISTRIBUTION

An in-field catch test was conducted on the original sprinklers and on Antelco Roto Rains®. It was found that the uniformity of distribution (coefficient of uniformity) could be increased from 67% to 87% by changing sprinkler heads.

SPRINKLER CONTROLLERS

Irrigation is controlled by 32-station Micro Master® controllers. To allow staff to irrigate individual areas without running the complete cycle, and without wetting clients, manual electric control boxes have been installed at visual vantage points throughout the nursery. Percentage run times of the controllers are monitored and altered according to the season. Manual input controls are also installed allowing nonmanagement staff to irrigate according to conditions. Simplicity of operation is the philosophy used throughout the nursery, to minimize operational errors and water wastage.

CHEMICAL CONTROL

Weed Control. We use glyphosate on weeds that "get away," Rout™ as a pre-emergent on most containers, and Sierra Ron™ as a pre-emergent on all growing surfaces. Used correctly it has little effect on the environment. In fact, since we have virtually eliminated weeds, we spray our deciduous plants less often as the breeding grounds for white fly in early spring have been eliminated.

Insect Control. We have always had a policy of using the safest possible spray that will do the job reasonably well. We now use a Hardi MRY® knapsack mist blower instead of a conventional tank, pump, and boom. We can spray the same area with 1/6 of the volume of spray. That is an 82% reduction.

SUMMARY

As a result of the above measures, the installation of a variable speed pump, and diligence, Heyne's Wholesale Nursery has been able to reduce the amount of irrigation water used (Table 1).

Table 1. Water use at Heyne's Wholesale Nursery.

Year	Water used (kL)	Saving since 1993/94
1993/94	89,500	
1994/95	81,000	9%
1995/96	64,000	21%

Our situation is unique, because of the adjacent wetlands, however on my recent trip to Fremantle (Western Australia) to the National Nursery & Garden Industry Association (NGIA) Conference, the amount of water recycling technology and the amount of assistance available now amazed me. NGIA development officers are available in every state. The technology is there for all to improve our irrigation techniques now and into the future.

Evaluating an Irrigation System Upgrade©

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INTRODUCTION

As part of a major irrigation system upgrade, Sunraysia Nurseries conducted a test of system efficiency under the Nursery and Garden Industry of Australia (NGIA) "Waterworks" program.

The program consisted of training in assessing existing system output and efficiency, and recommendations for improvements. There were two major areas that were examined:

- An existing shadehouse with overhead "B500" sprinklers on a 4.0 m × 4.5 m spacing.
- An existing group of polyhouses with overhead "Eindor" sprinklers on a 2.0 m × 3.2 m spacing.

METHOD

Catch cans were placed in a grid across the growing areas. Irrigation was allowed to run and the amount of water in each can was measured and analyzed using the Waterwork calculator supplied as part of the training package.