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*Incomplete draft for ISF Stage III water efficiency study*

# Alice Springs urban rainwater tank trial
# Final report

*10 May 2005*

**Executive summary**

*Tank owner, Roy Winther, with tank during installation. May 2004.*

**Contents**

## System overview

In May 2004 a 13,500-litre rainwater tank was installed at 1 Harper Crt Alice Springs and connected to the solar hot water system and evaporative air conditioner via a pressure pump. Water meters were fitted for monitoring purposes. The system was configured so that when the rainwater tank emptied, mains water trickled into the tank and was pumped to the house. In February 2005 a Davey Rainbank Controller was fitted so mains water bypassed the empty tank and flowed to the house via mains pressure.

## Optimum future set up

Results of the trial indicate that the following set-up is optimal for ground mounted rainwater tanks in Alice Springs:

- 9,000-litre tank with no first flush diverter. Leaf mesh over gutters. Maximum roof area captured.
- Connected to hot water system only (optional branch to drinking water outlet in kitchen).
- Davey Rainbank Controller (or similar) used to switch between rainwater and mains water.

Explanations for this set-up are provided below. Different configurations may be preferred for elevated tanks under eaves (e.g. gravity feed to toilets and washing machine), or for less expensive gravity-feed systems to gardens.

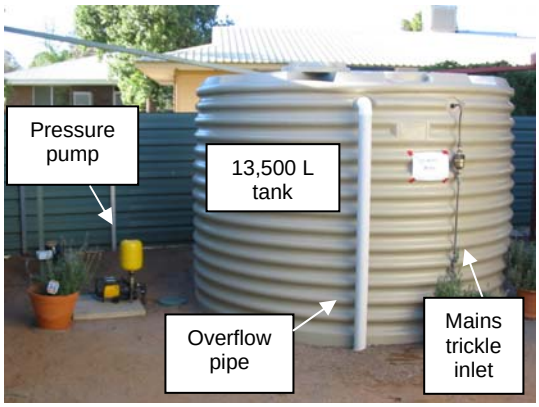
## Key findings & recommendations of the trial

### Tank size

*Size used:* 13,500-litre Teampoly tank. Wall height 2.24 m, total height 2.46 m, diameter 2.92 m.

Findings: Tank was too high to enable gravity fall from gutter to tank inlet. Hence tank had to be sunk 200mm into the ground requiring a bobcat and considerable labour. A tank of this diameter consumes a lot of room in back yards and is considered too large for typical house blocks.

*Recommendation*: Maximum tank height 2.2 metres (including 100mm base) so tank sits below standard roof gutter height. A 9,000-litre tank is a good compromise at 2.05m wall height and 2.57m diameter, but still big enough to capture substantial rainfall.




***Configuration pre-Rainbank Controller***

### Water volumes used

*Theoretical volume*. A 13,500-litre tank will capture around 27,000 litres from a 145 square metre roof area in an 'average' rainfall year in Alice Springs. The available volume and hence the percentage of time that the tank is empty is dependent on where and how much water is used. The adjacent table shows supply volumes and tank empty times for different scenarios.

*Findings*. Only 18,500 litres was captured and used in the year of the trial, due to experiencing the driest 11 month period on record since 1877. Luckily 82mm was captured three days after connecting the system in May 2004 (filling the tank), but then only a further 46 mm fell until the end of the trial in May 2005 (Alice Springs average rainfall is 250mm).

**Rainwater in 13,500-litre tank from 145sq.m. roof**

| Rainwater to: | Volume required | Volume supplied by rainwater | % time tank empty |
|---|---|---|---|
| Hot water tank | 44 kL/yr* (120 L/day) | 62% (27kL/yr,75L/dy) | 31% |
| Evaporative a/c | 49 kL/yr (230 L/day Oct-Apr) | 41% (20kL/yr, 94L/day Oct-Apr) | 55% Oct-Apr |
| Hot water & evap a/c | 93 kL/yr (255 L/day) | 33% (31kL/yr, 85L/dy) | 63% |
| All indoor water | 171 kL/yr (470 L/day) | 19% (32kL/yr, 89L/dy) | 79% |
| All household inc. garden | 700 kL/yr (1,960 L/dy) | 5% (34kL/yr, 93L/dy) | 95% |

*Water from solar hot water tank mixes with cold water at the tempering valve before delivery to hot water taps. Approx 50:50 in summer.

### Capturing clean rainwater

*Configuration used*. Gutters were not covered with mesh as there were no trees overhanging the roof. A 60-litre TeamPoly first flush diverter captured the first rainfall, mounted on the side of the tank.

*Findings*: If rainwater is plumbed solely to a hot water system, no diverter is required (saving $160). The diverter is meant to capture droppings and other contaminants, but any bacteria in the water are theoretically pasteurized by the 60C+ hot water system. Removing the diverter also reduces the tank inlet height by around 150mm. A sieve at the tank inlet is still required to capture leaves etc, and should be covered to stop sunlight entering the tank otherwise algae will grow.



*Recommendations*. If rainwater is to be used directly for drinking, a first flush diverter is recommended. If rainwater is used solely for the garden or hot water system then a diverter is an unnecessary cost.

**Switching from rainwater to mains water**

*Configuration used.* Initially an air gap separation system was installed in May 2004 where a float valve allowed mains water to trickle in from the top of the tank when rainwater levels got low. This was based on proven configurations in Beaudesert Shire, Qld. In February 2005 a Davey Rainbank Controller (www.davey.com.au) was fitted to switch automatically between rainwater and mains water. Approval to use Rainbank was granted by the NT Planning Minister circa February 2005 for all NT locations – an important outcome of the trial.

*Findings.* The Rainbank unit is recommended in favour of the air gap separation configuration, even though both work fine in delivering mains water when rainwater runs out, because:

- The air gap separation hardware requires the installer to enter the tank, whereas Rainbank components are entirely fitted from outside.
- Rainbank took around 1 hour to install vs. 2.5 hours for the air gap separation system. Hence the extra cost of the Rainbank hardware ($xxx vs. $xx) is countered by reduced labour costs ($xxx vs. $xx).
- Water entering through the air-gap cistern assembly made a noticeable hissing noise for the duration of the trial.
- If the power failed, mains water could not be pumped from the tank to the hot water system with the air-gap system, unlike Rainbank that automatically reverts to its mains water option if the power fails, allowing mains water to bypass the tank and reach the house via its own pressure.
- Rainbank allows more rainwater to be used before mains water takes over. For the air gap configuration, the rainwater level in the tank was 600mm when mains water began to trickle into the tank. For the Rainbank configuration the rainwater was drawn down to 300mm before switching to mains water (2,000L difference).
- A backflow prevention valve is incorporated within the Rainbank device.

It is important to note that for the trial, Rainbank would not switch from mains water to rainwater when the evaporative air conditioner was working, presumably because the low flow volume was too small to trigger the Rainbank solenoid (approximately 0.5 litre per minute).

**Fixtures plumbed into rainwater**

*Configuration used.* Rainwater was plumbed to the solar hot water system and evaporative air conditioner.
*Findings.* The solar hot water system showed no signs of abnormal operation during the year. For the first three months, 100% of hot water was supplied by rainwater. For the last nine months, 92% was supplied by mains water due to abnormally dry conditions. The effect of soft rain water on the hot water tank was not investigated in comparison to harder town water (including changes to internal scaling, impact on the sacrificial anode, reduced corrosion of pressure relief valves).

The evaporative air conditioner had a significant negative outcome. The bleed pipe was turned off by the homeowner prior to summer commencing based on the assumption that rainwater has no hardness and therefore no bleed was required. From the earlier water volume table, it is clear that even in average years only half of the a/c water requirements are met by rainwater, and in the very dry year of the trial only 6% was supplied by rainwater. Hence the pads quickly accumulated scale. Some water then began to flow down the outside of pads and made their way through hairline cracks where water pipes passed through the roof sheets and eventually ran into the house's fusebox and shorted the wiring of the house. The pads were subsequently descaled, and the wiring repaired at considerable cost and effort.

*Recommendations*. If rainwater is plumbed into an Alice Springs house, it is recommended to be plumbed only to the hot water system. This advice differs from southern states where toilet flushing and washing machine use is recommended. The hot water system is recommended because i) soft rainwater should extend the life of a hot water system compared to calcium-rich mains water that corrodes pressure relief valves, eats sacrificial anodes and corrodes tank linings; ii) the volume used by hot water systems suit rainwater volumes: hot water systems use around 100 litres per day of rainwater (mixed with another 50 to 100 litres of cold water at the tempering valve before reaching hot water taps), giving 90 days supply from a 9,000-litre tank and ensuring the tank is totally or mostly empty when the next rainfall occurs; iii) installation costs are reduced by only plumbing to one appliance.

It is not recommended to plumb rainwater to the evaporative air conditioner because i) they use around 30 litres per hour so can consume over 300 litres per day, emptying a 9,000-litre tank in only 30 days whereas dry summers can last 6 months; ii) bleed off of valuable rainwater is still required when rainwater is used, to cater for inevitable times when the rainwater tank is empty and calcium-rich mains water is used; iii) in the trial the Davey Rainbank Controller did not switch from mains water to rainwater under the low trickle flows of an evaporative air conditioner (0.5 litre per minute), even when rainwater was available.

If people only want rainwater for drinking, a 1,000 litre tank is entirely adequate as less than 5 litres per day is generally used for drinking and cooking. If the tank is raised on a stand, it allows gravity flow to a rainwater tap at the kitchen sink.

Rainwater can be used for garden irrigation, but it is likely to run out very quickly as average outdoor water use in Alice Springs' gardens is 1,300 litres per day[1]. However, gravity feeding to gardens is far cheaper than installing a pump, Rainbank Controller and plumbing to a hot water system or other internal fixture.

**Cost and payback period**

*Findings*. Total supply & installation cost was around $3,615 excluding gutters (already present) and meters used for monitoring. Two plumber quotes for another house were $,x,000[2] indicating systems are expensive to install.

**Cost of system**

| | |
|---|---|
| Tank | $1,720 |
| Pump (package price with tank) | $240 |
| First flush diverter | $155 |
| Rainbank controller | $400 |
| Pipework | $200 |
| Installation | $900 |
| *TOTAL* | *$3,615* |

Installation to an existing house has the added cost of re-plumbing to the hot water system (&/or other fixtures) and to the Rainbank unit. However existing houses may already have gutters, saving installation costs.

The amount of mains water saved in this drought year was 18,500 litres or $12.50 in mains water costs. In an average year 25,860 litres or $17.50 would be saved. Hence the simple payback period would be 207 years. This not include externalities such as enhanced water saving ethics for households that install rainwater tanks, increased life of calcium-affected hardware (e.g. hot water systems), stormwater detention, lengthened borefield life and other factors.

As part of the trial, the NT Government was asked to consider a rainwater tank rebate in Alice Springs. They declined, citing unfeasible payback periods of 200+ years. The Alice Springs Town Council also considered rebates but also declined for the same reason. This rationale does not include externalities.

**Tank & pump impacts during extended empty periods**

Possible impacts: The rainwater tank was mostly empty for the last 9 months of the trial. This was suggested to have three possible negative impacts being i) with the air-gap separation configuration the pump may have a shortened life due to pumping mains water from the tank to the house instead of allowing mains water to bypass the tank; ii) with the Rainbank configuration the pump may suffer problems from being idle for extended periods when the tank was empty and mains water was bypassing the tank & pump; iii) the plastic poly tank may deteriorate if empty for extended periods in Central Australia's harsh climate.

Findings. There was no evidence to suggest any of the above was an issue, although the trial's short length did not allow proper assessment. Davey indicated no such problems should arise with their pumps or Rainbank unit. The suggestion about deteriorating plastic came from anecdotal evidence in the Top End that poly tanks were suffering under the climate. When investigated, it emerged that there had been problems with large Adro poly tanks in remote Aboriginal communities due to the lack of a centre support pole and hence tank lids sagging downwards until they cracked. Other companies use centre support poles to avoid this issue, so it is not seen as a climate-specific problem.

**Maintenance requirements**

Findings. There was less than one millimetre of sludge accumulated in the bottom of the tank after 12 months. The first flush diverter was emptied after major rain events via the drain valve. No gutter maintenance was conducted due to no leaves entering gutters (nearby trees were absent). The original Davey pump cycled on and off very rapidly when hot water taps were turned on in the house. This was rectified by increasing the pressure in the pump's pressure tank.

As detailed in 'Fixtures plumbed into rainwater' above, the evaporative air conditioner pads clogged with scale due to lack of bleed-off, and water leaked through a crack in the roof and shorted out the fusebox.

**Power & greenhouse gas used by pump**

[1] 'Alice Springs Water Efficiency Study. Stages I & II final report'. 2003, Institute for Sustainable Futures. For Power Water and NT Dept Infrastructure Planning and Environment.
[2] Another house was originally considered for the trial and quotes were received from Araluen Plumbing and Alice S & K Plumbing.

Monitoring. A 'Sparometer' was fitted to measure pump electricity consumption but had technical problems resulting in no data being gathered.

Findings: xx kWh was used, costing $xx per year and generating xx kg of greenhouse gases at the Alice Springs power station. Conversely, the xx,000 litres of deferred mains water saved xx kg of greenhouse gases from not pumping water from the 120m deep Roe Creek aquifer.

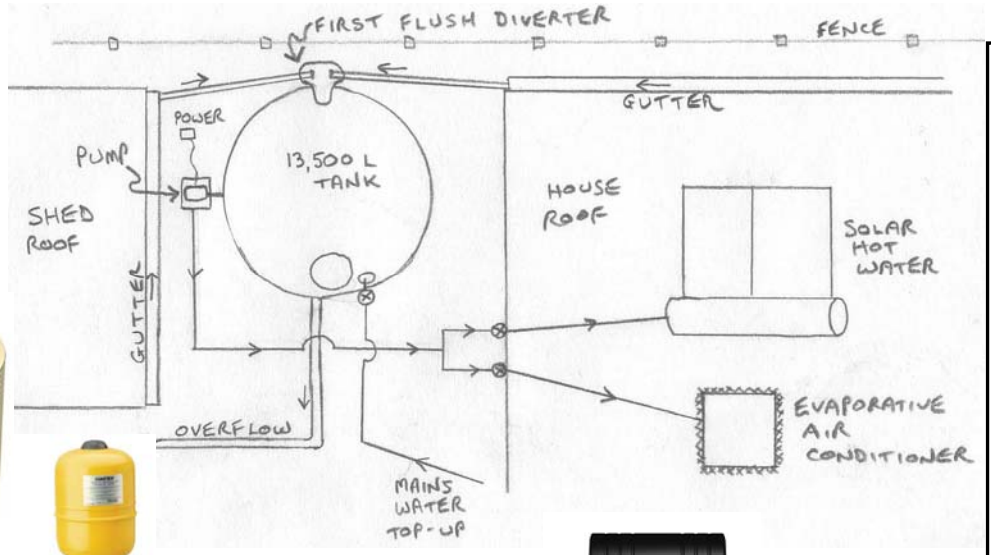
Recommendations. The CRC for Water Quality & Treatment is trialing energy efficient pumps for rainwater tank systems through the Gold Coast City Council.

**System layout**

Teampoly 60-litre first flush diverter.

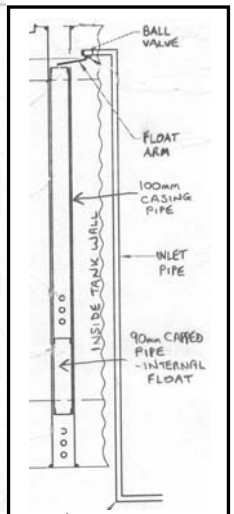
13,500-litre (3,000-gallon) plastic Teampoly tank.

Davey XP350P-8C pressure pump





Davey Rainbank switching controller




Mains water top-up assembly inside tank

**Configuration, rainfall & household consumption**

**Project background**

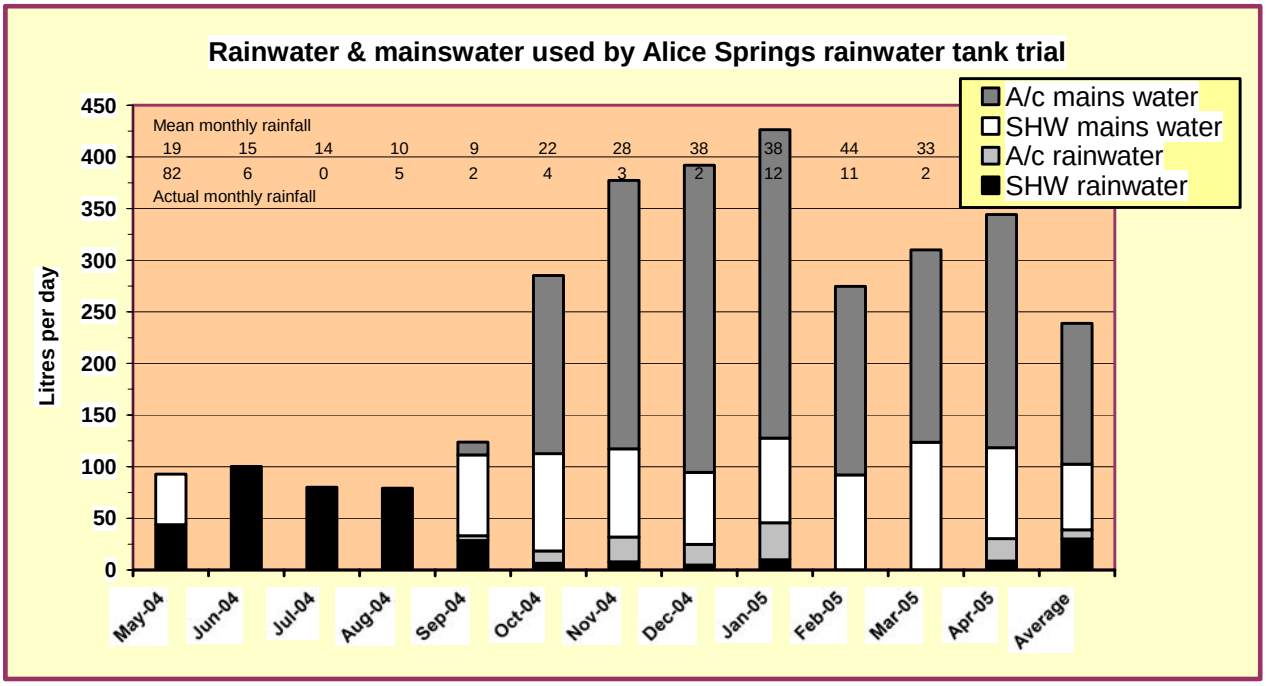
The Arid Lands Environment Centre received funding from Power Water in 2003 to set up an urban rainwater tank trial in Alice Springs. In May 2004 a 13,500-litre rainwater tank was connected to a solar hot water system and an evaporative air conditioner at 1 Harper Court, Alice Springs. The trial examined a) the volume of water saved; b) ease & cost of installation & maintenance; and c) reduction in hard water effects on the solar hot water system and evaporative a/c

**Water used (as at Feb 05)**

- To date, 14,600 litres has been supplied by rainwater. This is one-third of the total water used by the solar hot water and evaporative air conditioner systems, with the remainder supplied by mains water.
- Two days after installation in May, 82mm of rain fell and almost filled the tank (11,800 litres captured).
- Little rain has fallen since: June (6mm), July (0mm), August (5mm), September (2mm), October (4mm) and November (3mm), totaling 20mm (2,800 litres).
- The rainfall captured in May supplied all of the solar hot water needs through June, July and August, averaging 79 – 100 litres per day. The evaporative air conditioner was not used in that time.
- In September rainwater ran out and since then mains water has been mostly supplying the hot water system and air conditioner via the trickle-inflow system in the base of the tank (73% supplied by mains water in September, 93-94% in October and November).
- Volumes through the solar hot water system have remained steady at around 100 litres per day.
- *It has recently been identified that a hot water tempering valve is fitted to the solar hot water system, so that cold water is mixed with very hot water before it reaches the hot water taps. A meter will be fitted to the cold entry pipe in early February 2005 to measure how much cold water is being added. At*

*another house, meters show that around half of the hot water leaving taps comes from cold water mixed at the tempering valve.*

- The air conditioner began use in September (average 17 L/day), increasing in October (184 L/day) and November (284 L/day). The hourly consumption of the air conditioner has not yet been measured, but is expected to be around 30 litres per hour.




**Hardware & logistics**

- Installation was mostly performed by the homeowner Roy Winther with the exception of connection work by a plumber. It was a straightforward operation with no major hiccups.
- The mains water top up assembly inside the tank proved the most fiddly aspect to install. In September 2004 a practicing plumber asked to inspect the system because a client wanted to install a similar system in urban Alice Springs. He subsequently installed that system and reported that the top up assembly took several hours of work to assemble and install. He said the total cost of parts and labour was around $300 - $400. He estimated that a Rainbank switching controller would have been cost-competitive due to its ease and speed of installation.
- There have been no maintenance issues with the system since installation.
- The Davey pressure pump cycles on and off continuously when water is being drawn from the tank, because the pressure tank is not large enough to maintain operating pressure for long.
- Davey personnel in Adelaide indicate this should not have a negative impact on the pump life, but independent viewpoints on this will be sought.
- The amount of power drawn by the pump is not known. A ‘Sparometer’ was fitted to the pump in September to measure total power consumption but it malfunctioned and no data was obtained. The CRC for Water Quality and Treatment are soon to commence trials in the Gold Coast City Council area to investigate power consumption by Raintank pumps. They feel the pumps are not very efficient and there may be significant gains from identifying and developing more efficient pumps.
- Roy reports that there is noticeable noise when mains water is trickling into the tank. He says this fades into background noise after a while but is another reason why a Rainbank switching controller or similar may be beneficial due to the absence of noise.
- Water pressure at fixtures in the house has not been affected according to Roy.

**Interactions with public and decision makers**

- 17 May 2004. System commissioned.
- 10 August 2004. Hon Loraine Braham (Member for Braitling) writes to NT Treasurer asking for i) a subsidy for installation of rainwater tanks in new and existing homes; ii) a requirement that all new government homes in central Austraila be fitted with a water tank; iii) all new IHANT and NAHS homes

in remote communities be fitted with rainwater tnaks; iv) all tanks be connected to the solar hot water system.

- 9 September 2004. DIPE drafts ‘Rainwater tanks’ fact sheet for central Australia.
- 10 September 2004. Minister for Lands and Planning (Chris Burns) replies to Loraine Braham saying a subsidised rainwater tank has a payback period of over 200 years, but a tank rebate will still be considered in the context of a comprehensive demand management program.
- 12 September 2004. Open day held at the trial house, with around 40 people visiting including Loraine Braham and Ron Sterry (local property developer).
- 27 September 2004. Essential Services Minister Chris Burns visits the trial site, shows interest but makes no commitment beyond that made to Loraine Braham to examine further uptake in the comprehensive demand management program.
- 14 December 2004. ALEC writes to Minister Burns seeking NT-wide approval for the Davey Rainbank controller.
- February 2005. Minister Burns grants approval for use of Davey Rainbank across the NT.
- April 2005. Second open day held at the trial house. 50 people attend.
- Circa May 2005. Alice Springs Town Council considers providing rebates for rainwater tanks. Rejects the proposal based on long payback period.
- May 2005. Rainwater tank trial ends after the driest 11 months on record (since 1877).