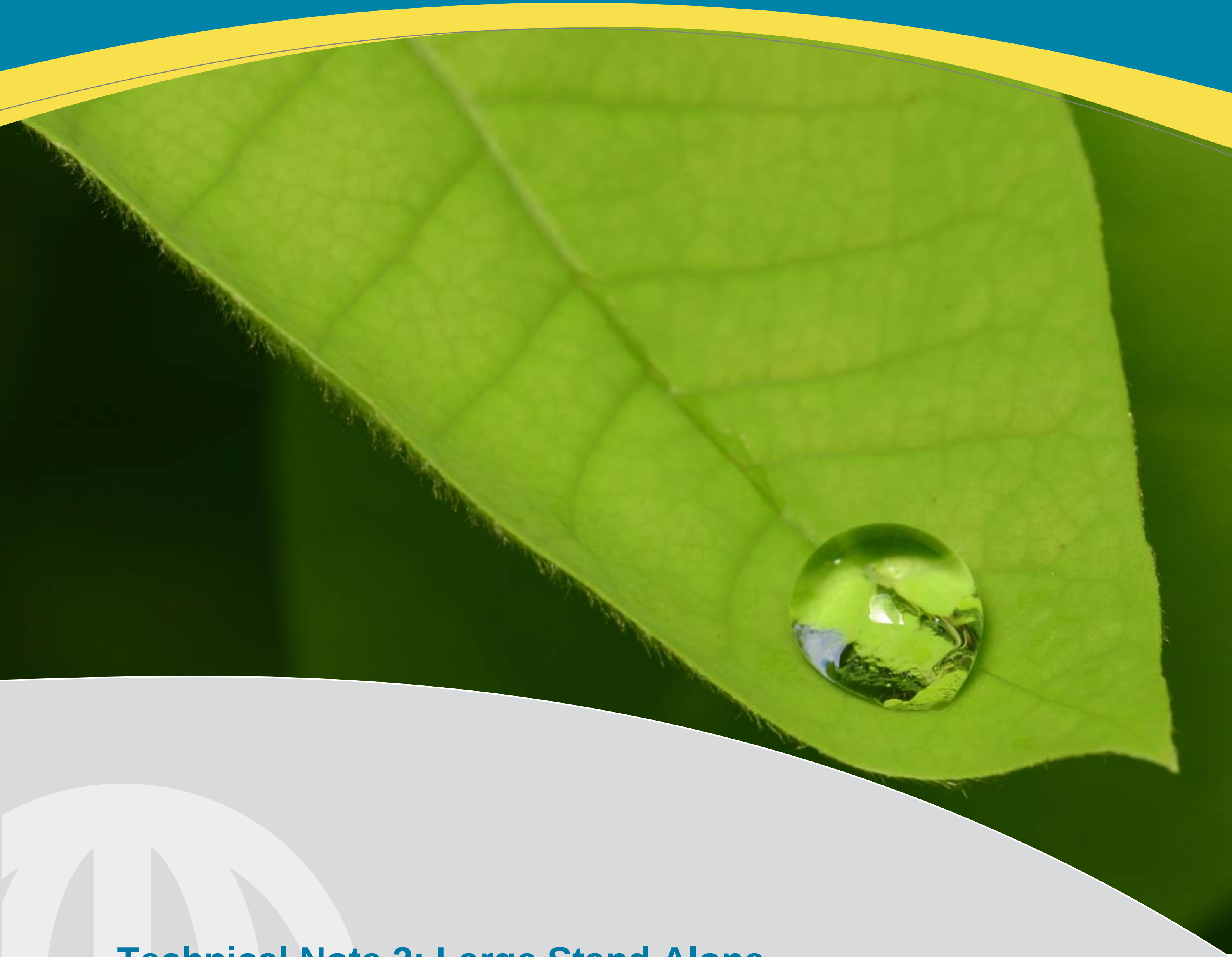
MWH

BUILDING A BETTER WORLD



Technical Note 2: Large Stand Alone Rainwater Tanks

Prepared for Tweed Shire Council

February 2010

CONTENTS

Tweed Shire Council

Technical Note 2: Large Stand Alone Rainwater Tanks

In line with our Quality System, this document has been prepared by Kelly Devrell and reviewed by Shane O'Brien and signed off by Mark Hunting.

BRISBANE Level 3, 35 Boundary Street, PO Box 3602, South Brisbane, QLD 4101

p +61 7 3029 5000, f +61 7 3029 5050

Figures

Tables

In line with our Quality System, this document has been prepared by Kelly Devrell and reviewed by Shane O'Brien and signed off by Mark Hunting.

BRISBANE Level 3, 35 Boundary Street, PO Box 3602, South Brisbane, QLD 4101
p +61 7 3029 5000, f +61 7 3029 5050

This document contains information about MWH, particularly about the culture of our organisation and our approach to business, which would be of value to our competitors. We respectfully request, therefore, that it be considered commercially sensitive.

In line with our Quality System, this document has been prepared by Kelly Devrell and reviewed by Shane O'Brien and signed off by Mark Hunting.

BRISBANE Level 3, 35 Boundary Street, PO Box 3602, South Brisbane, QLD 4101

p +61 7 3029 5000, f +61 7 3029 5050

1 Introduction

MWH was commissioned by Tweed Shire Council (TSC) in January 2010 to investigate the environmental benefits, and technical and legislative factors for a property to disconnect from the water supply network and rely solely on rainwater.

Rainwater tanks have a long history of use in Australia, predominantly in rural areas (farms and towns) which often depend upon them for household water. More recently the use of tanks has grown in urban areas, driven by State or local government policies or programs (i.e. rebates) to encourage their use and by home owners' personal choice.

The general public perception is that rainwater is safe to drink. In most areas of Australia, the risk of illness arising from consumption is low, providing it is visually clear, has little taste or smell and, importantly, the storage and collection of rainwater is via a well maintained tank and roof catchment system. While the risk from consuming rainwater is low in most areas of Australia, the water from domestic tanks is not as well treated or managed as the major urban water supplies. The microbial quality of water collected in tanks is not as good as the urban supplies. In a limited number of areas, specific industries or very heavy traffic emissions may affect the chemical quality of rainwater.

Rainwater can be used as a source for hot water services, bathing, laundry, toilet flushing, or gardening. These uses represent lower risks to public health than drinking rainwater.
Irrespective of how tank rainwater is used, water quality is dependent on implementing a sensible maintenance program. However, while maintenance requirements are not particularly onerous, in practice most roof catchments and rainwater tanks are poorly maintained. This may reflect the notion that rain is a relatively pure source of water and it may be related to the fact that in many rural areas, the availability of water is a bigger issue than quality. (enHealth, 2004)

The environmental advantages of using rainwater tanks include reduced stormwater flow and pollution which has water quality benefits for the receiving waters and reduced potential for wet weather sewage overflows due to reduced ingress of rainwater into the sewerage network.

This document investigates the feasibility of using large stand alone rainwater tanks as a sole supply and includes the current use of rainwater tanks in Australia, the size of tank required in Tweed to be independent of the reticulated water supply network, the water quality issues associated with rainwater, costs involved and the necessary operation and maintenance.

2 Current Position

TSC currently has a rainwater tank policy requiring dual supply rainwater tanks to have a minimum storage capacity of 4.5 kL and a minimum roof area catchment of 50 m^2. The Demand Management Strategy - Stage 1, recommends Council adopt requirements in excess of NSW Government's Building and Sustainable Building Index (BASIX). Through agreement, new developments would install dual flush toilets, 3 star showerheads and 5 kL rainwater tanks with a minimum roof catchment area of 160 m^2, connected to external, toilet flushing and cold water to washing machines.

Shown below are a number of case studies showing how large rainwater tanks are currently being used in Australia. The case studies use an integrated approach combining groundwater, greywater, recycled water and rainwater to augment their supply, and are thus not completely self-reliant on rainwater tanks.

In addition to these case studies there is also the town of Miriam Vale in Queensland which relies on rainwater tanks for internal uses due to the very poor quality of the potable supply and Marion Bay in South Australia which switched to desalinated water in 2007 as a better quality more reliable water source after being reliant on rainwater for years.

There are also projects which capture rainwater runoff from a number of properties and divert this into either a communal rainwater tank or into the raw water supply. Again, this rainwater is used to augment other water sources and not as the sole water supply.

2.1 Case Studies

2.1.1 Healthy Home – Gold Coast

The Healthy Home Project brought together Queensland's leading Universities and Government Departments in a joint venture with industry partners.

Driver: Environmental showcase building

Rainwater End-Use: Laundry, kitchen, bathrooms and garden sub-surface watering system.

Recycled/ Grey Water End-Use: The house also contains a greywater system and a water flow control system which reduces water use by up to 50 per cent.

Time in Operation: Unknown

Rainwater Tank Size: 22.5 kL

Rainwater Tank Treatment: First flush device, filters, Ultraviolet (UV) disinfection

Issues / Key Elements: There is also a manually controlled mains refill capacity for when the stored rainwater runs low.

2.1.2 Living Laboratory – Currumbin Ecovillage

The Living Laboratory, as with all homes in The Currumbin Ecovillage, is completely water self-sufficient.

Driver: Environmental showcase building, opted not to connect to reticulated water and sewer supply

Rainwater End-Use: Potable water supply utilised for drinking, cooking, washing up, bathing / showering.

Recycled/ Grey Water End-Use: Toilet flushing, gardens / lawn, clothes washing, car washing supplied by recycled water from the Ecovillage Water Reclamation Plant

Time in Operation: Since November 2007

Rainwater Tank Size: 22.5 kL above ground tank + 4 x 2.16 kL concrete water tanks embedded in ground and used as thermal mass[1] / water storage

Rainwater Tank Treatment: Unknown

2.1.3 Healthy Home – Canberra

The Canberra Healthy Home is in a rural location 30 km west of Canberra. The objective for the design of this house was to construct a building with the highest possible environmental credentials, it is constructed of mud brick and recycled timber construction, is independent of the electricity grid, and self-sufficient for water.

Driver: Environmental building

Rainwater End-Use: All internal.

Recycled/ Grey Water End-Use: The house also contains a greywater and sewage treatment plant which produces water of a suitable quality to use in gardening.

Time in Operation: Unknown

Rainwater Tank Size: 20 kL

Rainwater Tank Treatment: Unknown

[1] Heavyweight building materials store a lot of heat so are said to have high thermal mass, as opposed to lightweight materials that do not store much heat and have low thermal mass. Adding thermal mass within a home helps reduce the extremes in temperature experienced, making the average internal temperature more moderate year-round.

2.1.4 Capo Di Monte – Mount Tamborine

Capo Di Monte is a 46-residence (maximum equivalent population[2] of 100) leisure village catering for 'over-50's' on Tamborine Mountain. Each residence is self-contained with 1 or 2 bedrooms, and the development also has a community centre with swimming pool and activities rooms.

Water self sufficiency is achieved through two large community tanks with an effective rainwater storage of only 6.5 kL per residence and is made possible through using water-efficient fittings in the houses, an emphasis on sensible and conservative water use by residents, and by recycling of treated wastewater for non-potable purposes. There is also an on-site water bore to augment supply.

Driver: Sole water supply as there is no reticulated water supply or sewerage network on Tamborine Mountain, environmentally sustainable development

Rainwater End-Use: All internal except toilet flushing

Recycled/ Grey Water End-Use: Class A+ recycled water from the on-site treatment plant is used for toilet flushing and garden watering.

Time in Operation: Stage 1 completed in 2006

Rainwater Tank Size: Two 200 kL community tanks

Rainwater Tank Treatment: Pressure media filter, UV disinfection and dosed with sodium hypochlorite to provide a residual chlorine concentration.

Issues / Key Elements: An on-site water bore provides a back-up supply. An estimated 72% of internal water requirements except toilet flushing will be supplied by rainwater, with the remaining 28% from the existing on-site bore.

Other: Capital cost for the potable water supply $312,109, with headworks charges of $274,121 and an estimated O&M cost of $5,110 per year ($1.57 / kL produced).

2.2 Discussion

From the case studies it can be seen that none of the houses/developments are solely reliant on rainwater to provide their water supply with all using an integrated approach combining groundwater, greywater, recycled water and/or rainwater to augment their supply.

The highlighted projects also contain water efficient devices including flow control systems and water sensitive landscaping. These would reduce the demand significantly when compared to the demands from an existing house in Tweed that does not have water efficient devices and has an established garden. The estimated demands at the Capo Di Monte 'over 50's' village are 89 L per person per day for the potable supply and 21 L/person/day for the recycled water supply giving a total water demand of 110 L/person/day for all household houses. This is slightly less than the amount of water used per person in South East Queensland at the highest level of drought restrictions and less than half the 254 L/person/day used by existing single family residential properties in Tweed.

The Capo Di Monte village is a medium density village with small gardens and 110 L/person/day is not a realistic water demand target for existing houses in the Tweed area to achieve.

[2] Equivalent Population is a common way of expressing non residential water demands in terms of residential demands i.e. if the community centre has a demand ten times greater than the per person demand it will have an Equivalent Population (EP) of 10..

2.3 Current Funding Arrangements

As part of the NSW Government's $700 Climate Change Fund, established to help business, households, schools, communities and government save energy, water and greenhouse gas emissions, the NSW rainwater tank rebate provides up to $1500 cash back for the installation of any new rainwater storage system in residential properties in NSW.

The Australian Government is also providing Rebates of up to $500 for households to install rainwater tanks or greywater systems. Residents in NSW are eligible for both rebates provided the sum of received payments does not exceed the total cost of the tank. A reduced payment for the NSW rebate can be requested if the total payments would exceed the cost if it were paid in full.

Table 2-1: Available rebates

Rainwater tank capacity	NSW Home Saver Rebate (maximum)	Criteria	Federal Rebate – National Rainwater and Greywater Initiative	Criteria
2,000 litres – 3,999 litres	Tank Rebate – $150 Connection to toilet(s) – $500 Connection to washing machine(s) – $500 Maximum total –$1,150	Households **not connected to the mains supply** are eligible for a rebate for the purchase of the **tank only**. Rainwater tanks installed to comply with BASIX for new homes, major renovations or a pool installation are not eligible for a rebate. There is a limit of one rainwater tank per property. Connection to toilet and/or washing machine	$400	Internal reuse of the water for toilet and/or laundry use
4,000 – 6,999 litres	Tank Rebate – $400 Connection to toilet(s) – $500 Connection to washing machine(s) – $500 Maximum total –$1,400		$500	
7,000 litres and above	Tank Rebate – $500 Connection to toilet(s) – $500 Connection to washing machine(s) – $500 Maximum total –$1,500		$500	

3 Reliable Yield of Rainwater Tanks

3.1 Methodology

To determine the potential rainwater yields for a range of tank sizes and roof areas an analysis was undertaken using MWH's Residential Source Substitution model. The model is a daily water balance model, utilising historic climate data, annual demand and assumptions around the size and end uses connected to the rainwater tanks.

3.2 Modelling Assumptions

The models used were modified from those developed for the Demand Management Strategy and use Bray Park climate data from 1970 to 2007. Assumptions used in the model were taken from the Demand Management Strategy and are outlined below in Table 3-1.

Existing refers to existing single family residential houses in the Tweed area whereas Greenfield refers to new residential developments. Greenfield accounts generally use less water internally due to more efficient water fixtures.

Table 3-1: Residential Water Use in Tweed Shire

	Internal Use (L/day)	External Use (L/day)	Total Use (L/day)	Total Use (kL/year)
Existing per account	549	161	710	259
Existing per person[1]	196	58	254	93
Greenfield per account	493	161	654	239
Greenfield per person[1]	176	58	234	85

1 L/person/day calculated using 2.8 people per account for single family residential from the Demand Management Strategy

3.3 Tweed Climate

The Bureau of Meteorology classifies Tweed Shire Council as being in a summer rainfall zone of Australia. This rainfall zone is denoted by wet summers and low winter rainfall. This has an impact on rainfall tank sizing because the tank has to be large enough to capture the wet summer rainfall and store it to cater for the winter demand.

The majority of NSW, and some areas in Victoria and Tasmania are classified as being in an uniform rainfall zone whereby a smaller tank could cater for the demand as it is being topped up relatively uniformly throughout the year.

The annual and average monthly rainfalls at Bray Park for the period 1970 – 2007 are shown below in Figure 3-1 and Figure 3-2 respectively. The seasonal fluctuation described above can be seen in Figure 3-2 while significant yearly variations in total rainfall are shown in Figure 3-1.

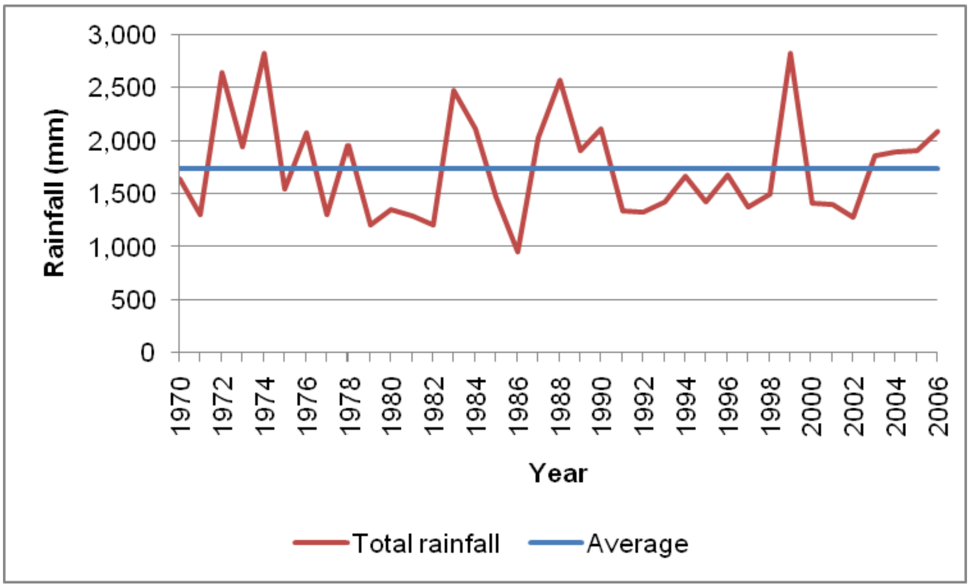


Figure 3-1: Annual Rainfall

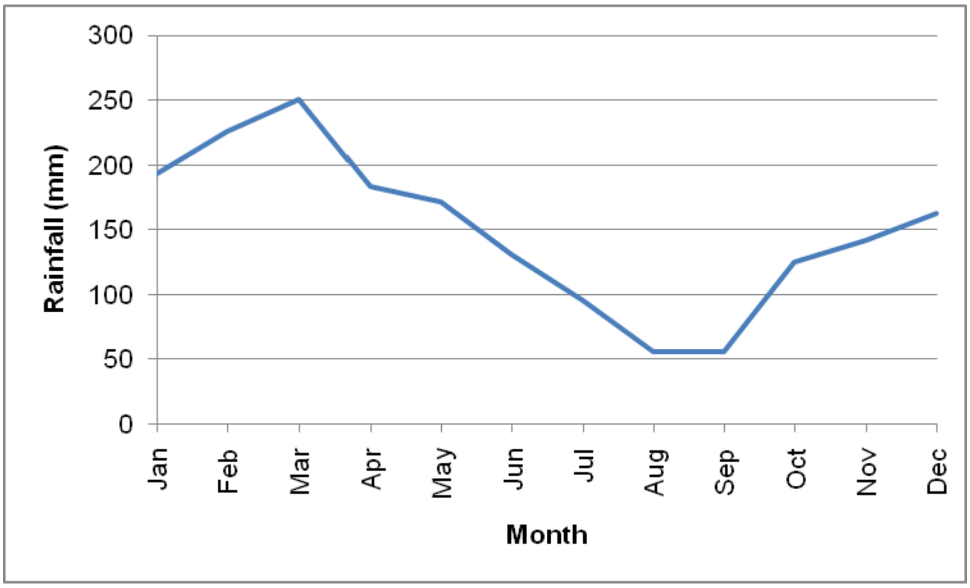


Figure 3-2: Average Monthly Rainfall

3.4 Yield Assessment Results

Rainwater tanks of various sizes were simulated for roof areas of 100, 200 and 300 m^2 connected roof area. The results of these simulations are shown in Figure 3-3.

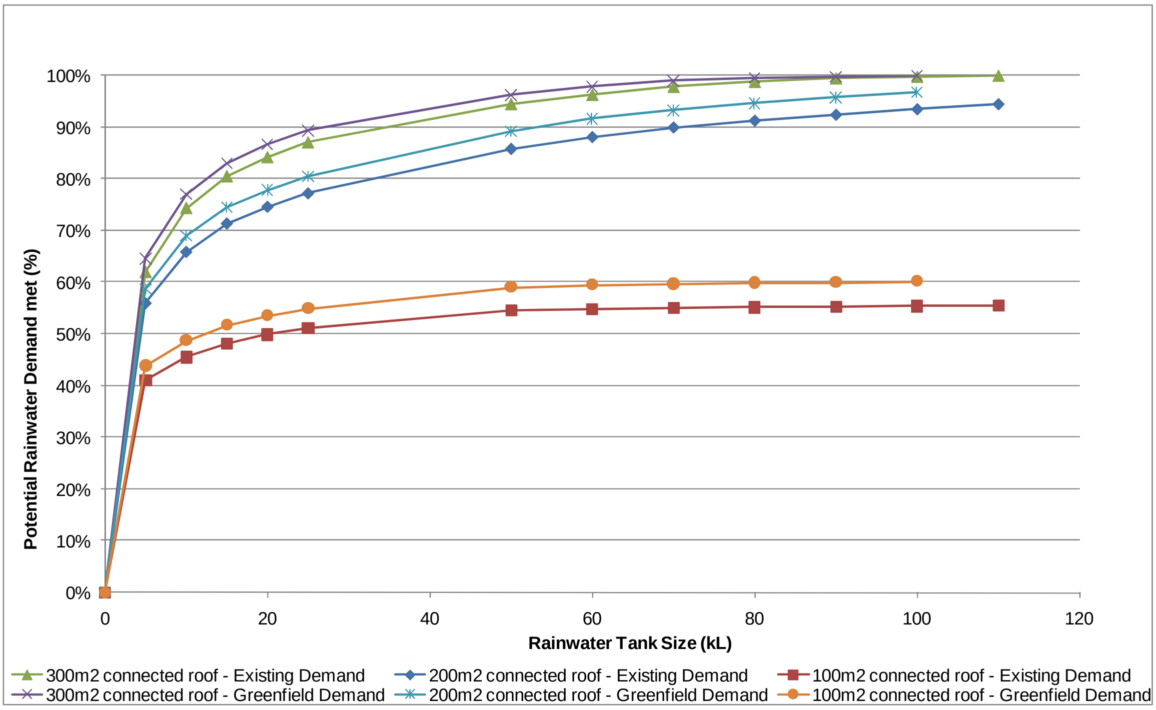


Figure 3-3: Average Annual Yield Analysis for Rainwater Tanks

It can be seen that for a Greenfield single family residential property a 100 kL tank connected to 300 m^2 of roof area would be required to meet 100% of the family's demand. A slightly larger volume tank of 110 kL would be required to take account of the less water efficient fixtures in an existing property compared to a new Greenfield property. Although there are larger industrial size rainwater tanks available, 110 kL is approximately equivalent to five 22.5 kL tanks, (one commercially available 22.5 kL tank has a diameter of 3.73 m)and would be extremely difficult to locate on an average suburban block.

The figure also illustrates that for a given roof area and demand, there is a 'point of diminishing returns' in tank size, where increasing the size further does not provide a significant increase in yield.

The tank volume over the period 1970 – 2007 for a 110 kL tank connected to 300 m^2 of roof area supplying 100% of demand for an existing single family residential property is shown in Figure 3-4. It can be seen that the tank runs out of water once during this period and is frequently full and overflowing. The rainwater tank model assumes a fixed internal demand and a seasonal demand based on irrigation requirements, it does not assume any self-imposed restrictions or changes to those demands whereas in reality, if there is a period of reduced rainfall and the volume in the tank is getting low householders would most likely manage their demands more carefully in order to preserve their only water supply source. The consequence of failure of a large stand alone rainwater tank is however very minimal as water carting is always available although this will be at an additional cost.

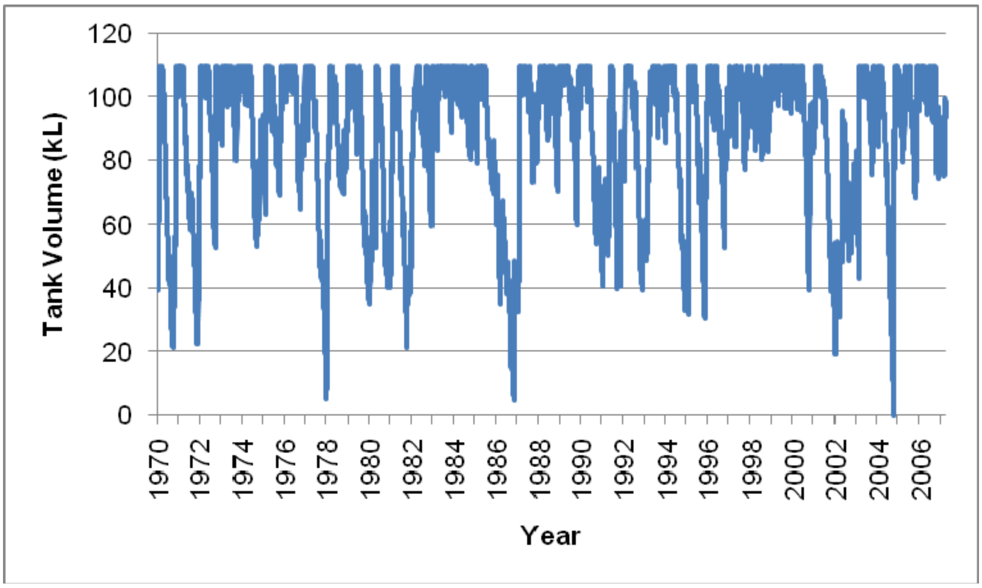


Figure 3-4: Tank Volume over time for 110kL tank using existing demand

In comparison to the Levels of Service for the reticulated water supply from Clarrie Hall Dam, Department of Water and Energy (DWE) guidelines in respect to levels of service for water supplies and water restrictions due to drought are described by the 5/10/20 rule.
This rule underpins the reasonableness of drought restrictions. Levels of Service under this rule are defined as follows:

- Restrictions implemented no more than 5% of the time, on average;
- Restrictions imposed no more than once every 10 years on average; and
- Demand reductions during drought restrictions should be 20%.

From the 2009 Tweed Shire Council Drought Management Strategy, which analysed the performance of Clarrie Hall Dam from 1986 to 2007, it is clear that the carting ban (imposed when the dam falls to 90%) will occur regularly (approximately once every two years). Water restrictions however have occurred only once in the past 20 years, during the drought of 2002, which is the worst on record and brought Clarrie Hall Dam down to its lowest level of 35% capacity. It is therefore believed that the level of service will meet the 5/10/20 rule for the foreseeable future. During the period 1986 – 2007, Clarrie Hall Dam fell below 40% only once in early 2003.

Assuming no flow in the system, Clarrie Hall Dam would fail in 14 to 15 months at 2008 demand levels and in around 12 months under 2018 demands. This case assumes zero inflow to Clarrie Hall dam and zero flow in the Tweed and Oxley Rivers. This is the worst case scenario and the probability of occurrence is very low as there has always been some level of flow in the Tweed system based on the available records spanning around 120 years. Compared to a large stand alone rainwater tank, the consequences of failure of Clarrie Hall Dam are major and contingency options to supply customers under a total failure scenario or to provide a back up supply if the dam reaches critical levels were also reviewed as part of the study.

If the period of 1986 – 2007 is examined, it can be seen that as long as appropriate restrictions are implemented, both Clarrie Hall Dam and a large stand alone rainwater tank have the capacity to continue to supply water throughout the modelling period. However, during this period, Clarrie Hall Dam only fell below 40% capacity once and restrictions were only applied once. The large tank however, failed once and almost failed on one other occasion. It is likely that the household would need to restrict their water use on these occasions. The large stand alone rainwater tank also fell below 40% capacity on 10 occasions during the period 1986 – 2007.

In 2006, SunWater analysed the security of the Tweed River water supply system using climate data from 1890 to 2004. This was a theoretical historic no failure yield analysis which determines the annual volume of water (in ML/year) that can be supplied, without failure for every year of the analysis. This analysis showed that using DWE criteria and assuming 20% demand reduction during drought restrictions the level of Clarrie Hall Dam would have dropped below 40% on only two occasions, once during the 1902/03 drought and again during the 2002/03 drought. Compared to the Drought Management Strategy the probability of Clarrie Hall Dam falling below 40% capacity is reduced to 1 in 100 years.

Therefore, although water restrictions would be required for both systems, the probability of failure of a large stand alone rainwater tank as the sole supply is far higher than for the reticulated water network supplied by Clarrie Hall Dam.

4 Water Quality Issues

4.1 Regulatory Requirements

While no specific legislation regulates rainwater harvesting and reuse, a large stand alone rainwater tank will be required to comply with a number of relevant legislative and non-legislative regulatory requirements. These along with other relevant reference documents are listed in Table 4-1.

Table 4-1: Regulatory Requirements and Reference Documents

Type of Document	Name	Key Issues
Legislation	*Water Management Act 2000*	Entitles householders to capture rainwater i.e. the States rights to water do not extend to private roofs. This is a NSW Act and this right is not the same in all States.
Standards	AS/NZS 3500 *Plumbing and drainage*	Technical standards for installation
Guidelines	*Guidance on Use of Rainwater Tanks* (enHealth, 2004)	Information is provided on the range of potential hazards that can threaten water quality, preventive measures that can be used to prevent these hazards from contaminating rainwater, straightforward monitoring and maintenance activities, and, where necessary, corrective actions.
	Australian Drinking Water Guidelines (NHMRC & NRMMC, 2004)	The ADWG provide a Framework for management of drinking water quality based on a preventive, risk management approach.
	Rainwater Tanks Where a Public Water Supply is Available - Use of (NSW Health, 2007)	In urban areas NSW Health supports the use of rainwater tanks for non-drinking uses. NSW Health recommends that people use the public water supply for drinking and cooking because it is filtered, disinfected and generally fluoridated.
Other Reference Documents	*NSW Code of Practice for Plumbing and Drainage* (CUPDR, 2006)	
	Rainwater Tank Design and Installation Handbook (MPMSAA, 2008)	
	Research Report 39: Guidance Manual for the Design and Installation of Urban Roofwater Harvesting Systems in Australia (Edition 1) (Chapman et al., 2008a)	
	Research Report 42: Water Quality and Health Risk from Urban Water Tanks (Chapman et al., 2008b)	

4.2 Tweed Shire Council Requirements for Rainwater Tank Installations

TSC has the following requirements for the installation of rainwater tanks:

- Submit a **Plumbing / Drainage Permit** ($42) to Tweed Shire Council and pay an **Inspection Fee** ($90).
- Clearly label any pipes and taps as 'rainwater'.

Note: *If the tank capacity is greater than 10,000 litres and you are not in a rural area, you must also submit a Development Application to meet other building requirements.*

4.3 Water Quality / Scheme Requirements

enHealth (2004) identified that collection and storage of rainwater provides the opportunity for a number of microbial (i.e. pathogens), physical (i.e. sediments) and chemical (i.e. heavy metals) contaminants to enter the water, with microbial contaminants being the most prevalent.

Chapman et al. (2008b) reported the following water quality results from a National survey of water quality from 35 rainwater tanks from Adelaide, Brisbane, Broken Hill, Canberra, Sydney and Wollongong:

- *Microbial:* Compared to conventional urban water supplies the water supplied from the rainwater tanks tested provided relatively poor microbial water quality. Pathogens responsible for gastrointestinal infection (*Campylobacter spp* and *Salmonella spp*) were detected in 1 and 2 rainwater tanks respectively.
- *Chemical:* High lead concentrations were detected in six tanks. High zinc concentrations were also detected but high zinc concentrations are more of an aesthetic issue, opposed to a health issue, since it may lead to taste problems. Occasional high levels of plasticisers and herbicides were detected although further investigation is required to ascertain the prevalence in a larger sample and over a longer sample time.

Both the NSW Department of Health and enHealth (2004) advise against drinking rainwater where a reticulated water supply is available as the water quality from a rainwater tank, in particular microbial quality, may not be consistently high quality.

The following measures can be implemented to improve rainwater quality obtained from a rainwater harvesting scheme:

- Prudent scheme design (e.g. rainwater tank location, materials of construction and guttering design can all impact on the water quality);
- Use of treatment processes (e.g. leaf and debris screen); and
- Regular Maintenance (e.g. regular removal of debris and leaves from the roof and guttering).

There are a number of treatment processes that are commonly adopted to improve rainwater quality depending on the particular end use. For a number of rainwater harvesting schemesTable 4-2 compares the end uses the rainwater is used for and the level of treatment adopted for the rainwater.

With the exception of Capo Di Monte, which provides community based water supplies, the examples are for schemes providing rainwater to an individual dwelling.

A rainwater harvesting and reuse scheme may also require additional measures to prevent mosquito breeding in the rainwater tanks.

Table 4-2: Indicative Combinations of Risk Mitigation Measures Requires for Selected End Uses

Example	End Uses	Adopted Rainwater Treatment
Various Locations	Outdoor water uses	None
Gold Coast Water	Outdoor water uses Toilet flushing Laundry (cold tap)	Leaf and Debris Screen First Flush Device
Capo Di Monte (Mt Tamborine, QLD)	All water uses including drinking.	Leaf and Debris Screen Sand Filter UV Chlorine Dosing

5 Capital and Operational Costs

5.1 Capital Costs

A range of capital costs for rainwater tanks, pumps, plumbing and installation is shown below in Table 5-1. This table has been taken from a 2007 National Water Commission report, by Marsden Jacob Associates, "The cost-effectiveness of rainwater tanks in urban Australia". The results were relatively consistent for the tank itself, but the estimates of installation and plumbing costs were far more variable. In some cases, indoor plumbing is inaccessible or encased within the concrete slab of the house, making plumbing to some areas of the house cost prohibitive which explains the variability of plumbing costs shown in Table 5-1.

Table 5-1: Rainwater tank costs provided by suppliers ($)

	2 kL tank	5 kL tank	10 kL tank	20 kL tank	Pump	Plumbing (approx.)	Installation (approx.)
Range	641-922	935-1,349	1,621-1,899	2,618-2,835	240-1,045	300-3,000	300-800
Average	732	1,080	1,656	2,852	622	885	549
Median	721	1,091	1,630	2,835	650	727	548

The Marsden Jacob report also contained a levelised cost analysis which demonstrated that in all of the cases examined, the cost per kilolitre of tank water is greater than the price currently charged by water companies and a "typical" property owner who installs a rainwater tank will, in most cases, face a net financial loss over time. To offset this loss, a rebate in the order of $1,600 to $4,000 would be required depending on tank size and roof size.

Using the average costs shown in Table 5-1 gives an approximate cost of $3,150 for a 5 kL tank and $27,000 for an equivalent 110 kL tank. This gives a capital cost of $3.50 per kL of rainwater supplied for the 5 kL tank based on a demand of 231 L/day over 20 years (outdoor use, toilet flushing and cold water to washing machine as analysed in the Demand Management Strategy). Using the same methodology the capital cost per kL of rainwater supplied for the 110 kL tank is $9.80 based on a demand of 710 L/day which is the existing single family residential demand shown in Section 3.2.

This is a very simplistic calculation; it does not contain any rebates, replacement of pump (expected every 10 years) or any ongoing maintenance. It is shown for comparative purposes only and shows that to supply all internal and external demands with rainwater costs approximately 2.8 times more than supplying the end uses recommended in the Demand Management Strategy with a 5 kL tank. This again highlights the effect of diminishing returns shown in Figure 3-3.

5.2 Operational Costs

Most research on operational costs of rainwater tanks has focussed on the more practical domestic tank sizes ranging from 2,000 litres (2 kL) to 10,000 litres (10 kL), which suggests that

> "*a typical household rainwater system supplying rainwater to the laundry, toilet and garden appears to have an average energy intensity of approximately 1.5 kWh/kL*". *(Retamal, 2009)*

Using this energy intensity to calculate the energy requirement of a pump to supply all internal/external demand for an existing single family residential property gives:

1.5 kWh/kL x 259 kL/yr x 21.582[3] c/kWh = approximately $85 per year

Other operational costs (both financial and non-financial) include:

- regular checking and cleaning of gutters, roof catchments and tank screens, including removing overhead branches where required;
- potentially installing gutter screens or guards;
- checking the tank for sludge every two to three years and having the tank cleaned if there is a thick layer of sludge at the bottom;
- if the tank owner suspects the tank has been contaminated, the water stored in the tank may require chlorine disinfection; and
- maintenance of the water pump as required.

In contrast to the installation and plumbing for a rainwater tank, the operating and maintenance of a tank can often be undertaken by the home owner and in some cases represents a cost that would have been incurred even without the tank (e.g. cleaning of gutters).

Interestingly, the cost of the physical tank itself might account for as little as 30% of the whole of life cost if the tank is plumbed for both indoor and outdoor use. In a "typical" installation, the water pump (including replacement every 10 years) might account for around 35%, installation and plumbing 25% and ongoing operation and maintenance around 10%. (NWC, 2007)

In 2009, Gold Coast Water implemented an inspection program for registered rainwater tanks in accordance with Queensland Local Government Act 1993. Although the majority of costs associated with rainwater tanks are borne by the customer this is one example of a cost that could be incurred by Council.

[3] TRU Energy NSW Electricity 5700 (peak) rate

6 Operation and Maintenance

Regular maintenance is the key to good water quality. Installing screens, filters and first flush devices will reduce contamination.

Unless adequately treated, rainwater is not as reliably safe to drink as the network water supply. It is almost impossible to completely protect rainwater from bird droppings and other debris containing micro-organisms and particularly in an urban environment, air pollution caused by nearby light / heavy industries and vehicle emissions.

Likely sources of micro-organisms and chemical contaminants that can be controlled are:

- Overhanging branches
- Soil and leaf litter accumulated in gutters – particularly if kept damp for long periods due to poor drainage
- Faecal matter deposited by birds, lizards, small rodents, marsupials etc
- Dead animals and insects either in gutters or in the tank itself

It is important that roofs, gutters, screens and first flush devices be regularly inspected and cleared of leaves and other debris.

To prevent mosquito breeding, and corrosion and metal contamination, guttering and pipework should be self-draining or fitted with drainage points. Water should not be allowed to pool under the overflow outlet or tap, as these can become mosquito-breeding sites.

The tank should be a sealed unit with the lid preventing sunlight from reaching the water. Sunlight encourages the growth of algae that will taint the water. Holes and spaces will allow mosquitoes to enter. The inlet should incorporate a mesh cover and a strainer to keep out leaves and to prevent the access of mosquitoes and other insects. The overflow should also be covered with an insect proof cover such as plastic insect mesh wired around the pipe.

The most common additional treatment measures utilised in Queensland case studies include:

- Filtering through a 20 micron filter;
- UV disinfection (to ensure all pathogens were eliminated); and
- Carbon filters on cold water taps.

The suggested maintenance procedures shown in Table 5-1 are recommended by Gold Coast Water to ensure risks to water quality are minimised.

It is recommended that the tank is emptied and cleaned once every two years which would require another source of supply during this time, especially if only one large tank is used to supply all internal and external end uses. Therefore, regardless of the size of tank 100% reliability from a large stand alone rainwater tank is impossible as allowance needs to be made for emptying and cleaning once every two years.

Table 6-1: Suggested maintenance procedures

Maintenance Action	Regularity
Check and clean mosquito net on tank overflow	October – March: every month April – September: every three months
Check and clean first flush device	Three months
Check roof and gutters for the presence of accumulated including leaf and other plant material	Three months
Clear accumulated plant material	Three months
Prune overhanging tree branches and foliage	Three months
Check water quality – must be clear with no smell	Six months
Check for evidence of animal, bird or insect access including mosquito larvae; if present locate and close access points	Six months
Check tank for defects and repair	Six months
Check for evidence of algal growth; if present, find and close points of light entry	Six months
Ensure taps have the correct signage installed	Six months
Clean tank to remove accumulated sediment or sludge	Two years

7 Property Development and Water Access Charges

The current Tweed Development Servicing Plan (DSP) for Water Supply Services makes no allowance for properties that are self-sufficient for water requiring *contributions where the anticipated development will or is likely to increase the demand for water supply services*.

As yields from rainwater tanks are susceptible to droughts there is no guarantee that connection to the reticulated water supply will not be necessary in the future to service the property.

The current water access charges from the TSC website (http://www.tweed.nsw.gov.au) are $102 annually for residential customers. This fee applies to all land that is within 225 metres of a water main and able to be connected (whether connected or not).

A similar approach is taken in Section 311 of the *Water Management Act 2000*, which states a water supply authority may only levy water service charges on land:

> (a) to which water is supplied, or
>
> (b) to which, in the opinion of the water supply authority, it is reasonably practicable for water to be supplied, from one of the water supply authority's water mains.

8 Considerations

An evaluation of large stand alone rainwater tanks is shown in Table 8-1 with some identified advantages and disadvantages of this method of source substitution. The reduced stormwater pollutant loads and peak discharge rates can also be achieved through the use of smaller rainwater tanks and these advantages are not solely applicable to large rainwater tanks.

Table 8-1: Large Stand Alone Rainwater Tanks considerations

Advantages	Disadvantages
Reduced potable water demand	Climate dependent – yield reliability calculated for average climate conditions and hence performance will reduce considerably during periods of below average rainfall
Reduced stormwater peak discharge rate and volume which reduces both flooding and erosion downstream	Cost prohibitive to supply entire internal/external demand due to size of infrastructure required to maintain 100% reliability
Reduced pollutant loads in stormwater increase the water quality and health of downstream water bodies	Large connected roof area required – not all roof area is available for use and will depend on the location of downpipes and tank location
New potable water supply sources could potentially be delayed	Required footprint for large rainwater tanks – e.g. one commercially available 22.5 kL rainwater tank has a diameter of 3.73 m and stands 2.44 m high. Existing single family residential property requires five 22.5 kL tanks to be self sufficient. Difficult to locate on an average suburban block.
Reduced potential for wet weather sewage overflows due to reduced ingress of rainwater into the sewerage network	Costs borne by customer not council
Reduced stormwater flow and pollutant loads lead to increased habitat protection for fish and other aquatic animals	Increased energy costs
Ability to be independent of reticulated supply, dams can be depleted over many years of drought and restrictions may still apply to reticulated supply although tanks contain water. Tanks can also be topped up by carting water although this will involve a cost.	May not reduce infrastructure costs if council deem that connection may occur in the future and hence demand is required to be catered for
Rainwater can be lower in salinity and hardness than mains water reducing corrosion and detergent use	Does not reduce developer charges or rates
	Maintenance is the onus of the owner not council
	Potential water quality issues
	May not be able to maintain current garden watering practices and other lifestyle choices i.e. pools/spas
	Alternative source of fluoride needs to be sought

Advantages	Disadvantages
	More expensive to retrofit in existing houses where access issues for installation and roofs/gutter connections may not be suitable

9 Discussion

Rainwater tanks have a long history of use in Australia, predominantly in rural areas (farms and towns) which often depend upon them for household water. More recently the use of tanks has grown in urban areas, driven by State or local government policies or programs (i.e. rebates) to encourage their use and by home owners' personal choice.

TSC currently has a rainwater tank policy requiring dual supply rainwater tanks to have a minimum storage capacity of 4,500 litres and a minimum roof area catchment of 50 m^2. The Demand Management Strategy - Stage 1 recommends for major development that requirements above the NSW Government's Building and Sustainable Building Index (BASIX) be pursued through agreement for dual flush toilets and 3 star shower heads and the provision of 5,000 L rainwater tanks with a minimum connected roof area of 160 m^2, connected to external, toilet flushing and cold water to washing machines.

In addition to the examples and case studies discussed in this report, there are few examples of communities which rely solely on rainwater tanks for their permanent water supply. While none of the examples or case studies are completely self-reliant on rainwater tanks, using an integrated approach combining groundwater, greywater and recycled water to augment their supply, they are examples of how rainwater tanks are currently being used in Australia

To be totally self sufficient for water an existing average single family residential property in the Tweed area would require a 110 kL tank connected to 300m^2 of roof area, and an average Greenfield property with water efficient devices would require a 100 kL tank also connected to 300m^2 of roof area.

Currently the disadvantages of using rainwater tanks to supply all of a households demand far outweigh the advantages due to the lack of water security and economics of large stand alone rainwater tanks in areas where potable supply is available.

The Bureau of Meteorology classifies Tweed Shire Council as being in a summer rainfall zone of Australia. This rainfall zone is denoted by wet summers and low winter rainfall. This has an impact on rainfall tank sizing because the tank has to be large enough to capture the wet summer rainfall and store it to cater for the winter demand. Yield reliability is calculated for average climate conditions and hence will fluctuate during periods of below average rainfall.

A large connected roof area is required which may not be feasible on typical urban blocks that do not have large sheds or outbuildings like rural areas. Large rainwater tanks also have a large footprint (a 110 kL tank equates to five 22.5 kL tanks, which are 3.7 m in diameter and 2.4 m high) which again may not be feasible in urban areas where land availability is limited.

It is important to realise that rainwater tank cost, both capital / operating, and maintenance time are borne by the customer not the council; there are also increased energy costs associated with pump operation.

Because large rainwater tanks are susceptible to drought and not a reliable source of supply, water infrastructure will still need to be sized to cater for peak demand with no reduction due to rainwater tank usage. This also means there will be no reduction in developer charges or rates.

There are also water quality issues associated with exposure to rainwater, which require treatment and increase the capital and operating costs. Rainwater does not contain fluoride and if used as the sole source of drinking water, an alternative source of fluoride will need to be sought.

Finally, demands in this study have been taken from average demands for Single Family Residential properties contained in the Demand Management Study. If individual property demands are significantly higher than average, then current garden watering practices and other lifestyle choices may not be able to be maintained.

10 Conclusions

- In urban areas NSW Health supports the use of rainwater tanks for non-drinking uses. NSW Health recommends that people use the public water supply for drinking and cooking because it is filtered, disinfected and generally fluoridated.
- To be totally self sufficient for water an existing average single family residential property in the Tweed area would require a 110 kL tank connected to 300m^2 of roof area, and an average Greenfield property with water efficient devices would require a 100 kL tank also connected to 300m^2 of roof area.
- Although there are larger industrial size rainwater tanks available, 110 kL is approximately equivalent to five 22.5 kL tanks, which have a diameter of 3.73m each and would be extremely difficult to locate on an average suburban block.
- Yield reliability is calculated for average climate conditions and hence will fluctuate during periods of below average rainfall.
- Although water restrictions do occur in the reticulated water supply network the probability of failure of the Clarrie Hall Dam is very low compared to using a large stand alone rainwater tank as the sole supply.
- The cost per kilolitre of tank water is greater than the price of water from the reticulated water supply.
- To supply all internal and external demands with rainwater costs approximately 2.8 times more than supplying the end uses recommended in the Demand Management Strategy with a 5 kL tank
- Property development and access charges will still apply.
- Because large rainwater tanks are susceptible to drought and not a reliable source of supply, water infrastructure will still need to be sized to cater for peak demand with no reduction due to rainwater tank usage. This also means there will be no reduction in developer charges or rates.
- Rainwater tank cost, both capital / operating, and maintenance time are borne by the customer not the council; there are also increased energy costs associated with pump operation.
- There are water quality issues associated with exposure to rainwater, which require treatment and increase the capital and operating costs. Rainwater does not contain fluoride and if used as the sole source of drinking water, an alternative source of fluoride will need to be sought.
- There are environmental advantages to using rainwater tanks, however these can also be provided by smaller tanks that are used to augment the existing water supply and not as the sole supply.
- Currently the disadvantages of using rainwater tanks to supply all of a household's demand far outweigh the advantages due to the lack of water security and economics of large stand alone rainwater tanks in areas where potable supply is available.

11 References

Your Home case study, Gold Coast, Queensland http://www.yourhome.gov.au/technical/fs84.html

Your Home case study, Canberra, ACT http://www.yourhome.gov.au/technical/fs814.html

Tweed Shire Council, Development Servicing Plan for Water Supply Services, July 2007

State of New South Wales, Water Management Act 2000

Smart and Sustainable Homes, Currumbin case study, April 2009, http://www.sustainable-homes.org.au/03_projects/currumbin_ll/currumbin_ll.htm

Environment, Climate Change and Water, NSW rainwater tank rebate http://www.environment.nsw.gov.au/rebates/ccfrtw.htm

Australian Government, Department of the Environment, Water, Heritage and the Arts, National Rainwater and Greywater Initiative, http://www.environment.gov.au/water/programs/nrgi/index.html

Bureau of Meteorology, Major seasonal rainfall zones of Australia http://www.bom.gov.au/climate/environ/other/seas_group.shtml

http://www.tweed.nsw.gov.au/Agenda21/pdfs/TSC%20Requirements%20for%20Rainwater%20Tank%20Installations.pdf

ABC News, Marion Bay awaits Desalination Plant http://www.abc.net.au/news/stories/2007/05/31/1938784.htm

Australian Government, National Water Commission, Marsden Jacob Associates, The cost effectiveness of rainwater tanks in urban Australia, March 2007

Retamal, Turner, White, Energy Implications of Household Rainwater Systems, published Water Journal, v36 8 December 2009

Gold Coast Water, FACT SHEET Inspection Program – Rainwater Tanks, http://www.goldcoastwater.com.au/attachment/goldcoastwater/pet_tank_inspection_fs.pdf

Chapman H., Cartwright T. & Tripodi N., 2008a. *Research Report 39: Guidance Manual for the Design and Installation of Urban Roofwater Harvesting Systems in Australia (Edition 1)*, The Cooperative Research Centre for water Quality and Treatment.

Chapman H., Cartwright T., Huston R. and O'Toole J., 2008b. *Research Report 42: Water Quality and Health Risk from Urban Water Tanks*, The Cooperative Research Centre for water Quality and Treatment.

Committee on Uniformity of Plumbing & Drainage Regulations in NSW (CUPDR) 2006. *NSW Code of Practice for Plumbing and Drainage,* Sydney.

enHealth Council, 2004, *Guidance on Use of Rainwater Tanks.* enHealth Council. Australian Government Department of Health and Ageing.

Master Plumbers & Mechanical Services Association of Australia, 2008. *Rainwater Tank Design and Installation Handbook.*

National Health and Medical Research Council & Natural Resources and Management Ministerial Council (NHMRC & NRMMC) 2004. *Australian Drinking Water Guidelines,* Canberra.

NSW Health, Rainwater Tanks Where a Public Water Supply is Available - Use of, June 2007 http://www.health.nsw.gov.au/policies/gl/2007/pdf/GL2007_009.pdf

MWH, Tweed Shire Council Demand Management Strategy, 2009

MWH, Tweed Shire Council Drought Management Strategy, 2009

SunWater, Tweed River System Water Supply Security Review, 2006