Managing Your Water

Storing water, saving water and making use of greywater

www.underthechokotree.com
Sustainable Living in the Suburbs

By Nev Sweeney

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Thanks to –

Greg, for allowing me to include your wonderful greywater system, and
Jose, for helping me with the constructed wetland greywater analysis

TABLE OF CONTENTS

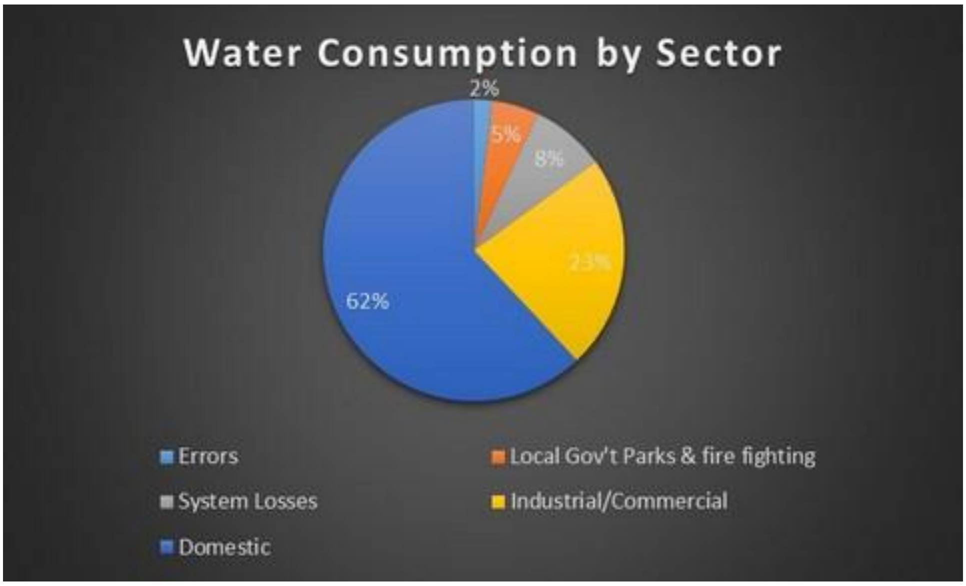
1.0 Context and Introduction

1.1 Context

Most of the ideas in this eBook have been tried by us on our 600m^2 western Sydney suburban block and found to work. Most will work just about anywhere, but our focus is on achieving a more sustainable life where we are – suburbia.

1.2 Introduction

Australia is a drought country and if the predictions of what is going to happen due to climate change are true, the position is likely to become worse rather than better. Australian households consume roughly 60% of the water captured, purified and then pumped to our cities us as part of our reticulated water system (See graph below). The average Australian uses 180 to 200 litres of water per day directly and this water is provided at an energy cost of 164 kilowatt-hours per person per year in Australia.



This energy use is usually not factored in when doing calculations on how much energy is consumed by a household because it is consumed indirectly and we think in terms of buying and consuming water rather than energy. As a result of the energy use, the provision of water contributes roughly 160 kilograms of CO2 per person per year here in New South Wales because our electricity is mostly generated by black coal (anthracite) powered power stations. In Victoria this figure is closer to 200 kilograms of CO2 per person per year due to the use of "dirtier" brown coal (lignite) for power generation.

Taking into account all this information it is easy to see that by reducing the amount of water we draw from the reticulated water supply, we are not only saving the water itself and thereby saving money we are also saving energy and thereby carbon dioxide emissions as well. Hopefully I have convinced you that saving water is a good thing!

Three Options

In general terms once we make the decision to reduce our water consumption there are three broad techniques for achieving our aims –

1. **Store and use rainwater** – By investing in rainwater tanks attached to any or all of the household buildings we can start to harvest what is essentially a free resource – rainwater. The rainwater can then be used in place of the reticulated water supply wherever you can manage it as it is energy, and therefore carbon, free.
2. **Re-use Greywater** – Greywater is water that has been used once and would normally be disposed of to a sewer system and lost to the household. This greywater can be made to do more work and fulfil duties that would normally be expected of fresh, reticulated water such as flushing toilets or watering lawns and trees. Greywater can be given a decontamination process before it is used or used as is, but should not be stored due to bacterial contamination. The water from a flushed toilet is referred to as black water and should not be re-used on site, water from the kitchen sink may be too heavily contaminated by fats, oils and detergents and likewise should not be re-used.
3. **Reduce Demand** – As well as using rainwater and greywater, there are lots of ways to reduce the amount of water we need to draw from the reticulated water supply. This saves us water and energy but also money!

Rainwater can help reduce your town water usage

Having said all that, this is not an “either/or” process and ideally you will want to implement techniques from all three of the above options to reduce you consumption of water from the reticulated supply.

2.0 Water Audit

Where do we Start?

The great quality management guru W. Edwards Deming said it best in the saying attributed to him –"that which you don't measure, you don't control". In other words, get some data which tells you where you are using the most water so you can hit those areas first. Fortunately there is a readily available process to help you work out where your water consumption is going – The Water Audit.

The Water Audit.

I thought that I had a handle on how much water we used and where it went as well as the opportunities for improvement, but there is nothing to make you take things more seriously like a load of hard data. I actually found the process to be fun.

What is a Water Audit?

A water audit is a tool that allows you to work out how much water you use and where it all goes and if you do it right, it doesn't allow you much squirming room but that is the point. The water audit itself has a number of stages –

- Identify the areas where your household uses water and work out the typical amount for each use.
- Conduct the audit by recording over a week the amount of water you use.
- Validate your workings against the records from your water supplier.
- Identify any leaks that will introduce inaccuracies to your figures.
- Work out how much water you have coming onto the property through rain and can be stored.
- Work out how much greywater you have available for re-use.
- Work out how much tank capacity you need for water security.

In the "Appendices" section of this eBook there is a form to help you work through the process and record all of this information.

Identifying and Quantifying Sources of Water Use

There are a whole stack of ways we can use water in our houses so here is a list the water uses we have and some of the things you might want to think about as you identify them. You will also need to know how much water is consumed by each use so that you can calculate your water consumption –

Toilet – this is a pretty obvious one. If you have a dual flush system you will need to give some thought as to how often each one is used. If you don't know how much water is used in each flush then have a look at any documentation you have when the toilet was installed, otherwise consult the internet like I did.

Shower and bath – these can be a bit difficult because the number and length will not only vary from person to person but may also vary with the time of year, more in summer and less in winter. Also when you wash your hair the showering time will be longer and the water use increased, so we divided the shower readings into hair washing and non-hair washing so we could get a more accurate reading. Otherwise you could work out an average and use that.

A water valve can help reduce water usage in the shower

If you get hold of a calibrated bucket (ie it has litre markings on the side) you can run the shower into the bucket for a minute and see how much water comes out. After that you just have to time the showers to know how much water is used on average. You can pull the same stunt for the bath or use the internet again to find out the volume of your make and model of bath, then make a judgement on how full the bath is and so how much water is consumed.

Dish washing – water use will depend on the size of your family, who eats at home and when and whether you use a dishwasher or do the dishes by hand. If you use a dishwasher then the water consumption should be on the paperwork under specifications, consult the internet again or ask the supplier. For hand washing we ran as much water into the sink as we would normally use then dipped it back out of the sink and into the calibrated bucket (see shower and bath above!) to give us a measure of how much we used.

Clothes washing – this will depend on the type of machine you have, although if you still go for the beat-the-clothes-against-the-rock style of clothes washing estimating water usage will be difficult, otherwise look up your user's manual or use the internet to find out.

Teeth brushing and had washing – this is probably a minor thing unless you leave the tap running while you brush your teeth! We set each of them at 1 litre per wash/brush but if you want to get more detailed than that it is up to you. It was interesting to note just how many times a day we washed our hands, a legacy of watching too many hand cleaner commercials I think.

Drinking and cooking – this is likely to be variable depending on the size of your household, what and how you like to cook, what and how much everybody drinks etc. After some to and fro we settled on 7 litres per day as a reasonable compromise but you may wish to do your own research on this one.

In the garden – This will depend on what time of year you conduct your audit and how long it has been since your last rain. If all else fails some kind of estimate may work but you should measure the output of every tap you use to water your yard, lawn, garden, veggies etc by running them into a calibrated bucket to identify how many litres per minute of water is delivered by the hose. Then you will need to measure, or estimate, how many minutes you spend watering the garden to give you an idea of how many litres of water are used each time.

Conducting the Audit

This is the simple bit, although it will require you to remember to record each water use at the time that you use it, but after a while you will get in the swing. Estimates are possible but there is nothing quite so educative and reviewing the tallies at the end of the week, you may well discover something that you wouldn't have thought credible, if you hadn't done the recording.

First off, make a copy of the blank Water Audit Form from the appendices at the end of this eBook. Then record all of your estimates for each use after the "@" in each of the sections of the right hand "Water Use" column.

Put the printed sheet up somewhere that you can get to it easily to enter your tallies, the kitchen or bathroom would probably be best, then each day mark of with tally marks in the appropriate square each time you wash, flush water or whatever or add in the number of minutes used where it is a consumption figure.

There is no saying that you only have to do this for only one week and you may want to do this several time over the year, say once each season, and the more times you do it, the more accurate your water usage figures will be.

Once your measuring period is complete, add the figure totals up along the bottom and down the right hand side and then calculate your total litres for the week, then multiply by 52 and you will have some idea of how much water you use in a year.

Validating Your Results

As a cross check, get hold of your last four (quarterly) water bills and then add them up to give a yearly total, just to see how close it is to your calculated total. If you don't have your last four water bills (who does?) you can ring up your provider and they will usually be able to give you a litre consumption figure over the phone. If your figure is wayyyyyy out, re-check the things you are measuring to see if you have missed something or if you have cut back water consumption just because you are measuring it. If you can't find a reason for the discrepancy you may (and assuming the consumption on your bill is larger than on your measured tally) have a leaking pipe somewhere and that is something worth pursuing.

Checking For Leaks

If you do think you have a leak, turn off all water in the house and write down the figure on you water meter. Leave everything off for as long as you can manage but at least two hours and then re-check the figure on your water meter, if it has changed you have a leak and need to obtain the services of a plumber, unless you are capable of tracking such things down yourself.

Fix those leaky taps!

Next on the list – Measuring your Greywater

Grey water is on the "plus" side of the equation because although it has already been used once, to clean clothes or to clean you or whatever, it can still be pressed into service to carry out other functions, like watering the garden or flushing toilets. The figures for shower, bath and washing machine can just be transferred from where you calculated them in the usage part of the audit but the laundry sink may have hand washing water or other things as well so either estimate or put the plug in for twenty four hours and then use a calibrated jug to empty it and record the amount.

Calculating your Potential Rainwater Harvest

In the suburban backyard it is highly unlikely that you will be able to put in a dam or a well to use as water sources but you can hold and store the water coming off your roof, but how much could that be? Now we will work it out.

If you have a rain gauge and are pedantic about keeping your records, the first entry in this section will be easy, but if not (and I have to put my hand up here!) go to the Bureau of Meteorology (BOM) website and find the rainfall monitoring station closest to where you live. Check the records for as far back as you can and at this stage we are only interested in the yearly total. Collect as many yearly totals as you can and then average them and record them in the "annual rainfall" box. It pays to be a little circumspect with the data from the BOM, especially the older data because if it seems that your yearly rainfall is decreasing, it might be worth only averaging more recent data so that you get a bit more conservative (or perhaps realistic) figure.

Calculating Catchment Area

It is quite likely at the moment that all rain falling on your property makes its way to the water table or to the sea with not much happening in between, but what we want to do is to capture it and make it do some work on the way. In that way we can replace some of the water your draw from the town water system, which has been filtered, disinfected and pumped to your house at considerable energy cost with water harvested on site and little or no energy cost.

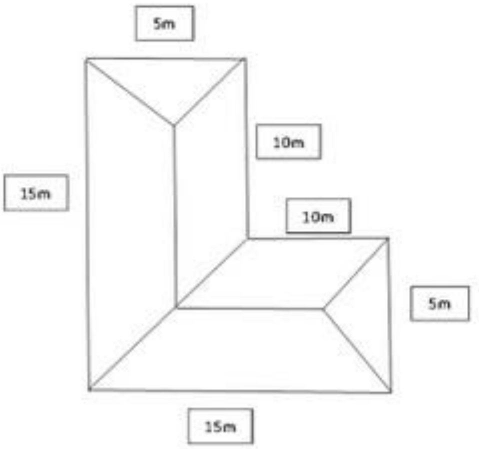


Figure 1 Sample house diagram with dimensions

So how much could you harvest? The first thing is to work out the area of every roof surface that you have which is capable of shedding water, which means your house, being most probably the largest structure on your land, garage, covered decks, sheds, greenhouses or whatever. It helps if you have a plan view of your block that includes all structures on the block.

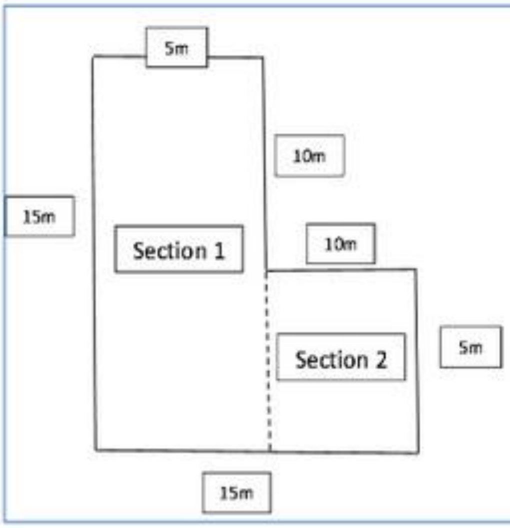


Figure 2 Sample house converted into 2 sections for ease of area calculation

Calculating Roof Area of Figure 2
Area of Section 1 = 15m x 5m =75m2
Area of Section 2 = 5m x 10m = 50m2
Total area or house roof = 75m2 + 50m2 = 125m2

Take a measuring tape and a friend (believe me this is much easier with a friend!), and measure the sides of each of the structures on your block, recording the measurements on the plan in metres. You can now work out the area of each structure, length multiplied by breadth. If any of your structures are not regular you may need to divide them up into squares or rectangles, multiply them out and then add them together to give total area (see figures 1 and 2 above). We had to do that with our house because one of the bedrooms just forward and, let's face it, few houses these days are a nice, neat square or rectangle.

Calculating the Potential Rainwater Harvest and Storage Requirements

Once all of your areas are calculated, put them on the form and then add them up to give the total area on your block that can be used to harvest rain water. You can then calculate the total possible amount of rainwater you can harvest in a year by multiplying the catchment area by the yearly rainfall figure from the BOM, which will give you an answer in litres. Now take 15% of that figure to allow for incomplete collection (for whatever reason) of the rainwater falling on your site, then record that on the audit form.

Sample Calculation 1
Roof area (m^2) x Rainfall (millimetres) – 15% for incomplete collection = Yearly rain catchment (litres)
The calculation for potential roof harvesting for the house in figure 1 and 2 above, assuming a rainfall of 900mm per year would be –

125 x 900 = 112,500 litres – 16875 litres = 95625 litres per year

Now enter the figures for daily and yearly water consumption into the form and then go back to be BOM website and look through the rainfall records for your area and identify the longest number of rainless days that you can find. Then multiply the number of rainless days by the daily consumption and this will give you an idea of how much water you will need to store to make it through a drought. Adding an allowance of 20% extra storage will provide extra water storage in case of reduced rainfall or increased consumption.

Sample Calculation 2
Daily water consumption (litres) x No of Rainless Days + 20% contingency = Amount of Tank Storage Capacity Required (litres)
Assuming a daily water consumption of 297 litres (average for Sydney). A household of 4 people and a likely maximum of 60 rainless days from the BOM data.

(4 x 297) x 60 = 71,280 litres + 20% = 85,536 litres of tank capacity required

From the above calculations it can be seen that reducing your water consumption means that there is less rainwater storage required to get you through the dry times.

In the second last line of the form add in the volume of any existing water tanks on your site and by taking that figure away from the one above it you will get an idea of how much rainwater storage you will need to install.

Using the Information

OK, now that you have gone through all of this rigmarole, what do we do with the information? The most obvious thing is to use it to put plans in place to install water tanks to cover at least as much as the figure on the bottom line of the form. Having said that, there are two sides to the water "debate", storage is one side but the other is consumption and you can use the information turned up by this audit to help you reduce your water consumption and thereby reduce the amount of water your need to store. (How much water you want to store is another matter!)

The audit will help you to identify what the big water consumption items for you are; maybe you have a huge top loading washing machine and can reduce your consumption by replacing it with a front loader or maybe it will show up a whole lot of smaller areas where you can reduce consumption.

For us it was watering the fruit trees etc in the front yard. We have a large tank in the front yard and it is plumbed into the back through a 12 volt pump so we can water the veggies easily, but we did not use the tank to water things in the front yard. After some quiet thought and discussion with my partner in the sustainable life we identified a couple of problems –

- While I had put a tap in the plumbing from the tank there was no attached hose, which meant removing the existing one from the front (mains water) tap and putting it onto the tank tap. The fix was to get another hose and nozzle that could remain fitted to the tank tap.
- The switch for the pump is in the garage so it means that you have to turn on the valve on the tank, walk to the garage and turn on the pump, then walk back to the tank to use the hose. The easier you make things to use, the more they will be used so the next fix is to install a switch next to the tank.
- Lastly, to make things more efficient, I need to install a drip watering system in the front yard.

So you can see that by carrying out a water audit you can get a handle on not only on how much water storage you need, but also where your water consumption is highest, so that you can know where to target to get the best reduction. It worked for me!

3.0 Water Storage (in a Water Tank)

3.1 The Original Galvanised Steel Tanks and the Polymer Tank

In the early 1980s, back before it was common to have water tanks in the Sydney suburbs, I wanted to have our own independent, sustainable (although the word wasn't used much back then) water supply and rainwater was the obvious way to do it. We had just put a hardiplank garage on the side of the house, the stormwater drains were all uphill from the downpipe and the builder said I should put in a rubble drain. Problem was it would have destroyed my main veggie patch, so I asked the council inspector about water tanks instead and after a bit of thought he said OK.

The original galvanised 2500 litre tanks

I wanted the old country style galvanised corrugated iron tank so we got a 2500 litre or 500 gallon as it was then, tall form one. It looked great and I was happy with it, but how to install it? I went to our local timber yard and they told me how –

First dig two trenches 4 foot apart, four foot long by one house brick wide. Lay house bricks in the trench side by side and cover them with concrete, this made a really good footing. Then lay three courses of bricks on the footings so that I had two brick "walls" four feet apart and parallel with each other and I let the concrete cure for a week. I am no expert brickie but so far so good.

Then I bought timber for the platform to support the tank itself, I bought 75mm x 100mm joists to go between the two brick supporting walls with about 300mm between them. I then nailed 150mm x 20mm hardwood over the joists to form a very stable platform on which the tank was to sit. The tank was installed, connected by just cutting off the downpipe to the right height and angling it towards the tank filling point. I t filled up rapidly, so rapidly I decided I wanted another. I followed the same process to the right of the original so that both tank stands flanked the garage back window, but the second one only had two courses of bricks so that I could run the output pipe from the first tank directly into the filling point of the second.

When we bought the second tank we were given a plastic strip with a mystery chemical in it (I think it may have been a phosphate of some type), it was to be suspended in the tank and the water would dissolve it coating the inside of the tank, reacting with it and extending its life. I had people tell me that the life of a galvanised water tank in the city was about 5 years, but the original one lasted about 15, sprung multiple leaks and died. We replaced it with an Aquaplate, plastic lined one and it is still going strong, as is the second one. There was only about 6 months between the first and second so that chemical worked! Mind you, by the time we replaced the older tank, water tanks were becoming popular again, so the bloke who sold it to us said, and he could charge more for them!

The tank stands are still in place, although the wood bits are looking a bit worse for wear and will eventually require replacement, but the service life has been pretty good!

The 5500 litre plastic tank

In the early 2000s, with the government rebate and all we decided to increase our water storage from 5000 litres to over 10,000 litres by adding a green plastic 5,500 litre tank to the front yard. While I prefer the look of the old galvanised corrugated iron, the plastic tank gave us the best cost per litre of water storage and it is installed under the mulberry tree, so even though they are UV stabilised, it should extend its service life even more. There is no way I was going to try the same trick with the bricks and hardwood to support it, so I was thinking about getting one of the guys from work to help me putting down a slab.

The guy who delivered the tank suggested another way – get treated sleepers and make a square two sleepers high a bit bigger than the circumference of the tank, then shovel in a whole stack of small size blue metal gravel and fines, the larger pointy stuff can wear a hole in the bottom of a plastic tank over time. So that's what I did, setting it up next to the roof outlet. It works remarkably well. I had to butcher the downpipe because I couldn't line it up properly with the top of the tank, but I could still channel

overflow from the tank back into the stormwater. Mind you, you can be feeling pretty good about yourself but you can't fool a shovel and a couple of tonnes of gravel!
The green tank takes water from about 1/3 to ½ of the roof, and the two galvanised tanks take all the water from the garage roof, but when I had the 30 year old guttering replaced recently I was able to get an extra downpipe put in from the house gutter to the garage roof so that I could capture more water. The new downpipe has a valve on it so I can turn it off in the event of wet weather when the galvanised tanks are full.

Extra downpipe to garage roof with valve

So we now have over 10,000 litres of water storage that gets used around the house!

3.2 Installing a water butt on a shed

Around the side of the house we have a shed, I'm sure lots of people do too, and when I was building it a mate of mine who has his own roofing business put a gutter and shot downpipe on it so that the rain wouldn't drip in the door and I could catch the rain coming off the roof. The gutter was attached to the thin overhang of the shed roof rather than a proper eave so we had to pop rivet some braces along it to keep it from sagging down and letting the rain flow over the top rather than going where I wanted it.

This shot shows a brace, pop riveted on the roof, curled around the gutter and pop riveted to the gutter

To catch the rain I installed a second hand black plastic 200 litre pickle drum just put up on a couple of bricks with the downspout pointed in its rough direction. There was no spout on the bottom for using the water, no screen on sop to stop mozzies and over the years it had developed a lean AWAY from the downspout. Hmmm, not good enough! After receiving some advice from an aquaponics expert, the 500 litre water butts I had gotten hold of to hold the fish suddenly became free (yeah, I know, don't laugh) so I decided to replace the black drum with a properly designed and installed water butt, not to mention with two and a half times the capacity, woo hoo!

After draining (onto the fruit trees of course) and removing the black drum I got hold of some bricks and set them in a square so they would support the bottom of the butt (is that a tautology?). One of the problems with the black drum was a relatively small footprint on the ground and that the sides of the drum tapered down towards the bottom, making it somewhat unstable whereas the water butt has a large round flat bottom making it very stable.

Once the base was ready the next thing was to fit the supplied tap, there was a positing for it moulded into the plastic on the side of the water butt but no hole had been drilled. By measuring up the thread on the sap I found I needed a 25mm hole and as luck would have it I had a 25mm speed bit so a couple of minutes after grabbing the cordless drill the hole was in place and all that was left to do was wind some Teflon tape (plumber-on-a-roll) around the thread end of the tap, insert it through the hole and screw on the securing nut and tighten.

Sitting in place, but not installed

The components for converting the downpipe

The downpipe is 150mm by 59mm rectangular aluminium whereas the area on the lid for the hole was round and the butt was somewhat shorter than the black drum so I needed to put an extension on the downpipe anyway. So after a quick trip to the hardware and finding that plastic converter from rectangular to square not only did not fit any of the round pipe I had, it only fitted pipe you had to buy in 3 metre lengths (why is that?) but I was able to find a converter from 80mm to 90mm diameter pipe which was available in a much cheaper 1 metre lengths.

A lousy shot of the circular depressions showing where to cut holes in the lid
Back home and I used the jigsaw to cut out the largest size hole pressed into the lid (there were several concentric circles pressed into the lid to show where to cut the hole for the downpipe) and placed the lid back on the butt. I assembled the downpipe and converters and slid the downpipe into the hole in the lid and marked off with a pencil where the lid came up to on the downpipe, removed the circular down pipe and cut it to size with the mitre saw. To finish off I reassembled the whole downpipe and drilled and screwed it together, I prefer the screw method of assembly as opposed to gluing just in case disassembly is needed at some future time.

Installation completed!

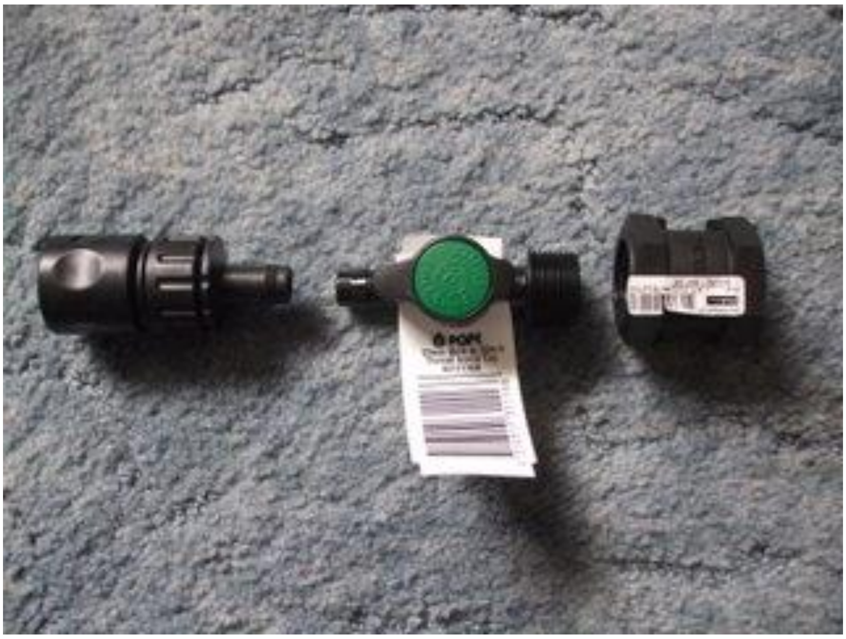
So all there is left to do now, is pray for rain!

3.3 Installing a Rain Barrel

If you want to gather and store your rainwater in a cost-effective manner, this is the way to go! Second hand plastic 200 litre barrels are available quite cheaply and to make it easy when we get to the bit about fitting the tap it is best to get a full-open-head barrel that you can climb inside if necessary. Needless to say the barrel must be made of food grade materials and only used to store and transport food materials, around here there are pickle barrels available which fit the bill nicely.

When you buy your barrel though go over it with a fine tooth comb, read any labels left on and sniff inside to see if you can detect any chemical residues and give it a rinse with water before starting work just to make sure.

It will be handy to know where you want to site your barrel and this would preferably close to, if not right under, a downspout of some description so that it will reduce the amount of plumbing that you have to do to get the supply to the reservoir. Depending on the height of the water harvesting surface above your barrel you will probably want to raise the barrel up on a platform of some description (I used some spare bricks and concrete blocks), to make the tap easier to access. Don’t forget that the full barrel will weigh upwards of 200 kg so make the platform solid enough to bear this weight.



The Fittings - Barb fitting - tap - socket

To turn your used pickle barrel into a new rainwater barrel you will need a couple of tools and fittings –

- A 25mm spade bit (and a drill to drive it of course)
- A hole saw as big as the downpipe that will be servicing the water barrel, I use 50mm piping so a 50mm hole saw works well for me. (and the drill as above)
- One x 13mm barb to 20mm thread inline tap which can be found in the irrigation section of your local hardware
- One x ¾ inch BSP socket, which can also be found in the irrigation section, and
- One x click on connector to 13mm barb fitting, which allows you to connect the tap to a standard garden hose female fitting with a bit of 13mm irrigation pipe.

The process is an easy one, work out where you want the tap to be and the, taking your 25mm spade bit and drill out the hole. In any case it should not be right at the bottom of the barrel so that the inevitable detritus that gets washed in from your collection surface eg roof, can accumulate on the bottom of the barrel without contaminating the water you draw off.

Drilling the hole for the tap

To fit the tap, screw the threaded end into the 25mm hole in the barrel and then (here comes the fun part!) with the barrel on its side climb in as far as you need to and screw the ¾ inch BSP socket onto the exposed threaded end protruding through the side of the barrel. You may need an assistant on the outside to hold the tap to prevent it rotating while you screw the socket on and the assistant could also provide some help it you have difficulty exiting the barrel. You should find that this will provide a good enough seal but if you are still concerned a bead of silicone sealant around where the tap meets the surface of the barrel will prevent any problems (always remember “silicone is my friend”!)

If your barrel is like mine, it will have a separate lid which is a push down seal on the main barrel, work out where your downpipe will meet the lid and drill your hole. A nice snug fit will reduce the likelihood of mosquito problems down the track. You may also want to drill an overflow hole at the side of the top of the barrel so that you can control which way the overflow goes.

Cutting the hole in the top

Once your water barrel is installed, you need to think how you want to use the water that is stored inside. If you want to use it to irrigate nearby plants such as a veggie patch, some herbs or a bruit tree or two with plumbed in irrigation pipe, you just need to run the pipe out then shove the end of the pipe over the 13mm barb on the end of the tap and bob’s your uncle.

If you want a more flexible solution you can ram on a bit of irrigation pipe and then inset the 13mm barbed end of the other fitting, which provides the outlet with a female standard 12mm hose socket. Just insert a double ended male joiner and you can put

any of your standard garden hoses on the end. Without a pump the pressure won't be much but you can gravity feed it to anywhere in your yard, with enough hose.
There you have it, a cheap and recycled water storage system that can let you take advantage of all that free rainwater, after the rain has finished.

3.4 Our Second Last Water Tank

We have a number of rainwater tanks which we draw from for various uses but mainly watering our productive gardens, front and back. Having a number of tanks is good because:

- if one becomes contaminated we still have access to water,
- a leak in one does not mean we lose all our water, and
- We don't have lots of room so it is easier to find space for a number of smaller tanks rather than one large one.

That being said we currently have storage for about 11,000 litres of rainwater, but I would like at least 20,000 litres, so I have spent some time working out how to increase our storage volume. I had a thought that we could put a slimline tank next to the driveway in front of the garage, so I broached it with the boss and the neighbours (it would be on our land but would impact their view) and both were OK with it.

After much research we settled on a "smooth cream" coloured 5,000 litre plastic tank, which is a similar colour to the carport from which it would take its water. It was 222cm high x 322cm long x 96cm wide, that way it would fit in so that there was room to get around it both ends and would be far enough away from the car that you could still open the doors. It would replace the wheelie bin tank currently taking the water from the carport roof.

To make the base I used a similar process to the one we used to install out 5500 litre round tank. In this case however, because the tank was a tall form one I had to dig the foundations down about 150mm – 200mm at the high end so that the inlet of the tank was not so high as to cause problems piping the water from the roof to the tank. This required digging almost a dozen wheelbarrows of solid, dry clay soil out of the area so I could build the foundation. Fortunately the couple across the road wanted the soil I had dug out to build up part of their front yard, so I didn't need to go far to dump it.

With the hole dug so that it was 50mm bigger than the tank footprint all around, I lined the edges with some 150mm wide x 28mm thick x 4000mm long CCA boards. Due to the slope of the land the eastern end was practically buried while the western end was about 100mm above the ground. I got hold of some 400mm stakes and placed the boards where they were supposed to go, drove in the stakes behind them, then screwed the stakes to the boards with 50mm screws. This gave me a good, solid surround.

With the surround in place I worked out the volume (0.8m3) and after discussion with a supplier, bought in 1.5 tonnes of blue metal dust (also referred to by some as just “metal dust”). I barrowed in the metal dust in layers, using my weight to compact the blue metal dust between layers (ie after each layer I stomped it down – crude, but effective). I then smoothed off the top level with the timber surround, which I had previously levelled with a spirit level.

The tank was delivered a couple of weeks later and fitted onto the pad I had prepared pretty well. Now I had to connect up the downpipe from the roof of the carport (currently running into a wheelie bin I use as a storage tank, more detail on this later on) into the new tank.

All of the tanks we have currently in place are connected directly to the guttering. That is good because it gives us the maximum amount of water into the tank, but it is bad because any crap on the roof gets washed into the tank and will accumulate in the bottom, reducing the water storage volume over time. The answer to this problem is to install a “first flush” system, which allows the first bit of rain (and any associated dust and debris) to go to waste, leaving only clean water to run into the tank.

While it is possible to design and build one of these beasties from scratch, I lazily decided to shell out about $25 to a local hardware and pick up a commercial kit. The kit consists of a black plastic ball/float; a tee piece and an end fitting with filter and orifice disks, all in 90mm PVC. You also get associated hardware like the saddle clips to hold the pipe in place, but you have to buy the 90mm pipe used to make the body of the diverter as an extra.

Contents of the First Flush Diverter kit (not including the 90mm pipe at the back)

The idea is you install the tee piece between where the downpipe exits the catchment area and the tank. The first water from the roof flows down into the vertical section of the first flush diverter (taking dust and debris from the roof with it) and fills it up. This causes the plastic ball to float upwards and once the vertical section is full, the black ball blocks the entrance so that subsequent rainfall travels along the horizontal section of the pipe and goes into the tank. The water under the floating ball gradually leaks out through an orifice at the bottom of the vertical pipe, allowing the ball to drop, thus resetting itself for the next rain.

Unfortunately the downpipe coming from the guttering on the carport was 68mm (OD) so I needed, and thankfully was able to get, a converter to 90mm pipe. Fortunately there is an upright supporting the carport between the tank and the guttering so that is where I mounted the first flush diverter. As mentioned previously, the kit comes with a couple of saddle clips to attach the vertical section. So I screwed a couple of horizontal pieces of timber onto the upright to allow the saddle clips to be screwed into them and thus support the vertical section of the diverter.

In the event, I could not screw the clips in tight enough and when the diverter filled with rain it was too heavy and started to slip through the clips. To prevent this happening I screwed a piece of timber to the post underneath the end of the vertical pipe such that the edge of the pipe sat on it. This now supports the vertical section and it cannot move down due to gravity.

The kit came with a number of orifice plates for the exit of the diverter, with two different size holes, which regulate the speed at which the water drains to re-set the diverter. I picked the smaller of the two types of orifice plates so we will see how that goes.

I assembled the diverter without using any glue (so that If I screwed it up I could pull it apart and re-do it) but it seems to be working well, all we need now is some rain to fill the tank! Due to the lack of rain for the past few months I have not put in an overflow on the tank just yet, the tank has barely a few centimetres of rain in the bottom so far, just enough to reach the bottom tap.

The Last Water Tank

I wanted as much rain water storage as we could manage and was working towards 20,000 litres but the amount of free space we have is extremely limited. When I looked around to where we might be able to fit a new tank in, the best I could come up with was to put a long skinny tank beside the garage. There were a few problems with the area but none that were insoluble. One of the not negotiables was that the gas man had to be able to wheel his trolley down beside the garage to deliver a 45kg LPG tank. This is a rare occurrence, less than once per year, but it still had to be allowed for and it worked out OK in the end.

We had a current rainwater storage capacity of 16,000 litres (round figures) but after considerable research it seems the best I could do was to fit in a 3,000 litre slim line tank which was only 720mm wide (and 2790mm long and 1960mm high) So that’s what I ordered – let the fun begin!

Tank delivered and sitting next to the under construction pad

The area beside the garage had a small, 740mm wide concrete pad where I wanted to put the tank but it was only half as long as the tank and had a composter and storage drum on it, which both had to be relocated. The pole supporting the (no longer functional) wind generator also took up space pushing the tank 60mm away from the wall of the garage, so that had to go too. Once that was done I measured up the space and found I could fit in the tank and still provide access down the side of the garage with no problems.

Bed prepared, moving tank over onto it

The area between the side fence and the garage has a covering of 20mm river pebbles which had to be cleared away first. To frame the tank base area I had a 150mm wide x 28mm thick x 4000mm long CCA board left over from the previous tank installation. It would provide an edge on two sides of the area next to the pad and by cutting the board in two to form a 1600mm and an 800mm length, this became the side and end of the base respectively. I was able to dig them in so that they were level with the top of the pad. I put whatever pebbles I had inside the form, then put in a 75mm layer of coarse sand over the top to support the base of the tank.

It seems the tank weighs 125kg, so shifting it around by myself had me sweating, cursing and swearing remarkably quickly, and even though I only had to lift it up 75mm - 100mm to sit it on the base, I was wishing I had the Force with me so I could just levitate it into place like Yoda could. However, no Force, so I used my shovel to lever it up and across such that it was mostly on the base and then shouldered it across the rest of the way into place. Once I worked out how to do it, it actually went remarkably quickly and easily!

Drain from older tank fitted and plumbed in

With the new tank it place, I needed to plumb it in. I was going to use the outlet from the 5000 litre tank next to the carport (difficult at this point because it didn't exist!) to supply the water and then run piping from it to the inlet of the new tank. One advantage of running the piping from the outlet of the older 5000 litre tank was that it had a first flush diverter already in place and so would only provide clean water to the new tank.

The inlet of the new tank was in the centre of the top of the tank and about 7 metres away from the 5000litre tank. I used 90mm stormwater piping running from the outlet of the first tank to the inlet of the new one. I didn't have a 90mm hole saw to drill the outlet hole in the 5000 litre tank but I did have a 65mm one and figured that would do the trick (which in fact it did!).

The outlet

Both tanks came with an outlet, 4 screws and a mesh fitting to go in it to keep the mozzies out. I drilled out a 65mm hole at the end of the 5000 litre tank closest to the new tank and fitted the outlet and the mesh, using silicone sealant (silicone is my friend!) to stop any leaks. I then ran 2 x 3 metre lengths of 90mm pipe plus a 1 metre length using joiners bought for the purpose, secured with more silicone. I used 90mm saddles every metre or so to fix the pipe to the side of the garage, ensuring there was a slight downward angle from the 5000litre tank to the new one so that the water flowed properly. I added a 90° angle piece to the end and then a short section to take the 90mm pipe over the inlet of the new tank.

The only things left to do were to drill out and fit the valve in the bottom of the tank and install the overflow to the 3000 litre tank, which I did.

Drain in place

It was a fair bit of hassle to push through and finish it by myself, but the weather report said that we were due a dump of rain and I had barely finished off the tank when it started. We got 9mm of rain in 10 minutes at one stage and now all of our tanks are filled to overflowing, including the new one!

I think this tank is full!

3.6 Wheelie Bin to Water Cistern

Wheelie bins have a number of advantages when used as rain water cisterns –

- They are watertight
- They have a built in lid to reduce evaporation
- They are sturdy and can put up with a considerable weight of water
- They come in different sizes
- They are transportable, although a bit difficult to move around if they are more than ¾ full of water
- They are comparatively cheap and available

I had a spare wheelie bin hanging around that I had bought with a project in mind that never eventuated and I also needed to catch some of the water coming off our new car port roof, rather than letting it turn a part of the yard into a swamp.

The concrete base in place

So having decided on my course of action (and keeping an eye on the gathering storm clouds!) measured up the wheelie bin footprint and the downpipe that I had to work with. The downpipe turned out to be 65mm diameter for some reason rather than the more common 50mm. I would rather have had 50mm because there are many more standard fittings for 50mm but I wasn't here when the thing was put in so I had no say in the matter.

The Raw Materials

I worked out that the wheelie bin would sit nicely on a 600mm x 600mm concrete slab, and the cheapest way would have been to put some formwork up and cast it in place with a bag of concrete mix. Unfortunately I am somewhat impatient and my concrete finishing skills are pretty crap so I bought a slab the right size and about 50mm thick and installed it. I dug it in to level it up a bit, put some sand under it and then fooled around with it using a spirit level until it was more or less level. It makes subsequent operations easier if your work surface is flat and level to start with.

The Trap Connector (Extended)

The fittings and tools that I needed to set up the wheelie bin were –

- A 25mm spade bit (and a drill to drive it of course)
- A hole saw (and the drill as above)
- One x 50mm Trap Connector which is a flexible pipe with a fitting that sits into the hole in the wheelie bin lid on one end and a 50mm socket on the other.
- One x PVC reducer socket from 65mm to 50mm
- One x 65mm straight PVC coupling
- A short length of 50mm downpipe

- One x 13mm barb to 20mm thread inline tap which can be found in the irrigation section of your local hardware
- One x ¾ inch BSP socket, which can also be found in the irrigation section.

The first part of the process once the slab is in place is to install the 13mm barb to 20mm thread inline tap, because this involves laying the wheelie bin over and that is easier to do before the other stuff is installed. With the wheelie bin horizontal I made a mark on the front section of the wheelie bin, about 150mm up from the bottom in the centre with the sharp bit of the spade bit. My bin is black and I don't have one of those white felt tipped pens so the only way I could make a mark I could see was to dig into the smooth surface a bit where I wanted the hole to be.

That being done I used the 25mm spade bit and drill to make the hole. I could then screw the inline tap into the hole from the front easily enough but needed to screw the ¾" (20mm) BSP socket on the thread on the other side to secure it and this necessitated crawling inside the bin. Now, a trap for young players! The bin has been left to its own devices sitting around in the back yard for a couple of years and to make sure it was OK I looked into it but saw nothing. With the bin on its side and Linda holding the tap to prevent it rotating I started to climb into the wheelie bin and hit.....you guessed it... spider web invisible from the top of the bin. I backed out and then grabbed a broom to use the handle to remove the rest of the web and what came out with it was a medium sized, evil looking and quite disgruntled spider. Note to self: if I ever do this again, completely clean out bin before starting!

With the spider relocated I was able to complete the securing of the tap with little difficulty and then pull the bin upright for the next operation, i.e. using the 50mm hole saw to drill a hole for the trap connector in the lid. I drilled the hole in the centre rear of the bin lid, as far back as I could manage without hitting the side wall. Unfortunately, when I tried to fit the trap connector I found it was still a bit too large so I had to attack the hole with a half-round file. This enabled me to remove the small amount of plastic required for the trap end to slip in easily.

The hole in the top for the rainwater inlet

I assembled the whole downpipe connection unit and then compared it to the existing downpipe and made a mark on it where it would come up to, then using a hand saw cut the downpipe off at the required height from the ground. The downpipe I cut off has been squirreled away into storage where it may become handy for yet another project. To fit the trap to the downpipe I first had to glue (using PVC plumber's glue) the PVC reducer socket into one end of the 65mm PVC straight coupling. I then placed the other end of the coupling over the cut off bottom of the downpipe so that the diameter of the downpipe was reduced from 65mm to 50mm. I then jammed one end of the short length of cut off 50mm downpipe into the top end of the trap and the other end into the bottom of the 50mm reducer connected to the down pipe.

The Trap etc in place

The Trap has a length of 50mm diameter concertina hose built into it so it can be used when the pipes to be connected are not exactly aligned. It took a little bit of pushing and shoving to get everything to fit but in the end it went together pretty quickly. I have not built an overflow pipe into the system yet and when overfull the wheelie bin pretends that it is a waterfall. As luck would have it, I had no sooner finished connecting everything up when we had a bit of a cloudburst and the bin was full in an hour.

A mighty Fine Looking Rainwater Cistern

3.8 Keeping Track of Your Rainwater

The originals (2,500l each)

We have a number of smaller rainwater tanks rather than one large one, and there are a number of advantages to this approach –

1. While one large tank is costs less per litre of storage, it is still going to cost more to start off with. Installing a number of smaller tanks over time spreads out the financial load.
2. Space – Our place is pretty intensely planted and we don't have vast amounts of room for water tanks. A number of smaller tanks are much easier to fit in and around our yard than one humungous one.
3. Ease of installation – I have installed all of our tanks and been able to move them around by myself or with the assistance of one other person. A very large tank is likely to require installation by professionals.
4. Handy access – with smaller water tanks strategically placed around our back yard, we can access the water where it is needed by gravity for the most part. The exception is the 5,500litre tank in the north of the front yard, which has a small 12volt pump connected.

5,500 litre tank

5. Resilience – If you have a single tank and it becomes contaminated or someone leaves the tap open (both of which have happen to various tanks on several occasions, your entire water supply may be rendered unusable. With many smaller tanks it is not any less irritating but if it's only one of many it is not as devastating.

Anyway, we have found that the 'many tanks' approach has worked for us. Lately, however, due to drought and high temperatures I have become passionately interested in tracking our rainwater use, and (as I am sure you are sick of hearing from me) what you don't measure, you don't control!

So I have devised a method to help me keep track of how we are going, using Excel, and this is how I did it –

I opened up Excel and started on a new spreadsheet
I allocated each tank a number, just to make things easier for me to keep track of what I am doing and recorded the nominal volume of each of the tanks, ie, the volume we were told when we bought them. I then measured the effective height of each tank (ie from the bottom of the tank to be bottom of the overflow pipe) in millimetres and recorded that. By dividing the nominal volume (in litres) by the effective height (in mm) it gave me an average figure of litres per millimetre for the height of the tank.

5,000 litre tank

Now, this idea works remarkably well for our cylindrical tanks, but less well for the skinny, tall form tanks. This is because the skinny tanks do not have a uniform profile, but have cut-outs in the middle to prevent the tank bowing outwards due to water pressure when they are full. I am happy that the figures I get will contain some inaccuracies but still give me a rough idea of how much water we have/are using.
So now the trick is to measure the water level in the tank. There are a number of contraptions and appurtenances on the market that can help you do this, for varying cost and level of complexity, but for me the best (and most cost effective) process is the oooooIllIld Tappa Tappa!

This just involves tapping the side of the tank with your hand or any other hard object hanging around, moving upwards along the side of the tank until the tone goes from dull thud to a cavernous echoey tap. Then measure that level in millimetres from the bottom of the tank. Temperature change also works fairly well in warm weather on steel tanks with the bare hand, but less so on the plastic ones.

So with the millimetres up from the bottom of the tank to the water level, and the number of litres per millimetre of tank height you can work out how much water is left in the tank by multiplying one by the other. Record that for each tank and you can work out how much water you have left in your system by just adding them up. You can, if you so desire divide the water left in litres into the total capacity of your storage and multiply by 100 to give you what percentage of your water storage is left. Whatever works for you!

3,000 litre tank

Of course the advantage of doing this is it gives you a handle, over time, on how much rainwater you are consuming. Bearing in mind that predictions seem to be saying we will be getting less rain events, but the rain events themselves will be more intense, you may want to install more tanks!

4.0 Water storage (in the ground)

4.1 A Drain Chimney

Many, many years ago when we put the first tanks on the back of the garage, the council inspector had said that I needed to put in a rubble drain to take the stormwater from the roof of the garage. This would have taken out most of my veggie patch at the time and fortunately he said putting in a couple of tanks instead was fine. However once the tanks were full, I still needed a place for the overflow to go. If I just let it go onto the ground the water would flow into the next door neighbours place, this crapped them off and meant the water was lost to our property.

The Tanks

This was a problem I have wrestled with for some years and had not found a suitable answer. I had considered putting in a dry well, which I had read about in some of the American books on sustainable living. It is basically a hole lined with bricks and filled with rocks, which allows rainwater to filter back into your soil. It does, however, require a fair bit of digging, and I am not getting any younger! So when I came across the concept of a drainage chimney, I knew I had the answer, and this is how I built it.

Construction

The key to building a drainage chimney is having access to a post-hole digger, one of those hand turned earth augurs that allows you to dig straight down into the earth without killing yourself. In the area where I needed to make the chimney it was quite shaded and still fairly moist after some recent rains, so it was easy to bore the hole. If this is not the case for you, start the hole off and get down about 20 or 30cm if you can, otherwise as deep as you can do it easily. Fill the resultant hole with water, let it drain, then fill with water again and leave overnight for the soil to soften. Next morning the digging will be much easier.

I wanted to dig my chimney down a metre (a nice round number!), but in the event I was only able to get down to 800mm before the handles started to run into obstructions and I had to call a halt. The digging was comparatively easy once I made it through a band of gravel some 50mm – 80mm thick just below the soil surface. The spoil went into a couple of old chook feed bags and the stuff from below the gravel layer wound up being incorporated into a garden bed which we were expanding.

Once rainwater started going into the hole the sides would collapse and it would eventually fill with dirt if that was all there was to the design, so I planned to fill the chimney with pebbles. I had access to some 30mm – 40mm rounded pebbles from my daughters place which would hold up the sides but still contain enough voids between the pebbles to hold a substantial amount of water as it moved into the soil. Even with the pebbles though, the spaces in between them was likely to fill up with soil eventually. The answer was to make a “sock” out of drain matting which would hold the pebbles together and keep out small soil particles but still allow water to infiltrate through the sides.

The Whole Hole!

It was my intention to make a sock deep enough to go from the top of the chimney to the bottom, then work out some kind of covering for the top which would let in the rainwater. I found the EASYdrain rainwater pit case in the local hardware, which is a box 260mm square and 280mm deep, which can have a drainage grate fitted into the top. As it was, there were no holes in it to let the water out so I needed to provide a drainage hole. With the pit case going down 280mm into the drain chimney, the sock did not need to be so long, which in the end turned out well.

The Sock

The drain matting I buy is 600mm wide, by 6m long and to make a sock 250mm in diameter I needed the fabric to be roughly 750mm wide. By cutting 750mm from the long side it gave me a sock 600mm deep, which was a bit short for the 800mm deep hole I needed, but with the 280mm contributed by the pit case it gave me 80mm overlap between the top of the sock and the bottom of the pit case.

Stormwater Pit Case

To fit the 260mm square pit case into a 250mm diameter round drainage chimney hole I had to dig away the sides of the hole a bit, and remove enough soil to make corners to fit the square profile of the pit case. This was basically trial and error – dig out the soil, fit the pit case and see how far down it would fit, remove and repeat – until it fitted all the way into the drainage chimney.

To make the hole in the bottom of the pit case to allow the water to drain through was a simple matter of applying a 75mm hole saw to the centre of the bottom of it and to attach the drain matting sock I used that marvel of modern engineering – duct tape. This proved to be as easy as fitting the open end of the sock over the bottom of the pit case, allowing a 50mm – 80mm overlap, and then securing the sock with a 150mm of tape up each side of the pit case. A final run of tape around the top edge of the sock and it was bound to the pit case (I hope) permanently.

To allow me to fit the sock/pit case into the hole I dropped a few pebbles through the hole and into the sock, keeping the sock vertical and stopping the side of it fouling on the sides of the hole. With the drain case and sock in place it was a simple matter to fill the sock the rest of the way to the top with pebbles through the central hole in the bottom of the pit case. I figured the pit case would stop the hole collapsing at the top level so I did not will it with pebbles, thus leaving more volume for rainwater to fill during a deluge. With the fitting of the removable grate in the top of the pit case, that part of the project was completed.

Directing the outflow

The outflow from the tanks goes into a black 200litre plastic drum and from there just overflows onto the ground, so I had to fabricate a 50mm overflow pipe from the side of the drum into the drainage chimney. This was accomplished with some 50mm pipe, a 90° elbow, a 50mm floor flange my perennial friend, silicon sealant. I just drilled a 75mm hole in the side of the 200 litre drum, inserted the floor flange, sealed with silicon sealant and screwue4d into place, then fitted the horizontal pipe section and also screwed it into place, sealed with silicon. The 90° elbow was then placed on the end of the pipe and then downpipe inserted into the other opening of the elbow. Done!

We have had one downpour since and the system seemed to work pretty well, we'll see how it goes in the future.

4.2 A Permeable path

When we built the back deck we did not include a gutter on the end of the roofing, so the water just drips off onto the lawn, or the dirt as the case may be. This has proved to be unsatisfactory because the drips are wearing a ditch into that part of the yard and it is contributing to flooding parts of the backyard during heavy rain. Some of this water can flow into the neighbours, which although it doesn't upset them, it does mean rainwater lost to our system.

The Finished Product

To get around this I proposed to Linda about digging down a bit and putting some gravel in so that the water would not overflow, but soak in and not be lost. With typical commonsense she suggested extending the soak area at each end and widening it so we could also use it as a path from the back step to the door of the garage. So it became a multipurpose path, which works for me!

To install the path/drain I did the following –

- First I marked out the extent of the area to be dug. Fortunately we have had a bit of rain and it is winter, so our essentially clay soil is still fairly soft and diggable. I marked out the extent of the path by using the spade to cut down a few centimetres forming a line which I could follow.
- After marking the area out, I went through with my mattock quite shallowly and removed the surface grass in the area to be dug and carted it away to be composted.
- Then the main dig commenced! To be able to hold the volume of rainwater required, I wanted to dig down to around 15cm, again for the most part this was easy because of the state of the ground, but closer to the deck had been sheltered from the rain and was quite hard and dry in places.

- Then came the surprise. Running along the area close to the deck and at a slight angle to it, I encountered and obstruction. As little as 5cm below the soil surface, unknown by me, was the terracotta pipe sewage line! Fortunately I was using the spade ant not the mattock – otherwise, mass unpleasantness! Once I knew it was there is was relatively easy to uncover it without damage, but it just goes to show, you never know!
- To dig out all of the spoil took me almost a week, working on and off and fairly early on I ran out of places to dump it in our yard. I noticed that one of the neighbours had some holes in their yard and a bit of a retaining wall and when I approached them they were happy to take the barrow-loads of clay and soil I was digging up.
- With the soil dug out, I got hold of some timber and used it to line the outside of the trench, keeping them in place with 450mm star pickets, making sure not to hit the sewer line while driving them in. I then lined the bottom of the trench with drain matting to reduce the chance of the gravel mixing with the soil beneath the trench.
- To fill the trench I used 10mm blue metal gravel. My preferred material would have been crushed, recycled terracotta tiles and bricks, but when I made enquiries I was told the place that made it had gone bust so gravel it was!
- I measured up the trench and calculated I needed 0.8m3, but had to order 1m3 (or 1.5Tonnes). The calculation was pretty rough but in the end must have been close as I still had some gravel over when the trench was filled. Starting at one end and filling it in meant I needed to put some particle board down or the wheelbarrow, which was quite heavy with gravel, would dig in too much.
- Once the gravel as in it was just a case of using a rake to smooth off and flatten the surface.

So we now have a dual purpose path/drainage trench and from the rain we have had it seems to work well, but I waiting for a big rain to see how it performs then!

The Area Prior to Commencement of Work

Grass cover removed

Dug out, with timber edging installed

Drain matting in place

Complete!

December 2018 Update
We have had a number of fairly severe rain events this December and the permeable path has performed remarkably well, accepting all run off from the back deck without overflow. The photo below was taken towards the end of the latest downpour. The water at the top end of the photo has run back from the drain point of the tanks.

4.3 Harvesting Direct from the Downpipe

This idea is a bit different, in that it enables you to take water from the downpipe and then direct it to wherever you want it to go. In our case, I use it to keep our productive water garden topped up.

In summer the water level in my productive water garden tends to drop fairly quickly, even in cooler weather due to the transpiration from the mass of herbage growing in it. Also, even good rains only go part way to filling it up because it has relatively small catchment (the pond surface only) which is the size of a bath tub. So I decided the answer was to divert some rainwater from the closest downpipe directly into the water garden to increase the virtual catchment area of the water garden. I also realised that I would have to be able to re-jig the water flow in heavy rainfall times back into the stormwater system so that I didn't flood the back yard.

I have seen some commercial systems that allow you to do this and I was even able to pick up one for a couple of dollars in a "no longer stocked" pile in our local hardware. However, it was designed for round pipes and to get the connectors for my rectangular ones cost over $20 for a couple of flimsy bits of plastic. I decided I could do better!

All of the storm water downpipes at the choko tree farm house are rectangular around the 100mm x 65mm mark, and this got me thinking. The lump of 65mm downpipe I cut off the carport when I was installing the wheelie bin water cistern could all of a sudden become handy. My thought was to drill an appropriate sized hole on either side of the downpipe and put in a piece of the 65mm downpipe horizontally with a cut-out in the centre and a cap on either end. A spout on one of the ends would allow water to be drawn off when the cut out was facing up. To return the rainwater to the stormwater system it would then just be a case of turning the tube through 90° to allow the water to flow through the cut out.

65mm pipe and end cap

Anyway, that was the theory.....here is the practice.

I grabbed the 65mm pipe left over from the wheelie bin and after carefully measuring the width of the downpipe and the depth of the caps I cut off a piece of the pipe at 135mm long. I then fitted the end caps to the pipe (push on only, not secured) and tried it up against the downpipe, low and behold, it seemed to fit OK. I glued one end cap in place and drilled and screwed it in place for extra security, there would be a fair bit of pressure from the water coming down the downpipe and splashing onto the ends and I didn't want an end being blown off! The other end I only drilled and screwed in place so I could fit and remove the pipe when I wanted to.

With the end caps in place I then drew a pencil line on the central cylinder beside each cap and then along the pipe about half way along to mark out the area of pipe I wished to remove. To make the cuts across the pipe it was easiest to use my little band saw but a hand saw would have worked just as well albeit a bit more slowly. The cuts along the pipe were a bit more difficult to work out due to reduced access. In the end I used my 12 volt "Dremel" style tool with a very small cut off wheel on a miniature arbour. It did a reasonable job even if it did get away from me at one stage and put an unintended nick in one of the end caps.

Now I needed a way to channel the water from the cylinder to where I wanted it to go, in this case the water garden. I decided to use the always handy ¾ inch BSP to 13mm barb poly fitting (I had a couple floating around) in a similar manner as I did in the back yard irrigator. Using a 25mm spade bit I drilled a hole at the bottom of the end cap which would be facing the direction I wanted the water to run. I then screwed it in tightly but to ensure a seal, slathered the join in silicon sealant (repeat after me – "silicon is my friend!"). After leaving the silicone to go off overnight, it was ready to go into the downpipe.

Cuts completed

The easiest way to make the holes in the downpipe is to use a 70mm hole saw and a drill, which is what I did. I measured up where I wanted the holes to go; about half way down the downpipe so that there would be some "head" to push the rainwater into the water garden a couple of metres away. I then marked the centre with a pencil mark and with a small drill (2-3mm) drilled a pilot hole to prevent the main drill going off centre. It was then a simple matter to drill out the 70mm holes in the downpipe although I did have to move the drill around a bit to make sure it cut through the stiffening ribs. All told the holes took less than 10 minutes to sort out.

70mm hole saw

What did surprise me was the cost of the 70mm hole saw and the arbour to fit it. If you don't already have one (and let's face it who has a 70mm hole saw just hanging around?) a cheaper way would be to scribe a line the size of the hole you want through the downpipe paint with a pair of dividers. Using the scribed line as a guide, drill a series holes (6mm or ¼ inch) around the inside of the line so that there is very little metal between the holes. Then with a pair of side cutters, cut through the remaining metal. This will leave a hole like a many pointed star (sort of) and you can then file away the extra metal up to the scribed line with a half round fine file. This method takes more time and effort but is quite accurate and will use tools that you hopefully will have handing around, hence it will be cheaper.

Finished Product

With holes now in place I was able to fit the cylinder by removing one end cap, sliding the cylinder in and then refitting and screwing the other end cap to secure it. It seems to seal OK and while not being sloppy it is still reasonably easy to turn. When the 13mm barb fitting is at the bottom of the end cap all of the water is diverted down the hose, when it is rotated through 90° the water is able to bypass through the cut out part of the cylinder.

A different view (No nozzle)

Once you have one of these bad boys in place you can use it to divert rainwater to a tank, garden bed, tree or water garden so that you are increasing the catchment area for the item that the rainwater is going to feed. It is cheap to make, effective and a handy way to get rainwater to where you want it without spending a fortune.

Holes cut in downpipe

In place - positioned to allow water to run past

Positioned to allow take-off of water

Hose in place

8 years on

After the above was written I did tweak it a bit. Rather than having the hose stick straight out I inserted a corner piece and screwed the hose to the downpipe with a couple of conduit half saddles to secure it. I then ran the hose long the back wall of the house and under the wood chip and bark to conceal it, just poking the end out over the bathtub. I checked and it worked!

As far as I was aware it continued to work from then on, I did some more work in that area and installed the constructed wetland and a few other things but there it was, another successful project!

The years roll on and in the 2020/2021 summer we got some pretty heavy downpours, to the point where I decided to go out the back and check whether I need to turn the bit that catches the water on its side to let water go down the drain rather than divert it. Well, I get out there and water is spraying EVERYWHERE, from the joins in the down pipe, from the diverter, from everything. I decided at this point that I DID need to turn the diverter around, which I proceeded to do, while getting soaked to the skin.

And……. It made no difference! I decided that now was the time to remove the diverter completely and just let the water go straight down the downpipe. As usual. This proved to be more easily said than done, but when I finally got it out I found the whole thing to be choked with leaves and debris such that it was totally blocked. With the diverter and leaves and crap removed the rain just went straight down the pipe, disaster averted!

Just this weekend I knew we were going to be in for some rain soon, so I finally got around to re-installing it and setting it up so we could harvest some rain into the water garden. When it started to rain, I headed out excitedly to check the situation and see how much water was coming out of the hose. After much debate and inspection I decided – none, the hose must be blocked!

To clear the blockage I tried blowing into both sides of the hose, to very little effect, with the exception of getting soaked to the skin again. After some rumination I made up a fitting to allow me to use water pressure from the house supply to clear the line. I set it up and turned on the tap, to be rewarded by the sound of gushing water, but it was not coming out of the end of the hose that I wanted! I looked down to where the hose curved around at the bottom of the downpipe and water was gushing out of a considerable hole it the hose. When I inspected it there were lots of cracks, it was old, weathered and in really poor nick so it needed to be replaced.

At least now I knew what was required, and it would be a simple matter to pull the hose out from behind the tanks and dispose of it. Except, it wasn't! I pulled on it but it would not move. I had not secured it to anything so it should pull right out *sigh*. Well it turns out that when I installed the (very heavy) constructed wetland, one of the supports was sitting right over the top of the hose.

That was it! I cut the hose either side of the wetland support, ran the replacement hose from the diverter to the water garden (while still getting soaked) and then set the diverter up to collect the water. And…… it worked!

I guess the moral of the story is something about being persistent, but I think there is a point to be made about stupidity also, and not mounting heavy constructions over the top of water supply hoses!

5.0 Greywater

5.1 Introduction

Greywater is water that has been used once and would normally be disposed of to a sewer system and lost to the household. This greywater can be made to do more work and fulfil duties that would normally be expected of fresh, reticulated water such as flushing toilets or watering lawns and trees. Greywater can be given a decontamination process before it is used or used as is, but should not be stored due to bacterial contamination. The water from a flushed toilet is referred to as black water and should not be re-used on site, water from the kitchen sink may be too heavily contaminated by fats, oils and detergents and likewise should not be re-used.

5.2 A Backyard Constructed Wetland

We try and live as sustainable a life as we can manage. However there is one area where our performance sucks pretty comprehensively and that is treatment/re-use of greywater. One of the issues has been that while our banana circle (a greywater recipient) was in the front yard, all our greywater plumbing was at the back of the house. For years I fantasised about complicated tank/pump/plumbing set ups until I realised that it was not going to happen, so with the help of friends, we relocated the banana circle to the back yard. We also corrected a plumbing problem with our spa so now all shower/bath water was directed into said banana circle. We were on our way!

It is possible to put raw greywater onto lawns and fruit trees and when we had our original top loading washing machine I had a hose on the greywater outlet and did just that. The amount of water we used to wash our clothes was considerable so we upgraded to a front loader. That meant that we used less water (good!) but also meant that the concentration of pollutants in the greywater now produced by clothes washing was increased (bad!) so I didn't feel right about running it directly out to the yard. I needed some way to treat it first.

My original thought was to put in a system similar to the 3 tier bathtub set up described by Scott Kellogg and Stacy Pettigrew in their book "Toolbox for Sustainable City Living", to save horizontal space. I had problems working out where it would go even so and I would be back to needing a pump and surge tanks and the frame would need to be well engineered to suit the weight. Fortunately, with the removal of the lemonade tree to accommodate the banana circle it seemed to open the area up. There was room for two bathtubs horizontally, both below the level of the laundry sink which would act as a surge tank and I could still use gravity to move the water around.

The bathtubs

I have had two bathtubs sitting on top of the chook retirement village for some years waiting for this moment! Once I was able to manhandle them down onto the ground, it was a case of arranging them in the space that I had to see how they fit best. There is another dug-in bath acting as a water garden in that area and the other two seemed to fit best when lined up parallel with the water garden but the lower on a bit off set from the higher one. I used silicone and bath plugs to permanently block the drain holes before starting work.

Roughly positioning the tubs

The weight of the bathtub, plus gravel, plus water, plus plants means that I needed to have a stable base that could support the weight. I had some solid besser blocks, right angle ones with one long and one short side, left over from an old incinerator. So I laid one with the short side down at each end of the bath, and used a brick to support the other side. I dug them in a little bit to ensure the tub was level but also to give a more stable base. In the end it was not high enough to allow drainage into the next bathtub, so I put in one besser block capping (40mm thick) under the drain end and two under the input end, when I realised the bath had a bit of fall the wrong way!


Supporting the first tub

The other bath I put in by turning two of the blocks upside down and placing one under each end of the bath. This ensured that the second bath was lower so that they would drain naturally by gravity. To improve stability of the baths and to make small adjustments to the fall, I put some offcuts of 6mm fibre cement board between the bath and the blocks to act as shims. In the end it all looked pretty good, or at least I thought so!


Supporting the second tub

The Plumbing

I needed to set the water flow up so that there was maximum contact with the bacteria which would (hopefully) grow on the gravel and the plants and plant roots so I didn't want to just dump the greywater on the top of the gravel and hope for the best! I wanted to run it so that it went in at the bottom of the batch, rose up through the gravel, then drained into the next batch and did the same thing before draining out of the second tub onto the trees.

To do what I wanted to do I got hold of three one metre lengths of 50mm PVC pipe and a series of 50mm pipe fittings which included –

- 3 x 50mm PVC end caps
- 3 x 90^{o} elbows
- 1 x Expandable Connector Waste Pvc Abey 50mm Trap Flxz22up
- 2 x Holman PVC 50mm floor flange
- 2 x 50mm mozzie proof vent cowl
- 2 x 50mm to 25mm barbed reducer
- 1 x 50mm two way valve

One of the reducers and the valve were for use on the inside part of the system (more on that later).

As it turned out a one metre length of pipe fits into the bottom of a bathtub really well so that became the basis for my horizontal part of the plumbing, which sits in the bottom of the bath. The first part of the work was to drill a whole stack of holes the length of the pipe, to let the water flow out slowly into the tub. A good size hole is 12mm or so but it can be difficult to drill into the pipe with this size twist drill and there is a tendency for the twist drill to snap out bits from the side as well as drilling the desired hole. To reduce this I used a 3mm twist drill to drill pilot holes about every 100mm down the pipe, with 4 rows at 90^{o} to each other.

With the holes in place in two of the one metre lengths I glued an end cap on one end and a 90^{o} elbow onto the other of each one, using the blue PVC plumber’s glue. I then cut the third one metre length of 50mm pipe in half and slid half into the other side of the 90^{0} elbow giving two L-shaped sections. The idea was that the pipe with the holes would sit along the bottom of the tub horizontally and water would flow in through the vertical section of pipe.

I put them in place to try them out and found out that the vertical section on the one in the second tub was too tall to allow water to flow by gravity so my intention was to cut it off level with the edge of the bath. After some thought however I worked out that the drain from the upper tub could be directed down into the horizontal tube just by using the PVC expandable waste connector and ensuring it sealed by applying silicon both ends. That did work out to be the best way to do it and gave me some spare pipe.

The was one more job before they were complete, and that was to put some fly screen in place over the holes in the horizontal pipe to keep rocks and plant roots from blocking the pipes and preventing greywater from flowing into the system. I got hold of some aluminium fly screen because it is stronger than the polyester stuff and wrapped one layer around the horizontal section of pipe with the holes in it. To keep it in place I took some of the spare 50mm pipe and cut 12mm thick rings from it, then made a cut in the side of each ring so they could be opened out. These rings were then put in place over the fly screen and around the tube to hold the fly screen in place.

The next thing to organise was the drain holes in the bathtubs. Yes, I know I blocked the standard bath drain hole, but that is because I need the greywater to slowly move up through the gravel and overflow in a controlled way into the next tub then through it and out to the garden. I needed to drill a 55mm hole near the top of the tub at the opposite end to where the water flows in to fit the outside diameter of the standard 50mm (nominal) pipe. I didn't have 55mm hole saw that would cut through ceramic and metal (I tried to sort it out but failed, loooooooong story!) but I did have a 70mm one.

Cutting through the side of the bath was a pretty noisy and hard job. It requires you to keep pressure on and some water going over the cut for lubrication for up to 10 minutes. I was using a battery drill and it was about as happy with me by the end as the neighbours were with the noise. I would use a 240v drill next time I think. The hole needed to be such that the bottom was 50mm to 75mm below the estimated level of the gravel. This was to ensure that there would be no standing water at the surface of the gravel and so no issues with mozzies.

50mm floor flange

The hole I had cut was about 15mm too big(because of the larger hole saw) so I inserted a 50mm floor flange in the hole and siliconed it in (silicon is my friend, again!). This took up the difference in hole size and allowed me to provide a seal to prevent leakage. The 50mm pipe I was using to make the drain from slid in with little moving about and was also siliconed in place. To stop the drain getting clogged with gravel or whatever I glued on a 50mm mozzie proof vent cowl on the inside end of the pipe. The cowl uses strong stainless steel mesh and it resisted any funny business by the gravel quite well.

Attachment of the 50mm mozzie proof vent

With that in place I siliconed the outside end of the drain in the first bathtub to the expandable waste connector referenced above, expanded it down so it fitted into the top of the elbow bend in the second tub and also applied a bit of silicon. Now the two bathtubs were connected I needed to fit the drain to the second tub.

Expandable waste connector in place

That followed mostly the same process: cut out the hole, insert the floor flange, apply silicon, insert 100mm or so of 50mm pipe and glue on the 50mm mozzie proof vent cowl. To allow me to connect a 25mm hose I put on a 90^{o} elbow after inserting and gluing in the 50mm to 25mm reducer into it. The reducer has a barbed fitting so that the hose slips on and won't fall off again.

System for the rear drain

In place

With all of the plumbing in place all that was needed was to fill both baths to the top with 20mm blue metal gravel. This is heavy stuff! I ordered half a cubic metre which filled both baths fully with enough left over to make a bathtub wicking bed. I had to shovel the gravel into a barrow then barrow it from the front yard to the back yard then, due to the position of the bathtubs, shovel it out of the barrow, into each tub.

During this process two things occurred to me –

1. It was hard work! (yes I know I am a genius!), and
2. If I had set up the baths as I originally wanted to (3 of them, one above the other) I have no idea how I would have gotten the gravel into the middle bath, let alone the top one!)

With the gravel in place I ran some tank water into the system to check flow and, believe it or not, it worked perfectly!

Gravel in place

To finish this part of the system off I needed to put in plants, preferably from a functioning constructed wetland. Fortunately two of my friends have such a beast and I was able to score irises, taro and papyrus which were then dug into the gravel far enough for any part of the plant bearing roots to be submerged. Plants in a greywater system should not be used for food but they can be periodically trimmed and cut up to make mulch or compost. Where our baths are located also means that the foliage with shade some of the back wall of the house in summer, to reduce the solar heat gain of that part of the house.

Plants in Place

The Inside Bit

The last bit of engineering required was to put something in place to get the greywater from inside house to outside the house and into the system. The easiest way to do this was to just run a flexible 25mm hose from the discharge hose of either the washing machine or the dish washer, whichever was in use directly to the input pipe of the first bathtub. I didn't want to do that for two reasons –

1. It would be effectively increasing the length of the discharge hose which would have meant the waterpump in the appliance would have to work much harder, resulting in possible early failure of the part, and
2. If the discharge from either of the appliance pumps was at a greater rate than the system could accept, it would overflow everywhere, defeating the purpose of the plumbing and reducing the effectiveness of the greywater system.

What I needed was an intermediate or surge tank, which would accept the discharge from the appliances, but then allow it to drain into the system via gravity. I worked out that I could do this using the laundry sink. I bought a 50mm two-way valve so that if the valve was in one position the greywater would go straight to waste, in the other position I could run it outside through a 25mm flexible tube into the greywater system.

Pre-valve

Valve set up

Post Valve

To fit the valve I cut the drain pipe leading out of the bottom of the sink about 220mm up from the floor using a crosscut wood saw (which made short work of it!). I unscrewed the S-bend and upper part of the pipe from the bottom of the sink and then cut off about 100mm from the free end of the pipe I had taken out. I then reassembled everything with the valve in place, just to make sure everything fitted where it should. It did! So I used the blue plumbers glue and put everything back in place and re-screwed the s-bend back onto the bottom of the sink. I also glued the other 50mm to 25mm barbed reducer into the horizontal outlet of the valve. I then left everything in place and did not use the sink for 24 hours to allow the glue to set.

Testing the Operation

The next morning I attached some 25mm flexible tube onto the 25mm barbed fitting and ran it out the back door and into the input pipe of the first bathtub. Unfortunately the 25mm flexible tube is flexible (funny that!) so it goes well around corners but is not self-supporting, any greywater in it would cause it to sag dramatically. To get around this I ran it through a spare one metres section of 50mm pipe supported on a couple of buckets and it did the job fairly well. It is only temporary for testing purposes and I will need to develop something a little more robust for final installation. Anyway the test went perfectly, no leaks anywhere. I am somewhat impatient (alright I am very impatient!) so I put the washing machine on and allowed one load of wash water to go through the system and again it performed flawlessly.

Once the constructed wetland is put together you are supposed to leave it for 3 months to allow the plants and beneficial bacteria to establish themselves before running any greywater. After the test I diluted the greywater in the system with more tank water and it seems to be doing OK. Just after completion we had two freakishly (for spring at least) hot days, both over 37°C but the system seems to have handled it OK and we haven't lost any plants. The secret is to keep an eye on them and top up with clean water periodically.

Another fun project is completed and once the establishment period has elapsed we will be using it full time.

5.3 Testing the Output of the Constructed Wetland

Once the wetland was constructed I left it to sit for a bit over two months while the plants and beneficial bacteria established. We have been using it for most of our washing loads (say 5 – 6 loads per week) for the last four months roughly. Was it making a difference? I really had no idea. The water coming out the other end looked pretty good but that meant little and gave no indication as to dissolved salts etc. I was doing it on faith, but I wanted data!

Fortunately a good friend of mine works for a local water utility and has access to a water testing laboratory. He agreed to run some tests for me then help me interpret the results.

Test Conditions

Usually water testing of this type would require multiple "before" and "after" samples to be taken over a period of time and then the results analysed statistically. Due to the access to facilities being limited we took two “grab” samples, the first being from the outlet of the washing machine part way through the effluent discharge from the washing cycle or in other words, worst case scenario. The second sample was taken at the exit from the second part of the constructed wetland, where the water goes to water the fruit trees. The previous loads were washed 3 days ago so the water tested had 3 days residence time in the system before it was tested. Samples were taken about 10:00am in late summer.

So, make of the results what you will, they give an indication of what is happening but are not a comprehensive analysis. I won’t keep you in suspense any longer, this is what we got.

Test 1 – Oxygen levels
Ex washing machine = 5.7mg/litre
Ex constructed wetland = <1 mg/litre
Clearly the oxygen has been consumed in the wetland breaking down pollutants in the water, but sufficient oxygen is being fed into the beds by the plant roots to prevent the beds becoming anaerobic (there is no unpleasant smell).

Test 2 – Electric conductivity (EC)
Ex washing machine = 2170 uS/cm
Ex constructed wetland = 1600uS/cm
The conductivity of the water is a measure of the level of dissolved salts it contains (this was a major concern for me). While the numbers show that the dissolved salt levels have been reduced by 26% the point worth noting is that the absolute upper limit for salts in drinking water is 1600uS/cm so it has gone from definitely brackish to almost drinking water quality.

Test 3 – pH
Ex washing machine = 9.6
Ex constructed wetland = 7.4
pH is of course the measure of acidity or alkalinity of a solution, 14.0 being highly alkaline, 1.0 being highly acid and 7.0 being neutral. As a control, tap water in our area is reported to be typically from 7.6 to 8.2 so water which was clearly alkaline is now almost in our drinking water range.

Test 4 - Oxidation/reduction potential (ORP)
Ex washing machine = 442 mV
Ex constructed wetland = 465 mV
In this case there was no significant difference between the two readings. ORP is a measure of water quality particularly in terms of if it is well disinfected. Generally an ORP of 650+ mV means that it is suitable for use in pools and spas or for drinking. However, a reading in excess of 250 mV indicates that the water is not anaerobic (resulting in foul smells) so in this case the ORP, being between these two limits, shows biological activity which is what we want.

Test 5 – Turbidity
Ex washing machine = 365 NTU
Ex Constructed wetland = 10 NTU
Turbidity is a measure of cloudiness or haziness in the water. It is measured by detecting light scattered at 90^o from the incident light beam using (in this case) a nephelometer with the units of the resultant reading expressed as NTU (Nephelometric Turbidity Units). Generally drinking water should be less than 5 NTU. But in this case the wetland has reduced the turbidity by a huge amount, and that works for me.

Conclusion

So, from the test results it appears that the water coming out the exit from the constructed wetland is somewhat improved in several important criteria over the washing machine grey water going in to the wetland.

5.4 Home Testing the Constructed Wetland

Our constructed wetland has been in and operating for about 5 years, we put water from the washing machine in one end and then use the water that comes out the other for watering some trees and things. But was the water really any cleaner? About six months after it was commissioned I took up the offer of a friend of mine who has access to water analysis stuff to do a 'before' and 'after' check on the grey water as it went into and out from the constructed wetland, and in fact it did make a difference. The results of those tests are recorded above.

The Constructed Wetland


and again

It must be said though, that was almost 5 years ago. Was the constructed wetland still functioning as intended? I don't have access to water analysis facilities so I just had to take it on faith. That was up until a week ago.
I was doing some reading (as you do) and by chance found a method of checking the performance of a constructed wetland, that could be done at home and at no cost. The results will not be numbers, but would give me an idea if the effluent from the constructed wetland had improved at all from what was going into it. The test was also reproducible and so easy I could do it again at any time.

For those playing at home, the source of this wonderful information was "Toolbox for Sustainable City Living" by Scott Kellogg and Stacy Pettigrew, published by South End Press back in 2008.

The idea behind the test is that the water coming out the end of the constructed wetland should look more like clean tap water than the wash water going in. To conduct the test I needed to take a water sample direct from the washing machine output, a water sample from the output of the constructed wetland and a sample of tap water to act as a blank for the test. I then had to keep them all in the dark for a week and see what they look like at the end of that time.

While they don’t specify, I thought it best to use three bottles of the same size and type. I filled and labelled each bottle and then placed them in a cardboard box, which I then placed in the lounge room, mainly because it is winter here and I didn’t want the samples to get too cold just in case it inhibited any of the biological effects.

The Results

Anyway, after a week I pulled the samples out and in fact the sample from the end of the constructed wetland did look much more like the blank than the stuff coming out of the washing machine, so it seems that even after 5 years (and in the middle of winter) our constructed wetland is still doing its thing!

5.5 Spa Bath Greywater and the Banana Circle

A few years ago we had our bathroom renovated, which included among other things replacing the bath with a spa, let’s face it, you gotta have some luxury in your life! As part of the renovation I did ask them to put a two way valve in the drain line so that I could run the greywater either down to the sewer or into the back yard and onto the fruit trees. They did as I asked, gluing in a blocked off pipe into the line into the back yard to prevent leakage and left the valve running to sewer until I got a chance to plumb it in properly.

The valve they used - less than $5 at a local hardware

Well, life gets busy and it was a number of years before I got the chance to finish the job. To complete things I got hold of a cap the same size as the outlet pipe and drilled a 25mm hole in it, then used silicon to attach a barbed irrigation fitting suitable to fit a 25mm hose. While I considered using garden hose it is only 12mm and would not drain quickly enough when the shower was in use.

Under the house

Having done the easy stuff, I ran some of the hose through one of the under-house vents which was in roughly the right area so when the time was right I could force it onto the barbed fitting. I then crawled under the house with the fittings, glue, torch and my trusty saw to remove the blank plug and install my pre-prepared cap with the barb on it. Installing the cap proved as easy to do as it could have been, lying on my back in amongst the spiders and dirt (I'm getting too old for this crap!), anyway, job done.

All that was left to do was to turn the valve from discharge to sewer to discharge to back yard……easy! Well, maybe not so. For some reason the valve simply would not turn, regardless of what I did. I tried heating up the outside of the valve with a gas flame to break what was holding it, but no go. I even sent my son-in-law under there to try his hand at it (I told you I was getting too old for this crap) but to no avail, it was stuck solid.

The original discharge pipe, blocked by a cap

There is a lesson here! When you have stuff like this put in, try and operate it as soon as they are finished installing it. It is my belief that some of the glue they used to install it in got into the moving part and gummed it shut, but because it was now a few years down the track, any warranty period had well and truly expired.

My cap with the barbed fitting siliconed on

Due to the way it was constructed down there, and all glued together, it was not just a case of simply replacing the valve, and whole stack of pipework needed to be replaced too. In the end I broke down and got a local plumbing company in and they did a great job of crawling under the house, fixing the problem and then actually checking to make sure it worked before they left. So we now have a functioning process for reusing greywater from the spa and if we get a spate of wet weather I can crawl under the house (*sigh*) and turn the valve so the spa empties to the sewer again. Woo hoo!

The Results -

Front yard – no greywater

Backyard – with greywater

5.6 Greg's Greywater System

A friend of mine, Greg Meyer, put together a system to treat the greywater coming out of his bath, shower and laundry areas. It was part of a larger plan to capture and store rainwater from the roof, pump it to the house for toilet flushing and use in the laundry and bathroom, then capture, treat and re-use the greywater produced from those areas.

He made the decision to install his water management system as a result of attending a permaculture course, which helped him focus on being more water wise and maximising the use he was getting out of the water resources available to him. His system makes his household more self-reliant as well, so that in the event of a failure occurring in the reticulated water system he and his family would be insulated from the effects of those failures.

He also hates waste and his system reduces water wastage to a minimum. The system does not treat or recycle any black water and has been operating for three years.

Installation

The first part of the process was to run pipes from the drainage system for the laundry and bathrooms to a central collection area. In the central collection area a 220 litre above ground pit was installed to act as a holding tank before the greywater was pumped further on in the process. A 240v submersible pump was installed to complete this part of the system. Fortunately the house is up on piers so this could be done fairly simply but due to the need for subsequent inspection a plumber was retained for this part of the project.

Two outlets were plumbed into the pit. One on the western side towards the top of the pit accepts the output from the pump and one at the bottom of the southern side of the pit is only used for washing out the pit and is plumbed through to a flower bed in the front yard (no edible species). The output from the pump is fed into 40mm ID blue line polypipe.

Pipes from the laundry and bathroom into the pit


Output, through the pump, to the treatment area


Pit drain to allow cleaning

The blue line polypipe runs in a trench along the side fence of the property all the way to the back fence (which is the highest part of the property) where it curves up so that it discharges into the water treatment area. The water treatment area was originally a pile of rocks which allowed the water to be oxygenated and exposed to the ultraviolet radiation from the sun to achieve a degree of biological contamination.

Support structure for spa

It proved difficult to direct the water output using this technique, so two (approx. 200 litre) bathtubs were installed in series but even this proved to be insufficient capacity and a disused 600 litre spa was installed.

Hose discharging into the spa

The set up now is such that the pipe discharges into the spa, with an air gap to prevent the greywater siphoning back toward the house. The spa has two discharge points, one above the other, towards the top of the spa and into the first bathtub. The top discharge point comes into play if the greywater flow rate exceeds the ability of the lower one to prevent the spa from overflowing. The first bath has a single discharge point towards the top of the bath, allowing discharge into the second bathtub and the second bathtub has a discharge point plumbed through a valve and a pipe. The now purified greywater is discharged into the pipe, which can direct the flow under gravity to any area of an existing food forest.

Water drain from spa into first bathtub

The spa and the baths are half filled with gravel to provide a substrate for aerobic water cleaning bacteria to colonise and the discharge points are set up such that the amount of water left in the spa and bathtubs is always below the level of the gravel. The spa and bathtubs have been levelled so that they fall slightly towards the next reservoir so that in the event of overflow, they will still overflow into the next reservoir rather than overflowing out of the system. The spa and bathtubs are planted out with taro and papyrus which is harvested on a quarterly basis to provide biomass for compost making.

Drain from first bathtub into second bathtub

Water discharge from second bathtub onto soil via hose

Hose distributing treated water to food forest floor

Ditto

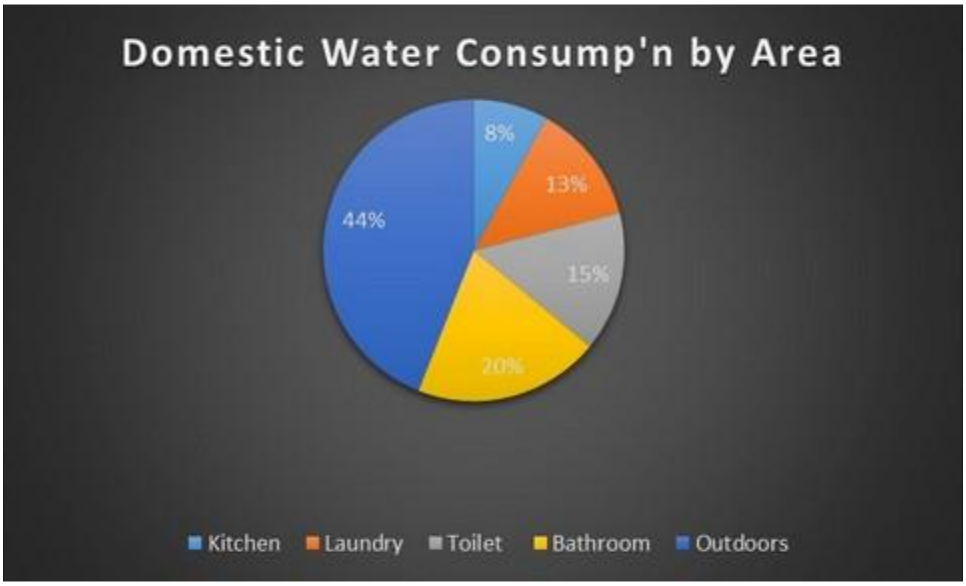
How does it Work?

Greg says his system works so well that he has to remember to check it regularly just in case, because it runs so well with minimum inspection or intervention from him. The system allows rainwater captured from the roof to provide three services before re-joining the water cycle –

1. The water is used initially to wash clothes and people inside the house,
2. The greywater grows biomass for composting as part of the purification process,
3. The purified greywater is used to irrigate a food forest

Vegetation used for composting

6.0 Managing Your Demand for (Saving) Water



If you follow the audit process you will not only get an appreciation for where your greatest areas of water usage are, you will also have an idea of (potentially) the volumes of rainwater and greywater which you can use to further reduce your consumption.

Once your water audit is complete you will have the data you need to start planning how to reduce your water consumption. Below is a generic graph showing the percentages of water consumption in the "average" household, but real data on how much your household consumes will be more meaningful and useful.

6.1 Management Techniques

Following are some management techniques that will help you reduce the amount of water you need to run your household –

GENERAL

Think before you turn on a tap – This is about making sure that rather than reflexively turning on the tap to say, use perfectly drinkable water to wash the freshly cut grass off your paths, think about it first, and hopefully use a broom instead.

Investigate low water use appliances – low water use versions of washing machines, dishwashers and toilets are in existence and efficiency is improving year by year. I am not advocating running out and updating your functioning appliances right now but when replacement time comes around at the end of their life, a water efficient model is work checking out.

Insulate hot water pipes – I know this sounds like an energy saving modification (and it is) but it also saves water. Your hot water pipes will lose heat more slowly and you should not need to run through the cold water to get to hot so often or for so long. So you actually save water as well as energy. Winner!

Check for leaks, running taps & toilets etc. – as part of your water audit you should conduct a leak check (as discussed above). This is simple to do by turning off all taps for a couple of hours and then keeping an eye on your water meter to see if it moves. If it does move water is leaking somewhere. Sometimes a slow leak can develop between the toilet cistern and the pan. One way to check this is to put a bit of food colouring into the water in the cistern and if the colour appears in the water in the pan, you have a leak!

But this is not just about the water we are personally responsible for. How many times have you walked into a public toilet and found a tap you can't turn off or (gentlemen) found a running cistern over a urinal. There are a number of public facilities that are maintained by commercial property owners or councils. if you see water being wasted in these facilities don't just walk away let someone know there is a problem, even if it means you have to make a phone call. Water is a shared resource so let's make sure we are not responsible for ignoring a leak.

THE GARDEN, GARAGE AND DRIVEWAY

Mulch, mulch, mulch – Mulch prevents evaporation of precious water which is needed by your plants, and if it keeps water in the soil where it is needed that means less watering you have to do to replace it. There are lots of advantages by mulching your soil such as providing nutrients as it breaks down, keep the soil cooler in hot weather (better for plants and other soil organisms) and it also prevents the soil surface being compacted by heavy rain. Once the soil surface is compacted the rainwater runs off instead of infiltrating the soil, then when your plants are wilting in hot weather when you water them you lose a lot of irrigation water through runoff too. Mulching means that the water form rain and water you apply goes where it is needed, into the soil.

Mulch, keeps the water where you need it!

Increase the organic matter in your soil – The amount of organic matter in your soil greatly increases its ability to retain moisture and this is especially true of sandy soils. By incorporating animal manures, compost or a green manure into your soil the organic matter and hence water holding capacity increases. When coupled with a good mulch, abundant soil organic matter ensures that not only does rainwater get into the soil it stays where it is needed in your plants root zone.

Install overhead veggie covers – Over the last summer we had lovely clear days that were very hot and the strength of the sun caused our veggies to wilt in the ground, almost regardless of the amount of water we applied. To try and recover the situation I put up some frames and covered them in shade cloth to try and break the sun down a bit and it not only stopped the strong sun killing off the plants it reduced the amount of times I had to water.

Install water efficient irrigation – Irrigating the veggies by hand using a hose takes time, allows water to evaporate before it gets where it needs to go and can waste water through runoff and overspray. Water efficient irrigation using techniques such as drip irrigation, irrigation lines being run under mulch and the use of ollas will make maximum use of the water you use to keep you plants alive and thriving. The subject of low tech, low cost, high efficiency irrigation is the subject of its own eBook in this series.

Store rainwater in the ground – If you increase your soil organic matter and mulch you are well on the way to keeping rainwater where you need it most, in the soil. But there are still other techniques that can enhance your soil moisture. One way is to look at how rainwater runoff comes onto and leaves your property and the build swales across water flows. Swales are mounds of earth which have a ditch in front of the them filled with organic matter or gravel etc. that allows water penetration. The swale slows the runoff water down and directs it into the porous ditch, preventing the water from leaving your site and letting it soak into the soil. When properly designed a system of swales will be constructed so that the overflow from one swale is directed into another down the slope.

Another method for storing water in your soil is to reduce or eliminate impervious areas on your property such as concrete, asphalt or plastic sheeting so that rainwater does not run off these surfaces. Rainwater hitting these materials can run off your property and be lost to you and your plants. Porous surfaces ensure that runoff is reduced and water is directed into the soils where it is needed. Examples of this approach include replacing concrete paths with gravel or woodchips or installing tracks instead of a solid concrete driveway. Where it is not possible to do away with impervious areas, divert the runoff to areas where it can be utilised by plants.

Consider using a wetting agent – If there has not been any rain in your area for some time and the soil has dried out it may actually become hydrophobic or in other words water repellent If this occurs, one way round this problem is to irrigate with water containing a wetting agent such as a small amount of dish washing liquid or commercial wetting agent. This decreases the surface tension of the water and allows it to soak into the soil.

Fit a trigger nozzle to your hose – If you don't have a more efficient system for watering your fruit and vegetables but your hose, make sure you have a trigger nozzle fitted so that you can shut off the water when you are moving from plant to plant or bed to bed. You should also water early in the morning or late in the afternoon as this gives time for the water to soak in before the sun hits the soil thus reducing water loss through evaporation.

Wash cars with a bucket, on the lawn or use a commercial car wash that recycles water.

BATHROOM

Install a low flow shower head – This can reduce the water use to less than half that of a standard shower head, down from a bit over 17 litres per minute down to a bit less than 7 litres per minute or in other words, save you 10 litres per minute for every minute the shower is in use. That is an amazing amount of water savings.

Catch cold water in a bucket while waiting for the shower to run hot – Back a few years ago when the drought was in full swing and John Howard was our prime minister, someone asked him if he was prepared to do this his response was disappointingly "no that would be taking it a bit far wouldn't it?". It is such a shame to see all that potable water (and the energy to produce it) wasted by letting it just flow down the drain when it can be so easily be caught and used to water plants, flush toilets or put into washing machines. Just keep a spare bucket in the bathroom and away you go!

Limit showers to 3 minutes – This where one of those little 3 minute egg timers comes in handy. It is only when you starting timing showers that you really start to appreciate how long a shower takes, particularly if you are female and need to wash your hair. (I'm just stating from my own observations). The three minute shower can be accomplished but you need to be organised and keep an eye on the hourglass, alternatively a time with a really annoying buzzer well outside the shower cubicle can be a keen motivator.

Shower Interrupter Valve

Use a shower interrupter valve – When you are washing your hair (I am reliably informed) there is a requirement to let the conditioner sit in your hair for a while, particularly if you are female and have long hair. Presumably, rather than waste all that shower water you turn the shower off. Unfortunately, when you turn the shower back on it takes some time to adjust both taps to get the temperature right, and during that time more water is wasted. Hence the interrupter valve, which sits between the taps and the shower nozzle, usually where the outlet for the flexible hose comes out of the wall. All you do is flick it to one side when you want the water to stop and when you flick it back the other way the water flow restarts at exactly the same water temperature as when you turned it off, and you don't touch the taps. We have one….it works!

Shower consecutively or with a friend – This can sound like more fun than it is, particularly if your significant other likes the water hot enough to raise blisters and you prefer a more moderate temperature. Having said that there is a fun game called "black rain" where you and your significant other shower together with the lights off, however this may not reduce your shower time. Showering consecutively means there is no water wasted on reheat time.

Don't run the tap while shaving or brushing your teeth – we have been into saving water for so long I can't remember ever having done either. This a is a proverbial no-brainer, just don't do it!

Always wash hands in cold water – I have no problem with this, but some people of the female persuasion may regard it as a bit draconian, especially in winter, but it also means no long seconds waiting for the water to run hot while all that potable but cold water runs down the drain. Your call.

LAUNDRY

Install a front loading washing machine – while a front loading washing machine can tend to take longer per load of wash and be noisier they also use less energy, detergent and water, up to 70% less water. I found the difference in water use to be amazing after we replaced our old top loader with a front loader a few years ago. Another benefit is that they are actually gentler on clothes and so you will get a longer life out of them. Again, I am not saying to rush out and buy a new washer, but when the time comes, give consideration to a front loader.

Only wash full loads – In most cases your washing machine will use a set amount of water regardless of how many clothes are in it, so by filling it up before you use it it means less washes. This then translates into less water used.

Hand wash small loads in a bucket, make a dolly or use a pressure washer – If you find that you do get a small load and don't want to wait, you still have options. Back in the days before washing machines they had what was called a washing dolly which was sort of like a three, four or five legged stool (as small one) on the end of a long stick or a "prosser" which was like a copper cone on the end of a stick and either was used to wash clothes by agitating them in a wooden or metal bucket designed for the purpose. A recycled 20 litre plastic drum and a (clean/new) toilet plunger would approximate this system or you could make yourself a dolly. Once the wash was done, toss the water out on the lawn.

A more modern device which can be used for small amounts of laundry is the pressure washing machine (Wonder Wash). The idea is you place your washing in the in the washer drum which is a pressure vessel on a stand, place hot water and detergent inside, replace the lid and seal. By rotating the washer vessel drum the hot water heats up the air inside, causing pressure to increase. Theoretically this causes the cleaning agents to be forced into the clothes. After 3 minutes of rotating the drum manually you release the pressure by turning a valve and remove the clothing. To rinse repeat with clean water.

Don't wash clothes until they need it – This is a hard one when you have been brought up to believe that you must wash your clothes after they have been worn once. However in many cases, with outer wear particularly, clothing will be suitable for wearing for more than one day. Just have a good look and smell and if it looks and smells good, it is right to re-wear and this will reduce the number of washing loads you need to run in a week saving water, energy and chemicals. OK, if you are working in the garden or under the car your clothes will probably need washing but don't assume – always check before you wash.

KITCHEN

Wash veggies in a basin or tub – Fairly simple one this, it is really easy to keep the tap running when peeling the spuds or whatever and a whole stack of water can end up going down the drain. By having a tub or basin with water in it you can wash the dirt off and peel your spuds using much less water and then toss the water out on the lawn, veggies or fruit trees at the end.

Don't defrost under running water – This can be a real water waster, but if you plan correctly you can defrost in the fridge overnight and save that water. If you forgot to plan ahead, place your meat on a metal surface like a metal sink or cast iron frying pan or even on your granite counter top if you have one, it works a treat.

Catch cold water while waiting for it to run hot – in a similar way to when you are taking a shower, have a catch tub which fits into the sink easily that can hold the cold water while you are waiting for it to run hot.

Install an aerator on kitchen taps – This is an interesting one because although aerators restrict the flow of water it still feels like there has been no change to the water pressure. Aerators are ideal for flow based tasks such as hand washing, but will have an impact on the time take during volume based tasks such as filling a kettle. Overall, the use of aerators is a cheap and easy way to save water.

Wash dishes by hand and only wash once a day – I have always been a fan of hand washing dishes over the use of electric dish washers because generally hand washing uses less water, although these days there are dish washers which approach the water consumption levels of hand washing. Whatever you do, don't wash things up after every meal, wait until the end of the day and do one big wash, overall the consumption of water is less.

Get hold of a low water use dishwasher – if you must use a dishwasher, make sure you get hold of a modern, low water consumption model. Again, don't rush out and replace your existing one, wait until it needs replacing or just don't use it and wash by hand! (LOL)

TOILET

Install a composting toilet – There are composting toilets which are approved for urban/suburban use although they can be expensive, but they are absolutely the best water saver in this room of the house! Also, if you can get an approved model and install it as required, you may be able to get the sewerage treatment fee removed from your water bill, which is a considerable saving. Otherwise you can fly under the radar and home make a cheapie, you will still have to pay sewerage charges but you may reduce your water consumption dramatically. (depending on type of toilet, number of people using it, flushing habits etc.)

A composting toilet eliminates water usage in this area

"If it's yellow, let it mellow, if it's brown flush it DOWN!" – This was a catch cry form when we had droughts years ago. It does seem a bit silly to me to use over 20 litres of clean potable water (in an old-style toilet)to get rid of a couple of cupsful of pee. So with no expense, just a little behaviour change, you can reduce your water consumption considerably. Another alternative is to get people to pee in a bucket, dilute 10 to 1 with clean water and use it as fertiliser!

Install a dual flush cistern – Dual flush cisterns are pretty common these days, the idea being that a 3 litre "half" flush is used for urine and a 4.5 – 6.0litre full flush is used for faeces. If your current toilet is the "one size fits all" type, particularly if it is on the older side it could be worth replacing particularly if you are remodelling the area, which is what we did. You may be able to replace your current cistern with a dual flush one with out replacing the pan, but check with the manufacturer first.

Flush the toilet with warm up water – One way you can use those bucket loads of saved up shower and sink water is to flush the toilet with them. While it is possible to just lift up the seat and pour water into the pan directly to simulate a flush, this is not very water efficient. Toilets are designed to remove the waste by admitting water into the pan from the cistern so a better way is to turn the toilet water supply off at the tap and then fill the cistern with recovered cold water from the shower etc.

Install a touch sensitive flush on older toilets – If you have one of the older style, single flush, large volume cistern, one push of the button and the entire cistern empties type of toilets you can install a tube that fits into the open overflow of single flush toilet systems causing the toilet to only flush whilst the flush button or lever is held down. There is a commercial version imaginatively called the "Water Wizz" Toilet Water Saver. The idea is that when you flush; say after a pee, you only hold the button down for enough time to effectively flush, rather than wasting the whole cistern full of water every time you push the button.

Put a soft drink bottle full of water in the cistern – again, this trick is for the old time, high flush toilets and by using it in one of the newer more water efficient toilet cisterns you may compromise the toilets' ability to flush correctly. The basic idea is you full up a soft drink bottle with 1-2 litres of water and then place it in the cistern. The drink bottle will then displace 1-2 litres of water in the cistern and correspondingly reduce every flush by 1-2 litres. This can save a lot of water over time.

6.2 Virtual Water

Up to now our discussion has been about working out how much water you use directly and what strategies you can use to reduce that direct water consumption, but there is a class of water that we do not consume directly. In much the same way as products we buy contain a greater or lesser amount of embodied energy, ie energy consumed in their production, water is consumed in the production of our food and industrial products. Such indirectly consumed water is usually referred to as embodied, embedded or virtual water.

Two guys who have done a lot of work with this concept, A.Y. Hoekstra and A.K. Chapagain, define virtual water as - "the volume of freshwater used to produce the product, measured at the place where the product was actually produced". It refers to the sum of the water use in the various steps of the production chain. Australians use 180 to 200 litres of water directly per day but it turns out that the industrial products and food we consume daily require almost 2192 litres to be consumed for each of us daily. Following are some examples of virtual water consumption for various food and industrial products –

Virtual Water - Food		
Item	Amount	Virtual water consumed to produce
Steak	1 kilogram	16,000 litres
Butter	1 kilogram	18,000 litres
Rice	1 kilogram	6,500 litres
Milk	1 litre	4,500 litres
Pork chop	1 chop	2,400 litres
Wine	1 glass	300 litres
Omelette	2 eggs	270 litres
Potatoes	1 kilogram	250 litres
Bread	Two slices	180 litres
Coffee	1 mug	170 litres
Tea	1 cup	20 litres

Virtual Water – Industrial Products		
Item	Amount	Virtual water consumed to produce
Cotton	For 1 shirt	3,000 litres
Jeans	1 pair	11,000 litres
A4 copy paper	1 sheet	12 litres
Steel	For 1 car	360,000 litres
Plastic	1 kilogram	240 litres
Personal computer	1	190,000 litres
Leather shoes	1 pair	20,000 litres
wool	1 kilogram	200,000 litres
biodiesel	1 litre	9,000 litres

So it seems that the water consumed indirectly on our behalf to produce our food and industrial products, virtual water exceeds the water we consume directly by a considerable margin. Direct water consumption is comparatively easy for us to directly impact, but even though we can't directly affect the use of virtual water we can still impact on it with the most powerful tool we have – our spending habits.

What we buy or don't buy and what we produce or conserve ourselves can certainly impact on our use of virtual water. Following are some hints you can implement to help reduce your virtual water consumption –

- Eat less meat, specifically beef
- Eat less dairy
- Drink tea or better, water instead of coffee
- Buy clothing second hand rather than new
- Repair and mend clothing rather than buying new
- Buy less "stuff"
- Buy second hand where possible
- Keep products for as long as possible before replacing them
- Grow your own food
- Waste less food

Unfortunately there is one piece of advice for reducing virtual water consumption which you see around the traps that I cannot in good conscience recommend – wear synthetic fabrics instead of natural fibre. There are so many good reasons to wear natural rather than synthetics, so let's leave that there shall we?

The Water Footprint

Another way of looking at water consumption is the "National water footprint" which includes both direct and indirect water consumption and, is averaged to reflect the water consumption by a whole country. For example, Australia has a water footprint of 2,315 m3/capita/year or in other words each of us Australians consumes 2,315 tonnes of water annually (directly and indirectly). The global average is 1,385 m3/capita/year and the UK consumes 1,258 m3/capita/year while the US consumes 2,842 m3/capita/year. Clearly we have some work to do before we can get down to the global average or less, which is where we need to be, so use the information presented in these articles to help you reduce both your direct and indirect water consumption.

7.0 Maintenance

7.1 Fixing a Leaking Flush Toilet Cistern

If the cistern of your toilet is leaking into the pan, and the leak is not too substantial, it can be difficult to detect. It will be leaking 24/7 though and as such can waste a surprising amount of potable water, which is a waste of resources, but also a waste of your money. This article will give you an idea of how to check and what to do about it if you do find a leak.

The Test

Remove the top of your toilet cistern and add a few drops of food colouring dye, just enough to give a discernible tint to the water in the cistern, and leave it for an hour or so without flushing. If you have a leak and it is a bad one, the colour will appear in the pan almost immediately, but if it is a very slow leak it may take a bit of time, hence leaving the system for an hour. If there is no obvious tint to the water in the pan after an hour you will be pretty right.

Having said that, things can change over time, so you should do this test every year or two so you can keep on top of things. If you suspect a leak (eg your water bill has gone up without any obvious changes) you should do the test right away just to make sure.

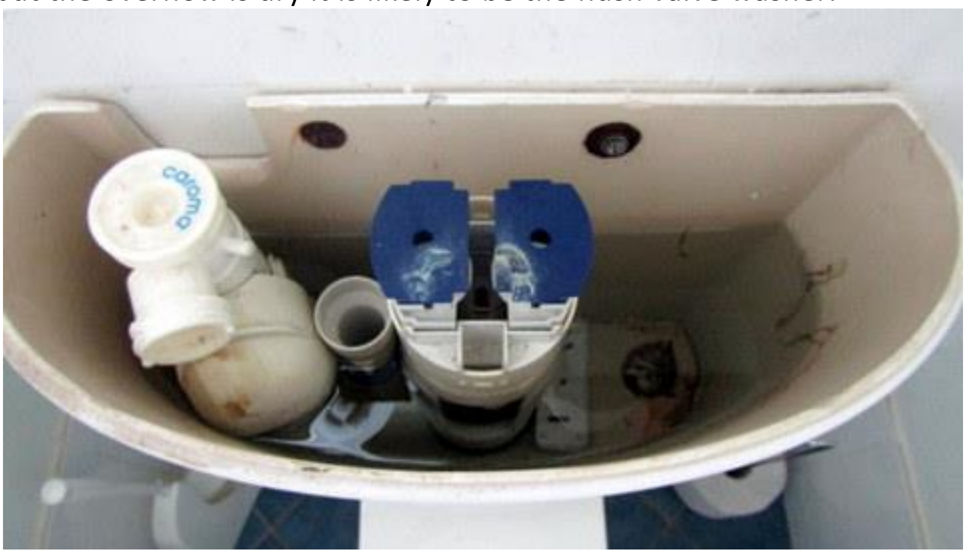
What You Can Do

The fix will vary slightly, depending on the brand of toilet you have, we have a "Caroma" brand. The most important thing is to get spare parts which are designed for use with your brand of toilet. They may look the same on the face of it, but unless the packaging states the parts are for your brand of toilet, you should not buy them. I picked up a part recently for an issue we had, the front of the part looked exactly the same as the one from our toilet, but when I bought it and removed it from the packaging the back looked somewhat different. It was not labelled as fitting our toilet.

Left: *original seal* ***Centre****: new replacement seal (correct)* ***Right****: New seal which llok OK from the front but rear was totally different*

With more hope than confidence I fitted the part, but sure enough it didn't work: wasting the part (I couldn't return it), a small amount of money, my time and the hassle of driving out to find the correct part. Another one of life's lessons learnt!
In my experience the leak is most likely to come from one of two places – The flush valve washer or the inlet valve head seat diaphragm.

Remove the top of the cistern and have a look in, if there is water going over the internal overflow pipe it's probably the head seat diaphragm, if water is still getting into the pan but the overflow is dry it is likely to be the flush valve washer.



The view inside our cistern - white structure on the left is the inlet, open tube in the middles is the internal overflow and the cylinder on the right is the dual flush mechanism.

The flush valve washer seals at the bottom of the (in our case) dual flush mechanism to prevent water getting to the pan once the flush is completed. To fix it is just a case of flushing the toilet to remove the water and then turning off the water inlet at the tap.

Then grasp the mechanism tower and twist it slightly to the left and lift it up out of the cistern. The washer is at the bottom of the tower, remove the old one and replace with a new one. Place the tower back into the cistern and twist slightly to the right to seat it. Turn on the fill tap and away you go.

The orange flush valve washer at the base of the dual flush mechanism

To replace the inlet valve head seal, again, empty the cistern and turn off the inlet tap, grab the attachment arm on the side of the mechanism and disconnect it, twist the housing to the right and remove it from the cistern. Pull out the head seal and replace with a suitable spare. Place the housing back onto the mechanism and twist to the right to re-seal, and reconnect the lever.

Inlet valve head seal - the old one, showing that the seal has come completely off the support fitting.


New inlet valve headseal in place and about to be refitted into the cistern

As mentioned earlier, this might not totally fit your cistern if it is a different type to Caroma, but it will give you an idea of where to look for the problem. Good luck!

7.2 Fixing a Leaking Tap

You would be surprised at the implications of merely fixing a dripping tap have for our sustainability, obviously there is the wastage of water (over 20,000 litres in a year) but there is also the aspect of fixing things for ourselves and repairing rather than replacing equipment. So having the skill and gear to fix a leaking tap can be a very good thing, here we will cover the skills you need but I will leave it up to you to pick up the gear.

The usual reason that a tap is dripping is because the washer, a flexible seal that screws down onto a bearing surface around the water supply hole in the tap shutting the water supply off, is shot. The bit that does work, the washer itself sits on a disk on the end of a small cylinder or stem that keeps the washer in place, which is usually nylon or brass. The brass ones used to have a bolt that secured the washer to the stem but all the new ones seem to be riveted on. If you can get hold of any of the old bolted ones do so, you can remove the nut and exchange the unserviceable washer without having to waste the whole stem.


Brass and nylon washer stems

All of the washers seem to be some sort of polymer these days, nylon or some other sort of plastic. In the old days ("back when I was a lad" said in an old crotchety voice...) the washers were made of leather for cold water or fibre for hot water. If you had some leather and a 19mm and/or 22mm pad punch to cut the leather disk for a washer and a 5mm hole punch for the central hole you could make your own washers and fit them to the stem.

Old style washer stem showing attachment nut

New style washer stem showing attachment rivet

Just recently I found one of our outdoor taps dripping and changed the plastic washer and stem, replacing it with a brass stem. The way I did this was to shut the water off where the main comes in from the street, at the water meter next to the front tap, then with a shifting spanner I undid the top of the tap, pulled the old washer out and replaced it with the new and re-screwed the top of the tap back on, tightening it up with the shifter. It was a simple matter then to turn the mains back on and low and behold..................it still leaked! (extensive use of magic words).

If you look closely at the bottom LHS of the bearing surface you can see the crack
While this has happened to me in the past, it has been rare that changing a washer did not fix the problem. Mind you, the washer was definitely no good so it was not a waste to replace it but there was clearly another problem here. I still don't know what causes it, but a crack or fissure can form on the bearing surface in the tap body that the washer mates with so that even if the washer is brand new (as it was in this case) water can still bypass it and continue to leak out of the tap. Frustrating!

Here is where a little tool worth getting hold of comes into its own – the tap reseater. A tap reseater is a carbon steel cutter the same diameter as the washer attached to a central threaded bar that rotates inside a threaded conical piece of steel that attaches to the tap body. The central threaded bar is rotated manually by pushing on the t-bar on the other end from the cutter. While they are not expensive it is worth making sure you get a good one, you used to be able to get a cheap model that relied on sandpaper rather than a steel cutter and it was practically useless, so go for the steel.

Tap Reseating Tool

Once you have identified that a crack is your problem, wind the central bar up into the tool and then screw the conical body of the tool down into the threaded section of the tap exposed when you take the handle off, making sure it is reasonably tight. Then screw the central threaded bar down until the cutter just makes contact with the washer bearing surface in the tap, push on the t-bar to rotate the cutter, shaving small amounts of brass off the bearing surface. It you try to go too fast it will either gouge hunks out of the bearing surface, buggering it, or the cutter will bind and you won't be able to turn it at all – slowly does it!

Tap reseater installed ready for use

Remove the tool and check the process of the work regularly so you only remove as much metal as is required. Once the bearing surface is free of cracks again, turn the water supply back on a bit and flush some water through the tap to wash out any brass shavings that have fallen into the tap body. Otherwise these can get caught between the bearing surface and the washer making you think the leak is still there (I'm speaking from experience here).

All that needs to be done now is to reassemble the tap, turn on the water supply and revel in your now leak free water supply. By doing it yourself you will not only save wasted water but also saved money on what would have meant a replacement tap.

8.0 Resources

Books about water, harvesting it, storing it and saving it!

Every Last Drop – Craig Madden and Amy Carmichael – Random House (AUS) 2007 ISBN 978 1 74166 888 9 – A detailed book on the theory and practice of saving water with a main focus on the home but some discussion around the bigger picture such as agriculture, desalination and water politics as well as a section on resources.

Waterwise Gardening – Kevin Walsh – Reed New Holland (AUS) 2004 ISBN 187706901 9 – Lots of good info, he covers waterwise design, mulch, the pros and cons of different watering systems as well there is an extensive section on drought tolerant plants although most of them tend to be ornamental rather than productive. There is also a good section on soils. The book strikes a good balance between theory and practice.

Water – Not Down the Drain – Stuart McQuire – Alternative Technology Association (AUS) 2008 ISBN 978 0 9578895 6 9 – This one is probably THE water book to have. Not all the material in it is aimed at the urban/suburban householder but has stacks of good information. It covers why and the how of saving water, how to work out how much water you have available from various sources and then goes into detail about rainwater, greywater and the toilet and waste water treatment. Well worth having in your library!

The Water Efficient Garden – John Archer, Jeffrey Hodges and Bob LeHunt – Random House (AUS) 1993 ISBN 0 09 182569 5 – Don't let the maple leaf on the cover fool you, this is an Aussie book! It is a great book, particularly if you want to design an urban watering system, although the book does start off with the basics about soil, plants and what makes a water efficient garden. There is also good data on setting up a system for productive plants rather than just straight ornamentals.

Waterwise House and Garden – Alan Windust – Landlinks Press (AUS) 2003 ISBN 0 643 06800 7 – There is a good emphasis on planning with this book, and detail on waterwise options and strategies that can be adopted to improve water efficiency, both inside the house as well as outside in the garden. There is also a good section on what to do during a drought. The section on selection of drought tolerant plants does focus on ornamental species.

The Earth Garden Water Book – Alan T. Gray (Ed.) – Earth Garden Books (AUS) 2004 ISBN 0 9586397 2 8 – This is a series of articles about water harvesting, usage and conservation from the pages of Earth Garden Magazine. Some of the subjects discussed in these articles are of more use to those with a bit of land or in a rural area but there is still much of value in this book for the urban/suburban dweller. The articles in the book are arranged around collecting, purifying, conserving and re-using/recycling water and there is an excellent section on water saving tips as well as a chapter on water saving suburbs showing how others in the city have done it.

Drip Irrigation – For Every Landscape and All Climates – Robert Kourik – Metamorphic Press (US) 1992 ISBN 0 9615848 2 3 – There is not a lot of books around on drip irrigation and this is a good one. While this is primarily suited to the suburban dweller, irrigating trees, shrubs and veggie patches there is also a chapter on irrigating containers which would be of value to the urban grower. It is quite a technical book covering the how and why of drip irrigation in some considerable detail.

A number of the above books contain information on the treatment, recycling and reuse of greywater and blackwater but the book listed below deal with the issues more fully, particularly in terms of the processing and use of human waste.

The Humanure Handbook – Joseph Jenkins – Chelsea Green Publishing (US) 2005 ISBN 978 0 9644258 3 5 – If you want to know about how to treat and use your human waste on site, this is the book for you. It is readable, not overly technical and very comprehensive. It is also available as an e-book, check out our links area.

Goodbye to the Flush Toilet - Carol Hupping Stoner (ed) – Rodale Press (US) 1977 – ISBN 0 87857 192 2 – lots of good stuff here, a lot of which is aimed at people with some land but if you have a bit of land (and a good cover story for the neighbours) the detail on DIY systems is good.

The Toilet Papers – Sim Van Der Ryn – Capra Press (US) 1980 ISBN 0 88496 121 4 – This one is all about urban/suburban human waste disposal, with interesting detail on historical systems and a number of designs for DIY waste disposal systems. The solutions are a bit more technical than the elegant simplicity in Jenkins' book (above) but there are some really good ideas here.

Gardening with Less Water – David A. Bainbridge – Storey Publishing (US) 2015 ISBN 978 1 61212 582 4 – This is not a big book but it is chock full of techniques we all should be using. Part 1 of the book covers the techniques: buried clay pots, porous capsules, deep pipes, wicks, porous hose, buried clay pipe and tree shelters. Part 2 is about taking it to the next level and covers water-wise gardening tips, rainwater harvesting, landscaping for water catchment and developing a plan. If you are concerned about the water used in your garden, you need this book in your library. The book has lots of colour sketches and colour photos.

Create an Oasis with Greywater (6th Edition) – Art Ludwig – Oasis Design (US) 2015 ISBN 978 0 9643433 3 7 – This book describes how to choose, build and use 20 types of residential greywater re-use system in just about any context. It explains how you can put together a simple greywater system in an afternoon. It also talks about how you can integrate it with water efficiency, rainwater use and food production. It does reflect the US experience so some approaches may not work in Aus and some products may not be available. Obviously, any discussion about laws etc. should be taken with a grain of salt! Lots of black and white photos and line drawings.

Water Storage – Art Ludwig – Oasis Design (US) 2011 ISBN 978 0 9643433 6 8 – This book describes how to store water for the home, farm and small community. The book talks about general system design principles, avoiding common mistakes, different kinds of storage and working out how much water you need. Also covered is how to work out the best material for your storage container, plumbing details and real life examples of storage designs. As for the previous book this is US based. Lots of black and white photos and line drawings.

Rainwater Harvesting for Drylands and Beyond: Volume 1 – Guiding Principles – Brad Lancaster – Rainsource Press (US) 2013 ISBN 978 0 9772464 3 4 – While the drylands referred to in the title are mainly the ones in the US there are lots of ideas here which will work well in Aus. The intro talks about the author's journey around water, the first chapter talks about rainwater principles and ethics. The second chapter talks about assessing your sites water resources and chapter 3 is an overview of harvesting water with earthworks. Chapter 4 covers integrated design, bringing in the effect of the sun on design, but chapter 5 – An integrated urban home and neighbourhood retrofit, I found to be most useful. Lots of B&W photos and line drawings.

Rainwater Harvesting for Drylands and Beyond: Volume 2 – Water Harvesting Earthworks – Brad Lancaster – Rainsource Press (US) 2013 ISBN 978 0 9772464 1 0 – The introduction covers how earthworks are defined, their advantages and a success stories. Chapter 2 covers the process you can use to assess your site and the next 10 chapters cover various water harvesting techniques including berms, French drains, terraces, infiltration basins, reducing hardscaping, swales, check dams and vegetation. The last chapter covers greywater and there is a motivational epilogue. While the title may not lead you to think there is much here for the suburban landscape it is a good book for the rural and suburban experience. Lots of B&W photos and line drawings.

Good Gardens with Less Water – Kevin Handreck – CSIRO (AUS) 2008 ISBN 978 0 643094 70 3 – The book covers how to improve soil structure to maximise water retention, selecting drought tolerant natives and exotics, working out how much water to apply to different plants, rainwater harvesting and use and how to avoid problems with greywater in the garden. Good info but not much on the productive garden and not particularly organic. Lots of colour photos.

The Water-wise Garden – Jeffrey Hodges – Viking (AUS) 2008 ISBN 978 0 670 07109 8 – This one IS nicely organic in approach! The book gives some theory around how plant use water and what effect this should have on watering practices, creating "water use" zones and improving the water-holding content of the soil. There are also sections on fertilising and dealing with pests and diseases using organic methods and the capture and use of rainwater and greywater. The book has a small number of colour photos and a few line drawings.

Watering Systems for Lawn & Garden – R. Dodge Woodson – Storey Publishing (US) 1996 ISBN 978 0 88266906 9 – The introduction talks about options for plant watering and the next chapter asks asks the question, "is irrigation practical?". Freshwater sources (including spear point well) are discussed followed by recycled water for irrigation. Following chapters cover moving water by pump and by gravity, surface, overhead and buried irrigation options and irrigation fitting and getting your system operational. As usual, the experience is US and so laws mentioned will not apply and not all products will be available. Lots of line drawings.

Water in Plain Sight – Judith D. Schwartz – St Martin's Press (US) 2016 ISBN 978 1 250 06991 7 – This is not a "how to" book, it is more a "big picture" book going through how our landscapes are drying and why, in areas so diverse as southern Africa, the Amazon basin and outback Australia. It is also a wonderful book about how not only does climate change affect our water supplies, but how our water supply can also drive climate change. Lots about the problems but also wonderful examples of what people are doing to fix the problems. No illustrations.

The Water Efficient Garden – Wendy Van Dok – Water Efficient Gardenscapes (AUS) 2002 ISBN 0957765525 – This is another small book with lots of great ideas. It starts off (after an intro which asserts we have enough water, but it is where the water is, geographically) with how to reduce you demand in the house and garden including working out a water budget. The next section talks about techniques for storing water in the soil, followed by one on how to supplement or replace tap water, with rainwater tanks etc. The final sections cover how to irrigate efficiently and how to minimise water loss. A great little book! Mostly B&W photos and line drawings with a few colour photos thrown in to confuse you.

The Wastewater Gardener – Mark Nelson – Synergetic Press (US) 2014 ISBN 978 090779152 2 – Again, this is not so much a "how to" as a "what I did" type of book! This guy does seem to know all there is to know about constructed wetlands and has worked putting them in and running them all over the world, including northern Australia. He was involved in the Biosphere 2 experiment and for 2 years managed their sewage treatment wetlands. He calls them wastewater gardens and has developed them in Algeria, Belize, the Bahamas, Indonesia, the Philippines, Spain – all over the world and this book is a distillation of his experiences. Lots of B&W photos and some colour photos.

Edible Water Gardens – Nick Romanowski – Hyland House (AUS) 2007 ISBN 978 1864471021 – Chapter 1 covers the generalities of growing aquatic and water edge plants, including notes about water, and water quality, soil, dissolved gases, fertilisers, propagation, harvest methods and vermin, disease and weeds. The other chapters are divided up into the types of growing environments and which plants suit them, such as floating plants, plants for shallower areas, plants for waterlogged soils and other useful and profitable wetland plants. In each chapter are a series of monologues on each suitable plant giving some history, how they are classified, a description, how they are grown and how they are used. The book has lots of colour photos and some line drawings.

Appendix 1 – Water Audit Form

Water Use	**Day 1**	**Day 2**	**Day 3**	**Day 4**	**Day 5**	**Day 6**	**Day 7**	**Av Daily Litres**	**Total Litres/ week**
Weekday/ Date									
Washing up @ litres/wash (Manual)									
Washing up @ litres/wash (Dishwasher)									
Shower (hair wash) @ litres/Min									
Shower (quick) @ litres/Min									
Toilet (full flush) @ litres/flush									
Toilet (half flush) @ litres/flush									
Washing machine @ Litres/wash									
Cooking & drinking @ litres/day									
Teeth cleaning @ Litres/clean									
Hand washing @ Litres/wash									
Cleaning water (surface cleaning) @ Litres/day									
Pet Water (chooks/cats etc) @ Litres/day									
Watering Garden (hose) @ litres/min									
Watering Garden (tank) @ litres/min									
Totals									
Total yearly water consumption (Total weekly consumption x 52)									

	June Quarter	September Quarter	December Quarter	March Quarter	Ave for Year
Average daily water usage from water bill (litres)					

Volume of Greywater Available for Re-use

Source	Daily Volume (Litres)	Weekly Volume (Litres)	Yearly Volume (Litres)
Shower			
Bath			
Washing Machine			
Laundry tub			
Total			

Volume of Rainwater Available for Harvest

Annual Rainfall (from Bureau of Meteorology)	
Roof Catchments in m^2	
House	
Garage/carport etc.	
Sheds	
Total catchment	
Total potential rainwater catchment per year (annual rainfall x total catchment)	
less 15% contingency for runoff or other loss (Potential rainwater catchment x 0.85)	
Total water use per day (from water consumption graph)	
Total water use per year (from water consumption graph)	
Longest number of rainless days (from Bureau of Meteorology)	
Water needed to cover longest number of rainless days (no of days x daily consumption)	
Water storage required for water security + 20% contingency	
Total capacity of current tankage	
Tankage shortfall/excess	

Appendix 2 – Sample Water Tank Record

				15-Dec-19			
Tank	Nominal Capacity (litres)	Effective height (millimetres)	Ave litres/mm of tank height	water level	Water Amount	water level	Water Amount
1	2,200	1800	1.22	790	964		
2	2,200	1800	1.22	1385	1690		
3	5,500	1690	3.25	850	2760		
4	5,000	1850	2.70	1115	3000		
5	3,000	1820	1.65	Full	3000		
6	500	820	0.61	Full	500		
Totals	18,400				11914		
Percentage					64.80%		