WITCHCLIFFE

ECOVILLAGE

Water Handbook 2020

SUSTAINABLE SETTLEMENTS

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Introduction

The Ecovillage

The Witchcliffe Ecovillage is a unique sustainable housing development in Western Australia which aims to be 100% self-sufficient in renewable energy, water and organic fresh produce.

This guideline provides advice and sets out the minimum requirements to ensure that all new dwellings in the Ecovillage are reliably provided with a potable water supply.

Water Supply in Witchcliffe

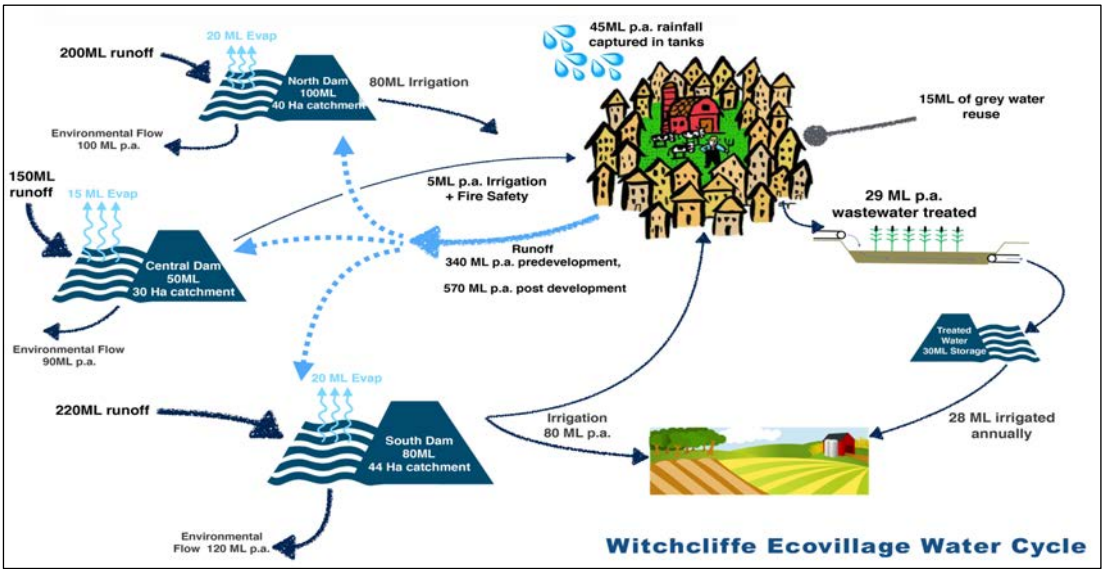
A mains water supply is not provided by WaterCorp in Witchcliffe, so each Witchcliffe Ecovillage dwelling must be designed to collect and store enough rainwater to provide for all household and private garden water requirements.

Residents in regional WA have reliably used rainwater tanks for their water requirements for many decades. The supply of rainwater makes use of a resource created by the roofs of houses, which in a conventional urban environment is simply drained away to the nearest water body, often causing environmental impacts downstream. Collecting rainwater for household use avoids the "hidden" offsite impact of many Australian scheme water supplies, including groundwater extraction, water treatment, extensive pipelines, pumping stations and dam infrastructure, energy for pumping and desalination, and impacts on water catchments, streams and wetlands. There are a number of excellent resources available to guide you in providing and managing your own water supply (see References, p. 11) however, we strongly recommend that you read the Australian Government Department of Health publication, "Guidance on use of rainwater tanks."

Water Supply in the Ecovillage

All water required by the Ecovillage community will be captured from natural rainfall and stored onsite in household tanks and dams. Water modelling for the project has been based on 30-year worst case rainfall data, from data recorded onsite by the Bureau of Meteorology weather station. Water for the community gardens (including your exclusive use veggie garden area), agricultural lots and public landscaping irrigation requirements is supplied by the Ecovillage Commons Ltd from the Ecovillage's three dams, which capture all of the additional stormwater created by the urban footprint of the Ecovillage.

Figure 1. Witchcliffe Ecovillage Water Cycle



Stormwater

Stormwater in the Witchcliffe Ecovillage will be collected and conveyed in surface water features that have been created to mimic natural ponds and streams, planted with native reeds and plants. Run-off from roads will be collected in landscaped swales, which provide biofiltration to remove pollutants, and will be directed via reconstructed streamlines through the community gardens where further treatment areas incorporating biofilters, riffle and wetlands will provide additional cleansing.

Treated stormwater collected and stored in dams will be used for irrigating community gardens, recreation areas, landscaping and agriculture throughout the Ecovillage. Extensive modelling has been carried out to ensure the Ecovillage has plenty of water, even in low rainfall years, to grow food in our community gardens and agricultural lots.

Wastewater Recycling

The Witchcliffe townsite does not currently have a connection to a centralised wastewater service, so the Ecovillage will provide a state-of-the-art small-scale wastewater treatment plant at the southern end of the project, on Davis Rd. It is located on Ecovillage Commons Ltd owned land and will be operated by an Economic Regulatory Authority (ERA) licenced wastewater provider, TMC Witchcliffe. The ERA is a WA State authority which regulates the annual fees of private service providers to ensure that households are charged fairly and provided with a perpetual service which complies with all regulations. The plant will use renewable energy to clean the Ecovillage's wastewater using a treatment system designed around a modular bioreactor that will expand as the Ecovillage grows. The system comprises screening, treatment in a bioreactor to remove nutrient and organic matter, a lagoon to store cleaned agricultural "A" grade recycled water for seasonal use, and re-use of treated water for horticulture and agroforestry areas located at the south western end of the project. The irrigation areas have been planted with a trial avocado orchard and a coppiced eucalypt, casuarina and poplar plantation for providing mulch to the future Ecovillage community gardens.

Education and resources will be provided to the community to ensure the use of environmentally friendly cleaning products throughout the Ecovillage. Wastewater costs will be similar to Water Corp's wastewater fees in Margaret River, which are approximately $1, 200 per house per annum. As a comparison, new houses in the Witchcliffe area *without* a deep sewerage service must install a stand-alone treatment system (ATU) which costs approx. $15,000, and pay to have the system serviced every 3 months and pumped out every 2 to 5 years.

Planning for Your Water Needs

Rainwater Tanks

Individual tanks are required for each Ecovillage property to comply with state legislation, as it is illegal in Western Australia to supply water for domestic use from one property to another without a license from the Economic Regulation Authority. This requirement ensures that each property owner is responsible for their own water quality and adequate storage volume.

The Witchcliffe Ecovillage Building Design Guidelines specify Zincalume tanks for all tanks visible from streets, path networks and community gardens, to ensure a common aesthetic. Poly tanks are a slightly cheaper option but may not be as durable when exposed to direct sun and will require screening in visible locations. Below ground concrete tanks are more costly due to excavation and construction costs, however, they are an option to explore for anyone wanting to maximise their garden space. Slimline tanks and bladder storage are also relatively expensive options; however, they can provide supplementary storage under decks and eaves if needed.

How Much Water Is Required?

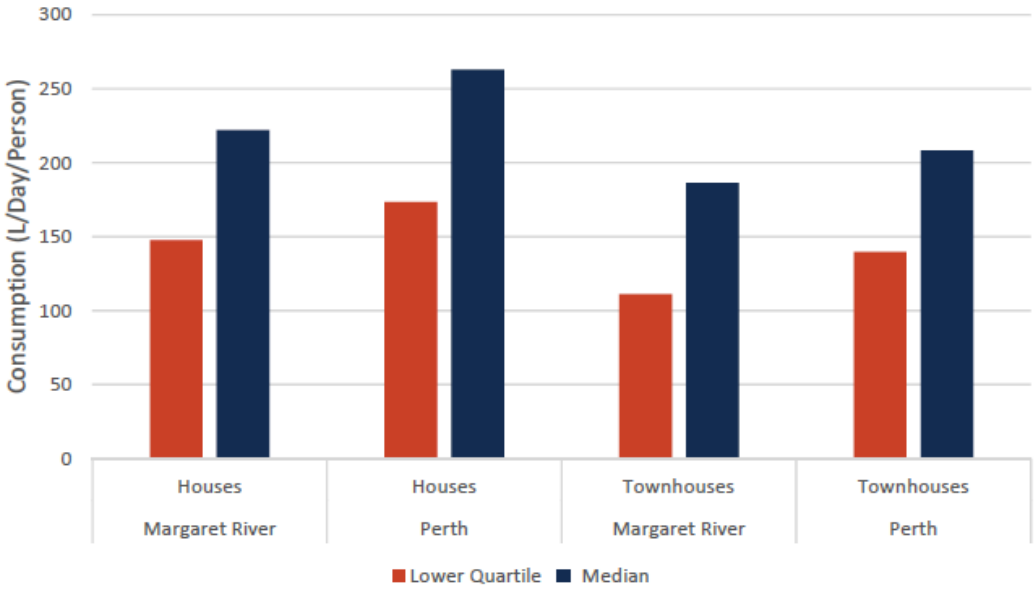
Our minimum water storage recommendations reflect the aspirations of the Witchcliffe Ecovillage community to be water efficient households. The recommendations assume that all households will be constructed with water efficient fixtures and fittings, and that household water consumption will be monitored via tank lever indicators and flow meters. These water efficiency measures are specified in the Witchcliffe Ecovillage Building Design Guidelines (2020).

The minimum quantity of water recommended for a water efficient household connected to a rainwater tank in the Witchcliffe Ecovillage is 100 litres per person per day.

This is the amount of water recommended for internal household use and does not include an allowance for gardens and lawns. This is substantially lower than the average Perth water consumption figures of 246 litres per person per day (L/p/d), however, this figure combines all household and garden use (including pools and spas). Unfortunately, there is currently no data available that provides the average water use of households which are reliant on rainwater tanks for 100% of their water supply, but there is sufficient evidence to assume that:

- water usage is substantially lower in the Margaret River region than in Perth (see Figure 1 below);
- water usage by residents supplied from rainwater tanks is lower than residents supplied from scheme water; and
- water usage in dwellings constructed with water efficient fixtures and appliances is less than the average dwelling connected to scheme water (e.g., "Josh's House," see Appendix 1, which uses approx. 50 L p/p/d.)

Figure 2. Water Consumption Comparison, Margaret River and Perth Regions, (Sustainable Trust).



The amount of water your household will require will be determined by:

- the number of bedrooms/occupants,
- water use practices within the household
- the efficiency of household fixtures such as taps, showers, toilets and appliances,
- the water you require for your garden, and
- whether you provide a greywater system.

The following table breaks down average household water use and demonstrates that 100 L per person per day (L/P/D) is easily achievable in a thoughtfully designed house. In reality, water use in houses may not be a constant 100 L/person/day through the year, as people with water tanks tend to use water more freely in winter when their tank is overflowing and naturally conserve water more diligently during a dry summer.

Table 1. Standard vs Efficient Household Water Consumption*

Water use (excluding garden use)	Standard water consumption L / Person / Day	Efficient water consumption L / Person / Day
Shower: 1 shower per day	63	42
Washing machine: 1/4 load per day	20	7.5
Dishwasher: 1 load per day	19	9
Toilet: 4 flushes per day	14	14
Taps: 5 mins running time per day	45	20
Other:	5	5
Total	**166**	**97.5**
Calculations based on:		
Shower time	7 mins	7 mins
Shower 3 WELS star	9 L / min	
Shower 4 WELS star		6 L / min
Taps 3 WELS star	9 L / min	
Taps 4 WELS star		4 L / min
Dishwasher 2 WELS star	19 L per load	
Dishwasher 6 WELS star		9 L per load
Washing Machine 6 kg top loader 3 WELS star	80 L / load	
Washing machine 6 kg front loader 6 WELS star		30/ load
Toilet 4 WELS star	3.5 L	3.5 L

* Based on information provided on the Australian Government Water Rating website: https://www.waterrating.gov.au/choose/compare

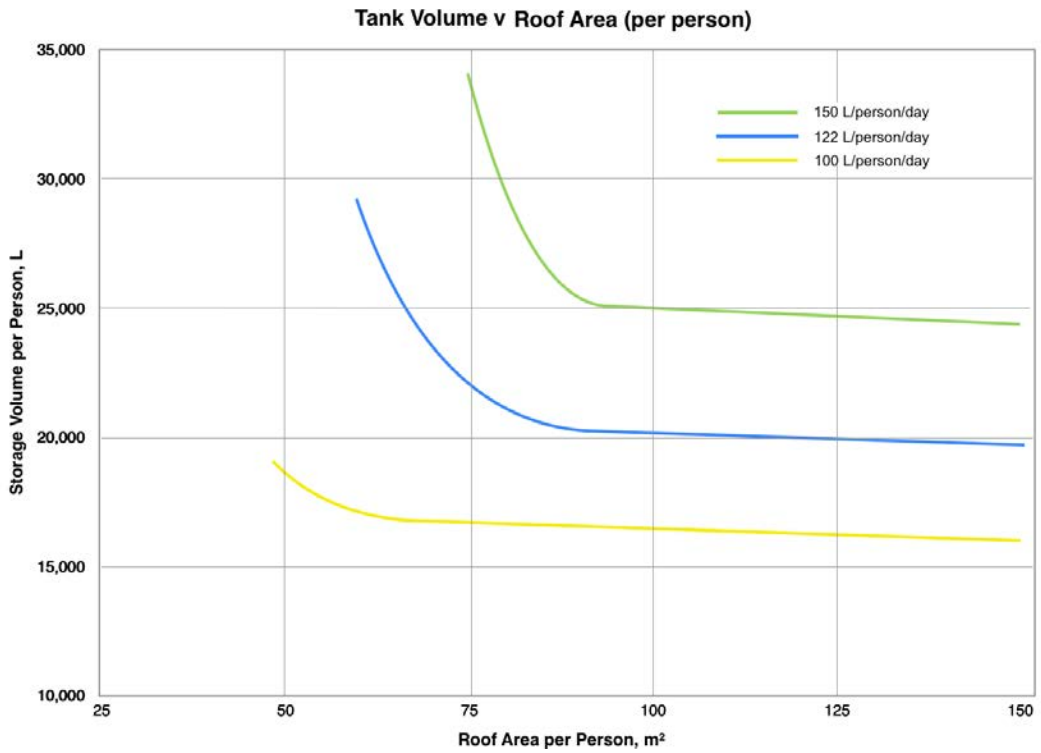
Roof Area and Tank Sizes

The Water Storage Guide (Figure 2, below) provides roof area and tank size recommendations based on:

- The daily rainfall patterns recorded at the Witchcliffe Bureau of Meteorology recording station over the previous 15 years.
- Losses of 10% from splashing and first flush diverters.
- 10% additional provision to allow for potential rainfall reduction or drought events.
- Regular daily water use patterns consistent with internal household use.
- 100% of water supply inside the house being provided from the rainwater tank.
- No allowance being made for external garden use.
- The usable water tank storage volume (excluding any volume below the outlet pipe or above the overflow level).
- Provision of gutters that are sized adequately to capture rainfall without overflowing.

As a rough guide, all dwellings in the Witchcliffe Ecovillage must provide a minimum roof area of 50m² per person and a storage volume of 18,750 L/person. The Water Storage Guide provides tank and roof sizing to supply the minimum 100L/person/day, as well as 122 L and 150 L, to assist owners who may wish to provide a larger water supply.

Figure 3. WEV Water Storage Guide



The total roof area may include the carports, eaves, sheds, pergolas and other structures, however these roof areas must be guttered effectively and connected to the tank.

If you choose to provide the minimum roof area and tank size, you should aim to manage your water supply efficiently by using high efficiency fixtures and appliances where possible (with a focus on the big water consuming items like showers and washing machines). Installing an advanced greywater system can also extend your water supply by re-using treated greywater to flush toilets (see p. 9, Innovative Solutions).

Number of Occupants and Dwelling Requirements

The water collection and storage provision for new dwellings needs to cater for the current owners' needs and also needs to give consideration to future requirements. In order to ensure that there is adequate water supply available for current and future needs, and to satisfy local government requirements, dwellings at the Witchcliffe Ecovillage should:

- Provide minimum storage volume to meet **their proposed occupancy** rates;
- Provide sufficient roof area and demonstrate that additional storage can be provided if required in the future for above ground tanks to meet **standard occupancy** rates;
- Show the maximum occupancy permissible for the dwelling on the building plans based on the actual roof area and storage volume area provided and to disclose this information to future purchasers on sale of the property.

The Residential Water Supply Guide assumes two occupancy rates:

- **proposed occupancy**: the actual number of residents that will occupy the dwelling when it is built; and

- **standard occupancy rates** (that relate to the number of bedrooms per dwelling) for which adequate roof catchment area must be provided and sufficient space provided to allow future additional tank storage to be installed (see Table 2, WEV Minimum Roof Areas / Water Storage Volumes).

Please note, if you have frequent long-term visitors, you may wish to provide additional storage capacity at your discretion.

Table 2. WEV Minimum Roof Areas and Water Storage Volumes

Bedrooms	Standard Occupancy	Recommended minimum storage volume povided	Minimum Storage Volume which must be planned for (area for tanks)	Minimum Roof Area to be provided
1	2	18, 750 L	37, 500 L	100 m2
2	3	37, 500 L	56, 250 L	150 m2
3	3	37, 500 L	56, 250 L	150 m2
4	4	56, 250 L	75, 000 L	200 m2
5	5	75, 000 L	93, 750 L	250 m2

These guidelines allow you to provide a lesser water storage volume initially as long as you can demonstrate that adequate space is allowed for additional tank storage to be provided in the future to cater for standard occupancy rates. The rationale for this approach is that tank storage can readily and economically be expanded in future if required if sufficient undeveloped space is provided on the lot.

This allows a degree of flexibility for the original household while ensuring that the dwelling's future residents' water requirements can be met. Therefore, if you are 2 people living in a 3 bedroom house, you can provide 150m2 of roof space, 37, 500 L of tank storage, and space on your lot where an additional 18, 750 L of tank storage could be installed in the future if your household size increases.

The area set aside for future tank expansion must be located in accordance with the requirements of Local Development Plans and the building design guidelines applying to the lot. The provisional storage area must be for above ground tanks as underground tanks are considerably more costly and access for excavation and installation of underground tanks may be difficult and highly disruptive in the future. (Note that this does not prevent the required storage volume being provided in underground tanks.)

A Water Budget template to assist with your calculations is provided at Appendix 2.

A basic plan showing an example layout for a 2-bedroom dwelling with tanks on a Groupie lot is attached at Appendix 3.

Higher Than Standard Occupancy

The maximum occupancy of dwellings is more difficult to determine. While the Augusta Margaret River Shire's health local laws provide some guidance based on minimum air volumes, these provide for very high occupancy rates that are rarely, if ever, experienced for extended periods. Maximum occupancy rates have therefore not been included in these guidelines.

Occupancy rates that are higher than the standard occupancy rates specified in Table 1 are not uncommon in the region and typically occur with large families or large houses designed for shared use or short stay accommodation. Occupants of dwellings that wish to inhabit dwellings at higher than the standard occupancy rates specified above need to make their own determination of whether the roof area and water storage volume provided will meet their individual circumstances, using the WEV Water Storage Guide (figure 2) to assist their calculations.

Water Use Outside of the Home

The minimum water guidelines for dwellings at the Witchcliffe Ecovillage do not provide any allowance for water use outside of the house for garden and lawn irrigation, car washing, swimming pools, spas, etc.

Residents are provided with irrigated vegetable beds, orchards and recreation areas within their community garden, but the Ecovillage Commons company is not licenced to provide water to private lots. Where residents wish to have irrigated gardens or lawn on their lot, they will need to source this water within their own lot. This may require the provision of additional rainwater collection and storage or the installation of a greywater reuse system.

Around 75 litres of water per person per day is likely to be available from greywater reuse systems. This will provide sufficient water for irrigating approximately 40m² of garden or lawn per person based on a maximum summer irrigation rate of 2mm per day. Native and hardy Mediterranean plants do not need summer irrigation in the Margaret River area once established, so it is possible to create a beautiful low water garden, with the added benefit that native gardens provide habitat for native birds, insects and marsupials.

Greywater reuse systems approved for use in Western Australia are listed on the WA Department of Health web site at http://ww2.health.wa.gov.au/Articles/A_E/Approved-greywater-systems. The installation of greywater systems requires approval from the local government health officers. All dwellings at the Witchcliffe Ecovillage are required to have plumbing that will facilitate the installation of greywater reuse systems. It is recommended that property owners considering the installation of a grey water reuse system include an application for greywater reuse approvals with their building approvals.

A code of practice for the use of greywater systems is also provided by the Department of Health and is available on their website at
http://ww2.health.wa.gov.au/~/media/Files/Corporate/general%20documents/water/PDF/Code_of_practice_for_the_reuse_of_greywater_in_WA_010_v2_130103.ashx

The installation of groundwater bores on private lots may be permissible, however groundwater bores are unlikely to provide a reliable or sufficient water supply in this location given the soil profiles on the site.

The supply of dam water to private lots is not permitted. Dam water allocations are provided exclusively for irrigation to community gardens, landscaping, public open space and agricultural production. The Ecovillage Commons Pty Ltd is not licensed to provide water to private residential lots.

Innovative Solutions

Roof areas or water storage volumes less than the minimum requirement will be permitted where an alternative or innovative solution is provided. An example is installation of an **advanced greywater treatment system** that recycles greywater for toilet flushing and laundry use. Such a system could reduce the rainwater requirement for a dwelling to around 60 L per person/per day with corresponding reductions in the minimum roof area and tank storage volume.

For more information on advanced greywater systems, see the Josh's House Water System Design Factsheet (http://joshshouse.com.au/wp-content/uploads/2013/10/131004-Joshs-House-Water-System-Design-Factsheet1.pdf) and the Greywater and Wastewater Industry Group website (https://www.gwig.org/).

Lower than minimum roof area and storage volumes due to innovation will be considered on a case by case basis and should be submitted with your water budget to the Ecovillage Design Team during your house approval process (see Witchcliffe Ecovillage Building Design Guidelines).

Managing Your Water Supply

Residents of the Witchcliffe Ecovillage will take an active role in managing their own water supply and in return will have no ongoing water bills, a high quality rainwater supply, reduced exposure to chemicals used for water treatment, and the satisfaction that their water supply does not have an off-site impact on natural streams and wetlands.

Managing Water Quality

To maintain a high quality of water fit for drinking in your rainwater tank, there are a few simple maintenance tasks that are required. These include keeping your gutters clean, ensuring pre tank filtration measures such as first flush devices and strainer baskets are clean and functional, and that post-tank filtration devices (membranes, UV filters, etc.,) are maintained and serviced as required.

The Australian Government Department of Health has compiled an comprehensive guide on managing water quality from rainwater tanks and is available on their website at https://www.health.gov.au/internet/main/publishing.nsf/Content/0D71DB86E9DA7CF1CA257BF0001CBF2F/$File/enhealth-raintank.pdf.

The guide highlights that simple preventative maintenance actions will maintain the quality of your water supply and is recommended reading for owners and residents with water supplied from rainwater tanks.

Please note that rainwater stored in non-concrete tanks is naturally slightly acidic, so to avoid the potential for copper to leach into drinking water from water pipes, the Witchcliffe Ecovillage Building Design Guidelines require the use of HDPE and/or butelane piping throughout your home. While the natural pH of rainwater is of no risk to health, simple measures can be taken to re-mineralise your water and raise the pH of your drinking water if you have any concerns (e.g., through adding bicarbonate of soda periodically to the tank, using an alkalinising filter system, or hanging a bag of limestone chips in the tank).

Managing Water Quantity

Just as you have a gauge on your car to ensure you don't run out of fuel or battery charge, a system to measure water usage and available tank storage will help you manage your water use to ensure you do not run out of water and to alleviate any worry about your water supply. There are a number of ways that this can be done:

- Probably the least sophisticated, but still one of the most common methods on rural properties around the region, is to keep an eye on your tank water level by looking in the opening at the top of the tank. Even with other methods, looking in the hatch is still a good backup system.

- A simple tank indicator which reads water level via a float and raises and lowers a big red arrow on the outside of the tank accordingly provides a quick visual indication of your tank water level. This is highly recommended, as a well-located tank gauge gives regular feedback for minimal effort and when tank levels are low it helps to support and reinforce efficient use of water in the house.

- Electronic water meters and tank level gauges are now available at affordable prices and can be combined with solar energy monitoring systems so that you can have real time information about your energy and water use and storage levels on your phone or computer.

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Appendix 1. Examples of Water Efficient Dwellings with Rainwater Supply

To help residents have a better understanding of how rainwater tanks have been successfully included as the water supply for other highly water efficient dwellings in an urban setting, the following examples are provided.

Josh's House

Josh Byrne lives with his young family of four in the house he built to demonstrate how sustainability can be incorporated into a regular house within a reasonable budget. Josh has also installed an extensive array of meters to record how water and energy is used in the house and he provides this information in both real time and in reports of historical usage on his website. Josh's House is one of the most extensively monitored and reported houses for water and energy in Australia. In his first annual performance report, Josh recorded an average water consumption of 50L/person/day.

https://joshshouse.com.au
https://joshshouse.com.au/wp-content/uploads/2014/11/141121-JH-Year-1-Performance-Report-Design-Version.pdf

Sustainable House, Michael Mobbs

Michael Mobbs and his family of four including two teenage kids lived in a terrace house in Sydney and disconnected from scheme power and water in 1996. The Mobbs family monitored their water use for many years and reported using approximately 88L/person/day. This included using recycled water for toilet flushing and clothes washing. The family collected all of their rainwater from the tiny roof of an inner-city terrace house.

www.sustainablehouse.com.au
https://www.sustainablehouse.com.au/water

Appendix 2 - Household Water Budget Template

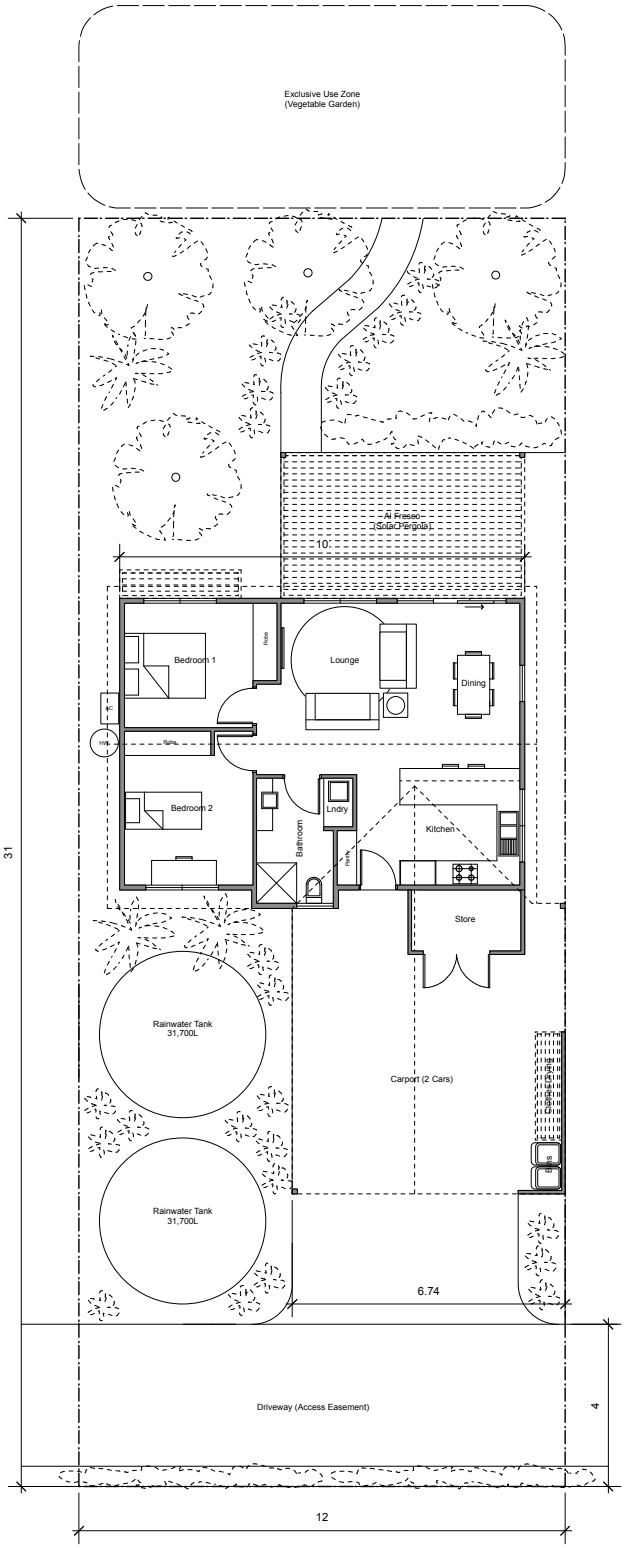
This template references the Witchcliffe Ecovillage Residential Water Supply Handbook 2020, in particular Figure 2, WEV Water Storage Guide (p.6) and Table 2, WEV Minimum Roof Areas and Water Storage Volumes (p.7). An accurate Household Water Budget must be provided to the WEV Design Team during the building application process, as well as to prospective purchasers if the house is sold in the future.

Property details	
1.1 Lot number	Lot
1.2 Cluster number	Cluster
1.3 Address	
2. Dwelling details	
2.1 No. of bedrooms	beds
2.2 Standard occupancy rate (see Table 2, p. 7)	people
2.3 Total roof area (including carports, sheds)	m2
2.4 Roof area connected to rainwater tanks	m2
2.5 Greywater system (if provided) (e.g., advanced treatment, greywater diverter, or N/A)	
3. Owner/Occupant Details	
3.1 Proposed permanent occupants	people
4. Water Consumption	
4.1 Consumption target (not less than 100 L /person/day)	L /p/d
5. Required Roof Area	
5.1 Minimum roof area required (based on bedrooms / standard occupancy rate, Table 2, p. 7)	m2
5.2 Proposed roof area (calculated from WEV Water Storage Guide (p.6) using proposed permanent occupancy rate in 3.1 and daily water consumption target in 4.1)	m2
5.3 Required Roof Area (greater of 5.1 and 5.2)	m2
6. Water Storage	
6.1 Actual water storage capacity required (based on proposed permanent occupancy and roof area, using WEV Water Guide @ 100 L /p/d)	L
6.2 Standard water storage capacity required (based on standard occupancy and roof area using WEV Water Storage Guide @ 100 L /p/d)	L
6.3 Required water storage to be planned for on lot layout (greater of 6.2 and 6.3)	L
6.4 Water storage provided in design: **_____ x tank/s @ _____ L**	L
6.5 Water storage capacity provided in lot layout: **Space for an additional _____ x _____ L tank/s**	L

Appendix 3. Example Water Budget, Groupie Lot

1. Property Details	
1.1 Lot number	Lot 24
1.2 Cluster number	1 A
1.3 Address	
2. Dwelling details	
2.1 No. of bedrooms	2 bedrooms
2.2 Standard occupancy rate (see Table 2, p. 7)	3 people
2.3 Total roof area (including carports, sheds)	150 m2
2.4 Roof area connected to rainwater tanks	150 m2
2.5 Greywater system (if provided) (e.g., advanced treatment, greywater diverter, or N/A)	N/A
3. Owner/Occupant Details	
3.1 Proposed permanent occupants	1 person
4. Water Consumption	
4.1 Consumption target (not less than 100 L/person/day)	100 L/person/day
5. Required Roof Area	
5.1 Minimum roof area required (based on bedrooms / standard occupancy rate, Table 2, p. 7)	150 m2
5.2 Proposed roof area (calculated from WEV Water Storage Guide (p.6) using proposed permanent occupancy rate in 3.1 and daily water consumption target in 4.1)	150 m2
5.3 Required Roof Area (greater of 5.1 and 5.2)	150 m2
6. Water Storage	
6.1 Actual water storage capacity required (based on proposed permanent occupancy and roof area, using WEV Water Guide @ consumption target of 100 L p/p/d)	18, 750 L
6.2 Standard water storage capacity required (based on standard occupancy and roof area using WEV Water Storage Guide @ 100 L p/p/d)	56, 250 L
6.3 Required water storage to be planned for on lot layout (greater of 6.2 and 6.3)	56, 250 L
6.4 Water storage provided in design: 1 Tank @ 31, 700 L	31, 700 L
6.5 Water storage capacity provided in lot layout: Space for an additional 31, 700 L Tank	63, 400 L

Appendix 3 - Example 2 bed cottage lot layout with one occupant



Lot area: 372 m2

Number of proposed occupants: 1

Standard occupancy: 3

Roof area: 150 m2
(inc. carport and covered pergola)

Storage area provided for
2 x tanks @ 31, 700 L
Total: 63, 400 L