Rainwater Tanks

AIM
The aim of this technical solution is to provide guidance on the calculations required to ensure that rainwater tanks are of an adequate size for toilet flushing with the range of annual and monthly rainfalls experienced in Victoria, and to provide advice on installation of cold water services.

PLUMBING REGULATIONS 2008
The Plumbing Code of Australia (PCA) is adopted by and forms part of the Plumbing Regulations 2008. Part B1 of the PCA specifies the objectives and performance requirements related to the installation of cold water services. AS/NZS 3500.1: Plumbing and drainage Part 1: Water services, is a “deemed to satisfy” document listed in Part B1 of the PCA and contains a section on “Installation of water supply systems from rainwater tanks”.

The 6 Star requirements as set out in the Victorian variation to the energy provisions of the Building Code of Australia provide that, in the case of a new Class 1 building, either a rainwater tank be connected to all sanitary flushing systems, or a solar water heater system is to be installed in accordance with the Plumbing Regulations 2008.

Where a rainwater tank option is selected, the Plumbing Regulations 2008 requires that the installation, in order to comply with the building regulations must:

- be installed in such a way that it receives the rainfall from a minimum catchment area of 50 square metres;
- have a minimum capacity of 2000 litres; and
- be connected to all toilets in the building for the purpose of sanitary flushing.

The option only applies where a reticulated mains water supply is available for new housing. If a mains water supply from a water authority is connected, or proposed to be connected to a building where a rainwater tank is installed for sanitary flushing, an automatic or manual interchange device that allows alternate use of mains water or rainwater must be installed to ensure that there is a continual supply of water for sanitary flushing.

RAINWATER FOR TOILET FLUSHING
Q: How do I know what the rainfall is in a given region of Victoria?
A: The Bureau of Meteorology provides extensive median average rainfall figures on its web page: www.bom.gov.au/climate/data/

The figures are given for places in the following eight Victorian regions: Eastern Melbourne, Western Melbourne, South West Victoria, Mallee and Wimmera, Northern Victoria, North East Victoria, East Gippsland, West and South Gippsland (see Table 1).
Q: How do I calculate the volume of rainwater needed for toilet flushing?

A: Calculating the available rainwater for toilet flushing is relatively simple once you know the average monthly figures.

In the majority of Victoria’s regions the average yearly rainfall is around 600mm or more, a 2000 litre tank size served by 50m² of roof catchment area will provide for reliable annual toilet flushing.

The regions where significantly less annual rainfall is received such as those shown in red will need to have the roof catchment area and possibly the tank size increased to provide a reliable rainwater supply for toilet flushing.

The following two examples of Dandenong and Mildura show the calculations to determine the projected monthly storage and usage patterns. Note that for the Mildura example the roof catchment area has been increased to 100m² to compensate for the much lower rainfall in that region.

**MONTHLY CATCHMENT CALCULATION**

Formula: \( \text{Run-off (litres)} = 0.85 \times \text{efficiency} \times \text{Rainfall} \times \text{Roof area} \)

\[
V_t = V_{t-1} + (\text{Run-off} - \text{Demand})
\]

\( V_t \) = theoretical volume of water left in the tank at the end of the month

\( V_{t-1} \) = volume of water left in the tank from the previous month

\( \text{Run-off} \) = as calculated above

\( \text{Demand} \) = 60 litres/day x 30 days

= 1800/month

**Notes:**

- Monthly median average rainfall is used in the formula and assumes at the start of the wetter months the tank is empty.
- The following examples shows the monthly calculations based on the above assumptions starting in August when the tank \( V_{t-1} = 0 \) is assumed to be empty.
TABLE 1 - SAMPLE MEDIAN AVERAGE RAINFALL FIGURES FOR VICTORIA

<table>
<thead>
<tr>
<th></th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Annual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brighton</td>
<td>37.5</td>
<td>38.3</td>
<td>38.8</td>
<td>56.8</td>
<td>58.5</td>
<td>58.0</td>
<td>46.8</td>
<td>53.3</td>
<td>56.5</td>
<td>55.3</td>
<td>57.2</td>
<td>54.2</td>
<td>54.0</td>
</tr>
<tr>
<td>Bundoora</td>
<td>43.8</td>
<td>28.0</td>
<td>40.8</td>
<td>52.9</td>
<td>48.6</td>
<td>50.3</td>
<td>49.3</td>
<td>58.4</td>
<td>47.6</td>
<td>58.9</td>
<td>56.1</td>
<td>50.8</td>
<td>59.6</td>
</tr>
<tr>
<td>Camperdown</td>
<td>37.6</td>
<td>37.6</td>
<td>36.6</td>
<td>56.5</td>
<td>55.1</td>
<td>53.0</td>
<td>62.8</td>
<td>69.0</td>
<td>67.8</td>
<td>64.2</td>
<td>65.6</td>
<td>58.5</td>
<td>56.0</td>
</tr>
<tr>
<td>Dandenong</td>
<td>42.6</td>
<td>32.3</td>
<td>42.5</td>
<td>60.6</td>
<td>70.6</td>
<td>62.6</td>
<td>67.5</td>
<td>75.4</td>
<td>84.2</td>
<td>62.6</td>
<td>61.4</td>
<td>54.2</td>
<td>76.5</td>
</tr>
<tr>
<td>Essendon</td>
<td>33.3</td>
<td>32.3</td>
<td>32.9</td>
<td>45.2</td>
<td>47.4</td>
<td>32.7</td>
<td>41.7</td>
<td>47.2</td>
<td>49.0</td>
<td>57.7</td>
<td>47.5</td>
<td>49.5</td>
<td>60.4</td>
</tr>
<tr>
<td>Koo Wee Rup</td>
<td>44.6</td>
<td>40.0</td>
<td>46.2</td>
<td>57.9</td>
<td>68.1</td>
<td>61.8</td>
<td>66.4</td>
<td>81.7</td>
<td>82.2</td>
<td>69.8</td>
<td>65.1</td>
<td>52.2</td>
<td>72.5</td>
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<tr>
<td>Lilydale</td>
<td>48.6</td>
<td>38.3</td>
<td>48.1</td>
<td>66.3</td>
<td>77.0</td>
<td>70.7</td>
<td>71.6</td>
<td>81.5</td>
<td>78.3</td>
<td>78.2</td>
<td>78.3</td>
<td>68.4</td>
<td>89.5</td>
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<tr>
<td>Melbourne</td>
<td>43.2</td>
<td>25.4</td>
<td>35.4</td>
<td>47.9</td>
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<td>40.8</td>
<td>50.5</td>
<td>58.5</td>
<td>52.3</td>
<td>63.4</td>
<td>52.5</td>
<td>59.3</td>
<td>67.0</td>
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<tr>
<td>Mornington</td>
<td>40.0</td>
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<td>41.6</td>
<td>54.9</td>
<td>61.4</td>
<td>64.2</td>
<td>64.9</td>
<td>73.0</td>
<td>66.8</td>
<td>61.5</td>
<td>57.6</td>
<td>47.7</td>
<td>72.7</td>
</tr>
<tr>
<td>Roselands</td>
<td>25.8</td>
<td>31.3</td>
<td>43.5</td>
<td>65.1</td>
<td>78.0</td>
<td>70.7</td>
<td>70.8</td>
<td>80.4</td>
<td>80.4</td>
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<td>49.5</td>
<td>48.3</td>
<td>59.4</td>
</tr>
<tr>
<td>Scoresby</td>
<td>50.8</td>
<td>38.3</td>
<td>46.9</td>
<td>62.6</td>
<td>83.2</td>
<td>64.2</td>
<td>71.2</td>
<td>85.2</td>
<td>80.8</td>
<td>79.9</td>
<td>73.8</td>
<td>72.9</td>
<td>65.1</td>
</tr>
<tr>
<td>Werribee</td>
<td>38.9</td>
<td>35.9</td>
<td>54</td>
<td>72.6</td>
<td>92.7</td>
<td>90.1</td>
<td>94.4</td>
<td>104.3</td>
<td>89.4</td>
<td>81.1</td>
<td>66.8</td>
<td>93.3</td>
<td>918.5</td>
</tr>
</tbody>
</table>

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**Eastern Victoria**

- **Ballarat**
  - 36.7
- **Dundee Town**
  - 35.7
- **Loddon**
  - 29
- **Geelong**
  - 20
- **Macedon**
  - 36.9
- **Melton**
  - 29
- **Quincliff**
  - 38.2
- **Warrnambool**
  - 38.4

**North West Victoria**

- **Angeles**
  - 38.2
- **Ararat**
  - 44.5
- **Bunyip**
  - 30.3
- **Colac**
  - 30.0
- **Horsham**
  - 18.9
- **Lake Boga**
  - 12.7
- **Mildura**
  - 11.4
- **Ouyen**
  - 11.9

**Southern Victoria**

- **Alexandria**
  - 35.0
- **Avoca**
  - 21.4
- **Bendigo**
  - 22.7
- **Cobram**
  - 20.2
- **Horsham**
  - 18.0
- **Kyneton**
  - 33.5
- **Lavington**
  - 27.3
- **Maryborough**
  - 32.7

**Western Victoria**

- **Bright**
  - 53.9
- **Echuca**
  - 17.9
- **Kyneton**
  - 33.5
- **Maryborough**
  - 27.3
- **Warrnambool**
  - 38.4

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**South Australia**

- **Barnard**
  - 5.1
- **Cabbage Tree Creek**
  - 57.6
- **Canina River**
  - 52.5
- **Point Hicks**
  - 47.2
- **Lake Tyers**
  - 50.4
- **New Norfolk**
  - 49.7
- **Orbost**
  - 57
- **East Sale**
  - 39
- **Echuca**
  - 66.2
- **Fish Creek**
  - 48.7
- **Leongatha**
  - 46.1
- **Moe**
  - 53.4
- **Naracoort**
  - 65.2
- **Stratford**
  - 43.6
- **Warragul**
  - 45.1
EXAMPLE 1 - DANDENONG (SOUTH EASTERN MELBOURNE REGION)

<table>
<thead>
<tr>
<th>Average daily flushing</th>
<th>60 litres (Assumes family of four, 3.8 litres from 6/3 cistern 16 flushes per day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average annual rainfall</td>
<td></td>
</tr>
<tr>
<td>Monthly average mm</td>
<td>Jan 46 Apr 60.6 Jul 67.6 Oct 62.6 Jan 31.2 May 70.6 Aug 76.2 Nov 61.4 Mar 42.5 Jun 62.6 Sep 64.4 Dec 54.2</td>
</tr>
<tr>
<td>Catchment area</td>
<td>50 m²</td>
</tr>
<tr>
<td>Catchment efficiency</td>
<td>85%</td>
</tr>
<tr>
<td>Number of downpipes</td>
<td>1 or 2</td>
</tr>
<tr>
<td>Run-off formula</td>
<td>Run off (litres) = 0.85 (efficiency) × Rainfall × Roof Area e.g. January Run off = 0.85 × 46 × 50 = 1,955</td>
</tr>
<tr>
<td>Tank size</td>
<td>2,500 litres (standard tank size)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Month</th>
<th>Calculation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aug</td>
<td>( V_t = V_{t-1} + (\text{Run-off} - \text{Demand}) )</td>
</tr>
<tr>
<td></td>
<td>( = 0 + (3,239 - 1800) )</td>
</tr>
<tr>
<td></td>
<td>= 1,439</td>
</tr>
<tr>
<td>Sep</td>
<td>( V_t = V_{t-1} + (\text{Run-off} - \text{Demand}) )</td>
</tr>
<tr>
<td></td>
<td>( = 1,439 + (2,737 - 1,800) )</td>
</tr>
<tr>
<td></td>
<td>= 2,376 (736 overflow)</td>
</tr>
<tr>
<td>Oct</td>
<td>( V_t = V_{t-1} + (\text{Run-off} - \text{Demand}) )</td>
</tr>
<tr>
<td></td>
<td>( = 2,376 + (2,661 - 1,800) )</td>
</tr>
<tr>
<td></td>
<td>= 3,236 (736 overflow)</td>
</tr>
<tr>
<td>Nov</td>
<td>( V_t = V_{t-1} + (\text{Run-off} - \text{Demand}) )</td>
</tr>
<tr>
<td></td>
<td>( = 2,500 + (2,610 - 1800) )</td>
</tr>
<tr>
<td></td>
<td>= 3,310 (810 overflow)</td>
</tr>
<tr>
<td>Dec</td>
<td>( V_t = V_{t-1} + (\text{Run-off} - \text{Demand}) )</td>
</tr>
<tr>
<td></td>
<td>( = 2,500 + (2,304 - 1800) )</td>
</tr>
<tr>
<td></td>
<td>= 3,004 (504 overflow)</td>
</tr>
<tr>
<td>Jan</td>
<td>( V_t = V_{t-1} + (\text{Run-off} - \text{Demand}) )</td>
</tr>
<tr>
<td></td>
<td>( = 2,500 + (1,955 - 1800) )</td>
</tr>
<tr>
<td></td>
<td>= 2,655 (155 overflow)</td>
</tr>
<tr>
<td>Feb</td>
<td>( V_t = V_{t-1} + (\text{Run-off} - \text{Demand}) )</td>
</tr>
<tr>
<td></td>
<td>( = 2,500 + (1,326 - 1800) )</td>
</tr>
<tr>
<td></td>
<td>= 2,026 (0 overflow)</td>
</tr>
<tr>
<td>Mar</td>
<td>( V_t = V_{t-1} + (\text{Run-off} - \text{Demand}) )</td>
</tr>
<tr>
<td></td>
<td>( = 2,026 + (1,806 - 1800) )</td>
</tr>
<tr>
<td></td>
<td>= 2,032 (0 overflow)</td>
</tr>
<tr>
<td>Apr</td>
<td>( V_t = V_{t-1} + (\text{Run-off} - \text{Demand}) )</td>
</tr>
<tr>
<td></td>
<td>( = 2,032 + (2,578 - 1800) )</td>
</tr>
<tr>
<td></td>
<td>= 2,808 (308 overflow)</td>
</tr>
<tr>
<td>May</td>
<td>( V_t = V_{t-1} + (\text{Run-off} - \text{Demand}) )</td>
</tr>
<tr>
<td></td>
<td>( = 2,500 + (3,001 - 1800) )</td>
</tr>
<tr>
<td></td>
<td>= 3,701 (1,201 overflow)</td>
</tr>
<tr>
<td>Jun</td>
<td>( V_t = V_{t-1} + (\text{Run-off} - \text{Demand}) )</td>
</tr>
<tr>
<td></td>
<td>( = 2,500 + (2,681 - 1800) )</td>
</tr>
<tr>
<td></td>
<td>= 3,361 (861 overflow)</td>
</tr>
<tr>
<td>Jul</td>
<td>( V_t = V_{t-1} + (\text{Run-off} - \text{Demand}) )</td>
</tr>
<tr>
<td></td>
<td>( = 2,500 + (2,873 - 1800) )</td>
</tr>
<tr>
<td></td>
<td>= 3,573 (1,073 overflow)</td>
</tr>
</tbody>
</table>

- This scenario caters for all toilet flushing with a total overflow of 5,646 litres.
EXAMPLE 2 - MILDURA (MALLEE AND WIMMERA REGION)

<table>
<thead>
<tr>
<th>Measure</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average daily flushing</td>
<td>60 litres (Assumes family of four, 3.8 litres from 6/3 cistern 16 flushes per day)</td>
</tr>
<tr>
<td>Average yearly flushing</td>
<td>21900 litres</td>
</tr>
<tr>
<td>Average annual rainfall</td>
<td>755mm</td>
</tr>
<tr>
<td>Monthly average mm</td>
<td>Jan 11.4 Apr 12.7 Jul 25.5 Oct 21.1 Feb 9.5 May 17.5 Aug 21.2 Nov 18.8 Mar 11.2 Jun 16.2 Sep 25.4 Dec 14.2</td>
</tr>
<tr>
<td>Catchment area</td>
<td>100 m²</td>
</tr>
<tr>
<td>Catchment efficiency</td>
<td>85%</td>
</tr>
<tr>
<td>Number of downpipes</td>
<td>3 or 4</td>
</tr>
<tr>
<td>Run-off formula</td>
<td>Run off (litres) = 0.85 (efficiency) × Rainfall × Roof Area e.g. January Run off = 0.85 × 11.4 × 50 = 969</td>
</tr>
<tr>
<td>Tank size</td>
<td>2,500 litres (standard tank size)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Month</th>
<th>Calculation</th>
<th>Month</th>
<th>Calculation</th>
</tr>
</thead>
</table>
| Jun 16.2mm | \( V_t = V_{t-1} \times (Run-off - Demand) \)  
\( = 423 \) | Dec 14.2mm | \( V_t = V_{t-1} \times (Run-off - Demand) \)  
\( = 72 \) |
| Jul 25.5mm | \( V_t = V_{t-1} \times (Run-off - Demand) \)  
\( = 368 \) | Jan 11.4mm | \( V_t = V_{t-1} \times (Run-off - Demand) \)  
\( = 831 \) |
| Aug 21.2mm | \( V_t = V_{t-1} \times (Run-off - Demand) \)  
\( = 370 \) | Feb 9.5mm  | \( V_t = V_{t-1} \times (Run-off - Demand) \)  
\( = -992 \) |
| Sep 25.4mm | \( V_t = V_{t-1} \times (Run-off - Demand) \)  
\( = 729 \) | Mar 11.2mm | \( V_t = V_{t-1} \times (Run-off - Demand) \)  
\( = -848 \) |
| Oct 21.1mm | \( V_t = V_{t-1} \times (Run-off - Demand) \)  
\( = 723 \) | Apr 12.7mm | \( V_t = V_{t-1} \times (Run-off - Demand) \)  
\( = -720 \) |
| Nov 18.8mm | \( V_t = V_{t-1} \times (Run-off - Demand) \)  
\( = 521 \) | May 17.5mm | \( V_t = V_{t-1} \times (Run-off - Demand) \)  
\( = -312 \) |

- Mains water supply supplement required: 4,198 litres
Q: What size downpipe is required to connect the roof catchment to the tank?
A: The size of the downpipe is determined as part of the normal eaves gutter and downpipe sizing process as set out in *AS/NZS 3500.1* or *SAA/SNZ HB39: Installation code for metal roofing and wall cladding*. You need to know the rainfall intensity for the locality, the total roof catchment area and the effective cross sectional area of the eaves gutter to enable the downpipe size to be determined.

Q: How do I get the rainwater from the tank to the toilet cistern?
A: The Regulations are not prescriptive on this issue. There are several methods that can be used such as:
- A pressure pump incorporating alternative drinking water connection and backflow device (see Figure 1).
- Interconnected supply at or near the cistern (see Figures 2 and 3).
- Dual supply at the cistern (see Figure 4).
Q: Is a mains water supplementary supply required?
A: Yes, to satisfy the requirements of the *Plumbing Regulations 2008*, an alternative source of supply from a normal Water Authority reticulated supply is required as a supplementary supply should the rainwater within the tank be depleted.

Q: How do I provide for the overflow from the tank?
A: The overflow must be of sufficient size to cope with the design rainfall intensity for the area it is being installed in and must be discharged to the normal stormwater network. Can rainwater be used for any other purpose than toilet flushing?

*AS/NZS 3500.1* does not specify what the rainwater can be used for. In Victoria, the Department of Health provides information on private drinking water supply including rainwater use. Refer to: [www.health.vic.gov.au/environment/water/tanks.htm](http://www.health.vic.gov.au/environment/water/tanks.htm)

Q: Are there any restrictions on the size of the tank or where it can be installed?
A: Some Local Government authorities may have restrictions on the maximum size of tank allowable and where it can be installed. For example a local council may require an above ground tank to be sited in a position that is not visible from the street and may require engineering computations for a large tank on a stand. The local council should be consulted by the property owner or plumber prior to installation.

Q: What materials are approved for a rainwater tank construction?
A: In general, the most common approved materials are polyethylene, concrete or zinc / aluminium for above ground tanks. *AS/NZS 3500.1* also specifies that tank materials in contact with rainwater and drinking water shall comply with *AS/NZS 4020: Testing of products for use in contact with drinking water*.

Q: Can rainwater tanks be installed below ground?
A: Rainwater tanks may be installed above or below ground surface. However the hazard level classification in respect to backflow prevention on the water supply for a tank below the ground would differ as would overflow provision when compared to a rainwater tank located above the ground.

Q: Do I have to install a first flush diverter on the tank?
A: No, the tank manufacturer usually supplied a screening device on the inlet to the tank. The plumbing regulations do not make it mandatory to install a first flush diverter, but in some cases where leaves and other debris are a problem it may be preferable to install one.

**REQUIREMENTS OF AS/NZS 3500.1 SECTION 14.**
Section 14 specifies the minimum requirements for the installation of the water supply system from the rainwater tank. The requirements only apply to those tanks installed where a reticulated mains water supply is also available.

Q: What are the general requirements for the installation of a rainwater system?
A: The installation and pipe material is as you would normally install a cold water service. The main difference is that the rainwater pipe must be clearly marked at intervals not exceeding 1m with the contrasting coloured wording ‘RAINWATER’ (see Figure 5). Water outlets shall be identified as ‘RAINWATER’ with a label or a rainwater tap identified by a green coloured indicator with the letters ‘RW’.
Q: Can an interconnection be made between the two water supply systems?
A: The water supply system from a rainwater tank may be interconnected with the water service from a water main supply. An appropriate backflow prevention device must be provided at the interconnection to protect the water main supply. Refer to Figures in AS/NSZ 3500.1 (a), (b) and (c). Figure (d) shows an air gap. A suitable device should also be provided on the pipeline from the rainwater tank to prevent water flowing into the rainwater tank.

Q: What hazard level / backflow prevention devices apply?
A: A rainwater tank installed above the ground, supplying flushing cisterns only or for other general use of rainwater is classified as a “low” hazard and applicable non testable backflow prevention devices in accordance with AS/NZS 3500.1 are suitable.

The hazard risk level increases where a rainwater tank is located to below the ground surface or the tank itself is used to mix chemicals / fertilizers etc. for garden irrigation. The hazard level would increase to at least a “medium” level and depending on the immediate environment could have a “high” hazard rating. For medium and high hazard ratings a testable backflow device must be provided.

Q: Is backflow prevention required at the water meter outlet?
A: The relevant Water Authority will determine the minimum “Containment Protection” that is required at the water meter outlet. A backflow prevention device may still be required at a water meter outlet regardless of whether the rainwater supply is interconnected with the water main supply.

FIGURE 5 - RAINWATER PIPE MARKING