# GREEN STAR - PUBLIC BUILDING

## POTABLE WATER CALCULATOR GUIDE

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## CHANGE LOG

| Version | Release Date | Description of Changes |
|---|---|---|
| 1.0 | October 2010 | Release |
| 1.0 | May 2011 | Re-formatted to suit Green Star® rebrand |
| 1.0 | December 2011 | Updated rainwater calculation methodology |
| 1.1 | April 2012 | Release for Green Star – Public Building v1 |

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# 1. INTRODUCTION

The Green Building Council of Australia (GBCA) has developed a Potable Water Calculator (the Calculator) used in Green Star - Public Building to estimate potable water consumption in buildings. The Calculator returns the number of points awarded for the Green Star credit Wat-1 'Potable Water'. This guide should be used in conjunction with the Potable Water Calculator in the Green Star - Public Building rating tool. The Calculator is embedded in the Green Star Rating Tool; it can be found on a tab in the spreadsheet next to the Water Category.

The Calculator determines the points awarded based on the usage of potable water in toilets, bathroom taps, kitchen taps, urinals, showers, heat rejection systems and landscape irrigation.

The water usage is calculated for each month. The total water demand from each of the water uses is added for each month and the available re-used water is subtracted for each month, to calculate a total monthly potable water demand. An annual potable water demand is calculated by adding the monthly potable water demands.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Total monthly potable water demand | = | Monthly water demand for fixtures and fittings | + | Monthly water demand for landscape irrigation | + | Monthly water demand for heat rejection | - | Monthly supply of non-potable water<br>(rainwater, greywater, blackwater, stormwater and off-site supply). |

A monthly calculation methodology is used to provide sensitivity to the seasonal variations in demand for water and in supply of water for re-use.

It should be noted that the GBCA assumes that thorough calculations and dimensioning of all components in the water recycling system have been undertaken in addition to the Green Star submission. The GBCA will not accept any responsibility for the dimensioning and functionality of the water recycling and re-use designs that are being assessed under Green Star - Public Building.

# 2. THE WATER CATEGORY

## HOW POINTS ARE AWARDED IN WAT-1 'POTABLE WATER

Points are awarded for reductions in potable water usage compared to the water usage in a building with standard practice water usage, as per the percentage improvements in Table 1. Points are awarded for best practice i.e. improvements on standard practice performance.

The standard practice benchmark represents water usage for a building designed to the level of standard practice; descriptions of how standard practice is defined are included in each section of this guide.

| Points awarded | Percentage reduction compared to standard practice benchmark |
|---|---|
| 0 | 0% |
| 1 | 5% |
| 2 | 15% |
| 3 | 25% |
| 4 | 35% |
| 5 | 45% |
| 6 | 55% |
| 7 | 65% |
| 8 | 75% |
| 9 | 85% |
| 10 | 95% |

Table 1 'Points Allocation for the Green Star credit Wat-1'

It should be noted that, as percentage reductions are rewarded with Green Star points, the absolute water consumption for the benchmark varies depending on the building's characteristics.

# 3. BUILDING INFORMATION

An estimation of how many people are occupying the building and how much time they spend in the building is done to determine how often the fixtures and fittings in the building are used, and how much greywater and blackwater is available for re-use. These parameters are estimated, based on the building's design.

## CALCULATION METHODOLOGY

To calculate the water demands from fixtures and fittings, it is necessary to estimate how many people are occupying the building, as well as how much time they spend in the building. The concept of person-hours is used in this calculation methodology. A person-hour means that one person has spent one hour in the space. The number of person-hours per month for each space is calculated as follows:

$$\text{Person hours per month} = \frac{\text{Area (m}^2\text{)}}{\text{Maximum design occupancy (m}^2\text{/person)}} \times \text{Equivalent hours at maximum occupancy in month (hours)}$$

Where:

$$\text{Equivalent hours at maximum occupancy in month (hours)} = \left(\text{Equivalent hours at maximum occupancy in a peak day (hours)} \times \text{Number of peak days per month}\right) + \left(\text{Equivalent hours at maximum occupancy in an off-peak day (hours)} \times \text{Number of off-peak days per month}\right)$$

The equivalent hours at maximum occupancy in a peak or off-peak day is calculated by summing the percentages in the relevant occupancy profile. This figure represents the equivalent number of hours that the space is occupied at maximum design occupancy. For example, the first occupancy profile shown in Table 2 (the BCA Table 2b 'peak day' profile) describes a space that is occupied from 7am until 9pm. The occupancy in this space varies from 15% at 7am, up to 100% at 9am down to 5% at 8pm. By summing the percentages we calculate that the equivalent hours at maximum occupancy is 9.5 hours on a 'peak' day for this space type.

The number of staff present on peak and off-peak day is needed to estimate the water demand from showers. The following calculation is for a peak day, the same is undertaken in the spreadsheet for off-peak days:

$$\text{Number of staff present on a peak day} = \frac{\text{Area } (m^2)}{\text{Maximum design occupancy } (m^2/\text{person})} \times \text{Maximum percentage of design occupancy present during peak day} \times \text{Percentage of occupants who are staff (that use the space as their primary place of work)}$$

## DATA ENTRY REQUIREMENT

The building should be divided into space types with different occupancy levels and patterns. For more information on how to do this, refer to Appendix A of the Green Star – Public Building Greenhouse Gas Emissions Calculator Guide. The following data must be entered for all occupied[1] space types:

1. Area, entered in $m^2$
2. Number of 'peak' days of operation per week - the number of days per typical week the space is occupied as described in the relevant 'peak' occupancy profile. The remaining days are assumed to follow the off-peak profile.
3. Occupancy profiles – the way the space is occupied must be entered by either:
    a. Selecting one of the four sets of default occupancy profiles (the default occupancy profiles are based on those included in Section J of the BCA 2010, see Table 2 'Default occupancy profiles included in the calculator'; or
    b. Entering peak and off-peak profiles into the spreadsheet manually. This options should be used where none of the existing profiles are suitable for the space type (see
    c. Figure 1 'How to enter profiles manually into the spreadsheet'),

The profiles used in this Calculator must correlate with those used in the Greenhouse Gas Emissions Calculator.

[1] Occupied spaces include all spaces in the building except for those with no or low/transient occupancy such as stairwells, corridors and storage rooms.

4. Maximum design occupancy – the maximum design occupancy must be entered by either:
    a. Selecting one of the default values as per table D1.13 of the BCA 2010; or.
    b. Entering the maximum design occupancy manually.
5. Percentage of occupants who are staff, and use the space as their primary place of work – for example, in an office, 100% of occupants can be assumed to be staff that uses the space as their primary place of work, whereas in an exhibition space, perhaps only 5% of occupants would be staff. This figure needs to be determined by the design team. It is used to estimate the number of staff in the building, a parameter required to calculate the water demand from showers (it is assumed that only staff will use the shower facilities). Only the staff that uses the space as primary places of work must be included in the percentage entered; this is so that staff are not double-counted as they move around the building.

| | BCA Table 2b (Class 5 building, Class 8 laboratory or Class 9a clinic, Day surgery or procedure unit) | | BCA Table 2c (Class 6 shop or shopping centre) | | BCA Table 2d (Class 6 restaurant or cafe) | | BCA Table 2f (Class 9b theatre or cinema) | |
|---|---|---|---|---|---|---|---|---|
| Time period | Peak | Off-peak | Peak | Off-peak | Peak | Off-peak | Peak | Off-peak |
| 12:00am to 1:00am | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| 1:00am to 2:00am | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| 2:00am to 3:00am | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| 3:00am to 4:00am | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| 4:00am to 5:00am | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| 5:00am to 6:00am | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| 6:00am to 7:00am | 0% | 0% | 0% | 0% | 5% | 0% | 0% | 0% |
| 7:00am to 8:00am | 15% | 0% | 10% | 0% | 5% | 0% | 0% | 0% |
| 8:00am to 9:00am | 60% | 0% | 20% | 0% | 5% | 0% | 20% | 0% |
| 9:00am to 10:00am | 100% | 0% | 20% | 0% | 5% | 0% | 80% | 0% |
| 10:00am to 11:00am | 100% | 0% | 15% | 0% | 20% | 0% | 80% | 0% |
| 11:00am to 12:00pm | 100% | 0% | 25% | 0% | 50% | 0% | 80% | 0% |
| 12:00pm to 1:00pm | 100% | 0% | 25% | 0% | 80% | 0% | 20% | 20% |
| 1:00pm to 2:00pm | 100% | 0% | 15% | 0% | 70% | 0% | 80% | 80% |
| 2:00pm to 3:00pm | 100% | 0% | 15% | 0% | 40% | 0% | 80% | 80% |
| 3:00pm to 4:00pm | 100% | 0% | 15% | 0% | 20% | 0% | 80% | 80% |
| 4:00pm to 5:00pm | 100% | 0% | 15% | 0% | 25% | 0% | 80% | 80% |
| 5:00pm to 6:00pm | 50% | 0% | 5% | 0% | 50% | 0% | 20% | 20% |
| 6:00pm to 7:00pm | 15% | 0% | 5% | 0% | 80% | 0% | 20% | 20% |
| 7:00pm to 8:00pm | 5% | 0% | 0% | 0% | 80% | 0% | 80% | 80% |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 8:00pm to 9:00pm | 5% | 0% | 0% | 0% | 80% | 0% | 80% | 80% |
| 9:00pm to 10:00pm | 0% | 0% | 0% | 0% | 50% | 0% | 80% | 80% |
| 10:00pm to 11:00pm | 0% | 0% | 0% | 0% | 35% | 0% | 80% | 80% |
| 11:00pm to 12:00am | 0% | 0% | 0% | 0% | 20% | 0% | 10% | 10% |
| Equivalent hours at maximum occupancy | 9.5 | 0 | 1.85 | 0 | 7.2 | 0 | 9.7 | 7.1 |

Table 2 'Default occupancy profiles included in the calculator'

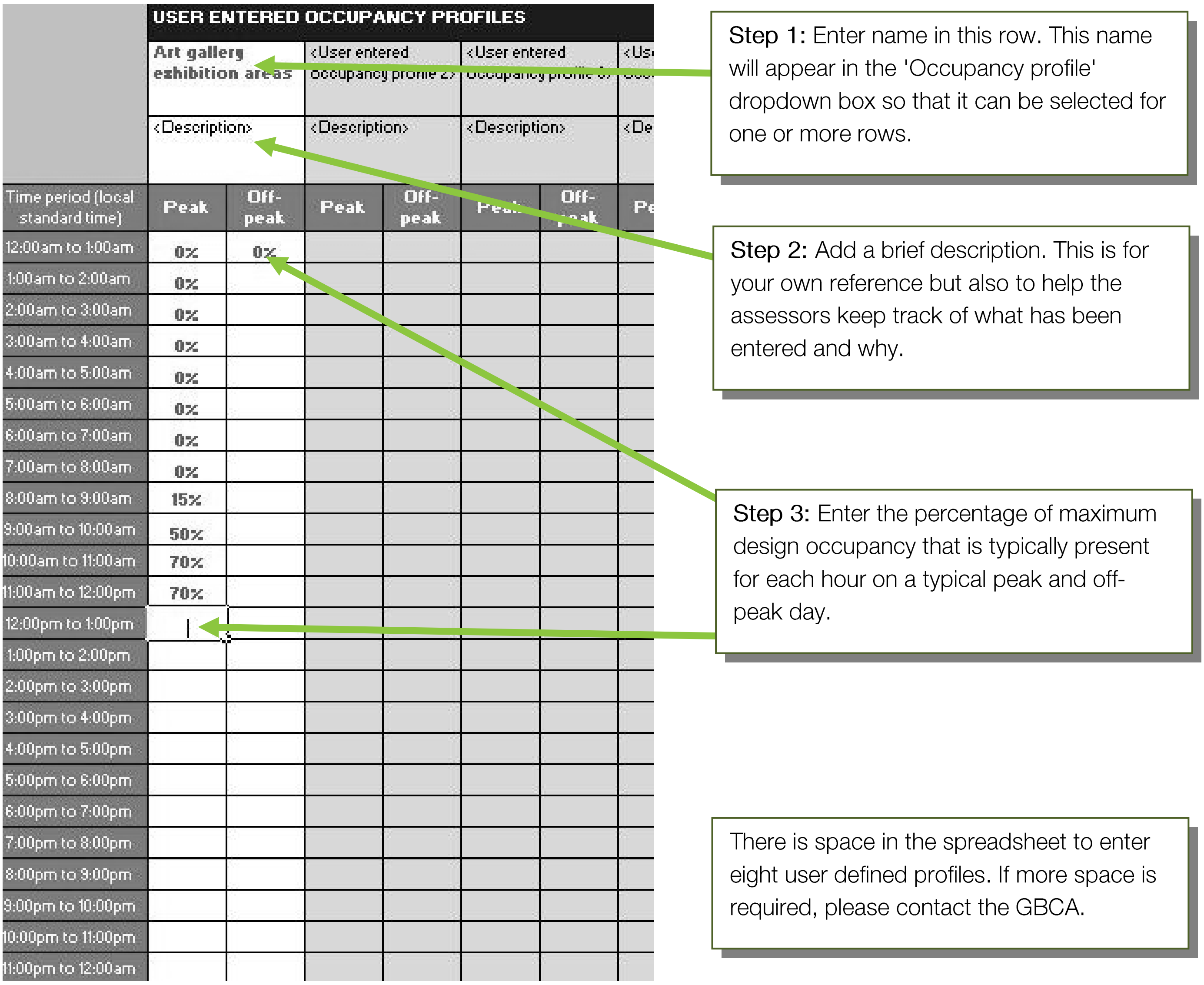


Figure 1 'How to enter profiles manually into the spreadsheet'

# 4. FIXTURES AND FITTINGS

## CALCULATION METHODOLOGY

The total water demand from fixtures and fittings is calculated as follows:

Monthly water demand from toilets, urinals and taps:

The following calculations are for toilets, the same calculations are done for urinals and taps.

Monthly water demand from toilets (l/month) = Number of toilet uses per month x Average water efficiency of toilets (L/use)

*Where:*

Number of toilet uses per month = Number of person hours per month x Usage rate (as per Table 3 'Assumed usage rates of toilets, urinals and taps')

*and*

Average toilet water efficiency of toilets (all toilets in the building (A, B, C etc) = ( Percentage (Toilet A) x Water consumption (Toilet A) ) + ( Percentage (Toilet B) x Water consumption (Toilet B) ) *and so on*

Monthly water demand from showers:

Monthly water demand from showers (l/month) = Number of shower uses per month x Average shower water efficiency (L/minute) x Average length of shower (minutes)

Where:

Number of uses on peak days per month = Number of staff in building on a peak day x Percentage of staff who shower (as per Table 4) x Number of peak days per month

This calculation is also done for off-peak days.

The number of shower uses per month is calculated by adding these two figures together.

Average shower water efficiency (all showers in the building) = ( Percentage (shower A) x Water consumption (shower A) ) + ( Percentage (shower B) x Water consumption (shower B) ) Etc... for all showers in the building

*and*

Average length of shower = 5 minutes

| Fixture/Fitting | Number of uses per person per day (based on data for 9.5[2] hour work day) | Uses per person-hour |
|---|---|---|
| Toilet - no urinals | 2.3 | 0.24 |
| Toilet with urinals | 1.3 | 0.14 |
| Urinal | 2 | 0.21 |
| Taps | 2.5 | 0.26 |

Table 3 'Assumed usage rates of toilets, urinals and taps'

| Description | Percentage of staff that use showers |
|---|---|
| No showers installed | 0% |
| No significant gym or cyclist facilities | 5% |
| 1 point achieved in Tra-3 'Cyclist Facilities' (or gym provided) | 10% |
| 2 points achieved in Tra-3 'Cyclist Facilities' | 15% |

Table 4 'Assumed percentage of staff that use showers'

Total monthly water consumption

Total monthly water consumption = Monthly water consumption (Toilets) + Monthly water consumption (Urinals) + Monthly water consumption (Taps) + Monthly water consumption (Showers).

## DATA ENTRY REQUIREMENT

Data about the fixtures and fittings included in the building design should be entered into the 'Water demand from fixtures and fittings' section.

The following information is required for each type of toilet, urinal, tap and shower being installed in the building:

1. The water efficiency of the fitting – this can be entered by either:

[2] This is the equivalent hours at maximum occupancy in for an office space as defined in BCA Table 2b Occupancy and operational profiles of a Class 5 building, Class 8 laboratory or Class 9a clinic, Day surgery or procedure unit.

a. Selecting the WELS Star Rating from the drop down menu. In this case, the corresponding water efficiency is automatically generated in the adjacent grey cell. A WELS star rating is awarded when the efficiency of a fixture is between a defined maximum and minimum water efficiency for that star rating; the efficiency with the highest water usage allowed for that particular WELS star rating is generated by the Calculator.

Or

b. Manually entering the actual water efficiency, if known.

2. The percentage of fittings of this type that are to be installed with this water efficiency.

Additional information required for urinals

3. Are urinals to be installed? – Select yes or no from the drop down menu.

For urinals on autotimer, the following information is required (if not urinals on autotimer are being installed, leave these sections blank).

4. Average water efficiency (L/flush).
5. Number of urinals on autotimer being installed.
6. Percentage of all urinals in the building that are on autotimer.

Additional information required for showers:

7. Level of shower demand – Select from the drop down menu: No showers installed; no significant gym or cycling facilities, one credit achieved in Tra-3 or gym facilities provided; or two credits achieved in Tra-3.

## STANDARD PRACTICE BENCHMARK WATER EFFICIENCY

The water efficiency of fixtures and fittings used to determine the total benchmark water consumption is presented in Table 5.

| Fixture/fitting | Water efficiency<br>WELS rating and water consumption |
|---|---|
| Toilet | 3 Star (4L/flush) |
| Urinals | 3 Star (2L/flush) |
| Taps | 4 Star (7.5L/min) |
| Showers | 3 Star (9L/min) |

Table 5 'Standard Practice Benchmark water efficiency'

## ADDITIONAL GUIDANCE

The water efficiency of all fixtures and fittings sold in Australia is registered in the Water Efficiency Labelling and Standards (WELS) scheme. The WELS scheme awards each fixture or fitting with a star rating from one to six stars (with six representing the most efficient). The WELS ratings of all fittings and fixtures sold in Australia are publicly available from a database administrated by the federal government. The water consumption is displayed on the WELS label on the registered products.

For further information about the WELS rating scheme and the water efficiency thresholds for each star band, please refer to AS/NZS 6400:2005 Water Efficient Products – Rating and Labelling and www.waterrating.gov.au.

It should be noted that the maximum WELS rating for showerheads is 3 Stars. A showerhead is registered under a 3 star rating if the performance is between 9L/min and 7.5L/min.

# 5. HEAT REJECTION WATER

This section of the Calculator quantifies the water demand in cooling towers. The calculation methodology used is based on chapter 3.6 in AIRAH's DA17 Cooling Towers.

## CALCULATION METHODOLOGY

The annual water demand is calculated by summing the water demand for heat rejection for each month during a year. Monthly water demand for heat rejection is calculated as follows:

$$\text{Make up water (L)} = \text{Evaporation (L)} + \text{Drift (L)} + \text{Bleed (L)}$$

Evaporation is calculated as follows:

$$\text{Evaporation (L)} = \frac{\text{Total cooling load (kWh)} \times 3600\ \text{(s/hour)}}{\text{Latent Heat of Vaporisation (2256kJ/kg)} \times \text{Density of Water (1kg/L)}}$$

Drift is calculated as follows

$$\text{Drift (L)} = \text{Drift Coefficient} \times \text{Total Condenser Water Flow for month (L)}$$

**Where:**

$$\text{Total Condenser Water Flow for month (L)} = \frac{\text{Total cooling load (kWh)} \times 3600\ \text{(s/hour)}}{\text{Specific Heat of Water (4.18 kJ/(L.°C))} \times \text{Condenser Water } \Delta T}$$

Bleed is calculated as follows:

$$\text{Bleed (L)} = \frac{\text{Evaporation} \times \text{TDS in make-up water}}{\text{TDS in system} - \text{TDS in make-up water}}$$

The following constants are used:

| Constants | |
|---|---|
| Specific Heat of Water (kJ/(L.°C)) | 4.18 |
| Latent Heat of Vaporisation (kJ/kg) | 2256 |
| Density of water (kg/l) | 1 |

Table 6 'Heat Rejection Water Constants'

## DATA ENTRY REQUIREMENTS

The following data must be entered to complete the Heat Rejection Water section of the calculator:

1. Monthly Cooling Load (kWh/month)
   The Cooling Load for each month in the Proposed Building and the Standard Practice Benchmark Building should be entered. The Cooling Load for each month must be determined by the modelling required as part of the Greenhouse Gas Emissions calculator for Green Star – Public Building.

2. Condenser Water ($\Delta T$ in °C)
   A predicted average monthly Condenser Water Temperature Difference $\Delta T$ should be entered in °C.

3. Drift coefficient (%)
   The predicted drift coefficient should be entered in %. A default value of 0.002% is given. This is based on the requirement in section 4.4 of AS/NZS3666.1 *Air-handling and water systems of buildings—Microbial control*. If a value different from the default value is to be used; the drift coefficient must be determined as per AS 4180.1 *Drift loss from cooling towers - Laboratory measurement*

4. Water Quality
   The values for make-up water Total Dissolved Solids (TDS) in parts per million (ppm), mains TDS in ppm and TDS set point for cooling system in ppm should be entered.

5. Total Dissolved Solids (TDS)

   TDS values should be obtained from the local water authority, data about TDS concentration in mains water is generally available in annual reports from the local water authority. Where water treatment is used, mains water quality should be entered as well as make-up water quality, as the mains water quality is used in the standard practice benchmark building. The quality of the treated make-up water is used in the proposed building calculations.

Where more than one heat rejection system is used to meet the cooling demand; the cooling load as calculated in the Greenhouse Gas Emissions calculator for Green Star – Public Building should be apportioned to each of the systems. The method for apportioning could be based the capacity of the system or the cooling demand of the spaces which the different systems are serving. The cooling demand in the Standard Practice Benchmark building is always assumed to be met by a heat rejection system with the characteristics described below.

## BENCHMARK WATER EFFICIENCY

The Standard Practice Benchmark is based on the following:

| Monthly cooling load | As per Standard Practice Benchmark building in Greenhouse Gas Calculator |
|---|---|
| Condenser Water ΔT | 5.5°C (as per the requirements in the GHG guide) |
| Drift coefficient (%) | 0.002% as required in AS3666.1 clause 4.4 |
| TDS in make-up water | Mains water is used as make-up water; TDS ppm same as entered for location |
| TDS set point in system | 500ppm (based on standard practice) |

Table 7 'Standard Practice Benchmarks'

# 6. LANDSCAPE IRRIGATION

This methodology uses site specific input parameters to determine the monthly and annual volume of water demand from irrigation. It simultaneously determines the performance of a standard practice benchmark building in the same location.

## CALCULATION METHODOLOGY

The irrigation requirement for the site is calculated for each month of the year, for each landscaped 'zone' in the site (a zone being a landscaped area that has the same soil type, irrigation system, microclimate, plant density and, as far as possible, types of plants). The irrigation requirement for each zone is calculated in three steps as described below:

Step 1: The irrigation requirement for each zone is calculated for each month of the year as follows:

$$\text{Irrigation requirement (mm)} = \frac{\text{Plant water demand (mm)} - \text{Rainfall available for plants (mm)}}{\text{Application efficiency of the irrigation system (\%)}}$$

Where:

$$\text{Plant water demand (mm)} = \text{Monthly point potential Evapotranspiration (mm)} \times \text{Highest Crop Coefficient} \times \text{Density factor} \times \text{Microclimate Factor}$$

And

$$\text{Rainfall available for plants (mm)} = \text{Monthly rainfall (mm)} \times \text{Application efficiency of rainfall (\%)} \times \text{(100\% - Percentage of zone undercover (\%))}$$

I.e. a zone's monthly irrigation requirement is calculated by determining how much water the plants in the zone require, how much water will be provided naturally by rainfall and therefore how much water must be provided from an irrigation system, taking into account how efficient the particular irrigation system is at delivering water to the plants.

**Step 2:** The irrigation requirements for each month are then added together to calculate the total annual irrigation requirement (mm).

**Step 3:** The annual irrigation requirement, in mm, is then multiplied by the area of the zone, in $m^2$, to calculate the zone's annual irrigation requirement in litres.

| Parameter | Description | Further information |
|---|---|---|
| Application efficiency of irrigation system (%) | The percentage of water applied via an irrigation system which is taken up by the plants. | Page 18 |
| Application efficiency of rainfall (%) | The percentage of rainfall that is assumed to be taken up by the plants. | Page 18 |
| Crop Coefficient | The crop coefficient is an agronomic multiplier used to determine the water usage requirement for a particular plant type. | Page 17 |
| Density factor | The density factor is applied to the Crop Coefficient and takes into account the density of planting in the zone. | Page 17 |
| Microclimate Factor | The microclimate factor is applied to the Crop Coefficient and takes into account the area's exposure to or protection from the elements. | Page 17 |
| Monthly point potential Evapotranspiration (mm) | Point potential evapotranspiration data from the Bureau of Meteorology. | Page 16 |
| Monthly rainfall (mm) | Rainfall data from the Bureau of Meteorology. | Page 16 |
| Percentage of zone undercover (%) | This refers to the total percentage of the zone that will receive very little or no rainfall, as a result of being undercover. | Page 17 |

Table 8 'Landscape Irrigation Definitions and Further Information'

## DATA ENTRY REQUIREMENTS

All landscaped areas in the project that are to receive water via irrigation should be divided into zones; each zone should have the same soil type, irrigation system, microclimate, plant density and as far as possible, types of plants.

The following data is required to be entered for each zone:

1. Climate data;
2. Zone name and description;
3. Microclimate water usage factor;
4. Percentage of zone undercover;
5. Highest Crop Coefficient in the zone. This reflects the water usage of the plant types in the zone. Crop Coefficients for various plant types are available in APPENDIX A. ;
6. Density of vegetation in the zone; and
7. Application Efficiency of irrigation system.

## Climate data

The monthly average rainfall and point potential evapotranspiration data must be obtained from the Australian Bureau of Meteorology (BoM). It should be noted that 'evapotranspiration' and 'evaporation' are not the same. 'Point potential' evapotranspiration data should be used. The highest resolution grid point extractions from base climatological data sets are required. For rainfall, the highest resolution currently available is based on a 2.5km grid. For point potential evapotranspiration, the highest resolution currently available is based on a 10km grid. The following data should be entered to the calculator:

1. Monthly 'point potential' evapotranspiration. This data is available from the BoM, and should be entered for each month for the specific location of the project;
2. Monthly Rainfall. This data is available from the BoM, and should be entered for each month for the specific location of the project.

Note that for the purposes of Green Star it is necessary to obtain data specific to the project site using the methodology outlined above. It is not acceptable to rely on the publically available data on the BoM web site, as this is not verifiable data, and does not have the resolution necessary to obtain accurate results from the calculator. The data sets purchased from the BoM must form part of the projects Green Star submission documentation.

An example of monthly rainfall and point potential evapotranspiration are given below. This data is for the grid coordinates -37.87 (Latitude) and 145.26 (Longitude).

| Month | Grid-point average data for rainfall (mm) | Grid-point average data for point potential evapotranspiration (mm) |
|---|---|---|
| January | 54 | 190 |
| February | 48 | 160 |
| March | 61 | 135 |
| April | 73 | 88 |
| May | 91 | 47 |
| June | 67 | 33 |
| July | 75 | 38 |
| August | 86 | 56 |
| September | 77 | 82 |
| October | 83 | 124 |
| November | 71 | 147 |
| December | 72 | 164 |
| Annual | 873 | 1264 |

Table 9 'Sample rainfall and point potential evapotranspiration data from the BoM for grid coordinates -37.87 (Latitude), 145.26 (Longitude)'

The climate data can be obtained from the BoM for a nominal fee. More information about this data can be obtained from the Climate Maps section of the BoM website. To purchase this data, please contact the BoM, National Climate Centre. Email: webclim@bom.gov.au Phone: (03) 9669 4082, FAX: (03) 9669 4515. To obtain the necessary data, the BoM will require the following:

- Latitude and longitude grid points (coordinates) of the project in decimal degrees. These coordinates can be obtained from good quality maps, or from web based maps/images including Google Earth;
- The type of grid (meteorological element) you require - rainfall and evapotranspiration (point potential);
- The period – average monthly data;
- The output format that you require – Excel.

## Zone name and Description

Each zone should be named and described in enough detail for Green Star Certified Assessors to locate it on drawings. The area of each zone should also be entered in $m^2$.

## Microclimate

The microclimate parameter allows adjustments to account for zones which are subjected to particularly harsh weather conditions, or which conversely, are highly protected from the elements. Microclimate water usage factors should only be changed in extreme situations. E.g. Dry areas with high temperatures, areas highly exposed to winds, small courtyards, atria etc. Where a microclimate water usage factor is changed from "normal' to 'protected', additional compliance documentation is required to justify that change.

| Microclimate | Water usage factor | Description |
|---|---|---|
| Exposed | 1.3 | Full sun – no shade during the day and high temperatures.<br>Fully exposed to the wind on all sides. |
| Normal | 1.0 | |
| Protected | 0.7 | Full shade – no direct sun during the day.<br>Highly protected – shelter on 3 or 4 sides. |

Table 10 'Microclimate factors'

## Percentage of zone undercover.

This refers to the total percentage of each zone that will receive very little or no rainfall, as a result of being undercover. This applies to areas which are completely covered e.g. by roofs, significantly covered e.g. under awnings, or under dense vegetation such as trees with thick foliage.

## Crop coefficient (Kc)

The crop coefficient is an agronomic multiplier used to determine the water usage requirement for a particular plant type. The **highest** crop coefficient for the zone should be entered into the calculator. See Crop coefficient (Kc) for the crop coefficients for common plant types. Crop Coefficients for various plant types are available in APPENDIX A.

## Planting density factor

The density of the planting in the zone should be selected from the drop down menu in the calculator. A planting density factor will be applied to the crop coefficients as follows:

| Planting density | Planting density factor |
|---|---|
| Dense, multi layered planting | 1.2 |
| Normal | 1.0 |
| Sparse, less than 40% coverage | 0.8 |

Table 11 'Planting density factors'

Zones with dense/multilayered planting are for example, zones that contain both shrubs and ground covers. Sparsely planted areas are areas where less than 40% of the zone contains plants.

## Application Efficiency

Many factors impact the application efficiency of an irrigation method including uniformity, runoff, wind drift, and evapotranspiration. For example, sprays have fixed application of water and generally cover short distances, sprinklers have rotating streams and cover larger distances, and underground drip systems are less affected by wind than above ground systems. The average values in Table 12 'Application efficiencies of common irrigation systems' reflect the differences between various irrigation system types. The system used in each zone should be selected from a drop-down menu in the calculator.

| IrrigationMethod | Average Application Efficiency |
|---|---|
| Sprinklers – Day | 65% |
| Sprinklers – Night | 75% |
| Sprays – Day | 65% |
| Sprays – Night | 70% |
| Microsprays – Day | 60% |
| Microsprays - Night | 65% |
| Drip – Bare soil | 80% |
| Drip – Under mulch | 85% |
| Subsurface drip (SDI) | 90% |
| Hand watering | 50% |

Table 12 'Application efficiencies of common irrigation systems'

Where the irrigation efficiency is different from any of the standard values, the available irrigation efficiency can be entered manually. Where a user determined application efficiency figure is used, additional compliance documentation is required to prove that such efficiency can be achieved. The application efficiency of rainfall is assumed to be 60%.

## STANDARD PRACTICE BENCHMARK WATER EFFICIENCY

The Standard Practice Benchmark is based on the following:

| Monthly 'point potential' evapotranspiration | As Proposed Building |
|---|---|
| Monthly Rainfall | As Proposed Building |
| Total landscaped area of the zone | As Proposed Building |
| Percentage of zone undercover | As Proposed Building |
| Highest Crop Coefficient in the zone | 0.6 |
| Microclimate water usage factor | Normal |
| Density of vegetation | Normal |
| Application Efficiency of irrigation system | 75% (night time sprinklers) |

Table 13 'Water Efficiency Benchmarks'

# 7. RECLAIMED WATER USE

Reclaimed water use refers to the use of on-site rainwater, greywater, blackwater and stormwater and the use of reclaimed water supplied from off-site.

The first step in determining how much reclaimed water is used on site is to establish the water demand that can be met with reclaimed water. The methodology used to establish the demands is given in 'Demand for reclaimed water'.

The second step is to calculate how much reclaimed water is available – this is described in 'Calculation methodology' and 'Data entry requirements'. If there is not enough reclaimed water to meet the demand, it is assumed that mains water will be used instead.

## DEMAND FOR RECLAIMED WATER

The demand for reclaimed water sets the **upper limit** to the reclaimed water use; it is the maximum potential demand. The demand for 'mains water only' is also calculated. This defines the minimum quantity of mains water used (i.e. regardless of how much reclaimed water is available, if the water uses are not connected to the reclaimed water system; reclaimed water will not be used).

The reclaimed water demand from water uses rewarded in other credits is also calculated in this section. The water demands from these 'Non-Wat-1' uses are met before the 'Wat-1' water uses.

The demands are established separately for each of the following water sources:

1. Rainwater systems;
2. Greywater and blackwater systems; and
3. Stormwater and off-site reclaimed water systems; and
4. Mains water only.

The demand for rainwater is calculated separately as the monthly demand is used in the Rainwater Calculator as described in Green Star Rainwater Calculator Calculation Methodology'. The demand for greywater and blackwater is calculated separately as this is used to determine the reduction in discharge to sewer in the Sewerage Calculator (the calculator used to establish the number of points achieved in Emi-6: Discharge to Sewer). The demand for stormwater and off-site reclaimed water is then calculated separately as the remaining reclaimed water sources.

Where water uses are supplied with water from more than one source, it is assumed that they are first supplied with water from any greywater and blackwater systems, followed by rainwater, stormwater and off-site reclaimed water systems. The order in these calculations are done has no effect on the score for Wat-1, but does affect the score in Emi-6. The calculations are done in this way to recognise and reward the maximum potential reduction of discharge to sewer from installing greywater and blackwater systems.

## Calculation methodology

The maximum potential demand for reclaimed water from a particular source (be it rainwater; greywater and blackwater; or stormwater and off-site reclaimed water systems) is calculated on a monthly basis using the total monthly water demands from each fitting/system, and the percentages of the fittings/systems connected to each type of reclaimed water system.

For example, the demand for rainwater, from Wat-1 water uses, is calculated for the month of January as follows:

$$\text{Maximum potential demand for rainwater in January} = \left(\text{Percentage of toilets connected to rainwater system} \times \text{Water demand from toilets in January}\right) + \left(\text{Percentage of urinals connected to rainwater system} \times \text{Water demand from urinals in January}\right)$$

And so on for all Wat-1 water uses:

- taps;
- showers;
- landscape irrigation;
and - heat rejection.

*(The water demands from toilets, urinals, taps etc.. in the formula above are determined in the Water Demand section of The Calculator (see Sections 3: Building Information through to 5: Heat Rejection Water* for more information)).

This calculation is undertaken for each month of the year and for rainwater systems; greywater and blackwater systems; stormwater and off-site reclaimed water systems; and the mains system separately.

The monthly demand for reclaimed water from Non-Wat-1 uses (such as water demands from fire systems and swimming pools) is calculated in the same way as for Wat-1 uses. The total monthly water demands are however entered directly into the calculator rather than being determined in the Water Demand section of The Calculator.

**Note:** Following this methodology, where the demand from a particular water use can be met by water supplied from more than one source, the total reclaimed water demands can add up to more than 100% of the actual demand. This is not an error as the 'mains water only' demand is also calculated, which limits the reduction in potable water demand from reclaimed systems I.e. regardless of how much reclaimed water is available, if the water uses are not connected to the reclaimed water system, the reclaimed water will not be used.

## Data entry requirements

To establish the Wat-1 reclaimed water demand:

1. Percentage of each Wat-1 water use connected to an on-site rainwater systems;
2. Percentage of each Wat-1 water use connected to an on-site greywater and/or blackwater system;

3. Percentage of each Wat-1 water use connected to an on-site stormwater system and/or off-site reclaimed water system; and
4. Percentage of each Wat-1 water use connected to mains water only.

To establish the Non-Wat-1 reclaimed water demand:

1. Monthly water demand (kL/month) from each Non-Wat-1 water use (fire system, swimming pool, other);
2. Percentage of each Non-Wat-1 water use connected to an on-site rainwater systems;
3. Percentage of each Non-Wat-1 water use connected to an on-site greywater and/or blackwater system;
4. Percentage of each Non-Wat-1 water use connected to an on-site stormwater system and/or off-site reclaimed water system; and
5. Percentage of each Non-Wat-1 water use connected to mains water only.

### Standard Practice Benchmark demand for reclaimed water

The standard practice benchmark building does not include any water re-use systems therefore there is no demand for reclaimed water.

## RAINWATER

The quantity of rainwater collected and used on site can either be established by:

- The Green Star Rainwater Calculator, within the Potable Water Calculator (see 'Summary of the calculation methodology'' and 'The calculation methodology in detai'l), or
- A methodology selected by the design team. The results of which are entered directly into the calculator (see 'User determined rainwater calculation methodology' and 'Data entry requirement for user determined rainwater calculation methodologies').

### Green Star Rainwater Calculator Calculation Methodology

The quantity of rainwater collected and used on site depends on the quantity of rainwater available for collection, the size of the rainwater tank and the demand for the rainwater. The calculations are done on a monthly basis to take into account the rainfall pattern over the year, the variation in demand for rainwater (e.g. when rainwater is used for cooling systems) as well as the ability of the rainwater tank to store water where supply exceeds demand from one month to the next.

### Summary of the calculation methodology:

The methodology has five steps:

Step 1 – Establish rainwater available for use in a given month one (month i);

Step 2 – Establish rainwater demand in month i from Wat-1 and Non-Wat-1 water uses;

Step 3 – Establish if there is an excess supply of rainwater in month i;

Step 4 – Establish how full the tank is at the end of month i (this volume of water is then available for use in the following month (month ii));

These calculation steps are undertaken each month, for 24 months, to establish how full the tank is at the beginning of January of the third year. The calculations are then repeated each month for one further year with one extra step:

Step 5 – Establish how much rainwater is used each month for Wat-1 water uses.

## The calculation methodology in detail:

### Step 1 - Establish rainwater available for use in month (i):

The quantity of rainwater available for use depends on the amount of rainwater that is already in the tank left over from previous months, the rain that can be collected in the month in question minus a certain volume of rainwater that must be diverted from the tank at each rain event to prevent contaminants polluting the tank (referred to as a 'first flush'). The amount of rain that can be collected depends on the monthly rainfall and the size, pitch and absorbency of the collection area. The first flush is always assumed to be 0.5L/m$^2$; a standard practice 'first flush' volume for rainwater collection systems in clean environments.

The larger the rainwater tank, the greater (to a limit) its ability to provide water during periods without rain. The potable water calculator assumes that a tank should be sized to meet 20 continuous days of rain water demand. If tanks are smaller than this, then the rainwater yield is multiplied by the capacity factor to account for dry days.

This means that if the tank is smaller than the ideal size, of 20 times the daily rainwater demand, then a capacity factor is applied.

$$\text{Rainwater available for use in month (i) (L)} = \text{Capacity factor} \times \left( \text{Rainwater already in tank from previous month's rainfall (L)} + \text{Rainfall on collection area in month (i) (L)} - \text{Rainwater diverted as first flush) (L)} \right)$$

Where

$$\text{Capacity factor} = \text{Minimum of} \left[ 1 \text{ and } \left( \text{Rainwater storage tank size} \div \text{Daily rainwater demand} \times 20 \right) \right]$$

Rainwater already in tank from previous month's rainfall (L) =
- 0 (for month (i))
- The result from Step 4 from the previous month (for months (ii) onwards)

$$\text{Rainfall on collection area in month (L)} = \text{Average monthly rainfall (mm)} \times \text{Collection area (m}^2\text{)} \times \text{Run-off coefficient (see table 14)}$$

1000

| | | | | | | |
|---|---|---|---|---|---|---|
| Rainwater diverted as first flush) (L) | = | Average number of rain events per month | X | 0.5L/m$^2$ | X | Collection area (m$^2$) |

*'Rainwater diverted as first flush' is the first water in a rainfall event. This water is diverted from the rainwater collection tank as it is of poor quality, as the first water washes the roof.*

The average number of rain events per month is calculated by averaging the number of yearly rain events over the year.

| Run-off coefficient for different roofs types: | |
|---|---|
| Steel roof >30° Pitch | 0.9 |
| Non-absorbent roof > 30° Pitch | 0.9 |
| Flat non-absorbent roof < 30° Pitch | 0.8 |
| Flat gravel or turf roof < 30° Pitch | 0.65 |

Table 14 'Run-off coefficients'

Step 2 – Establish rainwater demand from Wat-1 and Non-Wat-1 water uses in month (i)

As described 'Demand for reclaimed water'.

Step 3 – Establish if there is an excess supply of rainwater in month (i)

Excess supply of rainwater in month (i) (L) = Maximum of [ 0 and ( Rainwater available for use in month (i) (L) (result of Step 1) - Rainwater demand in month (i) (L) (result of Step 2) ) ]

This means that if the result of 'rainwater available for use in month minus the demand for rainwater is negative, there is no excess supply of rainwater, there is not enough supply to meet the demand. In this case the excess supply is zero.

Step 4 – Establish how full the tank is at the end of the month (this volume of water is then available for use in the following month, month (ii))

Tank volume at end of month (i) = Minimum of [ Tank storage capacity (L) and Excess supply of rainwater in month (i) (L) (result of Step 3) ]

This means that whatever is greater out of the capacity of the tank and the excess supply of rainwater.

Steps 1-4 are undertaken each month, for 24 months, to establish how full the tank is at the beginning of January of the third year.

The calculations are then repeated each month for one further year with one extra step:

Step 5 – Establish how much rainwater is used each month for Wat-1 water uses.

$$\text{Rainwater used for Wat-1 uses in month (i) (L)} = \text{Minimum of} \left[ \text{Rainwater demand from Wat-1 water uses in month (i) (L)} \quad \text{and} \quad \left( \begin{array}{c}\text{Rainwater available for use in month (i) (L)} \\ \text{(result of Step 1)}\end{array} - \text{Rainwater demand from Non-Wat-1 water uses in month (i) (L)} \right) \right]$$

I.e. whatever is less out of the demand for rainwater from Wat-1 uses and the rainwater available for use by Wat-1 water uses (‘rainwater available for use in month minus the demand for rainwater from Non-Wat-1 uses).

## Green Star Rainwater Calculator Data entry requirement

1. Collection area
   The area where rainwater is collected should be entered in $m^2$.
2. Run-off coefficient
   The type of roof should be selected and the associated run-off coefficient (see Table 14) will be displayed.
3. Storage Capacity
   The size of the total storage capacity for rainwater should be entered in kL.
4. Yearly Raindays > 15mm
   This data is available from the Bureau of Meterology.
5. Rainfall
   Monthly rainfall data for the location of the building should be used. Rainfall data for is accessible from the Bureau of Meteorology.

## User determined rainwater calculation methodology

A Credit Interpretation Request (CIR) should be submitted to the GBCA to demonstrate that the proposed methodology is at least of equivalent accuracy as the Green Star methodology for quantifying rainwater collection described above.

## Data entry requirement for user determined rainwater calculation methodologies

The user should enter a percentage of the demand for rainwater that is met, for each month of the year. The demand is calculated in the ‘Reclaimed water use’ section of The Calculator and presented in the ‘Rainwater Collection’ Section.

## Standard Practice Benchmark

The standard practice benchmark building does not include any water re-use.

# GREYWATER AND BLACKWATER

## Calculation Methodology

The quantity of greywater and blackwater collected, treated and used on site is established by the Greywater and Blackwater Calculator. The calculations are done on a monthly basis taking into account the varying supply and demand for this water throughout the year.

The methodology has three steps:

Step 1 – Establish how much greywater and blackwater is collected each in month (i)

The monthly quantity of greywater and blackwater collected from toilets, urinals, taps, showers and heat rejection bleed is established as follows:

| | | | | |
|---|---|---|---|---|
| Grey/blackwater collected from fitting/system (L) | = | Monthly water demand from fitting/system (L)<br>(as calculated in the 'Water Demand' section of the calculator) | X | Percentage of discharge collected from fitting/system (%)<br>(as entered by the user) |

The monthly quantity of greywater and blackwater collected from other onsite sources (such as dishwashers, washing machines, chiller condensate, fire test water, swimming pool water, cooling tower washdown or sewer mining) is entered directly into the calculator by the user.

The total greywater and blackwater collected on site is established by adding together the water collected from all the above sources.

Step 2 – Establish demand for greywater and blackwater in month (i) from Wat-1 and Non-Wat-1 water uses

The demand for greywater and blakwater is established in the 'Reclaimed water use' section of the calculator, as described 'Demand for reclaimed water'.

Step 3 – Establish how much greywater and blackwater is used each month for Wat-1 water uses.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Greywater/ blackwater used for Wat-1 water uses in month (i) (L) | = | Minimum of | \| | Greywater/ blackwater demand from<br>Wat-1 water uses in month (i) (L) | and | ( | Greywater/ blackwater available for use in month (i) (L)<br>(result of Step 1) | - | Greywater/ blackwater demand from<br>Non-Wat-1 water uses in month (i) (L) ) ] |

This means that whatever is less, the demand for greywater/blackwater from Wat-1 uses, or the greywater/blackwater available for use by Wat-1 water uses ('Greywater/ blackwater available for use in month minus the demand for Greywater/ blackwater from Non-Wat-1 uses).

## Data entry requirement

1. The percentage of discharge from toilets, urinals, taps, showers and heat rejection bleed that is collected and treated for reuse on site.
2. The monthly collection of greywater and/or blackwater from other sources such as dishwashers, washing machines, chiller condensate, fire test water, swimming pool water, cooling tower washdown or sewer mining etc...

## Standard Practice Benchmark

The standard practice benchmark building does not include any water re-use.

## STORMWATER

### Calculation Methodology

Calculations and documentation must be done according to the requirements of the Emi-5 'Stormwater' credit.

### Data entry requirement

Monthly supply of stormwater available for re-use in the building should be entered in kL for each month.

### Standard Practice Benchmark

The standard practice benchmark building does not include any water re-use.

## OFF-SITE SUPPLY OF RECLAIMED WATER

### Calculation Methodology

Using off-site reclaimed water is an acceptable way to achieve reductions in potable water consumption in Green Star provided that it can be demonstrated that the relevant local authority has given approval for its use. The reclaimed water system must be operational at the time of practical completion of the building.

Monthly supply of off-site supply should be entered in kL for each month. The volume entered for each month must be confirmed by the supply authority in the submission.

### Data entry requirement

Insert how much water is available per month in kL.

### Standard Practice Benchmark

The standard practice benchmark building does not include any water re-use.

# 8. GREEN STAR - PUBLIC BUILDING SEWERAGE CALCULATOR

The Green Star - Public Building Sewerage Calculator does not require any data input from the user. All required data is entered to the Potable Water Calculator and then exported to the Sewerage Calculator. The Sewerage Calculator returns the number of awarded points (out of four available[3]) for the Green Star credit Emi-6 'Discharge to Sewer'. The Sewerage Calculator is embedded in the Green Star Rating Tool; it can be found on a tab in the spreadsheet next to the Emissions Category.

[3] The Sewer Calculator awards up to four points, there are however five points available in the Emi-6 'Discharge to Sewer' credit, for further details please refer to the Technical Manual.

Points are awarded based on the percentage reduction compared to a standard practice building. Reduced flow to sewer can be achieved through water-efficient fixtures and fittings as well as the collection of greywater and blackwater. Descriptions of how standard practice is defined are included in each section of this guide.

# 9. GREEN STAR - PUBLIC BUILDING GREENHOUSE GAS EMISSIONS CALCULATOR

The Green Star - Public Building Greenhouse Gas Emissions Calculator is designed to assess reductions in greenhouse gas emissions compared to a standard practice building. The Greenhouse Gas Emissions Calculator is embedded in the Green Star Rating Tool; it can be found on a tab in the spreadsheet next to the Energy Category. More information about the Green Star - Public Building Greenhouse Gas Emissions Calculator is available in the *Green Star - Public Building Greenhouse Gas Emissions Calculator Guide*, available at www.gbca.org.au.

The energy consumption associated with water heating for taps and showers in the building (domestic hot water) is a required input of the Greenhouse Gas Emissions Calculator. The methodology that must be used to determine the energy consumption associated with domestic hot water is included in the *Green Star - Public Building Greenhouse Gas Emissions Calculator Guide*; it requires the demand for domestic hot water as an input. The methodology shows that reductions in greenhouse gas emissions can be achieved by installing more efficient fittings and fixtures as well as installing an efficient hot water system and or a solar hot water system.

The domestic hot water demand figures that must be used are calculated and displayed in the Potable Water Calculator. The calculator assumes that 50% of the water used in taps and showers in the Proposed and Standard Practice Buildings is hot water. The water efficiency of taps and showers in the Proposed Building are as entered by the project team in the Potable Water Calculator. The water efficiency of the fittings of the Standard Practice Building is based on the standard practice fittings described in 'Standard Practice Benchmark Water Efficiency'. The hot water consumption figures are displayed in the Results Section of the Potable Water Calculator.

# 10. REFERENCES


- AIRAH (2009) DA17 Cooling Towers Application Manual.
- Connellan, Geoff (2002) Efficient Irrigation: A reference Manual for Turf and Landscape, School of resource management and geography, University of Melbourne.

# APPENDIX A.
## CROP COEFFICIENT (KC)

The crop coefficient is an agronomic multiplier used to determine the water usage requirement for a particular plant type. The **highest** crop coefficient for the zone should be entered into the calculator.

The table below provides crop coefficients based on the general plant type e.g. native trees, exotic trees, native shrubs etc. and the expected water use of that general plant type. Examples of specific plants that belong in the crop coefficient category are also provided. For plants that do not appear on the list, project teams should pick a plant category that most closely matches the plants in the zone, based on the examples provided. Where a crop coefficient cannot be determined, a Technical Clarification may be submitted to the GBCA.

| 1. Trees | Crop Coefficient |
|---|---|
| 1.1 Native trees | |
| 1.1.1 Very Low Water Use | 0.1 |
| Banksia (Silver) (Banksia marginata) | |
| Eucalypt (Yellow Gum) (Eucalyptus leucoxylon) | |
| Eucalyptus (Sugar Gum) (Eucalyptus cladocalyx) | |
| Eucalyptus (Red Iron Bark) (Eucalyptus tricarpa) | |
| She-Oak (Drooping) (Allocasurina verticillata) | |
| Wattle (Cootamundra) (Acacia baileyana) | |
| Willow leaf Hakea (Hakea salicifolia) | |
| 1.1.2 Low Water Use | 0.25 |
| Bottlebrush (Weeping) (Callistemon viminalis) | |
| Melaleuca (Melaleuca stypheliodes) | |
| Oak (Silky) (Grevillea robusta) | |
| 1.1.3 Moderate Water Use | 0.5 |
| Ash (Mountain) (Eucalyptus regnans) | |
| Fig (Moreton Bay) (Ficus macrophylla) | |
| Cabbage Tree Palm (Livistonia australis) | |
| Umbrella Tree (Schefflera actinophylla) | |
| Lilly Pilly (Acmena Smithii) | |
| White Peppermint (Eucalyptus pulchella) | |
| 1.1.4 High Water Use | 0.7 |
| None | |
| 1.2 Exotic trees | Crop Coefficient |
| 1.2.1 Low Water Use | 0.35 |
| Pear (Ornamental) (Pyrus calleryana | |
| Chinese Elm (Ulmus parvifolia) | |
| Crab Apple (Malus “plena”) | |
| Crepe Myrtle (Lagerstroemia indica) | |
| Monterey Pine (Pinus radiata) | |
| 1.2.2 Moderate Water Use | 0.6 |
| Golden Ash (Fraxinus excelsior “Aurea”) | |
| Golden Poplar (Populus x canadensis “Serotina Aurea”) | |

**Continued >**

| | |
|---|---|
| Pin Oak (Quercus palustris) | |
| Pencil Pine (Cypressus sempervirens) | |
| Magnolia (Magnolia grandiflora) | |
| Jacaranda (Jacaranda mimosifolia) | |
| 1.2.3 High Water Use | 0.85 |
| Douglas Fir (Pseudotsuga menziesii) | |
| Paperbark Maple (Acer griseum) | |
| Maple (Japanese) (Acer palmatum) | |
| Rubber Plant (Ficus elastica) | |
| Silver birch (Betula pendula) | |

Table 15 'Tree Crop Coefficient'

Table 15

| 2. Shrubs | Crop Coefficient |
|---|---|
| 2.1 Native shrubs | |
| 2.1.1 Low Water Use | 0.25 |
| Banksia (Heath) (Banksia ericifolia) | |
| Bottlebrush (Splendens) (Callistemon citrinus "Splendens") | |
| Saltbush (Rhagnodia spinescens) | |
| White Correa (Correa alba) | |
| 2.1.2 Moderate Water Use | 0.5 |
| Banksia (Swamp) (Banksia robur) | |
| Boronia (Red) (Boronia heterophylla) | |
| Flame Pea (Chorizema cordatum) | |
| Snowy Daisy Bush (Olearia lirata) | |
| Native Heath (Epacris impressa) | |
| 2.1.3 High Water Use | 0.7 |
| Creamy Candles (Stackhousia monogyna) | |
| Birds Nest Fern (Asplenium australasicum) | |
| Soft Tree Fern (Dicksonia australis) | |
| Weeping Fig (Ficus benjamina) | |
| 2.2 Exotic shrubs | Crop Coefficient |
| 2.2.1 Low Water Use | 0.35 |
| Abelia (Abelia x grandiflora) | |
| Oleander (Nerium oleander) | |
| Euphorbia (Crown of Thorns) (Euphorbia milii) | |
| Lantana (Lantana camara) | |
| Sedum (Ice Plant) (Sedum spectabile) | |
| Yucca (Spannish Dagger) (Yucca gloriosa) | |
| Hebe | |
| 2.2.2 Moderate Water Use | 0.6 |
| Camellia (Camellia sasanqua) | |
| Daphne (Winter) (Daphne odora) | |
| Japanese Honeysuckle (Lonicera japonica) | |

Continued->

| | |
|---|---|
| Japanese Wisteria (Wisteria floribunda) | |
| Dogwood (Buddleia davidii)) | |
| Pittosporum (Diamond leaf) (Pittosporum rhombifolium) | |
| Viburnum (Viburnum x burkerwoodii) | |
| Rose (Rosa spp) | |
| Azalea | |
| 2.2.3 High Water Use | 0.85 |
| Hibiscus (Scarlet Rose-mallow) (Hibiscus coccineus) | |
| Hydrangea (Hydrangea x macrophylla) | |
| Rhododendron (Rhododendron hybrid) | |
| Gardenia | |

Table 16 'Shrub Crop Coefficient

| 3. Climbers | Crop Coefficient |
|---|---|
| 3.1 Native climbers | |
| 3.1.1 Very Low Water Use | 0.1 |
| Clematis (Small Leaved) (Clematis microphylla) | |
| Kennedia (Kennedia macrophylla) | |
| Native Sarsparilla (Hardenbergia violacea) | |
| 3.1.2 Low Water Use | 0.25 |
| Pandorea (Bower of Beauty) (Pandorea jasminoides) | |
| 3.1.3 Medium Water Use | 0.5 |
| 3.2 Exotic climbers | Crop Coefficient |
| 3.2.1 Very Low Water Use | 0.25 |
| Vine (Glory) (Vitis cultivar) | |
| 3.2.2 Low Water Use | 0.35 |
| Ornamental grape (Vitus vinifera) | |
| Star Jasmine (Trachelospermum jasminoides) | |
| Wisteria (Chinese) (Wisteria sinensis) | |
| 3.2.3 Medium Water Use | 0.6 |
| Banksia Rose (Rosa banksiae "Lutea") | |
| Carolina Jasmine (Gelsemium sempervirens) | |
| Virginia Creeper (Parthenocissus quinquefolia) | |
| 3.2.4 High Water Use | 0.85 |
| None | |

Table 16 'Climbers Crop Coefficient'

| 4. Ground Covers | Crop Coefficient |
|---|---|
| 4.1 Native ground covers | |
| 4.1.1 Very Low Water Use | 0.1 |
| Grevillea (Bronze Rambler) (Bronze Rambler) | |
| Yellow buttons (Chrysocephelum apiculatum) | |
| Kunzea (Scarlet) (Kunzea baxteri) | |
| Pigface (Carpobrotus glaucescens) | |
| 4.1.2 Low Water Use | 0.25 |
| Dusky Bells Correa (Correa "Dusky Bells") | |
| Banksia (Hairpin Dwarf) (Banksia spinulosa Dwarf) | |
| 4.1.3 Medium Water Use | 0.5 |
| Mint Bush (Alpine) (Prosanthera cuneata) | |
| Native Violet (Viola hederacea) | |
| 4.1.4 High Water Use | 0.7 |
| None | |
| 4.2 Exotic ground covers | Crop Coefficient |
| 4.2.1 Very Low Water Use | 0.2 |
| Creeping Boobialla (Myoporum parvifolium) | |
| Convolvulus (Convolvulus sabatius) | |
| 4.2.2 Low Water Use | 0.35 |
| Creeping Juniper (Juniperina horizontalis) | |
| Lambs Ears (Stachys lanata) | |
| Star Jasmine (Trachelospermum jasminoides) | |
| 4.2.3 Medium Water Use | 0.6 |
| Mondo Grass (Ophiopogon japonicus) | |
| Stinking Hellebore (Helleborus foetidus) | |
| Bugle Weed (Ajuga reptans) | |
| 4.2.4 High Water Use | 0.85 |
| 5. Desert Plants | |
| 6. Vegetables/Fruit Trees | |

Table 17 'Ground Cover Crop Coefficient'

| | Crop Coefficient | |
|---|---|---|
| 7. Turf | Strong growth, Good condition | Vigorous growth, Lush condition |
| 7.1 Warm Season Grasses | 0.6 | 0.85 |
| couch | | |
| kikuyu | | |
| buffalo | | |
| Zoysia | | |
| 7.2 Cool Season Grasses | 0.85 | 1.0 |
| Kentucky blue | | |
| Ryegrass | | |
| Tall Fescue | | |
| Bentgrass | | |
| 8. Ornamentals | 0.8 | 0.95 |

Table 18 'Grasses and Ornamentals Crop Coefficients'