

## 6.1 Introduction

A rain garden is used to attenuate peak flows and to provide stormwater treatment. Rain gardens use the concept of bioretention, a water quality practice in which plants and soils remove contaminants. Rain gardens are created in low-lying areas, with specific layers of soil, sand and organic mulch. These layers naturally filter the stormwater. During the inter-event dry period, the soil stores the rainwater and nourishes the garden's vegetation, promoting degradation, uptake and metabolism of contaminants. Some storage can be designed into the rain garden by allowing some temporary ponding to occur above the filter layers.

## 6.2 Description

Rain gardens look and function like any other garden except they treat runoff and are specifically designed with a number of components to suit site conditions.

### 6.2.1 Vegetation

Vegetation identified for use in rain gardens includes grasses and shrubs, with a preference for native species. Plants suitable for use in rain gardens are listed in Appendix C.

### 6.2.2 Mulch

A thin (up to 75mm) layer of mulch is recommended on the surface of the planting soil to maintain soil moisture and biota. This can be landscape-type shredded wood mulch or chips.

### 6.2.3 Planting soil

The layer of planting soil should be 1 metre or greater in depth. The soil composition must be permeable enough to allow runoff to filter through the media. The planting soil should be a sandy loam, loamy sand, loam, or a loam/sand mix (35-60% sand). The clay content should be less than 25% and the permeability should be at least 0.3 metres per day. The soil should be free of stones, stumps, roots or other woody material over 25 mm in diameter. Brush or seeds from noxious plants should not be present in the soils.

Placement of the soil should be in lifts of 300 - 400 mm and loosely compacted (tamped lightly with a backhoe bucket).

### 6.2.4 Sand bed (optional)

A sand bed may be used immediately below the planting soil to prevent the migration of particles into the underdrain material. The sand layer should be 300 mm deep and, if present, is included in the minimum 400 mm underdrain depth.

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### 6.2.5 Underdrain system

All rain gardens must include an underdrain system to collect treated runoff from the base of the system. This usually consists of a 100-150 mm perforated pipe system embedded in a gravel layer with at least 50 mm gravel cover over the pipe. In unstable or heavy soils the pipe can be positioned at the base of the underdrain to prevent water standing in the bottom of the system. In soils with high permeability, groundwater recharge may be encouraged by the infiltration of the treated runoff. This is achieved by elevating the piping system above the base of the gravel layer.

The combined depth of the sand bed and gravel underdrain layers should be at least 400 mm, depending on the diameter of piping used.

### 6.2.6 Filter fabric or impervious liner

Filter fabric is not recommended for use between the mulch, planting soil, sand bed or underdrain layers as it may clog with fine particles and reduce the overall permeability of the system. However, filter fabric should be used on the side walls and in some situations also the base of the system to prevent the migration of adjacent soil into the planting soil or the underdrain material. In stable soils the filter fabric can be a pervious, open-weave cloth, whereas unstable soils will require an impervious liner.

## 6.3 Considerations

The main issue on the long-term performance of rain gardens is adequate maintenance. Over time, the planting soil permeability may reduce which will increase surface ponding time. Another issue relates to maintenance of the rain garden vegetation. During dry periods the underdrain may cause the rain garden to dry out, which may necessitate watering of the vegetation on an as-needed basis to ensure vegetation remains healthy and viable.

Runoff from areas such as lawns and gardens should not require treatment. Overland flow from these areas located within the raingarden catchment may be diverted around raingarden by the use of a low diversion bund. Raingardens should be designed as off-line systems and situated in areas of the property that are not required for other purposes.

The maximum ponded depth on the surface of the raingarden is 220 mm. Provision of a maximum ponded water depth of 220 mm above the rain garden surface provides for storm events to be caught and treated. An overflow provision should be allowed for storm events that exceed the 220 mm freeboard.

Figure 6-1 illustrates a typical layout of a rain garden.

Figures 6-2 and 6-3 show the detailed design for an “in lawn” rain garden constructed by Ecowater Solutions. This design provides for dispersal of roof runoff over the rain garden area without surface ponding. The design shown is for treatment of roof runoff up to 200 m<sup>2</sup>. The details provided on Figures 6-2 and 6-3 should be checked and customised by a Chartered Engineer prior to adoption for a particular site.

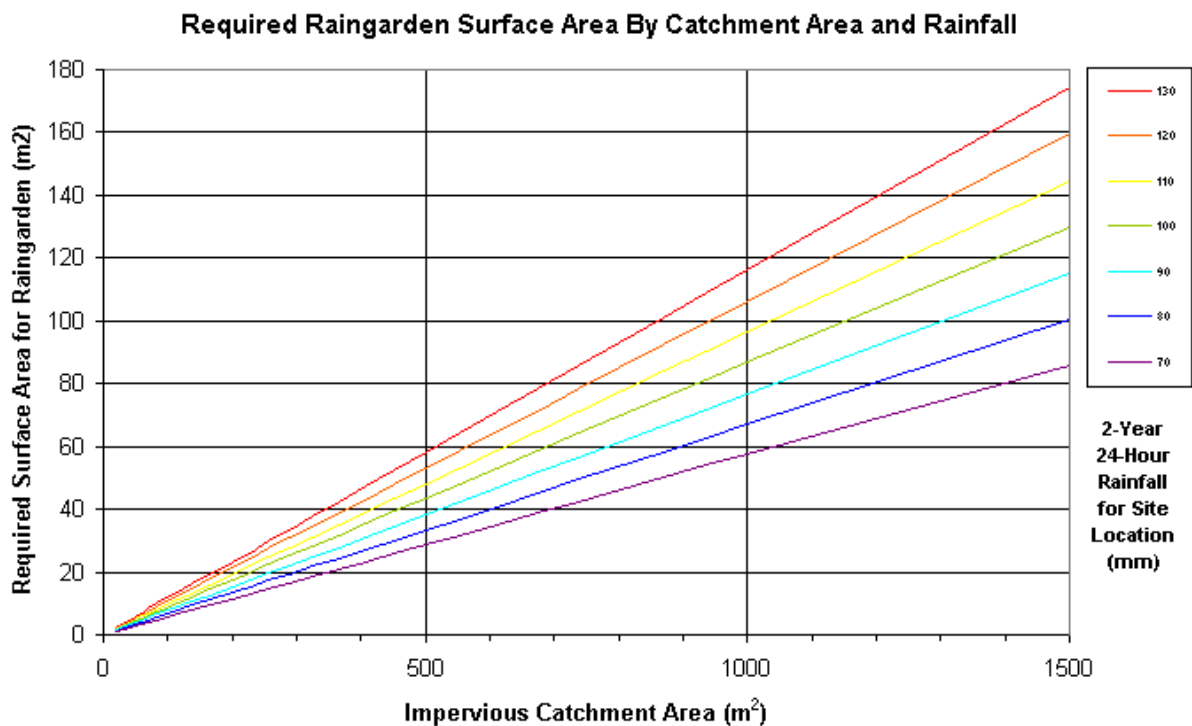
### 6.4 What to do?

The size of the rain garden depends on the area that drains into the rain garden. The area may include pervious areas as well as impervious areas. For entirely impervious catchments the graph presented in section 6.4.1 can be used.

These areas need to be calculated to determine the volume of runoff that can be expected from these areas in a 2 return period year storm.

The rainfall depth associated with a 24 hour period for a 2 year return period event is needed for input to design. Map A.1 from the ARC TP108 report has been reproduced in this section for this purpose.

#### 6.4.1 Impervious catchments



The above graph can be used to obtain a conservative estimate of the required surface area of the rain garden for various impervious catchment sizes and rainfall and has been produced using the following ‘worst case’ assumptions:

- Depth of planting soil d = 1 m
- Initial abstraction Ia = 0 mm
- Coefficient of permeability of planting soil k = 0.3 m/day

Hydraulic retention time	t = 1 day
Average depth of ponded water on surface of garden during storm	h = 0.11 m
Impervious Area Curve Number	CN = 98

### 6.4.2 Mixed catchments

#### 1) Calculate Required Surface Area of Rain garden

$$SurfaceArea = \frac{d * A * \left(\frac{R}{3} - Ia\right)^2}{1000 * k * t * (h + d) \left(\frac{R}{3} - Ia + \left[25.4 * \left(\frac{1000}{CN} - 10\right)\right]\right)}$$

- Where:
- d = Depth of planting soil [= 1 or greater] (m)
  - A = Catchment Area Contributing to Rain Garden (m<sup>2</sup>)
  - R = Rainfall 2-year 24-hour (mm)
  - Ia = Initial Abstraction [= 0 for impervious surfaces] (mm)
  - k = Permeability of planting soil [= 0.3 or greater] (m/day)
  - t = Hydraulic retention time [= 1 (residential) to 1.5 (non-residential)] (days)
  - h = Average depth of ponded water on surface of garden during storm [= 0.11 (half maximum pond depth 0.22m)] (m)
  - CN = Curve Number [= 98 for impervious surfaces]
  - S = Storage [= 0 for impervious areas] (mm)
  - WQV = Water Quality Volume (m<sup>3</sup>)

The above formula can be used by substituting site-specific values as calculated in the step-by-step worksheet example shown below:

#### 2) Step-by-step Worksheet

1. Calculate pervious and impervious areas of the catchment separately (m<sup>2</sup>)
  - Impervious area (**Area<sub>impervious</sub>**) may include roof, deck, patio, driveways or carpark.
  - Pervious area (**Area<sub>pervious</sub>**) may include lawns, gardens, bush.
2. Assume Initial Abstraction (**Ia**) values

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- Impervious area       $I_a = 0\text{mm}$
  - Pervious areas       $I_a = 5\text{mm}$
3. Assume Curve Numbers for the pervious and impervious areas
    - Impervious area,  $CN = 98$
    - Pervious areas,  $CN=74$  (grass)

4. Calculate a weighted Curve Number (**CN**) for the catchment

$$CN = \frac{(98 * Area_{impervious}) + (CN_{pervious} * Area_{pervious})}{(Area_{impervious} + Area_{pervious})}$$

5. Find the 2-year 24-hour rainfall (in mm) at the site using Map A.1 in TP108
  - Identify site location on map
  - Interpolate between isohyetal lines to obtain rainfall (**R**) in millimetres (mm).
6. Choose a depth (**d**) for the planting soil to be used (1m or more)
7. Obtain or estimate the coefficient of permeability (**k**) for the planting soil (m/day) (the soil selected must have a coefficient of permeability greater than 0.3 m/day).
8. The hydraulic retention time (**t**) for a residential site is 1 day
9. Estimate the maximum depth of water that could pond on the surface of the raingarden (metres). 0.22m is used as a rough guide. The average depth of water (**h**) is found by halving the maximum depth (i.e 0.11m).

The values can be directly substituted into the equation above to obtain the required surface area for the raingarden.

## 6.5 Construction Inspections

The construction of a rain garden will require two inspections. The first inspection will be conducted after the installation of the under drain pipe and drainage layer. The trench for the pipe connecting the rain garden and dispersal device should remain open for the inspection. The final inspection will be conducted upon completion of the rain garden, including planting of vegetation. Figure 6-4 shows the two inspection stages.

Figure 6-1

Conceptual Layout of Rain Garden

Figure 6-2

'In-Lawn' Rain Garden Plan and Section

Figure 6-3

'In-Lawn' Rain Garden Details

Figure 6-4

Inspection Stages