HCC 04: Bioretention devices

1. INTRODUCTION

This practice note[1] has been developed to provide information on the minimum design and sizing requirements for bioretention devices which are used in residential and non-residential applications for on-site stormwater management. Design information is provided for a bioretention device designed to provide full water quality treatment.

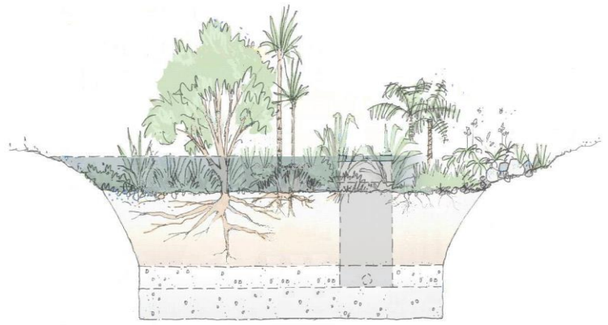
1.1 Bioretention devices

Bioretention devices are specially designed garden beds which filter stormwater runoff from surrounding areas or from stormwater pipes. Bioretention is widely accepted as one of the best stormwater management practices. It makes uses of the chemical, biological and physical properties of plants, microbes and soils and is an effort to mimic nature. Plants in a bioretention device transpire some of the water that is directed into it back into the atmosphere. Unlined bioretention devices allow infiltration of stormwater into the underlying soils, hence volume reduction. Bioretention devices also provide water quality treatment through the filtering that occurs through the soil media layer.

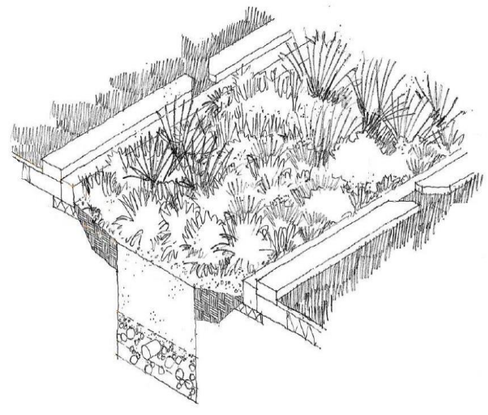
In this practice note, bioretention encompasses several different devices, including:

- Raingardens
- Bio-retention swales
- Stormwater planters, and
- Tree pits.

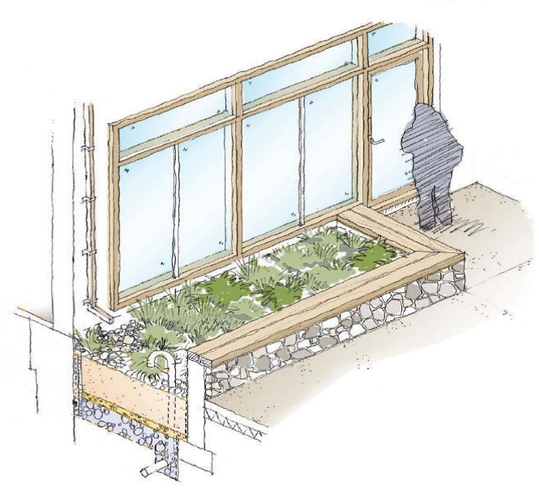
A **raingarden** is essentially a sunken garden with specially selected filter media soil and an underdrain to which stormwater is directed.



A **bioretention swale** is a long, narrow, gently sloping swale with a bioretention system along the base of the swale. It can be used to convey as well as treat stormwater.



Raingardens can be provided above ground, in large containers with bioretention planting media and an underdrain to which stormwater is directed, as shown in the picture below.



1.2 Advantages of a bioretention device

Bioretention offers a number of benefits over non-vegetated stormwater management systems which is why it is one of the preferred methods for on-site stormwater management. These benefits include:

- ***Improved water quality by treating and filtering out contaminants.***
- ***Improved hydrological response of stormwater peak flow and volume, especially for smaller rainfall events.***
- ***Providing amenity and increased vegetative cover.***
- ***Utilises the same space as is normally used for gardens.***
- ***Providing better growing conditions (free draining soils) for plants and thus improves the garden, and***
- ***Mimics nature and uses natural processes.***

[1] Three Waters Management Practice Notes are Hamilton City Council controlled documents and will be subject to ongoing review. The latest version can be downloaded from the Hamilton City Council website: http://www.hamilton.govt.nz/our-council/council-publications/manuals/Pages/Three-Waters-Management-Practice-Notes.aspx

2. BIORETENTION (RAINGARDEN)

2.1 Minimum design requirements

The following information is intended as a guide only. All bioretention systems within Hamilton City require specific design by a suitably qualified Engineer and approval from Hamilton City Council's Building Control Unit.

Where there is a Water Impact Assessment (WIA) for your site, follow the specific site requirements outlined in the WIA. Otherwise, general design requirements for bioretention systems are provided below. An approved design has been prepared for a bioretention system for a standard residential lot, for details refer to Council's standard detail:

- Typical planter box bioretention device - refer to Drawing HCC-04.1.

Variations from HCC's standard design will need to be submitted and approved by HCC.

Bioretention devices must be meet the following minimum design requirements:

1. **Size and shape:** Bioretention systems can be any shape. Bioretention systems are to be designed to cater to stormwater runoff from impermeable areas at your property. The bioretention system size refers to the AREA that is flat and filled with planting media and should be sized so that it has an area equivalent to **2%** of the contributing impermeable area draining to it. Generally, the minimum size for a bioretention system is $2m^2$.

2. **Location:** Devices should be located so that stormwater can flow to the device under gravity. Devices shall not be located within a 10-year ARI flood extent, and if possible, outside the 50-year ARI flood extent. Devices shall be located away from overland flow paths and unstable slopes. The base of devices shall be located above the winter high water table. On-lot devices shall not be shared between properties. If using the standard drawing the setbacks and location requirements are provided in the notes on the drawing. Otherwise refer to the project design engineer for setbacks from foundations and other surfaces.

3. **Inlet design**: Appropriate inlet design is essential for a bioretention device to work. Water must be able to flow into the device. Flow should be directed into the device with appropriate scour protection or in a sheet flow over a vegetated filter strip, if possible, and should always flow into the device to avoid concentrated flows and scour. If possible high flows should bypass the device.

4. **Plants:** Native plants are preferred. Plant selection should be in accordance with species nominated on Drawing XX-XX. The plants should be able to tolerate periods of inundation and longer dry periods, be perennial, have deep fibrous root systems, have spreading rather than clumped growth forms and to be suited to free draining soils.

   Successful plant establishment in bioretention devices has been achieved when the plants are robust and self-sustaining, and meet the following criteria:

   - Vegetation must cover at least 90% of the device surface with mulch covering the remainder (<10% mulch visible from above).
   - Average groundcover plant height >500mm.
   - Plants must be healthy and free from disease, no weeds or litter to be present.
   - Planting will require supplementary watering immediately after planting and for the first 4 weeks minimum.

5. **Mulch:** 50-100mm non-floating surface mulch layer. Mulch composition to be 75% organic mulch with 25% compost mix. The depth of mulch should be considered when setting the overflow level. Good design is required to ensure stormwater doesn't wash mulch into drains and cause blockages.

6. **Planting media:** The main component of the bioretention system is the planting media. Refer to Figure 1 for the typical layers within a bioretention system. Minimum planting media depth is 500mm (should be at least 1m depth for trees). The planting media shall be sourced from a reputable supplier. Refer to the bioretention device standard drawing for the planting media specification.

   For rain gardens, stormwater planters and tree pits, the surface of the planting media should be flat and level to avoid localised ponding and blinding, while for bio-retention swales the surface should be gently sloping.

   Place planting media in 300-400mm layers and wet to aid natural compaction. Use light weight lawn roller. Do not compact with a digger bucket.

7. **Transition layer:** 100mm transition layer is required between the planting soil and the drainage layer. A geofabric is not suitable for this purpose. The transition layer is to be clean, well graded coarse sand with minimal fines, 100mm thick.

8. **Drainage layer:** 200mm minimum thickness of washed drainage metal (2-5mm) is to be used below the transition layer. Void ratio equals 0.3.

9. **Under drain:** Bioretention systems require under drains. The under drain should be slotted rigid pipe (uPVC or similar to AS2439.1) with 2mm wide slots cut across the top third of the pipe at maximum 50mm centres. Minimum diameter:

   - Up to $10m^2$ bioretention device: 100mm dia.
   - $10m^2$ – $20m^2$ bioretention device: 1 x 150mm or 2 x 100mm dia.
   - $>20m^2$ bioretention device: specific design required.

   One drain per 3m width of bioretention system. The pipe **shall not** be installed with a filter sock around it.

   Under drains should be evenly spaced along the length of the device. They should be placed 75 – 300mm above the bottom of the drainage layer where no liner is present to allow for infiltration into the insitu soils, or on top of the liner if one is used. The under drain shall be connected to an approved stormwater outfall in accordance with Council's drainage hierarchy.

10. **Filter cloth/geotextile:** Geotextile fabric **not** to be placed between any filter layers. Geotextile to be placed below drainage layer when constructed in clay soils. Geotextile to be Duraforce AS240 or similar (filtration class 1-4, strength class 1).

11. **Saturated zone:** A 200mm thick saturated zone is recommended in the drainage layer, beneath the underdrain invert, to facilitate infiltration to the underlying natural soils and reduced discharge volumes.

12. **Impermeable liner:** Impermeable liners may be used where the raingarden is connected to a stormwater harvesting scheme or site conditions require lining. Lining to respond to site specific requirements, for example unstable ground or steep slopes and must consider adjacent services, adjacent trees, slope stability, buildings (including footings) and road substrates.

13. **Root barrier**: Consider using a root barrier when there are susceptible services such (as sewers) or foundations nearby. These are likely to be at risk from root penetration. The root barrier should only be placed adjacent to the services which require protection and not around the whole device.

14. **Ponding depth**: Ponding should be designed for a depth of 200-300mm above the surface of the planting media.

15. **Overflow:** Ideally, when the capacity of the rain garden is exceeded, flows should be by-passed to an overflow located outside the rain garden. If an overflow is located within the rain garden, then the overflow can be by means of a pipe/manhole which connects into the underdrain system, or it could be a gravel curtain which connects into the drainage layer.

16. **Access:** Suitable access needs to be provided for routine maintenance. Small residential gardens may require access for a wheelbarrow while larger commercial gardens will require more substantial access, suitable for a small excavator.

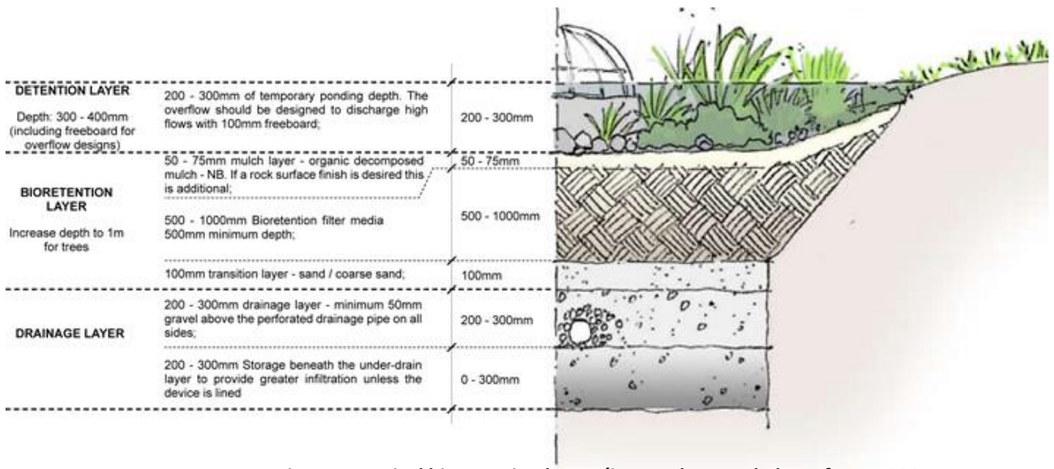


Figure 1: Typical bioretention layers (images here and above from NSCC Bioretention Guidelines July 2008)

The following table outlines indicative bioretention device sizes for a range of connected impervious areas:

Connected impervious area (m^2)	Bioretention device area (m^2)
50	1.0
100	2.0
150	3.0
200	4.0
250	5.0
300	6.0
350	7.0
400	8.0

Bioretention devices can be used to meet Waikato Regional Council's Waikato Stormwater Management Guideline volume control criteria[3].

This criterion is as follows:

> *A minimum retention of the site pre-development initial abstraction from all impermeable areas shall be provided. If soil conditioning is provided for permeable areas then retention of initial abstraction is not required for these areas. If soil conditioning is not proposed then initial abstraction is to be retained for the whole site (permeable and impermeable areas).*

This can be provided with a saturated zone beneath the under drain.

3. BIORETENTION – REDUCED DEVICE

If there is an approved downstream stormwater management device providing stormwater flow attenuation and stormwater quality treatment for your site, you can provide bioretention on-lot designed as a reduced at-source measure only, referred to bioretention reduced device (refer to HCC01 Overview for further discussion about this topic).

3.1 Minimum design requirements

The following information is intended as a guide only. All bioretention systems within Hamilton City require specific design by a suitably qualified person and approval from Hamilton City Council's Building Control Unit.

A bioretention reduced device should be designed in accordance with the minimum design requirements described above for the bioretention full treatment device, except the size of the reduced device is assessed differently, as outlined below:

1. The bioretention reduced device is designed to cater to stormwater runoff from impermeable areas where cars drive and park at your property. The bioretention reduced device should be sized so that it has an AREA equivalent to 2% of the impermeable trafficked areas draining to it (i.e., roof area does not need to drain to a bioretention reduced device). The device should be located to maximise the collection of site runoff from trafficked areas. Refer to Figure 2 below for an indicative schematic of the typical arrangement for a bioretention reduced device. Ensure overflow from the device drains to approved overland flowpath.
2. The minimum size for a bioretention system is $1m^2$.
3. Refer to Section 2.1 Minimum design requirements for all other details.
4. It is important to ensure the bioretention reduced device is above the winter high water table as per comment 2 in Section 2.1 above.

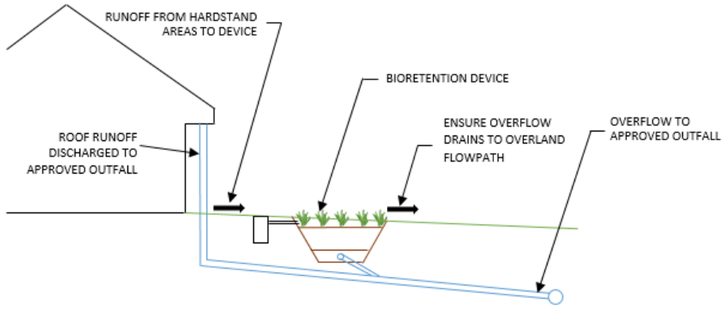


Figure 2: Schematic showing typical arrangement for bioretention reduced device

4. CONSTRUCTION

Bioretention devices should not be built until the rest of the site has been constructed and the site stabilised. They must be protected from stormwater flows carrying high sediment loads during construction activities from your site or neighbouring sites. If they are not protected during construction, then the planting media will need to be replaced.

If work on the bioretention device needs to commence before the rest of the site is stabilised then the device should be constructed, but only with pipe connections and no media and plants, until the site is stablised. The device would need to be secured from a safety perspective.

Bioretention devices must be protected during the building phase to ensure no dirty stormwater runoff enters the device.

If possible, do not construct the device until the surrounding areas have been stabilised and erosion is no longer a concern.

Incoming flows must be diverted until the raingarden is fully planted and mulched.

5. MAINTENANCE

One of the important considerations with bioretention devices is long-term maintenance. Remember that a bioretention device is a garden and not just a drainage system – they are generally low maintenance, not NO maintenance.

They need water when it doesn't rain until the plants are established.

During dry periods, the free draining filter media may cause the system to dry out. Watering the vegetation on an as needed basis helps ensure a healthy condition and appearance.

The following lists some requirements to keep your bioretention device in good condition:

- Mulch as required with hardwood mulch as this suppresses weeds and retains moisture.
- Every few years excess mulch may need to be removed.
- Weed regularly as you would with any garden.
- Do not park, or drive on the device as this causes compaction and leaves ruts.
- Do not let (fine) sediment build up – if a crust forms, remove it & rework the top layer of soil.
- Keep an eye on the plants – if they are unhappy, they may need moving. Plants may need pruning, thinning, or replacing from time to time.
- Strong water flows may cause erosion, this will need to be repaired and measures put in place to prevent recurrence.
- Check the overflow for clogging and remove any build-up of rubbish or debris regularly.
- Protect from the inflow of chemicals such as herbicides, fungicides (including wet and forget type moss removal), chemical roof cleaners, paint wash and general detergents.
- If the raingarden stops draining (i.e., there is permanent water at the surface between rainfall) call a plumber to inspect the system and potentially flush the underdrains.

6. SUMMARY OF PLANNING REQUIREMENTS

Your bioretention device must be consented either as part of the whole site's building consent or as a separate building consent. This will require information on the size and location of the device.

For details on building consents please contact Hamilton City Council's Building Control Unit phone (07) 838 6699.

Bioretention devices are required to be designed by a suitably qualified person based on the guidance provided in this practice note, the RITS, and other best practice guidance.

As-laid plans, authorised by a registered installer, are required for the drainage components of the bioretention device and shall be provided to council.

[3] Refer to Waikato Stormwater Management Guideline for details https://www.waikatoregion.govt.nz/assets/WRC/Services/publications/technical-reports/2018/TR201801.pdf