Residential Bioretention Design Guide

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Why is Stormwater Management Required for New Development?

Urban development is resulting in greater impervious surface coverage. This concentrates runoff into the stormwater network, carrying urban contaminants to our rivers and waterways. Council must ensure the effects of urban development on stormwater is minimised and where possible effectively mitigated.

Stormwater Reference Documents

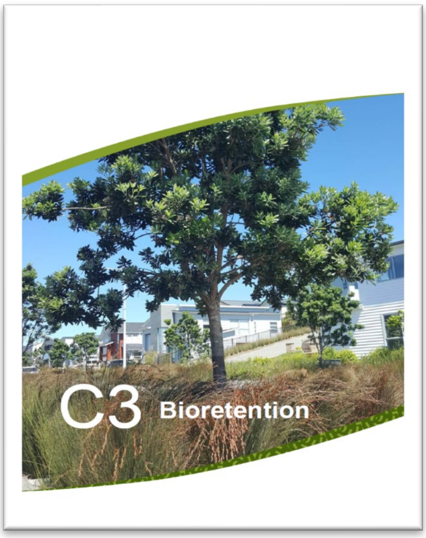
PNCC are developing a comprehensive Stormwater Management Framework that will provide the overarching guidance to the citywide stormwater management. It will describe the relationship between the stormwater devices with the city goals, the District Plan, the Horizons One Plan, the local environmental conditions, and the catchments that contribute to Palmerston North stormwater. The Engineering Standards for Land Development (ESLD) provides the rules for consenting the stormwater devices. It will reference both the Framework and this Guide. The Residential Bioretention Design Guide is the practical outline to assist developers and their representatives with suitable design criteria that will support the Stormwater Management Framework and the ESLD.

Purpose of Stormwater treatment

The purpose of stormwater treatment is to mitigate the effect of contaminants in stormwater before entering the receiving environment. Each site will have specific design solutions that collect runoff from impervious areas such as roofs, driveways, carriageways etc; then filters it before entering the stormwater network.

Design Guide Scope

The Design Guide is intended to provide guidance for residential stormwater treatment, on a small scale, lot-by-lot basis. Treatment of larger areas is subject to specific stormwater design. Large treatment systems are outside the scope of this design guide.



The Guide abbreviates the Auckland Regional Guideline Document 2017/001 C3 Bioretention GD01. This document should be referenced for greater detail. PNCC content has been created and included specific to the local requirements and environment where applicable.

This guide is presented using the following format:

- Site conditions
- Design components

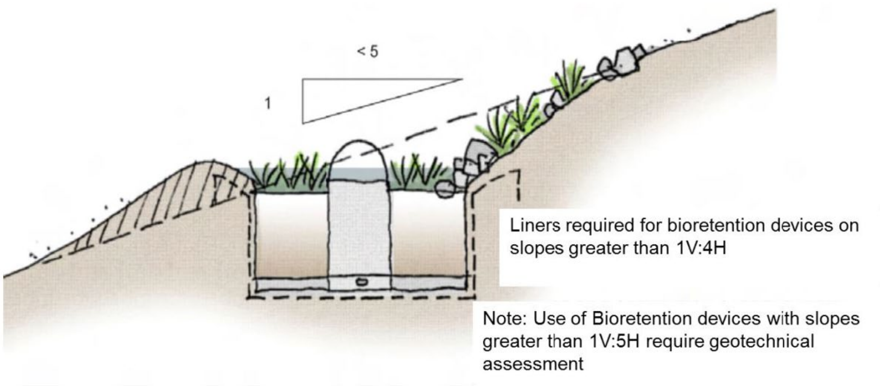
- Examples for planter beds, raingardens and bioretention swales.
- Worked example

Alternative designs that largely utilise the design components and best suit the individual site conditions can be submitted to PNCC for assessment.

Key considerations *Source: table 46, GD01*

1. Catchment size and location
    - Catchment under 1000m^2.
    - Bioretention devices should be located away from trafficable areas (such as public pathways) to avoid compaction.
    - Wherever possible, the bioretention gardens should be located to minimise the pervious areas draining to them and should not be located in overland flow paths.
2. Groundwater
    - The base of any bioretention device should be more than 300 mm above the seasonal high-water table.
    - If this is not possible, an impervious liner must be used but the device then provides no retention.
3. Slope
    - A bioretention garden may only be used on slopes steeper than 14° (25% or 1 V:4H) if the effects have been assessed by a geotechnical engineer.
    - Lined bioretention devices are required for sites that are part of an overall sloping site.
    - The device must be placed more than 15 m away from slopes of 9° (15%) or more.
4. Subsoils
    - Infiltration rates of subsoil must be understood to ensure retention occurs.
    - It is important to protect subsoils from compaction during construction.
5. Soils requiring structural support
    - These soils may require geotextiles, impermeable layers or liners.
    - Geotextiles should not be used between media layers.
    - Care should be taken to ensure plant growth is not inhibited by any geotextile.
6. Soils with poor drainage
    - Retention function is impaired in poor soils. Infiltration of subsoils must be evaluated.
7. Pre-Treatment
    - Unless directly from the roof, pre-treatment of stormwater prior to entry to a bioretention device is needed e.g. leaf diverters.
8. Private connections
    - Private bioretention devices must drain via gravity to the public system or the receiving environment via an approved outfall.

9. Location
    - Devices should be located no closer to a structure or boundary than the measure of their in-ground depth.
    - If a bioretention device is installed upslope and within 6 m of a structure, it should be lined (may only need to be lined on one side) to prevent potential saturation of the foundation soils. These distances may be reduced on the advice of a geotechnical engineer.
10. Minimum sizing:
    - Sizing – minimum 2m^2 footprint
    - Depth – 1m total media requirement
11. Planting
    - Appropriate species are specified in the Planting Appendix



Sizing stormwater treatment systems

Measure the impervious surface catchments:
- Roof areas, Patios/paving, driveways
- size the treatment system at 2% of the contributing catchment areas

Specific Requirement for Building Consent

It is the responsibility of the building consent applicant to provide design details and supporting calculations for the stormwater system, within the scope of the consent notice, and the design guidance provided. Inlet and outlet pipework is sized to comply with Building Code Clause E1.
Examples are provided at the end of this document. Every designer will need to develop their own drawings appropriate for the site.

Other details

- An overflow that drains to an approved stormwater outfall via gravity must be provided (i.e. stormwater network or kerb and channel). The overflow must be sized to accommodate the contributing catchment and comply with the building code.
- The design, construction and installation of the Bioretention system and associated pipework is the responsibility of the developer or property owner.
- The maintenance of the system and associated pipework is the responsibility of the property owner.

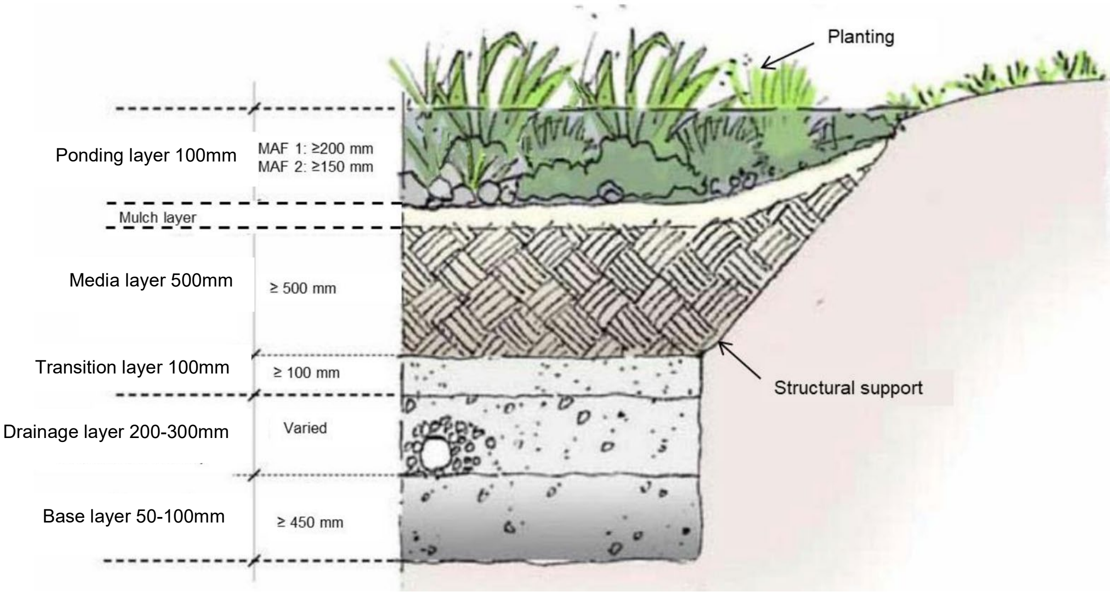
- If the rainwater treatment area is decommissioned in the future, the owner must provide treatment of equal or greater volume in an alternative location.
- The stormwater system details must be included in the building plans submitted as part of the building consent process, the installation will be inspected, and the work must be carried out by a licensed drainlayer.
- For buildings within a large subdivision, the bioretention design must meet the requirements set forth in the approved Stormwater Management Plan provided with the resource consent application.
- Consider the effect of additional ground water load on foundations.
- Stormwater treatment may be achieved with a combination of on-site measures, e.g. planter gardens and a swale

Bioretention media layering

Each system is comprised of the same material and media, layering in each is identical. The defining difference is the layout in site, and the elevation out of natural ground.

The specifications for engineered soils are provided in Stormwater Management Devices in the Auckland Region Guideline Document 2017/001, C3 Bioretention. All media must be laid below the inlet.

- **Mulch**: Must be laid below the inlet, not float or block off the device, and not add to contaminant loads. Further details on mulches are provided in Auckland Region Guideline Document 2017/001 Section C1: Plants and soils.
- **Media**: Specifications are provided in Table 51 of Stormwater Management Devices in the Auckland Region Guideline Document 2017/001, C3 Bioretention.
- **Transition layer**: Clean, well-graded gravel (2-7 mm diameter) with minimal fines, with 100 mm depth. A geotextile must not be used for the transition layer.
- **Drainage layer**: A layer of clean, washed pea gravel (+/-10 mm diameter) with little/no fines and a minimum infiltration rate of 4,000 mm/hr. The layer must be at least 200 mm deep, graded at a minimum of 0.5% towards the outlet and provide at least 50 mm of cover above the drainage pipe.
- **Basecourse layer**: Same media as drainage layer but sits below the underdrain invert. Must be at least 50 mm deep and not have an impervious liner.


Planting
Ponding layer 100mm
MAF 1: ≥200 mm
MAF 2: ≥150 mm
Mulch layer
Media layer 500mm
≥ 500 mm
Transition layer 100mm
≥ 100 mm
Structural support
Drainage layer 200-300mm
Varied
Base layer 50-100mm
≥ 450 mm

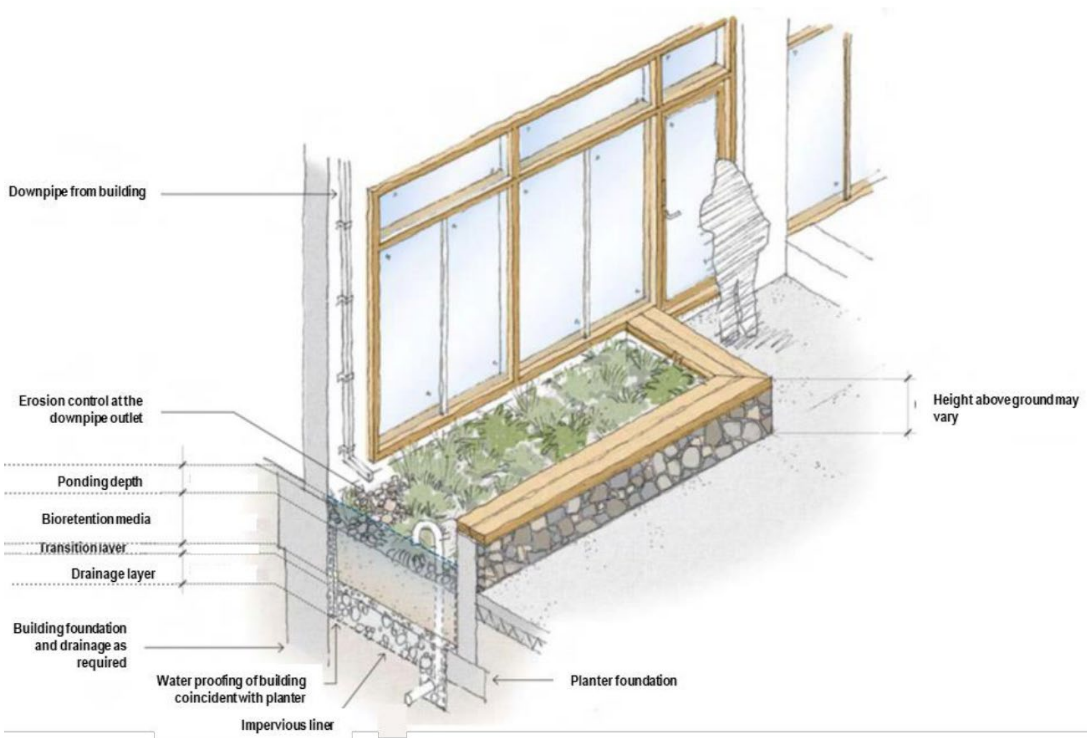
Stormwater planter beds

Bioretention planter boxes are an elevated version of a rain garden often using an above-ground pre-cast concrete unit, with specific soil media in which plants are grown. Stormwater planter boxes operate as follows:

- Roof water is discharged into the raised planter preferably from a charged stormwater riser. A direct discharge can be directed from a downpipe, however some energy dissipation will be required at the outlet location to prevent damage and erosion to the bed and media.
- The 'first-flush' of stormwater infiltrates soil layers and is then collected in a drainage layer to be directed to a discharge point.
- Ponding occurs as soils become saturated to the top-of-wall level in the planter box. This storage serves to further attenuate flows. An outlet riser comes into operation when the ponding capacity is full. Excess runoff, after the 'first flush' has been retained, is discharged through the outlet riser and standpipe to reticulated systems.
- An overflow is provided just below the lip level of the planter box, to accommodate higher than normal rainfall volumes.

Stormwater planters can be partially sunk, but advice from an engineer may be required if they are within 1:1 depth-to-distance of a building's foundation. Planters should not be constructed against wall faces. The device should have a horizontal surface. Stormwater planters are generally lined with impervious layer to protect adjacent structures and reduce opportunity for infiltration. Because they receive roof runoff, maintenance and media/plant renewal is generally less frequent than for rain gardens.

The minimum size of a planter box should be 2 m^2.

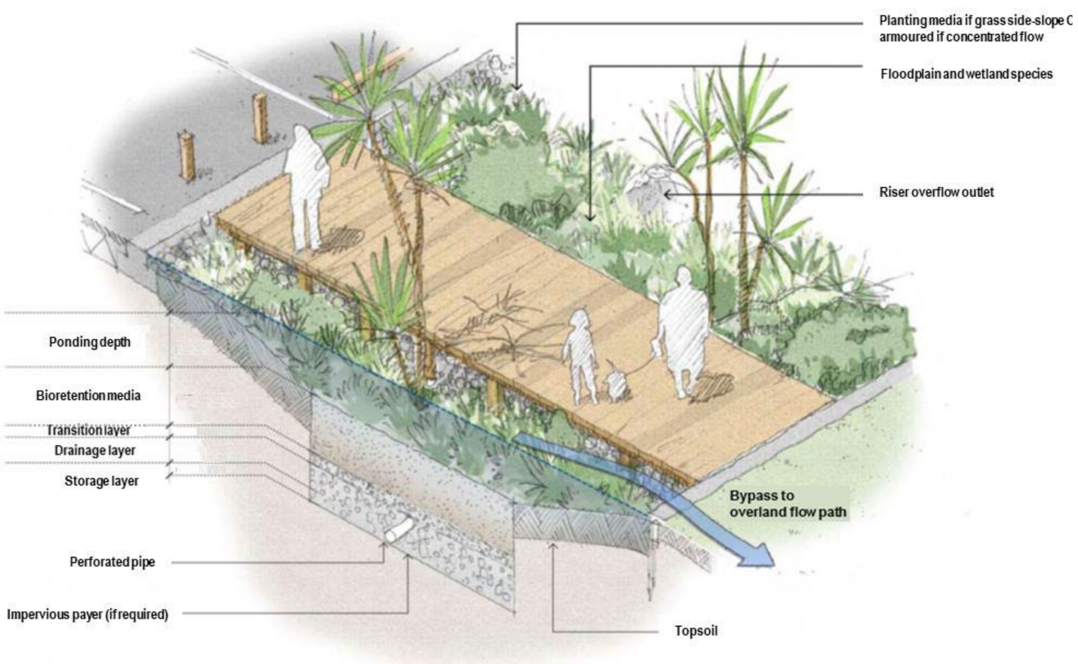


Rain gardens

Rain gardens are planted and defined garden beds containing specified soil media that promote filtering and retention. In most situations, rain gardens are bounded by impervious surfaces like paths and patios. Downpipes/stormwater pipes are directed to the raingarden in the same manner as a planter. A charged stormwater riser is preferred. Impervious surfaces direct runoff to the rain garden through crossfall.

- As stormwater enters the rain garden, it is filtered through plants specifically selected to tolerate the hydrologic conditions and provide water quality treatment. Often there is an intermediary filter strip or rock apron to reduce scouring or to capture entrained sediment.
- The stormwater then receives additional treatment as it permeates through an organic mulch layer, the root zone of the plants, and through a sequence of specific soil layers. These soil layers are organic in the top layers, such as a sandy loam enriched with compost, followed by porous sandy soil, to a gravel drain with a transition layer.
- Treated water in the gravel layer is then collected via perforated pipes. These pipes flow to an approved outlet to enter the receiving environment or reticulated systems via gravity.

As well as filtering and infiltrating stormwater, rain gardens also provide temporary ponding on the surface of the rain garden. Storm events that are greater than the design storm overflow from the rain garden into a grated overflow and connect to the reticulated system at the base of the rain garden. Alternatively, excess stormwater may overflow from a rain garden to an overflow path or a sequence of stormwater management devices in a treatment train. It should be noted that the grated overflow outlet and/or overflow path is positioned away from the inlet to avoid short-circuiting. Ensure the bioretention device is horizontal to encourage uniform flow over the full surface area.



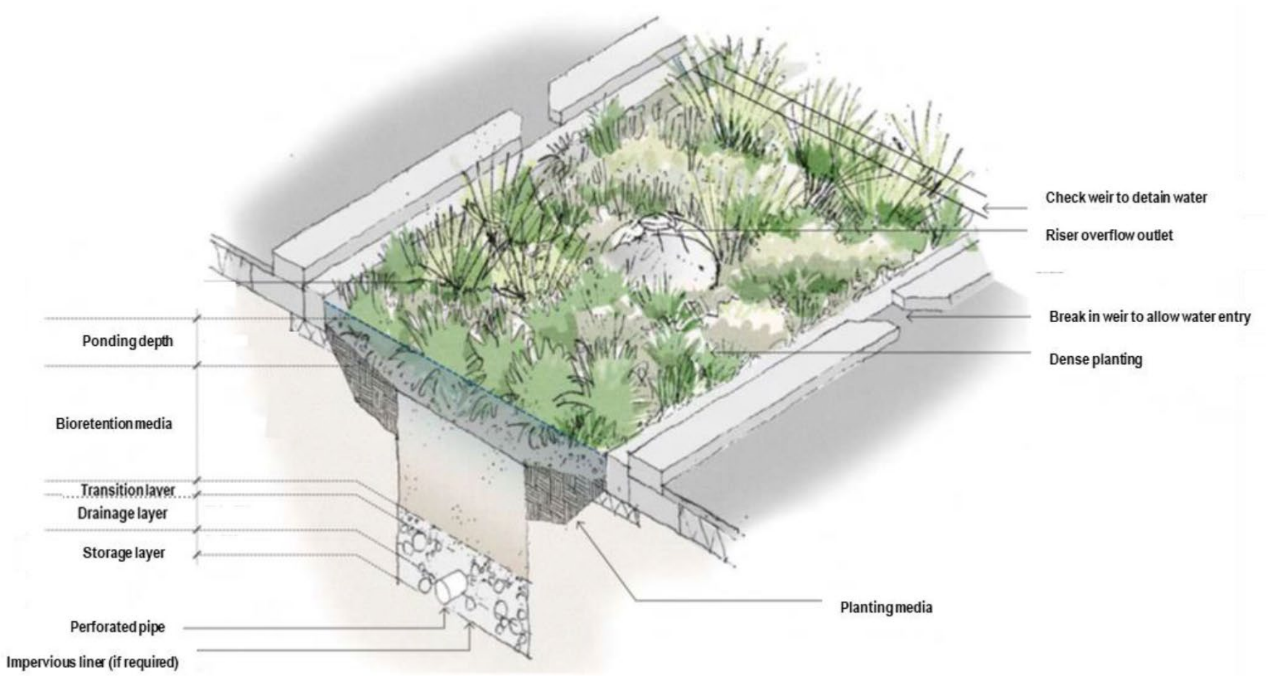
Residential Bioretention swale

This is effectively a raingarden that has a gentle overland slope aspect to it. This is more for contoured sites. The design takes advantage of natural overland flow characteristics, by enhancing the slope and forming the ground into a raingarden. A common location for this type of device would be:

- alongside a swept and sloping driveway/access
- along the boundary of a site to take advantage of a natural low point on the property
- across a site where the land naturally falls to a low point

Key points for design are:

- Flow needs to be uniformly distributed over the full surface area of the filter media.
- Swale design should incorporate a flow-spreading device at the inlet such as a shallow weir across the channel bottom or a stilling basic.
- When the bioretention trench is located along the full length of the swale base, the desirable maximum longitudinal grade is 4%. Check dams can be installed to increase residence time.



Attenuation as part of Residential Bioretention

Stormwater attenuation can be incorporated into a bioretention device by restricting the network outlet aperture size and providing additional storage volume in the ponding depth of the garden area. This should be calculated and designed as part of a stormwater management plan. If you propose to include attenuation as part of the Bioretention device, please contact PNCC Planning, Building or the Stormwater Infrastructure team early in your design process.

Worked example

Example Consent notice (generic)

> ***Impermeable Surface Restriction***
> *The proportion of impervious surfaces/non-porous surfaces on the lot must not exceed 65% of the total lot, inclusive of the accessway. This includes the roof area(s) of all buildings on-site, concrete surfaces, and anything that does not allow stormwater runoff to soak into the ground. To exceed this limit, written approval of the Council's Head of Planning is required. In order to obtain the written approval on-site attenuation or another suitable solution to be approved by Council will be required.*
>
> ***Treatment of Stormwater Onsite***
> *Each lot shall provide treatment of surface water onsite. The treatment device shall be designed as per Auckland's Stormwater Management Devices (GD01), Section C3 Bioretention. Sizing shall be 2% of the contributing catchment area (impervious area). The following are viable options:*

i. *Planter box raingarden – the roof leader discharges to an above ground planter box filled with appropriate soil for filtration and fitted with a subsoil drain to collect the treated stormwater and an overflow to prevent flooding.*

ii. *Inground raingarden – similar to the planter box but located inground. These also provide an additional benefit because they can treat hardstand area as well.*

iii. *Swale – longitudinal rain garden complete with subsoil drain and overflow.*

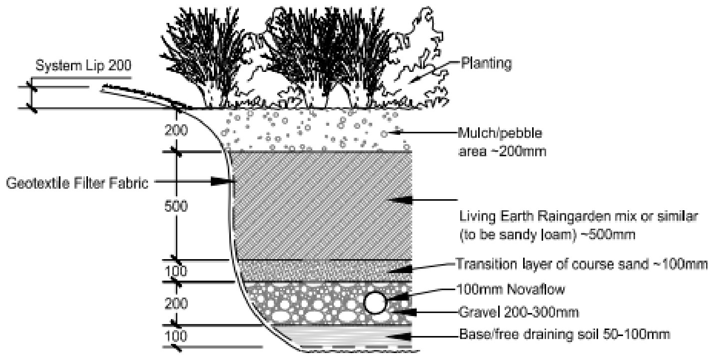
Site details
Site Area 659m²
65% impervious limit: 428m²
Dwelling footprint 198m²
Driveway and paved areas 146m²
Total impervious area directed to network: 344m²

Calculation:
2% of catchment = 0.02 x 344 = 6.88m²
Therefore, the site requires a 7m² bioretention device (raingarden)

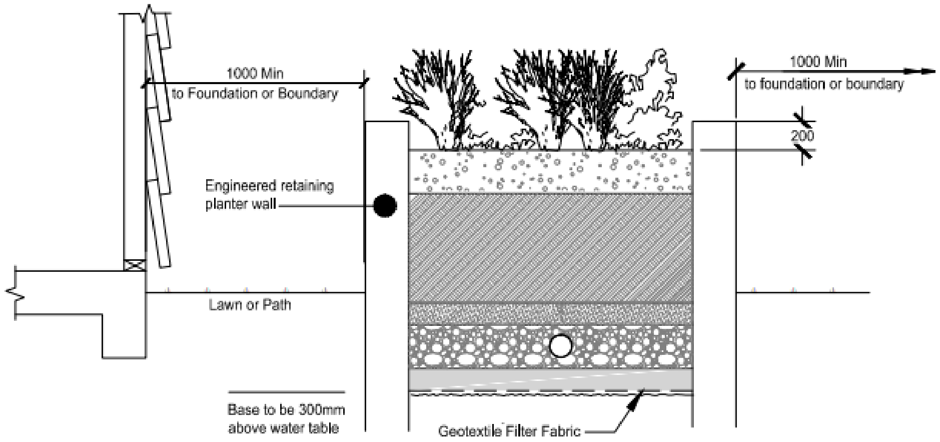
Drawn examples

The following example is a generic design, showing common components and principles. The system components shown in the drawing will need to be included in the site-specific design, along with the details required for the site.

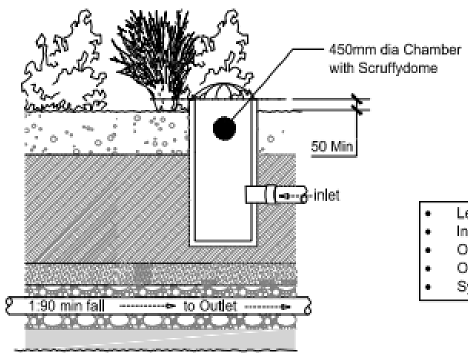
PLANTER / RAINGARDEN / SWALE GUIDELINE



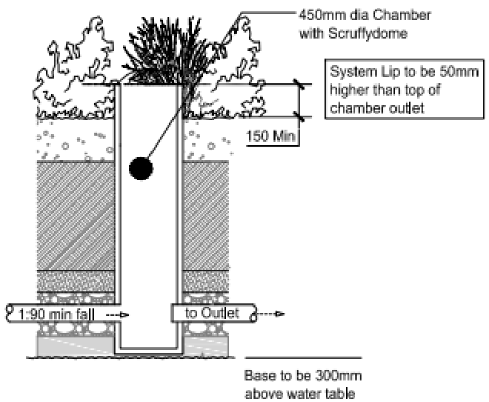
STORMWATER
BIORETENTION / RAINGARDEN
Scale 1:20



STORMWATER
RAISED PLANTER
Scale 1:20



- Leaf diverters on downpipe inlets
- Inlets sized to E1
- Outlet sized to E1
- Outlet / overflow - 50mm below inlet
- System lip to be 1m clear of building foundations or boundary



INLET
LONGITUDINAL SECTION
Scale 1:20

OUTLET
LONGITUDINAL SECTION
Scale 1:20

Planting Appendix

Bioretention Device Plant List

Table 1 provides a plant list selected for bioretention device installed within Palmerston North. This list is considered a work in progress. It is to be updated per experience with each bioretention device installed. The plant list is compiled using the following criteria:

- Endemic to the Manawatu Plains Ecological District
- Hardy to contaminants
- Tolerant of sprays for weed control; otherwise noted in Table 1
- Vigorous growth habit and will establish within 2 years
- Dense to ensure minimal weed growth through plants
- Open enough to allow water movement through the plant; otherwise noted in Table 1.

Plant Selection (see Table 1)

Plant selection should use the following criteria for the design:

- Plant Type: Sedges and Herbs are the mostly likely selection. Trees and Shrubs are only appropriate for large designs; where traffic visibility is possible; flow paths can be maintained; and the device container does not restrict the larger root volumes.
- Scientific Name: Pick at least 2 types of plants for each device to allow one plant to take over another's space if it doesn't develop well.
- Height: Pick height of plants so that one plant does not overshadow another; and the height is appropriate to the surrounding landscape.
- Base Strength: Use rhizomatous plants at entrances to the device and any other high flow areas.
- Environmental Conditions: Place plants across a bioretention device relative to the environmental conditions listed in Table 1. For example: If conditions will have significant dry periods 'wet' plants should be avoided. Wet plants are best suited at the base of a device; and dry plants on the sides.
- Concern to check: Select and place plants to ensure water movement through the device. For example, flax is only appropriate where there is a large space to allow flows around them

Plant Spacing

- Calculate the plant numbers according to their width. Ensure the placement allows for mature widths with minimal overhang to surrounding footpath and kerb etc.
- Pruning back is not acceptable. This is an unnecessary maintenance task.

Plant Ordering

- Check with local nurseries for their opinion about suitability to the specific site conditions and about availability.
- Order at least a year in advance for hard to get plant varieties and for large orders.

Table 1: Bioretention Plant Selection List (highlighted plants are the most preferred type)

Plant Type	Common Name	Scientific Name	Height	Spacing	Base strength Flow tolerance	Environmental Conditions	Concern to Check
			Height Swales use under 2m	Width	Rhizomatous For high flow entrance to garden	Moisture tolerance wet - base channel dry - side channel both	Vigorous, to cover area within 2 years
Herbs	Kakaha	Astelia fragrans	1.2	1	No	dry	
Herbs	Bush lily	Astelia solandri	1.2	1	No	dry	
Grass	Toetoe	Austroderia toetoe	1.5	1.5	No	both	Doesn't allow weed control with grass control spray
Sedge	Rautahi/cutty grass	Carex dipsaecea	0.75		No	both	
Sedge	Rautahi/cutty grass	Carex geminata	1		Yes	both	
Sedge	Rautahi/cutty grass	Carex lessoniana	1.5		Yes	both	
Sedge	Rautahi/cutty grass	Carex virgata	1		No	wet	
Fern	Swamp kiokio	Parablechnum minus	1	1	yes	both	moderate
Fern	Kiokio	Parablechnum novae-zelandiae	1.5	1	yes	both	moderate
Herbs	Turutu	Dianella nigra	0.5	0.5	yes	wet	
Herbs	Mikoikoi	Libertia ixioides	0.5	0.5	yes	both	
Herbs	NZ iris	Libertia grandiflora	0.5	0.5	yes	both	maybe weed prone

Plant Type	Common Name	Scientific Name	Height	Spacing	Base strength Flow tolerance	Environmental Conditions	Concern to Check
			Height Swales use under 2m	Width	Rhizomatous For high flow entrance to garden	Moisture tolerance wet - base channel dry - side channel both	Vigorous, to cover area within 2 years
Lianes & climbers	Small leaved pōhuehue	Muehlenbeckia complexa	2	2	no	dry	
Lianes & climbers	Large leaved pōhuehue	Muehlenbeckia australis	2	2	no	dry	maybe less vigorous to M. complexa
Rush	Giant rush	Juncus pallidus	2	0.5	yes	wet	maybe too dense
Rush	Giant rush	Juncus sarophorus	1.5	1	yes	wet	maybe too dense
Sedge	Rautahi/cutty grass	Carex lambertiana	1		No	wet	
Sedge	Rautahi/cutty grass	Carex maorica	2		No	both	
Sedge	Pūrei	Carex secta	1.5		No	wet	Does not tolerate high nitrogen concentrations
Sedge	Toetoe upoko-tangata/giant umbrella sedge	Cyperus ustulatus	1	1	no	wet	

Plant Type	Common Name	Scientific Name	Height	Spacing	Base strength Flow tolerance	Environmental Conditions	Concern to Check
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Sedge	Tall spikerush/kuta	Eleocharis acuta	0.5	0.5	yes	wet	requires wet conditions, maybe too dense
Sedge	Tall spikerush/kuta	Eleocharis spacelate	1	0.5	yes	wet	requires wet conditions, maybe too dense
Sedge	Giant Umbrella Sedge	Isolepis prolifera					
Sedge	Pepepe	Machaerina sinclairii	1	1		both	
Sedge	Kāpūngāwhā	Schoenoplectus validus	1.5	1	yes	wet	
Sedge	Kāpūngāwhā	Schoenoplectus tabernaemontani	1.5	1	yes	wet	
Shrubs	Makaka/broo m	Carmichaelia arborea	4	3	no	dry	
Shrubs	Thin leaved coprosma	Coprosma areolata	4	2	no	dry	
Shrubs	Mingimingi	Coprosma propinqua	3	2	no	dry	
Shrubs	Coprosma rhamnoides	Coprosma rhamnoides	3	2	no	dry	

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Shrubs	Swamp coprosma	Coprosma tenuicaulis	3	2	no	dry	
Shrubs	Hangehange	Geniostoma ligustrifolium var. ligustrifolium	3	2	no	dry	
Shrubs	Mingimingi	Leucopogon fasciculatus	2	1	no	dry	
Shrubs	Māpou/red mapou	Myrsine australis	5	2	no	dry	
Shrubs	Shrub daisy	Olearia solandri	4	2	no	dry	
Shrubs	Harakeke/mountain flax	Phormium cookianum	1.5	2	no	both	
Shrubs	Harakeke/flax	Phormium tenax	3	3	no	both	large for rain gardens no movement
Shrubs	Koromiko	Veronica stricta var. stricta	2.5	1.5	no	dry	
Trees	Tī kōuka/ cabbage tree	Cordyline australis	8	2	no	dry	
Trees	Kāramu	Coprosma robusta	5	2	no	dry	
Tree Fern	Wheki Tree fern	Dicksonia squarrosa	7	5	no	dry	

Plant Type	Common Name	Scientific Name	Height	Spacing	Base strength Flow tolerance	Environmental Conditions	Concern to Check
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Trees	Narrow leaved lacebark	Hoheria angustifolia	6	3	no	dry	
Trees	Kanuka	Kunzea ericoides	6	3	no	dry	
Trees	Mānuka	Leptospermum scoparium	8	3	no	dry	
Trees	Māhoe/whitey wood	Melicytus ramiflorus	5	4	no	dry	
Trees	Kohuhu	Pittosporum tenuifolium	6	3	no	dry	
Trees	Tarata	Pittosporum eugenoides	6	3	no	dry	
Trees	Mānatu/ribbon wood	Plagianthus regius	10	3	no	dry	
Trees	Horoeka/ lancewood	Pseudopanax crassifolius	5	1	no	dry	
Palm	Nikau	Rhopalostylis sapida	10	3	no	dry	Very slow growing
Trees	Kowhai	Sophora microphylla	4	3	no	dry	