

The background image shows a lush green landscape. In the foreground, there is a concrete curb or edge. Behind it, there are dense, vibrant green plants with long, narrow leaves, possibly a type of iris or similar aquatic plant. In the background, there is a dense stand of tall, thin grasses or reeds, some with light-colored seed heads. The overall scene is a natural, green environment.

AUCKLAND TRANSPORT

Bioretention Design Guide

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1. Context and document purpose

This document is intended to assist with the design of raingardens located within the road corridor¹. It provides insight into design details that Auckland Transport looks at when assessing consent and engineering approval applications for the capture and treatment of runoff from impervious surfaces.

This advice is supplementary to, and draws upon, the following documents:

- Auckland Council, Stormwater Management Devices in the Auckland Region (2017) ('GD01')²
- Auckland Council, Water Sensitive Design for Stormwater (2015) ('GD04')³
- Auckland Transport, Roads and Streets Framework⁴
- Auckland Transport, Transport Design Manual ('TDM')⁵
- Auckland Transport Bioretention Planting Guide⁶

The above documents address stormwater treatment device selection, siting, design and plant selection. This supplementary guidance is not a substitute for those detailed design documents.

Stormwater design is part of a wider and often iterative approach to determine the most appropriate lot and roading layout for the nature of the surrounding environment, the specific stormwater catchment, and Auckland's commitment to sustainable development and green infrastructure. The achievement of positive social, cultural and environmental outcomes should be considered. This is consistent with Auckland Council's approach, which is defined by strategic documents that include:

- Auckland Council Plan 2050 - Outcomes: Environment and Cultural Heritage⁷
- Auckland Council Plan 2050 - Outcomes: Transport and Access⁸
- Low Carbon Strategic Action Plan – Our built environment and green infrastructure⁹

2. Overview of raingardens

Raingardens in the road corridor are intended to mimic natural processes to treat road runoff, as well as adding to the streetscape. These stormwater treatment devices are primarily intended for quality treatment, due to their ability to remove pollutants by absorbing and filtering runoff through carefully selected plants and soil media. This quality treatment role is particularly relevant for runoff

¹ road corridor: area between opposite private boundaries, including the road pavement, footpaths, berm, cycle facilities (if applicable) and vehicle crossings

² Commonly referred to as GD01: Auckland Council, Dec 2017. *Stormwater Management Devices in the Auckland Region*, Guideline Document 2017/001 Version 2 - web link: [http://content.aucklanddesignmanual.co.nz/regulations/technical-guidance/Documents/GD01%20SWMD%20\(Amendment%202\).pdf](http://content.aucklanddesignmanual.co.nz/regulations/technical-guidance/Documents/GD01%20SWMD%20(Amendment%202).pdf)

³ Commonly referred to as GD04: Auckland Council, Mar 2015. *Water Sensitive Design for Stormwater*, Guideline Document 2015/004 - web link: <http://content.aucklanddesignmanual.co.nz/regulations/technical-guidance/Documents/GD04%20WSD%20Guide.pdf>

⁴ Web link to pdf download for AT Roads and Streets Framework: <https://at.govt.nz/media/1976084/roads-and-streets-framework-webcompressed.pdf>

⁵ TDM: Transport Design Manual— web link: <https://at.govt.nz/about-us/manuals-guidelines/transport-design-manual/>

⁶ Auckland Transport Bioretention Planting Guide—draft document utilised as part of the development of this design guide.

⁷ Web link: <https://www.aucklandcouncil.govt.nz/plans-projects-policies-reports-bylaws/our-plans-strategies/auckland-plan/environment-cultural-heritage/Pages/default.aspx>

⁸ Web link: <https://www.aucklandcouncil.govt.nz/plans-projects-policies-reports-bylaws/our-plans-strategies/auckland-plan/transport-access/Pages/default.aspx>

⁹ Web link: <https://www.aucklandcouncil.govt.nz/plans-projects-policies-reports-bylaws/our-plans-strategies/topic-based-plans-strategies/environmental-plans-strategies/docslowcarbonaim/low-carbon-strategic-action-plan-infrastructure.pdf>

from high vehicle usage roads, e.g. for the removal of heavy metals from wear on tyres and brake pads, and polycyclic aromatic hydrocarbons ('PAHs') originating from vehicle exhausts and oil leaks.

Raingardens are sometimes proposed to help reduce the volume of road runoff into the receiving environment. However, their ability to do so is dependent on the nature of the underlying soils. Heavily earth worked development sites and soils with low permeability, can create issues with the ability of roadside raingardens to store runoff. While raingardens can be utilized to meet SMAF detention requirements, they are best suited for meeting water quality and retention requirements. Auckland Transport **does not support the use of raingardens for detention only** (i.e., where there is no statutory requirement for treatment and retention is unable to be achieved due to ground conditions) as these have been shown to be costly to maintain and ineffective.

Raingardens are traditionally constructed in-situ, cut into the natural ground with battered sides and a trapezoidal cross-section. An alternative to the cut batter raingarden is a purpose-built concrete 'box' raingarden¹⁰. There are several concerns around this type of design, particularly where many small concrete box raingardens are proposed with limited evidence of other options being considered, and limited consideration of potential adverse community impacts - e.g. safety, increased time, costs and disruption to maintain many small roadside raingardens.

It is essential that the decision to construct raingardens within the road corridor is made based on a comprehensive options assessment for stormwater treatment devices. This assessment is required to follow evaluation principles and desired outcomes (for management of water quality, water quantity, or both) as prescribed within Auckland Council stormwater guidance, including GD04, GD01, the Auckland Network Discharge Consent (NDC) and the AT design guidelines. Raingardens are primarily a 'bioretention device' and acceptance as an asset for vesting to Auckland Transport would only be in instances where water quality treatment or retention of stormwater is a specific requirement under the Auckland Unitary Plan (Operative in Part).

There may be instances where the result of an options assessment is the proposed use of raingardens, but Auckland Transport design preferences cannot be achieved. It may be necessary to adopt a 'best practicable option' (BPO) approach to consider other solutions.

3. What does Auckland Transport consider?

If raingardens are deemed to be appropriate via a justified and suitable options assessment, Auckland Transport will consider not only the effectiveness of the raingarden's stormwater function, but also asset integrity and maintenance requirements, life cycle costs, and health and safety (to road users and during maintenance etc.). Consideration is given not only to internal raingarden elements, but also to implications for the construction, maintenance and use of adjacent road space e.g. the berm, footpath, kerb and channel, and pavement. This multi-faceted approach brings together a range of environmental and effect-based objectives established under the Resource Management Act (1991)¹¹, as well as asset owner and value for money considerations established under the Local Government Act (2002) and AT-TDM.

As an overview, Auckland Transport reviews proposals for roadside raingardens in terms of:

- appropriateness of raingarden selection for the specific location/site

¹⁰ 'Box' is considered to also include structures created onsite from concrete panels, on some but not necessarily all sides.

¹¹ RMA objectives filtering down through various national and regional statutory documents

- ability to ensure effective entry and exit of runoff to/from road
- safety implications of other road users at the raingarden edge – e.g. drop-off from kerb and footpath, potential risk for pedestrians and people on bikes
- ease to maintain – addressing both safety in design, and capital and operational costs
- structural integrity – of both the raingarden and the adjacent road pavement

The 'Typical raingarden cross section / internal design elements' has been adopted from GD01, with a focus on the internal workings and design elements of a raingarden (refer to Fig 3-1 in GD01). The cross-section in GD01 is based on a traditional cut batter side raingarden, suitable for use roadside (space dependent), in carparks, or in greenspace. Auckland Council is primarily responsible for ensuring that proposed raingarden designs, including those within the road, meet design parameters set out within GD01.

The only extent to which GD01 addresses external design features is the broad identification of the need for structural support at the raingarden edge. This will vary according to the raingarden location, soil properties etc. Auckland Transport has identified further specifics for structural support requirements in the road corridor, e.g. to support the road and the footpath (*Refer to Appendix 1*). Auckland Transport also focuses on the design for, and relationship between, the raingarden and the adjacent road space, addressing a range of safety, structural, maintenance and operational aspects (*Refer to Appendix 1*).

Table 1: 'Auckland Transport defined design elements of raingardens in the road corridor' combines these internal and external design elements. The internal design elements of raingardens, as established under GD01 and considered by Auckland Council from a wider stormwater treatment perspective, are identified as internal elements 1 – 10, while external / road related elements focused upon by Auckland Transport are identified as external elements 1 – 6.

TABLE 1: AUCKLAND TRANSPORT DEFINED DESIGN ELEMENTS OF RAINGARDENS IN THE ROAD CORRIDOR

Raingarden Design Elements
<i>Internal design elements, common to all raingardens</i>
1. Inlet erosion material
2. Ponding area
3. Mulch layer
4. Media
5. Overflow (bypass system)
6. Underdrain (perforated / slotted pipe)
7. Planting
<i>Optional internal elements depending on the raingarden function</i>
8. Transition layer
9. Drainage layer
10. Storage layer
<i>External design elements, for raingardens in the road corridor</i>
1. Interface with kerb and channel, including inlet / outlet (bypass flow)
2. Interface with footpath edge (including drop-off from kerb and footpath)

3. Interface with grass berm / adjacent parking / vehicle crossing / pram crossing, for both upstream and downstream ends
4. Structural support – for the road pavement / carriageway, and the raingarden fill material/s
5. Underdrain pipe connection to outlet (catchpit)
6. Check dam – *only required where a multi-unit / bay stepped raingarden is proposed to suit the road slope. For effective areas required for treatment performance and planting, check dams need to be twice the width (i.e. 2x2.5 between check dams).*

4. What does Auckland Transport want?

4.1. Overarching design approach

Consideration of stormwater early in the development design process is crucial to ensure an appropriate road layout that does not result in compromised stormwater management. If Auckland Transport's overarching design preferences cannot be achieved, roadside raingardens may not be a suitable option.

Desired approach	Design basis
✓ Check that supporting documentation demonstrates clear reasoning and justification for the selection of raingardens over other stormwater treatment options. ✓ Check that raingarden design demonstrates a site-specific basis. ✓ Check that supporting documentation demonstrates consideration of whole of life costs, and long-term implications / impacts for maintenance and renewal. ✓ Check that the proposed type of raingarden aligns with Auckland Transport design requirements. As per the TDM, concrete raingarden structures should be <u>avoided</u> where possible.¹³ ✓ Check that geotechnical aspects have been adequately considered.	<i>This is in accordance with a best practicable option (BPO) approach, guided by whether treatment goals for the site relate to quality, quantity, or both.</i> <i>A site specific, BPO approach is required. A repeated reliance on prefabricated concrete box raingardens is unlikely to reflect a site specific and holistic approach to stormwater design.</i> <i>Raingardens can be more expensive to maintain in the road corridor than other types of treatment devices. Applicants need to demonstrate a considered decision-making process, including life cycle costings and provision of an O&M¹² guide.</i> <i>Auckland Transport's preference is for cut batter raingardens. Concerns with concrete box raingardens include compromised plant health due to concrete's high thermal mass and heat adsorption properties.</i> <i>This is for infiltration ability (if required) and to ensure that structural integrity of the road corridor is maintained, particularly during construction and maintenance or renewals.</i>
✓ If multiple raingardens are proposed, check that approach aligns with Auckland Transport TDM requirement whereby drainage design favours fewer, larger raingardens.¹⁴	<i>Auckland Transport will not accept many small raingardens when fewer larger raingardens are possible. Catchment per raingarden should be maximised and/or explore opportunities of communal device(s) for the catchment with Auckland Council.</i>

¹² Operations and Maintenance guide

¹³ TDM, Road Drainage Chapter, Section 4 Stormwater management devices

¹⁴ TDM, Road Drainage Chapter, Section 4 Stormwater management devices

Desired approach	Design basis
✓ Check that the proposed raingarden sizing aligns with Auckland Code of Practice for Land Development and Subdivision Chapter 3 Transport requirements for minimum raingarden size. Also check that the width is no less than 2.5m (including battered sides).	<i>Auckland Transport has concerns around plant health in small raingardens. Narrow rain gardens (1-1.5 m wide) with hard surfaces on each side (e.g. concrete) and steep banks have more plant damage, compromising effective rain garden function. Small raingardens are also considered more problematic for efficient and cost-effective maintenance and renewals.</i>
✓ Check that raingarden design takes into account advice provided to support plant growth and optimise survival rates, as set out with Auckland Transport's Bioretention Planting Guide.	<i>Compromised health in raingarden plants cause concern for Tikanga Māori principles, effective stormwater treatment, and replanting costs.</i>
✓ Check that maximum longitudinal road slope of 5% is not exceeded, and that raingarden bed is designed to be flat with the inlet positioned to enable overflow back to the kerb.	<i>Auckland Transport will not accept raingardens on roads greater than a 5% slope. This limit is based on achieving balance between required ponding depth and frequency of check dams.</i>
✓ Check that any proposed design for stepped raingardens meets Auckland Transport's design requirements.	<i>Stepped raingardens introduce additional complexities, . The drop from an adjacent footpath (and roadside parking) into the raingarden increases and the associated mitigation can be problematic.</i>

4.2. Internal design elements

Below are internal raingarden design features that Auckland Transport gives consideration to, on the basis that they can lead to poor outcomes if not appropriately addressed during design. Auckland Transport's requirements for these specific internal design elements are outlined below. In addition to this 'checklist', both GD01 and the TDM (Road Drainage chapter, plus accompanying standard details and specifications) should also be referred to as part of the design process.

4.2.1. Inlet erosion material

- ✓ Check that inlet erosion material is not set too high relative to inlet invert level, with top of erosion material to be at least 40mm below inlet invert level. This is to avoid the risk of inlet blockage due to sediment build up between maintenance cycles.
- ✓ Check that inlet erosion material can readily facilitate the removal of accumulated sediment, and that is of sufficient size and appropriate design to stay in place over time.

4.2.2. Ponding area

- ✓ Check that the top of the ponding level matches to the kerb inlet invert. This is to ensure that water flows into the raingarden and an unnecessarily large drop is not created by setting the ponding level too low.
- ✓ GD01 specifies a minimum ponding layer depth of 100mm for water quality only and 150mm for SMAF 2 areas. Check that this is appropriately designed for. Maximum ponding depth in RG within road corridor is not to exceed 150mm. *(Note: the cross-section in Appendix 1 has 300mm total, however, this is 'down' batter slopes and not a vertical drop).*

4.2.3. Mulch layer

- ✓ Check that sufficient drawing detail is provided for the mulch layer, particularly near the raingarden inlet. This is to avoid overfilling of mulch during construction, and resulting issues for inlet blockage.
- ✓ The mulch layer is not to be relied upon for slope stability, due to the risk of settlement creating an increase the drop off depth into raingardens.
- ✓ Check that design and specifications for the mulch layer are in accordance with the Auckland Transport Bioretention Planting Guide and Auckland Council technical report TR2013/56 (TR56): *Mulch specification for Bioretention Stormwater Treatment Devices*. This is to achieve a consistent and high-quality approach, maximising opportunities for plant health and long-term device performance.

4.2.4. Media

- ✓ Check that proposed raingarden design shows media placed in horizontal layers, to facilitate an even flow of water.
- ✓ Check that design, specifications, and laboratory testing for the media layer are in accordance with GD01 requirements for drainage media. In-situ infiltration testing is to be carried out one month prior to 224c application and the results provided to Auckland Transport.

- ✓ Check that media is installed in layers no greater than 300mm and is thoroughly wetted prior to installation of the next layer. This is aimed at mitigating settlement, which can increase the drop off depth into raingardens.
- ✓ Check the media for settlement at 12 months post construction, to ensure that the maximum drop off depth into the raingarden is less than 150mm. Add more media if needed, rather than mulch.

4.2.5. Overflow (bypass system)

- ✓ Auckland Transport preference is for no cascade flow between raingarden 'units/cells' and for water to overflow back to the kerb.
- ✓ Check that overflow (bypass system) has been designed and constructed to provide the required ponding depth.

4.2.6. Underdrain (perforated / slotted pipe)

- ✓ Check that pipe size/material corresponds to Auckland Transport's requirement of 150mm diameter slotted uPVC pipe manufactured to AS2439.1.
- ✓ Check that only a nominal longitudinal slope of 0.5% to match drainage layer slope.
- ✓ Check that design shows how access is provided for flushing and cleaning.
- ✓ Check that raingarden pipework bends are 45 degrees or less, to facilitate maintenance.

4.2.7. Planting

- ✓ Check that design and specifications for plant selection, planting and care are in accordance with the Auckland Transport Bioretention Planting Guide.

4.2.8. Optional: Transition layer

- ✓ Check that transition layer meets requirements under GD01, i.e. clean, well graded gravel (2-7mm diameter) with minimal fines, and 100mm depth. A geotextile must not be used.

4.2.9. Optional: Drainage layer

- ✓ Check that drainage layer meets requirements under GD01, i.e. clean, washed peas gravel (approximately 10mm diameter) with little/no fines and a minimum infiltration rate of 4,000mm/hr. Layer depth is to be at least 200mm, graded at a minimum of 0.5% towards the outlet and with a minimum of 50mm cover above the underdrain.

4.2.10. Optional: Storage (retention) layer

- ✓ Check that drainage layer meets requirements under GD01, i.e. clean, washed peas gravel (approximately 10mm diameter) with little/no fines and a minimum infiltration rate of 4,000mm/hr. Layer depth is to be at least 450mm, with no impervious liner.

4.3. External design elements

Below are external design features that Auckland Transport gives consideration to, in terms of how the device interacts with the surrounding road corridor. These elements have been identified as those that, if not adequately addressed during design, can lead to poor outcomes for safety, construction and use, and maintenance and renewal (for both the raingarden and surrounding road features).

Auckland Transport's requirements for these specific external design elements are outlined below. In addition to this 'checklist', both GD01 and the TDM (Road Drainage chapter, plus accompanying standard details and specifications) should also be referred to as part of the design process.

4.3.1. Interface with kerb and channel, incl. inlet / outlet

- ✓ Check that lateral support/kerb and channel design will withstand vehicle wheel impact.
- ✓ Check that the kerb inlet channel invert is well-shaped to direct flow into the raingarden.
- ✓ Check that kerb inlet is designed to support ease of maintenance, e.g. minimum of 300mm wide to fit shovel/spade (for clearing).
- ✓ Check that Auckland Transport TDM requirements for kerb interruptions are achieved, i.e. interruptions (e.g. inlet) no more than 300mm wide and no closer than 600mm apart, with inlet capacity designed as a weir.
- ✓ Check that no catchpit is proposed to be located within the extent of raingardens.
- ✓ Check that there are no potential conflicts between roadside parking and raingardens, including any safety risk to people exiting from a parked vehicle adjacent to a roadside raingarden. A raingarden may not be appropriate where parking is required, or parking should not be permitted.

4.3.2. Interface with footpath edge or cycle facility

- ✓ Check that a 500mm buffer is provided between the edge of the raingarden and an adjacent footpath/cycle facility. This is to mitigate safety risk to pedestrians¹⁵ and people on bikes, and eliminate the need for path thickening.
- ✓ Check that the top of the media layer/mulch layer has a 1V:3H slope from the edge of the buffer down into the raingarden.
- ✓ Check that the buffer design considers what is proposed either side of the raingarden and makes appropriate provisions.
- ✓ Check that a connection detail is provided for securing any impermeable liner edges to a suitable fixing point/s.
- ✓ Check parking restriction in front of the roadside raingarden is in place (NSAAT).

¹⁵ Safety concerns arise from drop-off height between footpath and rain garden surface, and risk of pedestrians inadvertently 'falling' into the raingarden.

4.3.3. Interface with other road features – berm, parking, vehicle / pram crossings, upstream and downstream ends

- ✓ Check that raingarden's impact on, and relationship with, other road features has been considered, e.g. grass berm, adjacent parking, vehicle and pram crossings.
- ✓ Check that Auckland Transport design preference is met for a 500mm buffer at either end of raingarden. This is to mitigate safety risk to pedestrians¹⁶, and provide a buffer for vehicles using parking or a vehicle crossing.
- ✓ Provide maintenance workman vehicle parking bays adjacent to the raingarden

4.3.4. Structural support

- ✓ For cut batter raingardens, check that raingarden sides are designed at 1V:1H to ensure slope stability. This is to allow for partial or full removal/replacement of raingarden (layers) during maintenance/renewal, as well as the period between excavation and filling.

4.3.5. Underdrain – pipe connection to outlet (catchpit)

- ✓ Check that catchpit locations are optimised for efficient collection of road runoff first and foremost, rather than as a connection point for a raingarden.
- ✓ Check that pipework is non-perforated/slotted uPVC and bends are no more than 45 degrees, to facilitate maintenance.
- ✓ Check design for connection between the raingarden outlet and downstream stormwater network. The use of a solid carrier type pipe to connect to a catchpit is acceptable, as is the use of short lengths of solid carrier type drain to join raingardens. Check if additional maintenance access points are required for rodding/flushing (dependent on pipe length).
- ✓ Check if a downstream catchpit is readily available for connection. If not, then consider connection to a nearby stormwater manhole. If this is not practical then connection to a nearby stormwater line may be acceptable - check that connection detail meets Auckland Council requirements.

4.3.6. Check dam

- ✓ Check that a clear design basis is shown for proposed use of check dams, related to road slope and raingarden size.
- ✓ Check that material used for check dam is appropriate for use in a raingarden, e.g. durable, inert / non-toxic, readily available (for replacement).
- ✓ For effective areas required for treatment performance and planting, check dams need to be twice the width (i.e. 2x2.5 between check dams).
- ✓ Check dam vertical drop not to exceed 150mm on road and footpath side(s).

5. Roadside raingarden examples

Shown below are a variety of roadside raingardens in the Auckland region. They are at differing levels of completion and growth but do illustrate some of the design features desired by Auckland Transport, as well as some that are not so desirable.

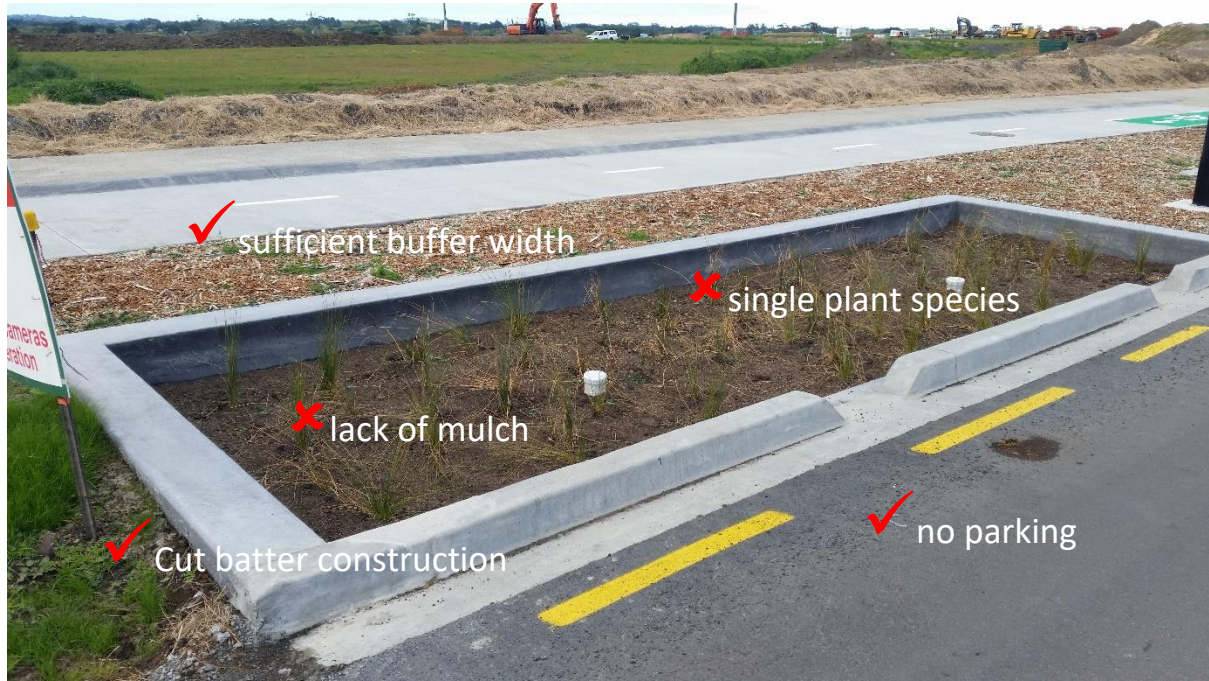


FIGURE 5-1: CUT BATTER ROADSIDE RAINGARDEN, WITH CONCRETE BORDER (1)



FIGURE 5-2: CUT BATTER ROADSIDE RAINGARDEN, WITH CONCRETE BORDER (2)



FIGURE 5-3: RAINGARDEN WITH INLET ISSUES



FIGURE 5-4: CONCRETE BOX ROADSIDE RAINGARDEN (1)



FIGURE 5-5: CONCRETE BOX RAINGARDEN (2)

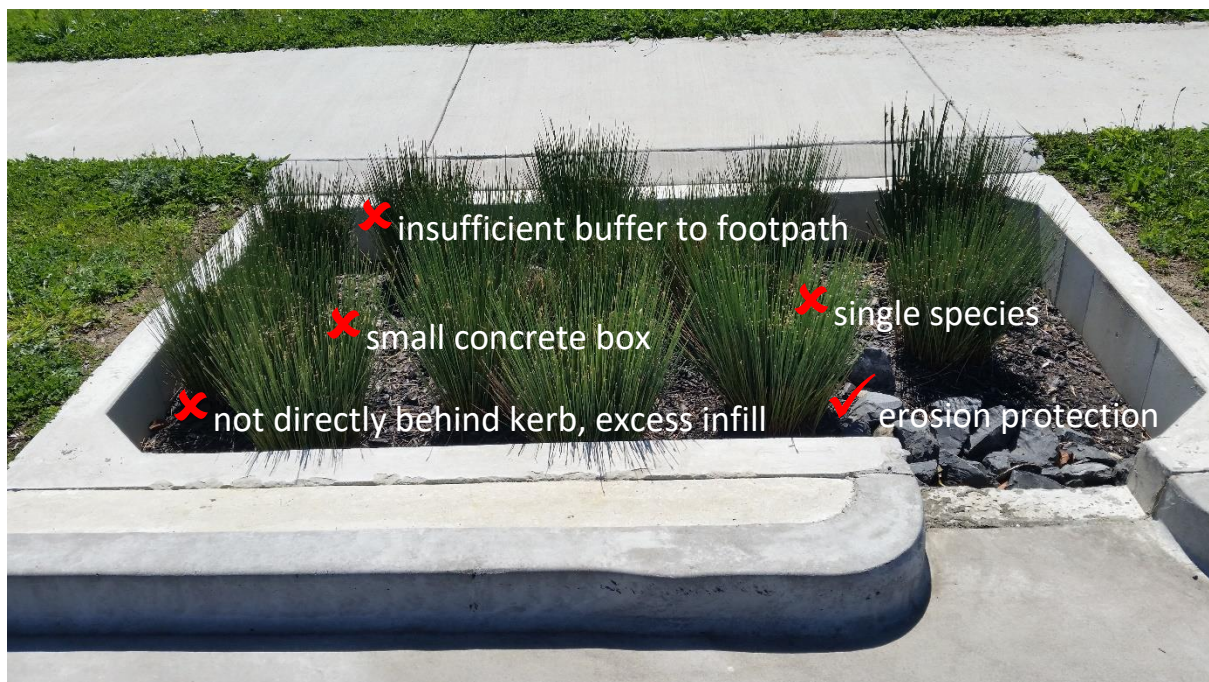


FIGURE 5-6: CONCRETE BOX RAINGARDEN (3)

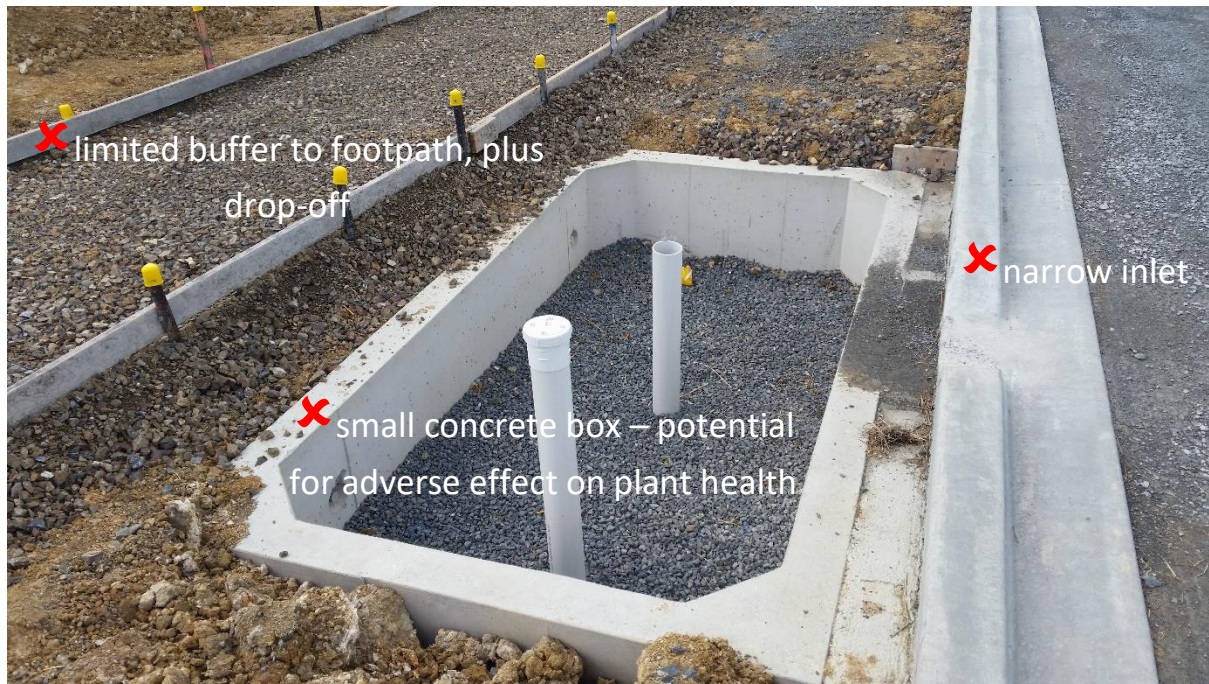


FIGURE 5-7: CONCRETE BOX RAINGARDEN (4)

Appendix 1:

The cross-section below encompasses the design and health and safety considerations for roadside raingarden(s).

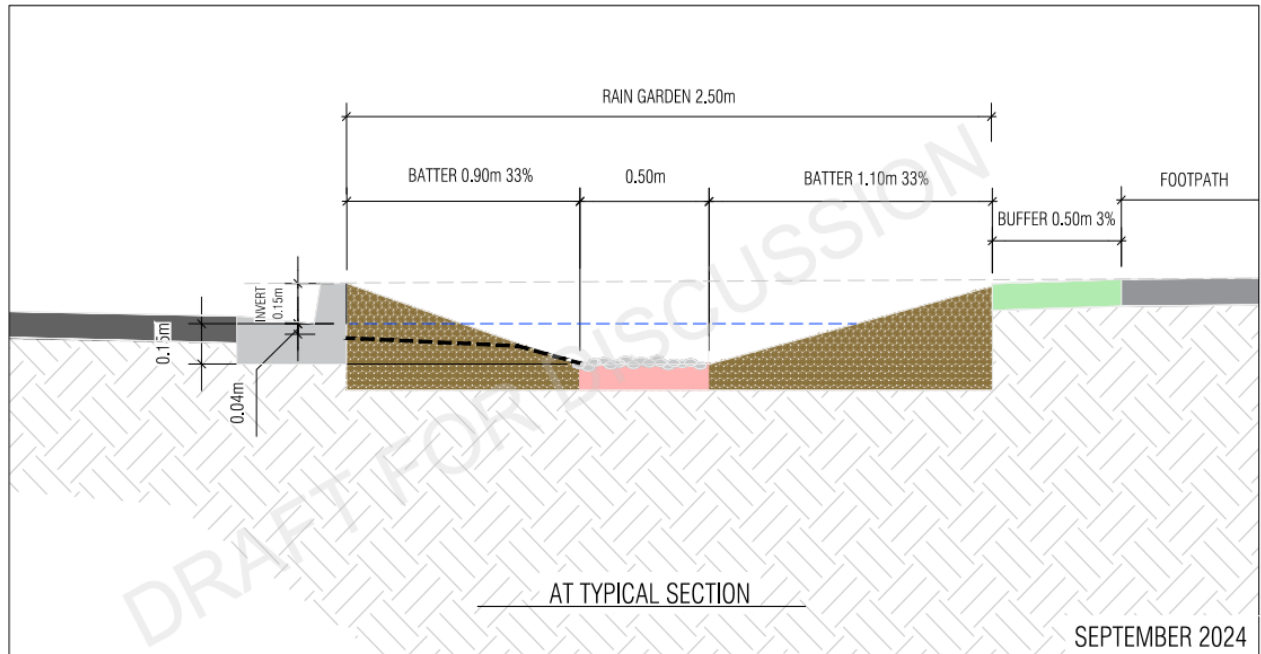


Figure 6: Cross-section of a typical AT roadside raingarden