4. STREETSIDE STORMWATER PLANTER

4.1 DESCRIPTION

A streetside stormwater planter is a type of bioretention facility located within the street right-of-way (ROW) in the amenity zone between the street and the sidewalk. A streetside stormwater planter is intended to provide water quality treatment of runoff from the street and adjacent pedestrian zone and may also be designed to treat runoff from adjacent private development. Stormwater runoff enters the streetside planter through a curb opening and chase type inlet, spreads over the planting media, infiltrates vertically downward, and exits through an underdrain. Treatment processes include filtration, absorption and adsorption, and plant uptake. A variety of vegetation can be established in streetside stormwater planters including grasses, perennials, shrubs, and a limited number of trees.

Except as noted, a streetside stormwater planter follows the design guidance provided in the Bioretention Fact Sheet in Urban Drainage and Flood Control District's (UDFCD) Urban Storm Drainage Criteria Manual, Volume 3 (USDCM Vol. 3). This fact sheet provides specific design guidance for the application of bioretention to a streetside stormwater planter. Detailed drawings and notes are provided at the end of this fact sheet to further illustrate the design of streetside stormwater planters.

Figure 7 illustrates how a streetside stormwater planter can be integrated into the amenity zone of a typical street section. The figure shows the basic elements of the planter in cross section and in perspective. Figure 8 represents an isometric diagram of a streetside stormwater planter.

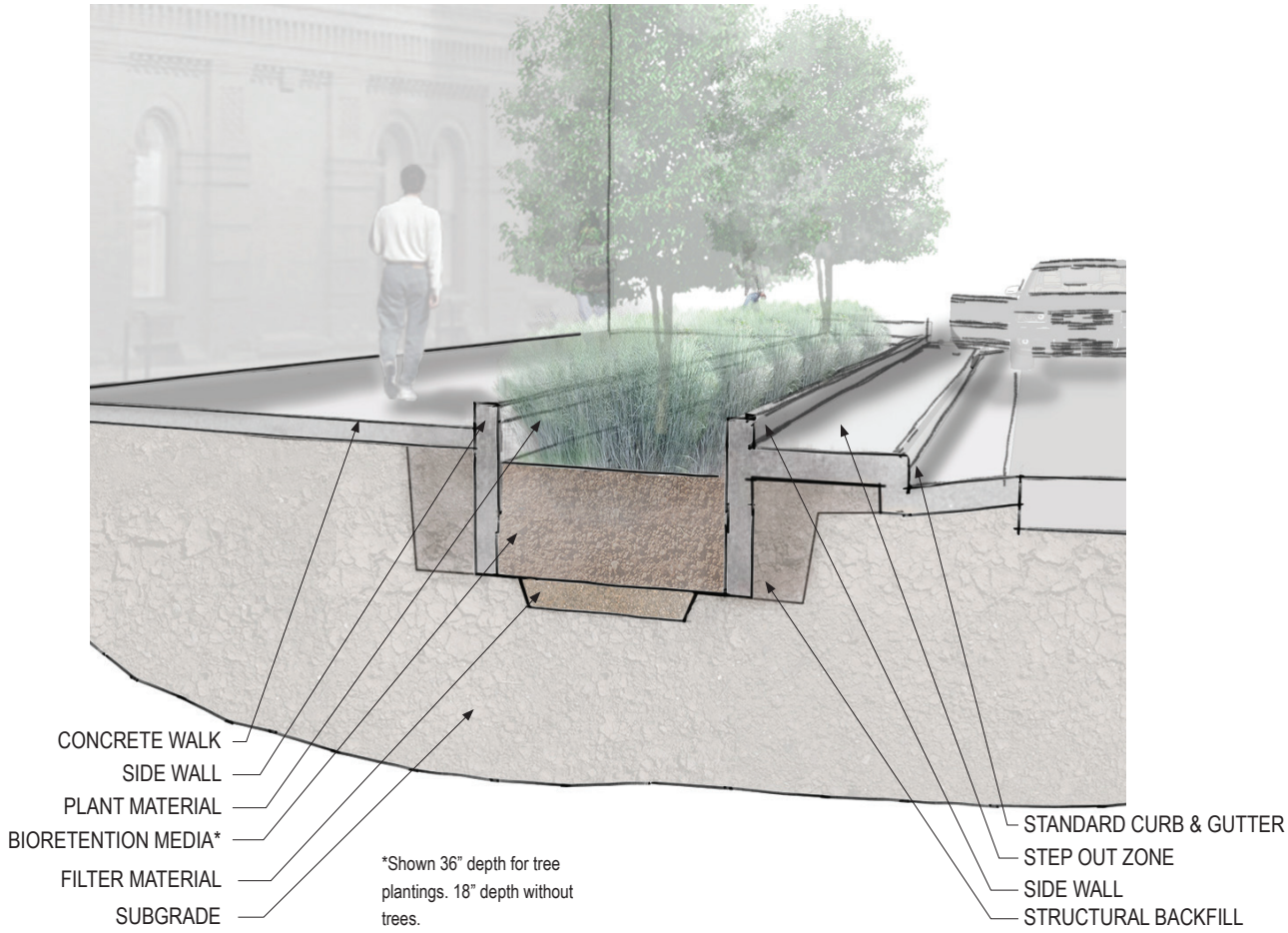
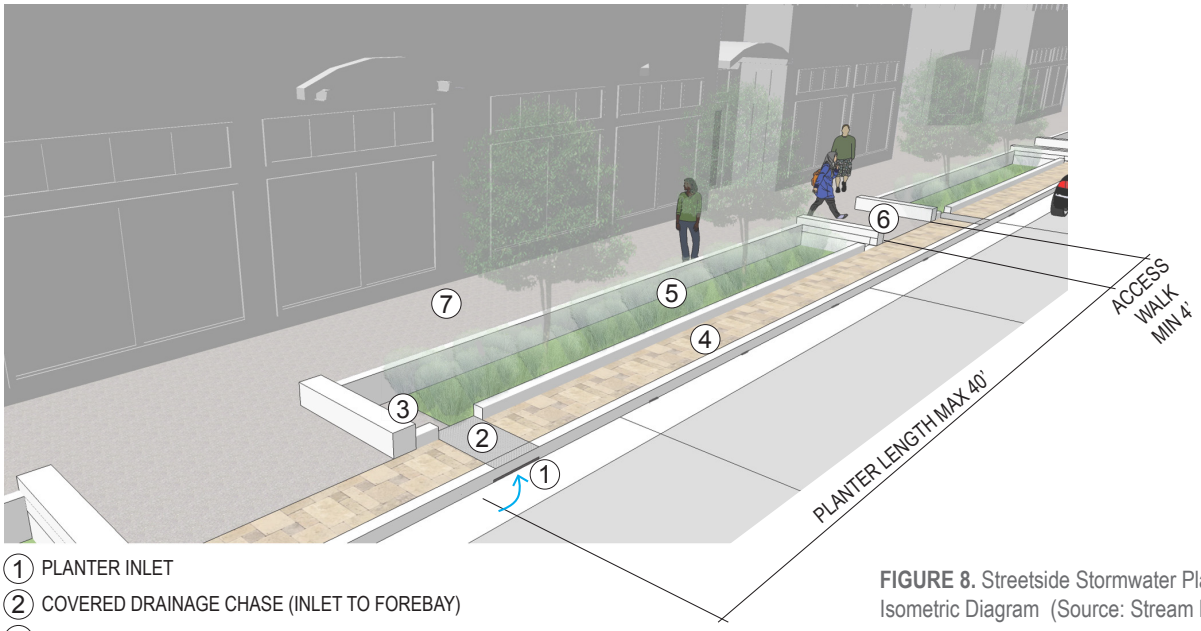


FIGURE 7: Streetside Stormwater Planter
(Source: Stream Design. 2015.)



1 PLANTER INLET
2 COVERED DRAINAGE CHASE (INLET TO FOREBAY)
3 FOREBAY (SEDIMENT COLLECTION)
4 STEP-OUT ZONE
5 PLANTING AREA (IRRIGATED)
6 ACCESS WALK
7 PEDESTRIAN SIDEWALK

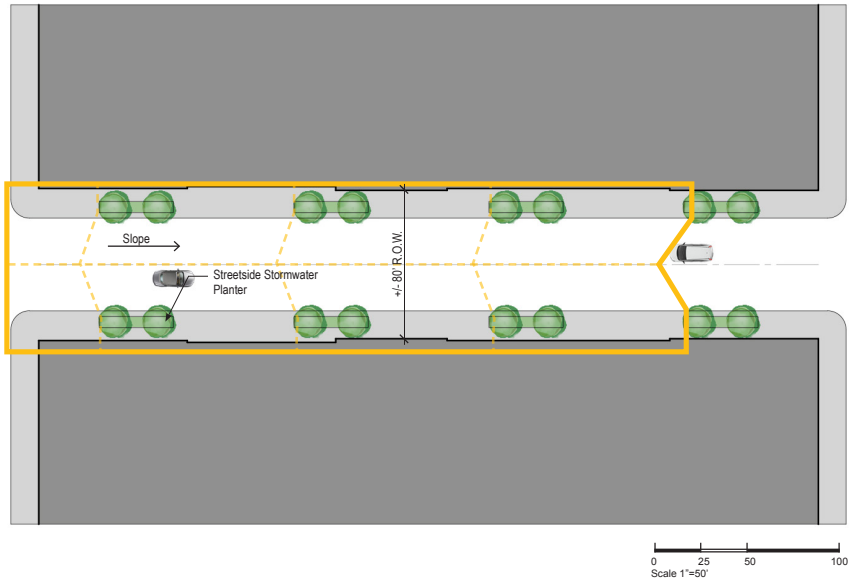
FIGURE 8. Streetside Stormwater Planter Isometric Diagram (Source: Stream Design.2015.)

4.2 USES AND RECOMMENDATIONS

Streetside stormwater planters can be created in mid-block locations or near corners on streets that do not receive a deleterious amount of deicing salts. Sizing and locating planters requires a determination of the area draining to the planter. There is a specific drainage area associated with a certain size of planter and it is necessary to place the planter in a location that has this upstream area draining to it. As such, the upstream end of a block is generally not an effective place to install a planter, while mid-block or the downstream end of a block is usually conducive. Adjustments can be made to locations and planter sizes to arrive at a properly sized facility in a desirable location. Siting streetside stormwater planters is also influenced by the presence of a storm drain system; ideally, a nearby inlet or manhole provides a convenient location in which to discharge a planter underdrain. If serving just the public right-of-way (ROW; the street and pedestrian zone), three to four streetside stormwater planters measuring 6 by 40 feet (outside dimensions) can satisfy the water quality requirements for an impervious area measuring 420 feet (a typical city block) by 30 to 34 feet (street crown to ROW) for Denver's local and collector street classifications. Five to seven streetside stormwater planters this size would be necessary to serve the water quality needs of a city block (crown to ROW) of Denver's four lane and six lane arterial classifications. If a portion of the adjacent private development is also served, additional planters would be necessary. If the planter length was limited based on steeper street slope to less than 40 feet, a greater number of planters would be necessary.

Figure 9 illustrates the layout of streetside stormwater planters measuring 6 by 40 feet (outside dimensions) for the drainage area shown in orange. This is based on a street crown to ROW distance of 40 feet.

Streetside stormwater planters can be implemented in various combinations with the other types of green infrastructure described in these fact sheets. Table 1 in the Introduction provides information on approximate drainage areas that can be treated by various types of green infrastructure BMPs.



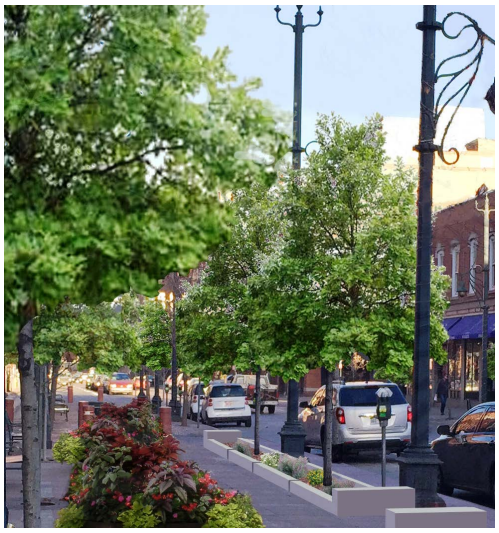


FIGURE 10. Streetside Stormwater in Urban Landscape (Source: Tetra Tech.2015.)

4.3 PLANTER AESTHETICS AND URBAN DESIGN

Streetside stormwater planters can be valuable amenities to the urban landscape if designed properly. Designers should take design cues from the surrounding streetscape (if improved) and/or special district urban design elements and materials. Planters should match or complement the larger urban context, as well as add value to the adjacent properties. Since planters are located within the public right-of-way, it is imperative that the design detailing for the planters is uniform within each block and preferably within each district or neighborhood. Figure 10 illustrates how streetside stormwater planters can be integrated into the urban landscape. Pedestrian access and safety considerations are discussed in the Design Criteria section of the Introduction. Use of sidewalls and end walls are recommended to discourage the deliberate or inadvertent entry by pedestrians, because the top of the planting media in the planters is depressed below the elevation of the sidewalk. While concrete curbs and walls and standard steel railings are part of a typical design palette, designers may explore the use of other materials, such as stone, railings, etc. All designs should comply with the City of Denver Streetscape Design Manual as well as the Public Works Transportation Standards and Details. In the event of conflicting criteria, these criteria supersede when constructing BMPs included in this manual.

4.4 GEOMETRY

The conceptual design details included in this fact sheet illustrate the geometry and design features of a streetside stormwater planter. The details are intended to provide a basis for the designer's final construction documents, although a site-specific design will be necessary addressing geotechnical issues, structural design, utility protection and relocation, tying in underdrain to a downstream storm drain or outfall, irrigation design, vegetation plan, and associated final design and construction document preparation tasks.

WIDTH

Normally, planters should be made as wide as possible within the available ROW based on desired widths of the step-out zone and sidewalk. Although these dimensions may vary, especially in older built-out areas, a typical width for a streetside stormwater planter with a stepout zone of 2.5 feet is six feet. Planters that have a minimum inside width of 5 feet can

incorporate trees. For situations where less ROW is available, the width may need to be reduced; however, there is a practical minimum below which it may not make sense to incorporate a streetside stormwater planter.

LENGTH

Section 2.2 Design Criteria (page 4) provides a discussion of design considerations associated with planter length. Those considerations translate into a typical range of lengths from about 20 feet to a maximum of 40 feet with adjacent access points on the ends at least four feet wide.

PROFILE

As mentioned in Section 2.2 Design Criteria, it is recommended that the top of the bioretention media be horizontal in longitudinal profile and that the top of the side walls be configured to be parallel to the sidewalk at a height of 6 inches or greater, as shown in the details.

If openings in the sidewall along the sidewalk are not used to provide drainage into the planter, the top of the walls can be designed to be horizontal, parallel to the top of the media, for the whole length of the planter. In this case, the water quality water surface can be retained within the planter even with steeper street slopes, as discussed in Section 2.2 Design Criteria of the Introduction.

4.5 PLANTER DESIGN CONSIDERATIONS

WQCV ZONE

In keeping with USDCM Vol. 3 criteria for bioretention facilities, a water quality capture volume (WQCV) zone is required above the planting media. This zone is measured from the top of the media to the elevation of the flow line at the inlet that controls when water will start to flow out of the planter and down the gutter. Although it is possible to design stormwater planters with a water quality depth as great as 12 inches, from an aesthetic standpoint it is desirable to keep the top of the media as high as possible relative to the adjacent sidewalk elevation. For this reason, the top of media will typically be set 6 inches to 9 inches below the water quality water surface. The details at the end of this fact sheet illustrate the critical flow line elevation that defines the water quality water surface.

In addition to the surface volume extending from the top of the media up to the water quality water surface, the volume of the pore spaces in the media equivalent to 14 percent of the media and filter material volume can be counted toward the required WQCV in the ultra-urban green infrastructure BMPs documented in this manual. This pore space volume was selected based on testing of media approximately 24 hours after saturation. As stated in Section 2.2 Design Criteria, the required WQCV for the upstream area draining to a streetside stormwater planter shall be computed using the procedures in Volume 3 of the USDCM. It is important to ensure that the area of the filter (the flat surface of the bioretention media) is sized appropriately for the tributary area. The filter area shall be no less than 2 percent of the upstream area draining to the planter.

INLET AND SEDIMENT COLLECTION PAD

A concrete sediment collection pad is recommended immediately downstream of the inlet to dissipate energy and collect a portion of the sediment and debris entering the planter for subsequent removal during maintenance operations. Additional information on inlet layout and sizing is provided in Section 2.2 Design Criteria.

OTHER PLANTER COMPONENTS

Section 2.2 Design Criteria provides information regarding the following components of a streetside stormwater planter:

- bioretention media
- underdrain system
- walls
- sidewalk drainage
- spillway
- liner

4.6 VEGETATION
TYPICAL PLANTING PLANS

General information on plant selection, critical success factors for establishment, and maintenance considerations are discussed in Section 2.2 Design Criteria of the Introduction. Typical planting plans specific for a streetside stormwater planter are described in this section. Trees are optional in these planters but may be used to meet tree right-of-way tree requirements where applicable. If trees are utilized the depth of media shall be increased to 36 inches. If trees that create dense shade are utilized, designers may opt to use more shade tolerant grass species. A recommended plant list is provided in Appendix C; a list of suitable trees is provided in Appendix D.

Custom planting designs should be developed for each project. Designs should take into account site characteristics such as shade, urban or residential character, planter size, and above all, anticipated maintenance schedule and responsibilities. Designs should also reflect neighborhood or district-wide planting approaches and plant palettes. Several typical planting plans are provided below. These are intended to provide examples of different planting approaches in a range of styles and maintenance levels. The use of non-plant landscape materials such as stone or boulders is not recommended as it will reduce infiltration. Regardless of the type of planting plan, a zone of dense vegetation is recommended adjacent to the concrete sedimentation pad to help dissipate the energy of incoming flows and promote deposition of sediment and debris on the pad.

BASIC GRASS COVER

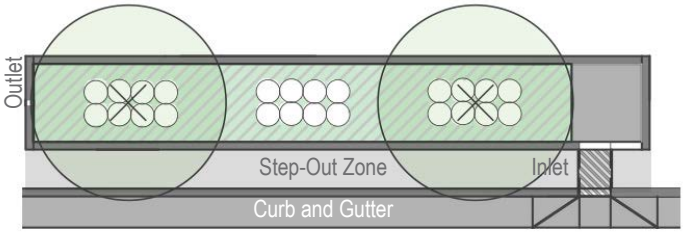


FIGURE 11. Basic Grass Cover Planting Plan (Source: Stream Design. 2015.)
Scale: 1" = 10'

PLANT LEGEND

Native grasses at triangular spacing to uniformly cover and fill the planter area with 6"-18" spacing. Preferred species include:
- *Bouteloua gracilis* 'Blonde Ambition'
- *Deschampsia cespitosa* 'Tufted Hairgrass'
- *Schizachyrium scoparium* 'Prairie Blues'
- *Muhlenbergia reverchonii* 'Undaunted Ruby'
- *Sporobolus heterolepis* 'Prairie Dropseed'

30" - 48" tall accent plant (native grass or approved perennial or shrub)

Tree per CCD Forestry recommendation

The Basic Grass Cover plan shown in Figure 11 comprises a relatively simple arrangement of primarily native grasses with some accent plants intended to create essentially full coverage of the bioretention media. The Basic Grass Cover plan is intended to create a "wall-to-wall" planting of low to mid height native and ornamental grasses with variety provided by clusters of taller grasses, perennials or shrubs in the center of the planter. While regular maintenance is required, the simple design of the Grass Cover plan allows easier identification of weeds by maintenance staff.

WESTERN PRAIRIE

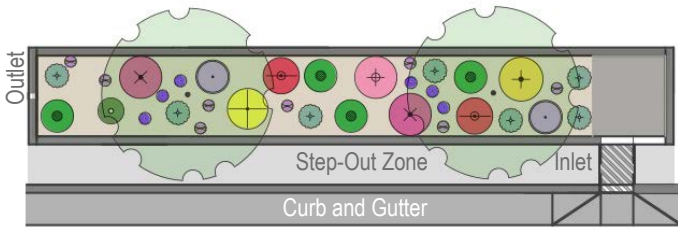


FIGURE 12. Western Prairie Planting Plan (Source: Stream Design. 2015.)
Scale: 1" = 10'

PLANT LEGEND

- *Andropogon gerardii* 'Windwalker Big Bluestem Grass'
- *Camassia leichtlinii* 'Blue Danube'
- *Phlox paniculata* 'David'
- *Liatris ligulistylis* 'Rocky Mountain Gayfeather'
- *Monarda fistulosa* 'Eastern Bergamot'
- *Muhlenbergia reverchonii* 'Undaunted Ruby'
- *Monarda bradburiana* 'Wild Bergamot'
- *Ratibida pinnata* 'Pinnate Prairie Coneflower'
- *Anaphalis margaritacea* 'Western Pearly Everlasting'
- *Schizachyrium scoparium* 'Prairie Blues'
- *Sporobolus heterolepis* 'Prairie Dropseed'
- *Aster laevis* 'Bluebird'

Tree per CCD Forestry recommendation

The Western Prairie typical planting plan illustrated in Figure 12 is intended to present an image of a "natural" prairie. Primarily native grasses and herbaceous perennials, this plan is arranged in a naturalistic style that allows for the planting to change with time as certain species thrive and others recede. While all streetside stormwater planters will require a significant amount of maintenance to keep them weed free and healthy, this planting plan can be more forgiving and will require less maintenance than more formal approaches.

MODERN MATRIX

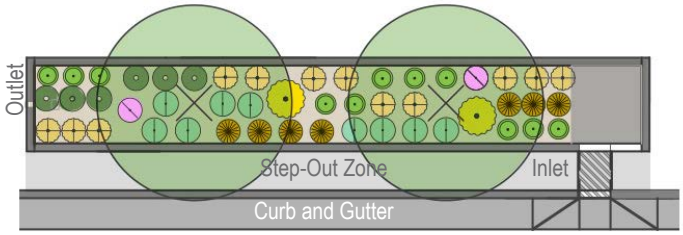


FIGURE 13. Modern Matrix Planting Plan (Source: Stream Design. 2015.)
Scale: 1" = 10'

PLANT LEGEND

- *Amorpha canescens* 'Leadplant'
- *Anaphalis margaritacea* 'Western Pearly Everlasting'
- *Calamagrostis × acutiflora* 'Karl Foerster'
- *Camassia leichtlinii* 'Blue Danube'
- *Liatris ligulistylis* 'Rocky Mountain Gayfeather'
- *Panicum virgatum* 'Northwind'
- *Panicum virgatum* 'Prairie Sky'
- *Monarda bradburiana* 'Wild Bergamot'
- *Helianthus maximiliana* 'Dakota Sunshine'
- *Sporobolus heterolepis* 'Prairie Dropseed'

Tree per CCD Forestry recommendation

The Modern Matrix plan uses drought tolerant native materials and groups them in regular clusters and groupings to create a more organic, urban garden. A typical plan is shown in Figure 13. While individual plant species are chosen for drought tolerance and hardiness, the more ordered approach may require slightly more maintenance to maintain its character and look attractive versus the other approaches illustrated.

4.7 STREETSIDE STORMWATER PLANTER DETAILS

A typical design of a streetside stormwater planter is illustrated in a series of detail drawings in this section. The details indicate various elements of the planter and representative dimensions. The designer is responsible for preparing final construction drawings suitable for the specific conditions, water quality requirements, utilities and constraints existing in the location where the BMP is to be sited. A geotechnical engineer shall consult on soil conditions and recommendations for lining. A structural engineer, with input from the geotechnical engineer shall design concrete elements, including wall thickness, reinforcing (reinforcing shown in details is representative only), any foundation components such as footings or bottom slab, and subgrade/bedding/backfill specifications. A site-specific design will also be necessary addressing utility protection and relocation, tying in underdrain to a downstream storm drain or outfall, irrigation design, vegetation plan, and associated final design and construction document preparation tasks.

The following design notes apply to the detail drawings.

DESIGN NOTES

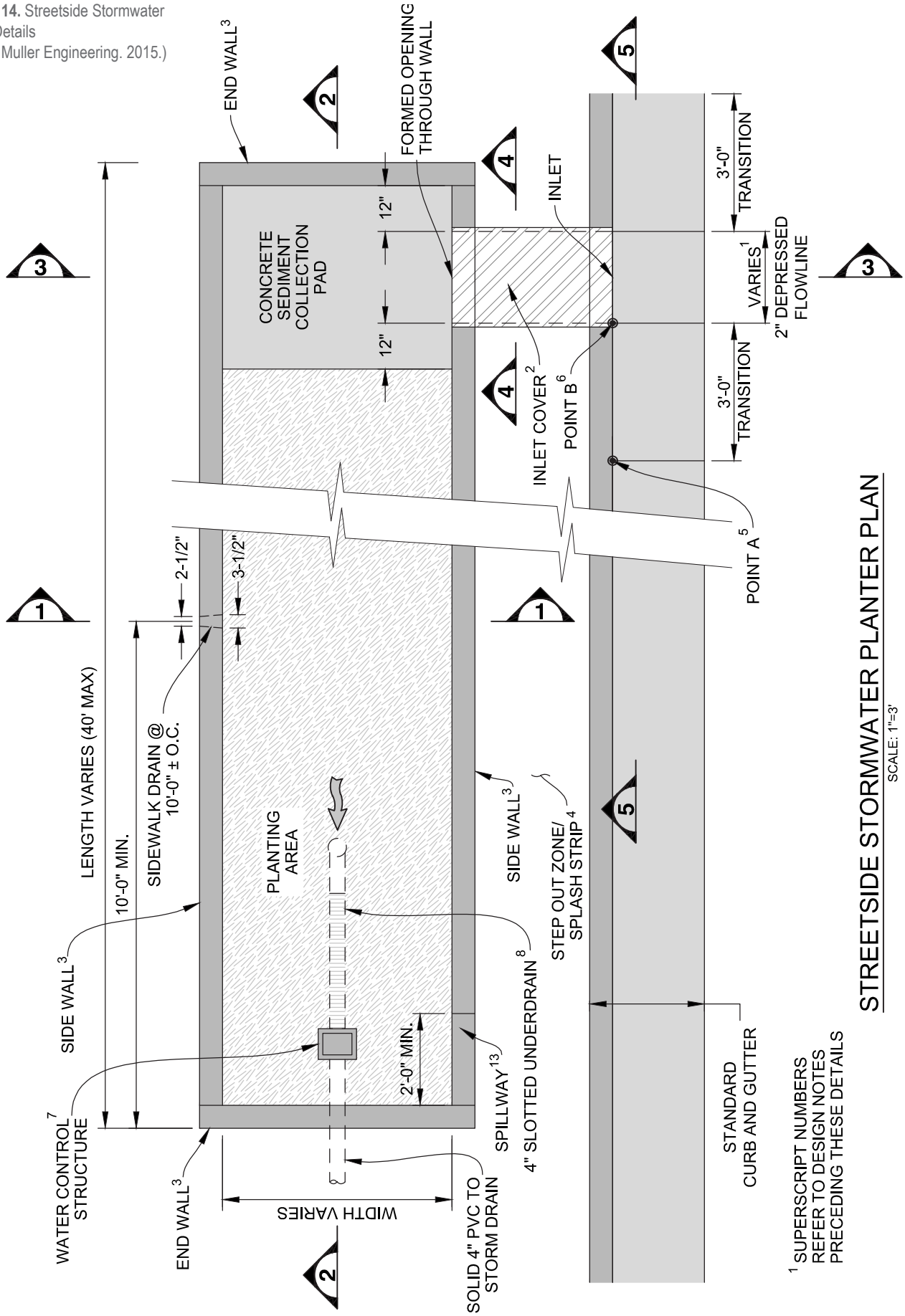
1. INLET WIDTH VARIES BASED ON UPSTREAM IMPERVIOUS AREA AND STREET SLOPE, WITH A MINIMUM WIDTH OF 2 FEET AND A MAXIMUM WIDTH OF 3 FEET. SEE CRITERIA FOR SIZING INLET WIDTH IN INTRODUCTION SECTION.
2. INLET COVER SHALL MEET ADA ACCESSIBILIY REQUIREMENTS AND AND CONSIST OF NEENAH R-4999 HEAVY DUTY BOLTED TRENCH GRATE TYPE D (SOLID) OR APPROVED EQUIVALENT – CATALOGUE NO. R-4999-HX FOR SPAN OF 2 FEET AND R-4999-MX FOR SPAN OF 3 FEET. THE LENGTH OF THE INLET COVER SHOULD BE FIELD CUT TO EXTEND CONTINUOUSLY FROM THE FACE OF CURB TO BACK OF PLANTER WALL AND SHOULD BE RECESSED FROM THE FACE OF THE CURB SO THAT THE CORNERS OF THE PLATE DO NOT PROTRUDE BEYOND THE TOP OF CURB.
3. STRUCTURAL ENGINEER, WITH INPUT FROM GEOTECHNICAL ENGINEER, SHALL DESIGN WALL DIMENSIONS, REINFORCING, ANY FOUNDATION COMPONENTS SUCH AS FOOTINGS OR BOTTOM SLAB, AND SUBGRADE/BEDDING/BACKFILL SPECIFICATIONS.
4. IN AREAS WHERE PARKING IS ALLOWED, THE MINIMUM STEP-OUT ZONE WIDTH FROM BACK OF CURB TO OUTER WALL OF PLANTER IS 2 FEET 6 INCHES. IN AREAS WHERE PARKING IS NOT ALLOWED, THE MINIMUM RECOMMENDED SPLASH STRIP WIDTH FROM BACK OF CURB TO OUTER WALL OF PLANTER IS 1 FOOT 6 INCHES.
5. FOR STREET SLOPES LESS THAN 5.5 PERCENT,THE ELEVATION OF THE FLOW LINE AT POINT A REPRESENTS THE WATER SURFACE ELEVATION ABOVE WHICH WATER IN THE PLANTER WOULD START TO FLOW OUT AND BE CONVEYED DOWN THE GUTTER. THIS ELEVATION IS EQUAL TO THE WATER QUALITY WATER SURFACE AND IS THE TOP OF THE WATER QUALITY CAPTURE VOLUME (WQCV).
6. FOR STREET SLOPES GREATER THAN 5.5 PERCENT, THE ELEVATION OF THE FLOW LINE AT POINT B REPRESENTS THE WATER SURFACE ELEVATION ABOVE WHICH WATER IN THE PLANTER WOULD START TO FLOW OUT AND BE

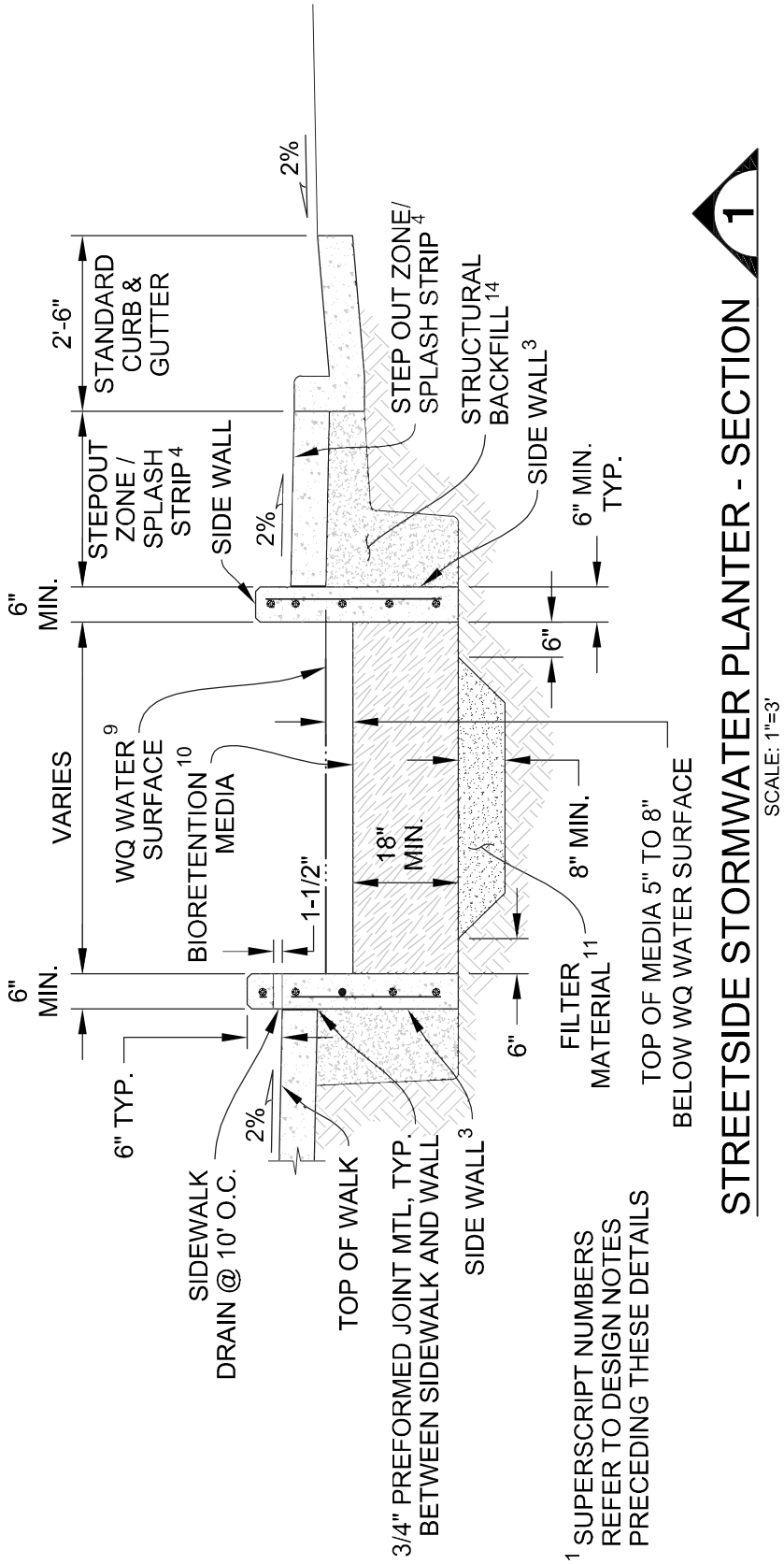
DESIGN NOTES

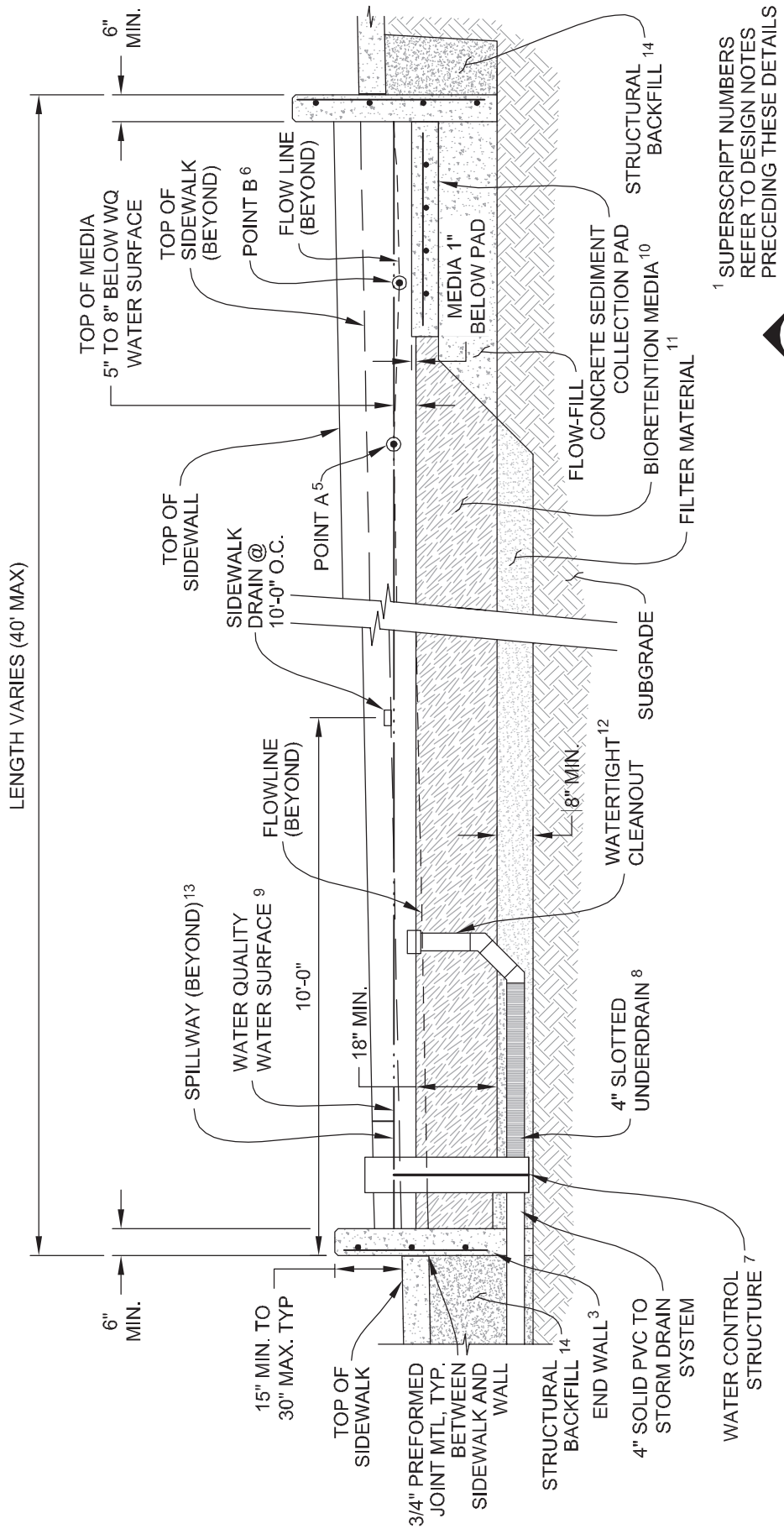
CONVEYED DOWN THE GUTTER. THIS ELEVATION IS EQUAL TO THE WATER QUALITY WATER SURFACE AND IS THE TOP OF THE WATER QUALITY CAPTURE VOLUME.

7. THE WATER CONTROL STRUCTURE IS COMPRISED OF AN INCLINE WATER LEVEL CONTROL STRUCTURE AS SHOWN IN THE DETAILS. THIS STRUCTURE HOUSES A CONTROL ORIFICE DESIGNED TO RELEASE THE WQCV IN 12 HOURS AND A WEIR SET WITHIN 2 INCHES BELOW TO 2 INCHES ABOVE THE WATER QUALITY WATER SURFACE. THE WATER CONTROL STRUCTURE SHALL BE AN AGRI DRAIN INLINE WATER LEVEL CONTROL STRUCTURE AS MANUFACTURED BY AGRI DRAIN CORPORATION, OR APPROVED EQUIVALENT.
8. THE UNDERDRAIN SHALL MEET THE MATERIAL AND SLOT SPECIFICATIONS IDENTIFIED IN USDCM VOLUME 3. THE MINIMUM LENGTH OF SLOTTED UNDERDRAIN SHALL BE 4 FEET.
9. THE WATER QUALITY WATER SURFACE IS THE TOP OF THE WQCV AND IS EQUAL TO THE ELEVATION OF THE FLOW LINE AT POINT A FOR STREET SLOPES LESS THAN 5.5 PERCENT AND AT POINT B FOR STREET SLOPES GREATER THAN 5.5 PERCENT.
10. BIORETENTION MEDIA SHALL MEET THE SPECIFICATIONS IDENTIFIED IN THE DESIGN CRITERIA SECTION OF THE INTRODUCTION. TOP OF MEDIA SHALL BE PER PLAN AND A MINIMUM OF 6 INCHES AND A MAXIMUM OF 9INCHES BELOW THE WQCV WATER SURFACE ELEVATION.
11. FILTER MATERIAL SHALL MEET THE SPECIFICATIONS IDENTIFIED IN USDCM VOLUME 3. FILTER MATERIAL (NOT BIORETENTION MEDIA) SHALL BE COMPACTED TO A DENSITY OF NOT LESS THAN 70 PERCENT OF RELATIVE DENSITY DETERMINED IN ACCORDANCE WITH ASTM D4253 AND D4254 (FOR FINES CONTENT LESS THAN 5 PERCENT).
12. THE UNDERDRAIN CLEANOUT SHALL CONSIST OF 4 INCH POLYVINYL CHLORIDE (PVC) PIPE WITH TWO 45 DEGREE BENDS AND A THREADED CAP SET 2 INCHES ABOVE THE TOP OF THE BIORETENTION MEDIA.
13. PROVIDE A GAP IN THE SIDEWALL OR DEPRESSED SECTION (SPILLWAY) AT THE DOWNSTREAM END OF THE STREETSIDE PLANTER WALL AT LEAST 2 FEET LONG TO ENSURE THAT OVERFLOWS FROM PLANTER WILL EXIT ON THE STREETSIDE. THE CREST OF THE SPILLWAY SHALL BE SET AT THE WQCV WATER SURFACE ELEVATION.
14. STRUCTURAL BACKFILL SHALL CONSIST OF CDOT CLASS 1 OR 2 STRUCTURE BACKFILL, AS DETERMINED BY ENGINEER AND COMPACTED TO AT LEAST 95 PERCENT OF MAXIMUM DENSITY IN ACCORDANCE WITH ASTM D698.

FIGURE 14. Streetside Stormwater Planter Details
(Source: Muller Engineering. 2015.)




2%
2'-6"
STANDARD CURB & GUTTER
STEPOUT ZONE / SPLASH STRIP 4
SIDE WALL
2%
STEP OUT ZONE/ SPLASH STRIP 4
STRUCTURAL BACKFILL 14
SIDE WALL 3
6" MIN. TYP.
6" MIN.
6"
VARIES
WQ WATER SURFACE 9
BIORETENTION MEDIA 10
1-1/2"
18" MIN.
8" MIN.
6" MIN.
6" TYP.
2%
6"
FILTER MATERIAL 11
TOP OF MEDIA 5" TO 8" BELOW WQ WATER SURFACE
SIDEWALK DRAIN @ 10' O.C.
TOP OF WALK
3/4" PREFORMED JOINT MTL, TYP. BETWEEN SIDEWALK AND WALL
SIDE WALL 3
1 SUPERSCRIPT NUMBERS REFER TO DESIGN NOTES PRECEDING THESE DETAILS
STREETSIDE STORMWATER PLANTER - SECTION
1
SCALE: 1"=3'



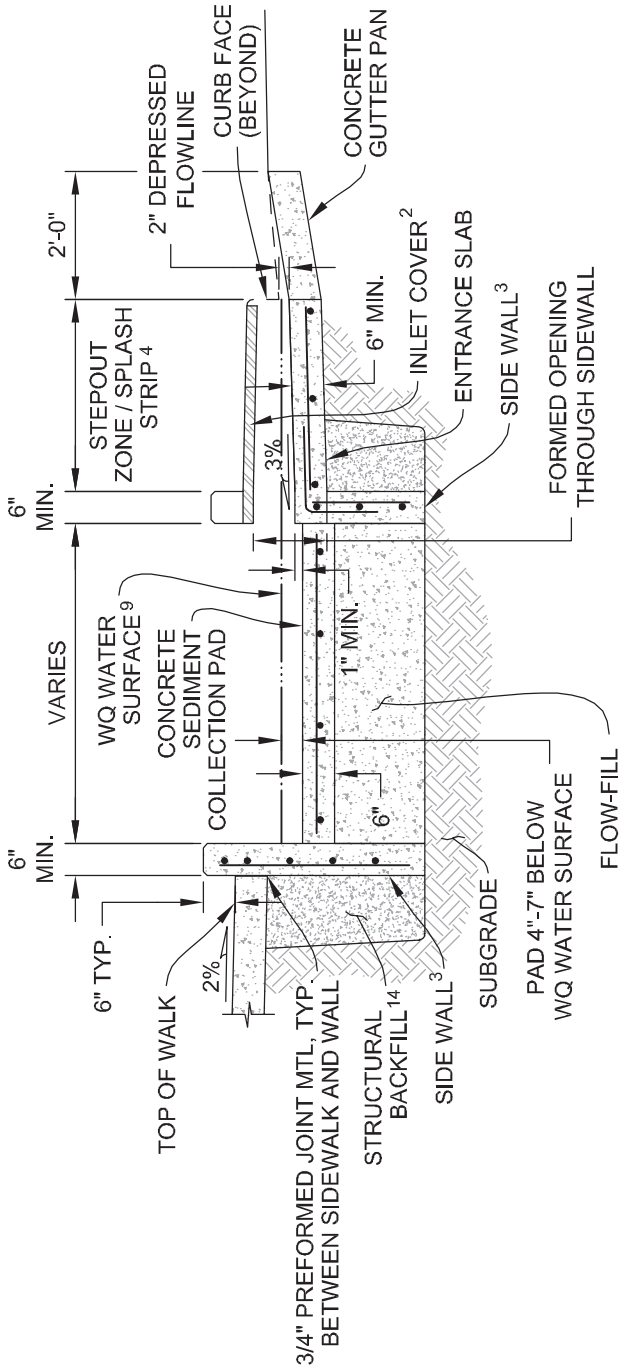
1 SUPERSCRIPT NUMBERS REFER TO DESIGN NOTES PRECEDING THESE DETAILS

2

STREETSIDE STORMWATER PLANTER - SECTION

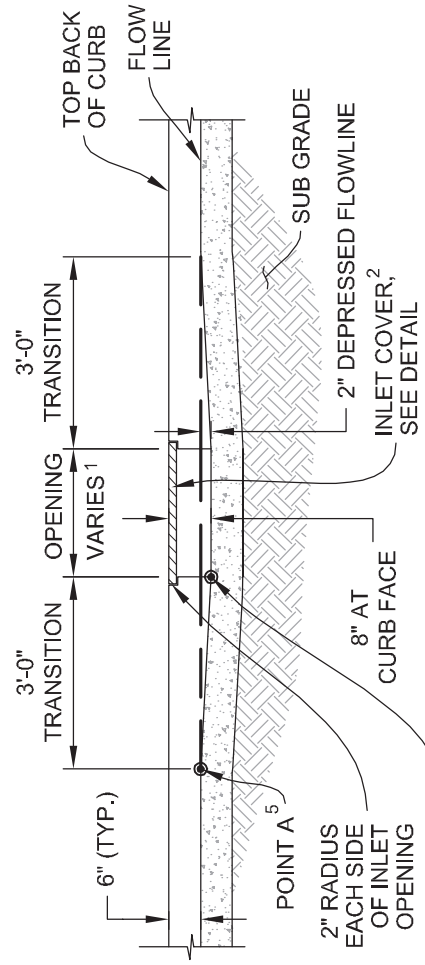
(LONGITUDINAL SLOPE OF 2% SHOWN WITH 40' PLANTER LENGTH)

SCALE: 1"=3'

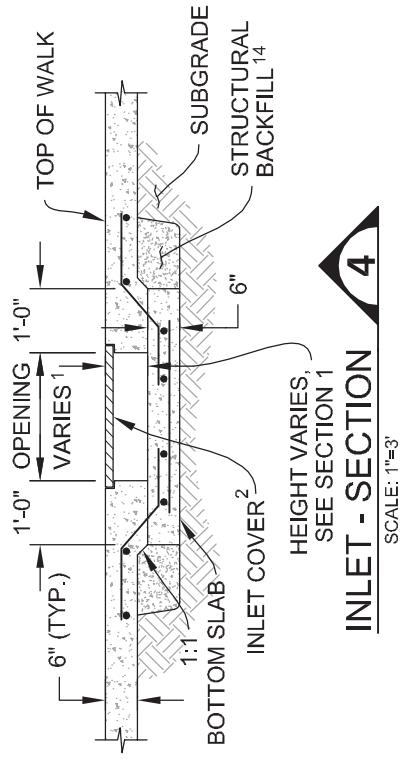


1 SUPERSCRIPT NUMBERS REFER TO DESIGN NOTES PRECEDING THESE DETAILS

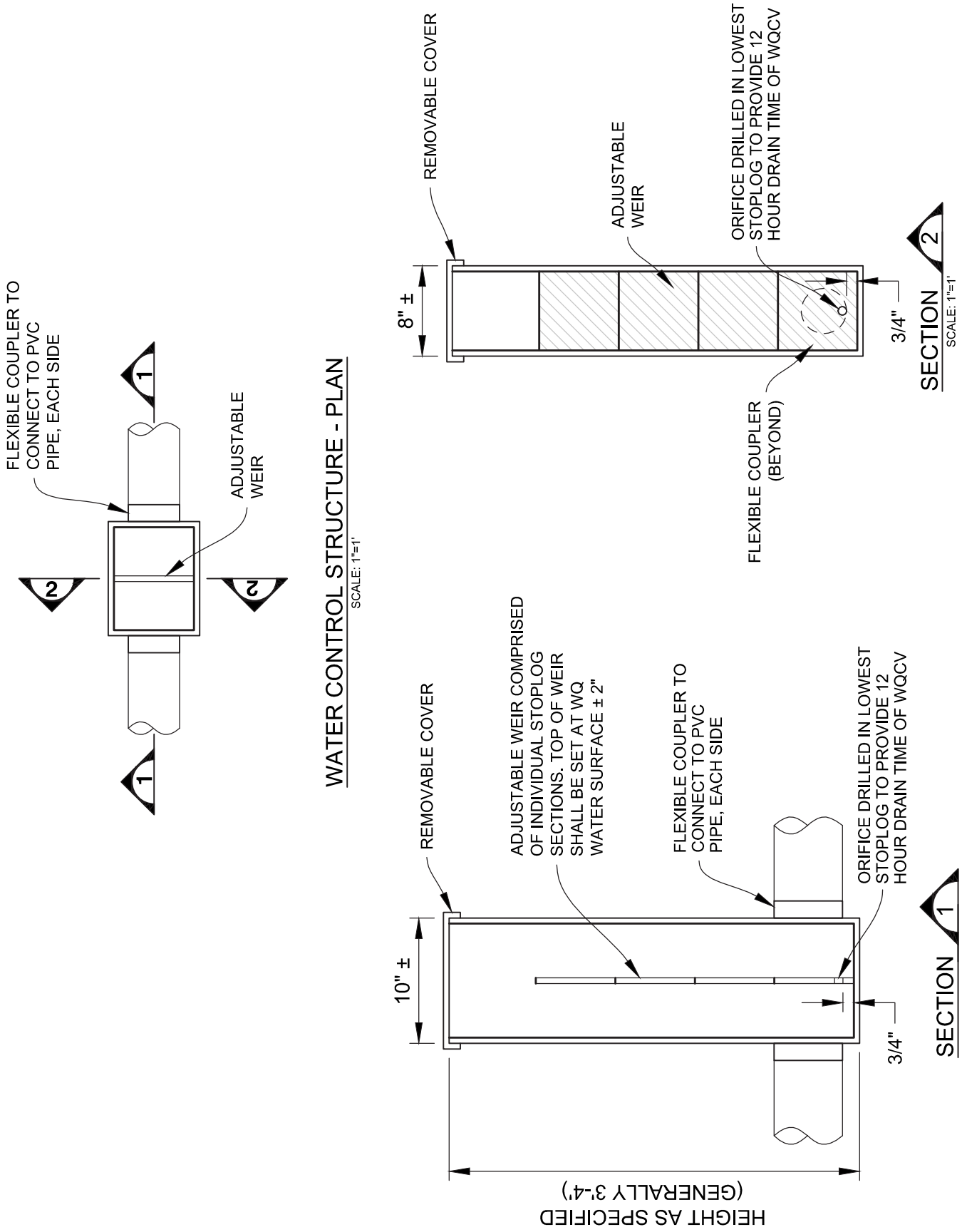
INLET - SECTION 3
SCALE: 1"=3'



INLET - SECTION 5
SCALE: 1"=3'



INLET - SECTION 4
SCALE: 1"=3'


FLEXIBLE COUPLER TO CONNECT TO PVC PIPE, EACH SIDE
ADJUSTABLE WEIR
1
1
2
2
WATER CONTROL STRUCTURE - PLAN
SCALE: 1"=1'
REMOVABLE COVER
ADJUSTABLE WEIR
ORIFICE DRILLED IN LOWEST STOPLOG TO PROVIDE 12 HOUR DRAIN TIME OF WQCV
8" ±
3/4"
FLEXIBLE COUPLER (BEYOND)
SECTION 2
SCALE: 1"=1'
REMOVABLE COVER
ADJUSTABLE WEIR COMPRISED OF INDIVIDUAL STOPLOG SECTIONS. TOP OF WEIR SHALL BE SET AT WQ WATER SURFACE ± 2"
FLEXIBLE COUPLER TO CONNECT TO PVC PIPE, EACH SIDE
ORIFICE DRILLED IN LOWEST STOPLOG TO PROVIDE 12 HOUR DRAIN TIME OF WQCV
10" ±
3/4"
SECTION 1
HEIGHT AS SPECIFIED
(GENERALLY 3'-4')