BERNALILLO COUNTY GREEN STORMWATER INFRASTRUCTURE

LOW IMPACT DESIGN STRATEGIES FOR
DESERT COMMUNITIES

ACKNOWLEDGMENTS

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PURPOSE

Green Stormwater Infrastructure (GSI) and Low-Impact Development (LID) are approaches to water management that attempt to mimic natural processes, through both engineering and leveraging ecosystem services, to improve water quality and conserve or enhance environmental functions. Many of these practices have been well-developed and implemented frequently in more temperate climate zones; however, many of the established GSI and LID interventions that work in these zones are often ineffective in arid and semi-arid climates where precipitation regimes and significantly different.

Previously developed guidelines for these practices have been developed for Bernalillo County and the City of Albuquerque such as the Bernalillo County Water Conservation Guidelines and the Design Process Manual (DPM), in which several new standard details for GSI and LID were created. These documents provide detailed background information, implementation and maintenance guidance for construction of low impact development projects and water conservation techniques. This document and others like it, while containing useful information regarding the implementation and the benefits of GI/LID interventions, are highly technical and cumbersome making them inaccessible to the general public.

The need for an abbreviated version of these larger documents was discovered in a recent study conducted by Bernalillo County, Impediments to Low Impact Development in Bernalillo County. The purpose of this document is to provide a clearer understanding of how GSI and LID interventions work, what their benefits are, and how they can be constructed within Bernalillo County, New Mexico, and arid climate zone by providing supplemental information about the functions of GSI and LID interventions along with the construction details from the DPM. The information provided in this booklet is not exhaustive, but rather a distillation or digest of information from several larger documents intended to promote the use of water conservation techniques and environmentally sensitive development approaches, including GSI and LID. It is intended to assist homeowners, developers, builders, and anyone interested in implementing GSI or LID practices to better understand how these interventions and strategies work, where they are most effective, and how to construct them.

HOW TO USE:

This digest is intended to provide the most relevant information pertaining to a selection of GSI/LID interventions frequently used in development in an easily understood format. As there is a broad range of applications for various strategies, this booklet demonstrates examples in four different categories where GSI/LID are likely to be implemented. As you will see on the Infrastructure Applications page, the four categories are represented by distinct icons. On the subsequent GSI/LID Interventions pages, the icons are used to indicate in which Infrastructure Application category the particular intervention is relevant and can typically be applied. Many of the interventions are applicable in all four categories. Others are highly specialized and may be appropriate only in particular categories.

Figure 7.1

WITHOUT GSI/LID STRATEGIES

Figure 7.2

WITH GSI/LID STRATEGIES

CONTEXT

MIDDLE RIO GRANDE WATERSHED

The Middle Rio Grande Watershed Based Municipal Separate Storm Sewer System (MS4) permit requires that each co-permittee identify opportunities to implement the use of GI/LID/Sustainable practices and encourage their use during site design as a part of development and redevelopment programs. A primary objective is to achieve recreating predevelopment hydrologic conditions while addressing means to remove both suspended and dissolved pollutants carried in storm water discharges. This design manual presents design approaches to meet the predevelopment hydrology and storm water quality improvements.

RECAP OF BERNCO STORMWATER QUALITY ORDINANCE (POST-CONSTRUCTION REQUIREMENTS)

Bernalillo County approved and implemented Ordinance 2107-8 to address requirements specified in the Watershed Based MS4 permit concerning predevelopment hydrology and storm water quality obligations. Division 3 of the ordinance establishes design standards toward reaching these goals. Specifically storm water treatment volumes (90% storm for new development, 80% storm for redevelopment) must be addressed within the boundaries of a proposed site development/redevelopment plan. Concurrently, the ordinance also highlights the need to reduce the quantity of Directly Connected Impervious Areas. Methods to address these treatment volumes are shown in the following design details and examples.

BERNALILLO COUNTY

Located in the northernmost reach of the Chihuahuan Desert, Bernalillo County lies in the Rio Grande Valley between the escarpment on the west and the Sandia Mountains on the east. Due to its relatively high elevation and location on the continental interior, the area experiences hot summers and cold winters, with nighttime temperatures dipping below freezing around 108 times per year on average. Annual precipitation averages slightly below 9 inches, an amount far exceeded by the average evapotranspiration rate. Prevailing winds for much of the county are out of the north from October through March, from the west in April and May, and from the east from June through September. The winds significantly contribute to erosion and increased evapotranspiration rates.

Given the county's scant precipitation and dwindling groundwater supplies, water is a critical resource. Water resource management and planning is best done on a regional level due to the many variables involved such as water supply and demand, climate, and legal and institutional constraints. The Office of the State Engineer has therefore defined New Mexico's water planning areas by basin designations. The majority of Bernalillo County lies within the Middle Rio Grande Basin, with the exception of the easternmost portion, which is within the Estancia Basin. Bernalillo County is the most populous in New Mexico and therefore can have a significant impact in terms of water conservation. The County Water Conservation Ordinance that became effective October, 2010, represents a significant step towards increased conservation for new development throughout the county. The ordinance requirements for water-conserving site design and development can be met by a range of best management practices and techniques. Variables such as soil types, elevations, climates, and vegetation must be evaluated when determining which water conservation devices to use on a particular site. As an example, the water needs for a plant on a west-facing slope in the sandy soils of the West Mesa would be much higher than those of the same plant on a flat area in the Rio Grande Valley or on a north-facing slope in the Sandia foothills.

Understanding the type of soil present on a site within the bioregion is key to appropriate design of the site and landscape. In a given bioregion within the county there may be no need to amend the soil, however some soils inhibit healthy plant growth and may need amendment. Determining the correct soil treatment and the soil amendment that might be needed begins with understanding the soil itself.

For the most part the relationship between plants, soil and water is based in the soil structure; this refers to the density of soil particles and the pore spaces between them (porosity or permeability) and the combination of soil types (texture). In general, a well-structured soil will readily accept, store, and transmit water, gases and nutrients to plants. The interrelated porosity or permeability and texture of soil if balanced can create the best conditions for low water use and plant growth. A dense structure, such as that of clayey soils, will greatly reduce the amount of air and water that can move freely through the soil. If the texture of the soil is too dense water can pond. A good soil repair for this problem can be adding gypsum to soil to open the pores. Water moves more readily through coarser-texture soils, such as those with a high percentage of sand. If water moves too freely through soils, as is the case with sands, it may be appropriate to add a percentage of clay or humus to the soil to increase water holding capacity and decrease permeability. Soil texture can effect plant growth and health; it is determined by the relative percentages of sand, silt, and clay. Loam, which has good texture, is considered a great gardening soil, it generally has percentages of 40% clay, 40% sand and 20% silt. Bioregions within Bernalillo County can be well drained or impermeable; they can have very simple textures as is the case in the sand of the west mesa or the clay in the valley. To understand how to amend or treat these various soil types for the best plant growth conditions consult with a green industry professional like a nursery person, landscape architect or designer, or the NMSU Cooperative Extension Service or other like agencies.

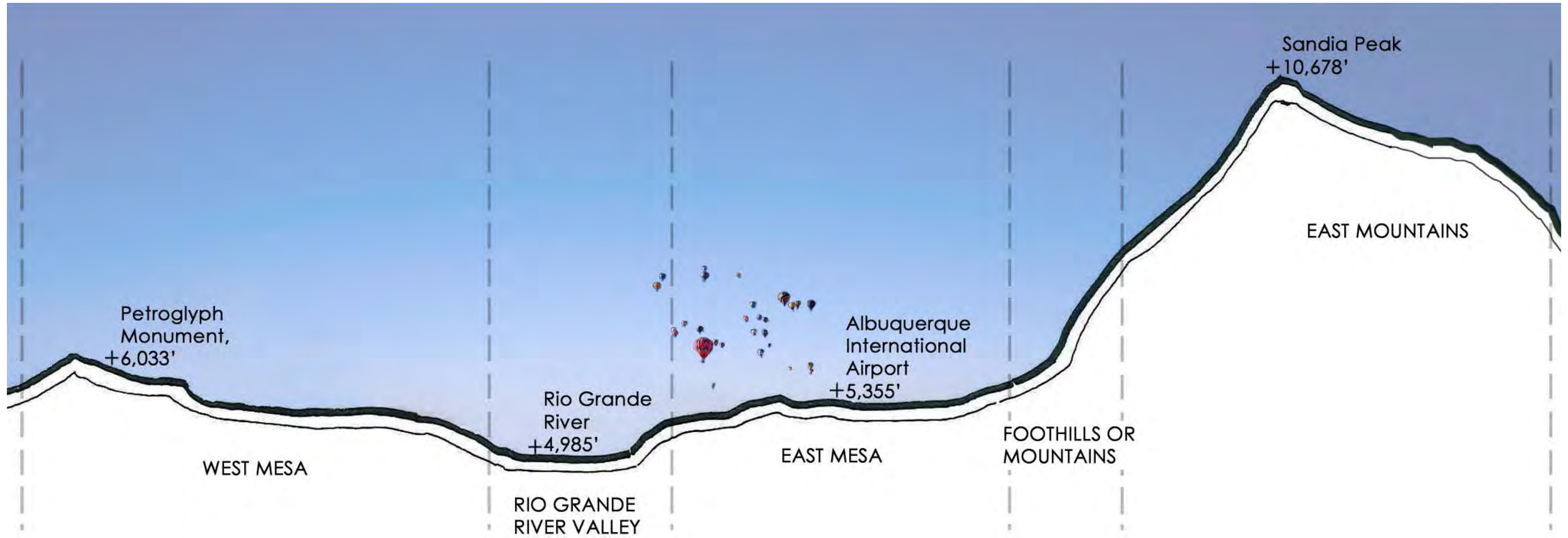


Figure 8.1: Bernalillo County Bio-Regions

Figure 9.1: Bernalillo County location within New Mexico state

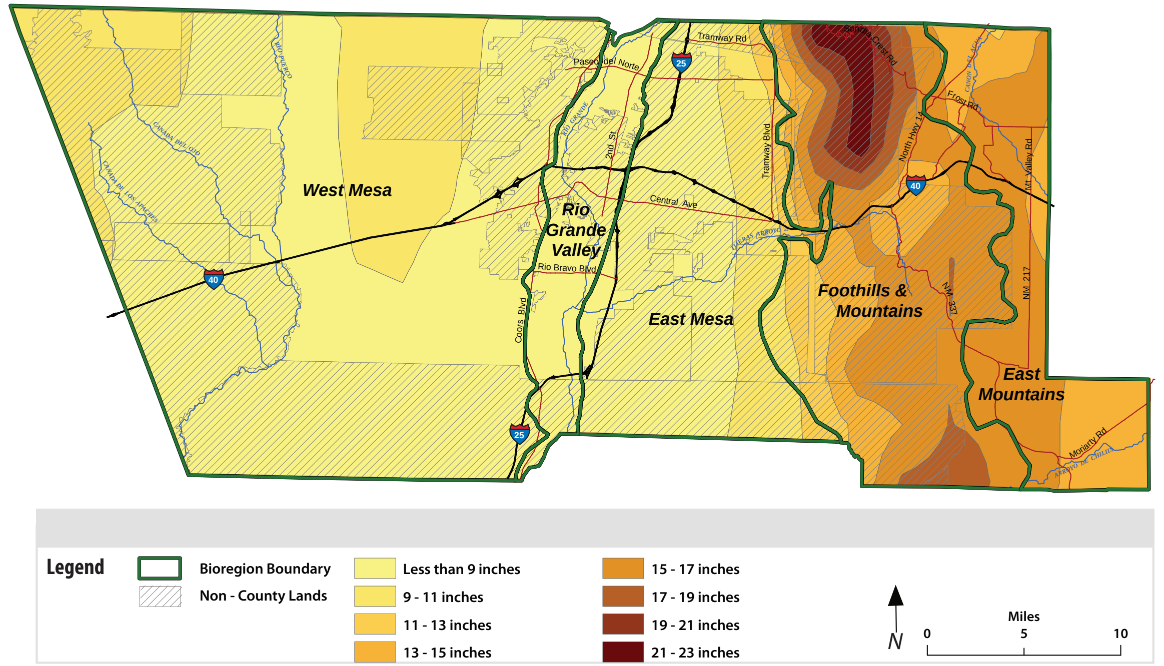


Figure 9.2: Bernalillo County annual precipitation averages

INFRASTRUCTURE APPLICATIONS

IN-STREET / MEDIAN

In-street medians are ubiquitous spaces that exist in most roadways. They are typically landscaped to provide an aesthetic att raction along the roadway. These structures are conducive to GSI and LID interventions as they can easily be modified as low points that stormwater can be directed toward. By modifying the curb and lowering the grade, stormwater can enter the basin from the roadway. Given their linear characteristics, they are often conducive to conveyance to other management interventions as well.

Typical applications in this context include:

- **Bioswale**
- **Infiltration Trench**
- **PermeableCheck Dam**
- **Raised Median**

Figure 10.1

STREET SIDE / RIGHT OF WAY

Street side or right-of-way areas existing along the sides of roadways. These buffers are typically landscaped to provide an aesthetic attraction along the roadway. These structures are conducive to GSI and LID interventions as they can easily be modified as low points that stormwater can be directed toward them. By using curb inlets and lowering the grade, stormwater can enter the basin from the roadway. Given their linear characteristics, they are often conducive to conveyance to other management interventions as well.

Typical applications in this context include:

- **Bioswale**
- **Infiltration Trench**
- **Stormwtaer Tree box**
- **Stormwater Planter**
- **Stormwater Curb Extension**

Figure 10.2

PARKING

Parking areas offer many opportunities for stormwater management as there are typically many landscape strips and existing basins utilized for on-site water management. These structures are conducive to GSI and LID interventions as they can easily be modified as low points that stormwater can be directed toward them. By using curb inlets and lowering the grade, stormwater can enter the basin from the roadway.

Typical applications in this context include:

- **Bioswale**
- **Infiltration Trench**
- **Stormwater Curb Extension**
- **Permeable Pavement**

Figure 11.1

GENERAL APPLICATIONS

This category refers to a less defined context where GSI/LID interventions can be applied. Typically, areas where the following interventions can be applied are on hill sides exhibiting erosion, swales and drainageways, or areas that need to be stabilized.

Typical applications in this context include:

- **Zuni Bowl**
- **Stone Channel Plating**
- **Permeable Check Dam**
- **Infiltration Trench**
- **Contour Swale**

Figure 11.2

BIOSWALE CONCEPT

General Notes:

Bioswales are linear stormwater management features used to convey, slow, and treat runoff through various methods of infiltration and natural processes. Bio-swales are often used to convey runoff from large impervious areas, such as parking lots or roadways, to a localized basin where the runoff can be further treated and infiltration can occur. Lined with various gravels, mulches, and plant materials, these features aid in removing silt and other suspended solids out of runoff. Additional water quality treatment can be achieved through the use of organic soils and appropriate vegetation choices that serve to remove specific pollutants and compounds from runoff. Bioswales are often used synonymously with the term Rain Garden – a water collection basin that utilizes runoff and precipitation to sustain the vegetation within it without any supplemental irrigation. Rain Gardens, however, are not typically sustainable in arid and semi-arid climates given the infrequent storm events and low annual rainfall accumulations. To sustain most vegetation year-round, supplemental irrigation is recommended.

Design Basics:

Application:
Collection and treat runoff from imperious areas.

Site Conditions:
Parking and roadway edges and margins, transition zones.

Implementation:
Quantify runoff volume to prevent overflow. Attempt to minimize flow velocities below 3 feet per second.

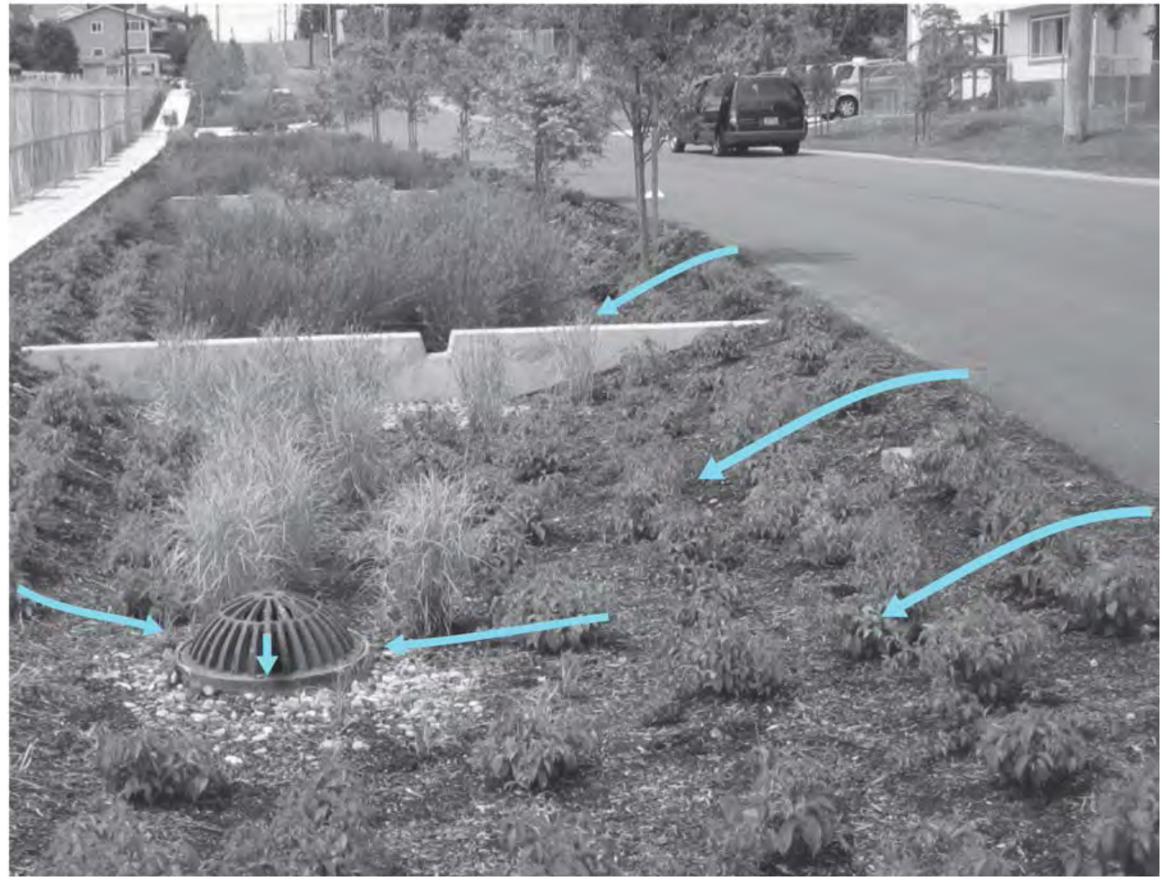


Figure 12.1: Planted bioswale with 'beehive' overflow structure to stormwdrain. Water sheet flows from roadway into the swale where it is slowed, collected, and infiltratied. Check structures along the swale promote infiltration by pooling water to allow for longer infiltration times and slow velocities

BIOSWALE DPM DETAIL 1.0

General Notes:

Bioswale alignment may be straight or meandering, depending on available space (meandering alignment provides more treatment length than a straight channel)

Bioswales may be part of a larger, unconstrained landscape, or may be edged by curbs or walls (see also 'infiltration trench' for a variation of the bioswale concept)

Check dams and/or boulders may be added to decrease flow velocity, encourage infiltration and minimize erosion

Trees and shrubs should be located at the edges of the swale to minimize duration of exposure to saturated soil conditions

"Rain gardens" are a variation on the bioswale concept, serving the same purpose in a more compact and non-linear configuration

Construction Notes:

A. 4" Non-floatable mulch layer (for non-meadow/lawn applications)

B. Perforated pvc pipe, sloped to drain (optional, if site conditions require)

C. Amended planting substrate (see general design considerations)

D. Optional curb/edge restraint with cutouts for in flow

E. Native and remediation plants per landscape architect/designer

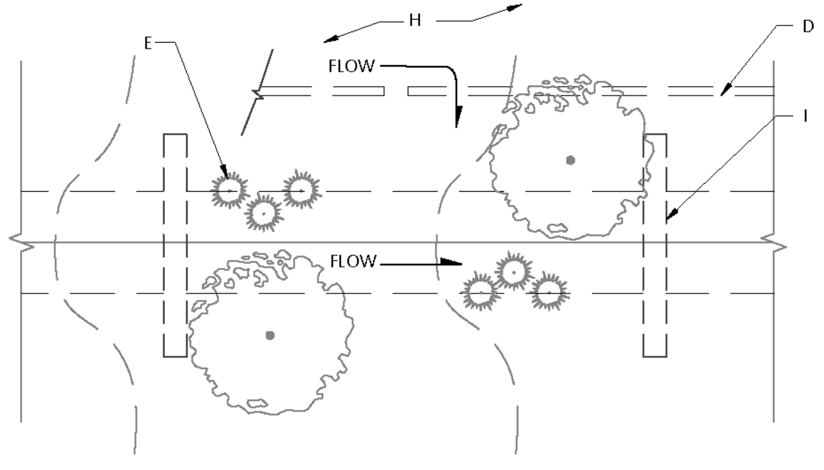
F. 90th percentile storm flow depth (varies)

G. Uncompacted subgrade

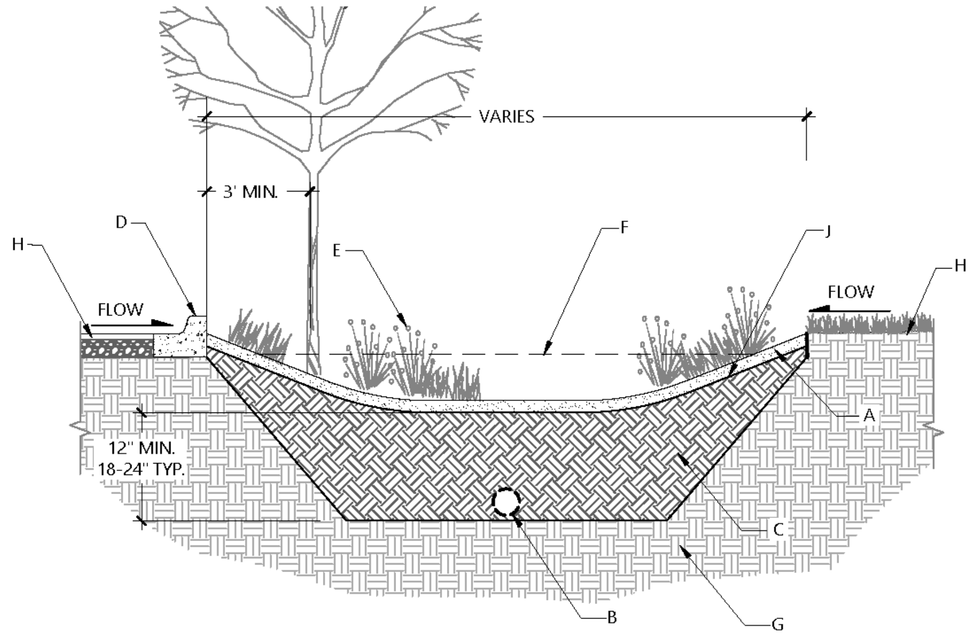
H. Adjacent surfaces may vary

I. Check dam or boulders (optional)

J. 3:1 side slope maximum



PLAN VIEW



SECTION

TYPE 1 INFILTRATION TRENCH DIFFUSE INLET CONCEPT

General Notes:

Infiltration trenches function as passive underground storage basins that allow runoff to be collected from adjacent impervious surfaces and then infiltrated into the soils and groundwater below. Through the creation of a filter fabric-wrapped gravel trench, runoff can be stored temporarily below grade within the pockets between the gravel stones, allowing it to slowly infiltrate. This is advantageous for areas that are prone to slow drainage or do not have a direct connection to a storm drain. Typical applications are frequently seen in roadway medians or between parking rows at parking lots. The top layer of gravel provides an area that can be cleaned out when sediment builds up, a routine maintenance practice on any stormwater structure.

Design Basics:

Application:
Collection and treat runoff from imperious areas.

Site Conditions:
Parking and roadway edges and margins, transition zones, and overland flow areas impacted by urbanized runoff.

Implementation:
Consider sediment contribution rates to avoid plugging.
Avoid standing water when saturate.
Evaluate infiltration rate of subgrade soils.

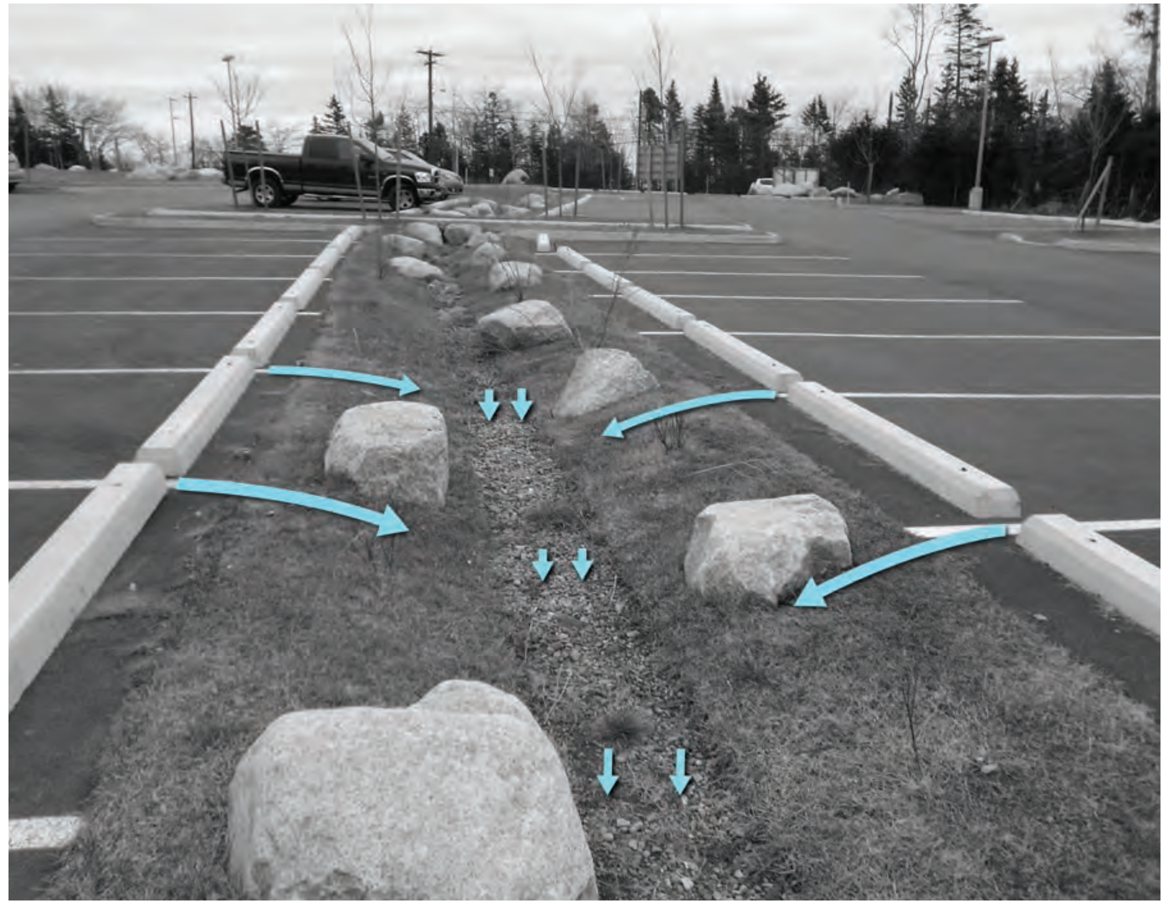


Figure 14.1: Typical infiltration trench with diffuse inlet application

TYPE 1 INFILTRATION TRENCH DIFFUSE INLET DPM DETAIL 2.0

General Notes:

For infiltration trenches that collect overland flows, a vegetative buffer strip (or other method of sediment removal) is important to preventing clogging of the gravel surface

Gravel surface filter may be comprised of clean, washed gravel in sizes varying from pea gravel to cobblestone, depending on design intent smaller gravel is easier to clean by raking (to break up surface clogging) or screening (to remove debris), while larger stone will stay in place better

Construction Notes:

A. Gravel surface filter

B. Buffer plantings

C. Optional slotted curb

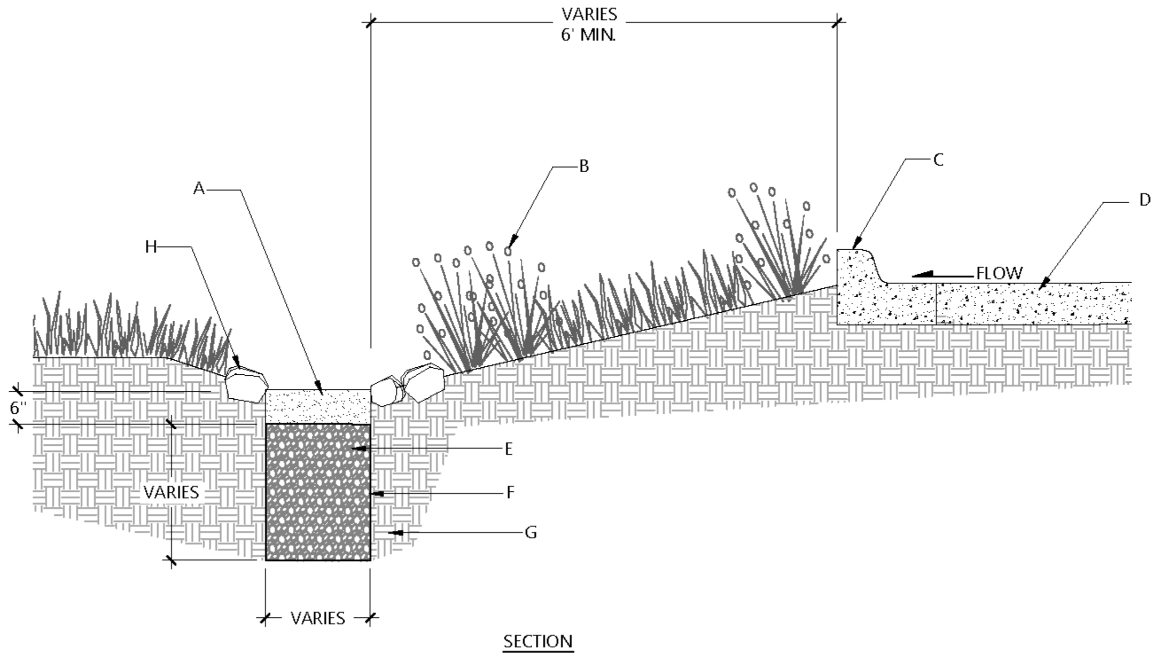
D. Pavement

E. Clean gravel bed, sized to handle design flows

F. Filter fabric wrapped around gravel

G. Uncompacted subgrade

H. Optional stone border



TYPE 2 INFILTRATION TRENCH CONCENTRATED INLET CONCEPT

General Notes:

Functioning similarly to the diffuse inlet infiltration trench, the concentrated inlet routes runoff into a mechanical settling tank below the surface where suspended sediment can be removed before entering a passive infiltration system. The passive infiltration system is a filter fabric-wrapped gravel trench where runoff can be stored temporarily below grade within the pockets between the gravel stones, allowing it to slowly infiltrate. This is advantageous for areas that are prone to slow drainage or do not have a direct connection to a storm drain. This application is particularly useful where contaminant such as oils or grease is prevalent. The sediment tank aids in removing much of this before entering the infiltration system, therefore, reducing maintenance and prolonging the effectiveness of the intervention.

Design Basics:

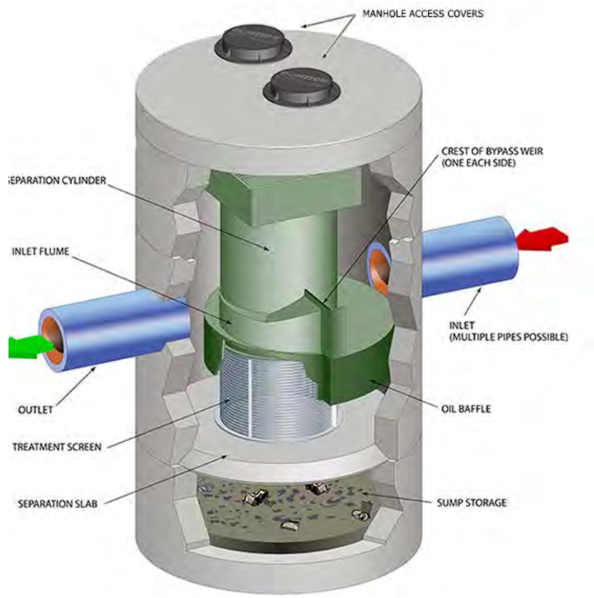
Application:
Collection and treatment of flows within paved and highly impervious area.

Site Conditions:
Parking areas, loading docks, roadways.

Implementation:
Consider clogging potential from debris (leaves, trash) maintain maintenance access for oil/grit separator.
Evaluate infiltration rate of subgrade soils.
Assess sediment contributions and size accordingly.

Figure 16.1 (top): Typical fabric-wrapped gravel infiltration trench application. (Infiltration trenches do not typically include underdrains as shown)

Figure 16.2 (bottom): Typical inline grate inlet unit filtration system



TYPE 2 INFILTRATION TRENCH CONCENTRATED INLET DPM DETAIL 3.0

General Notes:

For subsurface infiltration trenches, removal of sediment and debris is difficult once it enters the trench, so it is critical that contaminants be removed upstream of the trench. Oil and grit separators are available as proprietary systems available from various manufacturers, or can be site-built in a number of configurations

Oil and grit separator should be easily accessible for clean out by vacuum truck

Trench dimensions and pipe sizing will vary depending on size of the drainage area being accommodated

Bottom of trench should be at least 3' above seasonal high water table

Construction Notes:

A. Paved area slopes to drain inlet

B. Curb or drop inlet with grate (screens out large debris)

C. Oil/grit separator to remove floatables, sediment and oils (may be under or adjacent to paved area)

D. Access ports for inspection/clean out

E. Perforated pipe sized to handle design flows (may connect to storm drain or surface outfall beyond trench for overflow)

F. Clean gravel bed sized to handle design flows

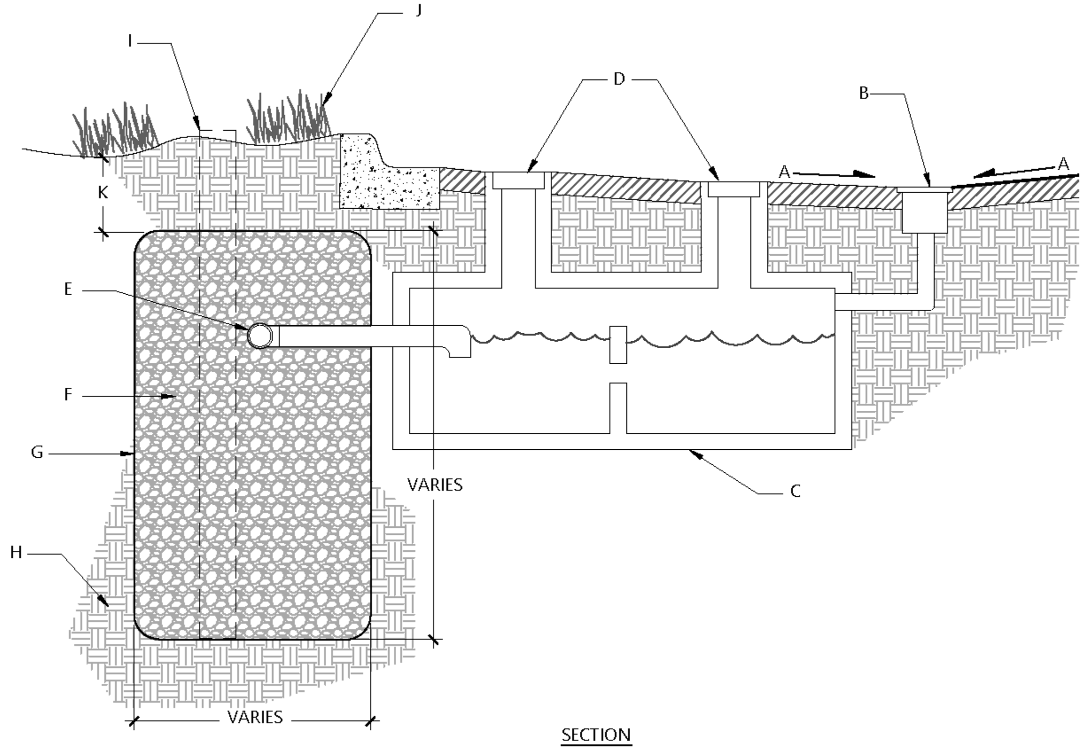
G. Line trench with filter fabric prior to placing gravel

H. Undisturbed native soil

I. Optional observation well with cap (6" minimum diameter)

J. Surface landscaping (varies)

K. 12" Minimum depth, 18-24" for tree and shrub beds



TYPE 3 INFILTRATION TRENCH BACK-OF-CURB RETROFIT CONCEPT

General Notes:

Functioning similarly to the concentrated inlet infiltration trench, the back-of-curb inlet routes runoff into a mechanical settling tank below the surface where suspended sediment can be removed before entering a passive infiltration system. The passive infiltration system is a filter fabric-wrapped gravel trench where runoff can be stored temporarily below grade within the pockets between the gravel stones, allowing it to slowly infiltrate. This is advantageous for areas that have already constructed landscaped areas or other stormwater infrastructure. This application allows for an entrance through the curb for stormwater that can then follow the curb line through the infiltration trench. This limits the invasiveness of the intervention to only several feet behind the curb. This application is particularly useful where contaminant such as oils or grease is prevalent. The sediment tank aids in removing much of this before entering the infiltration system, therefore, reducing maintenance and prolonging the effectiveness of the intervention.

Design Basics:

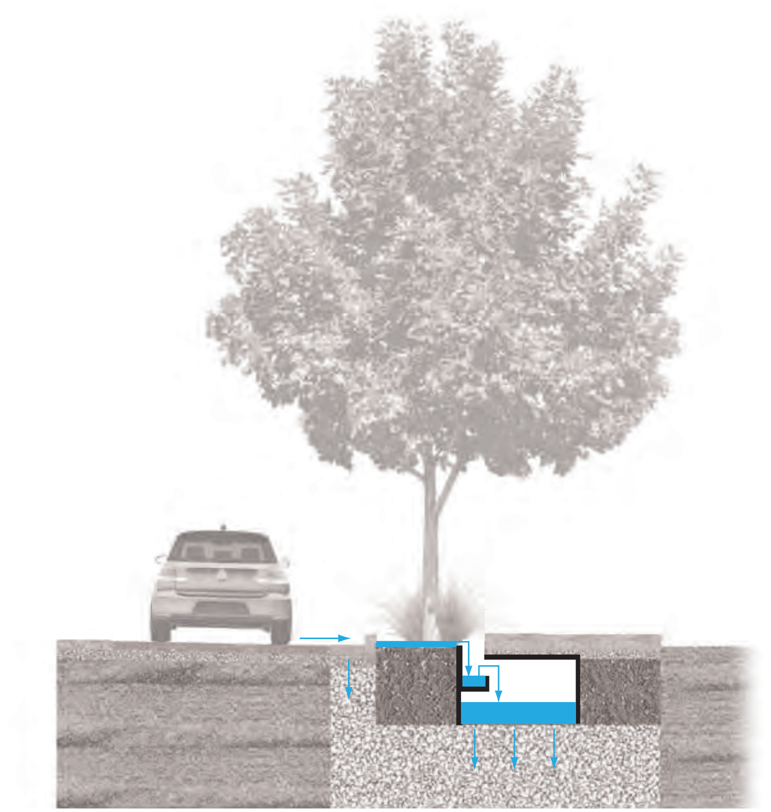
Application:
Collection and treatment of flows within paved and highly impervious area.

Site Conditions:
Back of curb, within medians.

Implementation:
Consider clogging potential from debris (leaves, trash) maintain maintenance access for oil/grit separator.
Evaluate infiltration rate of subgrade soils.
Assess sediment contributions and size accordingly

Figure 18.1 (top): Graphic showing the general strategy of conveying runoff from the street into an adjacent underground sediment tank before the stormwater is infiltrated through the infiltration trench

Figure 18.2 (bottom): Typical inlet to covered seperator and sediment tank



TYPE 3 INFILTRATION TRENCH BACK-OF-CURB RETROFIT DPM DETAIL 4.0

General Notes:

This version of an infiltration trench is intended as a small-scale retrofit, where landscape areas next to street or parking lots with existing mature plants that are above curb cuts. The configuration of this system is intended to minimize disturbance of existing tree and shrub root zones

Sediment removal is important to long-term functionality of the system Inlet sump/sediment collection boxes should be sized appropriately. Smaller boxes will require more frequent inspection and sediment removal, as will areas where run-off would be expected to carry higher concentrations of sand or silt

Length of perforated pipe and gravel trench vary depending on location and spacing of curb penetrations relative to road grade and surface collection areas. For steeper road grades, trench lengths should be shortened to minimize water collection and potential surface blowout at the downstream end

Construction Notes:

A. Core-drilled curb opening, 4"-6" angled in direction of flow, with PVC pipe connector grouted in place, flush with curb face

B. Inlet sump/sediment clean out box with perforated bottom to allow infiltration and prevent standing water, minimum 18"X 24" x 24" deep. Top may be solid or perforated

C. 4" minimum PVC outlet with down turned elbow to prevent oil and other floatable materials from entering drain field

D. 4" minimum perforated pipe bedded in clean, washed gravel, 2 cu. ft. of gravel per linear foot of pipe, wrap gravel in filter fabric

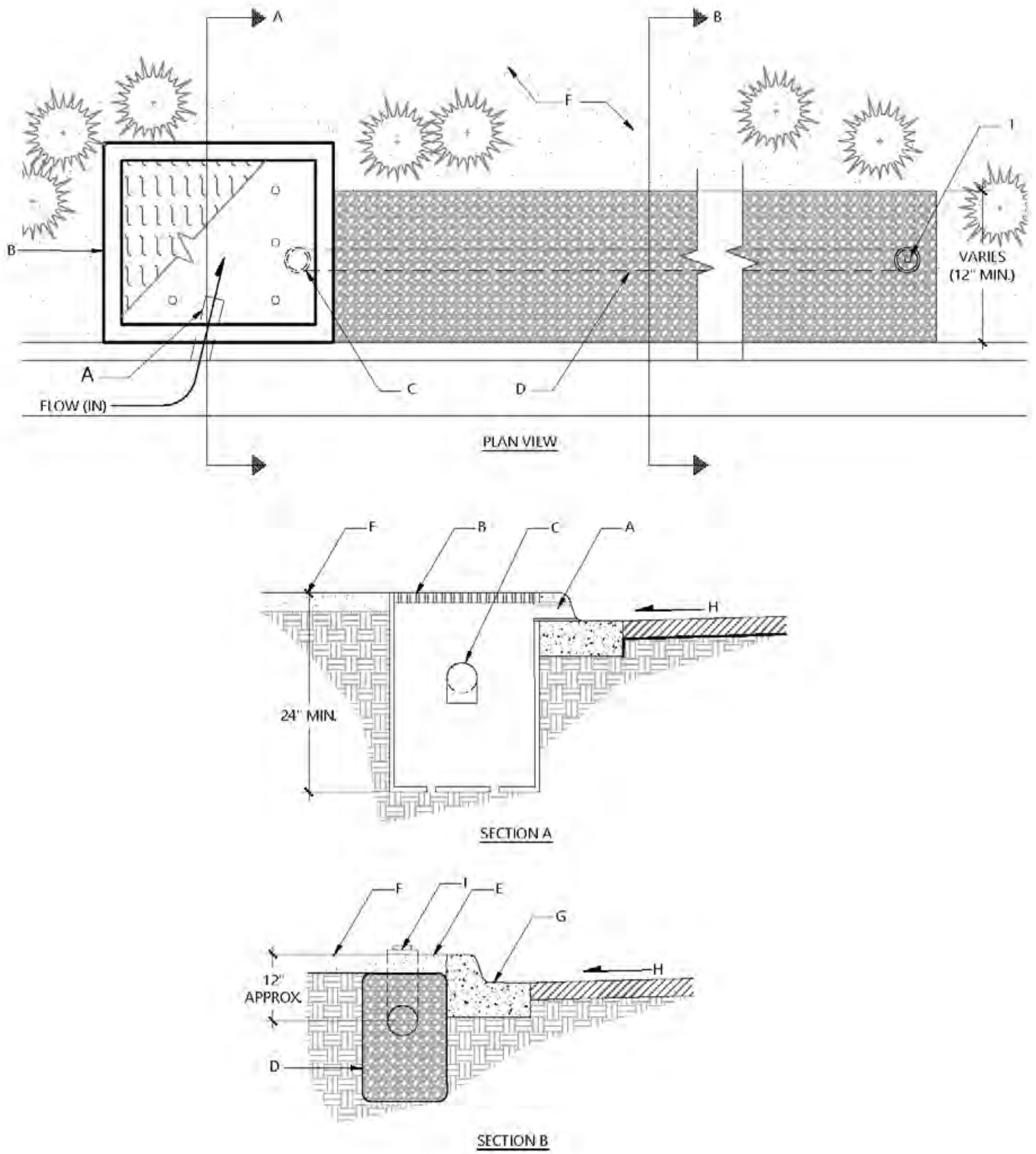
E. Gravel or organic mulch to match existing

F. Existing landscape/planting bed

G. Existing curb and gutter

H. Roadway crown or cross slope must drain to curb

I. Surface clean out with threaded cap at downstream end of perforated pipe



STORMWATER CURB EXTENSION RETROFIT CONCEPT

General Notes:

A stormwater curb extension or 'bump-out' is a vegetated curb extension that protrudes from the existing curb line some distance into the street either mid-block or at an intersection, creating an area that can be utilized for stormwater infiltration, typically composed of a layer of stone that is topped with soil and plants. A curb inlet directs runoff into the bump-out structure from the gutter where it passes through the infiltration media and can be taken up by the plants (evapotranspiration). Excess runoff is permitted to leave the system and flow to an existing inlet. The vegetation must be short enough to allow for open sight lines of traffic. In addition to managing stormwater runoff, curb extensions also aid in traffic-calming, and when located at crosswalks, they provide a pedestrian safety benefit by reducing the street crossing distance.

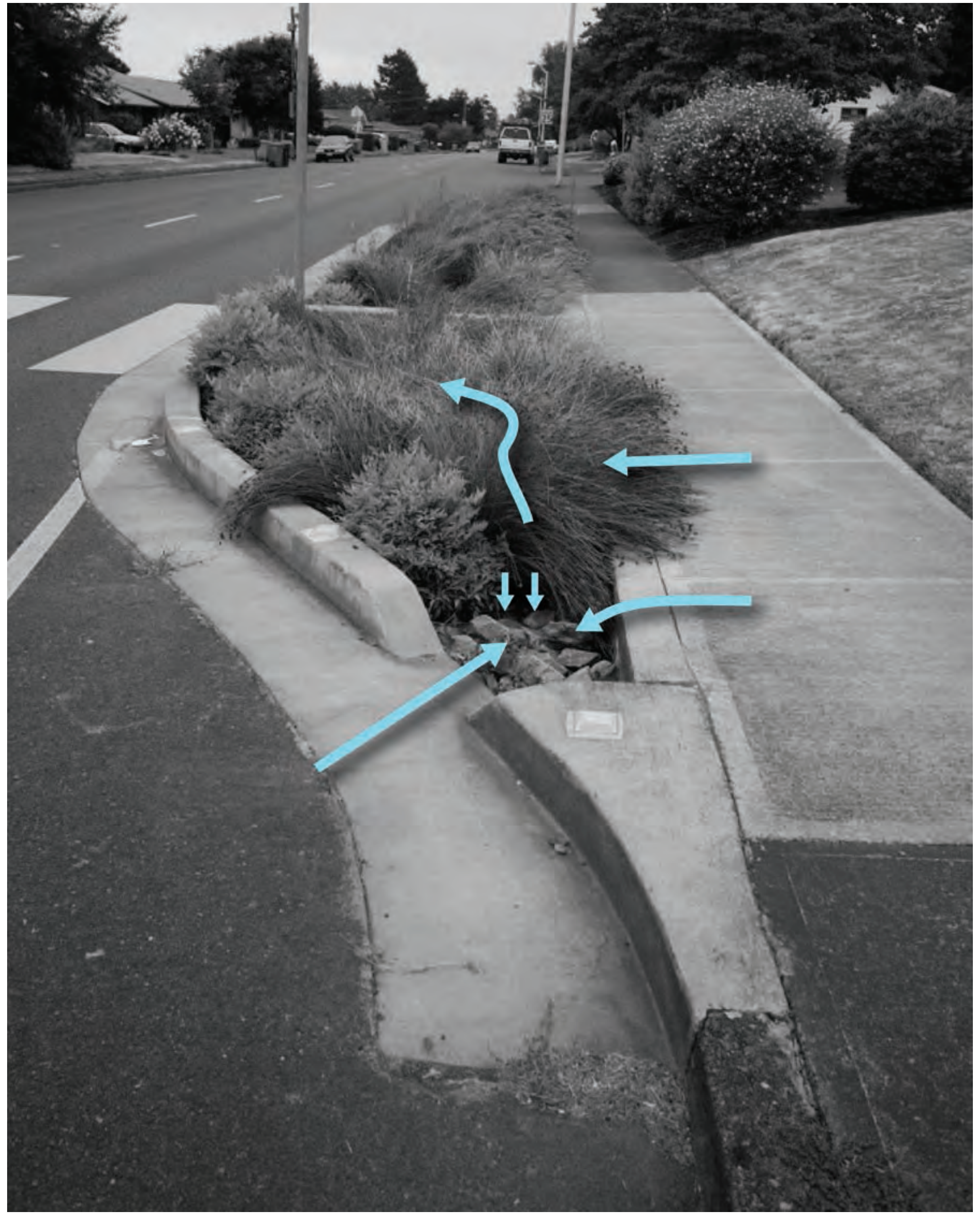
Design Basics:

Application:
Collection and treatment of flows within paved and highly impervious area.

Site Conditions:
Back of curb, within medians.

Implementation:
Consider clogging potential from debris (leaves, trash) maintain maintenance access for oil/grit separator.
Evaluate infiltration rate of subgrade soils.
Assess sediment contributions and size accordingly.

Figure 20.1: Typical stormwater curb extension retrofit application



STORMWATER CURB EXTENSION DPM DETAIL 5.1

General Notes:

Length of curb extension varies with roadway conditions and dimensions may vary with location. Check dam location and spacing varies, depending on road grade, additional check dams can slow flow velocity through curb extension. Curb extension should be regularly montiored for silt and debris accumulation. Splash apron is sized to allow debris removal with a standard flat shovel.

18" minumum depth shown for planting soil mix for low plantings only, minimum depth for tree plantings should be increased To 24" (plans shown are for retrofit application, or new construction)

Construction Notes:

A. Existing sidewalk at back of curb

B. Existing curb; sawcut and remove gutter pan flush with curb face

C. Match existing curb and gutter

D. 6" median curb and gutter per standard drawing 2415

E. 10' transition from standard curb and gutter to median curb and gutter

F. Monolithic curb extension

G. 18" wide inlet curb cut with 1:1 taper at each end

H. 12" wide outlet curb cut with 1:1 taper at each end

I. Sawcut and replace 12" asphalt adjacent to new curb to create smooth transition between surfaces and match asphalt thickness

J. 4' long splashpad/sediment removal apron; 4" concrete, 3000 psi minimum, rough broom finish

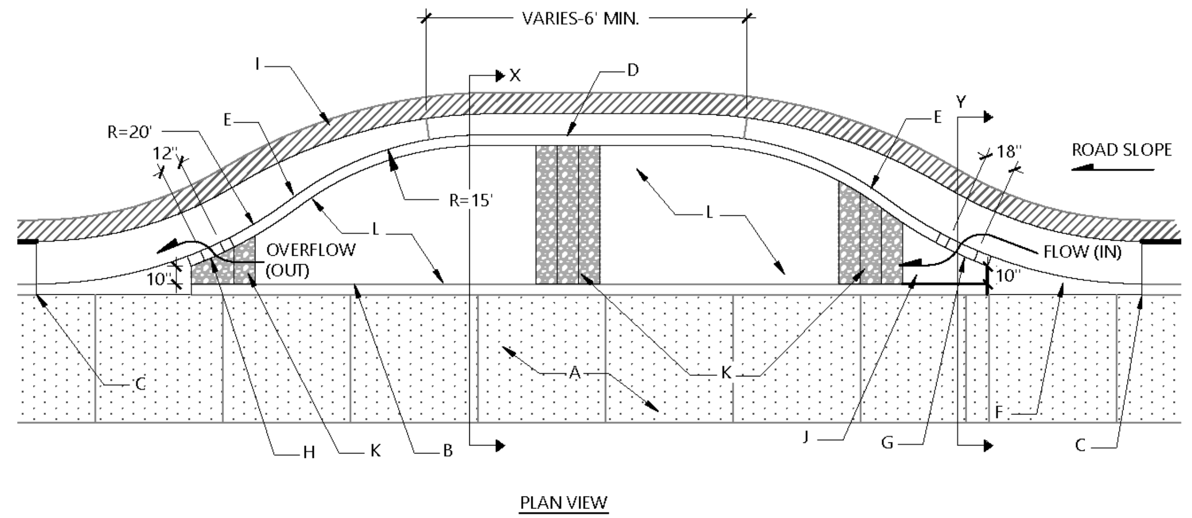
K. 3' wide check dam, full width; angular cobble or crushed gravel 1" minimum with filter fabric on bottom and 4" up sides. Taper from 3" below top of curb to 2" above finished grade of mulch at center

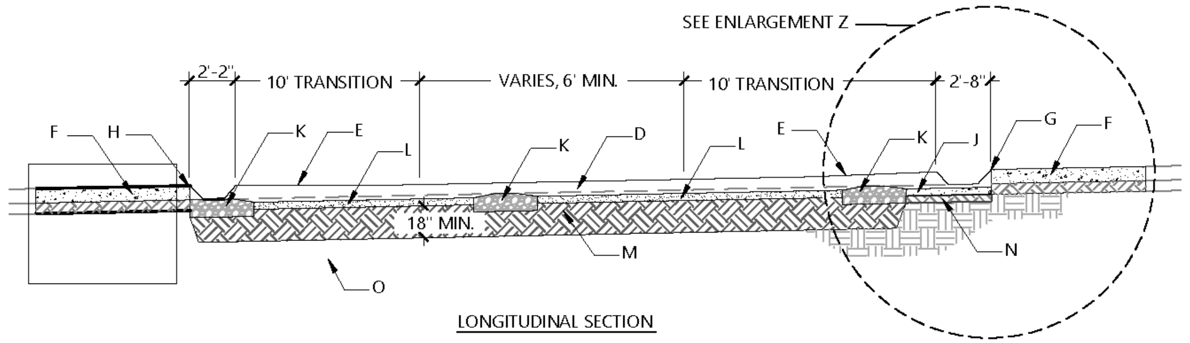
L. Planting bed with 4" non-floatable mulch

M. Planting soil mix

N. Compacted subgrade

O. Uncompacted subgrade, rip 8" deep to encourage infiltration





STORMWATER CURB EXTENSION RETROFIT DPM DETAIL 5.2

Construction Notes:

A. Existing sidewalk at back of curb

B. Existing curb; sawcut and remove gutter pan flush with curb face

C. Match existing curb and gutter

D. 6" median curb and gutter per standard drawing 2415.

E. 10' transition from standard curb and gutter to median curb and gutter

F. Monolithic curb extension

G. 18" wide inlet curb cut with 1:1 taper at each end

H. 12" wide outlet curb cut with 1:1 taper at each end

I. Sawcut and replace 12" asphalt adjacent to new curb to create smooth transition between surfaces. Match existing asphalt thickness

J. 4' long splashpad/sediment removal apron; 4" concrete, 3000 psi minimum, rough broom finish

K. 3' wide check dam, full width, angular cobble or crushed gravel (1" minimum) with filter fabric on bottom and 4" up sides. Taper from 3" below top of curb to 2" above finished grade of mulch at center

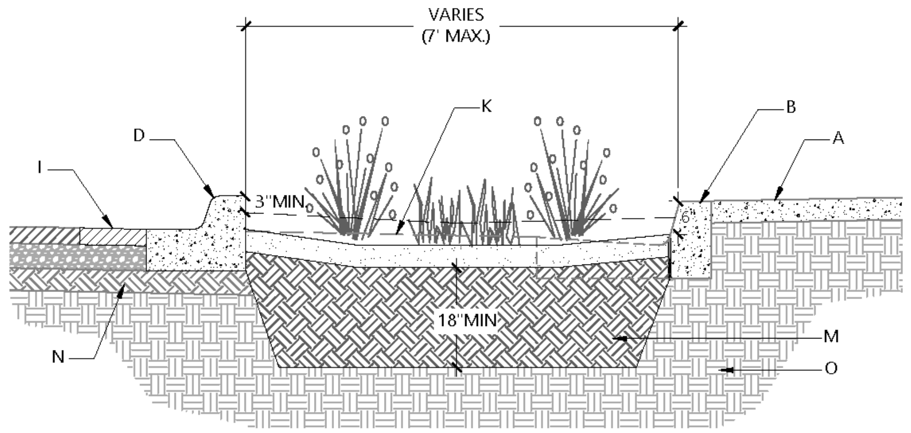
L. Planting bed with 4" non-floatable mulch

M. Planting soil mix

N. Compacted subgrade

O. Uncompacted subgrade, rip 8" deep to encourage infiltration

Figure 23.1 (right page): This system is meant to allow as much stormwater as possible to infiltrate, before it flows into the storm drain system



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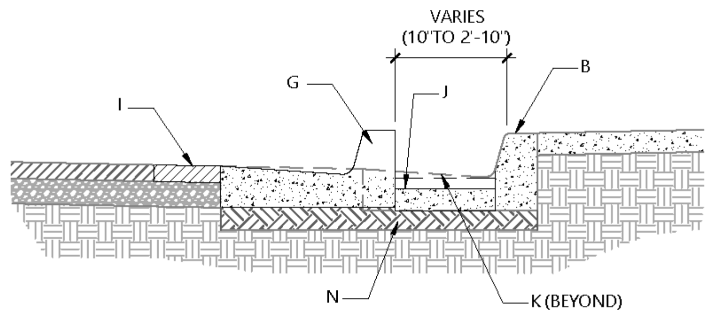

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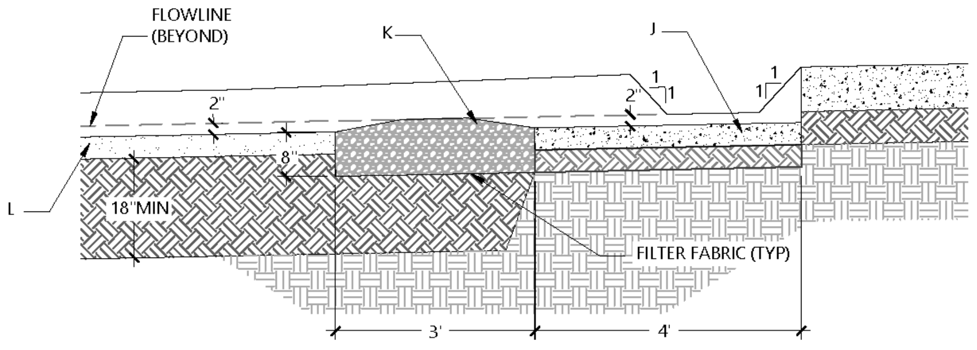


ENLARGEMENT Z

RAISED MEDIAN CONCEPT

General Notes:

Raised medians refer more to an infrastructure application category than an intervention, however, these raised medians can be found on most major roadways and are highly conducive to GSI/LID interventions like bioswales and infiltration trenches as they are linear in nature. The basic concept of a raised median retrofit is that if the adjacent street is crowned, the runoff will be directed toward the sides of the median at the curbs. By implementing curb inlets and depressing the area within the median, this runoff can be collected, conveyed and treated within the median area. Grade control structures and water-slowing interventions such as check dams or weirs are often necessary in raised medians to prevent water velocities from eroding the bioswale.

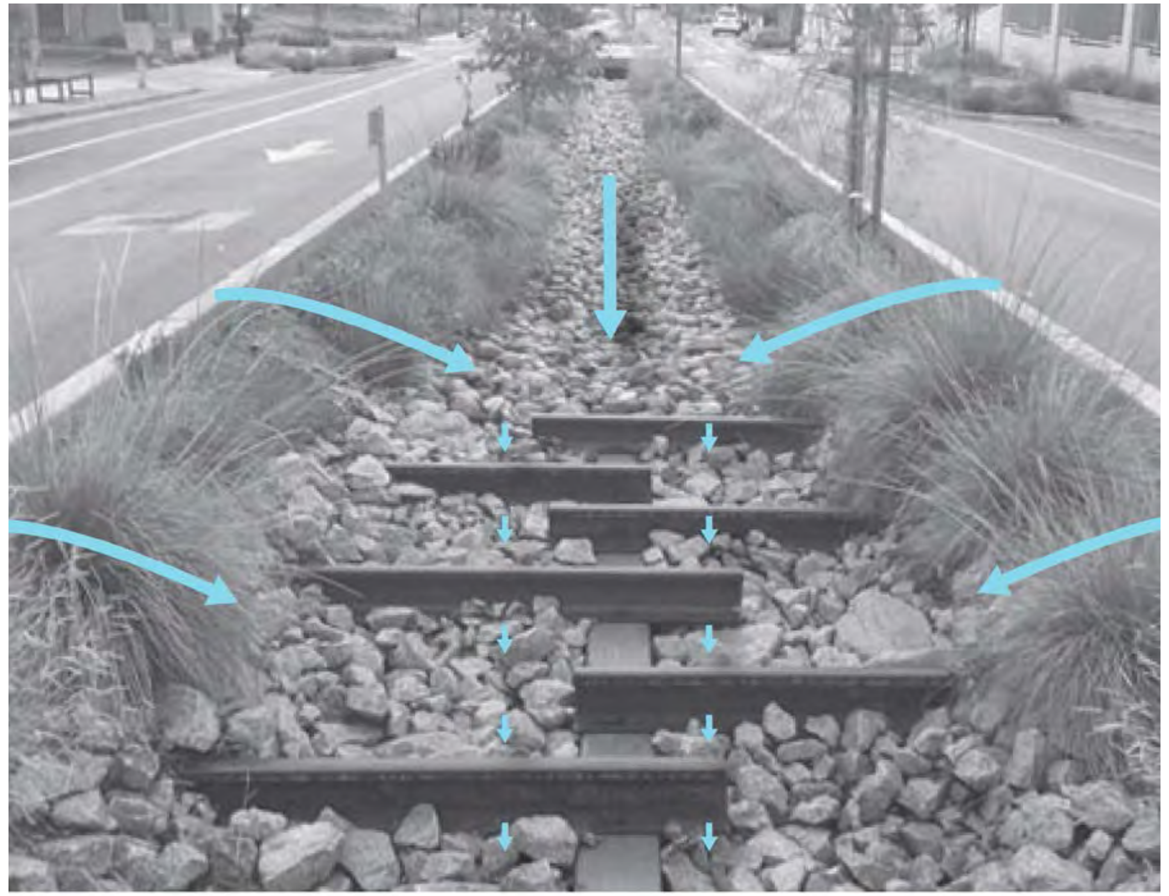
Design Basics:

Application:
Within roadways with inverted crown or road sections sloped to median.

Site Conditions:
Existing or proposed roadway.

Implementation:
Assess contributing area and storage requirements.
Consider impacts of floating debris (leaves, trash).
Ensure adequate maintenance access.

Figure 24.1: Typical raised median application



RAISED MEDIAN DPM DETAIL 6.1

General Notes:

Median water harvesting is only practical in streets with an inverted crown section, or where divided road bed is crowned in each travel direction, so that at least half of the road drains toward the median

Top of mulched landscape beds should be 1-2" below top of curb along each edge except at curb cuts, where grade should taper to 2" below gutter flow line

Sediment traps should be installed at each curb cut to allow easy removal of collected sediment

Construction Notes:

A. 4" non-floatable mulch layer

B. Amended planting substrate

C. Concrete curb with penetrations for inflow and overflow

D. Native and remediation plants per landscape architect/designer

E. Maximum depth of ponding

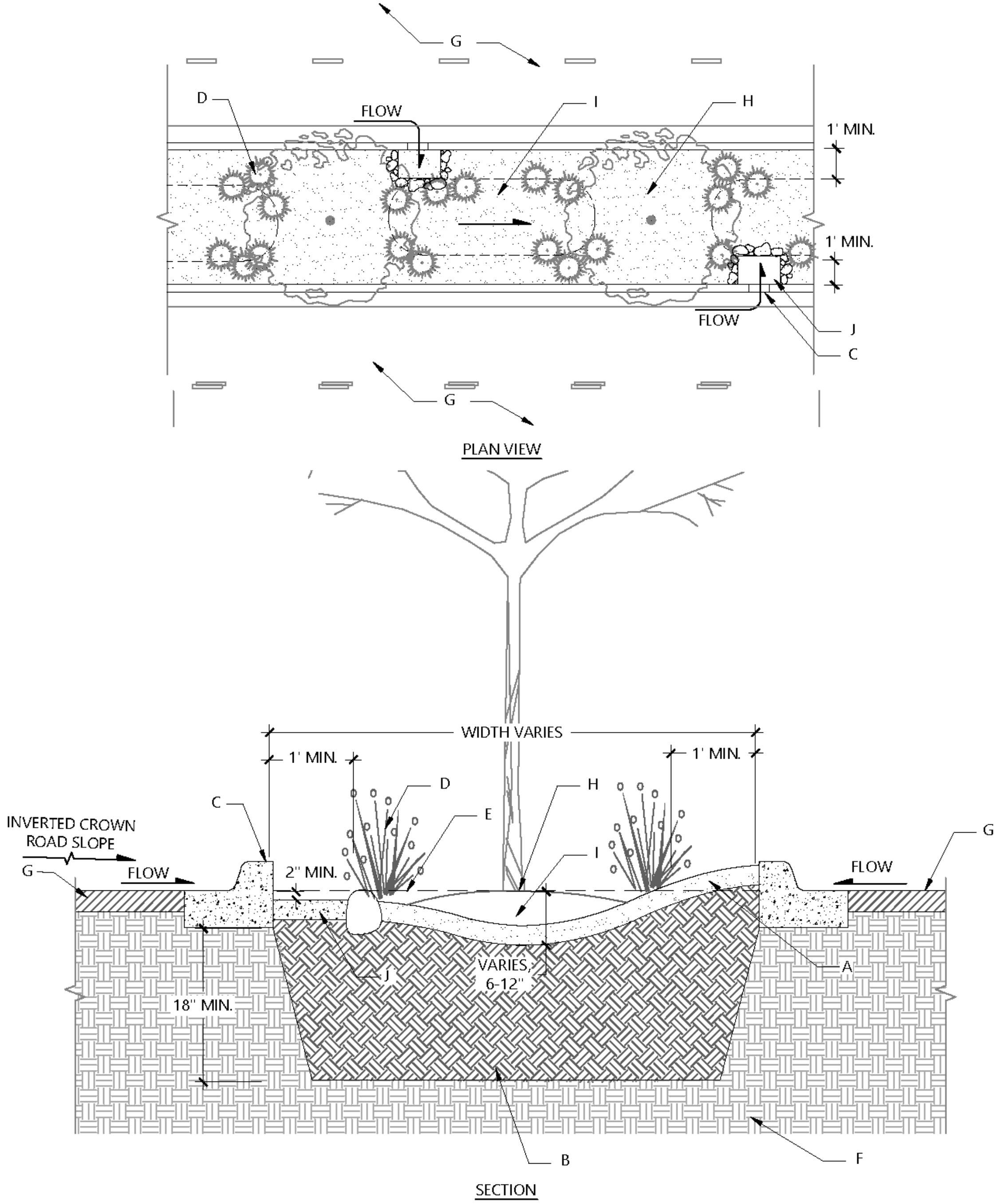
F. Undisturbed subgrade

G. Adjacent parking/road surfaces

H. Tree shelf

I. Water harvesting depression

J. 4" concrete sediment removal forebay, 3 square feet minimum, with cobble/stone perimeter sediment trap



RAISED MEDIAN
DPM DETAIL 6.2

Construction Notes:

A. 4" Non-floatable mulch layer

B. Amended planting substrate (see general design considerations)

C. Concrete curb with penetrations for inflow and overflow

D. Native and remediation plants per landscape architect/designer

E. Undisturbed subgrade

F. Adjacent parking/road surfaces

G. Mulch level beyond

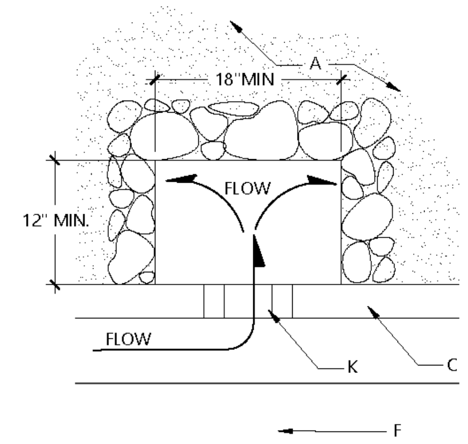
H. Filter fabric

I. 4" Concrete sediment removal forebay, level and centered on curbcut

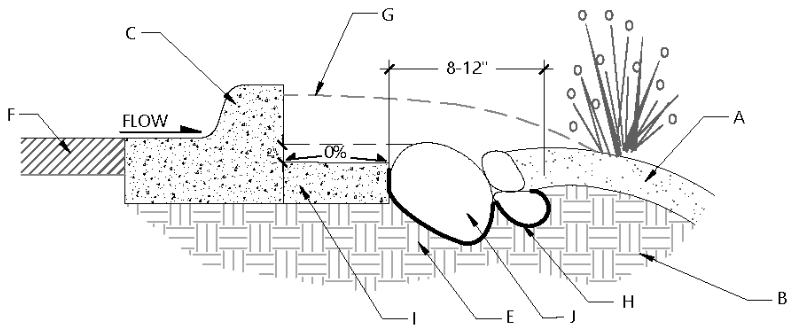
J. Cobble/stone sediment trap

K. 6" Curb cut tapered 1:1

Figure 27.1 (right page): Raised median with stormwater being collected from the adjacent street



PLAN VIEW



SECTION

DETAIL Q- SEDIMENT REMOVAL FOREBAY

STORMWATER TREE PIT WITH GRATE CONCEPT

General Notes:

Functioning similarly to a traditional tree pit, stormwater tree pits are designed and engineered to accept runoff, which is then utilized to support the tree growth and infiltrated into the soils, therefore, reducing the volume of runoff going into the storm drain system. Individually, stormwater tree pits have a relatively low impact, but connecting multiple pits in series through the use of continuous soil trenches, drains, or other grey or green stormwater infrastructure, the pits can have a significant impact on reducing stormwater runoff by maximizing capacity. Tree pits are most applicable and useful as retrofits in an urban environment where existing soils are very compacted or poor and underground space is limited.

Design Basics:

Application:
Parking lot margins behind curb.
Edge of roadway behind curb.

Site Conditions:
Impervious areas contributions.

Implementation:
Ensure mature tree canopy does not impede traffic flow.
Consider how to accommodate overflow due to intense rainfall events.
Consider applications to accommodate roof runoff.
Evaluate site grading (new construction) to direct flow into collection system.

Figure 28.1 (top): Typical stormwater tree pit with grate designed to collect stormwater and filter out pollutants

Figure 28.2 (bottom): Stormwater tree pit with grate filtration system

STORMWATER TREE PIT WITH GRATE DPM DETAIL 7.1-7.2

General Notes:

Stormwater tree pits are intended for isolated street tree installations in areas of heavy pedestrian traffic where open planters may impede circulation. Spacing will be determined by site plan and street tree ordinance. Amended soil planting mix should fully abut structural pavement support soils, with no filter fabric or other barrier separation

Structural planting soil system (suspended pavement system) is intended to provide additional root growth area while providing adequate support for surrounding paving. Acceptable systems include: Silva Cell (Deeproot Green Infrastructure, LLC.), Strata Cell (City Green Urban Landscape Solutions), CU Structural Soils (Cornell University). Other systems may be acceptable upon approval by project manager

Pre-manufactured stormwater tree boxes, which combine a stormwater vault and tree grate, are not recommended as they provide inadequate rooting area and result in tree stress and premature plant mortality

Construction Notes:

A. 4" Non-floatable mulch layer

B. Amended planting substrate

C. Tree grate (MFR varies) minimum 5' X 5'

D. Concrete curb/edge restraint with openings for inflow and overflow, 6" width for curb cut, 4" diameter minimum for core drilled penetration

E. Tree per landscape architect/designer

F. Structural planting soil system beneath sidewalk

G. Not used this sheet

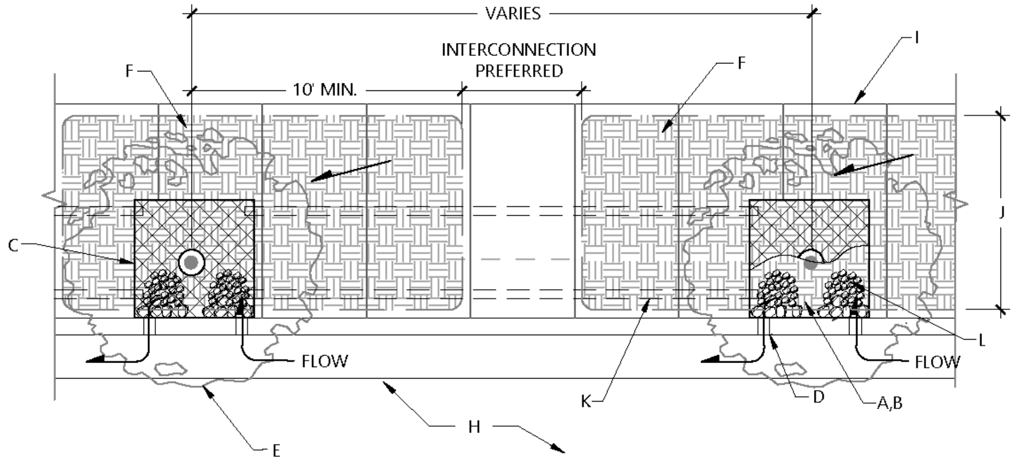
H. Adjacent parking/road surface

I. Sidewalk

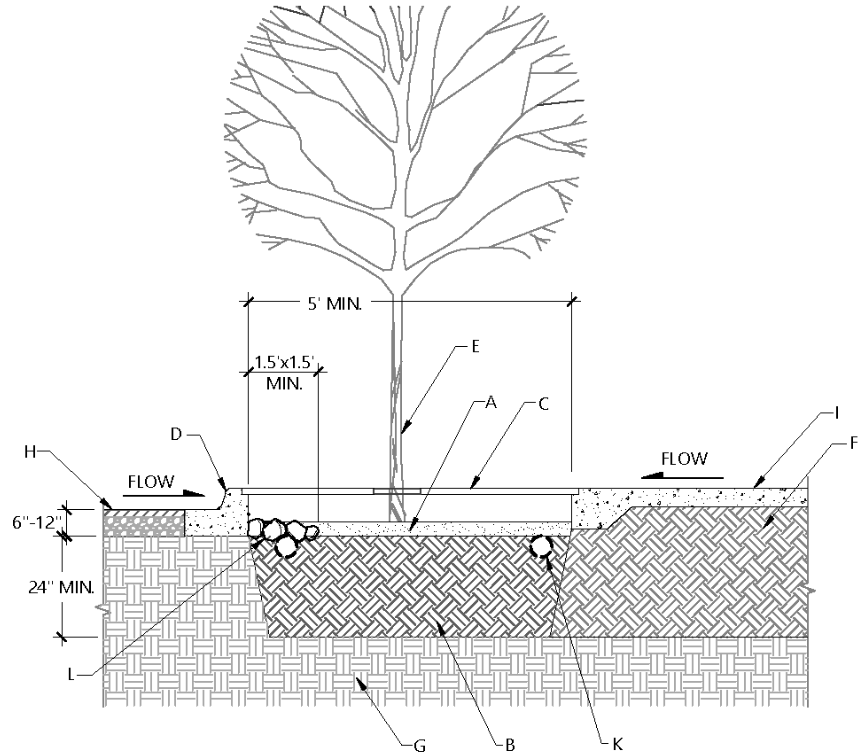
J. Structural planting soil support system to extend full width of sidewalk or 10' minimum for wider plaza areas

K. Optional 4"-6" diameter perforated pipe with filter fabric wrap to connect tree pits

L. 4"-6" cobble bed to slow entry flows



PLAN VIEW



SECTION

STORMWATER PLANTER BOX CONCEPT

General Notes:

Stormwater planters are specialized infiltration cells typically installed between the roadway and the right of way to manage street and sidewalk runoff. A stormwater planter manages runoff through infiltration and evapotranspiration (or detention and slow-release when underlying soils do not allow for infiltration). Typically composed of 4 rigid walls than encase infiltration media, stormwater planters are lined with a permeable fabric, filled with gravel or stone, and topped off with soil, plants, and sometimes trees. The finished grade of the media or infiltration zone in the planter is lower in elevation than the adjacent surfaces(sidewalks and roadway), allowing for runoff to flow into the planter through an inlet at street level. These planters manage stormwater by providing storage, infiltration, and evapotranspiration of runoff. Excess runoff can be directed into an overflow pipe connected to the existing combined sewer pipe. This application is typically utilized in urban areas where impervious surfaces are scarce.

Design Basics:

Application:
Parking lot margins, pedestrian paths and sidewalks

Site Conditions:
Impervious areas, roadways, parking, trails

Implementation:
Evaluate site grading (new construction) to direct flow into collection system

Figure 30.1: located adjacent to Portland State University in downtown Portland, this stormwater planter box sustainably manages street stormwater runoff

STORMWATER PLANTER BOX DPM DETAIL 8.1

General Notes:

Stormwater planter boxes are intended to intercept, store, and encourage infiltration of storm runoff from streets and/or parking areas. A minimum 24" wide paved setback is required between curb and planter box adjacent to any parking areas. Alternatives to concrete containment walls may be acceptable when detailed on construction plans and approved by engineer

Plants for stormwater planter boxes should be able to tolerate inundation by periodic storm flows. Supplemental irrigation may also be required during dry periods. Planting soil should be nearly level (1% maximum) which will affect planter length. Planters along steeper roads will need to be shorter or stepped down along the road. 18" minimum depth of planting soil mix, for low plantings only, and 24" minimum for trees

Construction Notes:

A. 4" mulch layer

B. Amended planting substrate

C. Concrete containment wall designed for site conditions

D. Native and remediation plants per landscape architect/designer

E. 12" X 12" minimum cobble splash pad

F. 4" concrete sediment removal apron, minimum 3 square feet with cobble/stone perimeter sediment trap

G. Uncompacted subgrade

H. Adjacent parking/road surface

I. Vertical curb cut (typical)

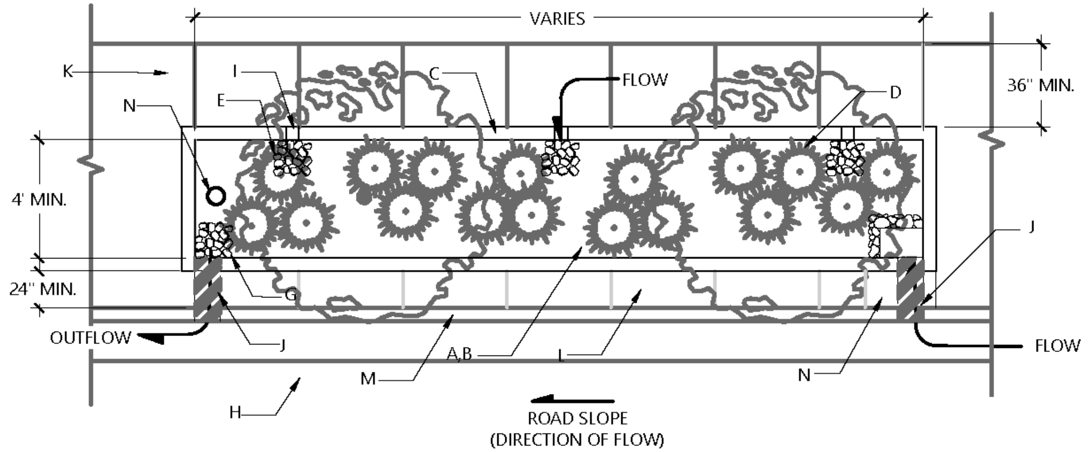
J. Sidewalk culvert or trench drain

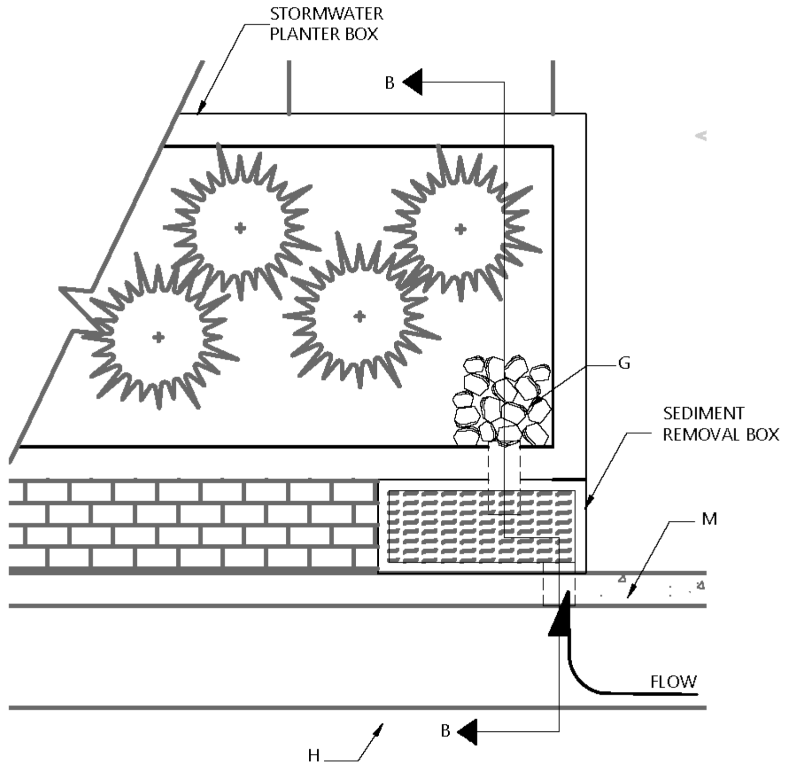
K. Sidewalk

L. Pedestrian buffer (applicable with parallel parking)

M. Curb and gutter

N. Optional sediment removal box





STORMWATER PLANTER BOX
DPM DETAIL 8.2

Construction Notes:

A. 4" mulch layer

B. Amended planting substrate

C. Concrete containment wall designed for site conditions

D. Native and remediation plants per landscape architect/designer

E. Water storage depth determined by outflow curb cut

F. 24" maximum unless additional pedestrian guardrail or ornamental fence is added

G. Uncompacted subgrade

H. Adjacent parking/road surface

I. Curb cut

J. Sidewalk culvert or trench drain

K. Sidewalk

L. Pedestrian buffer (applicable with parallel parking)

M. Curb and gutter

N. Optional perforated pipe connection to outfall or storm drain, if required

O. Optional sediment removal box

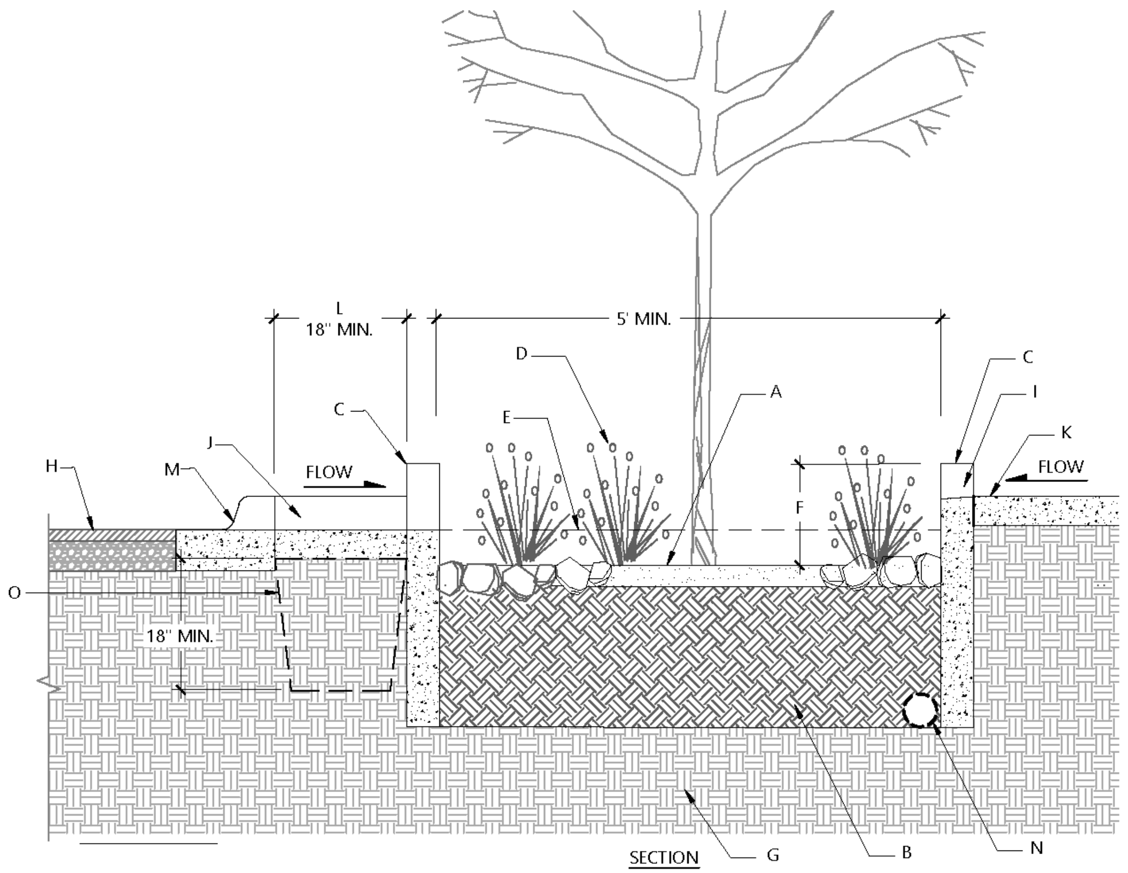
P. Perforated bottom to facilitate drainage and prevent standing water

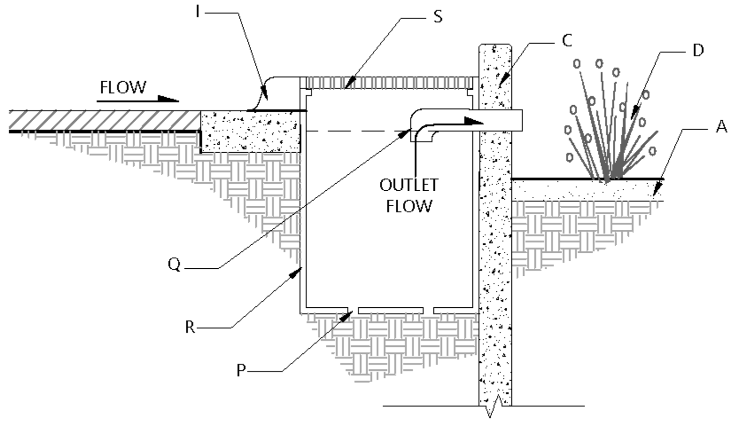
Q. Outlet pipe to be set level with elevation of outflow curb cut

R. Concrete or plastic sump/sediment removal box, minimum 18" X 24" x 24" deep

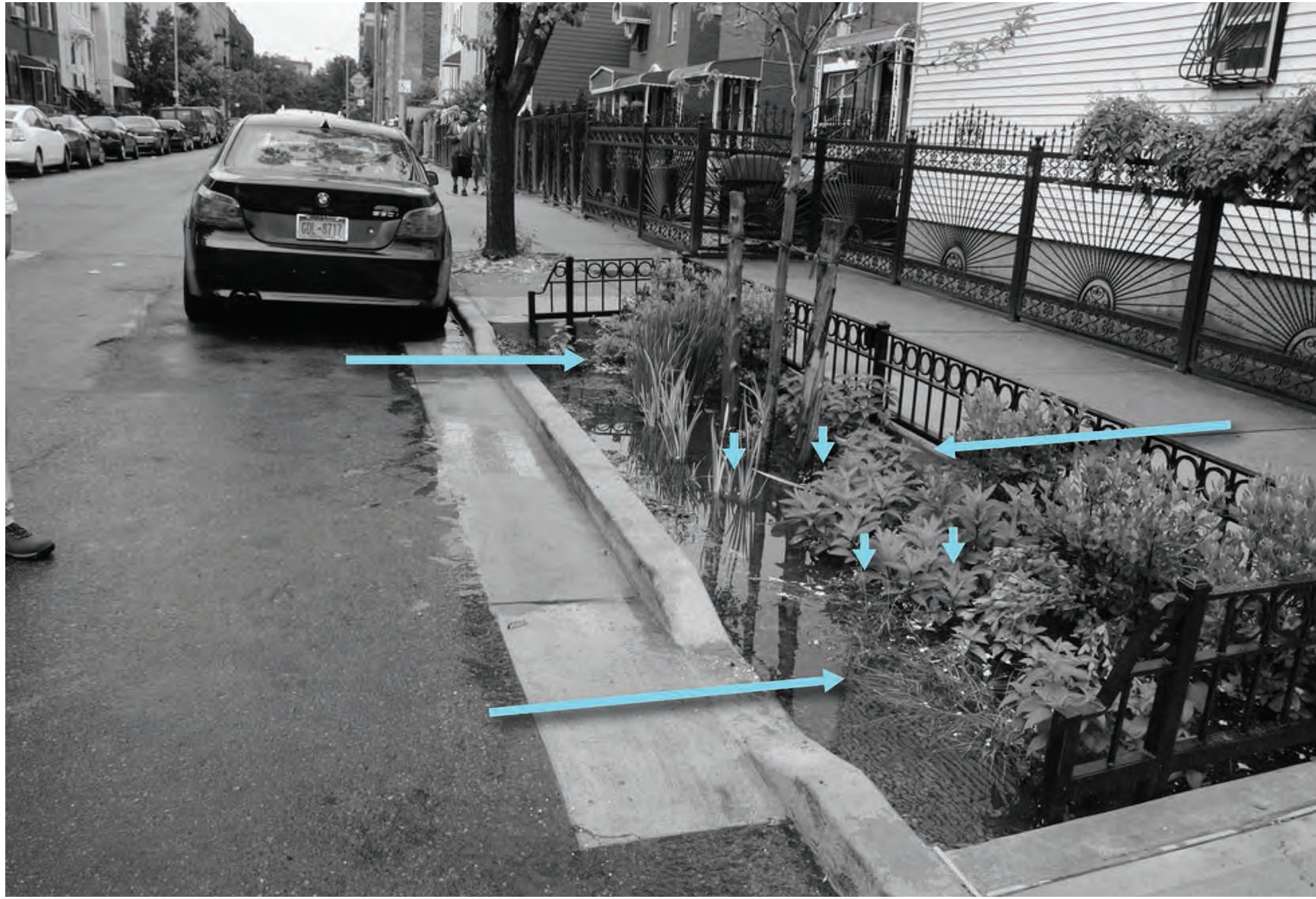
S. Grate or solid cover

Figure 33.1 (right page): Typical stormwater planter box retrofit application





SECTION B- OPTIONAL SEDIMENT REMOVAL BOX



PERVIOUS PAVEMENT CONCEPT

General Notes:

Pervious pavement refers to a wide variety of surfaces, including concretes, asphalts, and various types of grid and unit paver systems, that effectively treat, detains, and infiltrates stormwater runoff where other less rigid GSI/LID interventions are restricted or less desired. These pavements are designed with integrated voids that allow for water to pass through from the surface to the subsurface area where it can then be stored within the voids and slowly infiltrated. Pervious pavement applications are typically u sed in highly-urbanized areas where other GSI/LID interventions may not be feasible as they allow for infiltration of runoff while maintaining rigid surfaces in the built environment. Pervious pavements are typically used in parking lots, sidewalks, driveways, plazas and courtyards, tennis and basketball courts, bicycle trails, fire lanes and low-traffic roadways in parallel parking areas. The volume of runoff infiltrating into the system can be increased significantly when combined with other engineered systems that promote infiltration and vegetation growth, such as structural soil, suspended pavement, and stormwater tree pits.

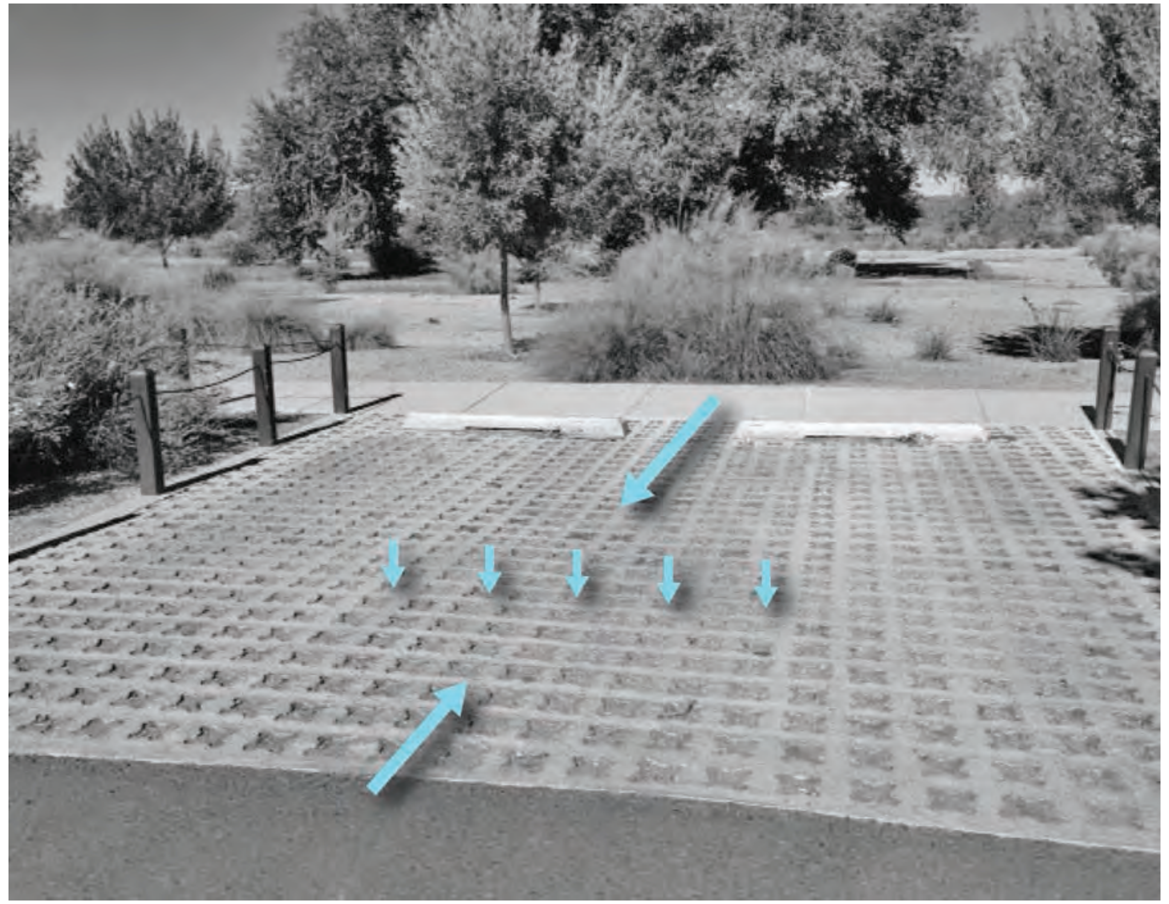
Design Basics:

Application:
Parking and internal circulation areas.

Site Conditions:
Impervious areas.

Implementation:
Minimize sediment contributions to avoid plugging.

Figure 34.1: Pervious pavement application used to allow stormwater runoff to infiltrate



PERVIOUS PAVEMENT DPM DETAIL 9.0

General Notes:

Permeable pavements should be located and graded so adjacent surfaces do not drain onto pavement surface, minimizing silt accumulation. Pavements may consist of permeable interlocking pavers (PICP) or bricks, pervious concrete, porous asphalt, or other proprietary systems. Consult a geotechnical engineer to recommend a thickness of paving and base rock based on the native soils in a wet, uncompacted state, and anticipated traffic loading and volume

If native soils have a minimum infiltration rate of < 0.1 inches per hour, supplemental drainage systems may be required. In areas of potential collapsible soils, subgrade should be graded flat (or in flat terraces) beneath gravel sub-base to eliminate areas of concentrated ponding, which could lead to uneven settlement of pavement areas. Supplemental drainage systems may be used to remove excess water from low areas. 18" minimum depth of planting mix is intended for low plantings only, 24" Minimum depth for tree plantings

Construction Notes:

A. Pervious pavement

B. 1" minimum, ASTM #8 aggregate (brick/paver applications) to provide filtration/separation beneath sand bedding

C. 4" minimum open-graded base course, ASTM #57 (2") to provide void space for water conveyance/storage

D. 6" minimum aggregate sub-base, ASTM #1 crushed stone to provide void space for infiltration and sub-surface conveyance

E. Woven geotextile

F. Uncompacted subgrade

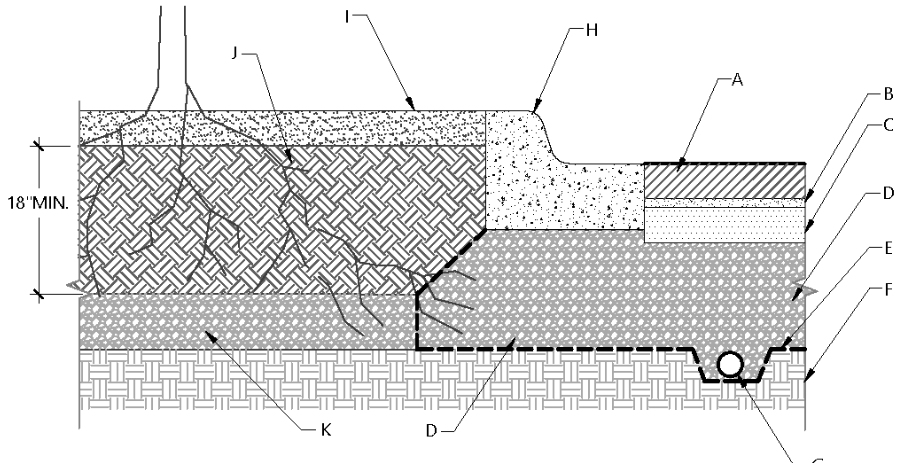
G. Perforated pipe(s), sloped to drain (if required by local conditions)

H. Concrete curb/edge restraint

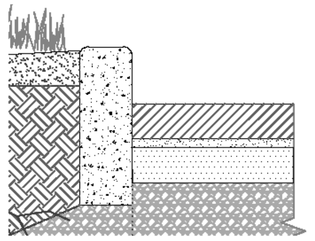
I. Sidewalk or landscape/infiltration area

J. Native or blended planting soil

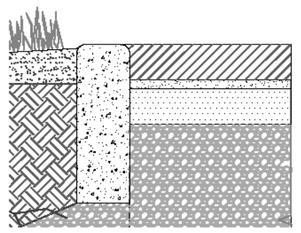
K. Extend aggregate sub-base under curb/edge restraint and (optional) into planting bed to increase plant access to runoff



STANDARD CURB & GUTTER OPTION



HEADER CURB OPTION



FLUSH CURB/EDGE RESTRAINT OPTION

PERMEABLE CHECK DAM CONCEPT

General Notes:

A check dam is a small, sometimes temporary, dam constructed across a swale, drainage ditch, or waterway to counteract erosion by reducing water flow velocity. Check dams are typically constructed from sturdy materials such as compacted earth, stone or a structure like gabion baskets, implemented as a system of several check dams situated at regular intervals across the area of interest creating several smaller ponding areas. Permeable check dams allow for water ponded behind the dam to slowly leak or permeate through the structure and they help to prevent channel erosion and allow suspended sediment to settle out. A check dam placed in the ditch, swale, or channel interrupts the flow of water and flattens the gradient of the channel, thereby reducing the velocity. They can be used not only to slow flow velocity but also to distribute flows across a swale to avoid preferential paths and guide flows toward vegetation. Although some sedimentation may result behind the dam, check dams do not primarily function as sediment trapping devices. Check dams can be constructed across swales, small channels or drainage ditches. They are particularly useful for steeply-sloped swales and channels where vegetation has difficulty holding the channel banks. The total drainage area should not exceed 10 acres. Consultation with a professional engineer is advised. Check dams should not be constructed in live streams as they will disrupt movement of fish and other aquatic fauna.

Design Basics:

Application:
Reducing flow velocities within earthen conveyance channels:

Site Conditions:
Earthen open channels:

Implementation:
Install at intervals suitable to reduce flow velocity.
Consider sediment and debris accumulations.

Figure 36.1: Typical permeable check dam application

PERMEABLE CHECK DAM DPM DETAIL 10.0

General Notes:

Check dams act as energy dissipators to reduce flow velocities and facilitate removal of debris and large sediments from storm runoff

Permanent or semi-permanent structures should be comprised of gravel or stone. Other aggregates, such as crushed concrete, may be suitable in certain applications. Angular or crushed gravel/stone will lock together better than rounded gravel or cobble, reducing maintenance

Permeable check dams will trap both sediment and debris, and require periodic cleaning to remove collected debris to maintain structure stability

Construction Notes:

A. Height varies, weir height should be at least 6" lower than ends of check dam and should not exceed one half of channel depth

B. Check dam should be embedded at least 6" into channel bed

C. Extend buried footing material to top of channel to prevent scouring at ends of structure

D. Space check dams such that the downstream weir elevation is at or above the toe elevation of the next upstream weir

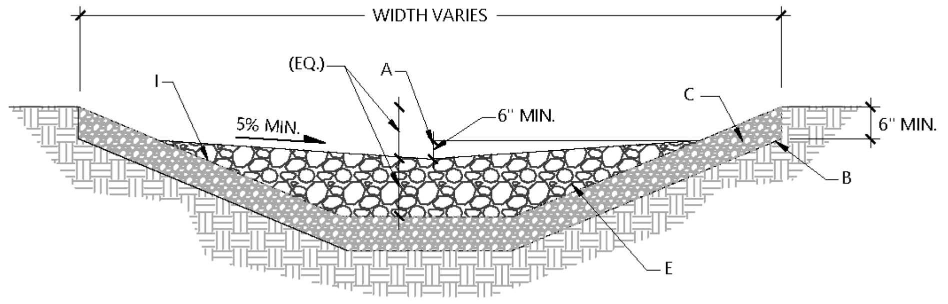
E. Gravel, cobble, broken concrete, or other suitable aggregate, sized to withstand design flow conditions

F. Upstream face should be 4:1 or flatter

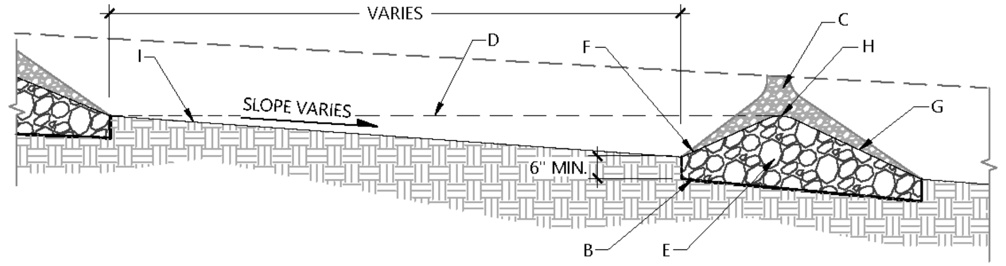
G. Downstream face should be 3:1 or flatter

H. Top width 6" minimum

I. Finished grade of channel



ELEVATION VIEW



PROFILE SECTION

STACKED STONE EROSION CONTROL BASIN “ZUNI BOWL” CONCEPT

General Notes:

An erosion control basin, locally known in the Arid Southwest as a Zuni Bowl, is an erosion control intervention composed of rock-lined step falls and basins that prevent headcuts from continuing to migrate within channels or large rills formed by erosion. Zuni Bowls are designed to stabilize actively eroding headcuts by dissipating the energy of falling water at the headcut pour-over and the bed of the channel by armoring the basins with stacked rock or stone and converts the single cascade of an eroding headcut into a series of smaller step falls.

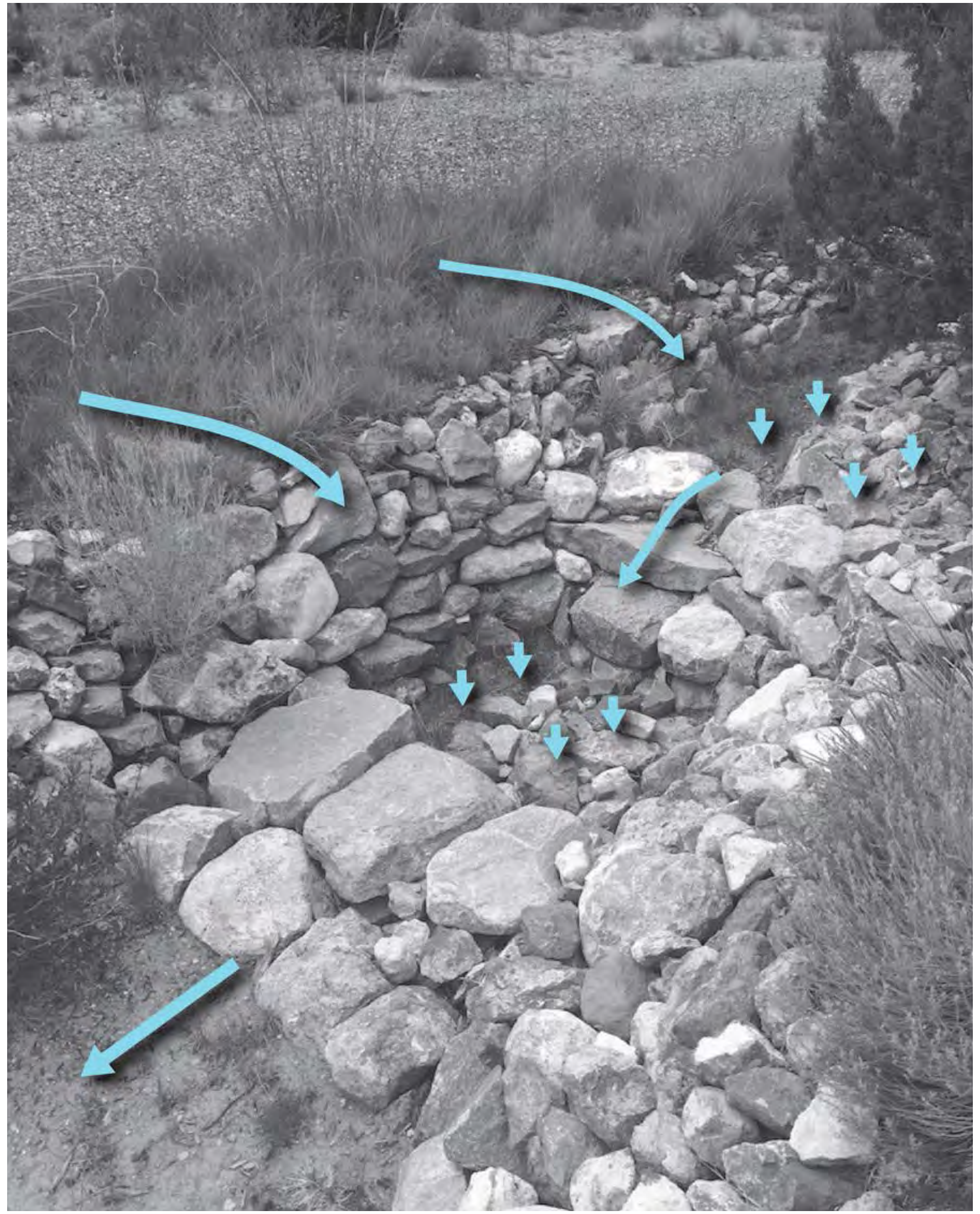
Design Basics:

Application:
Collection of small contributing areas with lesser flow rates and volumes.

Site Conditions:
Building and trail margins.

Implementation:
Consider ground slope to avoid erosive energy that may dislodge rock. Consider sediment and debris accumulations.

Figure 38.1: Typical stacked stone erosion control basin application, commonly referred to as a "Zuni Bowl"



STACKED STONE EROSION CONTROL BASIN “ZUNI BOWL” DPM DETAIL 11.0

General Notes:

Stacked stone erosion control basin “zuni bowl” can be used as a site specific application to stabilize a developing headcut in a natural-looking manner.

Potential applications include roadside drainage outfalls to unlined channels, as well as natural channels experiencing increased erosion from higher runoff volumes

Boulder sizes and shapes may vary, but should be angular to promote stacking and interlock, and should blend into the local environment

Loosen subgrade soils before placing rocks. Tamp bottom courses of rock firmly in place. Offset joints of subsequent courses for maximum stability of structure

Construction Notes:

A. Sidewalk culvert, curb, or upstream channel; see plans

B. Stacked stone, angled back into slope at 1:2 maximum

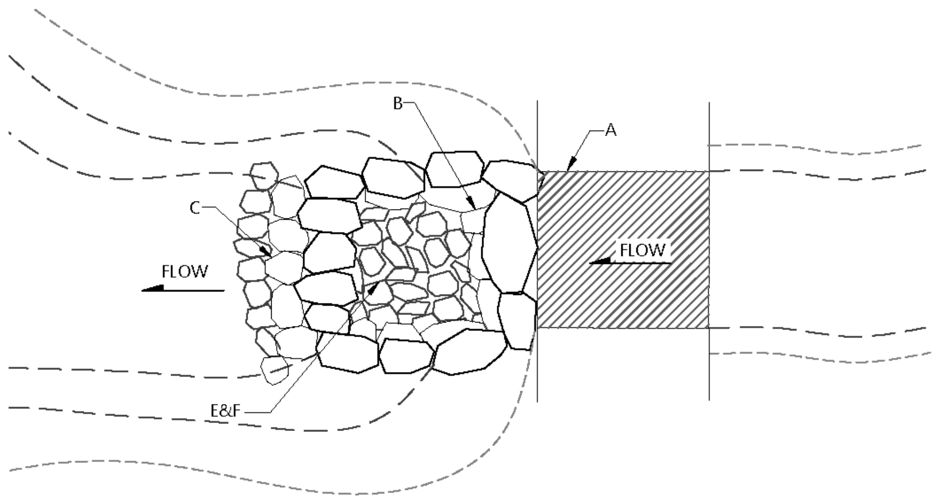
C. Sill boulders at downstream end of plunge pool, sized to prevent displacement during expected design flows

D. Sidewalls of basin (beyond) transition from downstream sill to upstream channel edge

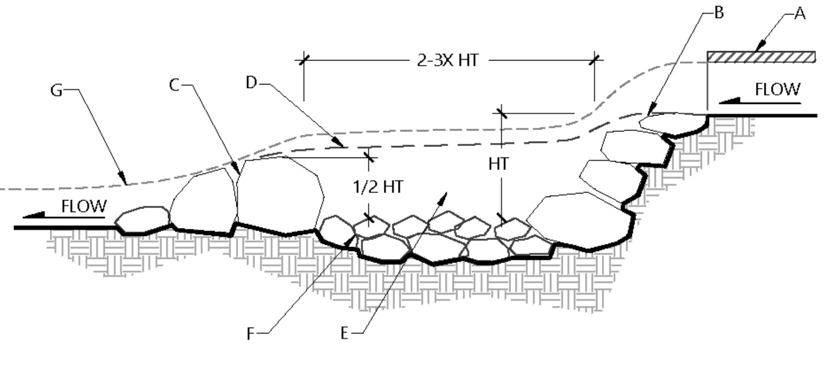
E. Plunge pool depth varies

F. Double layer of rock in bottom of plunge pool

G. Top of bank (beyond)



PLAN VIEW



LONGITUDINAL SECTION

STONE CHANNEL PLATING CONCEPT

General Notes:

Stone Channel Plating is an LID intervention that is intended to stabilize the bed of a channel, typically in an area exhibiting heavy erosion. The plating is constructed of a band of a single course of stones placed tightly together that function to dissipate concentrated runoff velocities by increasing channel roughness and then spread them to increase infiltration. The plating interventions are typically applied in series for the length of areas of erosion control. This helps to maintain the slower velocities and prevent erosion downgrade of the structures. The stone channel plating can also act as a mulch, keeping the sun and wind away from the soil. This encourages vegetation growth which can contribute to established natural soil stabilization and reduced erosion. As the vegetation establishes, it will continue to spread into the landscape. This intervention is most applicable on larger scale settings for erosion control on hill sides or disturbed sites.

Design Basics:

Application:
Reduce flow energy to reduce erosion of earthen channels.

Site Conditions:
Head cuts, earthen channels, open areas

Implementation:
Evaluate contributing flow rate and area.
Use appropriately sized rock based on flow energy.

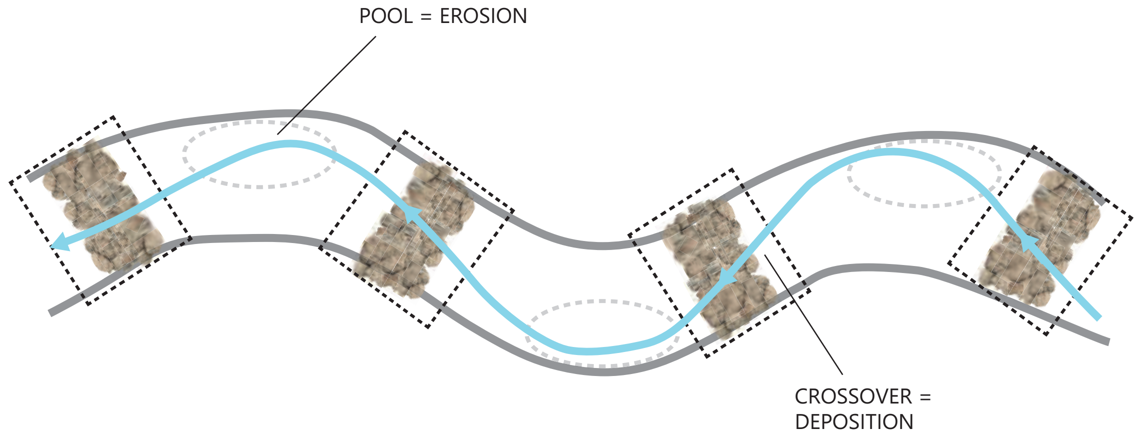


Figure 40.1: Plan diagram of a typical stone channel plating concept

STONE CHANNEL PLATING DPM DETAIL 12.0

General Notes:

These structures are low-level grade control structures intended to slow surface flows by increasing roughness and supporting vegetation growth. As a passive water harvesting technique, rock mulch traps moisture and encourages infiltration.

Rock mulch applications are most effective in sheet flow conditions and in low energy areas where channelized erosion is just beginning to occur

Rocks should be similar in thickness to create a uniform surface one rock in depth

Construction Notes:

A. Till or hand rake subgrade to a minimum depth of 3" to increase infiltration capacity

B. Place first course of rock in footer trench (downstream). Place remaining rock firmly against footer course and tamp in place to minimize potential for displacement

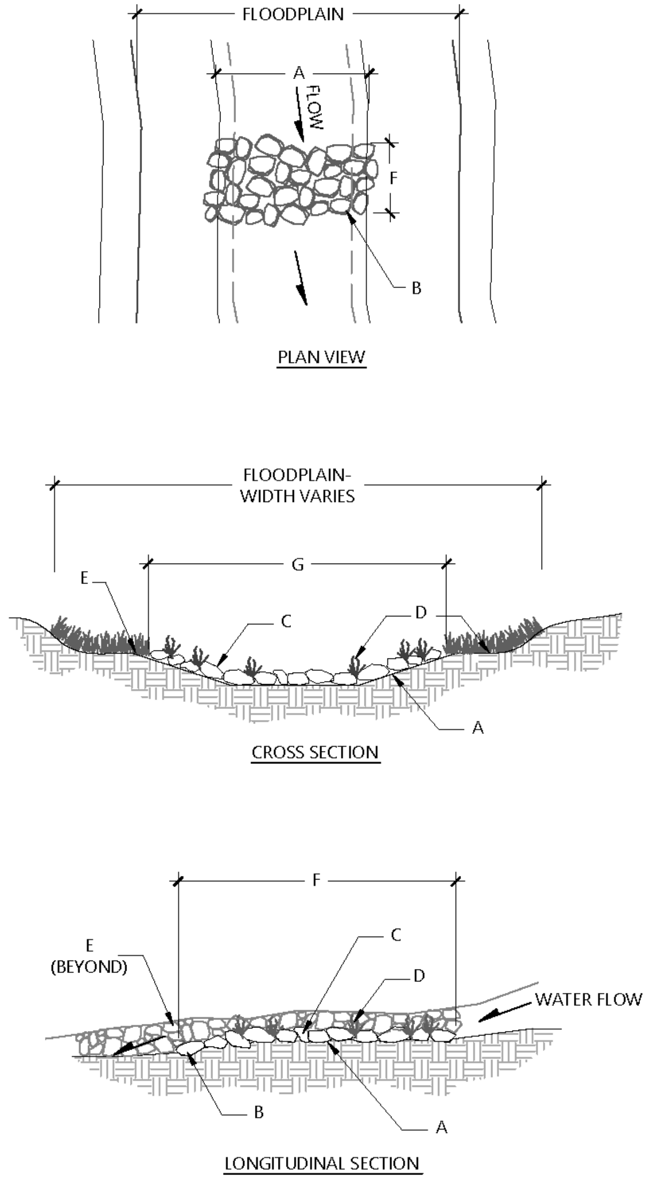
C. 6"-12" angular cobble. Line width of low flow channel, placing rock to minimize gaps and completely cover surface

D. Overseed with native grass/wildflower seed mix, as appropriate Vegetation will help stabilize structure

E. Top of low flow channel.

F. Length varies; 5'-10' typically (minimum of 5 rows of rock)

G. Low-flow (bankful) channel,15' maximum



CONTOUR SWALE CONCEPT

General Notes:

A contour swale is an application of a typical swale utilized on a slope, constructed parallel to the site elevation contours, to capture, distribute, and infiltrate stormwater runoff allowing pollutants to settle and filter out. Contour swales can be lined with hard materials like rip-rap or cobble, or planted with a range of plant materials to enhance their function and can be designed as single channels or connected in a series to increase their water distribution and infiltration and capacity. The addition of check dams for swales on sloping sites can further enhance their infiltration capacity. vegetative and soil filtration. Contour swale interventions are best suited for small and large drainage areas with gentle to steep slopes, such as open spaces, parks and landscaped areas. Swales should be constructed at least 10 feet away and downslope from building foundations. They are not appropriate for use in drainage channels, on fill areas or on sites with extremely sandy soils that may erode even at low-water-flow velocities.It is generally preferable to construct multiple swales at several points in the watershed versus a single large swale. Contour swales can be built in linked series with spillways that allow overflow from one swale to flow into swales at lower elevation levels. Spillways should be positioned so that the water is forced to move along the swale for as long as possible before flowing to subsequent swales. The top of the berm should be level except for spillway areas. The spillway should be lined with stone or other non-erosive materials. A rock apron or splash pad should be installed on the downstream side to absorb the erosive impact of water exiting the spillway.

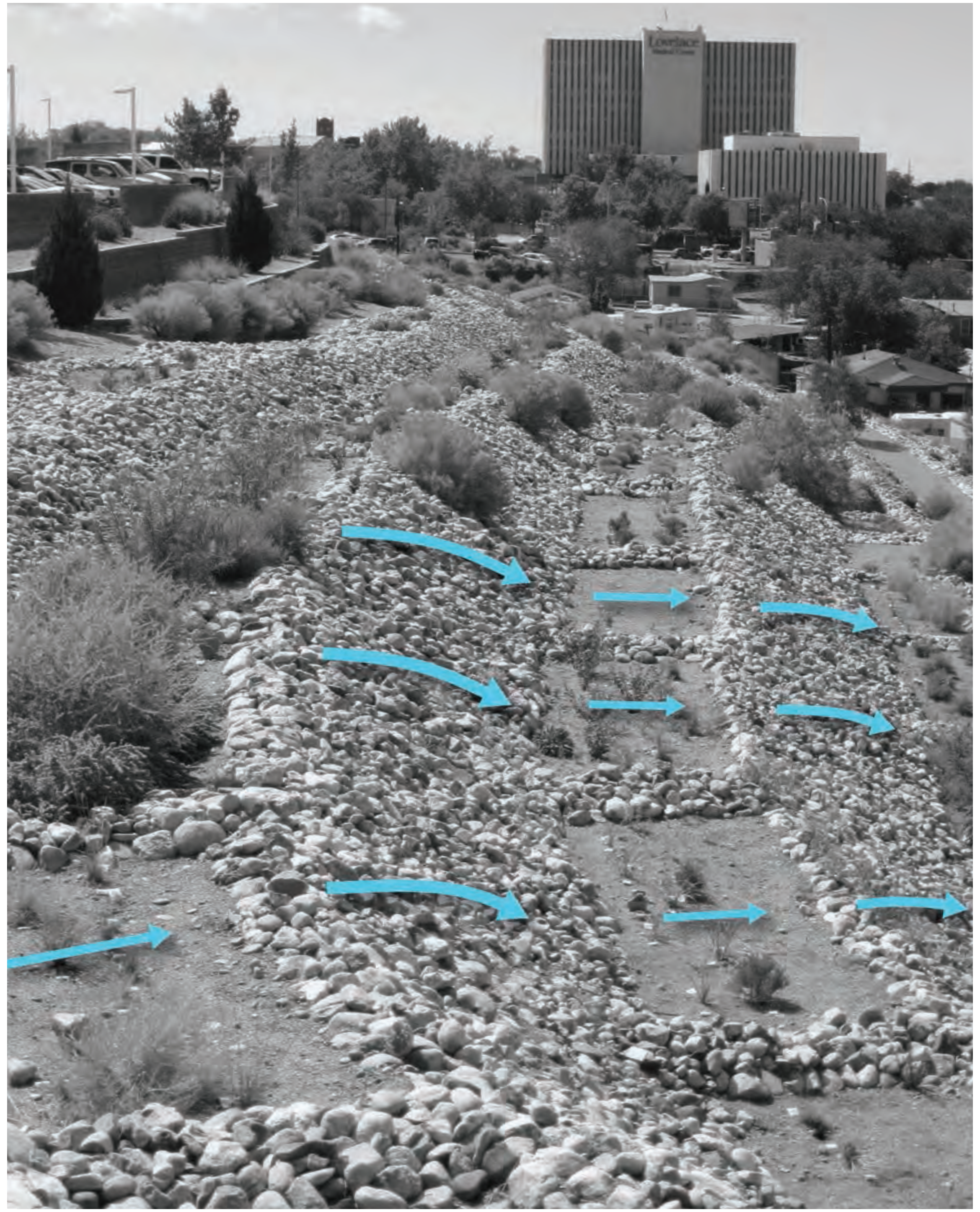
Design Basics:

Application:
Reduce flow down slopes to prevent riling and head-cutting.

Site Conditions:
Open areas with extended slopes.

Implementation:
Spacing determined by calculated flow velocity down slope.
Ensure depth and length can effectively reduce flow energy.

Figure 42.1: Typical contour swale application



CONTOUR SWALE DPM DETAIL 13.1

General Notes:

Contour swale system will capture runoff originating on the slope above and hold it for use by adjacent plant materials.

Optional wick material may vary. Straw bales effectively absorb water, but deteriorate over time and will eventually need to be replaced. Gravel filled gabions are less absorbent, but encourage infiltration into the surrounding soil and help stabilize the slope. pumice (crushed volcanic rock) is
absorbant and non-degradable, but may not be available in all areas and is not considered a "sustainable" material.

Contour swale terraces may be continuous along a slope or may be staggered to intercept runoff from gaps in terraces above.

Construction Notes:

A. Create berm with material cut from terrace

B. Riprap, cobble or gravel spillway for erosion protection; provide armored low point at each end for overflow

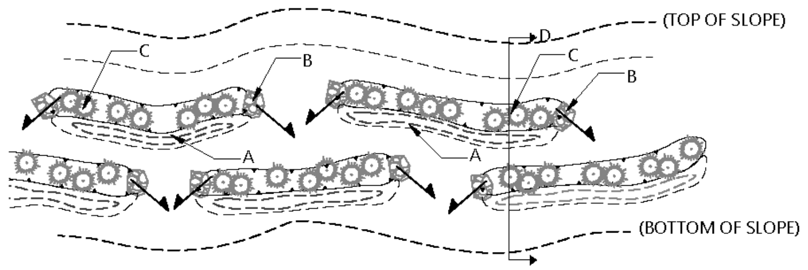
C. Swale/basin plantings by landscape architect/designer

D. Low point of swale should be 6"-12" below top of berm

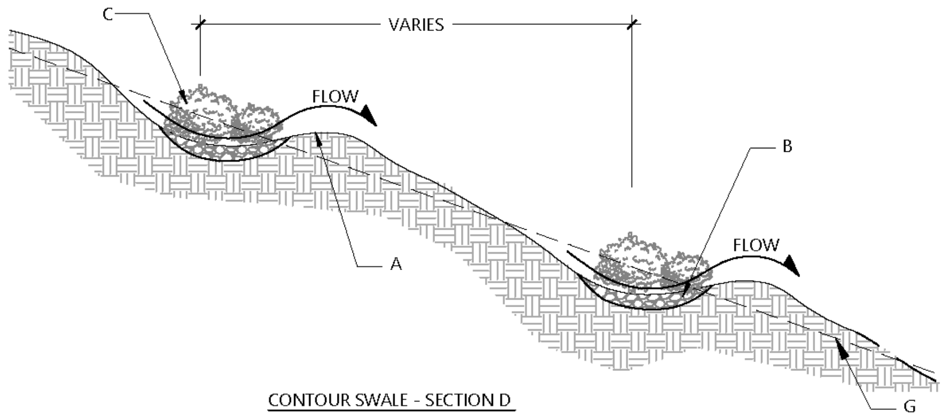
E. Locate plant material between low and high points to avoid standing water and accumulation of sediment around base of plants

F. Native seeding or gravel mulch on finished grade (see plans)

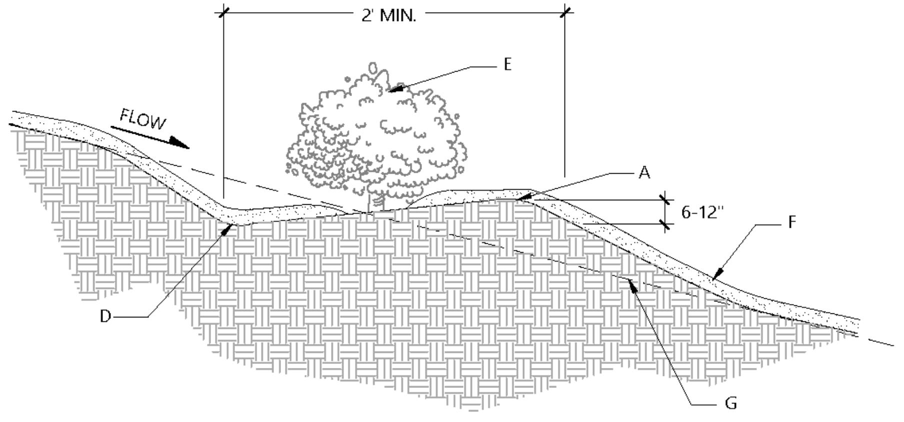
G. Original grade line



CONTOUR SWALE - PLAN VIEW - OFFSET CONFIGURATION



CONTOUR SWALE - SECTION D



CONTOUR SWALE/RUNOFF COLLECTION TERRACE (BASIC)- SECTION

CONTOUR SWALE
DPM DETAIL 13.2

Construction Notes:

A. Original grade line

B. Graded planting terraces; length varies

C. Graded berm at edge of terrace; min. 6" high

D. 4" Mulch (preferably non-floating)

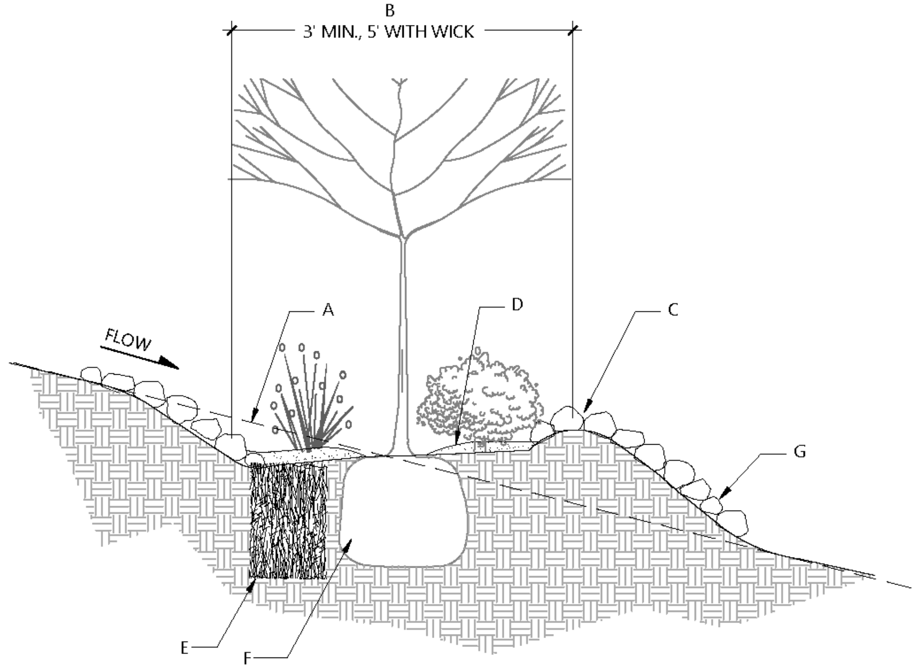
E. Pumice, straw bale or gravel filled gabion wick, continues along planted terrace

F. Plant material as specified by landscape architect/designer

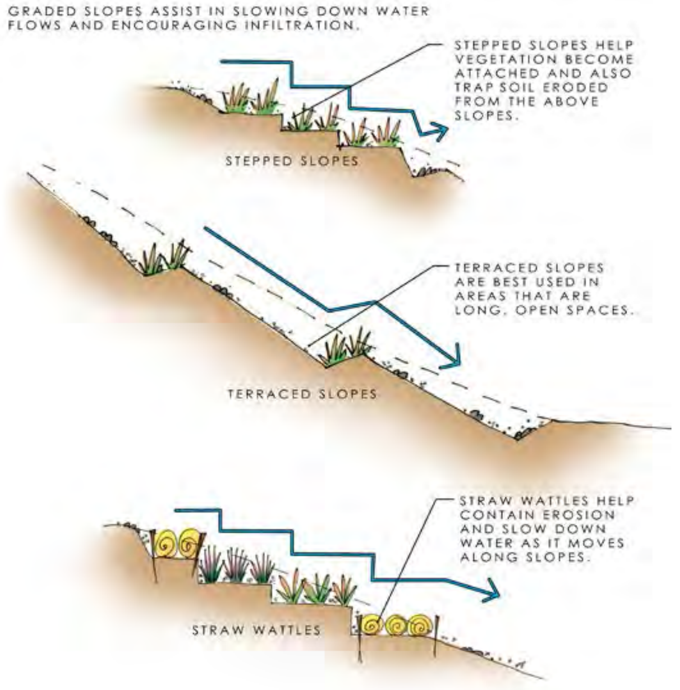
G. Cobble or stone slope plating where slopes exceed 3:1. Overseed with native/ revegetation seed mix for Additional slope stability

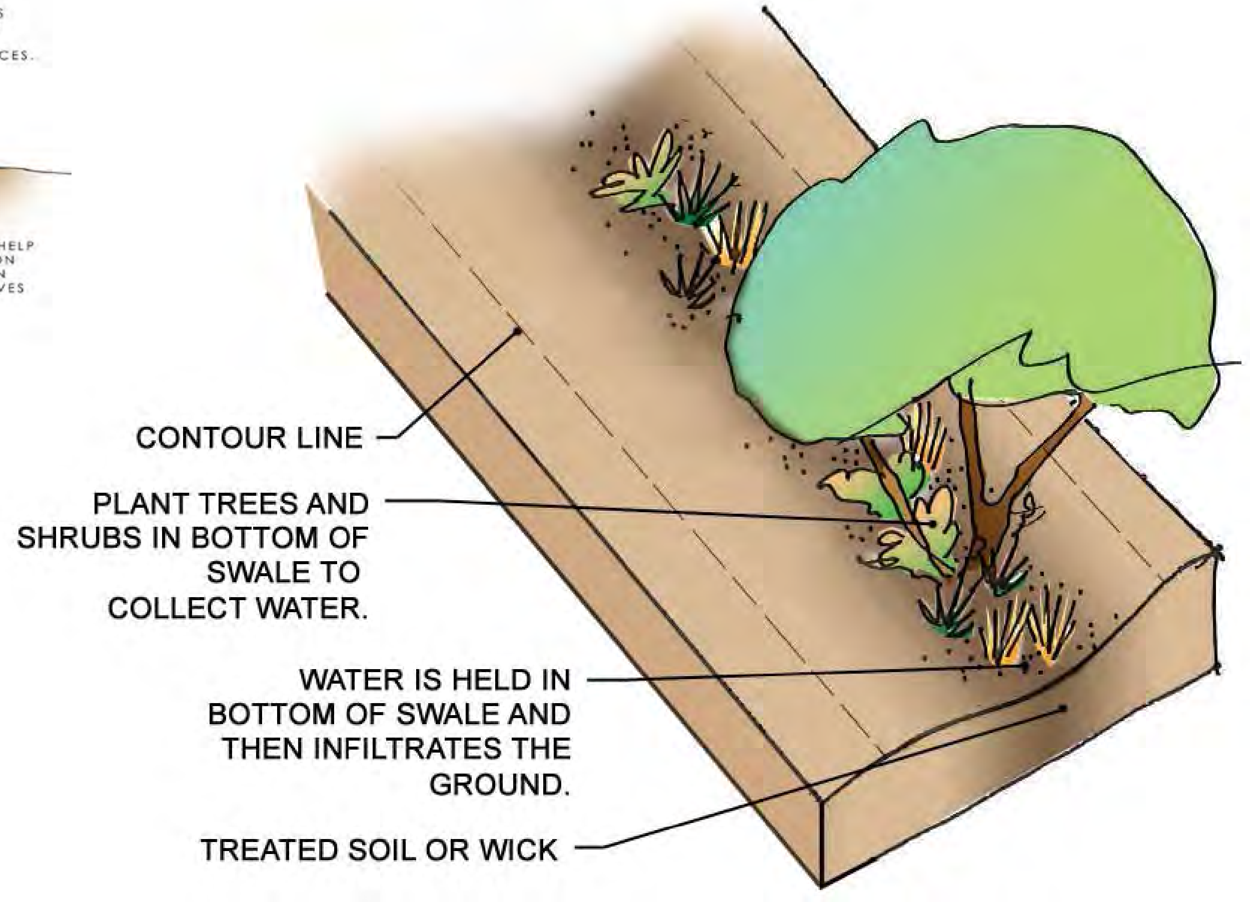
Figure 45.1 (right page, left): Section diagram of a typical contour swale

Figure 45.2 (right page, right): Plan diagram of a typical contour swale



CONTOUR SWALE/RUNOFF COLLECTION TERRACE (ENHANCED) - SECTION





MEDIA LUNA FLOW SPREADER CONCEPT

General Notes:

Flow Spreaders are LID interventions that effectively reduce the erosive energy of concentrated stormwater flows by distributing runoff as sheet flow to stabilized vegetative surfaces. These structures spread concentrated flow out and release the flow simultaneously across the same elevation. These interventions also promote infiltration and improved water quality by slowing flows and allowing them time to infiltrate into the adjacent soils. Flow spreaders may be used in conjunction with runoff infiltration interventions such as bioswales, infiltration basins, and infiltration trenches. Applications are common on hillsides or other areas exhibiting erosive conditions.

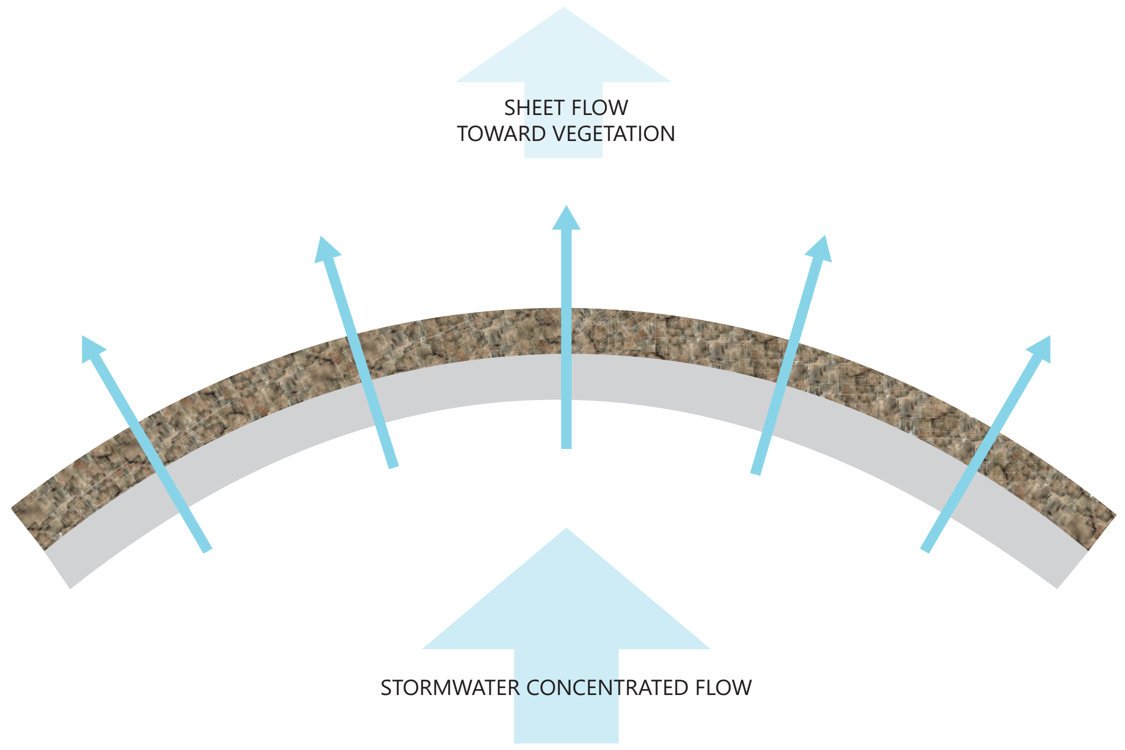
Design Basics:

Application:
Slope protection of overland areas with erosive soils.

Site Conditions:
Disturbed areas denuded of vegetation.
Poorly vegetated overland flow areas.

Implementation:
Consider use of small equipment (skid steer) or manual labor for installation.
Ensure placement is effective in reducing flow energy to prevent riling.
Assess potential for upland erosion burying the rock mulch rendering it less effective.

Figure 46.1: Plan diagram of a Media Luna flow spreader



MEDIA LUNA FLOW SPREADER DPM DETAIL 14.0

Construction Notes:

A. Upper edge should be level, end to end

B. 6"-12" angular cobble, place rock to minimize gaps and completely cover surface

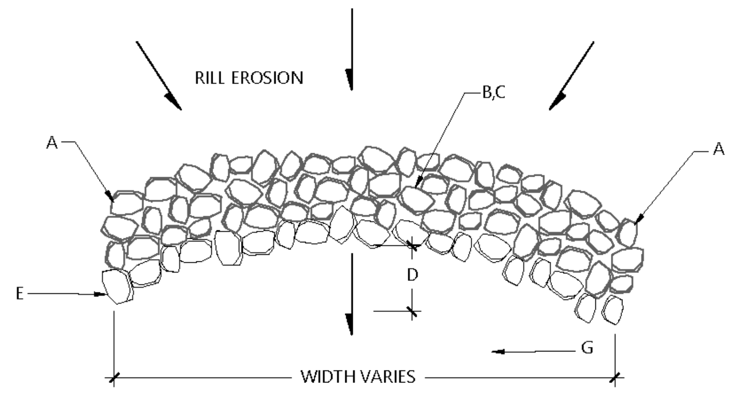
C. Overseed with native grass/wildflower seed mix, as appropriate Vegetation will help stabilize structure

D. Depth of arc varies; minimum 1/8 of structure length

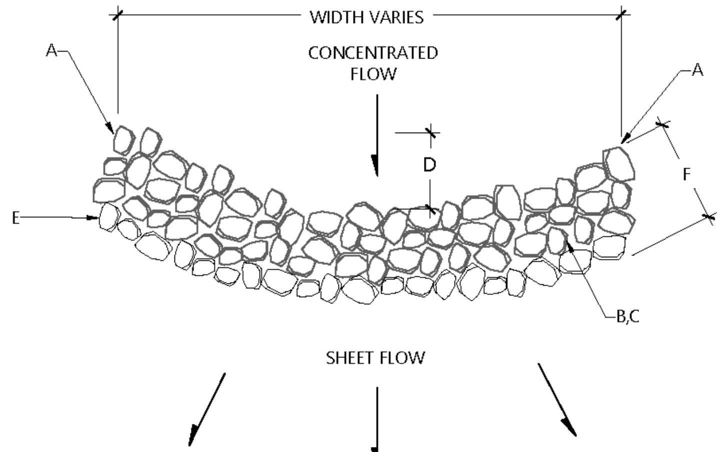
E. Place downstream course of rocks in a shallow trench to serve as footer/splash apron. Set remaining rock courses in successive rows, working upstream

F. Width varies; 3' minimum

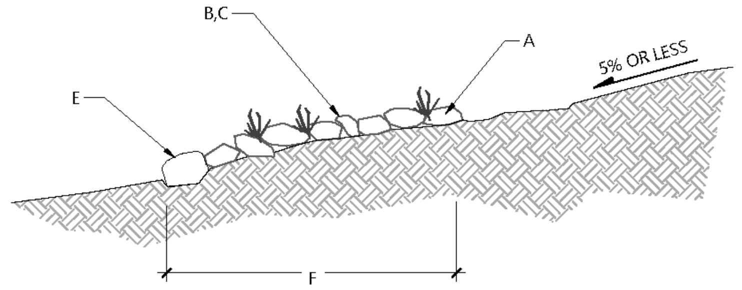
G. Channelized flow-bioswale or similar



MEDIA LUNA-SHEET FLOW CONCENTRATOR-PLAN VIEW



MEDIA LUNA-SHEET FLOW SPREADER-PLAN VIEW



LONGITUDINAL SECTION

GLOSSARY

Acequia

The Spanish Colonial word (with Arabic roots) for a community-operated network of irrigation canals typically constructed of earthen berms anchored by tree roots. In addition to the irrigation function of the channels, many cultural practices and historical connections are associated with this infrastructure. Acequias also play an important role in groundwater recharge.

Active Rainwater Harvesting

A method of capturing rainwater from a surface in a container to be redistributed in a variety of uses at a later point in time, typically for supplemental irrigation. *(See cistern)*

Arid Climate

An arid climate is one that receives less than 10 inches (25.4 centimeters) of rainfall in an entire year. The rain that falls in an arid climate is sporadic and when it does fall, it is usually in the form of a thunderstorm. Plants and animals that survive in an arid climate have adapted to cope with the rare rainfall.

Basin

An earthen depression designed to collect and infiltrate stormwater.

Berm

Raised structure (generally earthen or concrete) constructed to manage stormwater runoff and control erosion.

Best Management Practices (BMPs)

Activities, practices, or prohibitions of practices designed to prevent or reduce pollution.

Bioinfiltration

The use of ecological processes from vegetation and organic soils to treat and infiltrate stormwater runoff. Usually requires soil amendments and carefully chosen xeric plant species that can withstand short periods of saturation. Supplemental irrigation required for an establishment period. In addition to transpiring significant stormwater volumes, vegetation and healthy soil can enhance pollutant removal, reduce soil compaction, and provide ecological and aesthetic value. Examples of bioinfiltration structures include bioswales, rain gardens, brown roofs, tree trenches, and contour swales. Formerly known as bioretention. However, since stormwater is not being retained, the word bioinfiltration more accurately reflects this approach.

Bioretention

See 'Bioinfiltration.' which is more accurate for a New Mexico context.

Bioswale

Linear stormwater management features used to convey, slow, and treat runoff. Bioswales use vegetated and mulched channels that convey stormwater runoff, slow its flow, and enhance infiltration as the water flows downslope. Often employed to convey runoff from impervious surfaces to localized basins.

Brown Roof

Rooftops designed with xeric or no vegetation for the primary purpose of insulation and gradually releasing stormwater and creating wildlife habitat. Unirrigated except for rainwater. *See Vegetated Roof*

Stormwater Buffer / Filter Strip

An area that separates land from waterways and is designed to filter and capture pollutants from stormwater. Best if vegetated. Otherwise known as 'filter strips'.

Bump out Stormwater Planter

An area for infiltration and green infrastructure interventions created when the curb and gutter is moved out in the portion of the roadway normally reserved for parking This application is effective for highly urbanized areas. Otherwise known as 'bulbouts' or 'chicanes'.

Check Dam / Check Structure

A low, sometimes leaky barrier (such as a gabion) placed perpendicular to the flow of water within a linear drainage feature to slow the water's flow, allowing more time for infiltration into the soil, and retaining soil and organic matter higher in the watershed. Can also be a grade control structure.

Cistern

A tank that stores rainwater from rooftops or from other impervious areas for later use, thereby reducing the volume of stormwater runoff. Cisterns capture larger proportions of stormwater and address more irrigation demand than rain barrels. The minimum desired capacity for cisterns in the Albuquerque area is 2,000 gal.

Contour Swale / Terrace Swale

A depressed linear feature that runs parallel to the contour of a slope to catch stormwater and sediment in place. Typically, contour swales exist in series to capture the overflow from each subsequent swale up slope.

Curb Inlet

An opening in a curb or a pathway that allows stormwater from the surrounding street catchment area into an area of infiltration, such as a bioswale. Examples of inlets include curb cuts, curb cores, and sidewalk scuppers.

Detention Basin

A basin designed for temporary storage of stormwater to control discharge rates, allow for infiltration, and improve water quality. Outflow structures allow excess water to drain at a reduced flow rate. Must drain within 96 hours.

Dry Well

A gravel-filled hole in the ground that collects stormwater, temporarily storing it and allowing for gradual infiltration. Must be appropriately sized to meet capacity needs. Adaptations of this concept are 'pumice wicks' and 'soil sponges.'

Ecosystem Services

Anthropocentric term referring to the benefits that humans receive from an ecosystem.

Engineered Soil

The base sand and gravel mix under permeable paving, compacted to prevent settling; the mix is used to replace existing soil before permeable paving is installed and creates consistent drainage . Expand definition to include emphasis on infiltration.

Evapotranspiration

The combined measurement of water loss to evaporation and transpiration through the pores of vegetation. This measurement is important when determining a water budget.

First Flush

The initial stormwater runoff captured at the beginning of a rainstorm. The first flush generally contains a higher pollutant and sediment load compared to the same water volume captured at later periods of the same storm. MS4 requirements typically require the 90th percentile storm (approximately the first 1/2" of rainfall) to be captured.

Gabion

Wire frames filled with rock that are anchored into slopes, typically along steep slopes or across drainage channels, that aid in retaining soils. Used with plants, in time they may become buried in sediment.

Green Alley

A type of stormwater quality intervention applied to alleys and intended to filter runoff from the alley through the use of permeable pavement.

Green Stormwater Infrastructure / Green Infrastructure

A term referring to constructed features that use living, natural systems to provide ecosystem services, such as capturing, cleaning, and infiltrating stormwater, creating wildlife habitat, shading and cooling streets and buildings, and calming traffic. Should add something about leveraging ecological functions.

Heat Island Effect

This phenomenon describes urban and suburban temperature that are 2°F to 10° F warmer than nearby rural areas due to absorption and retention of heat by buildings and paved surfaces in the built environment. The HIE can increase energy demands, air conditioning costs, air pollution, greenhouse gas emissions, and heat-related illness and mortality.

Impervious

Refers to a material or layer that prevents fluid from passing through. Typical examples are roofs, asphalt surfaces, and other concrete structures.

Infiltration

The movement of water from the land's surface into the soil.

Infiltration Gallery

A subsurface hollow chamber that creates space for temporary storage with an open bottom that allows for gradual infiltration of water. Requires permeable soils for fast infiltration.

Infiltration Trench

A linear excavated area that is lined with filter fabric and filled with rock in order to create additional space for water to collect and infiltrate. Requires permeable soils for infiltration in under 96 hours. May or may not be installed with an underdrain.

Interception

The portion of rainfall that lands on plants and is absorbed or dissipates.

Low-Impact Development (LID)

LID is an approach to land development (or re-development) that works with nature to manage stormwater as close to its source as possible. LID employs principles such as preserving and recreating natural landscape features and minimizing effective imperviousness to create functional and appealing site drainage that treats stormwater as a resource rather than a waste product. In arid climates, the techniques and applications of LID are different than in other climates.

Non-point Source Pollution

Pollution that comes from diffuse sources like auto oil, pet waste, herbicides, and sediment. It is picked up by stormwater flowing over roofs, driveways, lawns, and streets, and is carried to streams and rivers.

Passive Rainwater Harvesting

Directing rainwater to swales and basins to benefit adjacent plants. Intended to release water into the soil within 96 hours.

Permeable

Refers to anything permitting fluid to pass through. Synonym for pervious.

Permeable Pavement

Any paving material that allows stormwater to infiltrate where it falls. Includes permeable interlocking pavers, porous asphalt, and pervious concrete.

Pumice Wick

A trench or pit that is backfilled with pumice or scoria, covered with geotextile and mulched with heavy stone. Used to create in-ground reservoirs. The wicks keep the surface relatively dry while collecting rainwater runoff and putting it where plant roots can use it. Pumice or scoria is a good rooting medium for plants but is light and needs a heavy mulch over the top to prevent floating. (Pumice and scoria are both crushed porous volcanic rocks.)

Rain Garden

A shallow depression with native or amended soil and plants that is designed to capture, infiltrate, and filter stormwater from small adjacent contributing areas like rooftops or driveways. A type of bioinfiltration structure. Careful attention must be paid to choice of plants that can survive with rainwater only. Requires maintenance.

Retention

Holding stormwater on the surface for more than 96 hours. Not a recommended or legal practice in New Mexico.

Sediment

Soil, sand, and minerals washed from land into water usually after rain. Excessive sediment can destroy fish nesting areas and animal habitats, clog French drains and porous pavement, and obscure waters so that sunlight does not reach aquatic plants. It can also carry non-point source pollution.

Sediment Trap

A pretreatment area at the inlet to a structural GI practice used to capture sediment, oil, grease, and other pollutants through settling.

Semi-Arid Climate

A climate receiving between 10 and 20 inches of rainfall per year.

Soil Amendment

Additions to native soils to improve plant growth and water infiltration and storage. By building healthy soil, filtration is also improved.

Soil Sponge

An innovation on the pumice wick concept, sponges are holes approximately 1' x 1' x 2' deep dug within the rooting area of trees in rainwater harvesting basins and backfilled with a non-floating mix of 5/16" pumice, sand, composted woody materials (around 1") and high-quality living compost. The sponges absorb and store rainwater and the compost inoculates the surrounding soil with beneficial microorganisms.

Stormwater Runoff

Water from rain or melting snow that is not absorbed into the ground. Areas with higher proportions of impervious surface cover, such as streets, parking lots, and buildings, generate more stormwater runoff because rain is not able to infiltrate into the ground as it would in pre-development conditions. Also known as overland flow or surface water runoff.

Stormwater Basin

See 'Detention Basin'.

Structural Soil

An engineered material that maintains the structural quality of paving while also supporting plant growth.

Suspended Pavement Systems

Any scaffolding type structure that supports the weight of paving or concrete but creates a subsurface space that can be filled with soil for root growth. Structures allow greater soil volumes that are not compacted for greater tree growth, in-place stormwater management, increased infiltration, and minimizing non-point source pollution.

Tree Pit

A small, carefully engineered area designed to capture and infiltrate stormwater for optimal tree growth.

Tree Trench

A continuous, linear tree pit usually in a street / sidewalk setting, linking street trees together below the paving. Allows for a greater volume for tree root growth and can distribute stormwater among multiple trees. Ideally pervious paving is installed above the tree trench.

Waffle Garden

A grid of 2-foot-square planting spaces sunken 6-8 inches below the surrounding native soil to capture rainwater and contain it until it seeps into the soil . Developed in pre-historic times by Southwest Native People for agricultural use.

Watershed

A watershed is the area of land where all of the water that falls in it and drains off of it goes to a common outlet. Watersheds can be as small as a footprint or large enough to encompass all the land that drains water into the Rio Grande.

Xeric

A habitat or environment containing little moisture.

Xeriscape

Commonly mistaken as 'zeroscape', xeric or xeriscape refers to a landscaping technique that utilizes regionally adapted or native plants with low water demand to reduce supplemental watering and overall water use.

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