Appendix

K

COUNTY OF SAN DIEGO BMP DESIGN MANUAL

Guidance on Green Infrastructure

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Appendix K Guidance on Green Infrastructure

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Design Criteria, Design Standard Drawings, and Specifications for Green Streets and Green Parking Lots can be found on the County's Watershed Protection Program website under Green Infrastructure Resources within the Development Resources tab:

https://www.sandiegocounty.gov/stormwater

K.1 Guidance on Green Infrastructure

County of San Diego Guidance on Green Infrastructure

January 2019

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COUNTY OF SAN DIEGO GUIDANCE ON GREEN INFRASTRUCTURE

Green Infrastructure is an approach to stormwater and flood management that protects, restores, and mimics the natural water cycle using vegetation, mulch, soils, and natural processes while creating healthier environments. At the County scale, green infrastructure refers to the network of natural features that provides habitat, flood protection, cleaner air, and cleaner water. At the scale of a neighborhood or site, green infrastructure refers to stormwater and flood management systems that mimic nature by soaking up and storing water.

Roadways and parking lots present many opportunities for coordinated Green Infrastructure use. A Green Street or Parking Lot use a natural system approach to reduce stormwater flow, improve water quality, reduce urban heating, enhance pedestrian safety, reduce carbon footprints, and beautify neighborhoods. Green Streets and Parking Lots are components of Green Infrastructure, integrating strategies into roads and right-of-ways.

Green Streets Guidelines are an outreach tool and are also intended to serve as a companion to the rest of the Green Streets publications. They include an introduction, strategies, procedures and design examples for implementing Green Streets projects. The strategies include tree wells, dispersion areas, biofiltration, and permeable pavement.

Green Streets Design Criteria lay out general definitions, general policy, and landscape design criteria for Green Infrastructure strategies in the right-of-way. This can be found on the County's Development Resources website.

Green Streets Supplement to County Design Standard Drawings includes construction details which may be referenced in improvement plans similar to current County Design standard drawings. This can be found on the County's Development Resources website within the Green Streets Standard Drawings.

Green Streets Maintenance Schedules include a list with maintenance tasks, frequency, and time of year for initial, routine, and as- needed maintenance of each Green Infrastructure strategy. This can be found on the County's Development Resources website.

Green Streets Specifications include detailed construction material and installation requirements for Green Infrastructure strategies including aggregates, geosynthetics, underdrains, permeable pavement, bioretention soil media, mulch, overflow risers, check dams, and tree grates. This can be found on the County's Development Resources website.

Green Parking Lots Guidelines are an outreach tool and are also intended to serve as a companion to the rest of the Green Parking Lots publications. They include an introduction, strategies, procedures and design examples for implementing Green Parking Lots projects. The strategies include tree wells, dispersion areas, biofiltration, and permeable pavement.

Green Parking Lots Design Criteria lay out general definitions, general policy, and landscape design criteria for Green Infrastructure strategies in parking lots. This can be found on the County's Development Resources website.

Green Parking Lots Supplement to County Design Standard Drawings includes construction details which may be referenced in improvement plans similar to current County Design standard drawings. This can be found on the County's Development Resources website within the Green Streets Standard Drawings.

Green Parking Lots Maintenance Schedules does not have parking lot specific maintenance and references the Green Streets Maintenance Schedules.

Green Parking Lots Specifications does not have unique parking lot specifications and references the Green Streets Specifications.

K.2 Green Streets

K.2.1 Green Streets Performance Standard

This section builds on text from Section 1.4.3 providing more detailed guidance on compliance with the performance standard for Green Street PDP Exempt projects (herein referred to as Green Street projects).

Green Street projects must provide stormwater treatment for the volume of runoff associated with the project's net increase in impervious area. Compliance with this standard may be demonstrated at the project-scale, meaning there is no obligation to treat runoff from each discrete segment of new impervious area. Green Street projects are encouraged to achieve compliance through treatment of runoff from any combination of land uses including existing/proposed surfaces, onsite/offsite surfaces, pervious/impervious surfaces. As summarized below, Green Street compliance can be demonstrated through determination of the following 1) Required Treatment Volume, 2) Provided Treatment Volume, and 3) Comparison of Required and Provided Treatment.

1) REQUIRED TREATMENT VOLUME

Project proponent must calculate a single water quality runoff volume associated with the net increase in impervious area across the entire project site. This calculation should exclude runoff volumes associated with existing/replaced impervious areas within the project footprint, as treatment is not mandated for these areas. Supporting exhibits delineating new impervious areas, existing/replaced impervious areas, and removed impervious areas must be provided as needed to support this determination.

2) PROVIDED TREATMENT VOLUME

Project proponent must calculate the total volume of stormwater runoff treated through site design elements and/or structural BMPs proposed by the project. Completion of this step requires consideration of all surfaces draining to proposed treatment elements (existing/proposed, onsite/offsite, pervious/impervious areas draining to BMPs).

Project proponent must provide treatment through use of "Conventional" treatment elements where feasible but may also be permitted to use "Alternative" treatment elements upon demonstration of infeasibility.

> Conventional Treatment Elements: Elements that utilize conventional retention and/or biofiltration designs that are consistent with the County BMPDM[10]. Use of these elements may achieve Green Street compliance and are eligible to generate alternative compliance credits if implemented sufficiently. [*Examples: tree wells, dispersion areas, biofiltration basins (lined or unlined), bioretention basins, infiltration basins (vegetated or non-vegetated), pervious pavements without impermeable liners.]*

[10] Minimum retention requirements waived for Green Streets.

Alternative Treatment Elements: Elements that provide filtration for anticipated pollutants at medium to high efficacy and provide significant pore storage capacity. Use of these elements may achieve Green Street compliance but are typically not eligible[11] to generate alternative compliance credits. [*Examples: vegetated swales, non-vegetated filtration BMPs (sand filters, biofiltration soil media, pervious pavements with impermeable liners and underdrains), detention basins, wet ponds, proprietary filtration devices with significant pore storage capacity.]*

Treatment Elements lacking significant pore storage such as filter fabrics, debris racks, filter baskets, CDS units, hydrodynamic separators or similar devices may not be classified as either of the two categories above.

3) COMPARISON OF REQUIRED AND PROVIDED TREATMENT

Project proponent must demonstrate that the provided treatment volume is greater than or equal to the required treatment volume. This may be demonstrated at the project-scale, meaning there is no obligation to demonstrate treatment for each discrete segment of new impervious area. The pages that follow present a standard calculation template for demonstrating Green Street compliance as well as several calculation examples.

[11] If project proponent desires to bank credits through use of Alternative Treatment Elements, more detailed guidance outlined in the Regional Water Quality Equivalency must be referenced.

Table K.2-1 : Green Street Performance Standard Calculations

Item			Value	Description
Required Treatment Volume	1	Land Use of Net Impervious Area	Transportation	*Per project drawings.*
	2	Total Net Impervious Area [12]	ft^2	*Per project drawings.*
	3	85th Percentile Rainfall Depth	in.	*Determine per BMPDM Appendix B.1.*
	4	Runoff Coefficient	0.90	*Value of 0.90 applies to new impervious areas.*
	5	Required Treatment Volume	ft^3	*(Line 2 x Line 3 x Line 4) / 12*
Provided Treatment Volume	6	Land Use of Treated Area[13]		*Per project drawings.*
	7	Land Use Factor[14]		*Determine per Note 5 below.*
	8	Conventional Treatment Volume[15]	ft^3	*Determine per Note 6 below.*
	9	Alternative Treatment Volume		*Determine per supplemental applicant calculations.*
	10	Final Treatment Volume	ft^3	*Line 7 x (Line 8 + Line 9)*
Result	11	Is Project Green Street Compliant?		*Compliant if Line 10 ≥ Line 5. Otherwise, non-compliant.*
	12	Optional Credit		*(Line 7 x Line 8) – Line 5*

[12] The Net Increase in Impervious Area should **not** reflect any work occurring within existing impervious areas.

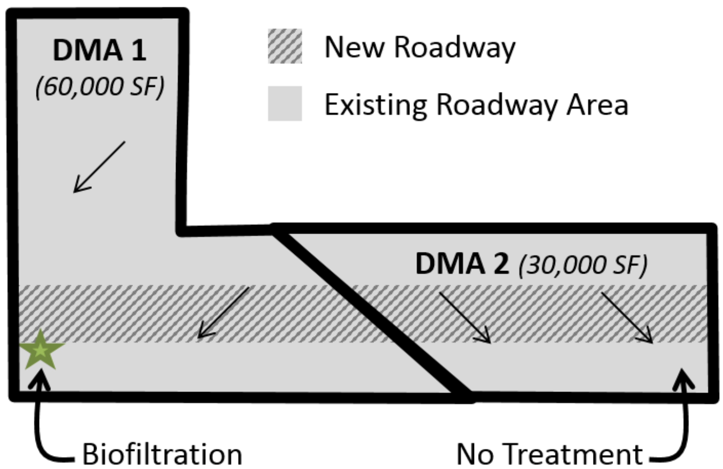
[13] Classify drainage area into following land use types (may use more than one) agriculture, commercial, education, industrial, multi-family residential, orchard, rural residential, single family residential, transportation, open space.

[14] If Land Uses from Lines 1 and 6 match, use a value of 1.0. Otherwise, refer to Regional Water Quality Equivalency Guidance for determination of appropriate Land Use Factor.

[15] Conventional Treatment Volume may be determined by subtracting the project's total "Deficit of Effectively Treated Stormwater" from the project's total Design Capture Volume. These values can be found in Version 2.0 of the County of San Diego Automated Control Worksheet on Line 48 of the BMP Performance Tab and Line 26 of the DCV Tab respectively.

Example 1: Green Street Compliance using **Conventional Treatment Elements**

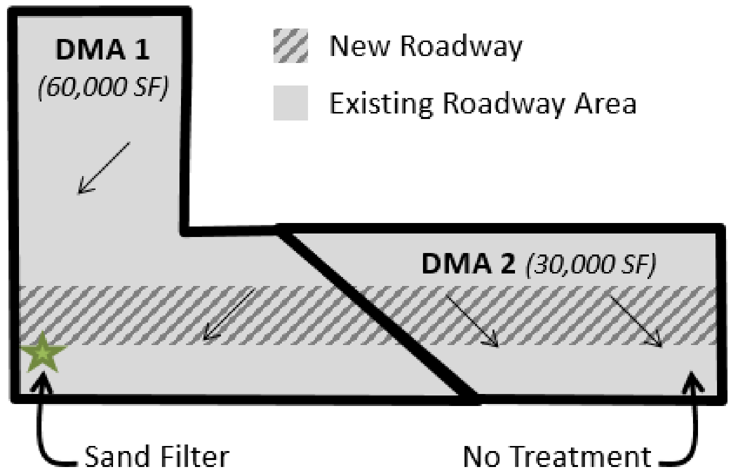
A green street project will create 20,000 SF of new impervious surface through the addition of a center turn lane on an existing road that currently has a vegetated center divide. The project is divided into two Drainage Management Areas (DMAs) as shown below. DMA 1 consists of impervious roadway surfaces that drain westerly to a proposed biofiltration basin. DMA 2 consists of impervious roadway surfaces that sheet flow in an easterly direction and leave the site without treatment. The project applicant demonstrates compliance with the Green Street Performance Standard as presented below.



Item			Value
Required Treatment Volume	1	Land Use of New Impervious Area	Transportation
	2	Total New Impervious Area	20,000 ft^2
	3	85^{th} Percentile Rainfall Depth	0.70 in.
	4	Runoff Coefficient	0.90
	5	Required Treatment Volume *(See Excerpt 1 for calculations)*	1,050 ft^3
Provided Treatment Volume	6	Land Use of Treated Area	Transportation
	7	Land Use Factor	1.00
	8	Conventional Treatment Volume *(See Excerpt 2 for calculations)*	3,150 ft^3
	9	Alternative Treatment Volume	0 ft^3
	10	Final Treatment Volume	3,150 ft^3
Result	11	Is Project Green Street Compliant?	Compliant
	12	Optional Credit	2,100 ft^3

Example 2: Green Street Compliance using **Alternative Treatment Elements**

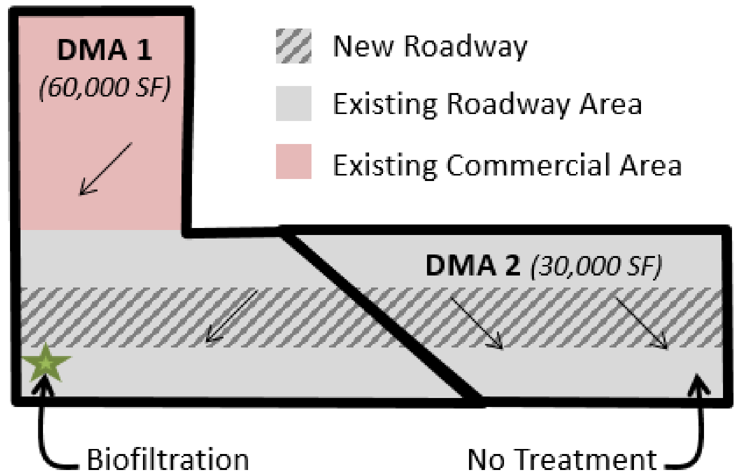
If the project described in the previous Example 1 implemented a sand filter instead of biofiltration, the project would demonstrate compliance with the Green Street Performance Standard as presented below.



Item			Value
Required Treatment Volume	1	Land Use of New Impervious Area	Transportation
	2	Total New Impervious Area	20,000 ft^2
	3	85th Percentile Rainfall Depth	0.70 in.
	4	Runoff Coefficient	0.90
	5	Required Treatment Volume *(See Excerpt 1 for calculations)*	1,050 ft^3
Provided Treatment Volume	6	Land Use of Treated Area	Transportation
	7	Land Use Factor	1.00
	8	Conventional Treatment Volume	0 ft^3
	9	Alternative Treatment Volume *(Applicant Calculations)*	3,150 ft^3
	10	Final Treatment Volume	3,150 ft^3
Result	11	Is Project Green Street Compliant?	Compliant
	12	Optional Credit *(Alternative treatment not eligible)*	0 ft^3

Example 3: Green Street Compliance using Conventional Treatment Elements for **Offsite Run-on**

If the project described in Example 1 provided stormwater treatment for offsite run-on from an adjacent commercial area, the project would demonstrate compliance with the Green Street Performance Standard as presented below.



Item			Value
Required Treatment Volume	1	Land Use of New Impervious Area	Transportation
	2	Total New Impervious Area	20,000 ft^2
	3	85th Percentile Rainfall Depth	0.70 in.
	4	Runoff Coefficient	0.90
	5	Required Treatment Volume *(See Excerpt 1 for calculations)*	1,050 ft^3
Provided Treatment Volume	6	Land Use of Treated Area	Transportation & Commercial
	7	Land Use Factor *(See Excerpt 3 for calculations)*	0.82
	8	Conventional Treatment Volume *(See Excerpt 2 for calculations)*	3,150 ft^3
	9	Alternative Treatment Volume	0 ft^3
	10	Final Treatment Volume	2,583 ft^3
Result	11	Is Project Green Street Compliant?	Compliant
	12	Optional Credit	1,533 ft^3

Excerpt 1 - Required Treatment Volume for New Impervious Surface of 20,000 SF

County of San Diego Automated Stormwater Pollutant Control Worksheet B.1 (Version 2.0)

Category	#	Description	*i*	Units
Standard Drainage Basin Inputs	1	Drainage Basin ID or Name	Perf Std	unitless
	2	85th Percentile 24-hr Storm Depth	0.70	inches
	3	Impervious Surfaces Not Directed to Dispersion Area (C=0.90)	20,000	sq-ft
	4	Semi-Pervious Surfaces Not Serving as Dispersion Area (C=0.30)		sq-ft
	5	Engineered Pervious Surfaces Not Serving as Dispersion Area (C=0.10)		sq-ft
	6	Natural Type A Soil Not Serving as Dispersion Area (C=0.10)		sq-ft
	7	Natural Type B Soil Not Serving as Dispersion Area (C=0.14)		sq-ft
	8	Natural Type C Soil Not Serving as Dispersion Area (C=0.23)		sq-ft
	9	Natural Type D Soil Not Serving as Dispersion Area (C=0.30)		sq-ft
Dispersion Area, Tree Well & Rain Barrel Inputs (Optional)	10	Does Tributary Incorporate Dispersion, Tree Wells, and/or Rain Barrels?	No	yes/no
	11	Impervious Surfaces **Directed to Dispersion Area** per SD-B (Ci=0.90)		sq-ft
	12	Semi-Pervious Surfaces **Serving as Dispersion Area** per SD-B (Ci=0.30)		sq-ft
	13	Engineered Pervious Surfaces **Serving as Dispersion Area** per SD-B (Ci=0.10)		sq-ft
	14	Natural Type A Soil **Serving as Dispersion Area** per SD-B (Ci=0.10)		sq-ft
	15	Natural Type B Soil **Serving as Dispersion Area** per SD-B (Ci=0.14)		sq-ft
	16	Natural Type C Soil **Serving as Dispersion Area** per SD-B (Ci=0.23)		sq-ft
	17	Natural Type D Soil **Serving as Dispersion Area** per SD-B (Ci=0.30)		sq-ft
	18	Number of Tree Wells Proposed per SD-A		#
	19	Average Mature Tree Canopy Diameter		ft
	20	Number of Rain Barrels Proposed per SD-E		#
	21	Average Rain Barrel Size		gal
Initial Runoff Factor Calculation	22	Total Tributary Area	20,000	sq-ft
	23	Initial Runoff Factor for Standard Drainage Areas	0.90	unitless
	24	Initial Runoff Factor for Dispersed & Dispersion Areas	0.00	unitless
	25	Initial Weighted Runoff Factor	0.90	unitless
	26	Initial Design Capture Volume	1,050	cubic-feet
Dispersion Area Adjustments	27	Total Impervious Area Dispersed to Pervious Surface	0	sq-ft
	28	Total Pervious Dispersion Area	0	sq-ft
	29	Ratio of Dispersed Impervious Area to Pervious Dispersion Area	n/a	ratio
	30	Adjustment Factor for Dispersed & Dispersion Areas	1.00	ratio
	31	Runoff Factor After Dispersion Techniques	0.90	unitless
	32	Design Capture Volume After Dispersion Techniques	1,050	cubic-feet
Tree & Barrel Adjustments	33	Total Tree Well Volume Reduction	0	cubic-feet
	34	Total Rain Barrel Volume Reduction	0	cubic-feet
Results	35	Final Adjusted Runoff Factor	0.90	unitless
	36	Final Effective Tributary Area	18,000	sq-ft
	37	Initial Design Capture Volume Retained by Site Design Elements	0	cubic-feet
	38	Final Design Capture Volume Tributary to BMP	1,050	cubic-feet

Excerpt 2- Summary of Stormwater Pollutant Control Calculations (Part 1 of 2)

County of San Diego Automated Stormwater Pollutant Control Worksheet B.1 (Version 2.0)

Category	#	Description	*ii*	Units
Standard Drainage Basin Inputs	1	Drainage Basin ID or Name	DMA 1	unitless
	2	85th Percentile 24-hr Storm Depth	0.70	inches
	3	Impervious Surfaces Not Directed to Dispersion Area (C=0.90)	60,000	sq-ft
	4	Semi-Pervious Surfaces Not Serving as Dispersion Area (C=0.30)		sq-ft
	5	Engineered Pervious Surfaces Not Serving as Dispersion Area (C=0.10)		sq-ft
	6	Natural Type A Soil Not Serving as Dispersion Area (C=0.10)		sq-ft
	7	Natural Type B Soil Not Serving as Dispersion Area (C=0.14)		sq-ft
	8	Natural Type C Soil Not Serving as Dispersion Area (C=0.23)		sq-ft
	9	Natural Type D Soil Not Serving as Dispersion Area (C=0.30)		sq-ft
Dispersion Area, Tree Well & Rain Barrel Inputs (Optional)	10	Does Tributary Incorporate Dispersion, Tree Wells, and/or Rain Barrels?	No	yes/no
	11	Impervious Surfaces **Directed to Dispersion Area** per SD-B (Ci=0.90)		sq-ft
	12	Semi-Pervious Surfaces **Serving as Dispersion Area** per SD-B (Ci=0.30)		sq-ft
	13	Engineered Pervious Surfaces **Serving as Dispersion Area** per SD-B (Ci=0.10)		sq-ft
	14	Natural Type A Soil **Serving as Dispersion Area** per SD-B (Ci=0.10)		sq-ft
	15	Natural Type B Soil **Serving as Dispersion Area** per SD-B (Ci=0.14)		sq-ft
	16	Natural Type C Soil **Serving as Dispersion Area** per SD-B (Ci=0.23)		sq-ft
	17	Natural Type D Soil **Serving as Dispersion Area** per SD-B (Ci=0.30)		sq-ft
	18	Number of Tree Wells Proposed per SD-A		#
	19	Average Mature Tree Canopy Diameter		ft
	20	Number of Rain Barrels Proposed per SD-E		#
	21	Average Rain Barrel Size		gal
Initial Runoff Factor Calculation	22	Total Tributary Area	60,000	sq-ft
	23	Initial Runoff Factor for Standard Drainage Areas	0.90	unitless
	24	Initial Runoff Factor for Dispersed & Dispersion Areas	0.00	unitless
	25	Initial Weighted Runoff Factor	0.90	unitless
	26	Initial Design Capture Volume	3,150	cubic-feet
Dispersion Area Adjustments	27	Total Impervious Area Dispersed to Pervious Surface	0	sq-ft
	28	Total Pervious Dispersion Area	0	sq-ft
	29	Ratio of Dispersed Impervious Area to Pervious Dispersion Area	n/a	ratio
	30	Adjustment Factor for Dispersed & Dispersion Areas	1.00	ratio
	31	Runoff Factor After Dispersion Techniques	0.90	unitless
	32	Design Capture Volume After Dispersion Techniques	3,150	cubic-feet
Tree & Barrel Adjustments	33	Total Tree Well Volume Reduction	0	cubic-feet
	34	Total Rain Barrel Volume Reduction	0	cubic-feet
Results	35	Final Adjusted Runoff Factor	0.90	unitless
	36	Final Effective Tributary Area	54,000	sq-ft
	37	Initial Design Capture Volume Retained by Site Design Elements	0	cubic-feet
	38	Final Design Capture Volume Tributary to BMP	3,150	cubic-feet

Excerpt 2- Summary of Stormwater Pollutant Control Calculations (Part 2 of 2)

County of San Diego Automated Stormwater Pollutant Control Worksheet B.3 (Version 2.0)

Category	#	Description	*ii*	Units
BMP Inputs	1	Drainage Basin ID or Name	DMA 1	sq-ft
	2	Design Infiltration Rate Recommended	0.000	in/hr
	3	Design Capture Volume Tributary to BMP	3,150	cubic-feet
	4	Is BMP Vegetated or Unvegetated?	Vegetated	unitless
	5	Is BMP Impermeably Lined or Unlined?	Lined	unitless
	6	Does BMP Have an Underdrain?	Underdrain	unitless
	7	Does BMP Utilize Standard or Specialized Media?	Standard	unitless
	8	Provided Surface Area	1,620	sq-ft
	9	Provided Surface Ponding Depth	6	inches
	10	Provided Soil Media Thickness	21	inches
	11	Provided Gravel Thickness (Total Thickness)	14	inches
	12	Underdrain Offset	3	inches
	13	Diameter of Underdrain or Hydromod Orifice (Select Smallest)	8.00	inches
	14	Specialized Soil Media Filtration Rate		in/hr
	15	Specialized Soil Media Pore Space for Retention		unitless
	16	Specialized Soil Media Pore Space for Biofiltration		unitless
	17	Specialized Gravel Media Pore Space		unitless
Retention Calculations	18	Volume Infiltrated Over 6 Hour Storm	0	cubic-feet
	19	Ponding Pore Space Available for Retention	0.00	unitless
	20	Soil Media Pore Space Available for Retention	0.05	unitless
	21	Gravel Pore Space Available for Retention (Above Underdrain)	0.00	unitless
	22	Gravel Pore Space Available for Retention (Below Underdrain)	0.40	unitless
	23	Effective Retention Depth	2.25	inches
	24	Fraction of DCV Retained (Independent of Drawdown Time)	0.10	ratio
	25	Calculated Retention Storage Drawdown Time	120	hours
	26	Efficacy of Retention Processes	0.12	ratio
	27	Volume Retained by BMP (Considering Drawdown Time)	381	cubic-feet
	28	Design Capture Volume Remaining for Biofiltration	2,769	cubic-feet
Biofiltration Calculations	29	Max Hydromod Flow Rate through Underdrain	2.8291	cfs
	30	Max Soil Filtration Rate Allowed by Underdrain Orifice	75.44	in/hr
	31	Soil Media Filtration Rate per Specifications	5.00	in/hr
	32	Soil Media Filtration Rate to be used for Sizing	5.00	in/hr
	33	Depth Biofiltered Over 6 Hour Storm	30.00	inches
	34	Ponding Pore Space Available for Biofiltration	1.00	unitless
	35	Soil Media Pore Space Available for Biofiltration	0.20	unitless
	36	Gravel Pore Space Available for Biofiltration (Above Underdrain)	0.40	unitless
	37	Effective Depth of Biofiltration Storage	14.60	inches
	38	Drawdown Time for Surface Ponding	1	hours
	39	Drawdown Time for Effective Biofiltration Depth	3	hours
	40	Total Depth Biofiltered	44.60	inches
	41	Option 1 - Biofilter 1.50 DCV: Target Volume	4,154	cubic-feet
	42	Option 1 - Provided Biofiltration Volume	4,154	cubic-feet
	43	Option 2 - Store 0.75 DCV: Target Volume	2,077	cubic-feet
	44	Option 2 - Provided Storage Volume	1,971	cubic-feet
	45	Portion of Biofiltration Performance Standard Satisfied	1.00	ratio
Result	46	Do Site Design Elements and BMPs Satisfy Annual Retention Requirements?	Yes	yes/no
	47	Overall Portion of Performance Standard Satisfied (BMP Efficacy Factor)	1.00	ratio
	48	**Deficit of Effectively Treated Stormwater**	0	cubic-feet

Excerpt 3 – Determination of Land Use Factor for Example 2

Water Quality Equivalency Automated Land Use Factor Worksheets (Version 1.0)

Automated Spreadsheet Calculation for Worksheet A.5: Land Use Factor Determination (Version 1.0)

Land Use Designation	ACP Tributary Characteristics		Reference Tributary Characteristics [2]		Relative Pollutant Concentrations by Land Use [3]						
	Area (Acres)	Runoff Factor [1]	Area (Acres)	Runoff Factor [1]	TSS	TP	TN	TCu	TPb	TZn	FC
Agriculture		0.10		0.10	0.45	1.00	1.00	1.00	1.00	0.59	1.00
Commercial	0.69	0.80		0.80	0.13	0.16	0.16	0.56	0.48	1.00	0.87
Education		0.50		0.50	0.13	0.20	0.11	0.14	0.25	0.39	0.13
Industrial		0.90		0.90	0.13	0.19	0.15	0.54	0.68	0.89	0.49
Multi Family Residential		0.60		0.60	0.10	0.13	0.13	0.14	0.15	0.29	0.27
Orchard		0.10		0.10	0.18	0.17	0.67	1.00	1.00	0.59	0.11
Rural Residential		0.30		0.30	1.00	0.51	0.14	0.10	0.71	0.13	0.19
Single Family Residential		0.40		0.40	0.13	0.20	0.15	0.27	0.43	0.35	0.63
Transportation	0.69	0.90	0.46	0.90	0.11	0.26	0.12	0.53	0.31	0.62	0.12
Vacant / Open Space		0.10		0.10	0.16	0.10	0.10	0.12	0.10	0.10	0.10
Water		0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	1.38	-	0.46	-	-	-	-	-	-	-	-
	Relative Pollutant Concentration for ACP Tributary [4]				0.12	0.21	0.14	0.54	0.39	0.80	0.47
	Relative Pollutant Concentration for Reference Tributary [4]				0.11	0.26	0.12	0.53	0.31	0.62	0.12
	Watershed Management Area				San Diego River						
	Hydrologic Unit				San Diego (907.00)						
	Land Use Factor [5]				-	0.82	1.16	-	-	-	3.94

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K.2.2 Green Streets Guidelines

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Green Streets Guidelines

A Guide to Green Street Implementation in the County of San Diego

January 2019

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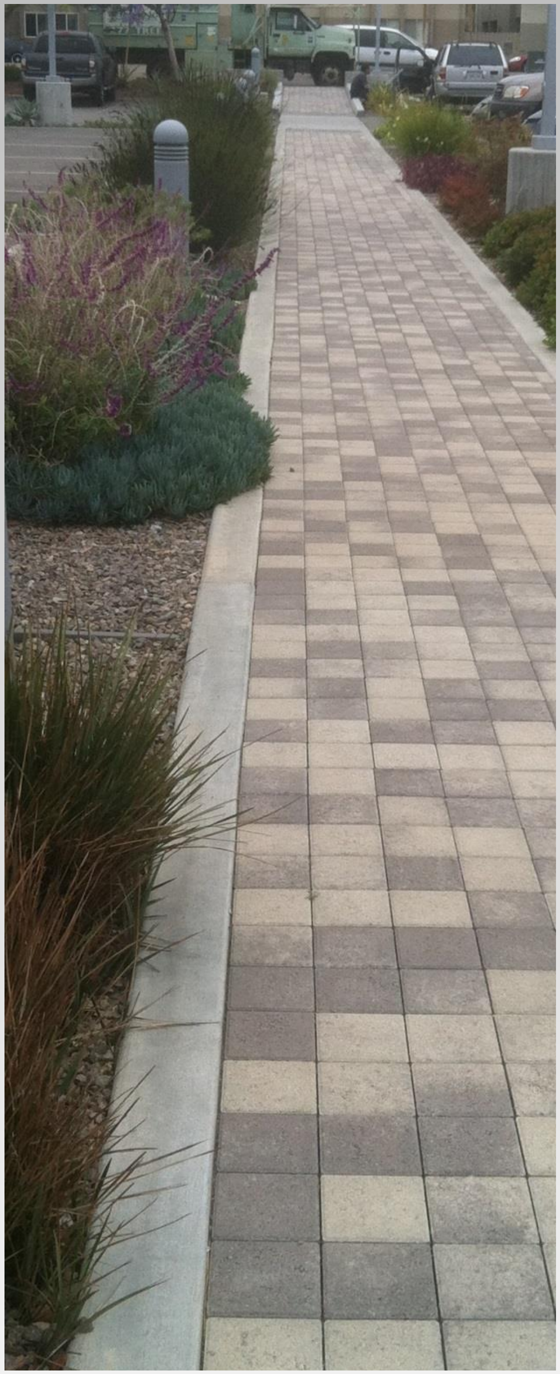

What is a Green Street?

Pavement on roadways can contribute to excess stormwater runoff and increased levels of pollutants in the County's waterways. Green infrastructure reduces stormwater runoff and improves water quality. The Green Streets program incorporates a wide variety of Green Infrastructure design elements including, but not limited to: tree wells, dispersion areas and biofiltration, and permeable pavement. The use of Green Streets offers the capability of transforming a significant stormwater and pollutant source into an innovative treatment system.

Additionally, the State of California is in the midst of a severe drought, with water years of 2012-14 recording the driest three consecutive years in the state's history, as well as setting new records for statewide average temperatures. On April 1st, 2015 Governor Brown signed executive order B-29-15 setting the first mandatory statewide water restrictions. This order prohibits ornamental turf on public street medians, and requires a reduction in potable water use for irrigation. The Green Streets program promotes water conservation through the use of low water use and drought tolerant plants (xeriscape) and improving groundwater supplies through infiltration.

Green infrastructure, unlike traditional "gray" infrastructure approaches to stormwater management, provides multiple benefits to communities. Planting more trees and landscaping in public spaces cleans the air, cools the land, provides more habitat for wildlife, adds green maintenance jobs, increases property values and promotes a better, healthier quality of life for San Diego County residents and visitors.
Under the Municipal Separate Storm Sewer System (MS4) Permit for San Diego Region (Permit [Order No. R9-2013-0001]), the County may make Priority Development Project (PDP) Exemptions for projects redeveloping or retrofitting existing paved roads, streets, and alleys as "EPA Green Streets." This is accomplished by meeting the criteria set forth in section 1.4.3 of the County of San Diego BMP Design Manual and based in part on the EPA publication "Green Streets: Municipal Handbook, Managing Wet Weather with Green Infrastructure."

This guide is to be used along with the County's BMP Design Manual for meeting stormwater requirements within the County's public right-of-way. These Green Streets measures, when implemented, will ensure the County remains a green community for many years to come.

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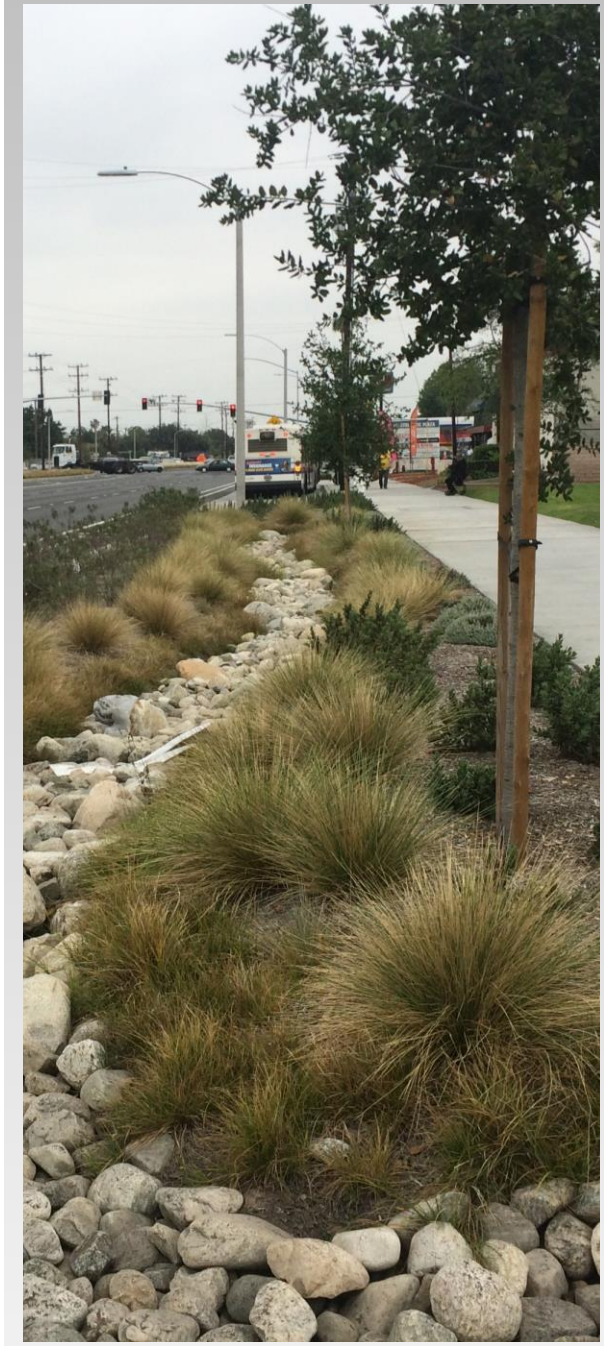


CHAPTER 1 Introduction to Green Streets

1.1 INTRODUCTION

These guidelines have been prepared to assist in the design and construction of projects that retrofit or redevelop existing paved streets and roads. These Guidelines and Standards have been developed in accordance with the United States Environmental Protection Agency Green Streets Guidance “Green Streets: Municipal Handbook, Managing Wet Weather with Green Infrastructure.”

These Guidelines may also be used to assist in the design and construction of new or retrofit paved sidewalks, bicycle lanes, or trails.

The functional goals of these guidelines are to:

- Provide source control of stormwater;
- Limit stormwater transport and pollutant conveyance to the collection system;
- Restore predevelopment hydrology to the extent possible by slowing the runoff down and allowing for infiltration; and
- Provide environmentally enhanced roads.

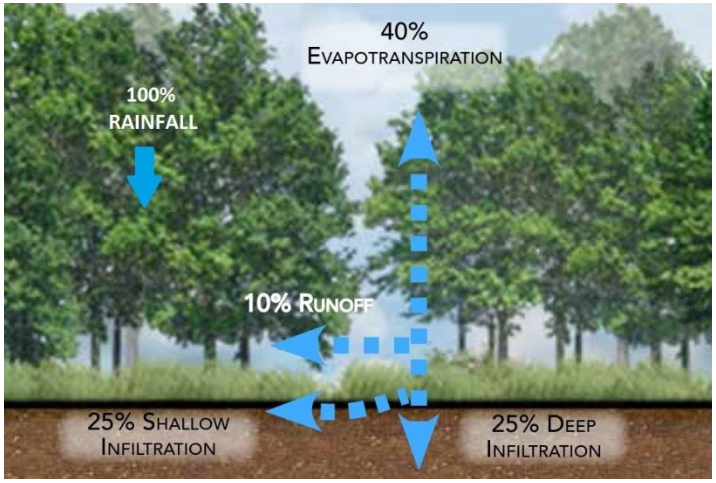
A review of existing County policies has been performed and included in the accompanying Green Streets Standards document that includes an addendum to the Public Road Standards, as well as Green Streets Standard Drawings and Specifications.

Green Streets configurations and locations presented in this guideline are schematic/conceptual in nature. The configurations (or locations) could be modified as long as the design and construction details are in conformance with the Green Streets technical documents (i.e. – Green Streets Supplement to Public Road Standards, Standard Drawings, Specifications, Plant List, and Maintenance Schedule).

1.2 THE NATURAL AND DEVELOPED ENVIRONMENT

NATURAL AREAS

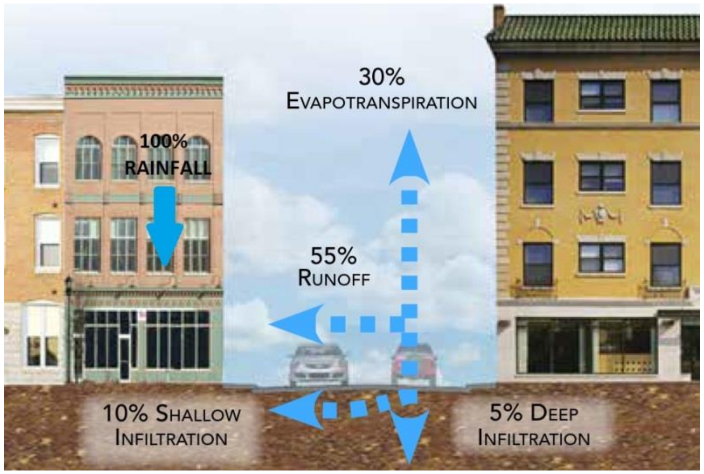
In areas such as meadows, thickets, woodlands, and parks, rain can soak into the ground and be used by plants. Trees and shrubs intercept rainfall and it slowly trickles down to the ground where it is absorbed by mulch and humic soil. Shaded areas are cooler, moister and provide wildlife habitat. Very little rainwater runs off the ground.



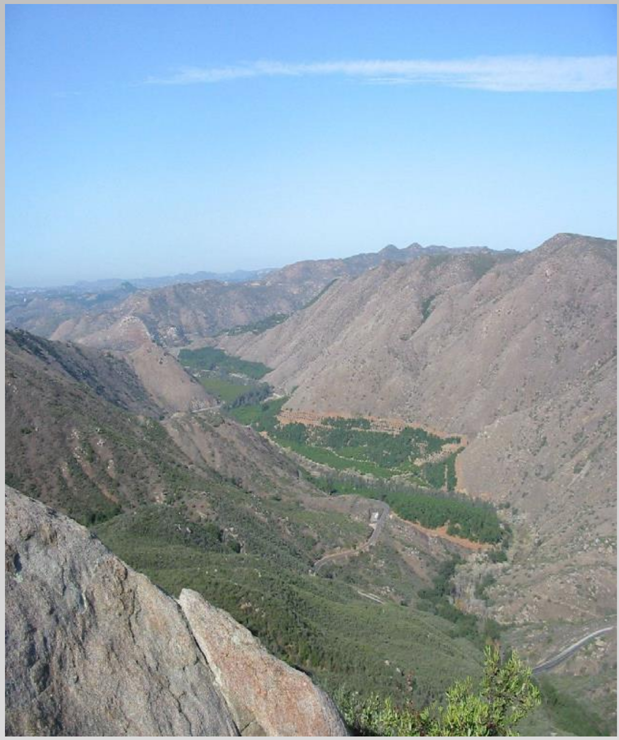
Natural Area Diagram
(Source: DDOT, 2014)

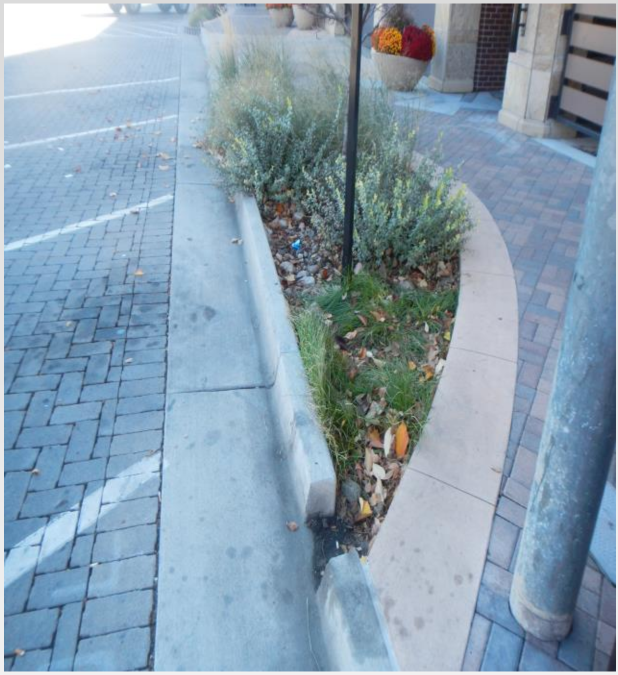
URBAN AREAS

In urban areas, building rooftops, streets, alleys, sidewalks, and other paved surfaces are smooth and mostly impervious. Very little rain has a chance to soak into the ground. These paved urban areas are hotter and offer very little wildlife habitat. Most of the rain that falls in the urban areas quickly runs off impervious surfaces picking up pollutants and carrying them into storm drains. These flows quickly combine to create flash floods that degrade downstream waterways.



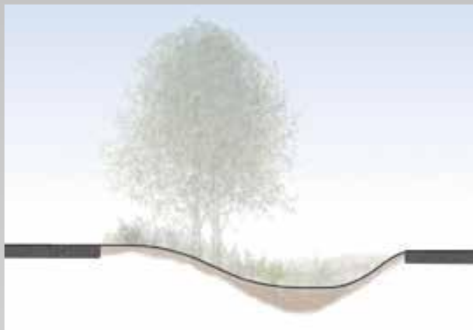
Urban Area Diagram
(Source: DDOT, 2014)





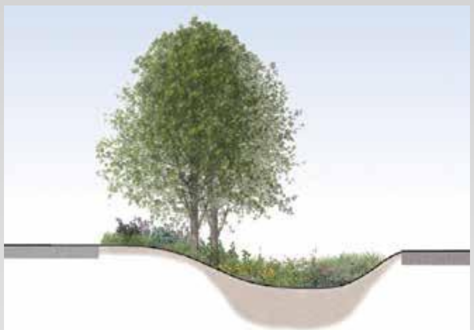
Stormwater

Capture



Runoff from impervious surfacing

Store



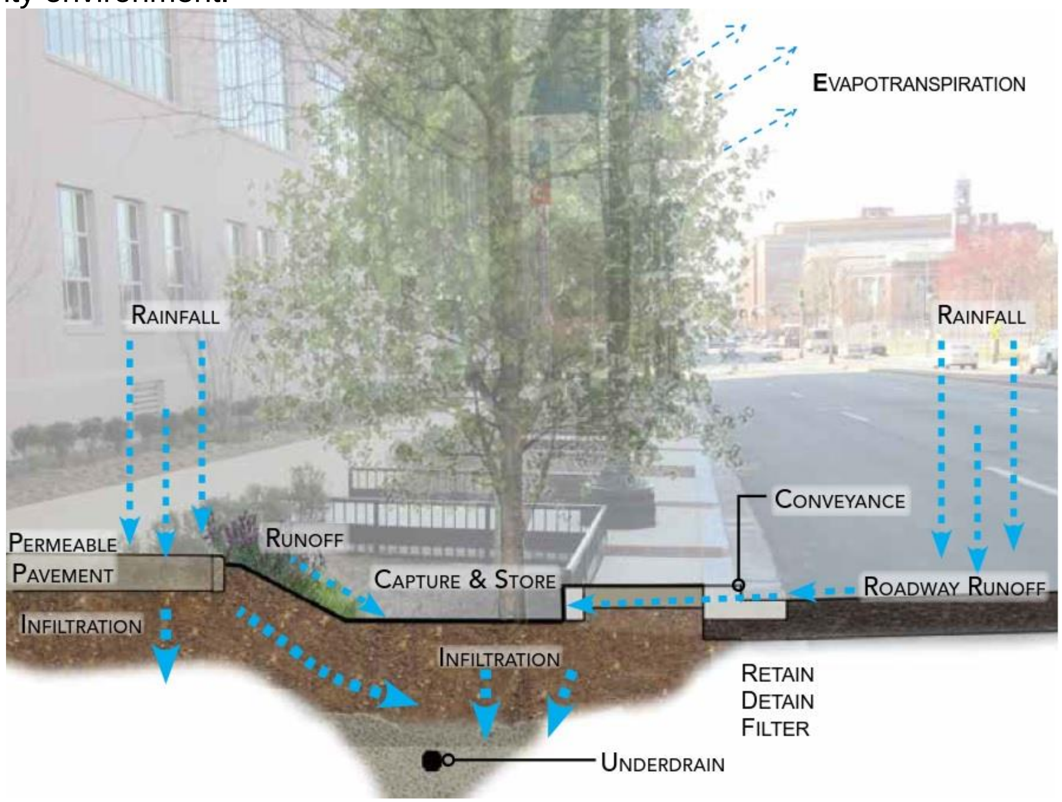
Store and retain captured runoff

Infiltrate/Evapotranspire

Water is infiltrated into the ground, evapotranspired by plants or drained

1.3 Greening The Streets

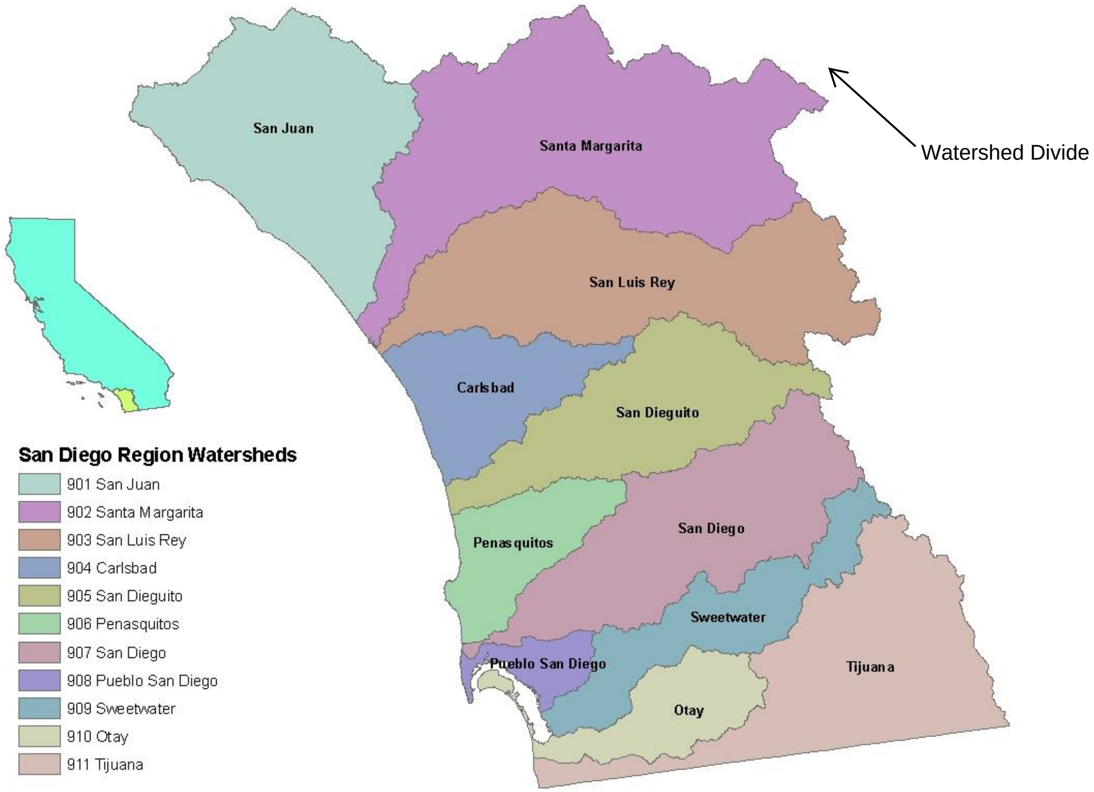
Green Streets, which includes Green Infrastructure (GI), incorporates elements found in natural areas into the County road right of way. GI is the living network that connects impervious areas to landscape areas, natural areas, and waterways. GI captures rainfall; cools buildings and pavement; and creates natural pathways for wildlife. GI includes Low Impact Development (LID) techniques, which mimic nature to capture and treat stormwater as close to the source as possible. When implemented, GI creates living green streets that capture, store, and infiltrate stormwater to treat it as a resource and improve the County environment.

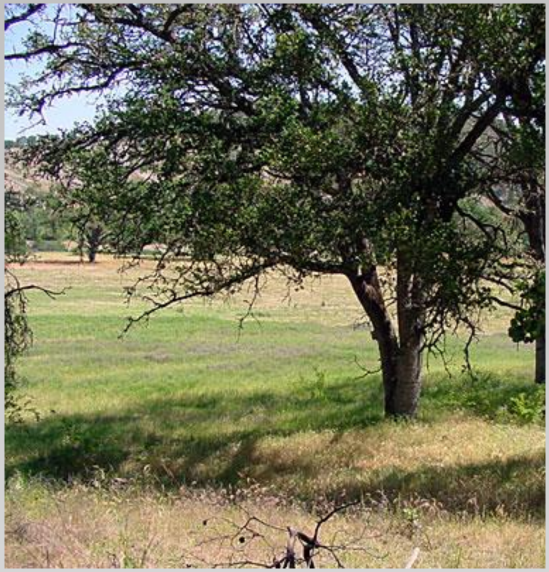


Green Streets Stormwater Diagram
(Source: DDOT, 2014)

1.4 THE COUNTY ENVIRONMENT

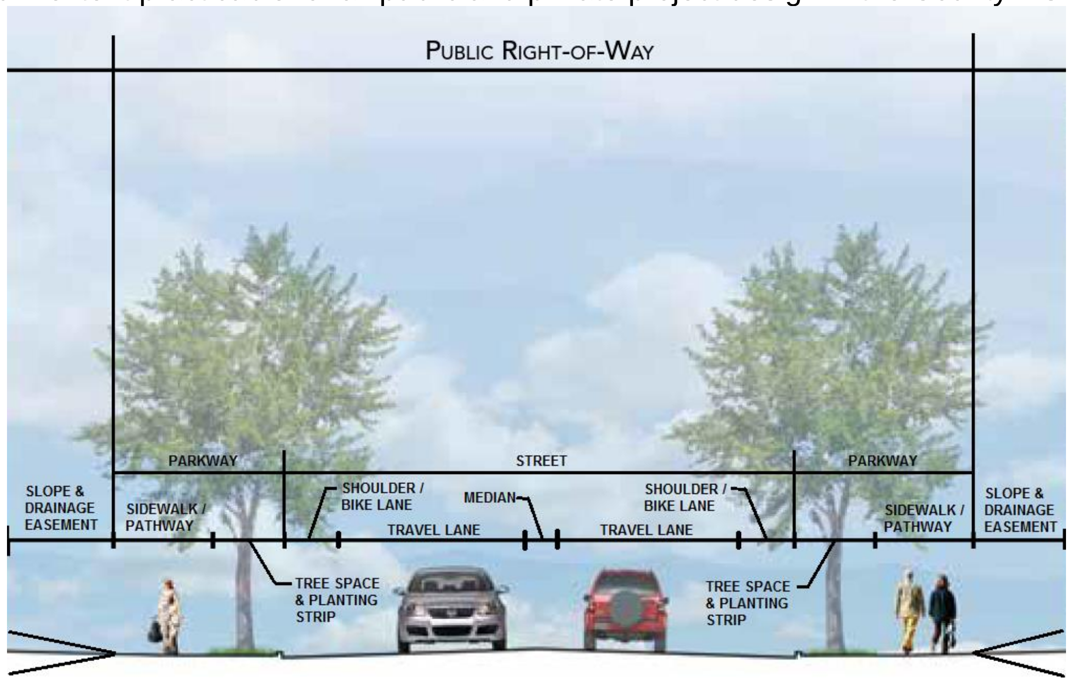
The County of San Diego is a unique environment made up of natural, rural, and urban areas. When rain falls in the County and becomes stormwater runoff, it flows through eleven major watersheds. Stormwater carries the pollutants, trash, and warmer temperatures it collects from roads, buildings, and other impervious surfaces and delivers them into our rivers, streams, bays, lagoons, and ocean. Urbanization and other land use changes in the County can modify the natural watershed hydrologic processes and stormwater runoff characteristics resulting in increased stormwater runoff and erosion.





1.5 County Right-of-Way

Land within the road right-of-way (ROW) presents a significant opportunity to reduce runoff and improve the urban environment through Green Streets. This manual introduces techniques to install green infrastructure in the median, street, bike lane, shoulder, parkway, and slope and drainage easements. This guide and the "Green Streets Standards," which includes supplements to the Public Road Standards, Green Streets Standard Drawings, and specifications, should be used the maximum extent practicable for all public and private project design in the County ROW.



ROAD RIGHT-OF-WAY DIAGRAM
(Source: DDOT, 2014)

Early in the green street planning and design process careful consideration should be given to the location of existing and proposed utilities and appurtenances (utility poles, vaults, and pedestals), fire hydrants, traffic signals, signage, mail boxes, bus stops, and their interaction with the proposed green street measures.

CHAPTER 2 Green Streets Strategies

2.1 INTRODUCTION

Green Streets, including Green Infrastructure (GI), and Low Impact Development (LID) solutions are intended to be sustainable, attractive, and cost effective. The range of opportunities includes tree wells, landscape areas, dispersion areas, biofiltration, permeable pavement, and removal of impervious pavement. These strategies use natural processes to reduce the volume of runoff, peak flow, and pollutants. This chapter will focus on five (5) areas appropriate for use in the road right-of-way.

TREE WELLS

Trees are a powerful green streets tool due to their ability to intercept water on leaves, slowly deliver it to the mulch and soil, absorb it through root systems, and transpire it as water vapor directly back to the atmosphere.

DISPERSION AREAS

Dispersion areas disconnect impervious areas from directly running to the storm drain system. Dispersion areas use the natural functions of plants, mulch, and soils to remove pollutants and slow stormwater runoff. The strategy uses storage, sediment capture, and biological processes to clean the water. These mimic processes that occur in nature before water reaches waterways.

BIOFILTRATION

Biofiltration facilities are vegetated surface water systems that filter water through vegetation, and soil or biofiltration soil media prior to discharge to the storm drain system. They also utilize shallow depressions to provide storage and evapotranspiration.

PERMEABLE PAVEMENT

Permeable paving systems provide a hard surface, while allowing water to flow through to the underlying soils instead of directly to the drainage system. The areas where this strategy may be used include: sidewalks, pathways, medians, and parking lanes.

REMOVE IMPERVIOUS PAVEMENT

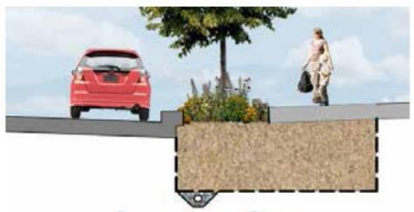
Roadway improvement projects have the opportunity to remove portions of impervious pavement within the right of way and replace it with permeable material.

2.2 Tree Wells

Why Are Trees Important?

Trees make a streetscape feel welcoming, help manage stormwater, and reduce the urban heat island effect by providing shade. An urban heat island remains significantly warmer than the surrounding rural areas due to less vegetation. Trees promote air quality, natural habitat, the human environment, and well-being.

Trees in a congested road right-of-way are confined to small planting areas where they struggle to reach a mature size or live a long life. Through the use of Structural Soil, Structural Cell, or Suspended Sidewalk techniques, soil volumes and space for tree roots to grow uninhibited can be greatly increased. These techniques also allow for more water and air to reach the tree roots.



Structural Soils

A specific mix of stone and soil that supports the sidewalk while allowing tree roots to grow normally.

Structural Cells

Manufactured cells support the sidewalk allowing uncompacted soil to promote tree roots to grow below.

Suspended Sidewalk

Thickened sidewalk with reinforcement and/or footings can be used allowing tree roots to grow below the sidewalk.

(Source: DDOT, 2014)

Soil Volume Sizing

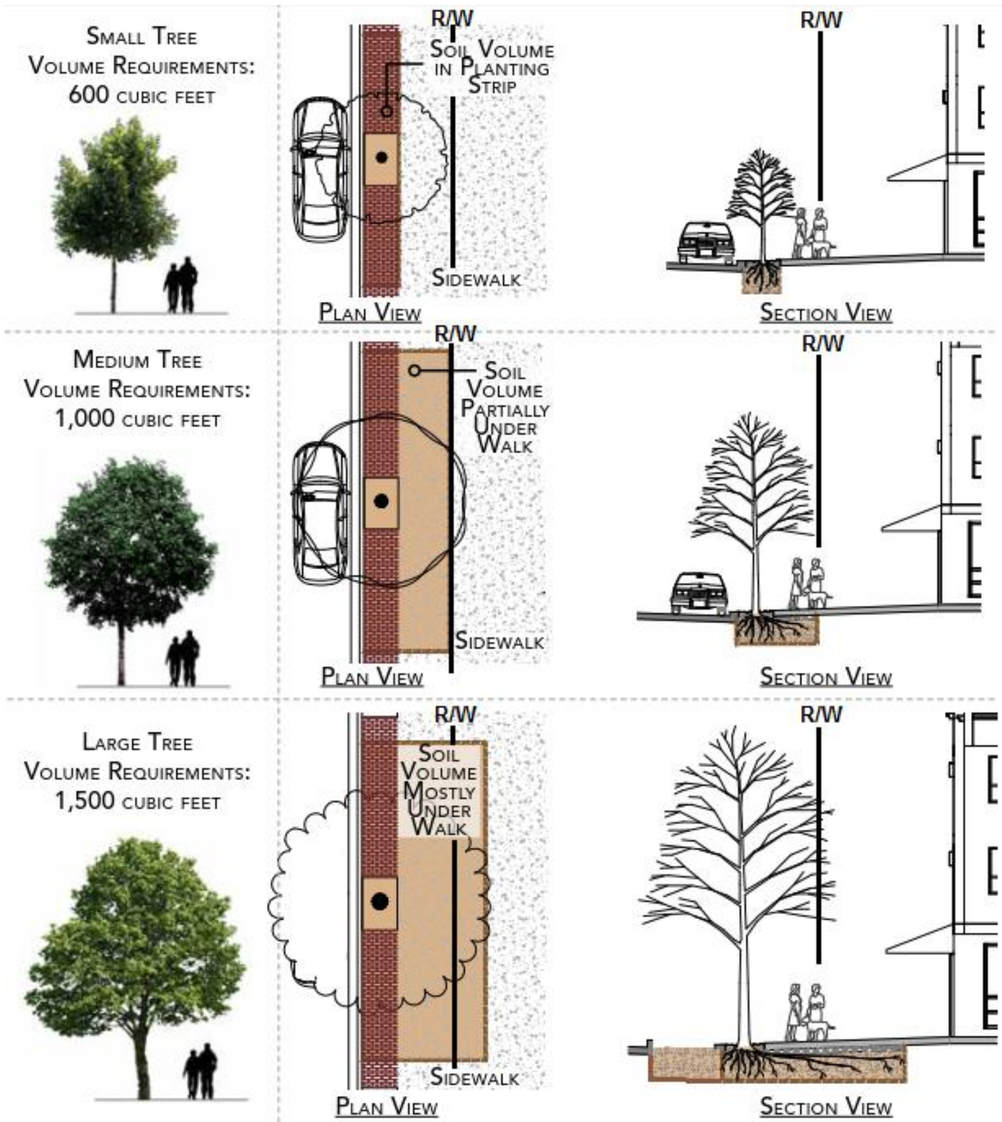
- Adequate planting soil space provides the nutrients, water, air, and root space that trees need to have a long, healthy life.
- The planting soil volume required depends on the fully-grown tree size (generally two cubic feet of soil per one square foot of the tree's mature drip line area).
- Planting soil amendments for trees should be three-feet deep; the length and width must ensure the appropriate volume for the tree species and site.

Other Considerations

- Provide as much open space as possible for the tree to allow the tree to grow and access water.
- Providing structural soils, suspended sidewalks, or structural slabs to edges of paved areas prevents planting soil compaction and encourages tree roots to extend further and into adjacent green areas.
- Evaluate temporary and permanent irrigation needs
- Evaluate utility locations and required clearance.

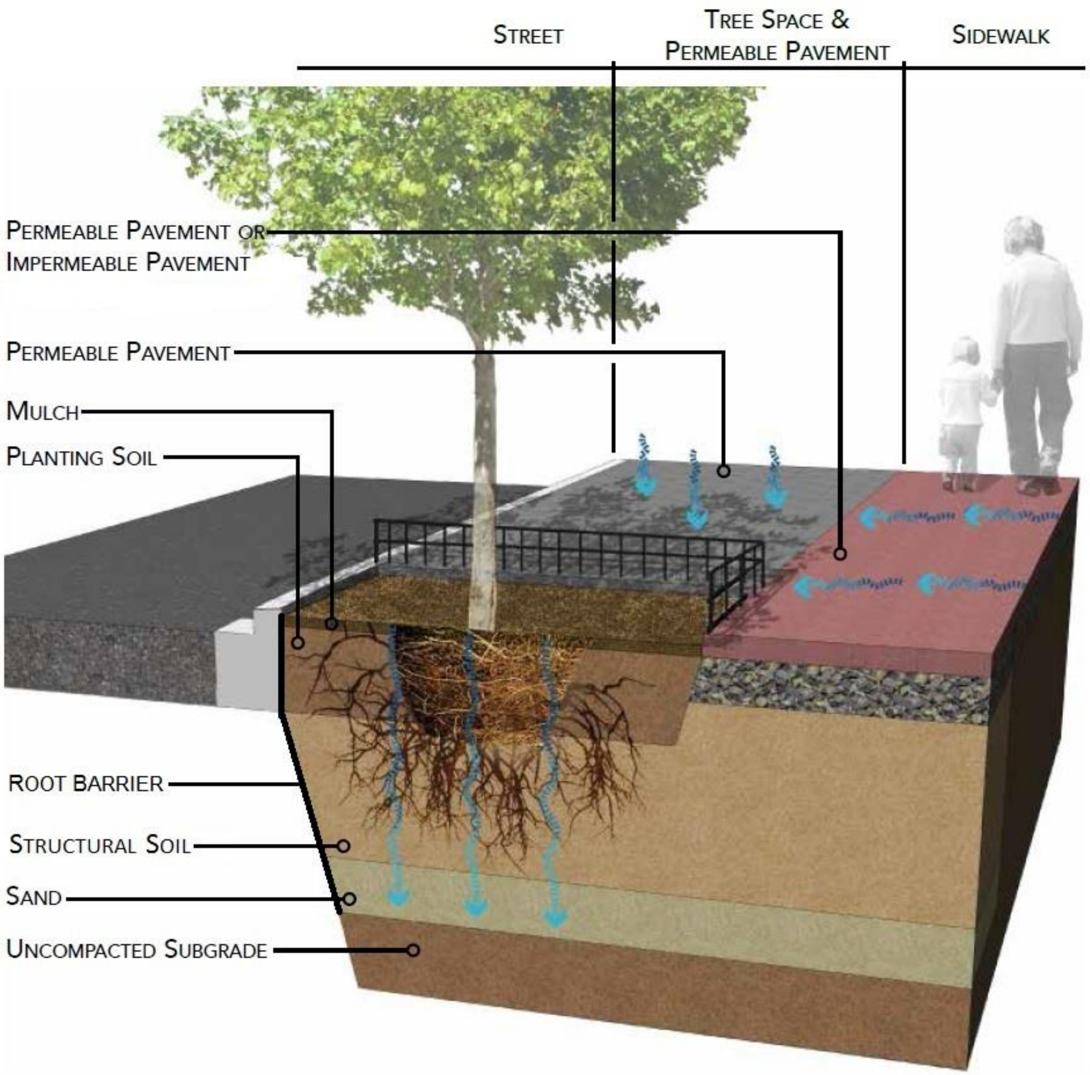
Design Issues

- Maintenance Access: allow for maintenance access from road
- Pedestrian Considerations: allow for 18-inch minimum setback from curb and minimum 48-inch sidewalk width. Comply with ADA requirements.
- Suspended sidewalks and structural slabs/cells: may require evaluation by geotechnical and structural engineers
- Clear Recovery Zone: Consider clear recovery zone requirements and minimum setback requirements.
- Tree Size: Evaluate tree size versus the right of way width.



(Source: DDOT, 2014)
Note: Trees may also be located behind the sidewalk/pathway.

TREE WELLS – WHAT'S UNDERNEATH?



(Source: DDOT, 2014)

Note: Other options include suspended sidewalks and structural cells as shown on page K-30.

PUTTING IT TOGETHER

- Permeable Paver: Permeable pavers allow water to infiltrate into the planting soil to be used by the trees.
- Mulch: A soil topping that may be organic or inorganic material which covers the planting soil to retain water and trap pollutants.
- Planting Soil: Uncompacted and amended soil mix allows root growth when used in open areas, with structural cells, or suspended sidewalks.
- Structural Soil: Supports pavement and allows root growth.
- Sand: Acts as a drainage layer for excess stormwater (when needed).
- Uncompacted Subgrade: Existing soil where stormwater may infiltrate.

WATER TREES WITH STORMWATER

In addition to large planting soil volumes, trees need sufficient water, air, and nutrients to be successful in the road right-of-way environment. Tree space design includes integrating opportunities for directing stormwater into the soil. See the County of San Diego's Water Conservation in Landscaping Ordinance for irrigation requirements.

2.3 Types of Dispersion Areas and Biofiltration

What Are Dispersion Areas and Biofiltration?

Dispersion Areas and Biofiltration are landscape systems that filter pollutants and sediment from runoff. The layers of plant material, mulch, biofiltration soil media (a mix of planting soil, sand, and compost), and stone capture metals, nutrients, and bacteria that would otherwise flow into the surrounding creeks and rivers. The rainwater is held in the planting bed until it infiltrates into the ground or evaporates. The entire system can fit into small spaces, making it adaptable to tree spaces along the road, planter boxes, curb extensions, medians, roundabouts, and open areas.

Planter Boxes

Runoff enters the facility through curb cuts. Excess runoff exits through the same curb cuts or into drains located in the planting area.

Curb Extension

Runoff enters the facility following the existing curb line. Excess runoff flows through the system and returns to the curb and gutter downstream.

Medians

Runoff follows the existing curb line and enters the facility through curb cuts. Excess runoff flows through the system or into drain inlets.

Bulb-out at Intersection

Runoff follows the existing curb line and enters the facility through curb cuts. Excess runoff flows through the system or into drain inlets.

VEGETATED FILTER STRIP

Runoff enters the facility directly via sheet flow. Excess runoff flows through the system to a drain inlet downslope.

SWALES

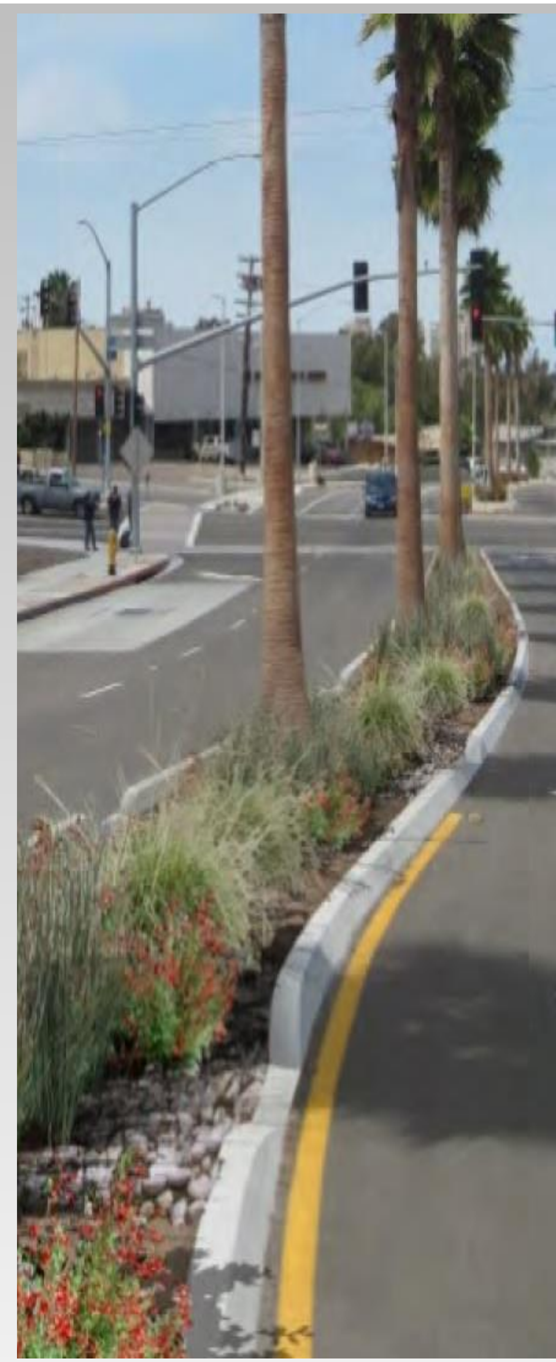
Runoff enters the facility directly or through curb cuts. Excess runoff flows through the system to a drainage outlet.

TRAFFIC CIRCLE/ROUNDABOUT

Runoff follows the existing curb line and enters the facility through curb cuts. Excess runoff flows through the system or into drains located in the planting area.

OPEN AREAS

Runoff drains into the planting area from the surrounding area. The size and shape can fit the available space.



(Source: County of San Diego, 2014)

WHERE TO USE?

- Street with no adjacent on-street parking.
- Where Tree wells are needed.
- Street where bike lane is adjacent to curb.

LIMITATIONS

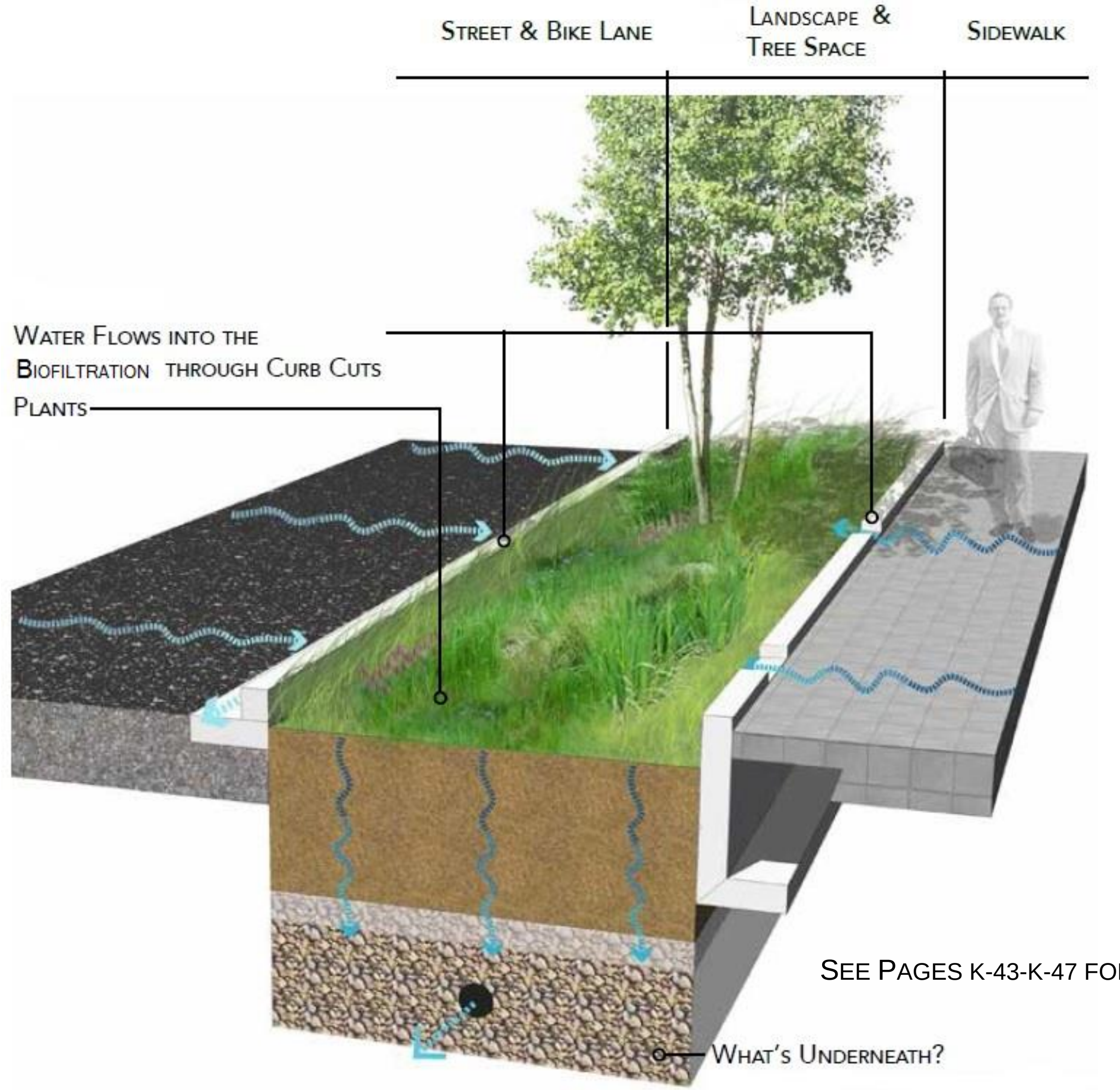
- Not for on-street parking.

DESIGN ISSUES

Maintenance Access: Allow for adequate maintenance access from road.

Pedestrian Considerations: Allow for minimum allowable sidewalk width. Consider trip hazards and fall protection. Comply with ADA requirements.

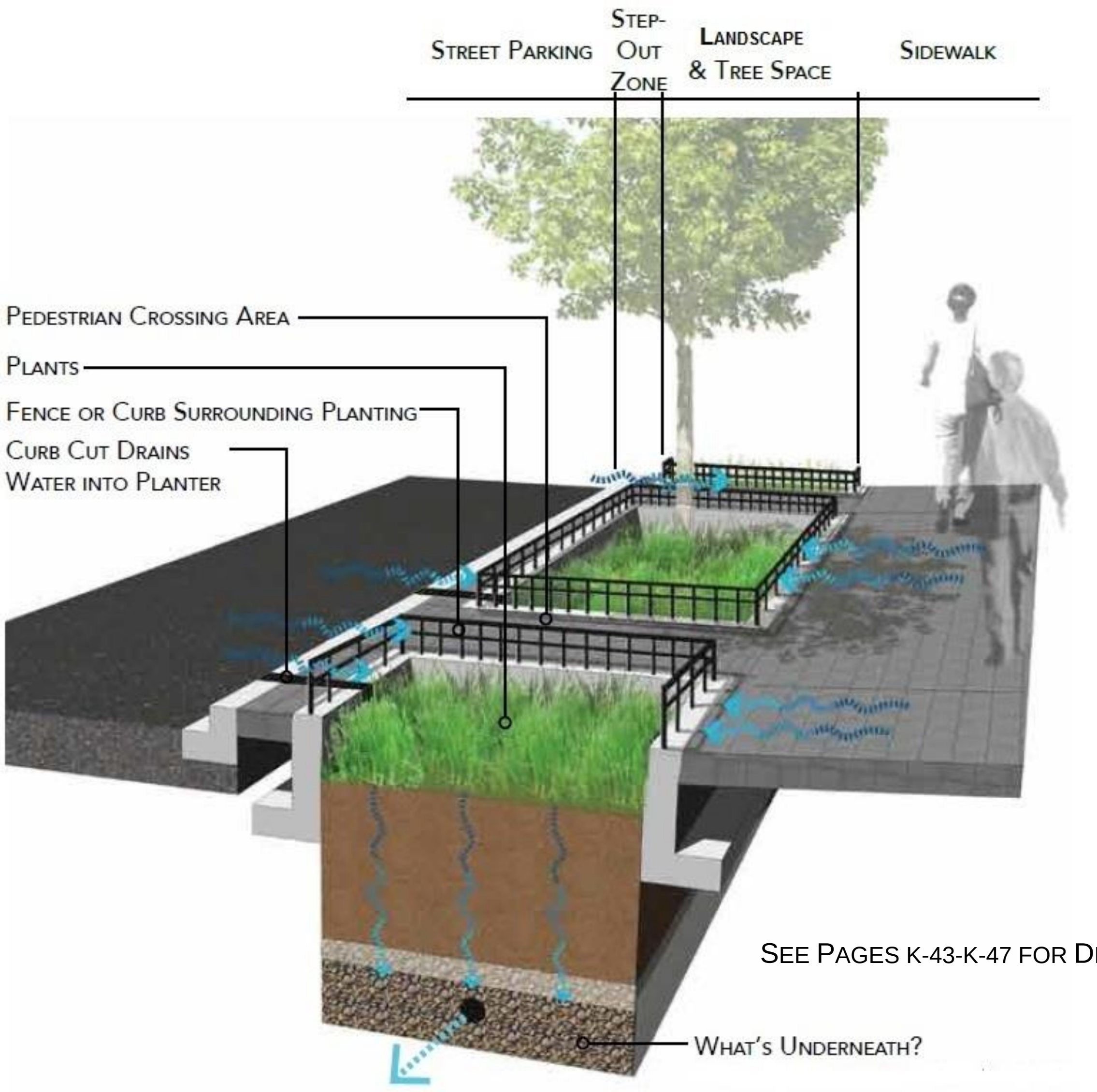
PLANTER BOX ADJACENT TO ROADWAY



SEE PAGES K-43-K-47 FOR DETAILS

(Source: DDOT, 2014)

PLANTER BOX WITH STEP OUT ZONE



SEE PAGES K-43-K-47 FOR DETAILS

(Source: DDOT, 2014)

WHERE TO USE?

- Wide sidewalk area with adjacent on-street parking.
- High-volume pedestrian areas.
- Areas with other streetscape features (lights, bike racks, bus stops, etc.).

LIMITATIONS

- Do not disturb existing, mature trees and root systems.
- Provide low fence or curb for pedestrian safety.

DESIGN ISSUES

Planting Design: Same as for planter box adjacent to roadway.

Maintenance Access: Allow for adequate maintenance access from road.

Pedestrian Considerations: Areas in the streetscape can have dropped or have sloped sides. Short fences or curbs prevent pedestrians from stepping into a recessed area. Planter boxes with side slopes can use a small step-out area in place of a fence or curb. When the planter box is next to street parking areas, a step-out zone must be provided to allow access from the vehicle to the sidewalk. Crossing areas must be provided between street parking and the sidewalk. Comply with ADA requirements.

Where to Use?

- Areas with low on-street parking demand.
- In wide roadways.
- For traffic calming.
- In “no parking areas” on street (excluding loading zones and curb cuts).
- Next to mature trees.

Limitations

- Sufficient street parking or off-street parking must be available to residents.
- Do not disturb existing, mature trees and root systems.
- Ensure sight lines and turning radii are preserved.

Design Issues

<u>Maintenance Access:</u> Allow for adequate maintenance access from road.

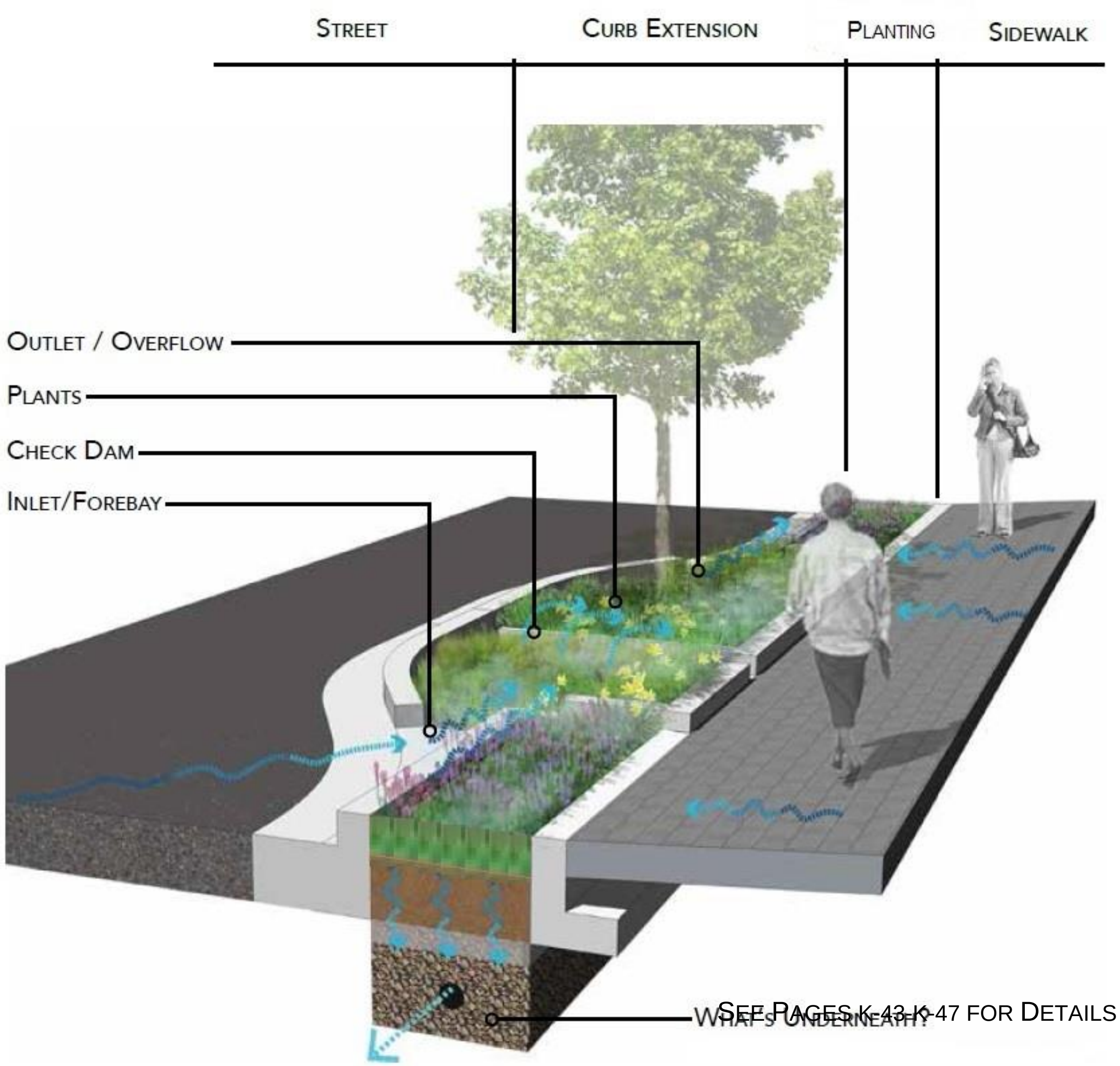
<u>Pedestrian Considerations:</u> Consider trip hazards and fall protection. Short fences or curbs prevent pedestrians from stepping into a recessed area. A 3:1 transition from the sidewalk to planter bottom is an alternative. Comply with ADA requirements.

<u>Parking:</u> Consider trip hazards and adequate spacing in order to park.

<u>Flood Control:</u> Locate so that stormwater can drain away from the roadway and be directed through the curb inlet.

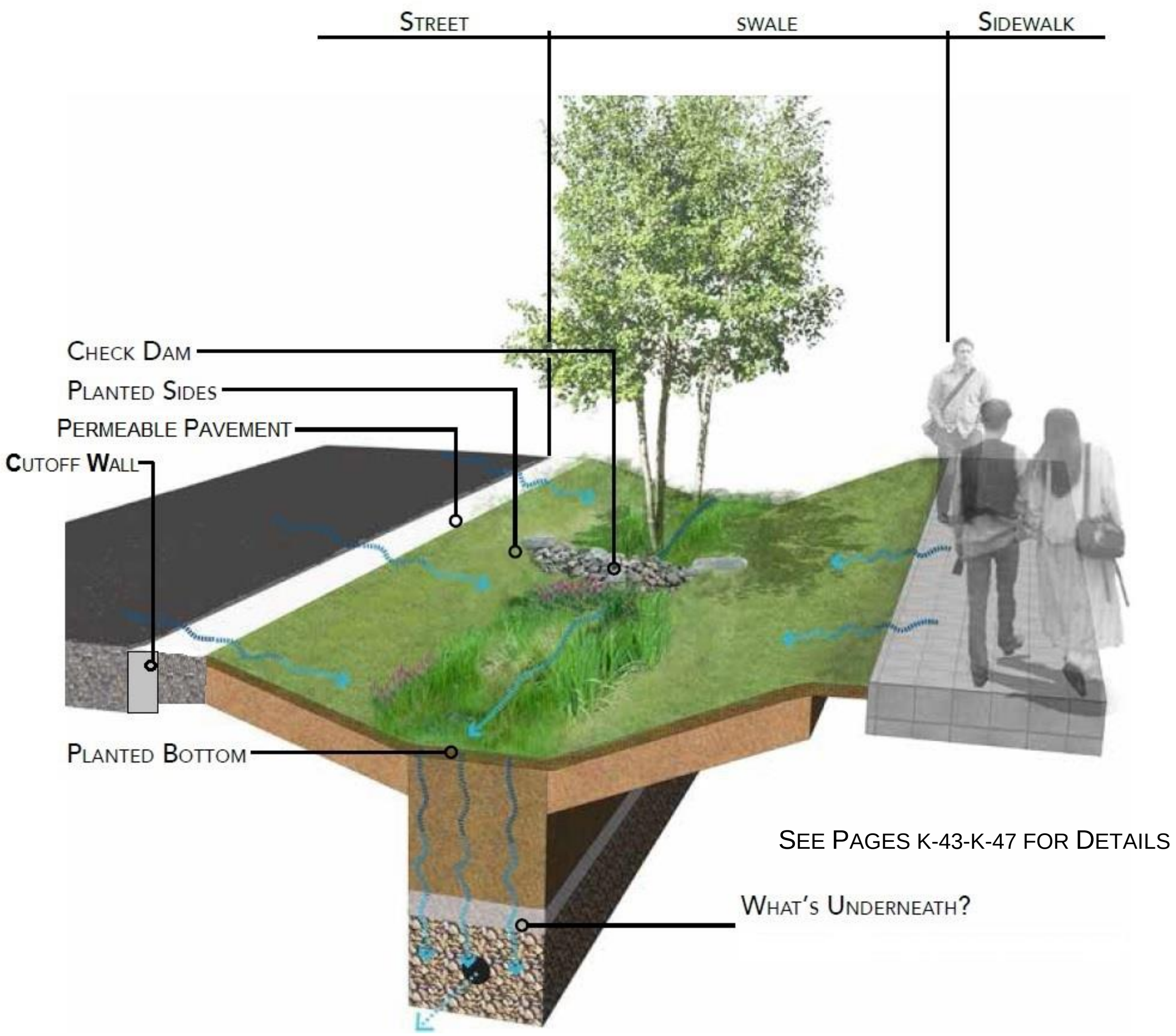
<u>Bike Lanes:</u> Consider bike lane traffic.

Curb Extension



(Source: DDOT, 2014)

Swale Adjacent to Roadway



(Source: DDOT, 2014)

Where to Use?

- On street with no curb.
- In wide ROW area with or without sidewalk.
- Areas with less pedestrian use.

Limitations

- Not suitable for narrow sidewalk areas.

Design Issues

Slope and Check Dams: Swales are placed where street runoff is flowing and optimally before catch basins that convey water from the street to the drainage system. Swales may be built on moderate slopes with the use of check dams. Rock armoring or turf reinforcement mat may be required in steep areas with erosive velocities between check dams.

Maintenance Access: Allow for adequate maintenance access from road.

Pedestrian Considerations: Limit pedestrian access to swale. Transition swale at intersections for pedestrian facilities. Comply with ADA requirements.

Driveway Crossings: Driveway crossings may limit swale lengths.

Where to Use?

- Where runoff can sheet flow into filter strip area.
- Moderate slopes (less than 5%) adjacent to impervious area of treatment (sidewalk or road).
- Rural areas.

Limitations

- Not recommended on steep slopes.
- Prone to rill formation.
- Areas with on-street parking.

Design Issues

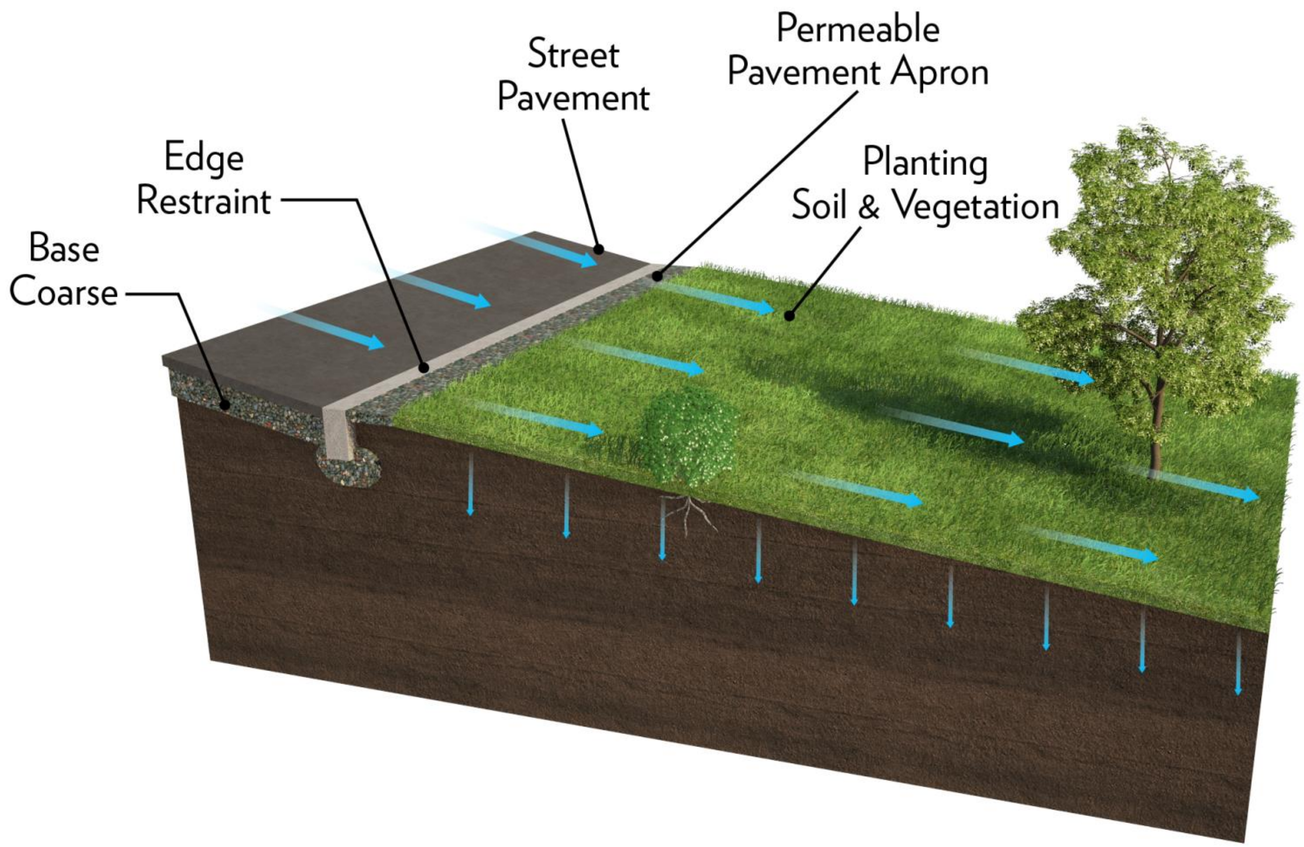
Maintenance: Vegetated cover must be maintained to ensure that filter strips do not export sediment due to erosion of exposed ground.

Slope: Maximum slopes in the direction of flow will be based upon drainage area size, soil type, vegetation cover, and slope length to prevent rill formation. Slopes less than 5% are preferred.

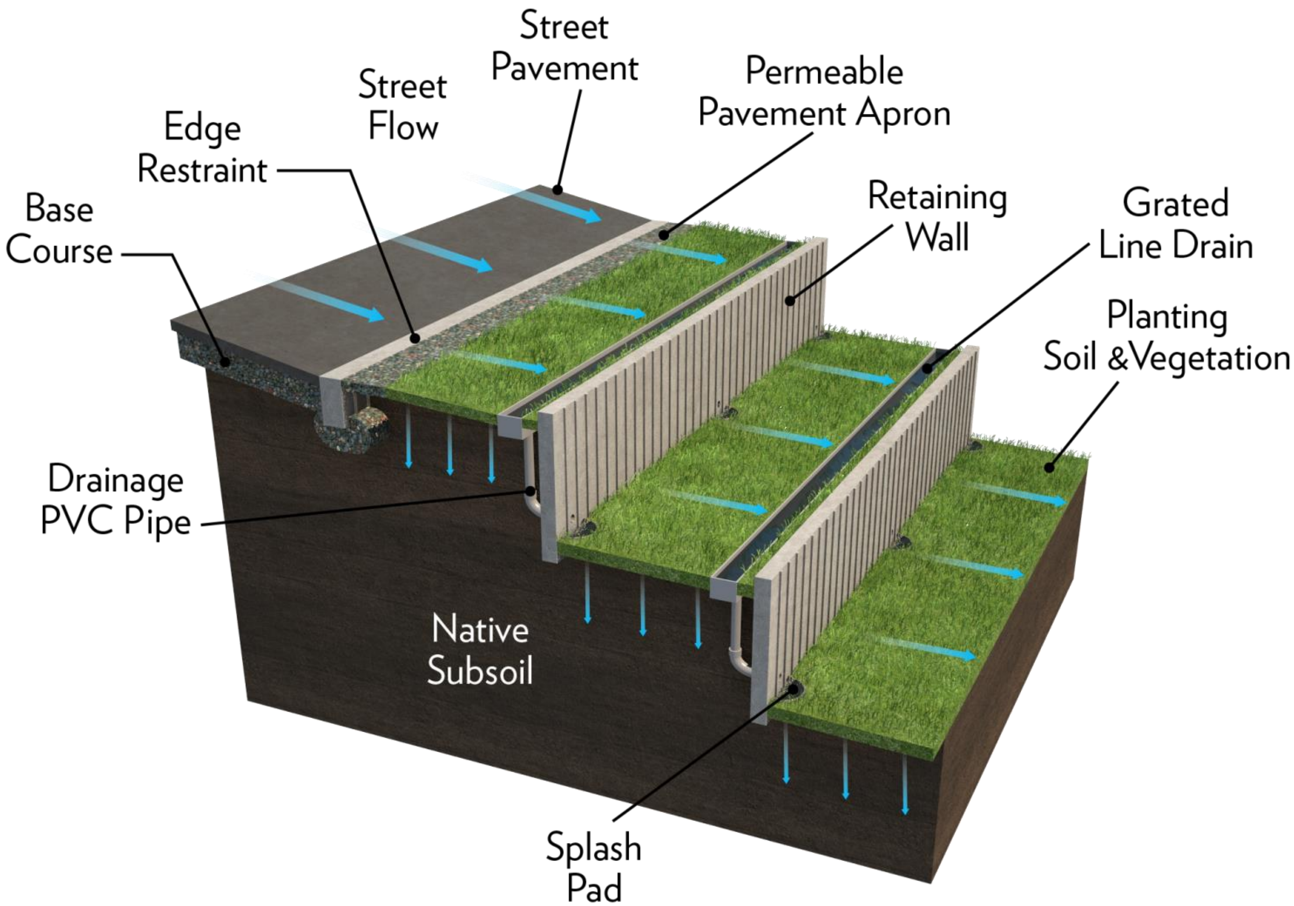
Maintenance Access: Allow for adequate maintenance access from road.

Pedestrian Considerations: Limit pedestrian access across filter strip to prevent formation of dirt pathways. Comply with ADA requirements.

Vegetated Filter Strip



VEGETATED TERRACED FILTER STRIP



WHERE TO USE?

- Where runoff can sheet flow into filter strip area.
- Steep slopes (greater than 5%) adjacent to impervious area of treatment (sidewalk or road).
- Rural areas.

LIMITATIONS

- Prone to rill formation.
- Areas with on-street parking.
- Walls over 3 feet tall require structural design.

DESIGN ISSUES

Maintenance: Vegetated cover must be maintained to ensure that filter strips do not export sediment due to erosion of exposed ground.

Slope: Maximum slopes in the direction of flow will be based upon drainage area size, soil type, vegetation cover, and slope length to prevent rill formation. Slopes less than 5% are preferred.

Maintenance Access: Allow for adequate maintenance access from road and bottom of slope.

Pedestrian Considerations: Limit pedestrian access across filter strip to prevent formation of dirt pathways. Comply with ADA requirements.

Where to Use?

- Areas with low on-street parking demand.
- In wide roadways.
- For traffic calming.
- In "no parking areas" on street (excluding loading zones and curb cuts).

Limitations

- Sufficient street parking or off-street parking must be available to residents.
- Ensure sight lines and turning radii are preserved.

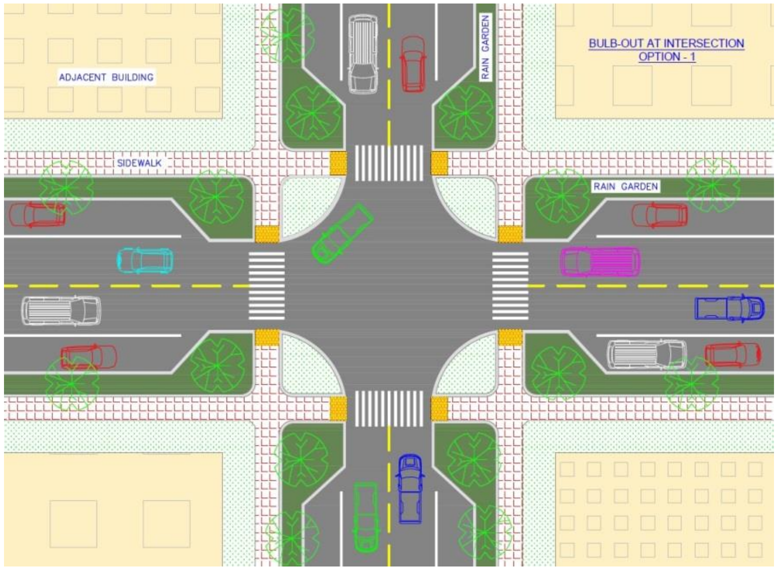
Design Issues

Maintenance access: Allow for adequate maintenance access from road.

Pedestrian considerations: Short fences or curbs prevent pedestrians from stepping into a recessed area. Walkways and ramps may need to be designed through bulb-outs to provide pedestrian access at intersections. Comply with ADA requirements.

Design: Requires County Traffic Engineering Section approval.

Bulb-Out at Intersection



ROUNDABOUT

WHERE TO USE?

- Areas with low on-street parking demand.
- In wide roadways.
- For traffic calming.

LIMITATIONS

- Sufficient street parking or off-street parking must be available to residents.
- Ensure sight lines and turning radii are preserved.

DESIGN ISSUES

<u>Maintenance Access:</u> Allow for adequate maintenance access from road.

<u>Pedestrian Considerations:</u> Short fences or curbs prevent pedestrians from stepping into a recessed area. Comply with ADA requirements.

<u>Design:</u> Requires County Traffic Engineering Section approval.

The NRCS hydrologic soil groups are defined as:

• **Group A** soils have a high rate of percolation and a low runoff potential. The rate of water transmission is high; thus, runoff potential is low. Group A soils are generally referred to as sandy soils.

• **Group B** soils have moderate percolation rates when thoroughly wet. These are chiefly soils that are moderately deep to deep, moderately well-drained to well-drained, and moderately coarse textured. Rate of water transmission is moderate.

• **Group C** soils have a slow percolation rate when thoroughly wet. They are chiefly soils that have a layer impeding the downward movement of water, or they are moderately fine to fine-textured soils that have a slow infiltration rate. The rate of water transmission is slow.

• **Group D** soils have very slow percolation rates when thoroughly wet. They are clays that have a high shrink-swell potential, soils that have a high permanent water table, soils that have a claypan or clay layer at or near the surface, or soils that are shallow over nearly impervious material. The rate of water transmission for group D soils is very slow.

Dispersion Areas and Biofiltration – What's Underneath?

Soil Type and Infiltration Rate

Dispersion areas and biofiltration can be located in many areas. However, site constraints will help to determine what goes underneath the dispersion area or biofiltration. Common considerations include soil type, relative soil compaction, required utility setbacks, slope setbacks, and structural setbacks. Depending on the factors at the site, what's underneath the dispersion area or biofiltration is determined by the level of infiltration: high, medium, low, or none.

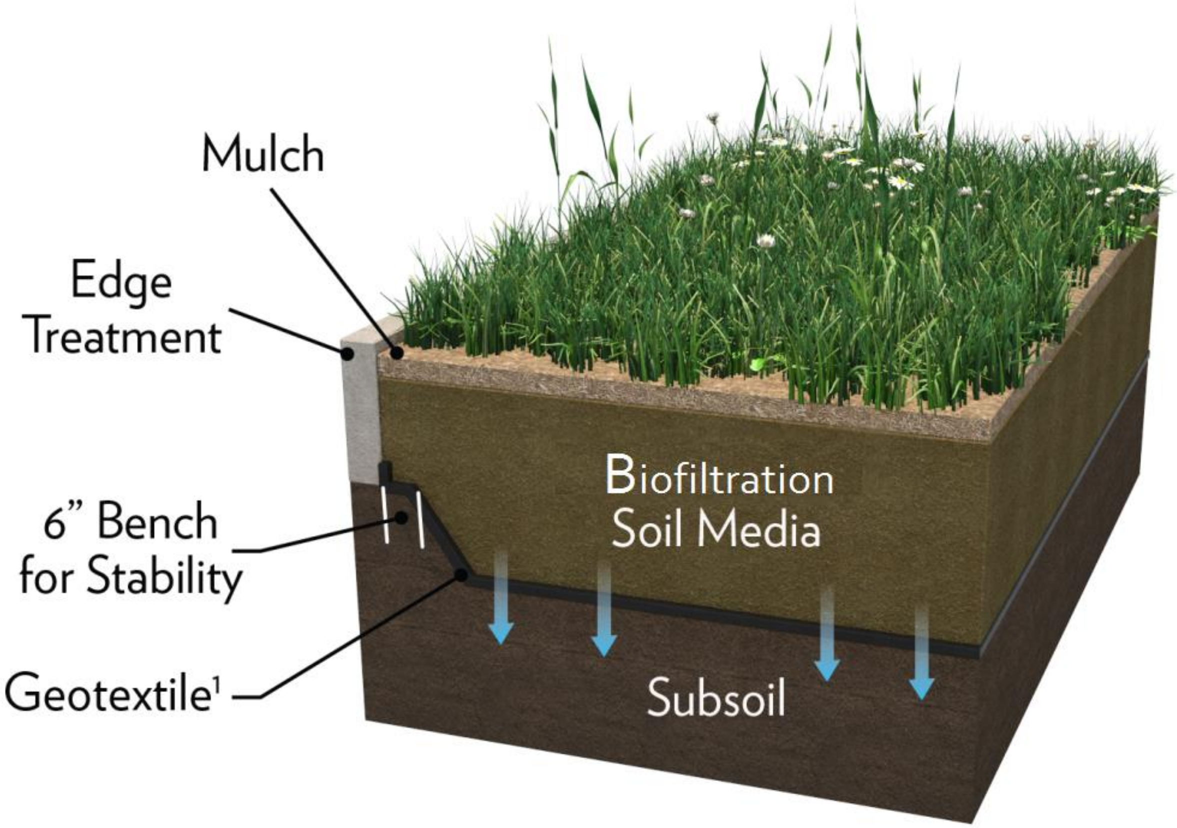
A qualified engineer practicing geotechnical services shall review the proposed stormwater infiltration to provide a professional opinion regarding the potential adverse geotechnical conditions that the implementation of these practices may create. Geotechnical conditions such as slope stability, expansive soils, compressible soils, seepage, groundwater, and loss of foundation or pavement subgrade strength should be considered.

The U.S. Department of Agriculture Natural Resources Conservation Service (NRCS), formerly the Soil Conservation Service, conducted a soil survey of the San Diego area in the early 1970s. The NRCS has classified San Diego area soils with respect to: (1) their ability to accept and absorb water, (2) their tendency to produce runoff, and (3) their erodibility.

The soil survey classified soil runoff potential into four hydrologic soil groups labeled A through D. Group A and B soils exhibit the greatest infiltration rates (unless soils are compacted during construction) and are generally best suited to stormwater percolation. The San Diego area, however, has a relatively high concentration of group C and D soils, which exhibit lower percolation rates that generally limit the use of infiltration-based stormwater management systems. Instead, dispersion areas and biofiltration facilities are often equipped with underdrains. Such a design provides for filtration of the water quality design event through a biofiltration soil media as well as incidental infiltration of low flows.

Retaining a geotechnical engineer and conducting exploratory excavations at the site are highly recommended. Consideration should be given to the effects of urbanization on the natural hydrologic soil group. If heavy equipment can be expected to compact the soil during construction, or if grading will mix the surface and subsurface soils, appropriate changes should be made in the soil group selected.

High Infiltration



HIGH INFILTRATION

Notes:

1. Geotextile per Geotechnical Engineer's Recommendations (street side and sidewalk side).

Putting it Together

- Ponding Depth: Stores runoff within the planting area prior to treatment.
- Mulch: A soil topping that may be organic or inorganic material which covers the planting soil to retain water and trap pollutants.
- Biofiltration Soil Media: A specific blend of soil, compost, and sand to retain and drain water and support plant growth.
- Geotextile: Prevents existing soil from migrating into the biofiltration soil media.
- Uncompacted Subsoil: Existing soil where stormwater infiltrates.

Common Design Issues

Utilities: In the County, utility lines are common and necessary components of infrastructure within the right-of-way. Utility lines should be avoided where necessary and allowed to coexist where possible.

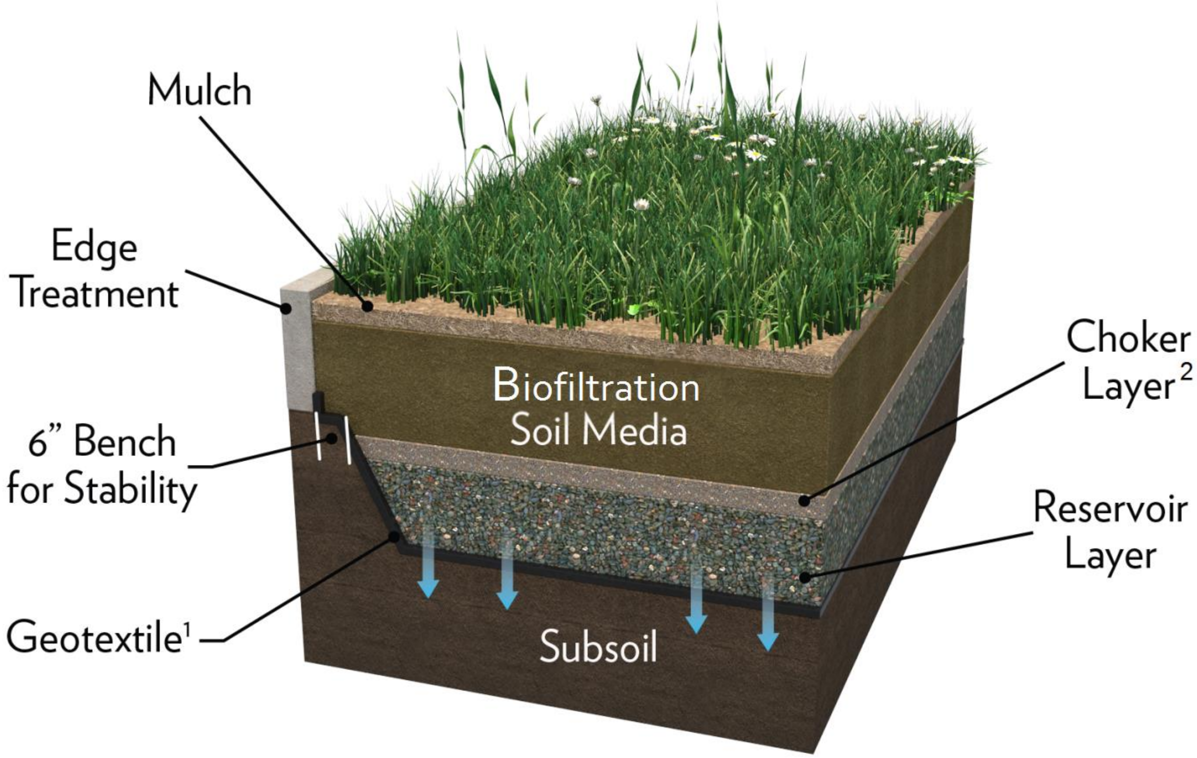
Putting it Together

- Ponding Depth: Stores runoff within the planting area prior to treatment.
- Mulch: A soil topping that may be organic or inorganic material which covers the planting soil to retain water and trap pollutants.
- Biofiltration Soil Media: A specific blend of soil, compost, and sand to retain and drain water and support plant growth.
- Choker Layer: Sand and gravel to prevent biofiltration soil media from migrating into the reservoir.
- Reservoir Layer: Stone to hold excess water until it infiltrates.
- Geotextile: Prevents existing soil from migrating into the biofiltration soil media and stone reservoir layer.
- Uncompacted Subgrade: Existing soil where stormwater infiltrates.

Common Design Issues

Utilities: In the County, utility lines are common and necessary components of infrastructure within the right-of-way. Utility lines should be avoided where necessary and allowed to coexist where possible.

Medium Infiltration

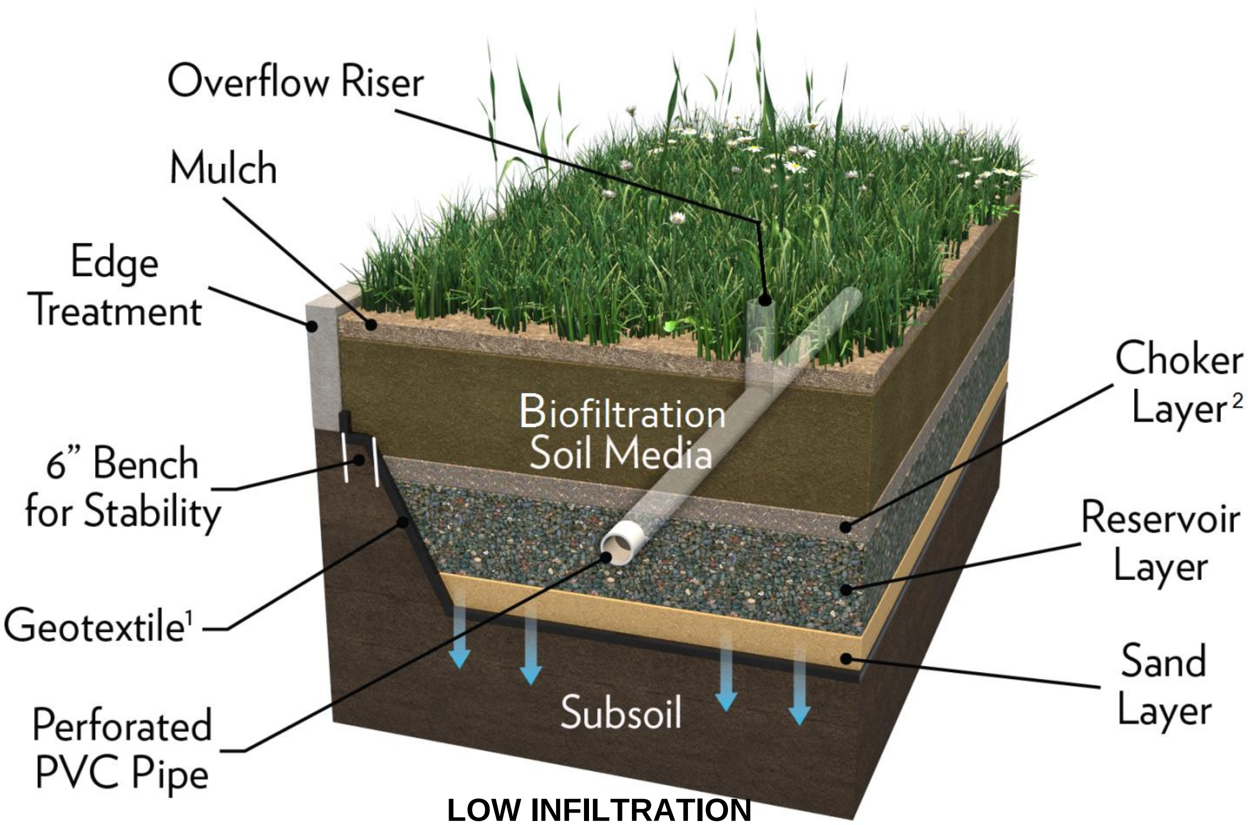


MEDIUM INFILTRATION

Notes:

1. **Geotextile per Geotechnical Engineer’s Recommendations (street side and sidewalk side).**
2. **Choker layer may be required depending the type of reservoir layer.**

LOW INFILTRATION



LOW INFILTRATION

Notes:

1. **Geotextile per Geotechnical Engineer's Recommendations (street side and sidewalk side).**
2. **Choker layer may be required depending the type of reservoir layer.**

PUTTING IT TOGETHER

- Ponding Depth: Stores runoff within the planting area prior to treatment.
- Overflow Riser: Pipe to capture high water flow.
- Mulch: A soil topping that may be organic or inorganic material which covers the planting soil to retain water and trap pollutants.
- Biofiltration Soil Media: A specific blend of soil, compost, and sand to retain and drain water and support plant growth.
- Choker Layer: Sand and gravel to prevent biofiltration soil media from migrating into the reservoir.
- Reservoir Layer: Stone to hold excess water until it infiltrates.
- Underdrain: An underdrain is required.
- Geotextile: Prevents existing soil from migrating into the biofiltration soil media and stone reservoir layer.
- Uncompacted Subgrade: Existing soil where stormwater infiltrates.

COMMON DESIGN ISSUES

Utilities: In the County, utility lines are common and necessary components of infrastructure within the right-of-way. Utility lines should be avoided where necessary and allowed to coexist where possible.

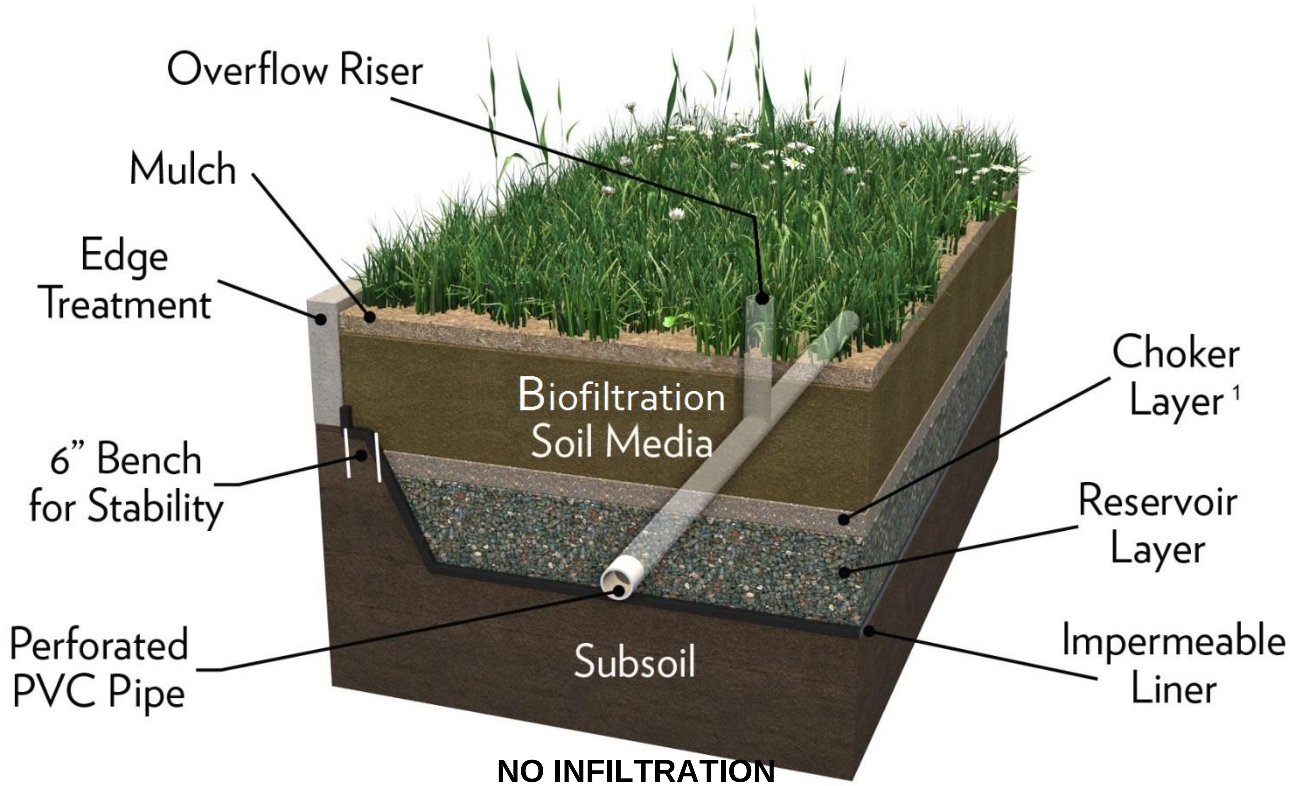
Putting it Together

- Ponding Depth: Stores runoff within the planting area prior to treatment.
- Overflow Riser: Pipe to capture high water flow.
- Mulch: A soil topping that may be organic or inorganic material which covers the planting soil to retain water and trap pollutants.
- Biofiltration Soil Media: A specific blend of soil, compost, and sand to retain and drain water and support plant growth.
- Choker Layer: Sand and gravel to prevent biofiltration soil media from migrating into the reservoir.
- Reservoir Layer: Stone to hold excess water until it enters the underdrain.
- Underdrain: An underdrain is required.
- Impermeable Liner: Prevents infiltration and prevents existing soil from migrating into the biofiltration soil media and stone reservoir layer.

Common Design Issues

Utilities: In the County, utility lines are common and necessary components of infrastructure within the right-of-way. Utility lines should be avoided where necessary and allowed to coexist where possible.

No Infiltration



NO INFILTRATION

Notes:
1. Choker layer may be required depending the type of reservoir layer.

2.4 Planting & Irrigation of Dispersion Areas, Biofiltration, Tree Wells, and Other Areas

Planting Design

Tree wells, dispersion areas, and biofiltration add a landscape amenity to the street-scape. Trees, shrubs, grasses and perennials are used to create a diverse landscape suitable for the site conditions and neighborhood. Plants should be chosen based on the level of care expected at the facility. Planting design must be done to ensure sight lines are preserved for pedestrians, cyclists, and vehicles on the street.

Existing trees are an important component of the green street. Mature trees capture stormwater, provide shade, and cool pavement. Existing trees should be protected when implementing green streets and not disturbed during construction.

Refer to the County of San Diego's Water Efficient Landscape Design Manual and Low Impact Development Handbook for suitable plant species to use in dispersion areas and biofiltration. Also refer to the community right of way development standards for suitable plants within specific communities.

Irrigation Design

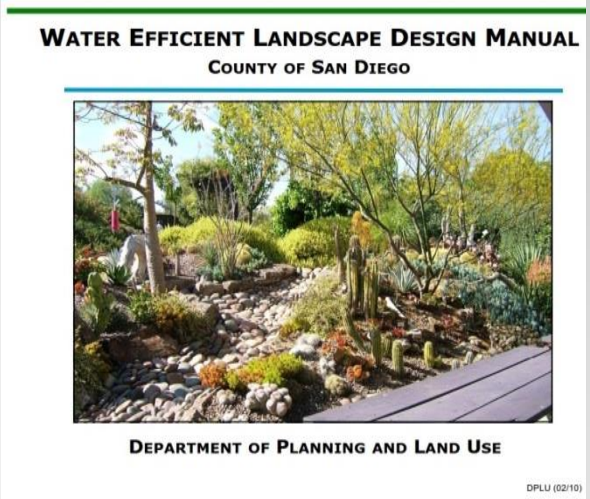
Irrigation design should comply with the County of San Diego's Water Efficient Landscape Design Manual.

Planting Zones (Hydrozones)

Grouping plants into hydrozones is an approach to irrigation and planting design where plants with similar water needs are grouped together. Ideally, each zone of the irrigation system will supply plants with the same water needs with the appropriate amount of water.

Water Conservation

State executive order B-29-15 requires mandatory statewide water restrictions. This order prohibits ornamental turf on public street medians, and requires a reduction in potable water use for irrigation. Low water use, drought tolerant, native plants should be used for Green Streets applications. The use of reclaimed water is recommended to reduce the amount of potable water used for irrigation.



2.5 Types of Permeable Pavement

What is Permeable Pavement

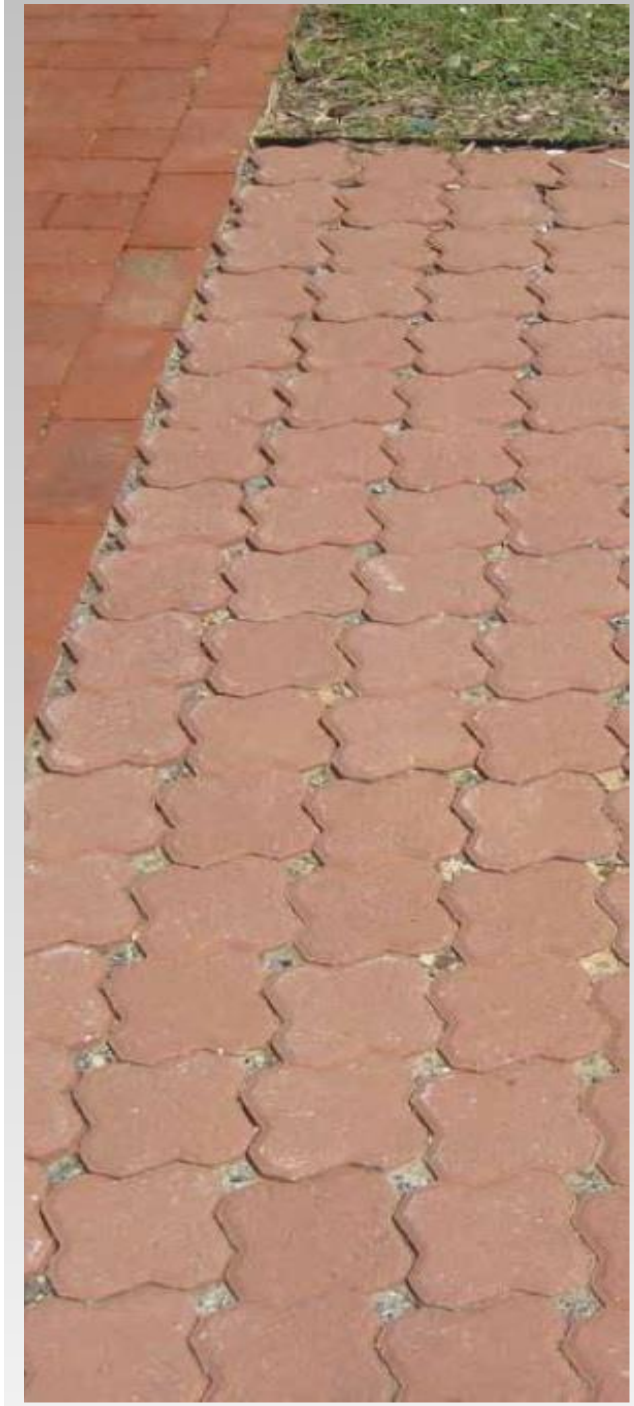
Permeable pavement is an engineered top layer and base layer that allows water to move through it. The goal is to take rainwater as it falls and quickly move it to the lower layers of the system. Stormwater is stored in an underlying stone layer until it infiltrates into the soil below, aiding in groundwater recharge, or releases slowly to the storm drain system. Pollutants are filtered through the pavement and base layers. The terms 'Permeable Concrete Pavers', 'Pervious Concrete', 'Porous Asphalt', and 'Porous Rubber' are industry standard names, but all surfaces are 'permeable' and provide sufficient openings at the surface to allow stormwater to infiltrate.

Permeable Concrete Pavers

Unlike traditional pavers, there are gaps between each paver to allow water to flow between the pavers and into the base layer.

Pervious Concrete

Sands and "fines" are reduced in the concrete mix to allow water to flow through the pavement into a stone bed and eventually the ground.



Types of Permeable Pavement (Continued)

Porous Asphalt

Porous asphalt is very similar to traditional asphalt except that the sands or "fines" are reduced in the mix so water can move through the pavement.

Porous Rubber

Made from recycled rubber and small stones, porous rubber works like pervious concrete, but can be installed over tree roots.

Decomposed Granite (DG) Pathway

Decomposed granite can be used for pathways. It can be installed and compacted to meet ADA handicapped accessibility specifications and criteria. Although highly compacted, the surface has some infiltration capacity.

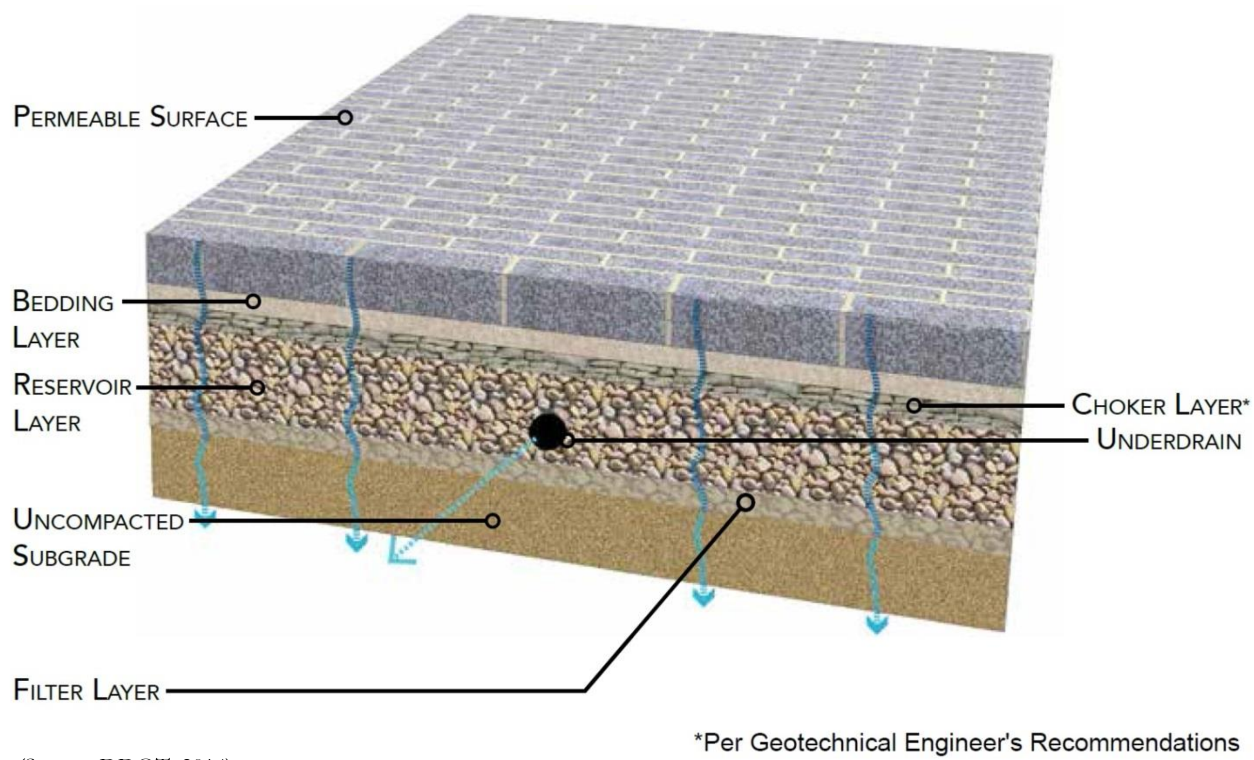
Boardwalk

Made from wood or composite, boardwalks may be used for pathways. Rain easily passes through the spaces between the boards to the earth below.

Putting it Together

- Permeable Surface: Permeable concrete pavers, pervious concrete, porous asphalt, porous rubber, DG, or boardwalk.
- Bedding Layer: Used for pavers so they can be laid flat.
- Choker Layer: A layer of small rock to prevent fine material from migrating into the reservoir layer.
- Reservoir Layer: Stone to hold excess water until it infiltrates.
- Underdrain: Conveys excess water into drainage system when the reservoir fills.
- Filter Layer/Geotextile: A layer of stone or permeable geotextile to separate the reservoir layer from the soil below and prevent migration of fines into the reservoir layer.
- Impermeable Liner: Prevents infiltration into subgrade or adjacent roadway structural section.
- Uncompacted Subgrade: Existing soil into which stormwater infiltrates.

Permeable Pavement – What's Underneath?

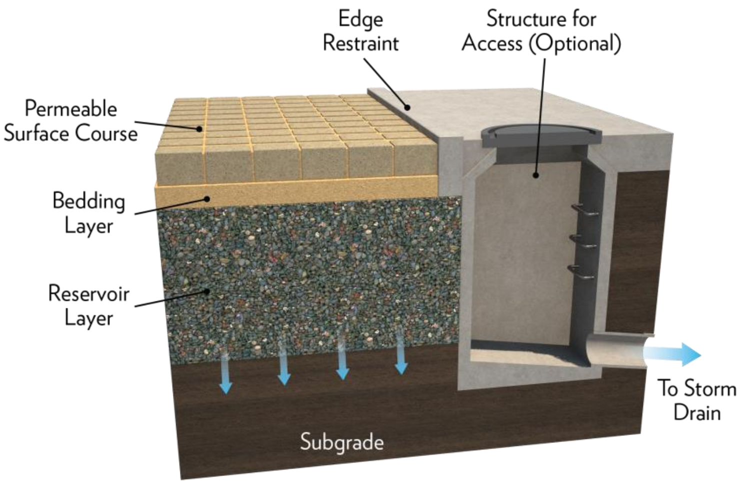


(Source: DDOT, 2014)

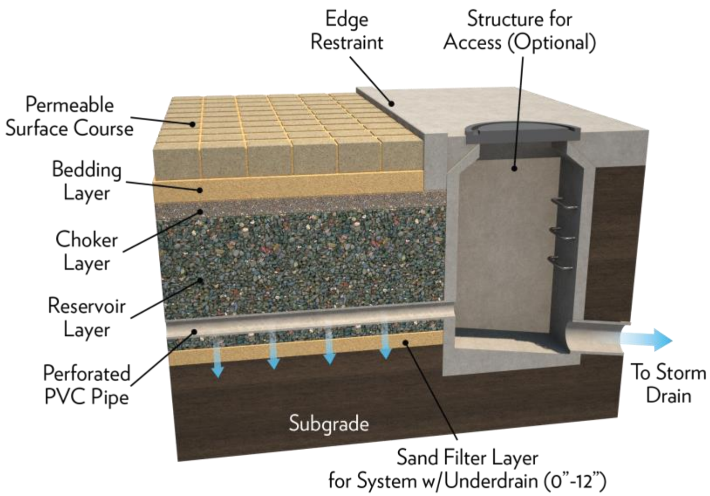
As with dispersion areas and biofiltration, there are multiple options for the subsurface components for permeable pavement including:

- Reservoir layer only with no underdrain
- Reservoir layer with underdrain (shown)
- Reservoir layer with underdrain and impermeable liner

PERMEABLE PAVEMENT SUBSURFACE DESIGN OPTIONS



Reservoir layer only with no underdrain



Reservoir layer with underdrain

WHERE TO USE?

- Pedestrian areas
- Pathways
- Parking lanes

LIMITATIONS

- Use is limited to areas curb-separated from the traveled way.
- Use in areas with little to no sediment production.

DESIGN ISSUES

<u>Soil Infiltration and Drainage:</u> Soil infiltration tests must be completed to determine if an underdrain system is required.

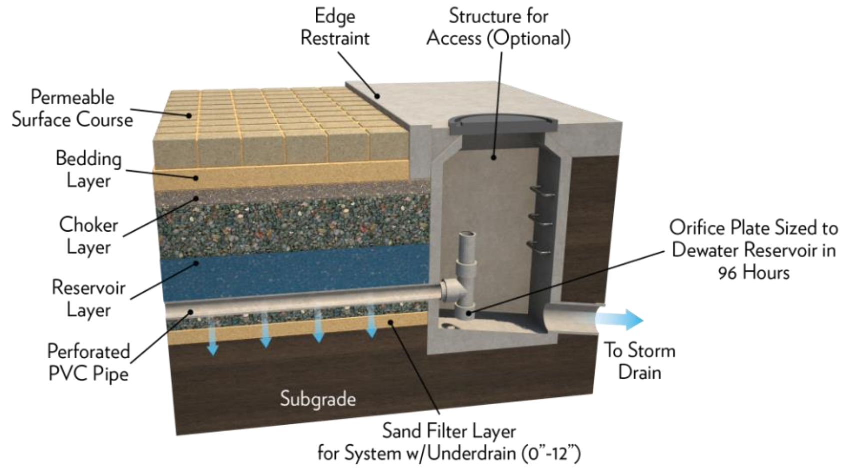
<u>Structural Section:</u> A qualified and licensed professional should complete a pavement structural analysis.

<u>Edge Restraints:</u> Provide a concrete transition strip between any permeable and impermeable surface and around the perimeter of paver installations.

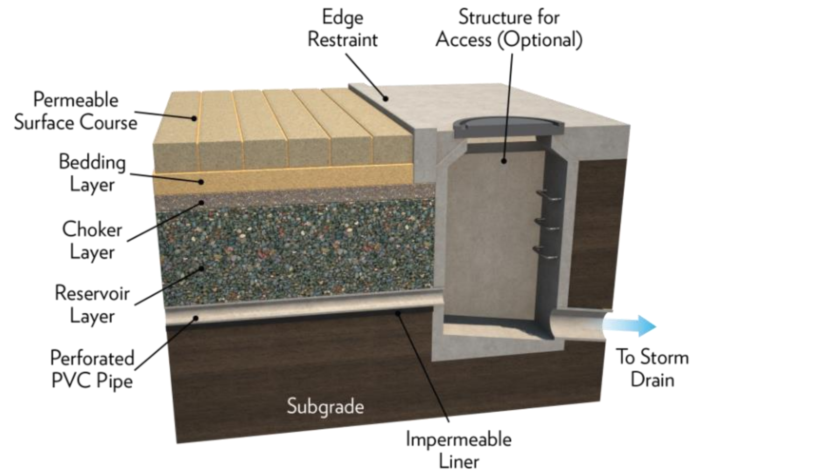
<u>Pedestrian Considerations:</u> Provide signage to indicate prohibited activities that cause premature clogging.

<u>Maintenance Access:</u> Provide adequate access for sweeping and/or vacuuming of surface.

PERMEABLE PAVEMENT SUBSURFACE DESIGN OPTIONS (CONTINUED)



Reservoir layer with upturned underdrain



Reservoir layer with underdrain and impermeable liner

CHAPTER 3 Procedures and Design Examples

3.1 Introduction

Implementing Green Infrastructure (GI) and Low Impact Development (LID) within the road right-of-way requires a number of considerations to create an amenity that is attractive while treating stormwater from the surrounding streets and sidewalks.

Implementation of Green Streets features can be approached from evaluating the opportunities within each zone of the right-of-way: median, traveled lane, bike lane, shoulder, parkway, sidewalk/pathway, slopes and drainage easements. Each zone presents different opportunities, benefits, risks and technical design factors for GI and LID implementation to enhance stormwater quality within the right-of-way.

Conducting a comprehensive inventory and assessment of site conditions is the crucial initial step for implementing GI and LID. The County LID Handbook inventory check list can be used to assist with identifying and evaluating a potential site for LID and to produce a list of opportunities and constraints.

The LID concept from the EPA of “slow it down, spread it out, and soak it in” should be at the forefront in the planning stages of project evaluating the implementation of Green Streets design practices to control runoff and enhance water quality.

The following site design principles should be evaluated and implemented to "slow it down, spread it out, and soak it in":

- Minimize the impervious footprint of the site by constructing streets and sidewalks to the minimum required widths.
- Minimize soil compaction in landscaped areas. Landscape with native or drought-tolerant species.
- Disconnect impervious surfaces by dispersing runoff from impervious surfaces to pervious areas. To be considered 'disconnected' impervious areas should be designed to drain to a pervious area at least one-half their size.
- Design and construct tree wells, dispersion areas, biofiltration, and permeable pavements to effectively receive and infiltrate or retain runoff from impervious areas before it discharges to the storm drain or exits the right of way.

When green street design principles are employed over street design techniques that utilize conventional stormwater quality treatment techniques they have the potential to significantly reduce impervious areas and provide potential project cost savings.

Conventional Design Approach

- Impervious median and parking lane
- Biofiltration and stormwater vault in parkway

Green Street Design Approach

- Permeable median and parking lane
- Tree wells and biofiltration in parkway

(Source: DDOT, 2014)

Green Street Approach

Direct stormwater runoff from impervious roadway elements to:

- Tree wells, dispersion areas, and biofiltration in the median or parkway.
- Permeable pavement surfaces located in the median or parking lane.

Construct sidewalks and trails with permeable pavement or direct runoff to adjacent landscaped area.

Constraints

In no way shall green streets LID features be designed to block sight distance for motorists from adjacent streets and driveways, create obstacles for pedestrians, impede the visibility and maintenance of traffic control devices and signs, and reduce or eliminate clear recovery area and minimum horizontal clearances from fixed objects.

3.2 Design Procedure

Qualification

Under the Municipal Separate Storm Sewer System (MS4) Permit for San Diego Region (Permit [Order No. R9-2013-0001]), the County may make Priority Development Project (PDP) Exemptions for projects redeveloping or retrofitting existing paved roads, streets, and alleys as “EPA Green Streets.” This is accomplished under an adopted Green Streets program by the County of San Diego and based in part on the EPA publication “Green Streets: Municipal Handbook, Managing Wet Weather with Green Infrastructure.”

Opportunities and Constraints

- Conduct a comprehensive inventory and assessment of site conditions.
- Evaluate each zone of the right-of-way for Green Street implementation opportunities: median, traveled lane, shoulder, parkway, sidewalk/pathway, slopes and drainage easements.
- Evaluate constraints including, but not limited to: right-of-way width, utilities, roadway geometry and slope, site distance, proximity to storm drain, maintenance access, pedestrian and vehicle safety, bike and parking lanes, etc.

Design Capture Volume/Flow Rate

- For volume based features () use the 24-hour, 85th percentile volume. For flow based features (swales) utilize the 24-hour, 85th percentile rainfall intensity (use CASQA method within Caltrans Basin Sizer).

Treatment Train

- Utilize a treatment train approach that connects and combines features to maximize water quality treatment within the Green Street. An example Green Street treatment train approach is provided in Section 3.6.

Documentation

- Document the design criteria, methodology, drainage areas/treatment areas, calculated volumes/flows, BMP selection, and maintenance requirements in the project Stormwater Management Plan and/or Drainage Report.

3.3 MEDIANS

The median presents an opportunity to implement green streets principles by use of Tree wells, biofiltration, or permeable pavements. The graphics below illustrate various green streets design concepts that can be utilized within the median.

Roadway before Green Streets

Roadway with depressed median and bulb out planter at intersection

Conventional raised median curb, impermeable surfacing and trees

Green street depressed median with curb cuts and planter/swale

DESIGN ELEMENTS

- <u>Raised median:</u>
  - Plant low water use/drought tolerant trees and landscaping.
  - Install permeable pavement.
- <u>Depressed median:</u> Utilize roadway cross slope to direct stormwater runoff from impervious roadway elements to:
  - Tree wells
  - Planter boxes
  - Vegetated swale

DESIGN CONSIDERATIONS

- Vehicle safety
- Median width and length
- Roadway longitudinal and cross slope
- Structural integrity of adjacent traveled way (design to prevent subsurface infiltration or ponding under traveled way)
- Underdrain and overflow devices
- Proximity of storm drain
- Maintenance access
- 'Mid-block' pedestrian crossing potential

Design Elements

- Raised section:
  - Plant low water use/drought tolerant trees and landscaping.
  - Install permeable pavement.
- Depressed section: Utilize roadway cross slope to direct stormwater runoff from impervious roadway elements to:
  - Tree wells
  - Planter boxes
  - Vegetated swale

Design Considerations

- Roadway geometrics
- Structural integrity of adjacent traveled way to prevent subsurface infiltration or ponding under traveled way
- Underdrain and overflow devices
- Proximity of storm drain
- Maintenance access

3.4 Intersections

Roundabouts

The design elements and design considerations for roundabouts are similar to medians.

Aerial view of rural intersection before roundabout

Aerial view of constructed roundabout with permeable pavement and biofiltration with connection to storm drain

Closeup view of same roundabout

Street view of same roundabout

BULB-OUT AT INTERSECTION

The design elements and design considerations for bulb-outs are similar to curb extensions. Bulb-outs provide traffic calming at intersections, increase pedestrian visibility, and decrease cross-walk lengths. Bulb-outs at intersections prevent motorists from parking too close to a cross-walk or from blocking a curb ramp. Motor vehicles parked too close to corners present a safety concern, since they block sight lines, obscure visibility of pedestrians and other vehicles, and make turning difficult for emergency vehicles and trucks. Bulb-outs are only appropriate where there is an on-street parking lane or shoulder and must not extend into bike lanes or travel lanes. The turning requirements of larger vehicles such as fire trucks and school buses require consideration in design.

Bulb-out planter box at intersection

Bulb-out at intersection

DESIGN ELEMENTS

- Raised section:
  - Plant low water use/drought tolerant Tree wells and landscaping
  - Install permeable pavement.

- Depressed section: Utilize roadway cross slope to direct stormwater runoff from impervious roadway elements to:
  - Tree wells
  - Planter boxes
  - Vegetated swale

DESIGN CONSIDERATIONS

- Appropriate only where there is on-street parking or shoulder
- Roadway geometrics
- Structural integrity of adjacent traveled way to prevent subsurface infiltration or ponding under traveled way
- Underdrain and overflow devices
- Proximity of storm drain
- Maintenance access
- Turning requirements for large vehicles
- Bike lanes

Design Elements

- Traveled Way and Bike Lane:
  - Design lane widths to minimum allowable.
- Shoulder/Parking Lane:
  - Utilize permeable pavement with edge restraint at interface with traveled way

Design Considerations

- Permeable pavement not acceptable in traveled way, bike lane, and parkway
- Structural section design to handle vehicle loading
- Shoulder utilization (with or without parking, temporary use during lane closures)
- Roadway geometrics
- Hydrologic design requirements (stone reservoir depth and underdrain requirements)
- Design to maintain structural integrity of adjacent traveled way with edge restraints and prevention of infiltration beneath traveled way section
- Interrupt permeable pavement at intersections
- Surrounding land use and sediment sources
- Long term maintenance
- Pedestrian safety
- Maintenance access

3.5 Traveled Way, Bike Lane, and Shoulder Permeable Pavement

The use of permeable pavements within the traveled way and bike lanes of County maintained roads is not currently permitted. However, their use may be considered for low volume driving lanes in parking lots, private streets, alleys, and fire access roads. The use of permeable pavement in the shoulder/parking lane should be evaluated based upon the following design considerations listed to the left.

Conventional street with bike lane and shoulder

Green street with permeable pavement in parking lane

Curb Extensions

Curb extensions reduce overall street dimensions and provide traffic calming. Among other benefits, curb extensions provide added space for biofiltration.

Curb extensions shall never encroach upon the traveled way or bike lanes. When existing tree roots are damaging adjacent curb, gutter, or pavement curb extensions provide an excellent opportunity to preserve the tree and provide green infrastructure.

Careful survey of street parking impacts should be considered when locating curb extensions.

Curb extension with planter box

Curb extenstion with planter box

Design Elements

- Low water use/drought tolerant trees and landscaping
- Permeable pavement
- Planter boxes

Design Considerations

- Roadway geometrics
- Structural integrity of adjacent traveled way to prevent subsurface infiltration or ponding under traveled way
- Underdrain and overflow devices
- Sight distance at intersection
- Proximity of storm drain
- Utility conflicts
- Pedestrian mobility aspects
- Maintenance access
- Parking requirements

Parkway Design Elements

- <u>Landscape area:</u>
  - Tree wells
  - Planter boxes
  - Curb extensions
  - Bulb outs at intersections
  - Swales
- <u>Sidewalk or trail:</u>
  - Drain to adjacent landscaping
  - Drain to green street LID practice
  - Permeable pavement
- <u>Other areas:</u>
  - Filter Strip
  - Dispersion Area

3.6 Parkway

The parkway including the tree space, planting strip, sidewalk, pathway, and other areas has numerous opportunities for Green Street implementation.

Tree Wells

Existing Road

Conceptual desgin with Tree wells, and permeable sidewalk

Existing Road

Reconstructed Road with Trees and planter boxes

PLANTER BOXES

Before and After Concept

Road retrofit with planter boxes and trees

Planter Box with step out zone

Planter box with step out zone

PARKWAY DESIGN CONSIDERATIONS

- Roadway classification and parkway width
- Location (urban or rural setting)
- Tree type and spacing requirements
- Sidewalk or trail width requirements
- Streetside parking requirements
- Roadway and parkway horizontal and vertical geometrics (curves and longitudinal slope)
- Pedestrian mobility and safety
- Maintenance access
- Interface with driveways
- Utilities and appurtenant structure locations
- Hydrologic design requirements
- Proximity of storm drain systems
- Structural integrity of adjacent traveled way (utilize edge restraints and prevent infiltration beneath roadway section)
- Low water use/drought tolerant Trees and landscaping

Design Elements

- Low water use/drought tolerant landscaping
- Rock
- Curb cuts and outlet design
- Energy dissipation
- Check dams

Design Considerations

- Roadway geometrics
- Structural integrity of adjacent traveled way to prevent subsurface infiltration or ponding under traveled way
- Underdrain and overflow devices
- Proximity of storm drain
- Pedestrian mobility aspects
- Maintenance access

Swales

Swale adjacent to road

Rock swale adjacent to road

Rock swale adjacent to road

Swale adjacent to road

Sidewalks and Pathways

Permeable pavement sidewalk with biofiltration planter in curb extension

DG pathway with rock swale

Pervious concrete sidewalk

Porous asphalt pathway

Design Elements

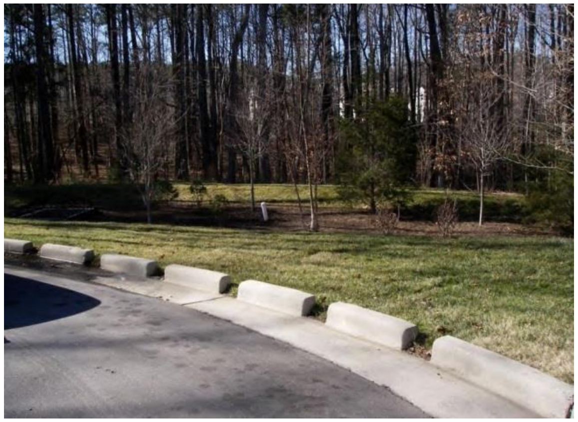
a. Drain to adjacent landscaping or adjacent LID facility
b. Permeable pavement

Design Considerations

- Sidewalk width and ADA requirements
- Public safety
- Pedestrian mobility aspects
- Maintenance access

Other Parkway Areas

Swale outside of sidewalk and road



Curb cuts with filter strip

Dispersion Area

Rock swale

Design Elements

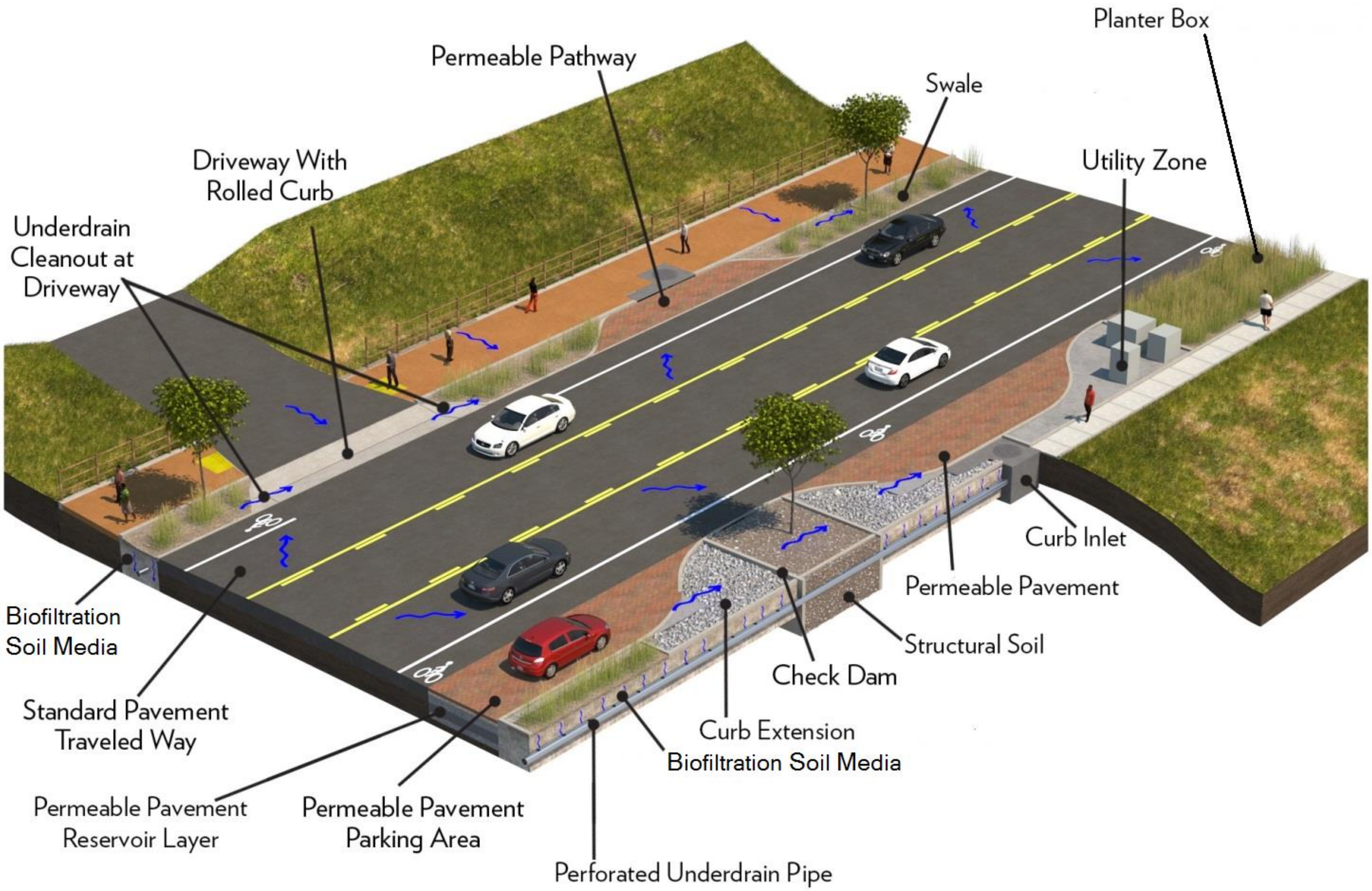
- Low water use/drought tolerant landscaping
- Swales
- Dispersion areas
- Vegetated filter strips

Design Considerations

- Available space
- Vehicle and public safety
- Structural integrity of adjacent traveled way to prevent subsurface infiltration or ponding under traveled way
- Underdrain and overflow devices
- Proximity of storm drain
- Maintenance access

3.7 PUTTING IT ALL TOGETHER

This graphic shows a treatment train concept as an example of how several different techniques may be combined for Green Street implementation.



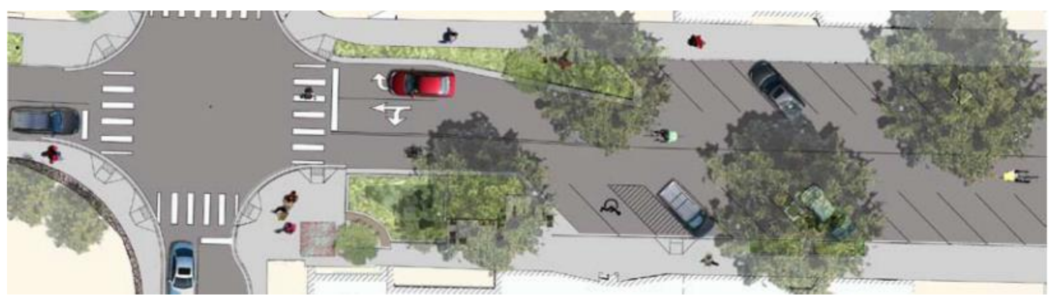
CHAPTER 4 Implementing Green Streets

4.1 Design and Construction

The goal of the County of San Diego (the County) Low Impact Development (LID) Program is to protect stormwater quality by preserving and simulating natural hydrologic functions through the use of stormwater planning and management techniques on a project site. Both public and private projects constructing in the ROW are required to retain stormwater to the maximum extent practicable. Designers must examine all uses of public space and place stormwater management where space and use allows.

DPW is installing green infrastructure as part of regulated construction projects and retrofit projects to reduce stormwater runoff in more areas of the County. Green Street projects utilize green infrastructure techniques and may be constructed independently to improve watershed health, or as a part of other infrastructure improvement projects.

These Green Street Guidelines are a planning tool intended to assist project engineers with identifying and selecting suitable Best Management Practices (BMPs) for their respective Green Infrastructure projects. Technical standards, including drawings, specifications, maintenance schedule, and plant list, can be found in the Green Street Standards document.



4.2 MAINTENANCE

Implementing green infrastructure and Low Impact Development (LID) practices requires maintenance to keep them attractive and functioning. Maintenance levels of care should be considered during the design phase and plants selected from the Green Streets Plant List according to the following levels:

- Low level of care: Annual maintenance; no irrigation
- Medium level of care: Quarterly maintenance; some water available
- High level of care: Monthly maintenance; site is potentially irrigated

San Diego County DPW is typically responsible for maintaining publicly-installed green infrastructure and LID facilities within their right-of-way. The final determination of maintenance responsibility is determined during project review. Private installations must have a maintenance covenant from the owner. Residents can help with maintenance by removing trash and weeds. Refer to the Green Streets Maintenance Schedule for frequency and detail of maintenance.

Type of Maintenance	Dispersion Areas and Biofiltration	Permeable Pavement	Tree Space
Inspect after storms	•	•	
Remove trash/sediment/leaves	•	•	•
Clean inlets/outlets	•		
Adjust mulch and/or stone	•		
Water for establishment	•		•
Weed/remove invasive species	•		•
Prune (as needed)	•		•
Replace mulch (3” depth)	•		•
Street sweeper/vacuum (as needed)		•	

4.3 FUNDING

Funding mechanisms for Green Streets maintenance may include:

- Community Service Districts
- Home Owner’s Associations or other private sources

References

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K.3 Green Parking Lots

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K.3.1 Green Parking Lots Guidelines

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Green Parking Lots Guidelines

A Guide to Green Parking Lots
Implementation in the County of San Diego

January 2019

What is a Green Parking Lot?

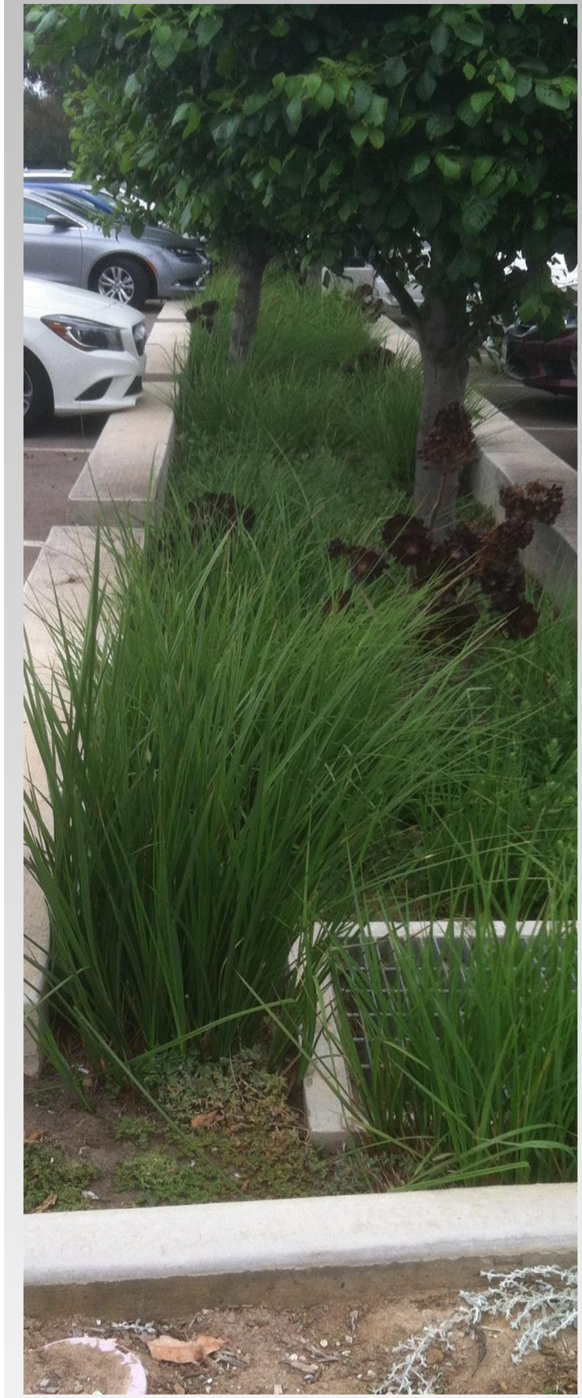
Pavement on parking lots can contribute to excess stormwater runoff and increased levels of pollutants in the County's waterways. Green infrastructure reduces stormwater runoff and improves water quality. Green Parking Lots incorporate a wide variety of Green Infrastructure design elements including, but not limited to: trees, dispersion areas and biofiltration, and permeable pavement. The use of Green Parking Lots offers the capability of transforming a significant stormwater and pollutant source into an innovative treatment system.

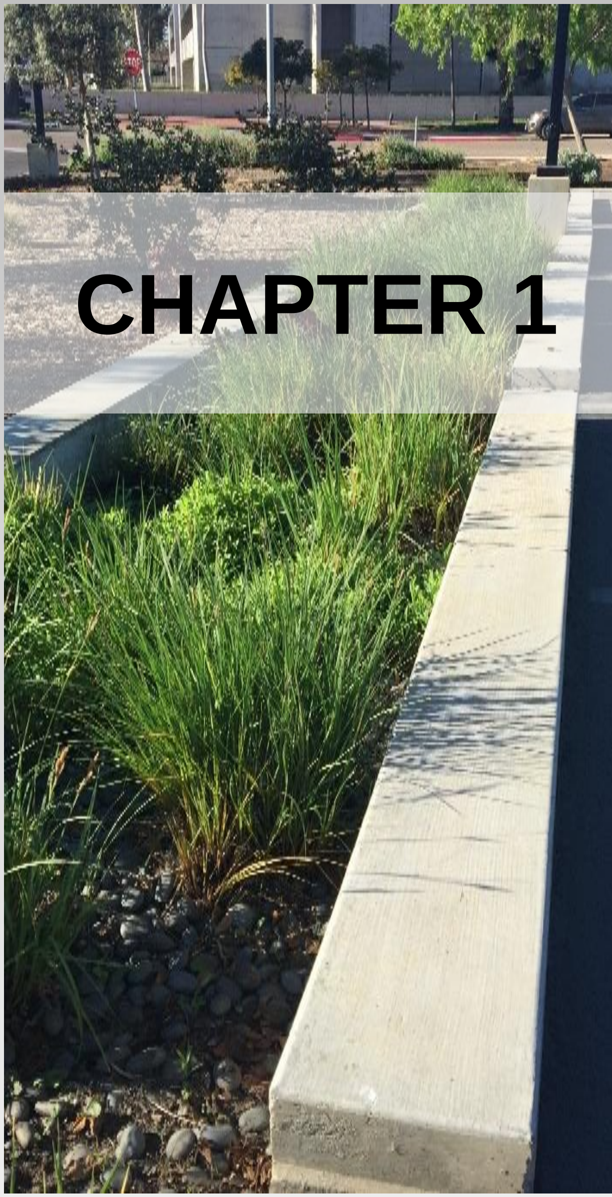
On April 1st, 2015 Governor Brown signed executive order B-29-15 setting the first mandatory statewide water restrictions. This order prohibits ornamental turf on public street medians, and requires a reduction in potable water use for irrigation. Green Parking Lots promote water conservation through the use of low water use and drought tolerant plants (xeriscape) and improving groundwater supplies through infiltration.

Green infrastructure, unlike traditional "gray" infrastructure approaches to stormwater management, provides multiple benefits to communities. Planting more trees and landscaping in public spaces cleans the air, cools the land, provides more habitat for wildlife, adds green maintenance jobs, increases property values and promotes a better, healthier quality of life for County residents and visitors.

This guide is to be used along with the County's Green Parking Lots Standards. These Green Parking Lots measures, when implemented, will ensure the County remains a green community for many years to come.

Table of Contents





CHAPTER 1 Introduction to Parking Lots

1.1 Introduction

These guidelines have been prepared to assist in the design and construction of parking lots projects for new or redeveloped parking lots. These Guidelines may also be used to assist in the design and construction of new or retrofit paved sidewalks, bicycle lanes, or trails.

The functional goals of these guidelines are to:

- Provide source control of stormwater;
- Limit stormwater transport and pollutant conveyance to the collection system;
- Restore predevelopment hydrology to the extent possible by slowing the runoff down and allowing for infiltration; and
- Provide environmentally enhanced parking lots.

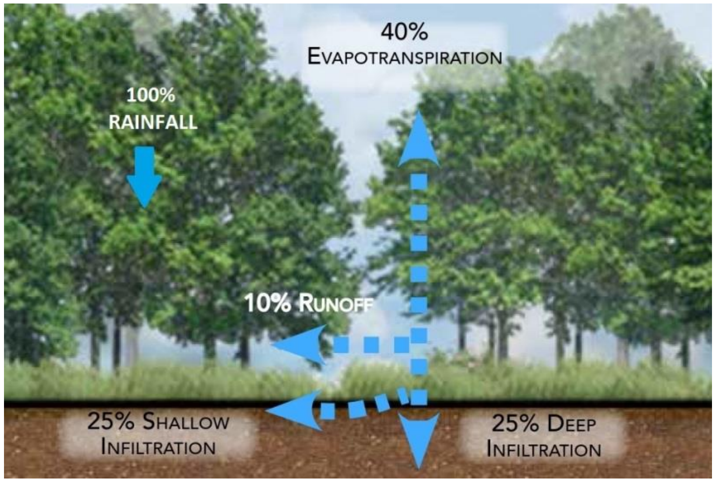
A review of existing County policies has been performed and included in the accompanying Green Parking Lots Standards document that includes an addendum to the 2016 County of San Diego BMP Design Manual. The Green Parking Lots Standards publications include an addendum to the 2016 County of San Diego BMP Design Manual. The intent is to utilize the current standard drawings with suggested modifications where appropriate.

Green Parking Lot configurations and locations presented in this guideline are schematic/conceptual in nature. The configurations (or locations) could be modified as long as the design and construction details are in conformance with the Green Parking Lots technical documents (i.e. – Green Parking Lots Supplement to the BMP Design Manual, Standard Drawings, Specifications, and Maintenance Schedule).

1.2 The Natural and Developed Environment

Natural Areas

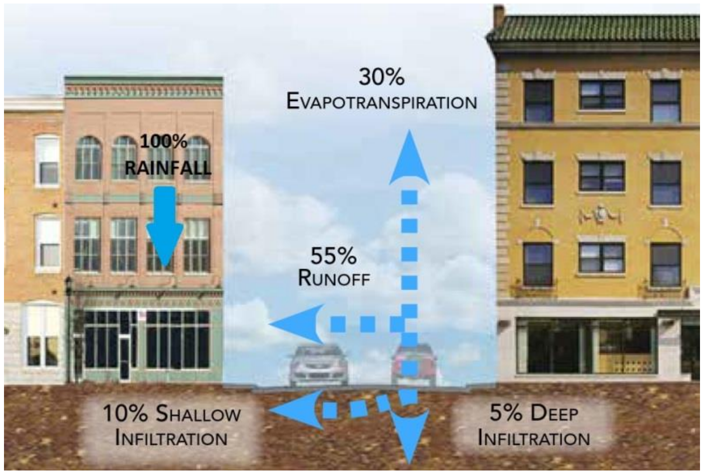
In areas such as meadows, thickets, woodlands, and parks, rain can soak into the ground and be used by plants. Trees and shrubs intercept rainfall and it slowly trickles down to the ground where it is absorbed by mulch and humus soil. Shaded areas are cooler, moister and provide wildlife habitat. Very little rainwater runs off the ground.



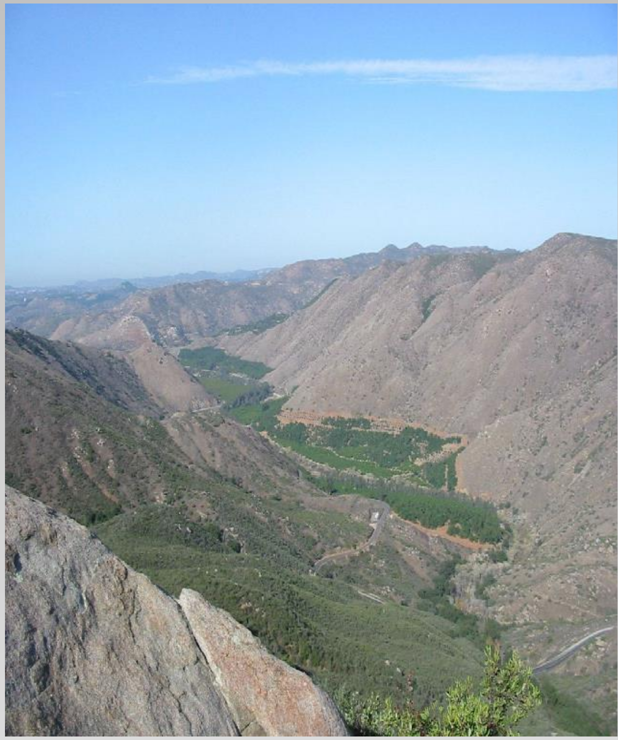
Natural Area Diagram
(Source: DDOT, 2014)

Urban Areas

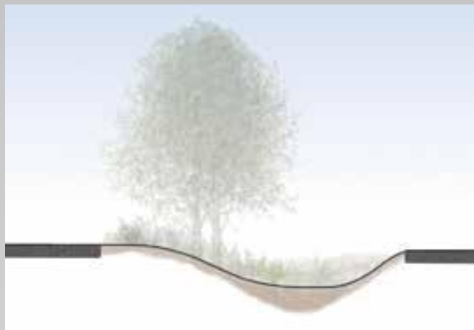
In urban areas, building rooftops, streets, alleys, sidewalks, and other paved surfaces are smooth and mostly impervious. Very little rain has a chance to soak into the ground. These paved urban areas are hotter and offer very little wildlife habitat. Most of the rain that falls in the urban areas quickly runs off impervious surfaces picking up pollutants and carrying them into storm drains. These flows quickly combine to create flash floods that degrade downstream waterways.



Urban Area Diagram

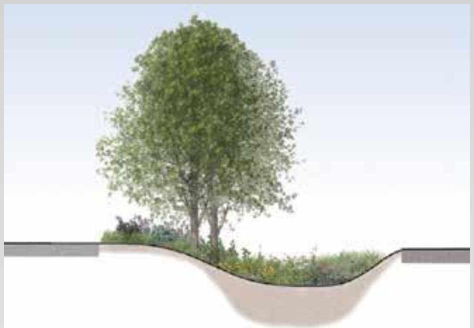


STORMWATER
CAPTURE



Runoff from impervious surfacing

STORE



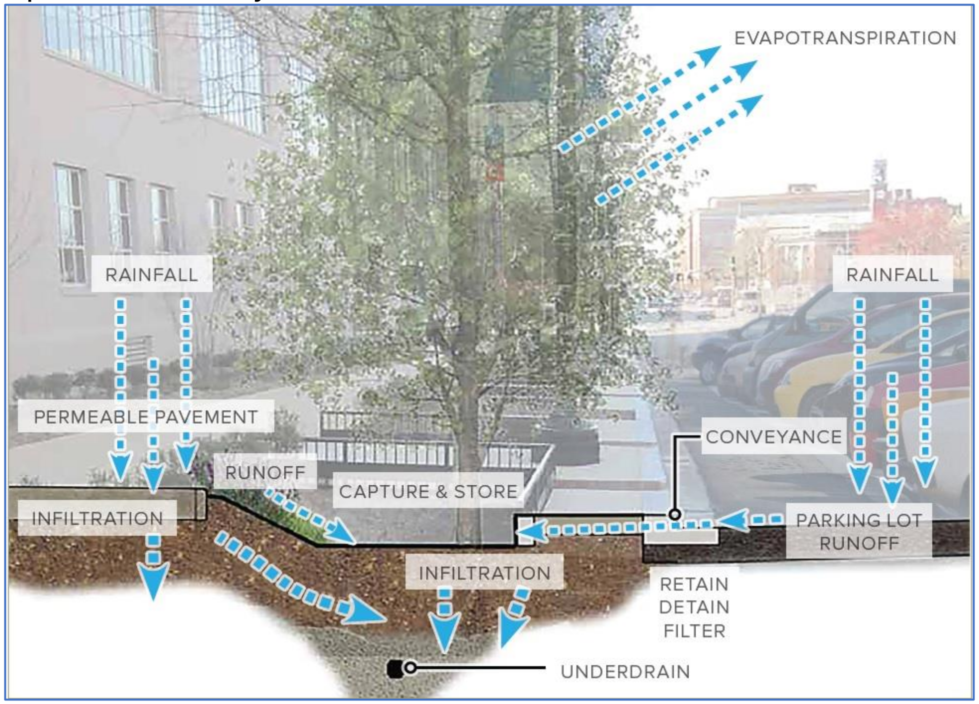
Store and retain captured runoff

INFILTRATE/EVAPOTRANSPIRE

Water is infiltrated into the ground, evapotranspired by plants or drained

1.3 GREENING PARKING LOTS

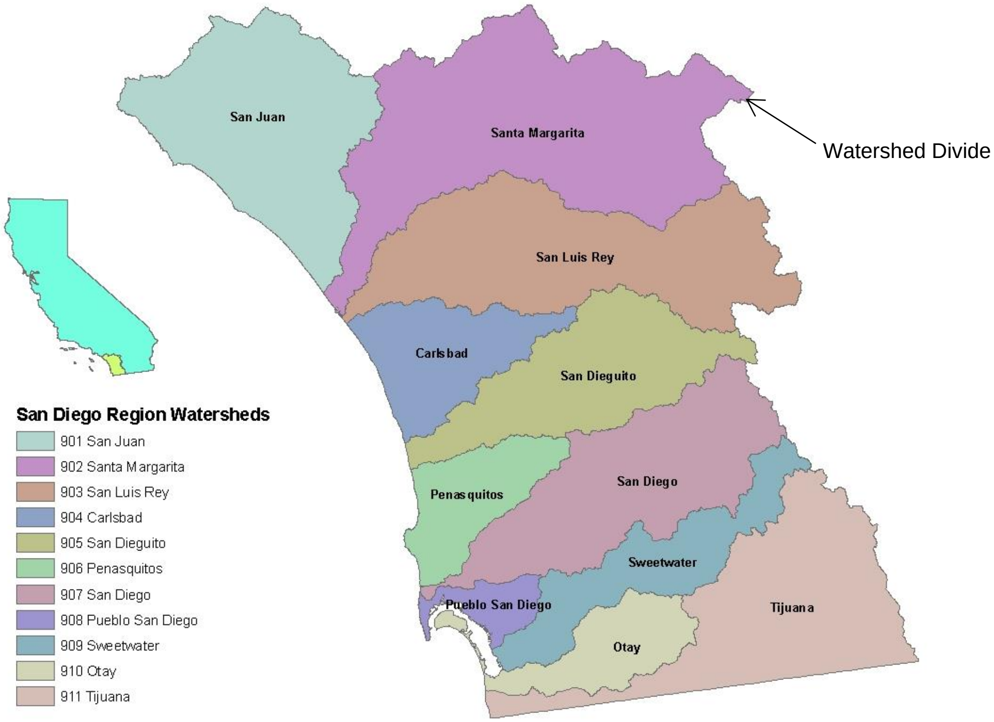
A Green Parking Lot includes Green Infrastructure (GI), incorporating elements found in natural areas into a parking lot area. GI is the living network that connects impervious areas to landscape areas, natural areas, and waterways. GI captures rainfall; cools buildings and pavement; and creates natural pathways for wildlife. GI includes Low Impact Development (LID) techniques, which mimic nature to capture and treat stormwater as close to the source as possible. When implemented, GI creates living green parking lots that capture, store, and infiltrate stormwater to treat it as a resource and improve the County environment.



Stormwater Diagram
(Source: DDOT, 2014)

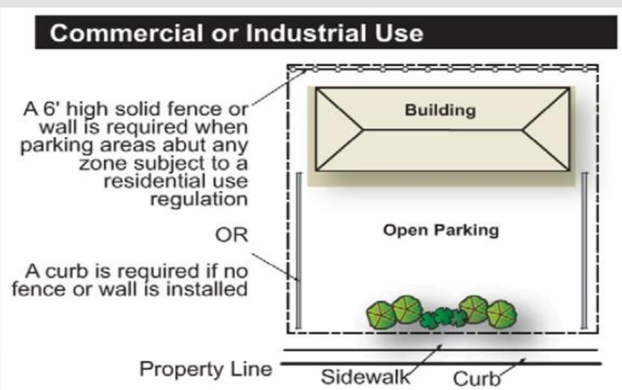
1.4 THE COUNTY ENVIRONMENT

The County of San Diego is a unique environment made up of natural, rural, and urban areas. When rain falls in the County and becomes stormwater runoff, it flows through eleven major watersheds. Stormwater carries the pollutants, trash, and warmer temperatures it collects from roads, buildings, and other impervious surfaces and delivers them into our rivers, streams, bays, lagoons, and ocean. Urbanization and other land use changes in the County can modify the natural watershed hydrologic processes and stormwater runoff characteristics resulting in increased stormwater runoff and erosion.



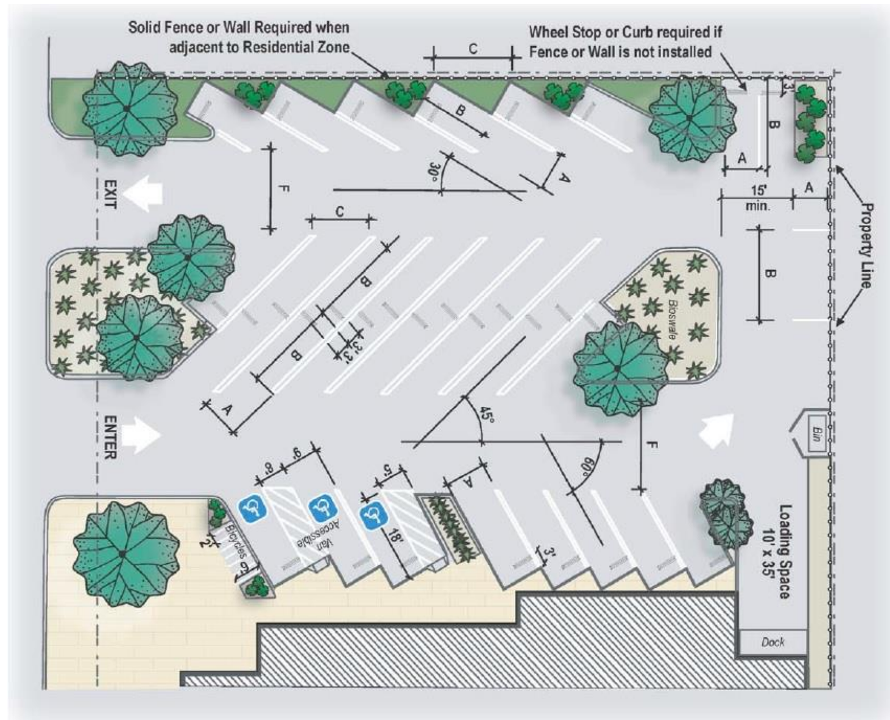
(Source: DDOT, 2014)

PARKING LOTS



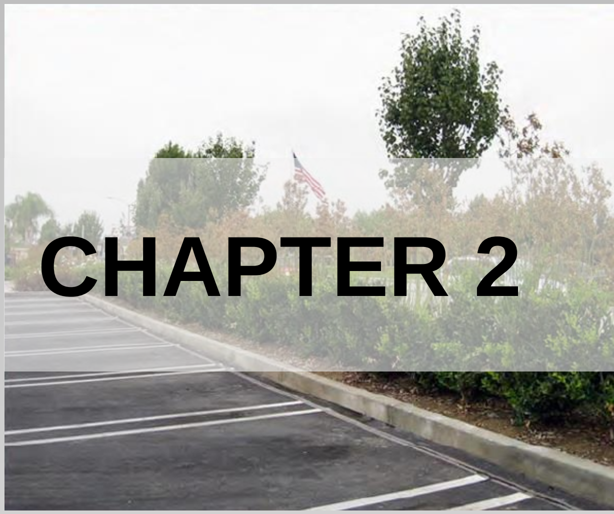
(Source: County of San Diego Parking Design Manual)

Land within parking lots present a significant opportunity to reduce runoff and improve the urban environment through Green Infrastructure. This manual introduces techniques to install green infrastructure in areas within and around parking lots. This guide includes supplements to the BMP Design Manual, Standard Drawings, and specifications, and should be used to the maximum extent practicable for all public and private project design of parking lots.



CONCEPTUAL PARKING LOT DIAGRAM
(Source: County of San Diego, Parking Design Manual)

Early in the planning and design process careful consideration should be given to the location of existing and proposed utilities and appurtenances in the parking lot and their interaction with the proposed green parking lot measures.



CHAPTER 2 Green Parking Lots Strategies

2.1 INTRODUCTION

Green Parking Lots, including Green Infrastructure (GI), and Low Impact Development (LID) solutions are intended to be sustainable, attractive, and cost effective. The range of opportunities includes trees, landscape areas, dispersion areas, biofiltration, and permeable pavement. These strategies use natural processes to reduce the volume of runoff, peak flow, and pollutants. This chapter will focus on four (4) areas appropriate for use in the road right-of-way.

TREES

Trees are a powerful tool due to their ability to intercept water on leaves, slowly deliver it to the mulch and soil, absorb it through root systems, and transpire it as water vapor directly back to the atmosphere.

DISPERSION AREAS

Dispersion areas disconnect impervious areas from directly running to the storm drain system. Dispersion areas use the natural functions of plants, mulch, and soils to remove pollutants and slow stormwater runoff. The strategy uses storage, sediment capture, and biological processes to clean the water. These mimic processes that occur in nature before water reaches waterways.

BIOFILTRATION

Biofiltration facilities are vegetated surface water systems that filter water through vegetation, and soil or biofiltration soil media prior to discharge to the storm drain system. They also utilize shallow depressions to provide storage and evapotranspiration.

PERMEABLE PAVEMENT

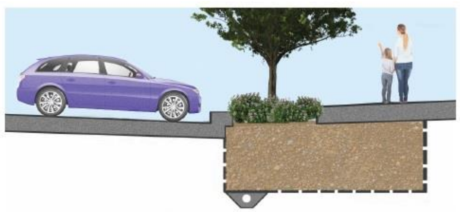
Permeable paving systems provide a hard surface, while allowing water to flow through to the underlying soils instead of directly to the drainage system. The areas where this strategy may be used include: sidewalks, pathways, medians, and parking lanes.

2.2 Trees

Why Are Trees Important?

Trees make a parking lot feel welcoming, help manage stormwater, and reduce the urban heat island effect by providing shade. An urban heat island remains significantly warmer than the surrounding rural areas due to less vegetation. Trees promote air quality, natural habitat, the human environment, and well-being.

Trees in parking lots are sometimes confined to small planting areas where they struggle to reach a mature size or live a long life. Through the use of Structural Soil, Structural Cell, or Suspended Sidewalk techniques, soil volumes and space for tree roots to grow uninhibited can be greatly increased. These techniques also allow for more water and air to reach the tree roots.

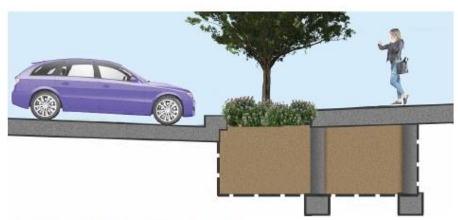


STRUCTURAL SOILS

A specific mix of stone and soil that supports the sidewalk while allowing tree roots to grow normally.

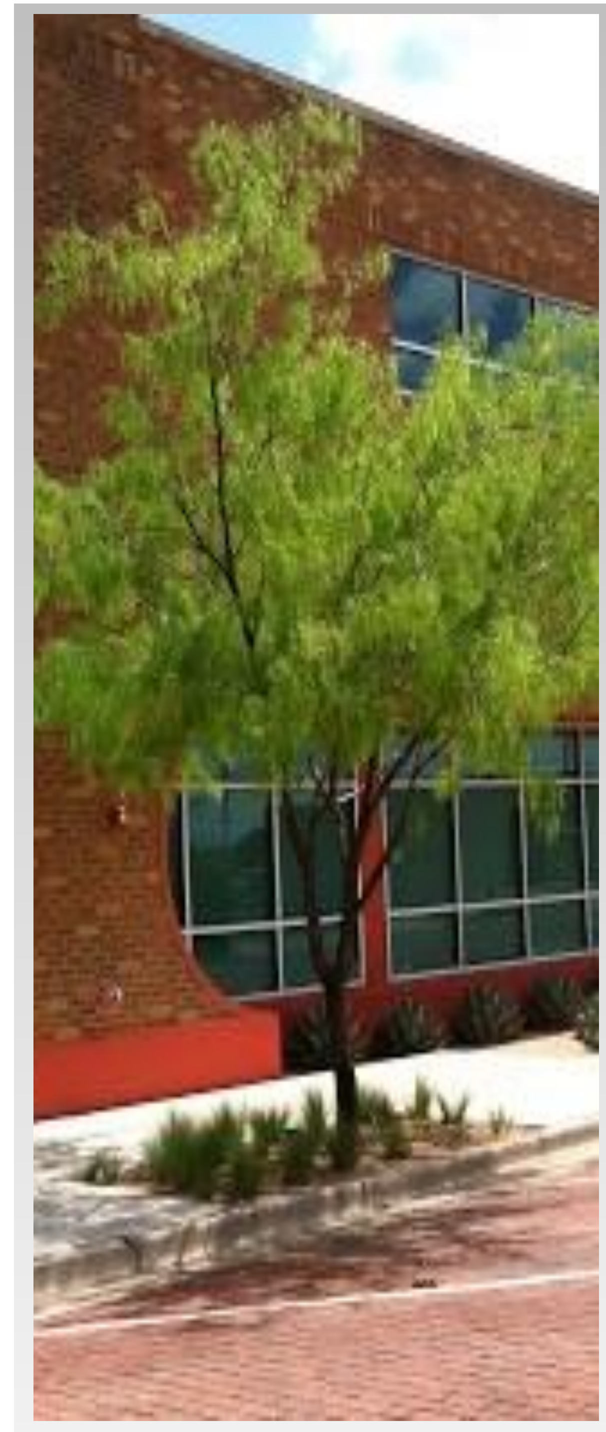
STRUCTURAL CELLS

Manufactured cells support the sidewalk allowing uncompacted soil to promote tree roots to grow below.



SUSPENDED SIDEWALK

Thickened sidewalk with reinforcement and/or footings can be used allowing tree roots to grow below the sidewalk.



Soil Volume Sizing

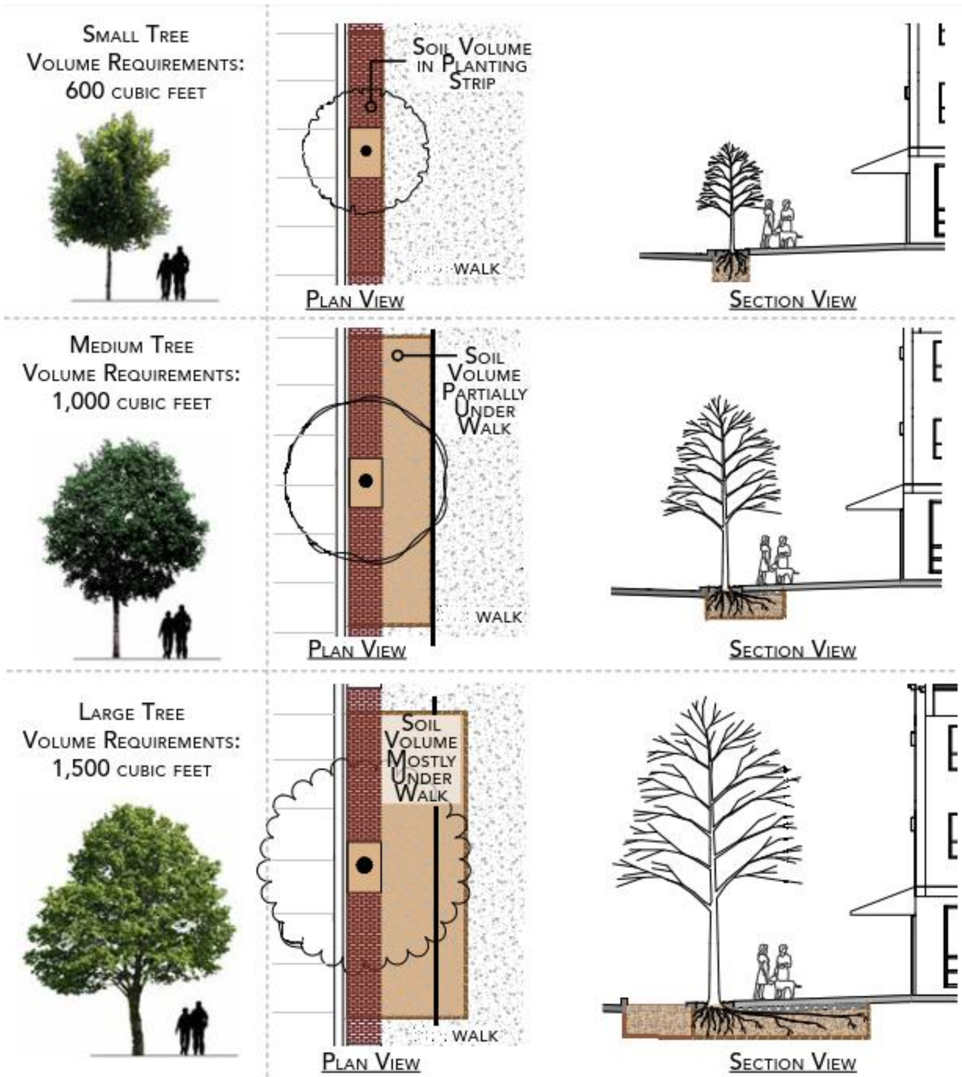
- Adequate soil space provides the nutrients, water, air, and root space that trees need to have a long, healthy life.
- The soil volume required depends on the fully-grown tree size (generally two cubic feet of soil per one square foot of the tree's mature drip line area).
- Soil for trees should be three-feet deep; the length and width must ensure the appropriate volume for the tree species and site.

Other Considerations

- Provide as much open space as possible for the tree to allow the tree to grow and access water.
- Providing structural soils, suspended sidewalks, or structural slabs to edges of paved areas encourages tree roots to extend further and into adjacent green areas.
- Evaluate temporary and permanent irrigation needs
- Evaluate utility locations and required clearance.

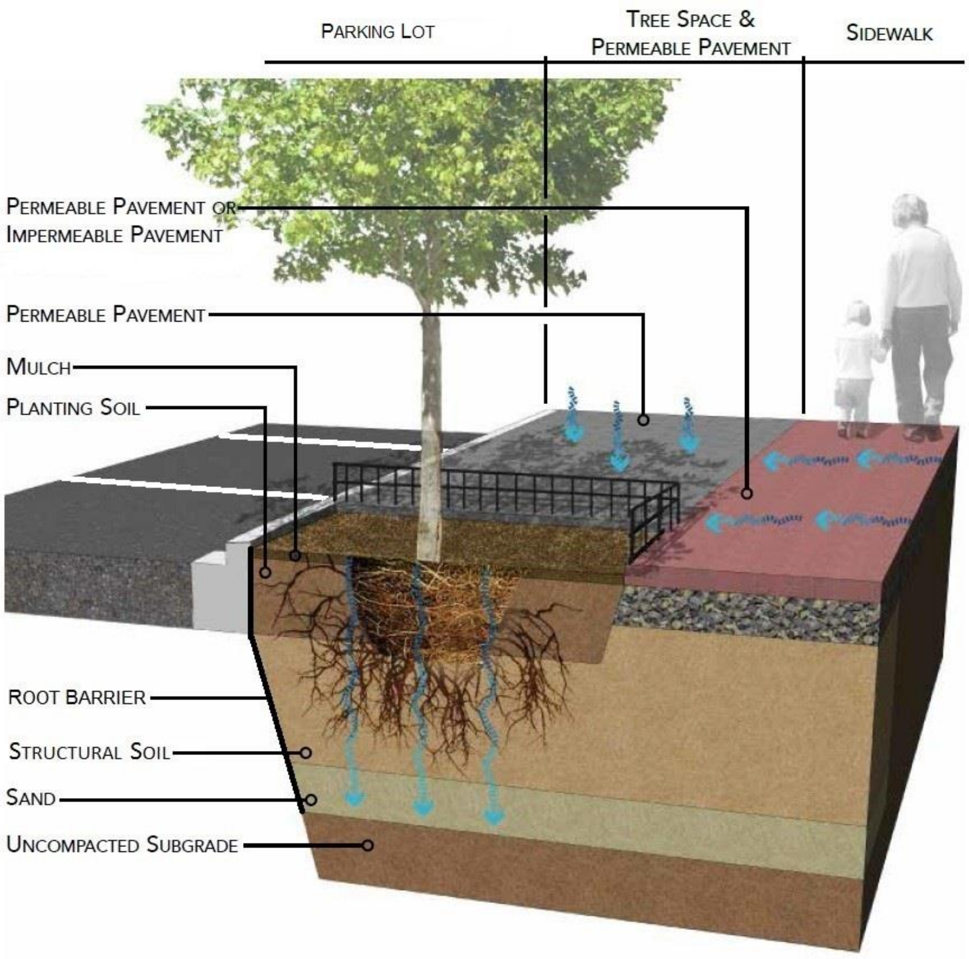
Design Issues

- <u>Maintenance Access:</u> allow for maintenance access
- <u>Pedestrian Considerations:</u> allow for 18-inch minimum setback from curb. Comply with ADA requirements.
- <u>Suspended sidewalks and structural slabs/cells:</u> may require evaluation by geotechnical and structural engineers
- <u>Tree Size:</u> Evaluate tree size versus the required parking lot dimensions.
- <u>Tree Location:</u> Refer to Parking Design Manual for minimum numbers of trees and guidance on tree location.



(Source: DDOT, 2014)

TREES – WHAT'S UNDERNEATH?



(Source: DDOT, 2014)

Note: Other options include suspended sidewalks and structural cells as shown on page 7.

PUTTING IT TOGETHER

- Permeable Paver: Permeable pavers allow water to infiltrate into the soil to be used by the trees.
- Mulch: Shredded hardwood layer to retain water and trap pollutants.
- Planting Soil: Uncompacted soil mix allows root growth when used in open areas, with structural cells, or suspended sidewalks.
- Structural Soil: Supports pavement and allows root growth.
- Sand: Acts as a drainage layer for excess stormwater (when needed).
- Uncompacted Subgrade: Existing soil where stormwater may infiltrate.

WATER TREES WITH STORMWATER

In addition to large soil volumes, trees need sufficient water, air, and nutrients to be successful in the road right-of-way environment. Tree space design includes integrating opportunities for directing stormwater into the soil. See Water Efficient Landscape Design Manual for irrigation requirements.

2.3 Types of Dispersion Areas and Biofiltration

What Are Dispersion Areas and Biofiltration?

Dispersion Areas and Biofiltration are landscape systems that filter pollutants and sediment from runoff. The layers of plant material, mulch, planting media (a mix of soil, sand, and compost), and stone capture metals, nutrients, and bacteria that would otherwise flow into the surrounding creeks and rivers. The rainwater is held in the planting bed until it infiltrates into the ground or evaporates. The entire system can fit into small spaces, making it adaptable to tree spaces, planter boxes, and islands.

Planter Boxes

Runoff follows the existing curb line and enters the facility through curb cuts. Excess runoff exits through the same curb cuts or into drains located in the planting area.

Parking Islands

Runoff follows the existing curb line and enters the facility directly. Excess runoff flows through the system or into drain inlets.

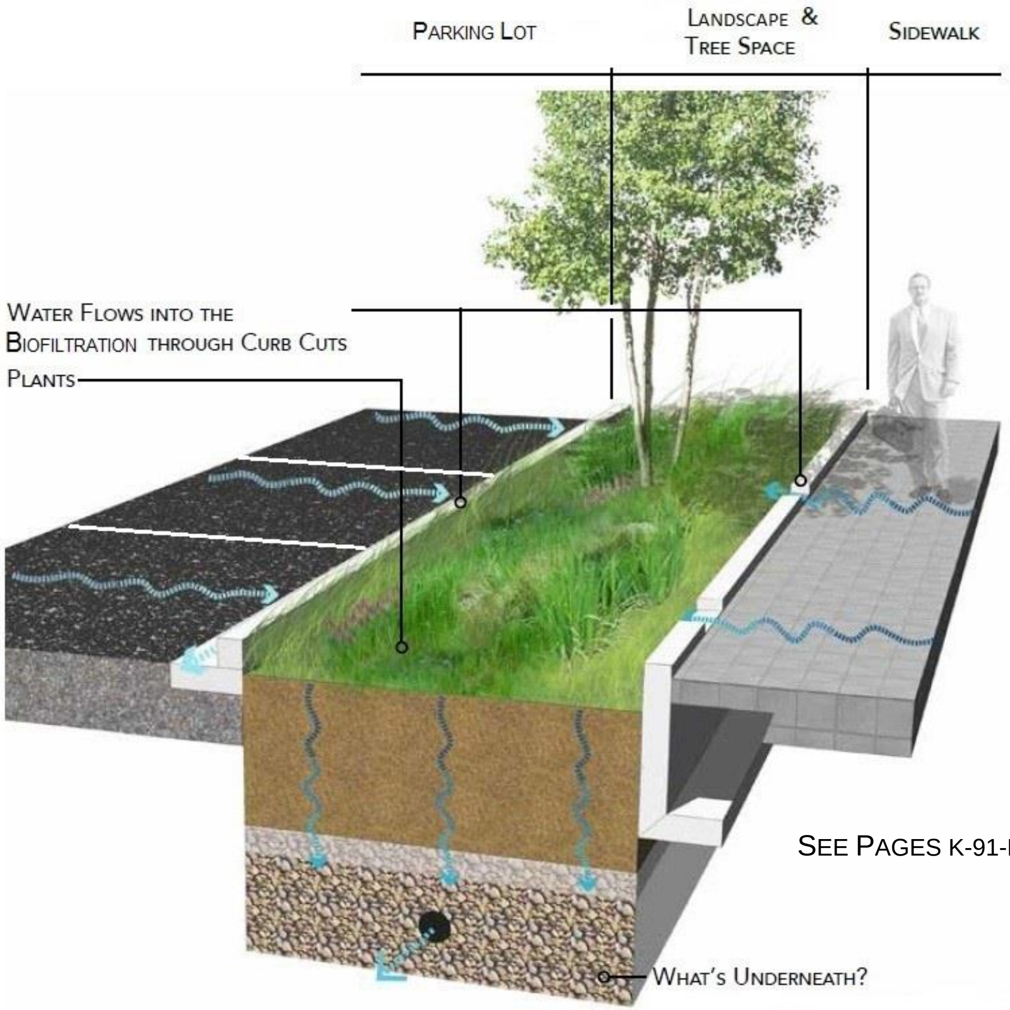
Swales

Runoff enters the facility directly or through curb cuts. Excess runoff flows through the system to a drainage outlet.

Filter Strip/Dispersion Area

Runoff enters the facility directly via sheet flow. Excess runoff flows through the system to a drain inlet downslope.

Planter Box



See pages K-91-K-95 for details

Where to Use?

- Parking lot areas adjacent to sidewalk/walkway/plaza area.
- Where trees and landscaping are needed.

Limitations

- Limited pedestrian access across planter.

Design Issues

Maintenance Access: Allow for adequate maintenance access from parking lot.

Pedestrian Considerations: Allow for minimum allowable sidewalk width. Consider trip hazards and fall protection. Comply with ADA requirements.

Where to Use?

- Parking lots with islands.
- For parking lot traffic calming.
- Next to mature trees.

Limitations

- Do not disturb existing, mature trees and root systems.
- Ensure sight lines and turning radii are preserved.

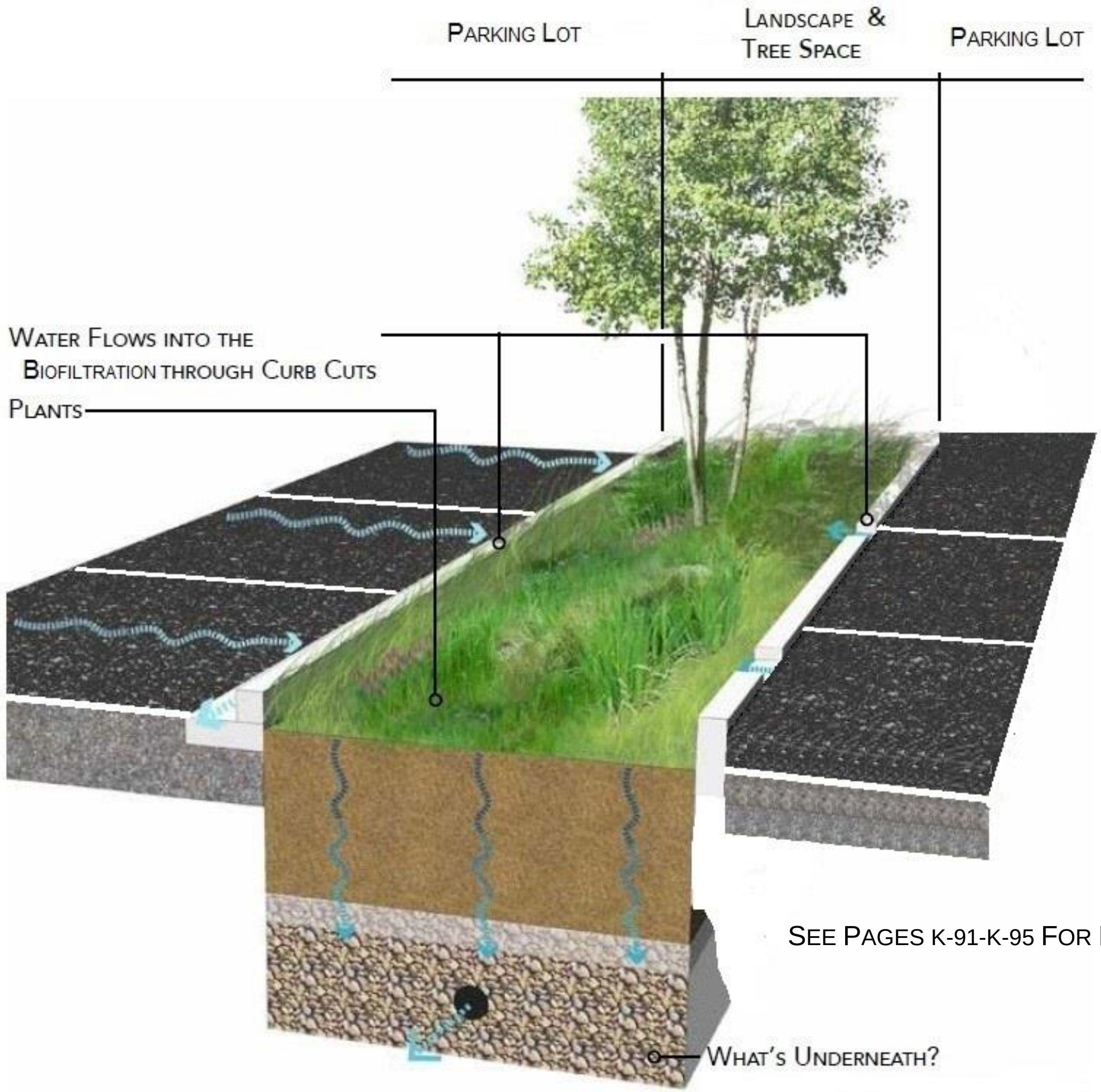
Design Issues

Maintenance Access: Allow for adequate maintenance access from road.

Pedestrian Considerations: Consider trip hazards and fall protection. Short fences or curbs prevent pedestrians from stepping into a recessed area. A 3:1 transition from the sidewalk to planter bottom is an alternative. Comply with ADA requirements.

Parking: Consider trip hazards and adequate spacing in order to park.

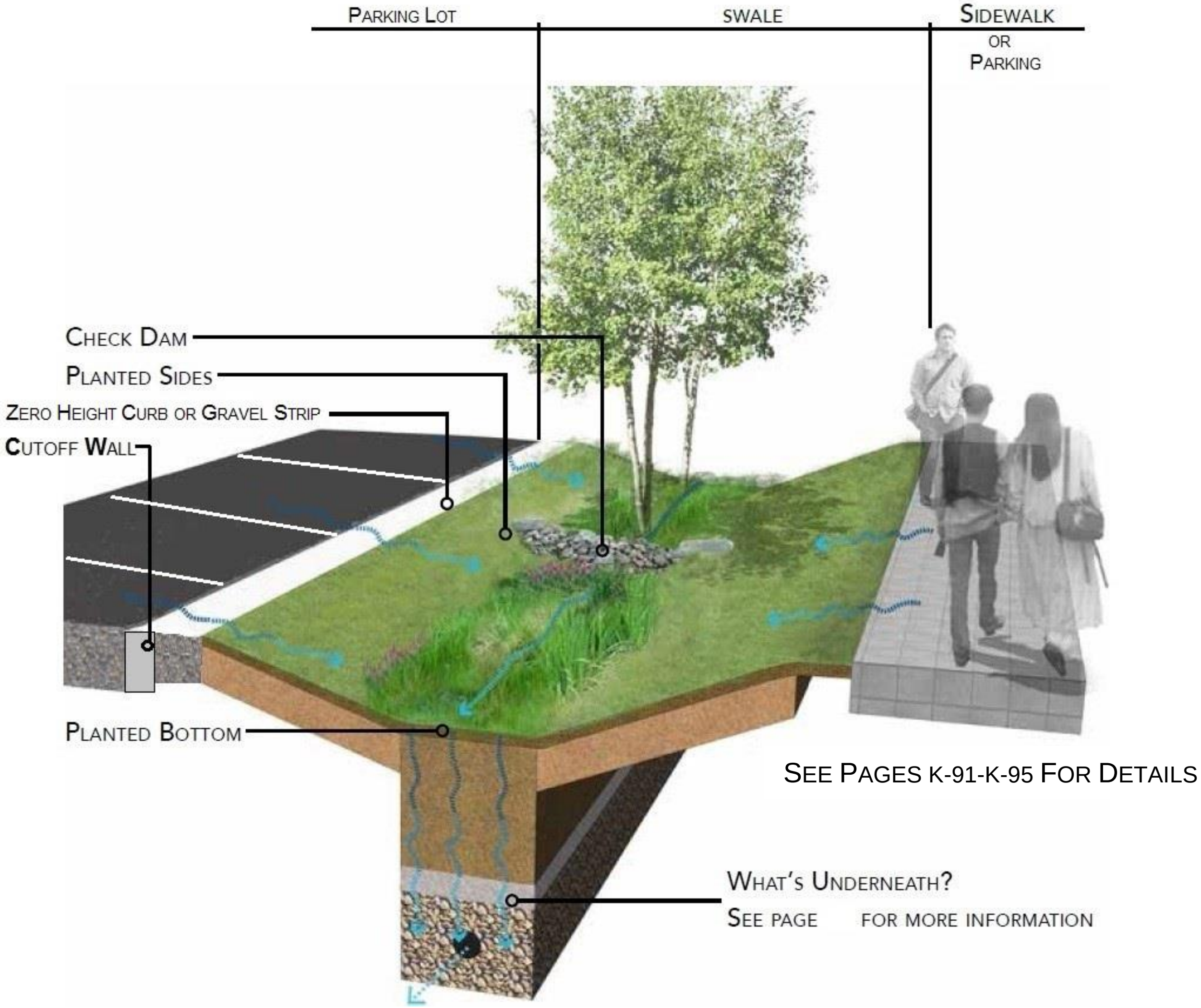
Parking Islands



See Pages K-91-K-95 For Details

(Source: DDOT, 2014)

Swale Adjacent to Parking



Where to Use?

- In parking lots with zero height curb or curb cuts.
- In parking lot areas with less pedestrian use.

Limitations

- Not suitable for narrow island areas.

Design Issues

Slope and Check Dams: Swales are placed where runoff is flowing and optimally before catch basins that convey water from the parking lot to the drainage system. Swales may be built on moderate slopes with the use of check dams. Rock armoring or turf reinforcement mat may be required in steep areas with erosive velocities between check dams.

Maintenance Access: Allow for adequate maintenance access from parking lot.

Pedestrian Considerations: Limit pedestrian access to swale. Transition swale at intersections for pedestrian facilities. Comply with ADA requirements.

Where to Use?

- Where runoff can sheet flow into filter strip area.
- Moderate slopes (less than 5%) adjacent to impervious area of treatment (parking lot).
- Rural areas.

Limitations

- Not recommended on steep slopes.
- Prone to rill formation.

Design Issues

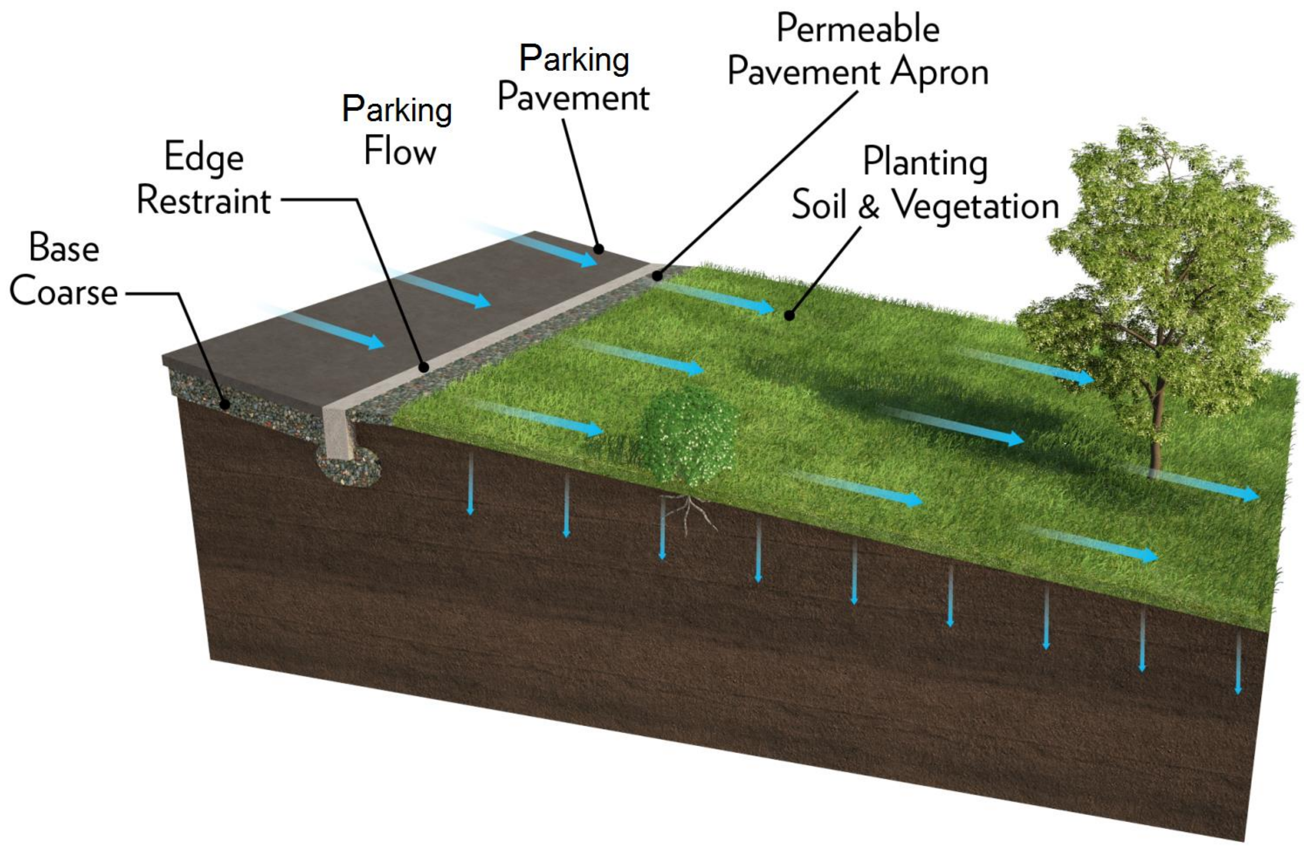
Maintenance: Vegetated cover must be maintained to ensure that filter strips do not export sediment due to erosion of exposed ground.

Slope: Maximum slopes in the direction of flow will be based upon drainage area size, soil type, vegetation cover, and slope length to prevent rill formation. Slopes less than 5% are preferred.

Maintenance Access: Allow for adequate maintenance access from parking area.

Pedestrian Considerations: Limit pedestrian access across filter strip to prevent formation of dirt pathways. Comply with ADA requirements.

Vegetated Filter Strip/Dispersion Area



Dispersion Areas and Biofiltration – What's Underneath?

Soil Type and Infiltration Rate

Dispersion areas and biofiltration can be located in many areas. However, site constraints will help to determine what goes underneath the dispersion area or biofiltration. Common considerations include soil type, relative soil compaction, required utility setbacks, slope setbacks, and structural setbacks. Depending on the factors at the site, what's underneath the dispersion area or biofiltration is determined by the level of infiltration: high, medium, low, or none.

A qualified engineer practicing geotechnical services shall review the proposed stormwater infiltration to provide a professional opinion regarding the potential adverse geotechnical conditions that the implementation of these practices may create. Geotechnical conditions such as slope stability, expansive soils, compressible soils, seepage, groundwater, and loss of foundation or pavement subgrade strength should be considered.

The U.S. Department of Agriculture Natural Resources Conservation Service (NRCS), formerly the Soil Conservation Service, conducted a soil survey of the San Diego area in the early 1970s. The NRCS has classified San Diego area soils with respect to: (1) their ability to accept and absorb water, (2) their tendency to produce runoff, and (3) their erodibility.

The soil survey classified soil runoff potential into four hydrologic soil groups labeled A through D. Group A and B soils exhibit the greatest infiltration rates (unless soils are compacted during construction) and are generally best suited to stormwater percolation. The San Diego area, however, has a relatively high concentration of group C and D soils, which exhibit lower percolation rates that generally limit the use of infiltration-based stormwater management systems. Instead, dispersion areas and biofiltration facilities are often equipped with underdrains. Such a design provides for filtration of the water quality design event through a biofiltration soil media as well as incidental infiltration of low flows.

Retaining a geotechnical engineer and conducting exploratory excavations at the site are highly recommended. Consideration should be given to the effects of urbanization on the natural hydrologic soil group. If heavy equipment can be expected to compact the soil during construction, or if grading will mix the surface and subsurface soils, appropriate changes should be made in the soil group selected.

The NRCS hydrologic soil groups are defined as:

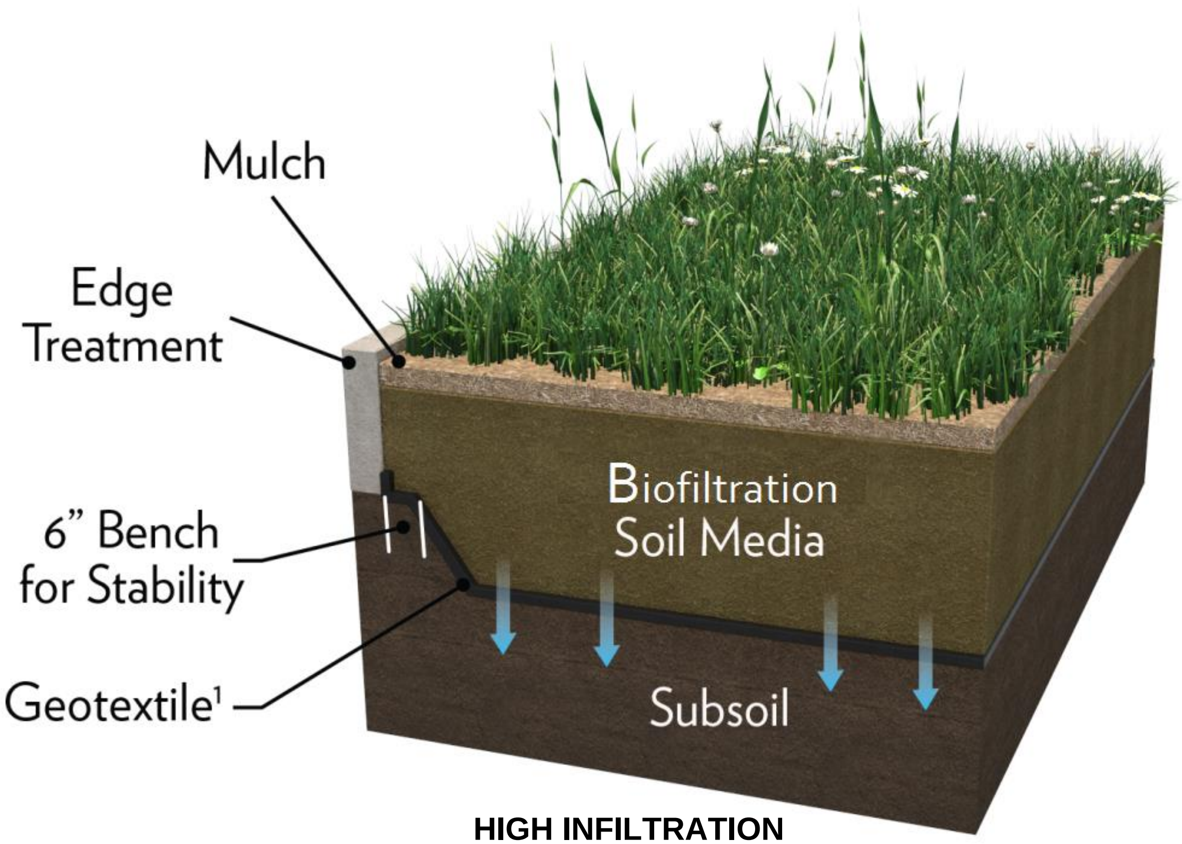
- **Group A** soils have a high rate of percolation and a low runoff potential. The rate of water transmission is high; thus, runoff potential is low. Group A soils are generally referred to as sandy soils.

- **Group B** soils have moderate percolation rates when thoroughly wet. These are chiefly soils that are moderately deep to deep, moderately well-drained to well-drained, and moderately coarse textured. Rate of water transmission is moderate.

- **Group C** soils have a slow percolation rate when thoroughly wet. They are chiefly soils that have a layer impeding the downward movement of water, or they are moderately fine to fine-textured soils that have a slow infiltration rate. The rate of water transmission is slow.

- **Group D** soils have very slow percolation rates when thoroughly wet. They are clays that have a high shrink-swell potential, soils that have a high permanent water table, soils that have a claypan or clay layer at or near the surface, or soils that are shallow over nearly impervious material. The rate of water transmission for group D soils is very slow.

High Infiltration



HIGH INFILTRATION

Notes:
1. Geotextile per Geotechnical Engineer’s Recommendations.

Putting it Together

- Ponding Depth: Stores runoff within the planting area prior to treatment.
- Mulch: Shredded hardwood layer to retain water and trap pollutants.
- Biofiltration Soil Media: A specific blend of soil, compost, and sand to retain and drain water and support plant growth.
- Geotextile: Prevents existing soil from migrating into the biofiltration soil media.
- Uncompacted Subsoil: Existing soil where stormwater infiltrates.

Common Design Issues

Utilities: Utility lines should be avoided where necessary and allowed to coexist where possible.

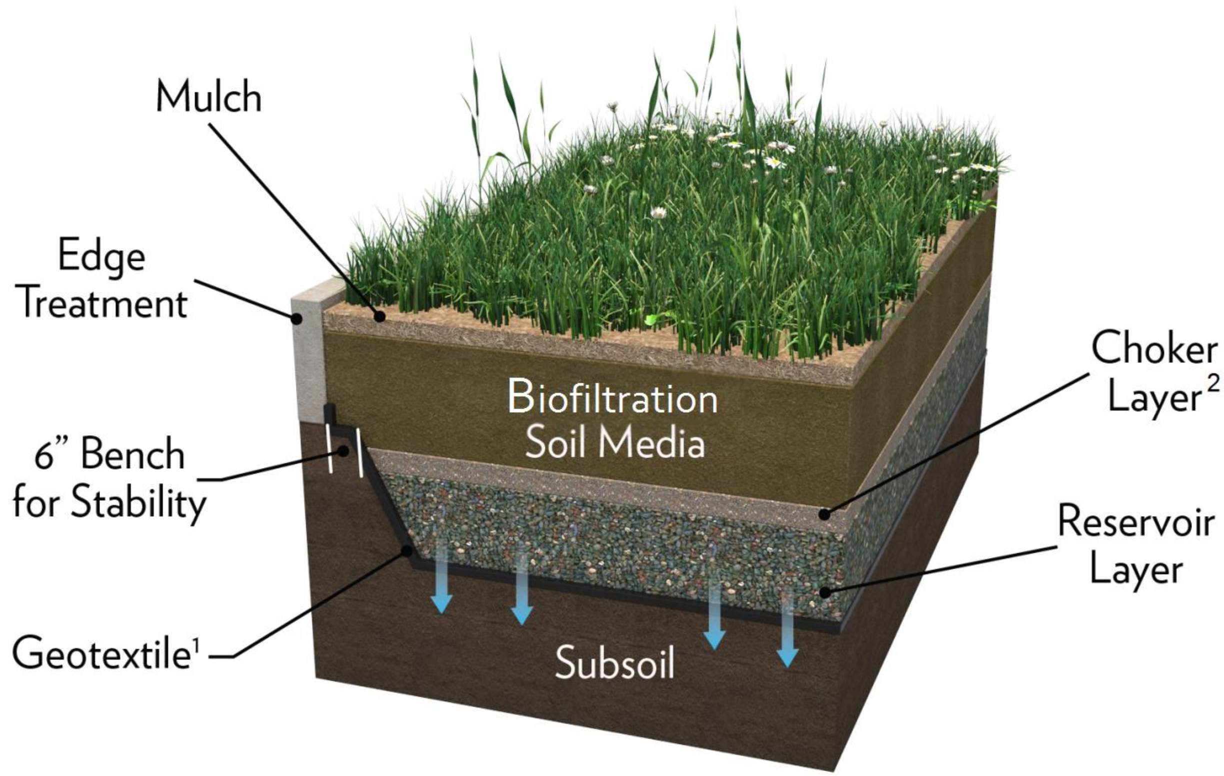
Putting it Together

- Ponding Depth: Stores runoff within the planting area prior to treatment.
- Mulch: Shredded hardwood layer to retain water and trap pollutants.
- Biofiltration Soil Media: A specific blend of soil, compost, and sand to retain and drain water and support plant growth.
- Choker Layer: Sand and gravel to prevent biofiltration soil media from migrating into the reservoir.
- Reservoir Layer: Stone to hold excess water until it infiltrates.
- Geotextile: Prevents existing soil from migrating into the biofiltration soil media and stone reservoir layer.
- Uncompacted Subgrade: Existing soil where stormwater infiltrates.

Common Design Issues

Utilities: Utility lines should be avoided where necessary and allowed to coexist where possible.

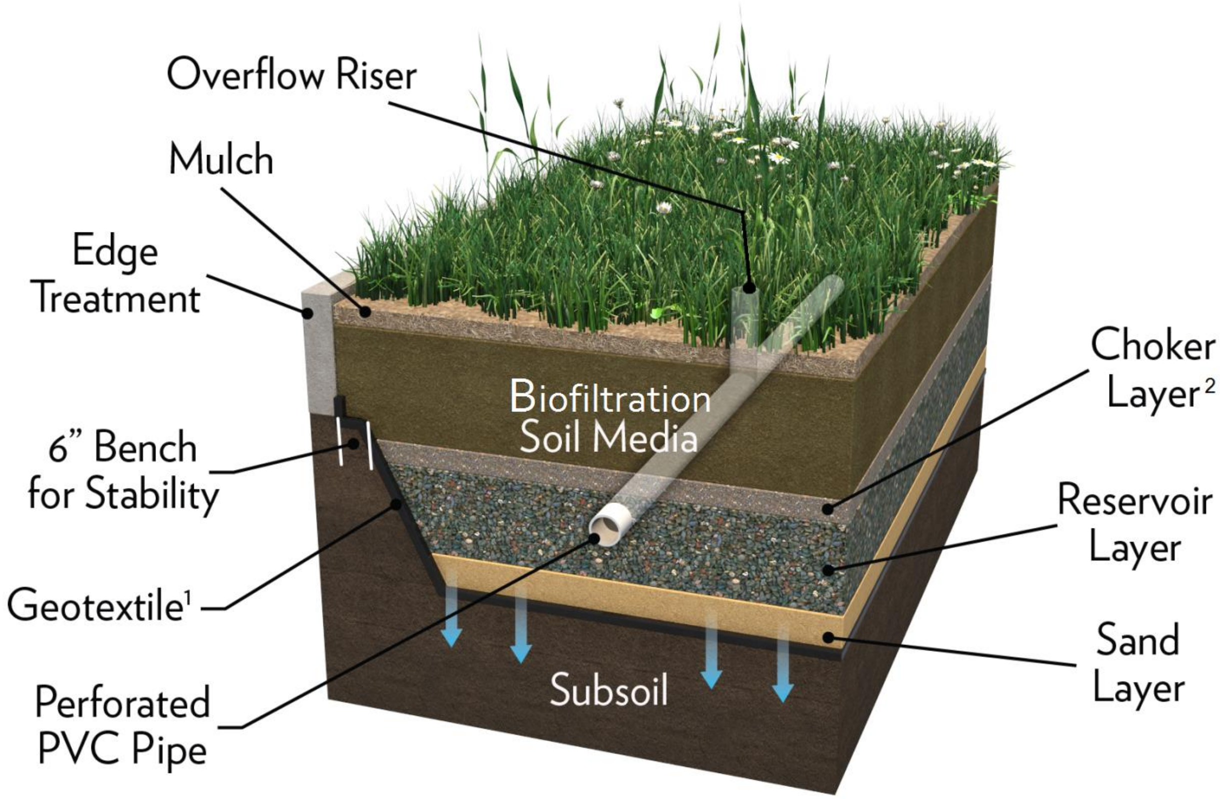
Medium Infiltration



MEDIUM INFILTRATION

Notes:
1. **Geotextile per Geotechnical Engineer's Recommendations.**
2. **Choker layer may be required depending the type of reservoir layer.**

Low Infiltration



LOW INFILTRATION

Notes:

1. Geotextile per Geotechnical Engineer's Recommendations.

2. Choker layer may be required depending the type of reservoir layer.

Putting it Together

- Ponding Depth: Stores runoff within the planting area prior to treatment.
- Overflow Riser: Pipe to capture high water flow.
- Mulch: Shredded hardwood layer to retain water and trap pollutants.
- Biofiltration Soil Media: A specific blend of soil, compost, and sand to retain and drain water and support plant growth.
- Choker Layer: Sand and gravel to prevent biofiltration soil media from migrating into the reservoir.
- Reservoir Layer: Stone to hold excess water until it infiltrates.
- Underdrain: An underdrain is required.
- Geotextile: Prevents existing soil from migrating into the biofiltration soil media and stone reservoir layer.
- Uncompacted Subgrade: Existing soil where stormwater infiltrates.

Common Design Issues

Utilities: Utility lines should be avoided where necessary and allowed to coexist where possible.

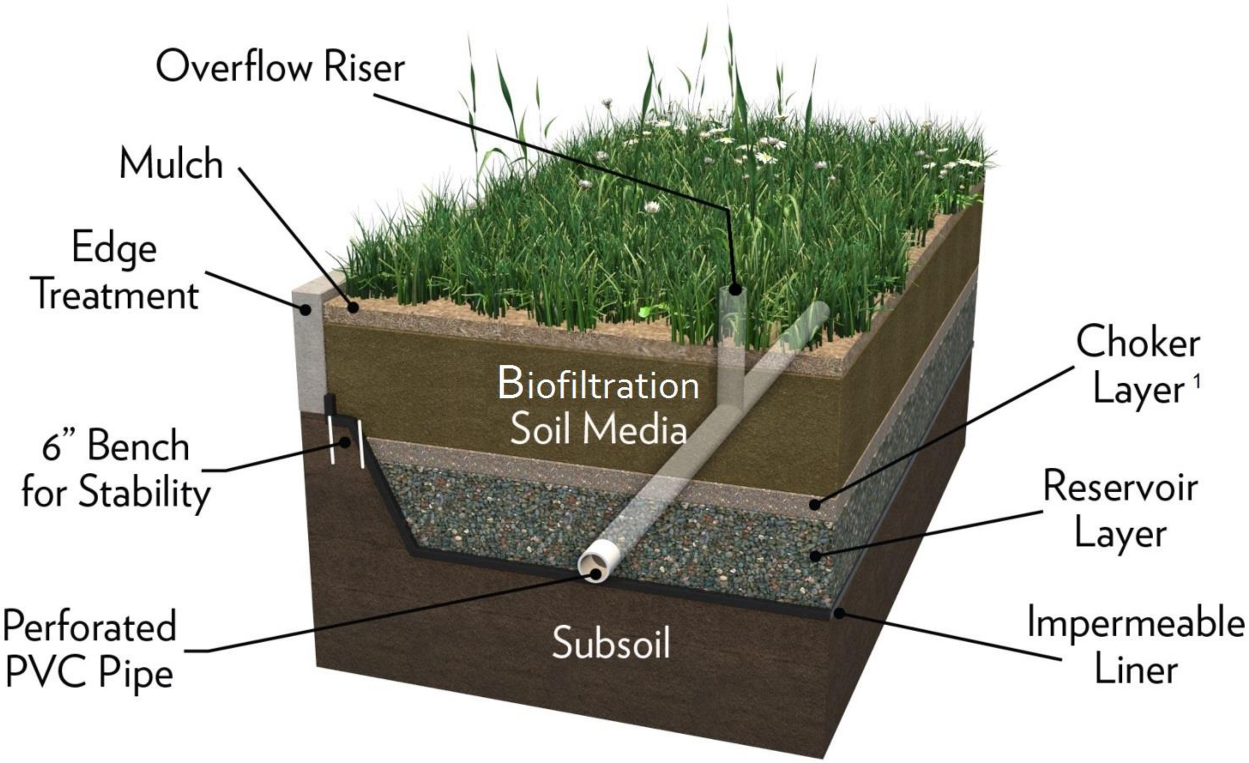
Putting it Together

- Ponding Depth: Stores runoff within the planting area prior to treatment.
- Overflow Riser: Pipe to capture high water flow.
- Mulch: Shredded hardwood layer to retain water and trap pollutants.
- Biofiltration Soil Media: A specific blend of soil, compost, and sand to retain and drain water and support plant growth.
- Choker Layer: Sand and gravel to prevent biofiltration soil media from migrating into the reservoir.
- Reservoir Layer: Stone to hold excess water until it enters the underdrain.
- Underdrain: An underdrain is required.
- Impermeable Liner: Prevents infiltration and prevents existing soil from migrating into the biofiltration soil media and stone reservoir layer.

Common Design Issues

Utilities: Utility lines should be avoided where necessary and allowed to coexist where possible.

No Infiltration



NO INFILTRATION

Notes:
1. Choker layer may be required depending the type of reservoir layer.

2.4 Planting & Irrigation of Dispersion Areas, Biofiltration, Trees, and Other Areas

Planting Design

Trees, dispersion areas, and biofiltration add a landscape amenity to the parking lot. Trees, shrubs, grasses and perennials are used to create a diverse landscape suitable for the site conditions and neighborhood. Plants should be chosen based on the level of care expected at the facility. Planting design must be done to ensure sight lines are preserved for pedestrians, cyclists, and vehicles in the parking lot.

Trees are an important component of a Green Parking Lot. Mature trees capture stormwater, provide shade, and cool pavement. Existing trees should be protected when possible in parking lot retrofit projects.

Refer to the County of San Diego's Water Efficient Landscape Design Manual and Low Impact Development Handbook for suitable plant species to use in dispersion areas and biofiltration. Also refer to the community right of way development standards for suitable plants within specific communities.

Irrigation Design

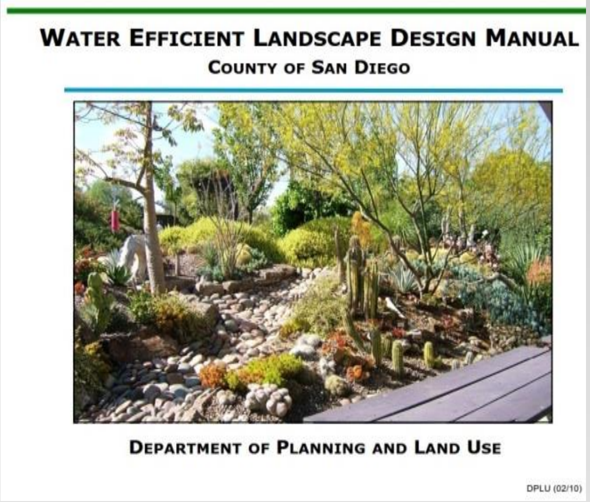
Irrigation design should comply with the County of San Diego's Water Efficient Landscape Design Manual.

Planting Zones (Hydrozones)

Grouping plants into hydrozones is an approach to irrigation and planting design where plants with similar water needs are grouped together. Ideally, each zone of the irrigation system will supply plants with the same water needs with the appropriate amount of water.

Water Conservation

State executive order B-29-15 requires mandatory statewide water restrictions. This order prohibits ornamental turf on public street medians, and requires a reduction in potable water use for irrigation. Low water use, drought tolerant, native plants should be used for Green Parking Lot applications. The use of reclaimed water is recommended to reduce the amount of potable water used for irrigation.


WATER EFFICIENT LANDSCAPE DESIGN MANUAL
COUNTY OF SAN DIEGO
DEPARTMENT OF PLANNING AND LAND USE
DPLU (02/10)

2.5 Types of Permeable Pavement

What is Permeable Pavement

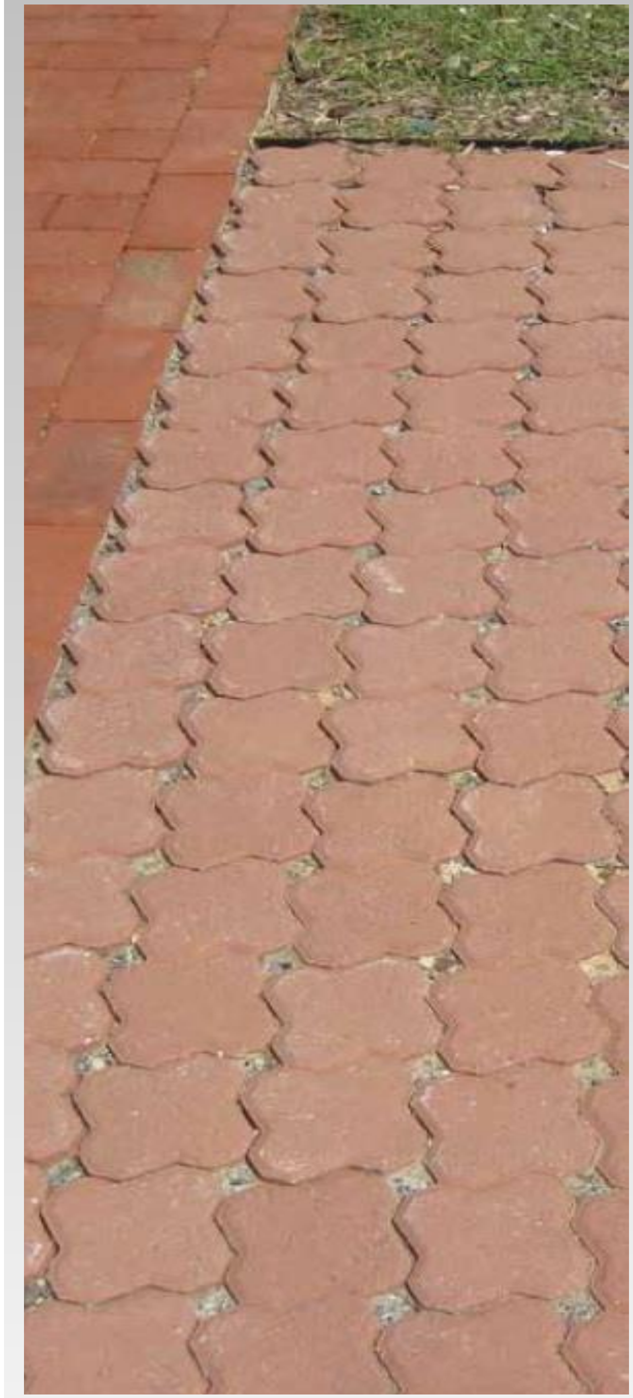
Permeable pavement is an engineered top layer and base layer that allows water to move through it. The goal is to take rainwater as it falls and quickly move it to the lower layers of the system. Stormwater is stored in an underlying stone layer until it infiltrates into the soil below, aiding in groundwater recharge, or releases slowly to the storm drain system. Pollutants are filtered through the pavement and base layers. The terms 'Permeable Concrete Pavers', 'Pervious Concrete', 'Porous Asphalt', and 'Porous Rubber' are industry standard names, but all surfaces are 'permeable' and provide sufficient openings at the surface to allow stormwater to infiltrate.

Permeable Concrete Pavers

Unlike traditional pavers, there are gaps between each paver to allow water to flow between the pavers and into the base layer.

Pervious Concrete

Sands and "fines" are reduced in the concrete mix to allow water to flow through the pavement into a stone bed and eventually the ground.



Types of Permeable Pavement (Continued)

Porous Asphalt

Porous asphalt is very similar to traditional asphalt except that the sands or “fines” are reduced in the mix so water can move through the pavement.

Porous Rubber

Made from recycled rubber and small stones, porous rubber works like pervious concrete, but can be installed over tree roots.

Decomposed Granite (DG) Pathway

Decomposed granite can be used for pathways. It can be installed and compacted to meet ADA handicapped accessibility specifications and criteria. Although highly compacted, the surface has some infiltration capacity.

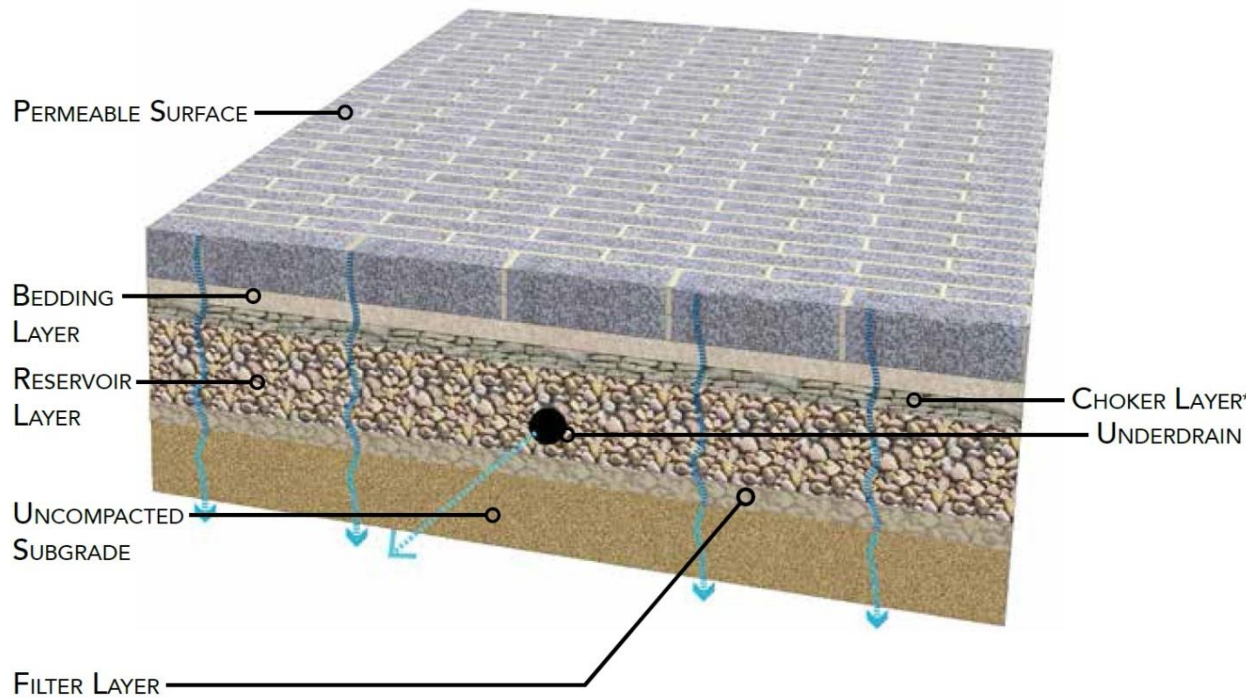
Boardwalk

Made from wood or composite, boardwalks may be used for pathways. Rain easily passes through the spaces between the boards to the soil below.

Putting it Together

- Permeable Surface: Permeable concrete pavers, pervious concrete, porous asphalt, porous rubber, DG, or boardwalk.
- Bedding Layer: Used for pavers so they can be laid flat.
- Choker Layer: A layer of small rock to prevent fine material from migrating into the reservoir layer.
- Reservoir Layer: Stone to hold excess water until it infiltrates.
- Underdrain: Conveys excess water into drainage system when the reservoir fills.
- Filter Layer/Geotextile: A layer of stone or permeable geotextile to separate the reservoir layer from the soil below and prevent migration of fines into the reservoir layer.
- Impermeable Liner: Prevents infiltration into subgrade or adjacent roadway structural section.
- Uncompacted Subgrade: Existing soil into which stormwater infiltrates.

Permeable Pavement – What's Underneath?



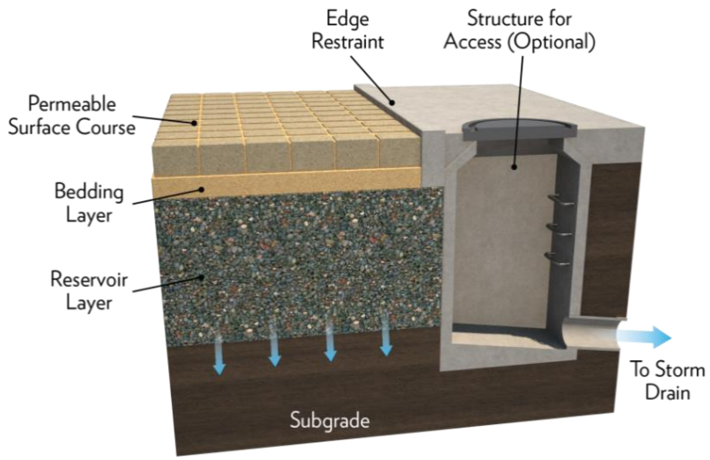
(Source: DDOT, 2014)

*Per Geotechnical Engineer's Recommendations

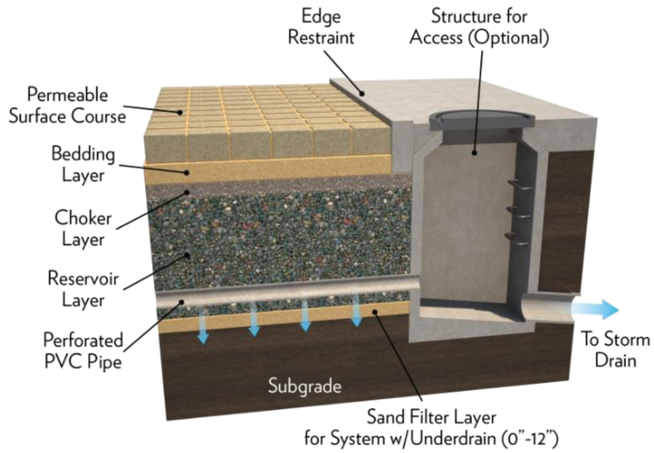
As with dispersion areas and biofiltration, there are multiple options for the subsurface components for permeable pavement including:

- Reservoir layer only with no underdrain
- Reservoir layer with underdrain (shown)
- Reservoir layer with underdrain and impermeable liner

Permeable Pavement Subsurface Design Options



Reservoir layer only with no underdrain



Reservoir layer with underdrain

Where to Use?

- Pedestrian areas
- Parking areas/stalls

Limitations

- Use in areas with little to no sediment production.

Design Issues

<u>Soil Infiltration and Drainage:</u> Soil infiltration tests must be completed to determine if an underdrain system is required.

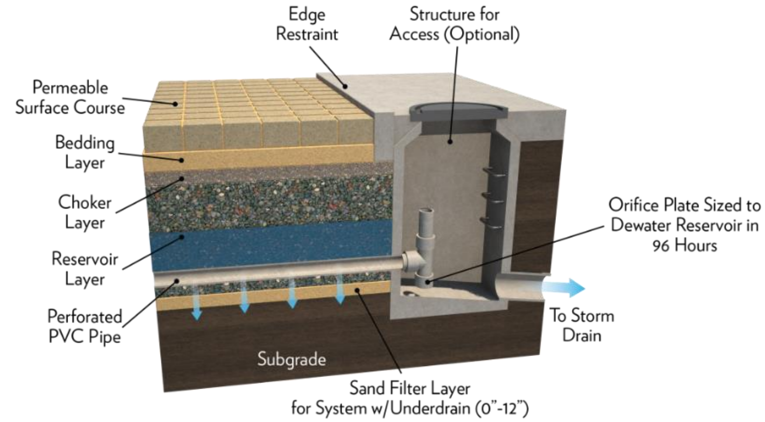
<u>Structural Section:</u> A qualified and licensed professional should complete a pavement structural analysis.

<u>Edge Restraints:</u> Provide a concrete transition strip between any permeable and impermeable surface and around the perimeter of paver installations.

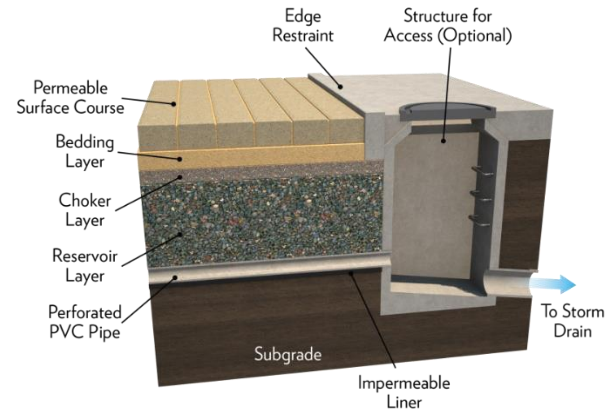
<u>Pedestrian Considerations:</u> Provide signage to indicate prohibited activities that cause premature clogging.

<u>Maintenance Access:</u> Provide adequate access for sweeping and/or vacuuming of surface.

PERMEABLE PAVEMENT SUBSURFACE DESIGN OPTIONS (CONTINUED)



Reservoir layer with upturned underdrain



Reservoir layer with underdrain and impermeable liner

CHAPTER 3 Procedures and Design Examples

3.1 INTRODUCTION

Implementing Green Infrastructure (GI) and Low Impact Development (LID) within a parking lot requires a number of considerations to create an amenity that is attractive while treating stormwater from the surrounding streets and sidewalks.

Implementation of Green Parking Lots features can be approached from evaluating the opportunities within each zone of the parking lot: traveled lane, parking stalls, islands, sidewalk/pathway, slopes and drainage easements. Each zone presents different opportunities, benefits, risks and technical design factors for GI and LID implementation to enhance stormwater quality.

Conducting a comprehensive inventory and assessment of site conditions is the crucial initial step for implementing GI and LID. The County LID Handbook inventory check list can be used to assist with identifying and evaluating a potential site for LID and to produce a list of opportunities and constraints.

The LID concept from the EPA of “slow it down, spread it out, and soak it in” should be at the forefront in the planning stages of project evaluating the implementation of Green Parking Lots design practices to control runoff and enhance water quality.

3.2 Site Design Principles

The following site design principles should be evaluated and implemented to "slow it down, spread it out, and soak it in":

- Minimize the impervious footprint of the site.
- Minimize soil compaction in landscaped areas. Landscape with native or drought-tolerant species.
- Disconnect impervious surfaces by dispersing runoff from impervious surfaces to pervious areas. To be considered 'disconnected' impervious areas should be designed to drain to a pervious area at least one-half their size.
- Design and construct trees, dispersion areas, biofiltration, and permeable pavements to effectively receive and infiltrate or retain runoff from impervious areas before it discharges to the storm drain or exits the right of way.

When Green Parking Lot design principles are employed over typical design techniques that utilize conventional stormwater quality treatment techniques they have the potential to significantly reduce impervious areas and provide potential project cost savings.

Conventional Design Approach
- Conventional storm drain
- Conventional pavement

Green Design Approach
- Dispersion areas and biofiltration
- Pervious pavement

Green Parking Lot Site Design Approach

Direct stormwater runoff from impervious parking lot elements to:

- Trees, dispersion areas and biofiltration in islands or on perimeter of parking lot.
- Permeable pavement surfaces located in walkways or parking stalls.
- Adjacent landscaped area

Constraints

In no way shall green parking lots LID features be designed to block sight distance for motorists from adjacent streets and driveways, create obstacles for pedestrians, impede the visibility and maintenance of traffic control devices and signs, and reduce or eliminate clear recovery area and minimum horizontal clearances from fixed objects.

GREEN PARKING LOTS SITE DESIGN APPROACH

Grading and Drainage

Direct runoff to trees, biofiltration, swales, permeable pavement:

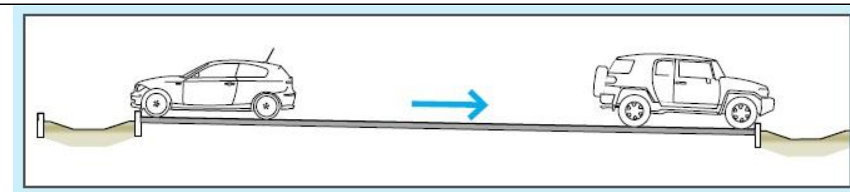
- When designing large parking lots, break up and direct flows to multiple LID features.
- Avoid compaction in biofiltration areas during construction.

Inlets and Outlets

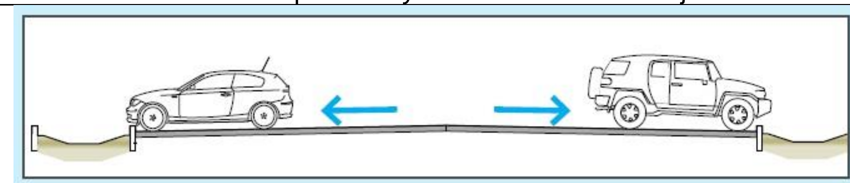
2 Direct runoff into, and out of biofiltration areas. Proper placement of inlets helps to spread runoff over the biofiltration planting areas, which slows the flow and reduces erosion.

3 Outlet, including overflow structures, direct excess runoff to the storm drain system.

4 Avoid placing overflow structures flush with soil to allow stormwater retention.



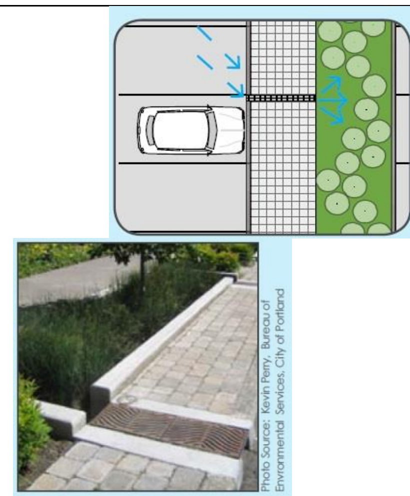
Continuous cross slope conveys the full aisle to an adjacent swale



Crowned slope conveys half of each aisle to adjacent swale

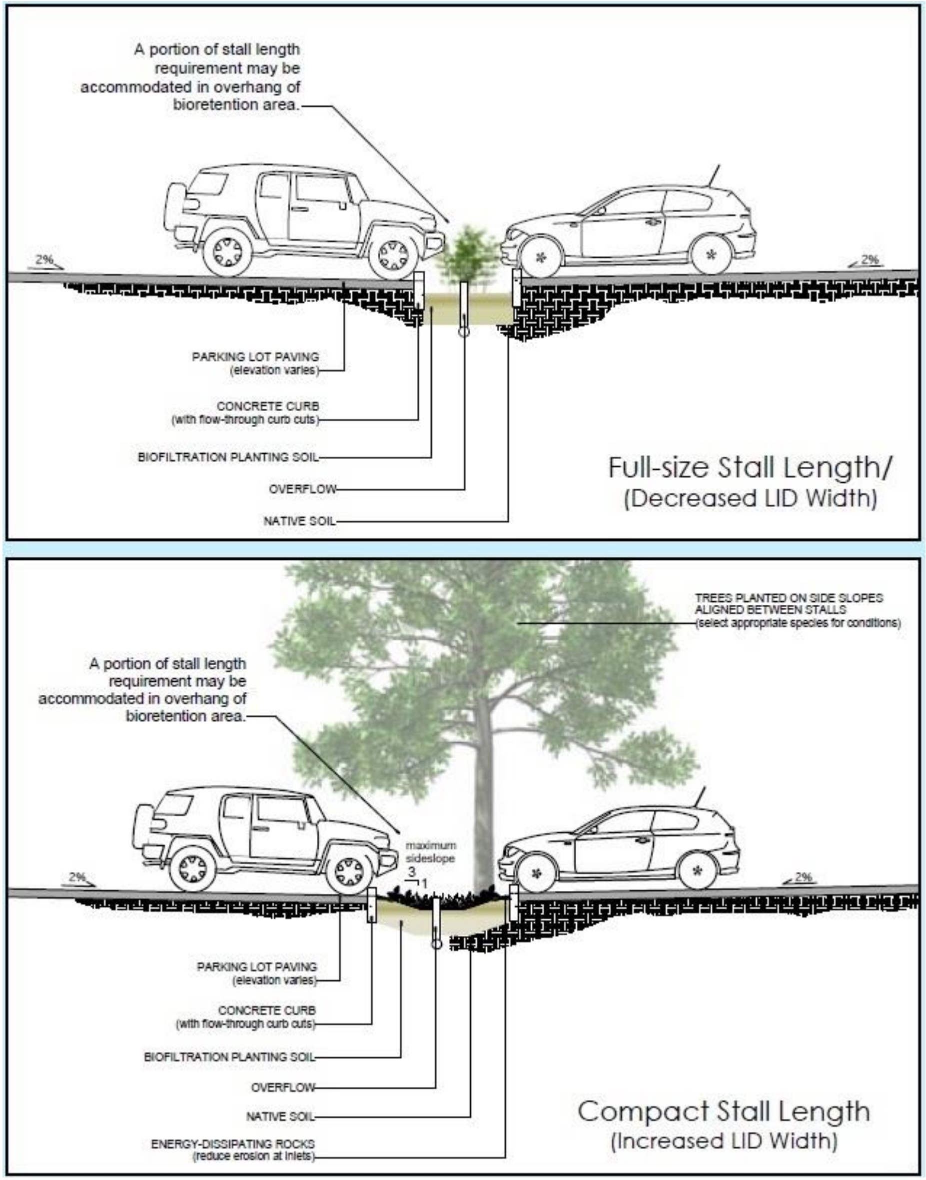
A curb inlet directs runoff into a biofiltration planter

An overflow outlet conveys runoff that exceeds the biofiltration area capacity



A patterned steel grate inlet conveys flow under a pedestrian walkway

Source: Central California Coast, Technical Assistance Memo, LID Parking Lots



Source: Central California Coast, Technical Assistance Memo, LID Parking Lots

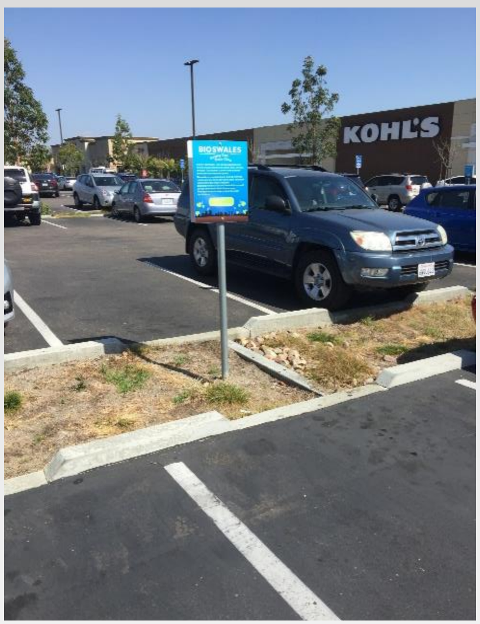
Green Parking Lots Site Design Approach

Parking Configuration

Parking configurations can be adapted to meet both parking and stormwater management needs by sizing biofiltration areas to fit compact and full sized parking stalls.

Tree Considerations

- Locate trees on side slope, above areas that pond
- Select trees that will tolerate seasonally wet soils
- Do not specify trees with invasive roots.



3.3 Design Procedure

General Requirements

- Green Parking Lots features will meet the requirements set forth in Section E.3.b.(3)(a)(iii) and (b) of the 2013 MS4 Permit.
- Many of the low impact development (LID) requirements for site design that were applicable only to Priority Development Projects under the 2007 MS4 Permit are applicable to all projects (Standard Projects and PDPs) under the MS4 Permit.

Opportunities and Constraints

- Conduct a comprehensive inventory and assessment of site conditions.
- Evaluate each zone of the parking lot for implementation opportunities: traveled way, parking stalls, islands, sidewalk/pathway, slopes and drainage easements.
- Evaluate constraints including, but not limited to: utilities, parking lot geometry and slope, site distance, proximity to storm drain, maintenance access, pedestrian and vehicle safety, etc.

Design Capture Volume/Flow Rate for Priority Development Projects

- The standard for storm water pollutant control (formerly treatment control) is retention of the 24-hour 85th percentile storm volume, defined as the event that has a precipitation total greater than or equal to 85 percent of all daily storm events larger than 0.01 inches over a given period of record in a specific area or location.
- For situations where onsite retention of the 85th percentile storm volume is technically not feasible, biofiltration must be provided to satisfy specific “biofiltration standards”. These standards consist of a set of siting, selection, sizing, design and maintenance criteria that must be met for a BMP to be considered a “biofiltration BMP” – see Section 2.2.1 and Appendix F of the County BMP Design Manual.

Treatment Train

- Utilize a treatment train approach that connects and combines features to maximize water quality treatment within the Green Parking Lot. An example Green Parking Lot treatment train approach is provided in Section 3.6.

Documentation

- Document the design criteria, methodology, drainage areas/treatment areas, calculated volumes/flows, BMP selection, and maintenance requirements in the project Stormwater Management Plan and/or Drainage Report.

Parking Islands

The parking island presents an opportunity to implement GI principles by use of street trees, dispersion areas, biofiltration, or permeable pavements. The graphics below illustrate various design concepts that can be utilized within parking lot islands.

Conventional parking lot

Green Parking Lot

Conventional parking lot

Green Parking Lot Swale

Design Elements

- <u>Raised Island:</u>
  - Plant low water use/drought tolerant street trees and landscaping.
  - Install permeable pavement.

- <u>Depressed Island:</u> Utilize roadway cross slope to direct stormwater runoff from impervious roadway elements to:
  - Trees
  - Planter Boxes
  - Vegetated Swale

Design Considerations

- Vehicle safety
- Island width and length
- Parking lot longitudinal and cross slope
- Structural integrity of adjacent traveled way (design to prevent subsurface infiltration or ponding under traveled way)
- Underdrain and overflow devices
- Proximity of storm drain
- Maintenance access
- Pedestrian crossing potential

Design Elements

- <u>Traveled Way:</u>

  - Design lane widths to minimum allowable.

- <u>Shoulder/Parking Lane:</u>

  - Utilize permeable pavement with edge restraint at interface with traveled way

Design Considerations

- Structural section design to handle vehicle loading
- Parking space utilization (with or without parking, temporary use during lane closures)
- Parking lot geometrics
- Hydrologic design requirements (stone reservoir depth and underdrain requirements)
- Design to maintain structural integrity of adjacent traveled way with edge restraints and prevention of infiltration beneath traveled way section
- Interrupt permeable pavement at intersections
- Surrounding land use and sediment sources
- Long term maintenance
- Pedestrian safety
- Maintenance access

Permeable Pavement

The use of permeable pavements may be considered for walkways, low volume driving lanes in parking lots, driveways, and fire access roads.

Conventional parking lot with

Asphalt Concrete in stall

Green parking lot with permeable pavement in parking stall

PLANTER BOXES

Planter Box with trees

Planter Box with trees

Biofiltration Planter

Biofiltration with trees in Island

DESIGN CONSIDERATIONS

- Parking Lot layout
- Location (urban or rural setting)
- Parking Lot tree type and spacing requirements
- Sidewalk or path width requirements
- Parking requirements
- Parkway horizontal and vertical geometrics (curves and longitudinal slope)
- Pedestrian mobility and safety
- Maintenance access
- Interface with driveways
- Utilities and appurtenant structure locations
- Hydrologic design requirements
- Proximity of storm drain systems
- Structural integrity of adjacent traveled way (utilize edge restraints and prevent infiltration beneath roadway section)
- Low water use/drought tolerant street trees and landscaping

Design Elements

- Low water use/drought tolerant landscaping
- Rock
- Curb cuts and outlet design
- Energy dissipation
- Check dams
-

Design Considerations

- Parking Lot geometrics
- Structural integrity of adjacent traveled way to prevent subsurface infiltration or ponding under traveled way
- Underdrain and overflow devices
- Proximity of storm drain
- Pedestrian mobility aspects
- Maintenance access

Swales

Swale with trees

Swale with trees between parking

Bioswale adjacent to parking and sidewalk

Swale in Island

SIDEWALKS/PATHWAYS/DRIVEWAYS

Permeable pavement sidewalk with biofiltration

DG pathway with rock swale

Pervious concrete sidewalk

Permeable pavement driveway

DESIGN ELEMENTS

- Drain to adjacent landscaping or adjacent LID facility
- Permeable pavement

SIDEWALK DESIGN CONSIDERATIONS

- Sidewalk width and ADA requirements
- Public safety
- Pedestrian mobility aspects
- Maintenance access

DRIVEWAY CONSIDERATIONS

- Permeable pavement may require underdrain or overflow storm drain system
- Not appropriate for use in areas of high sediment loading (e.g. debris/soil from adjacent landscaping)

DESIGN ELEMENTS

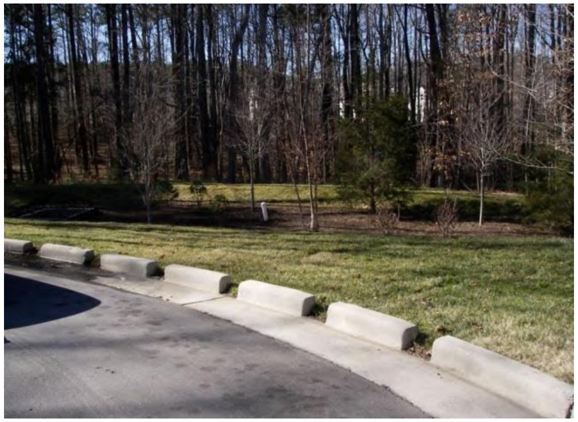
- Low water use/drought tolerant landscaping
- Swales
- Vegetated filter strips

DESIGN CONSIDERATIONS

- Available space
- Vehicle and public safety
- Structural integrity of adjacent traveled way to prevent subsurface infiltration or ponding under traveled way
- Underdrain and overflow devices
- Proximity of storm drain
- Maintenance access

OUTSIDE OF PARKING AREAS

Swale outside of parking lot

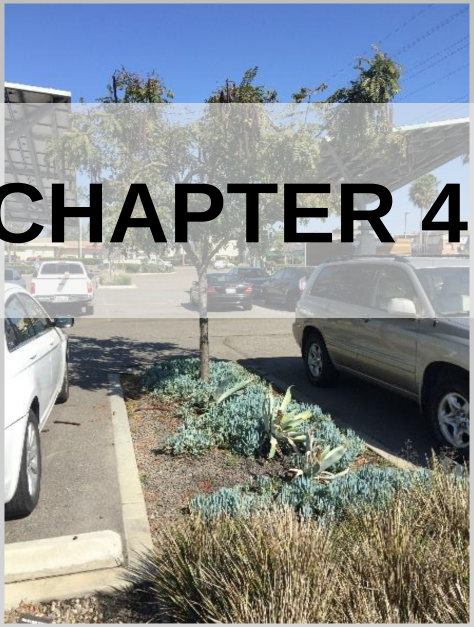


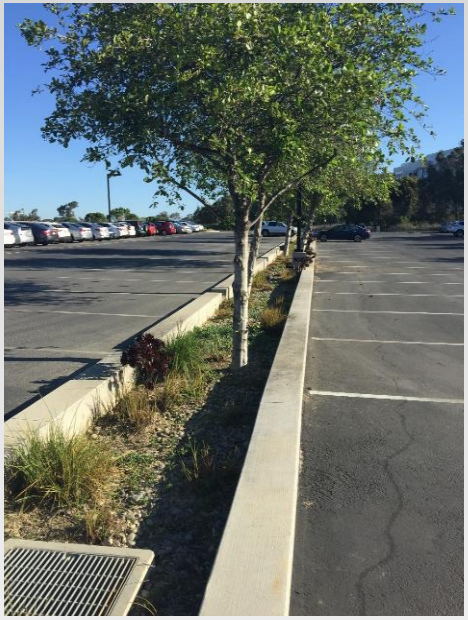
Curb cuts with filter strip/dispersion area

3.4 Putting It All Together

This graphic provides an example of how several different techniques may be combined for Green Parking Lot implementation.

CHAPTER 4 Implementing Green Parking Lots





4.1 DESIGN AND CONSTRUCTION

The goal of the County of San Diego (the County) Low Impact Development (LID) Program is to protect stormwater quality by preserving and simulating natural hydrologic functions through the use of stormwater planning and management techniques on a project site. Both public and private projects constructing parking lots are required to retain stormwater to the maximum extent practicable. Designers must examine all uses of available space and place stormwater management where space and use allows.

DPW is installing green infrastructure as part of regulated construction projects and retrofit projects to reduce stormwater runoff in more areas of the County. Green Parking Lots projects utilize green infrastructure techniques and may be constructed independently to improve watershed health, or as a part of other infrastructure improvement projects.

These Green Parking Lots Guidelines are a planning tool intended to assist project engineers with identifying and selecting suitable Best Management Practices (BMPs) for their respective Green Infrastructure projects. Technical standards, including drawings, specifications, maintenance schedule, and plant list, can be found in the Green Parking Lots document.

4.2 MAINTENANCE

Implementing Green Infrastructure and Low Impact Development (LID) practices requires maintenance to keep them attractive and functioning. Maintenance levels of care should be considered during the design phase and plants selected from the County LID Manual or Water Efficient Landscape Design Manual according to the following levels:

- Low level of care: Annual maintenance; no irrigation
- Medium level of care: Quarterly maintenance; some water available
- High level of care: Monthly maintenance; site is potentially irrigated

San Diego County DPW is typically responsible for maintaining publicly-installed green infrastructure and LID facilities within their right-of-way. The final determination of maintenance responsibility is determined during project review. Private installations must have a maintenance covenant from the owner. Residents can help with maintenance by removing trash and weeds. Refer to the Green Parking Lots Maintenance Schedule for frequency and detail of maintenance.

Type of Maintenance	Dispersion Areas and Biofiltration	Permeable Pavement	Tree Space
Inspect after storms	•	•	
Remove trash/sediment/leaves	•	•	•
Clean inlets/outlets	•		
Adjust mulch and/or stone	•		
Water for establishment	•		•
Weed/remove invasive species	•		•
Prune (as needed)	•		•
Replace mulch (3” depth)	•		•
Street sweeper/vacuum (as needed)		•	

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