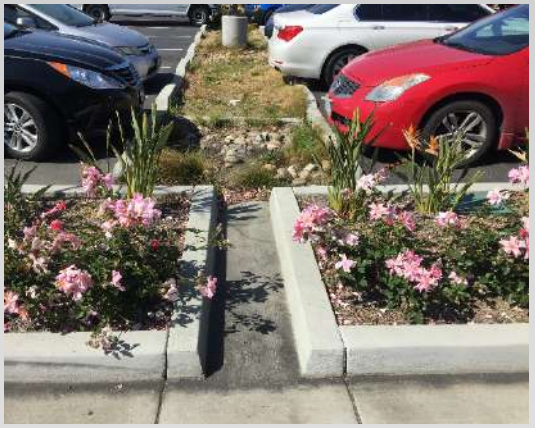
Green Parking Lots Guidelines

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 GREEN PARKING LOTS……K-77

1.6 INTRODUCTION
1.7 THE NATURAL AND DEVELOPED ENVIRONMENT
1.8 GREENING PARKING LOTS
1.9 THE COUNTY ENVIRONMENT
1.10 PARKING LOTS

CHAPTER 2 – GREEN PARKING LOTS STRATEGIES……K-82

2.1 INTRODUCTION
2.2 TREES
2.3 TYPES OF DISPERSION AREAS AND BIOFILTRATION
2.4 PLANTING & IRRIGATION OF DISPERSION AREAS, BIOFILTRATION, TREES AND OTHER AREAS
2.5 TYPES OF PERMEABLE PAVEMENT

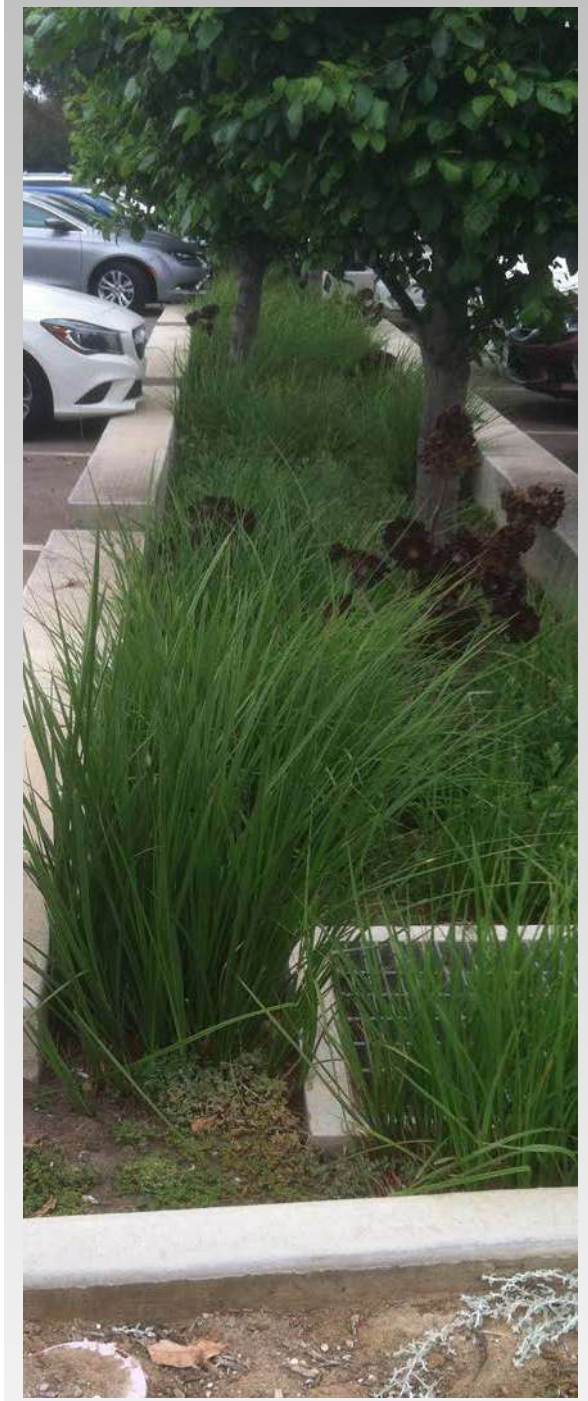
CHAPTER 3 – PROCEDURES & DESIGN EXAMPLES……K-102

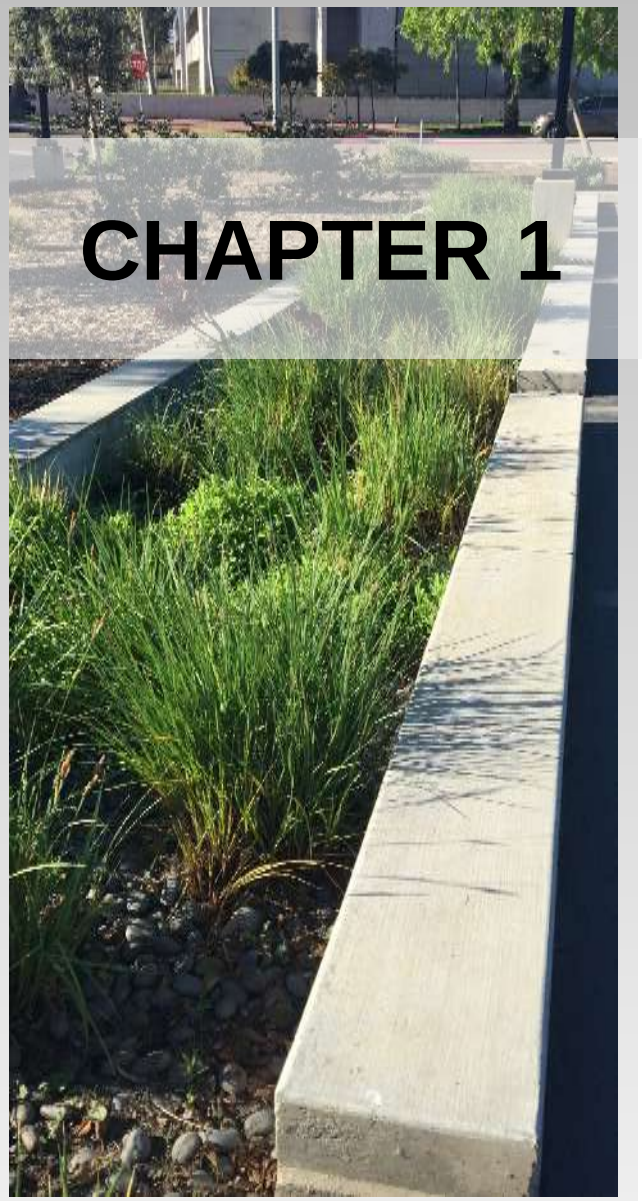
3.1 INTRODUCTION
3.2 SITE DESIGN PRINCIPLES
3.3 DESIGN PROCEDURE
3.4 PUTTING IT ALL TOGETHER

CHAPTER 4 – IMPLEMENTING GREEN PARKING LOTS……K-114

4.1 DESIGN AND CONSTRUCTION
4.2 MAINTENANCE

REFERENCES……K-116





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.

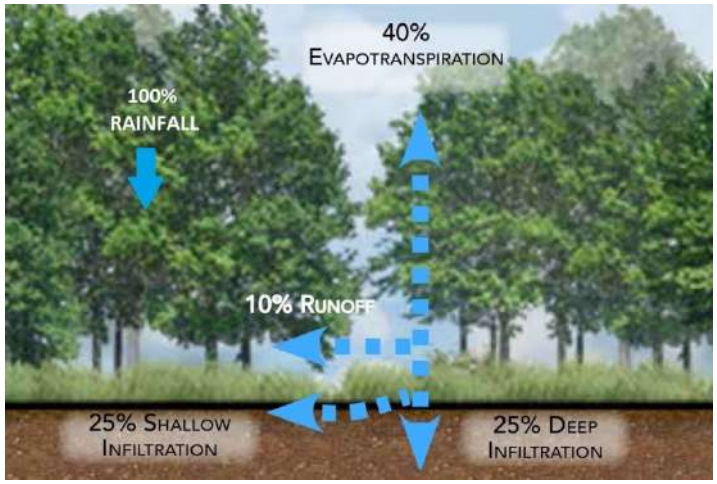
A review of existing County policies has been performed and included in the accompanying Green Parking Lots Standards document that includes an addendum to the 2016 County of San Diego BMP Design Manual. The Green Parking Lots Standards publications include an addendum to the 2016 County of San Diego 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).

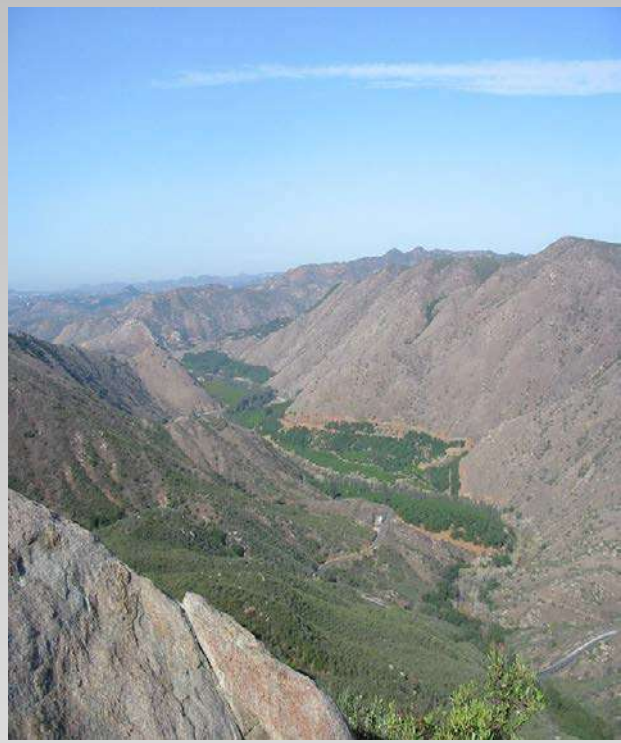
1.2 The Natural and Developed Environment

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.

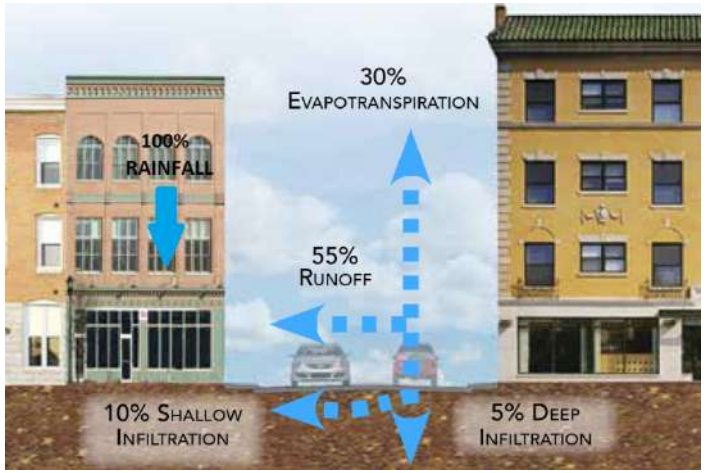


Natural Area Diagram
(Source: DDOT, 2014)



Urban Areas

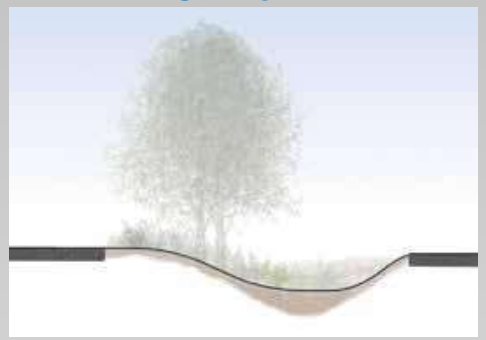
In urban areas, building rooftops, streets, alleys, sidewalks, and other paved surfaces are smooth and mostly impervious. Very little rain has a chance to soak into the ground. These paved urban areas are hotter and offer very little wildlife habitat. Most of the rain that falls in the urban areas quickly 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
(Source: DDOT, 2014)

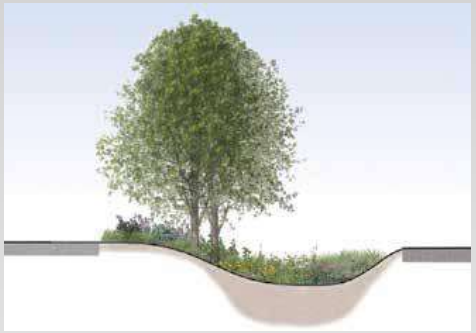


STORMWATER CAPTURE



Runoff from impervious surfacing

STORE



Store and retain captured runoff

INFILTRATE/EVAPOTRANSPIRE

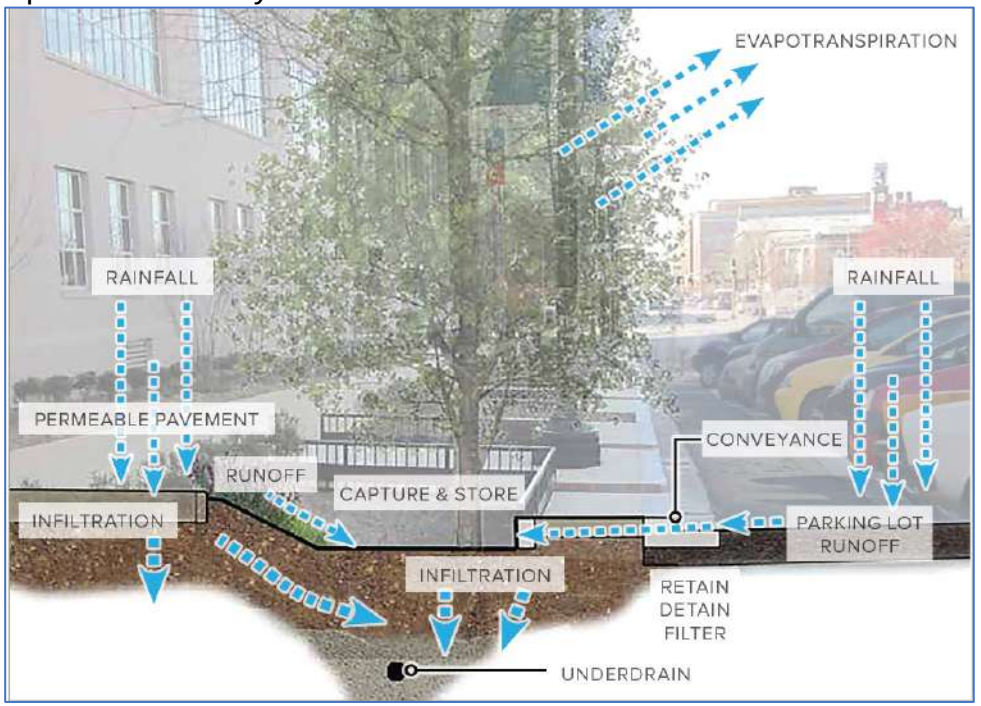


Water is infiltrated into the ground, evapotranspired by plants or drained

(Source: DDOT. 2014)

1.3 GREENING PARKING LOTS

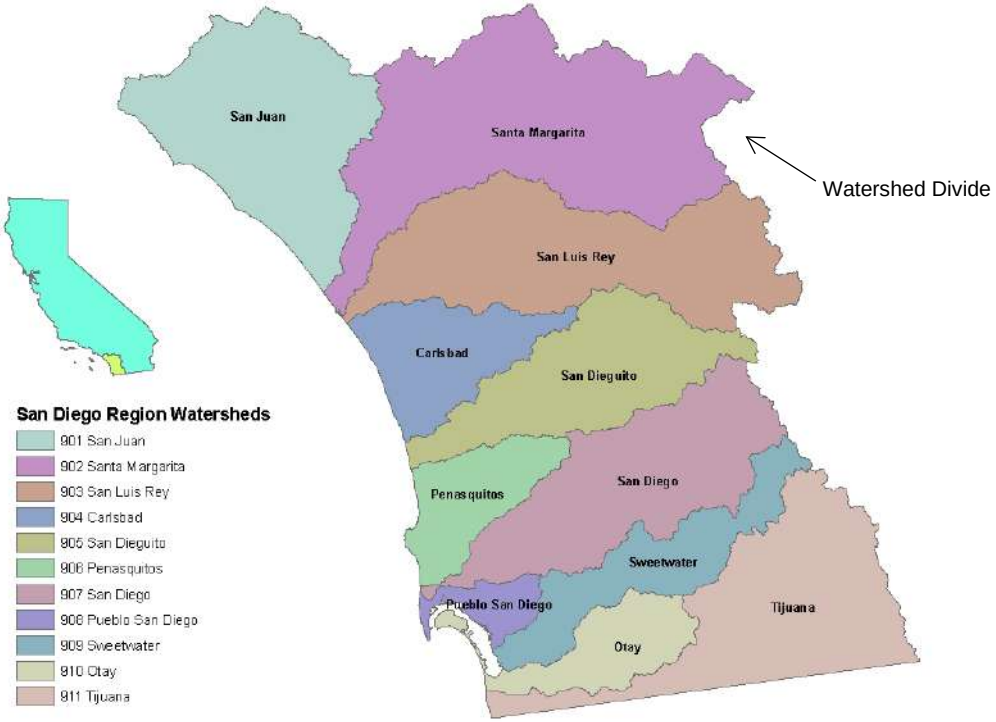
A Green Parking Lot includes Green Infrastructure (GI), incorporating elements found in natural areas into a parking lot area. GI is the living network that connects impervious areas to landscape areas, natural areas, and waterways. GI captures rainfall; cools buildings and pavement; and creates natural 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.





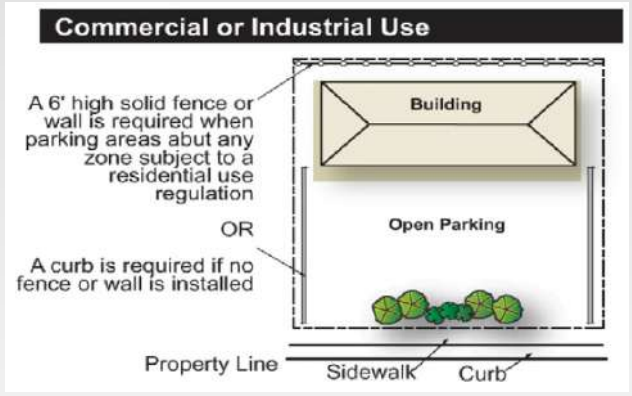




(Source: DDOT, 2014)



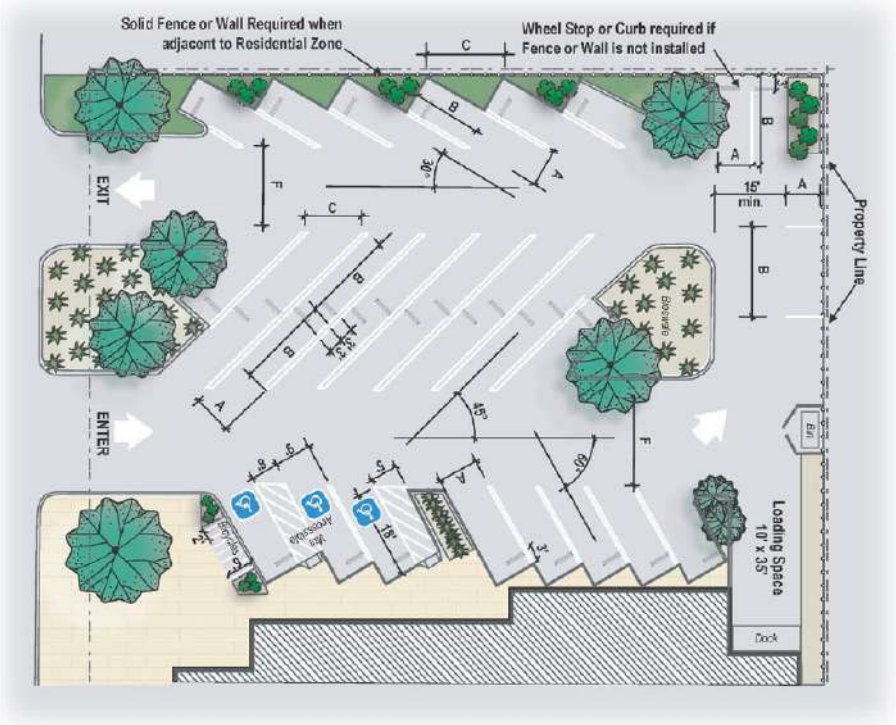




(Source: County of San Diego Parking Design Manual)

1.5 PARKING LOTS

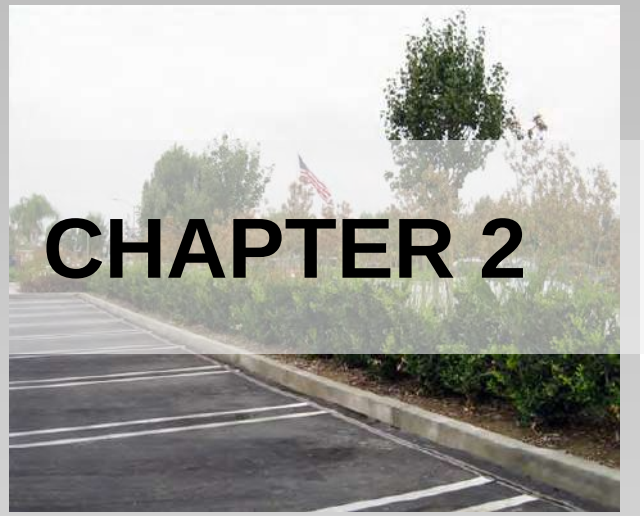
Land within parking lots present a significant opportunity to reduce runoff and improve the urban environment through Green Infrastructure. This manual introduces techniques to install green infrastructure in areas within and around parking lots. This guide includes supplements to the BMP Design Manual, 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.



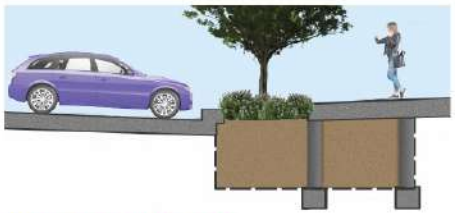
STRUCTURAL SOILS

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

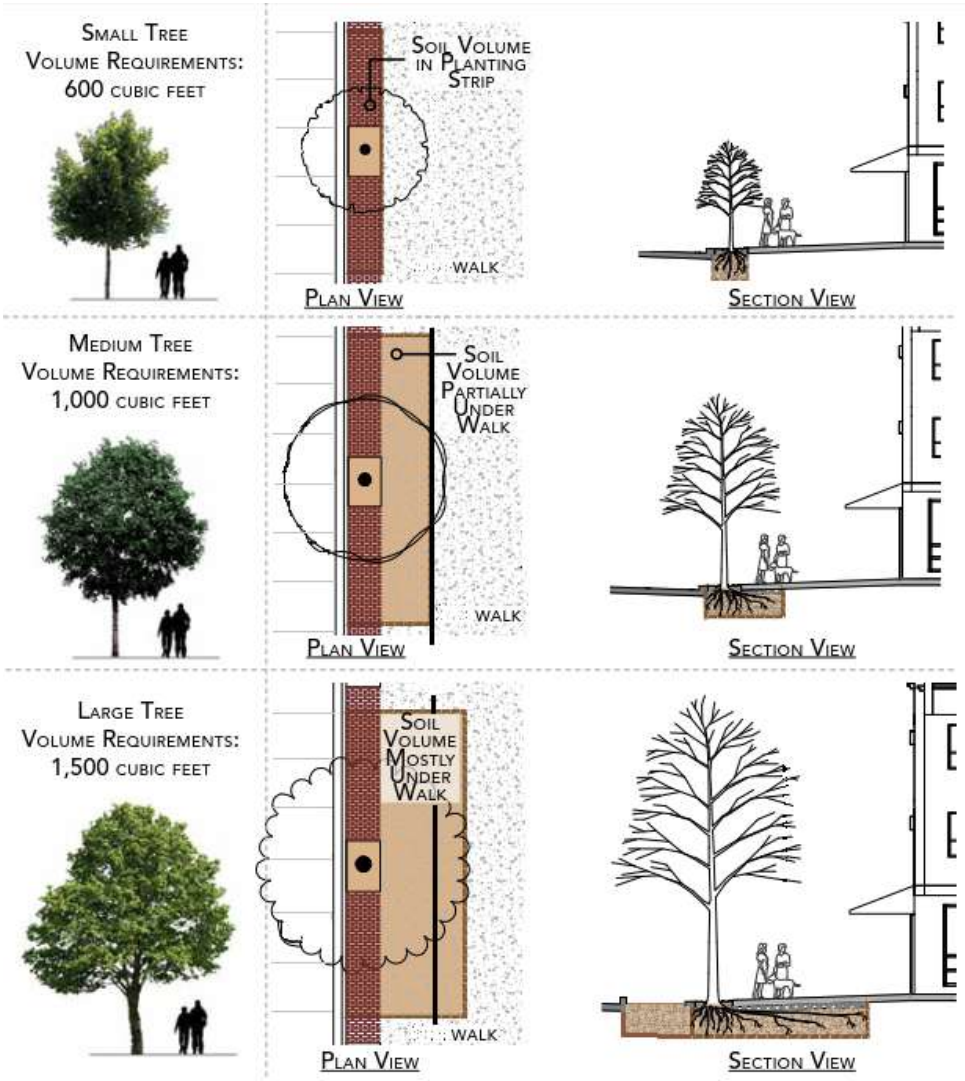
- Adequate soil space provides the nutrients, water, air, and root space that trees need to have a long, healthy life.
- The soil volume required depends on the fully-grown tree size (generally two cubic feet of soil per one square foot of the tree's mature drip line area).
- Soil for trees should be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

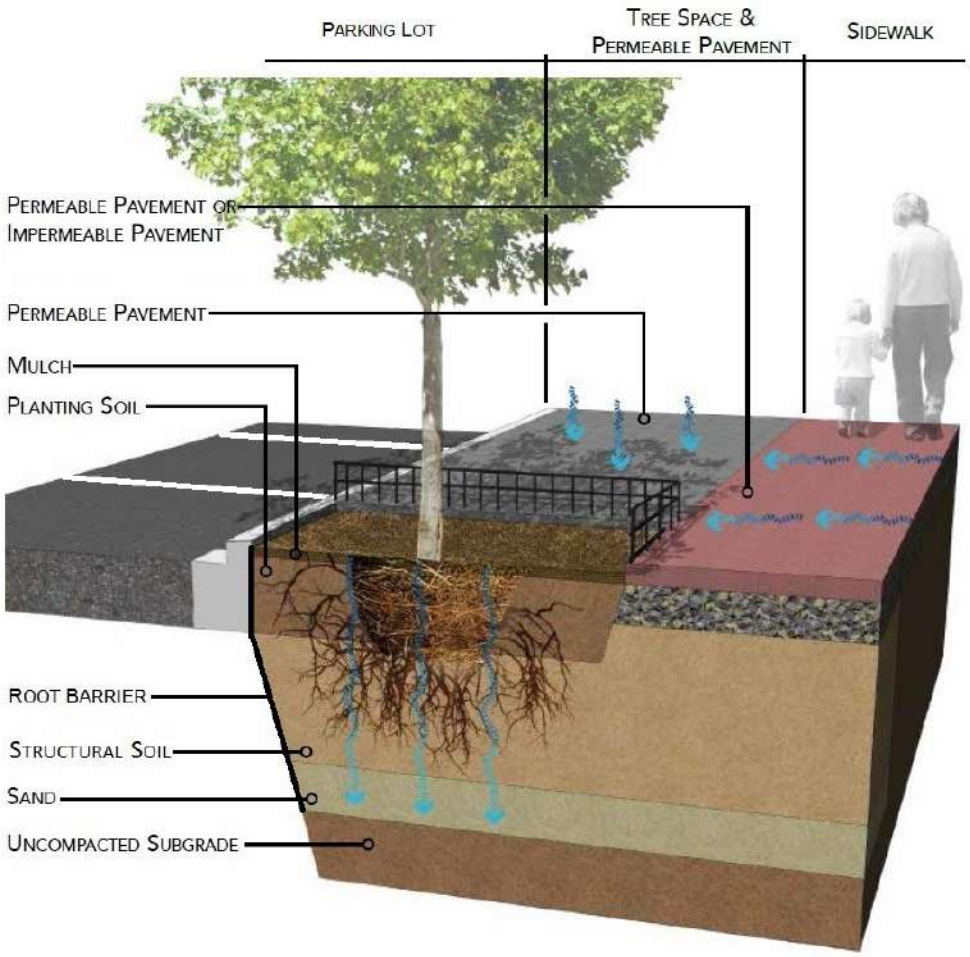
Design Issues

- Maintenance Access: allow for maintenance access
- Pedestrian Considerations: allow for 18-inch minimum setback from curb. Comply with ADA requirements.
- Suspended sidewalks and structural slabs/cells: may require evaluation by geotechnical and structural engineers
- Tree Size: Evaluate tree size versus the required parking lot dimensions.
- Tree Location: 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

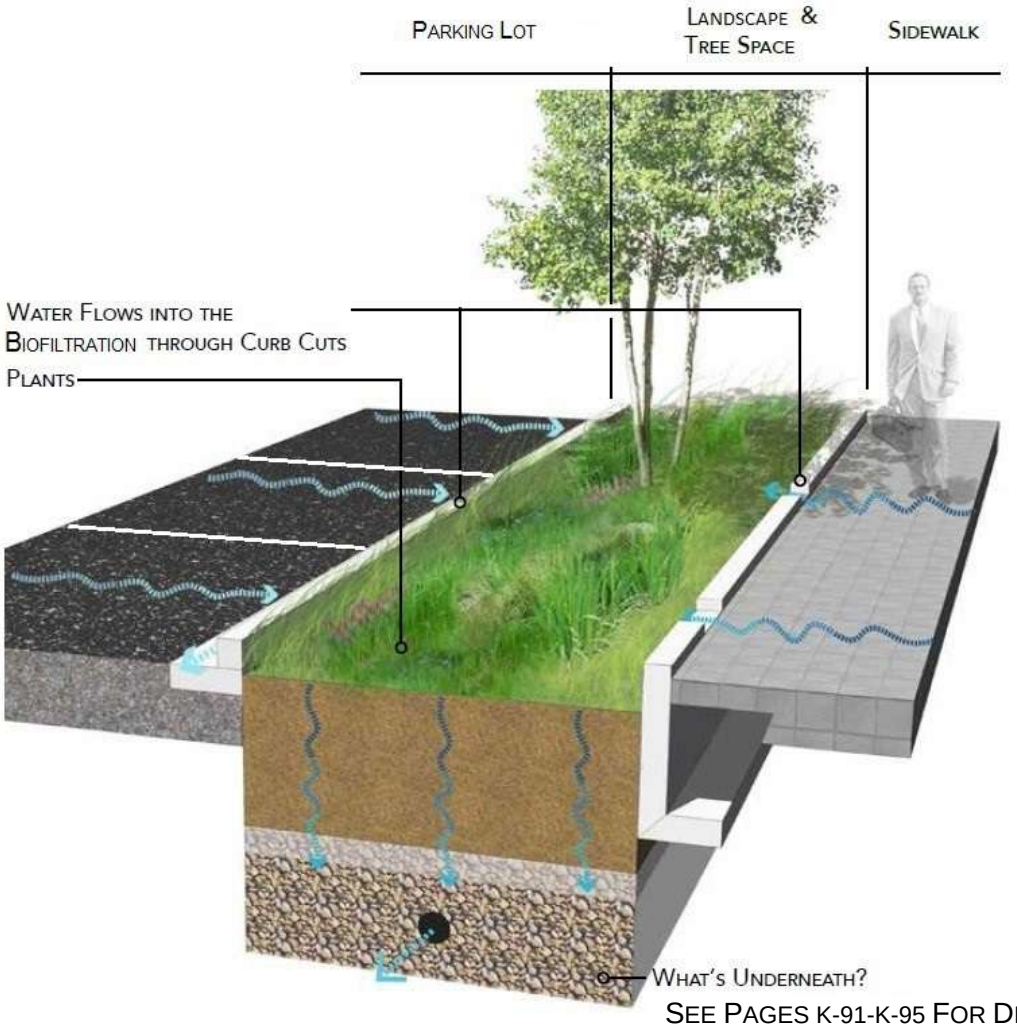
Runoff enters the facility directly or through curb cuts. Excess runoff flows through the system to a drainage outlet.



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

(Source: DDOT, 2014)

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

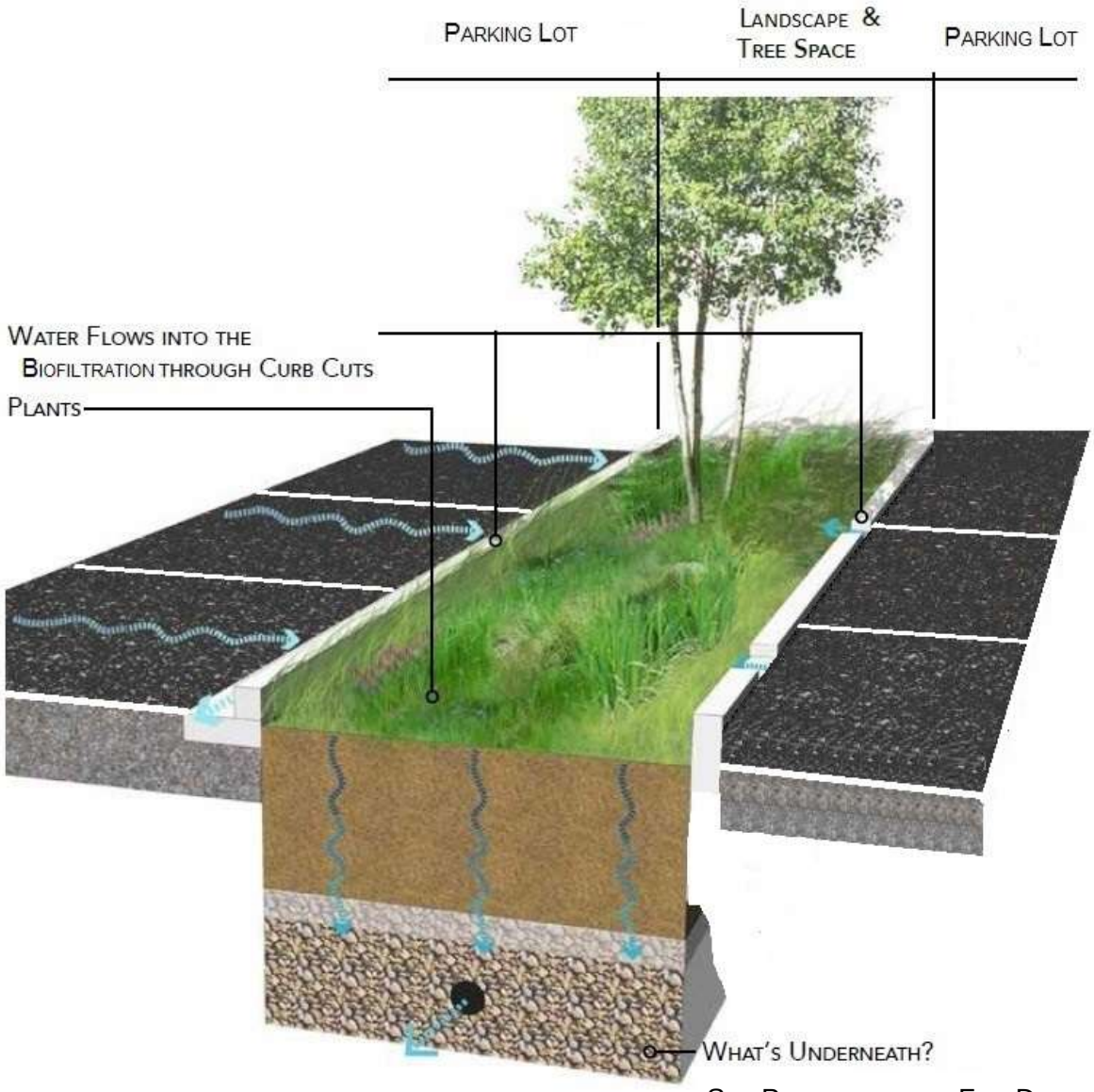
Maintenance Access: Allow for adequate maintenance access from road.

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.

.

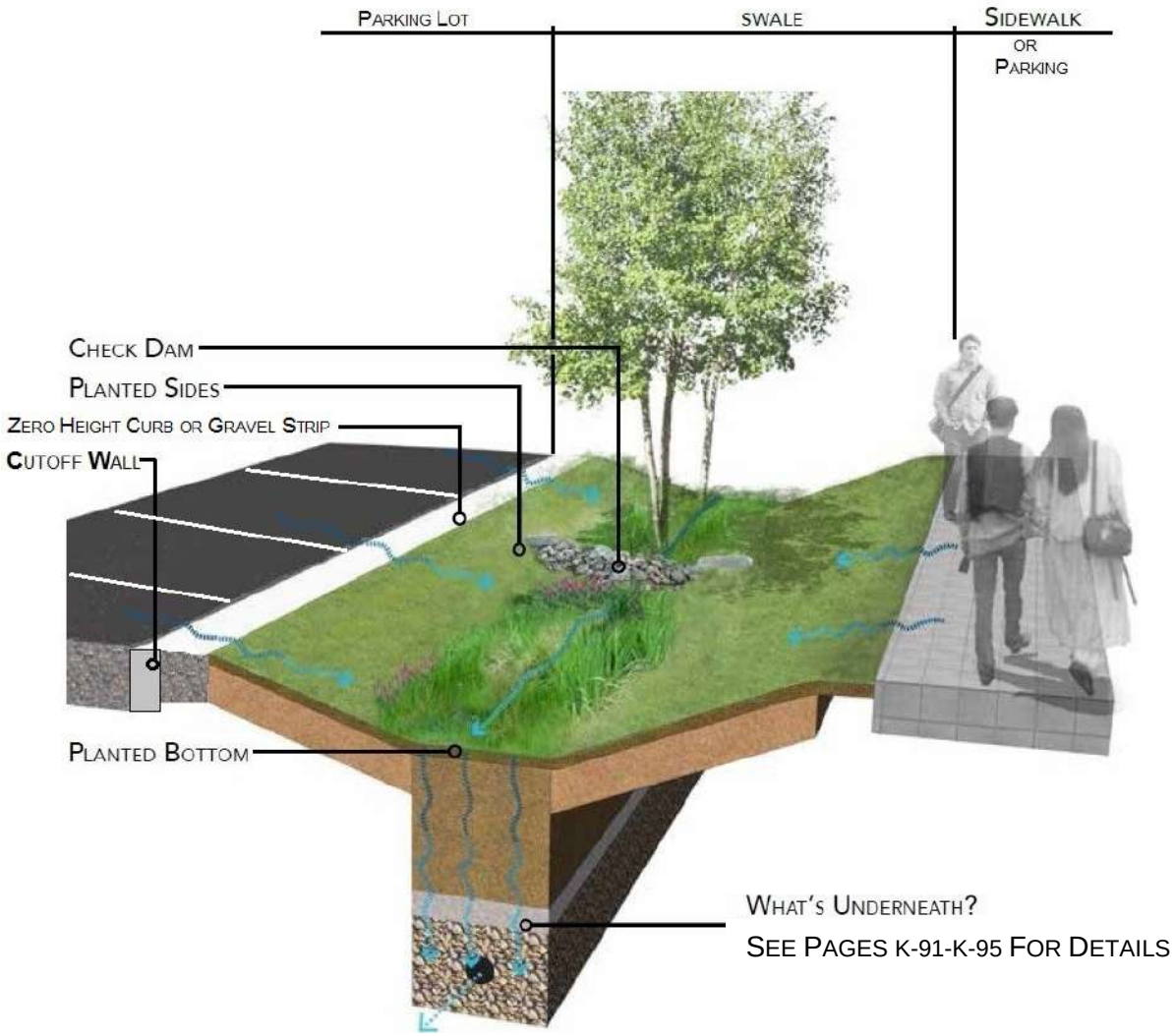
Parking Islands



See Pages K-91-K-95 For Details

(Source: DDOT, 2014)

SWALE ADJACENT TO PARKING



(Source: DDOT, 2014)

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

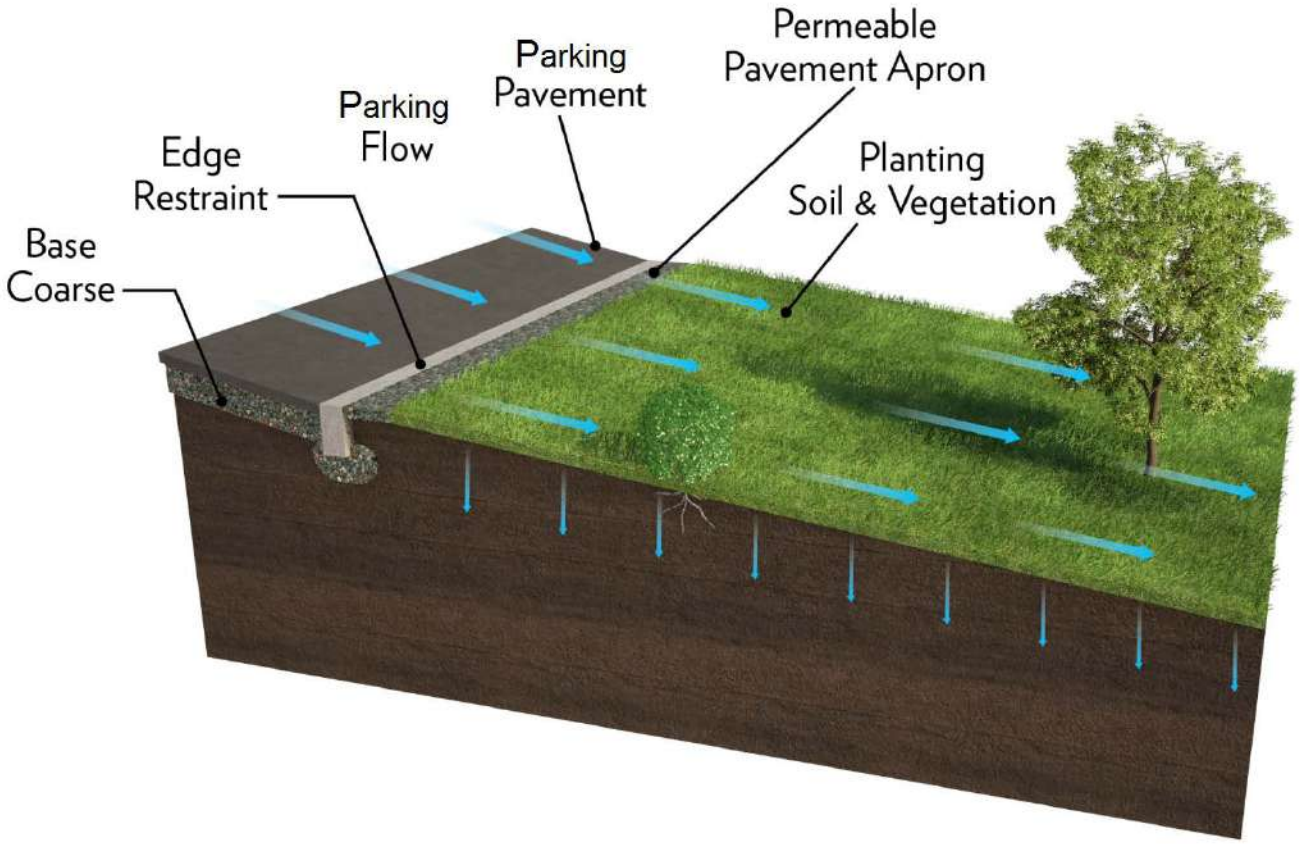
Maintenance: Vegetated cover must be maintained to ensure that filter strips do not export sediment due to erosion of exposed ground.

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



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.

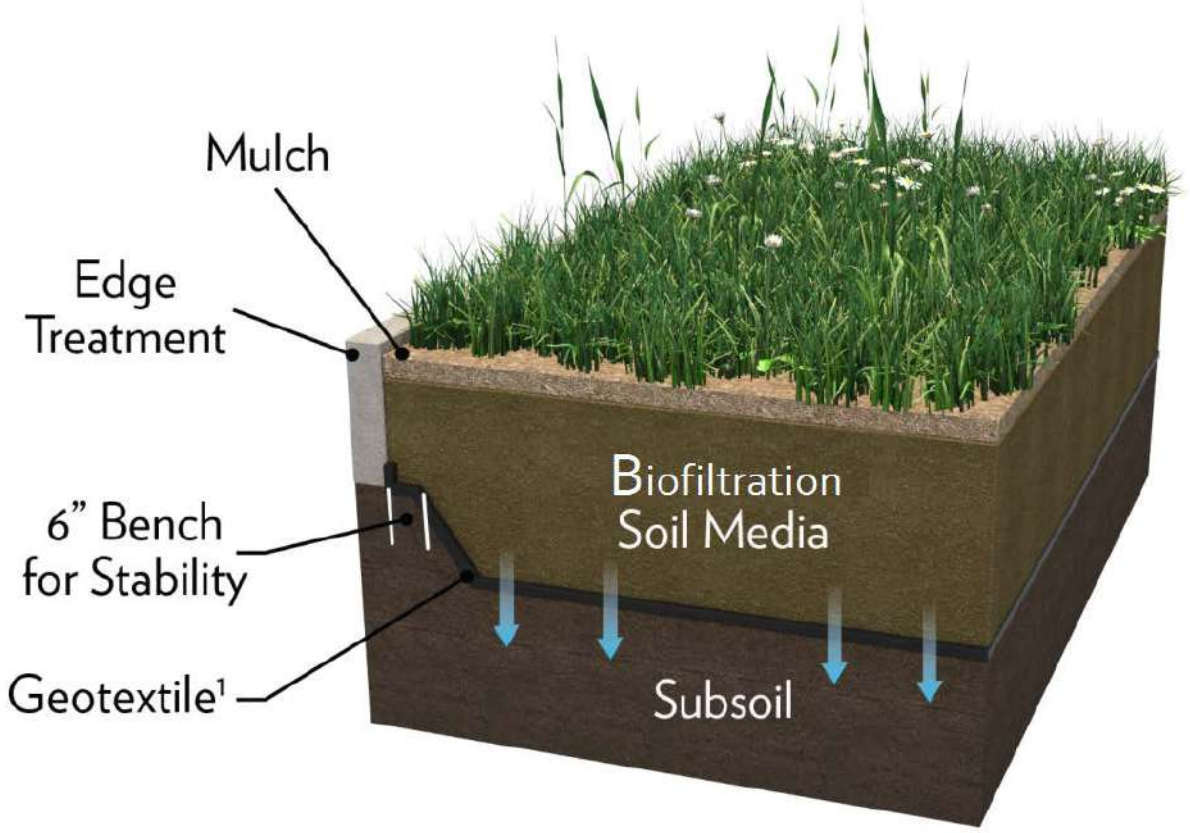
A qualified engineer practicing geotechnical services shall review the proposed stormwater infiltration to provide a professional opinion regarding the potential adverse geotechnical conditions that the implementation of these practices may create. Geotechnical conditions such as slope stability, expansive 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.

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.

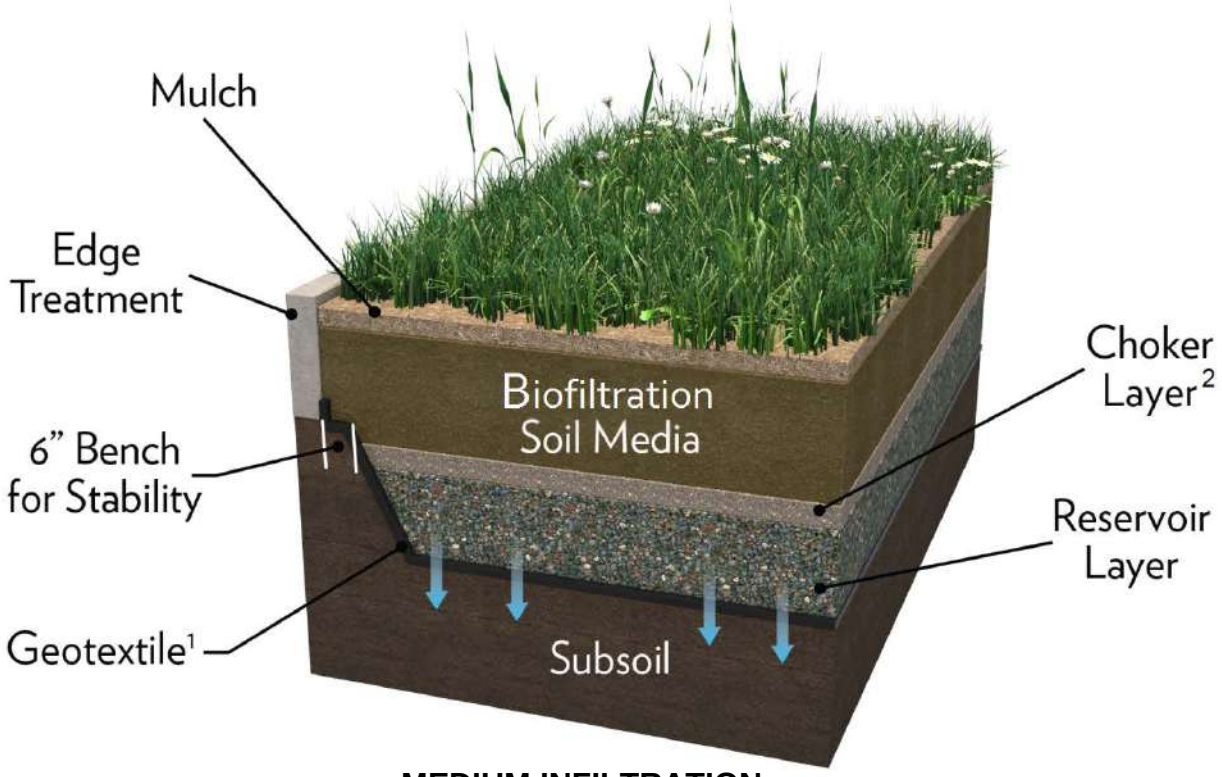
Putting it Together

- 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.

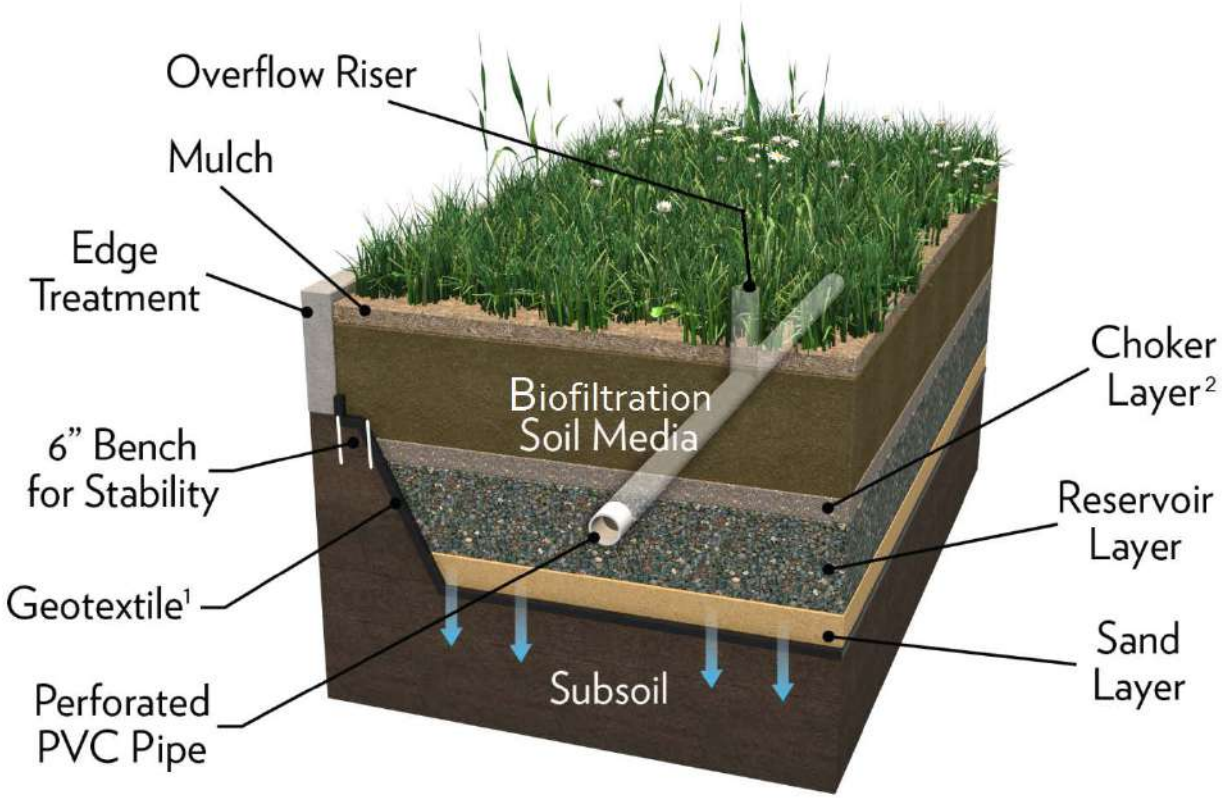
Medium Infiltration



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.

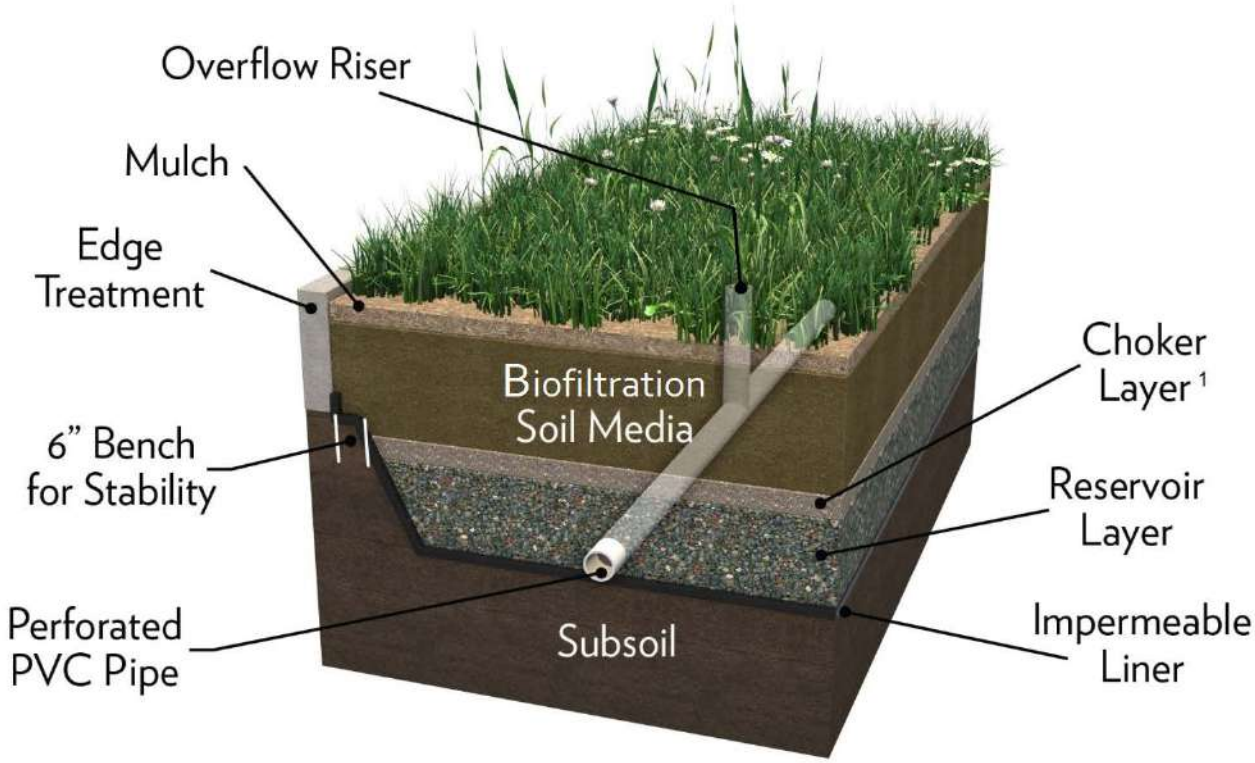
Putting it Together

- 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.

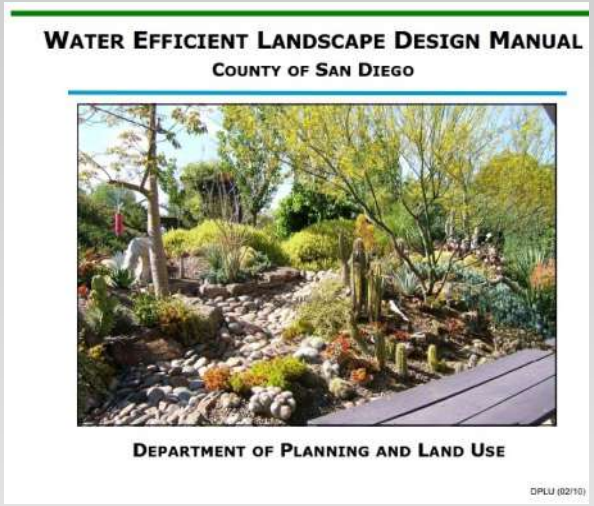
Planting Zones (Hydrozones)

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.







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.



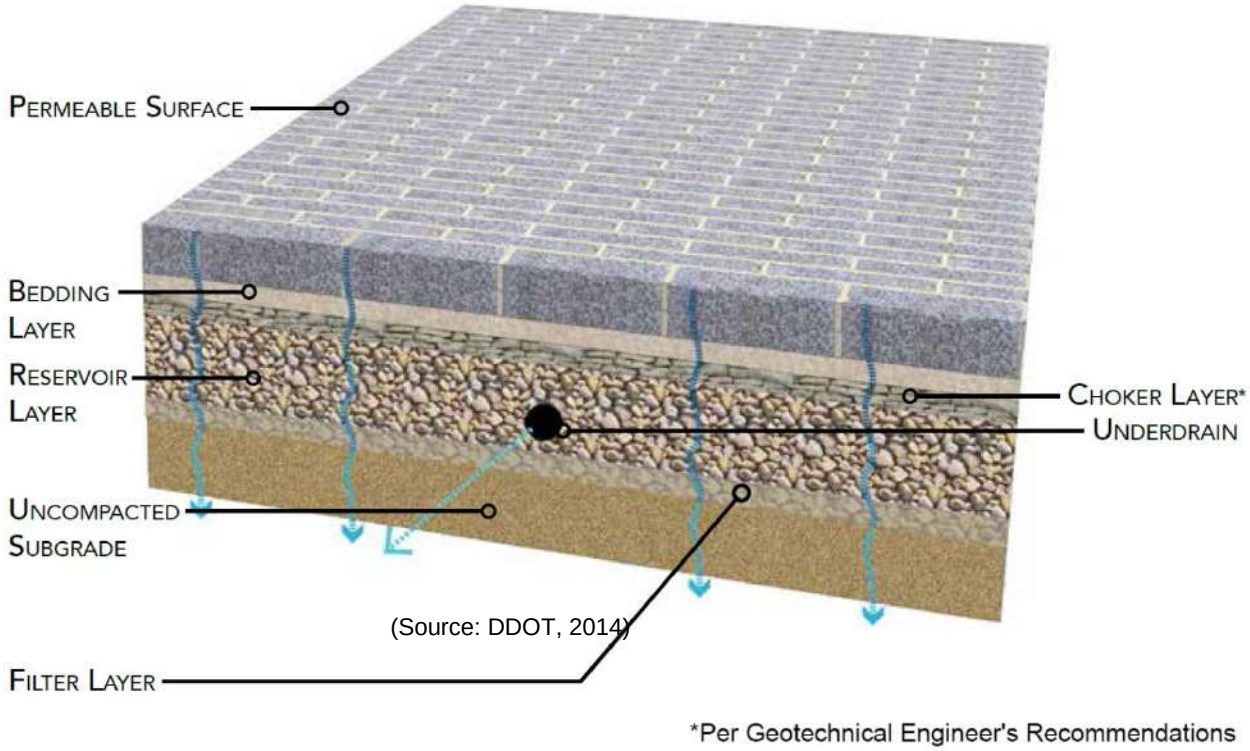
BOARDWALK

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.

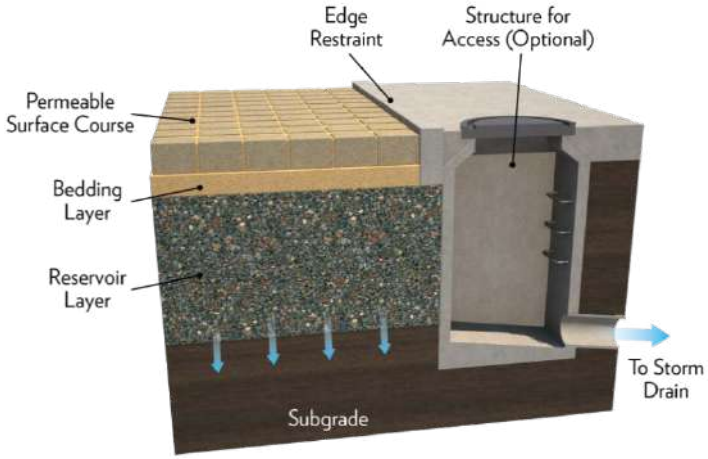
Permeable Pavement – What's Underneath?



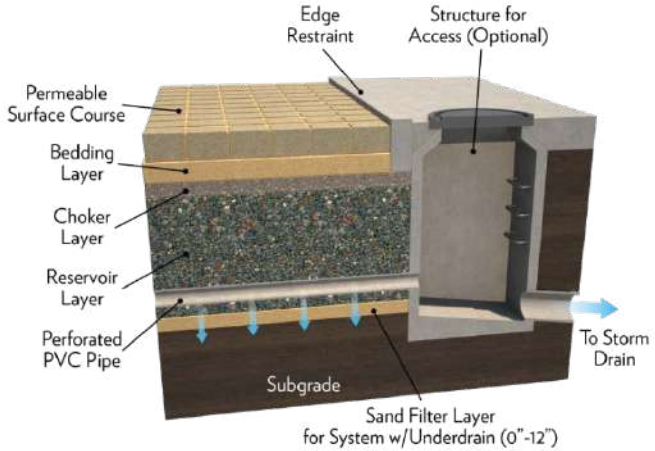
As with dispersion areas and biofiltration, there are multiple options for the subsurface components for permeable pavement including:

- 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

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

Structural Section: A qualified and licensed professional should complete a pavement structural analysis.

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

Pedestrian Considerations: Provide signage to indicate prohibited activities that cause premature clogging.

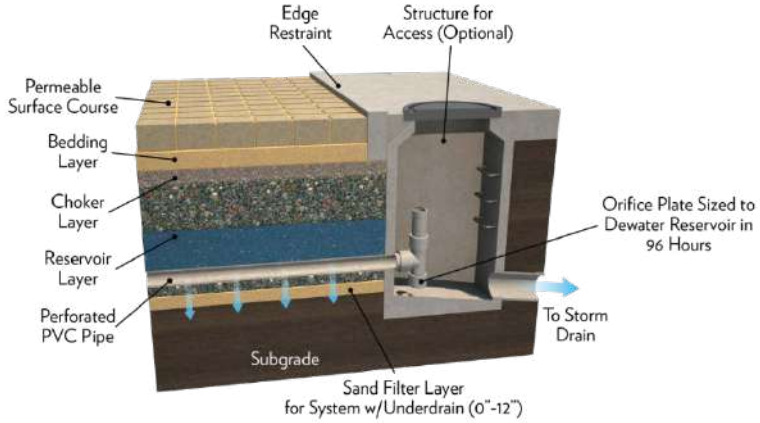
Maintenance Access: Provide adequate access for sweeping and/or vacuuming of surface.



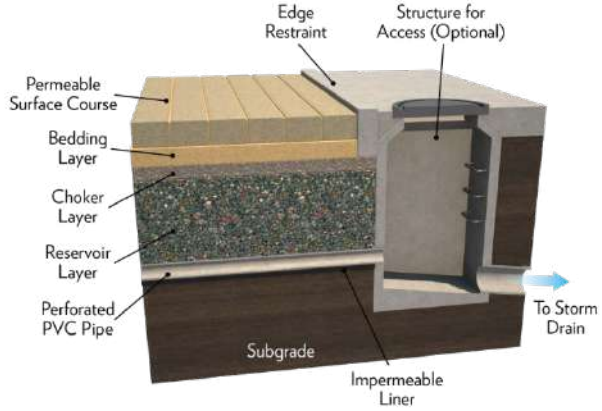




PERMEABLE PAVEMENT SUBSURFACE DESIGN OPTIONS (CONTINUED)



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

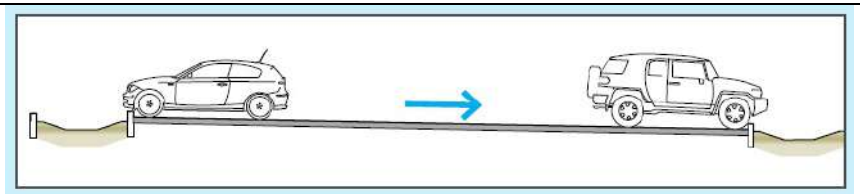
Grading and Drainage

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

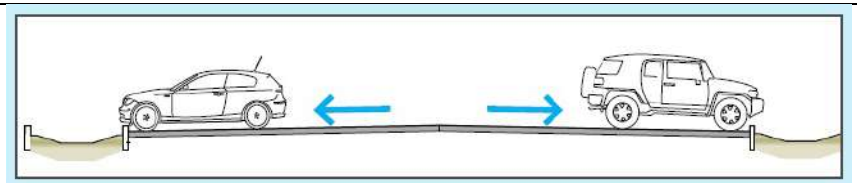
- When designing large parking lots, break up and direct flows to multiple LID features.
- Avoid compaction in biofiltration areas during construction.

Inlets and Outlets

- 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.
- Outlet, including overflow structures, direct excess runoff to the storm drain system.
- Avoid placing overflow structures flush with soil to allow stormwater retention.



Continuous cross slope conveys the full aisle to an adjacent swale



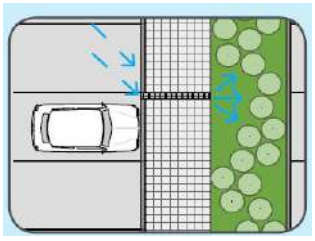
Crowned slope conveys half of each aisle to adjacent swale



A curb inlet directs runoff into a biofiltration planter



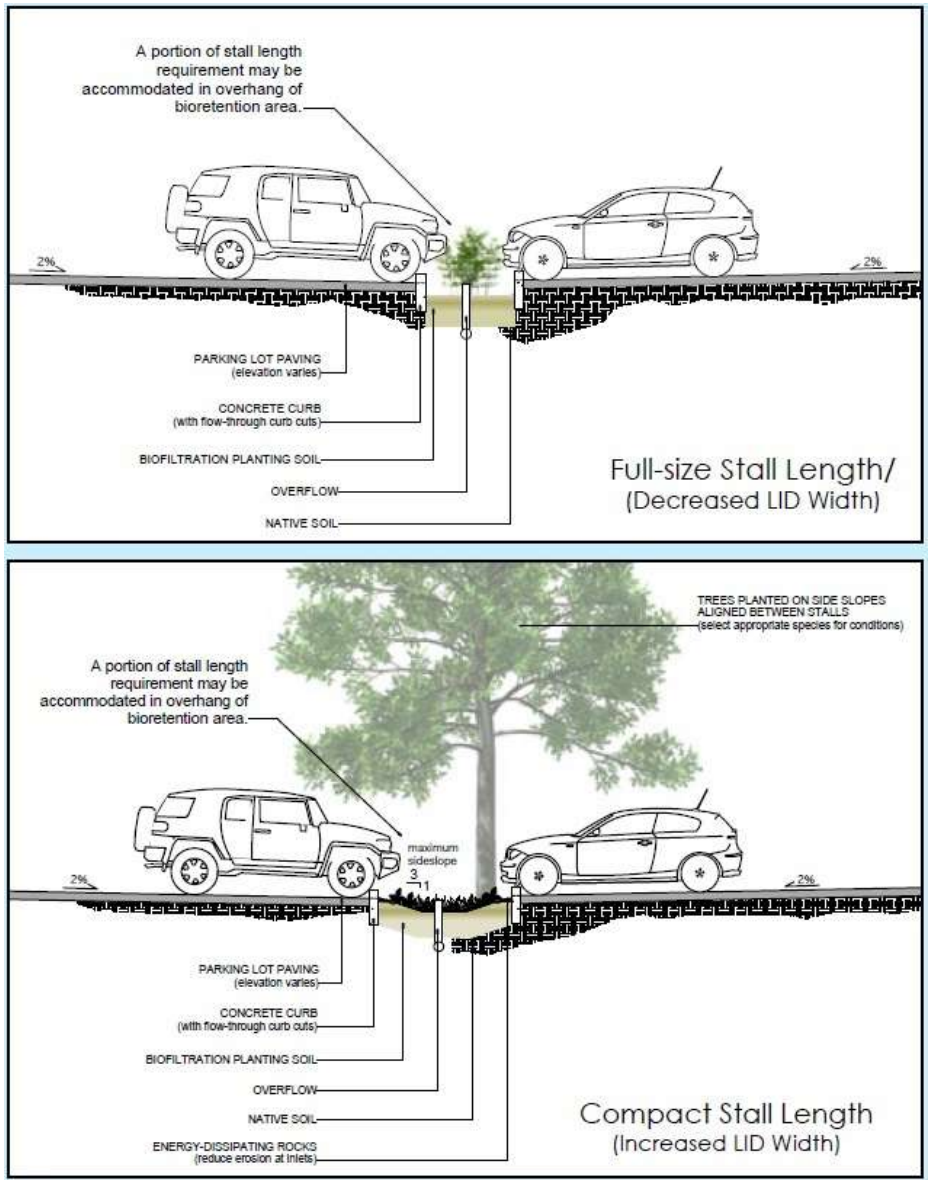
An overflow outlet conveys runoff that exceeds the biofiltration area capacity





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

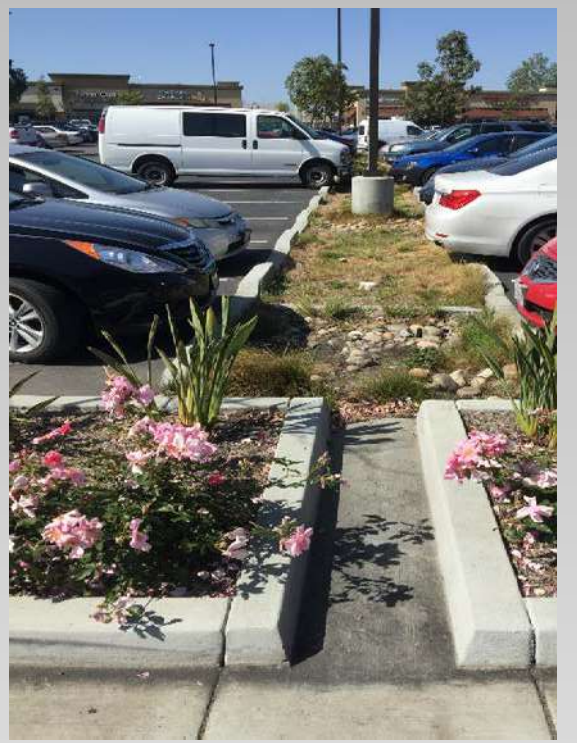
Green Parking Lots Site Design Approach

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

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

- Depressed Island: 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

- Traveled Way:
  - Design lane widths to minimum allowable.
- Shoulder/Parking Lane:
  - 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

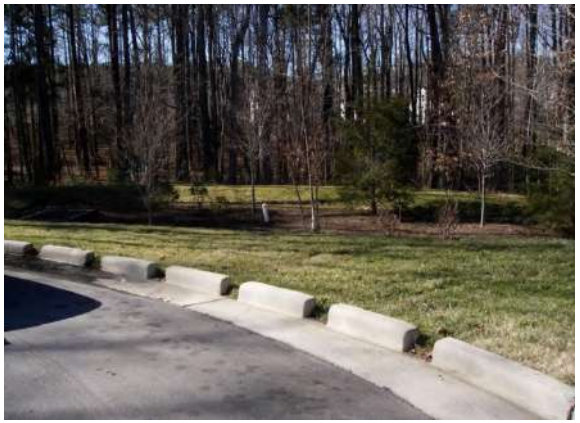
Design Considerations

- 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)		•	









REFERENCES

Central California Coast Technical Assistance Memo, LID Parking Lots
http://centralcoastlidi.org/uploads/LID%20Parking%20TAM_WEB_1.pdf

County of San Diego – Best Management Practice Design Manual, 2016
http://www.sandiegocounty.gov/content/sdc/dpw/watersheds/DevelopmentandConstruction/BMP_Design_Manual.html

County of San Diego – Low Impact Development Handbook, 2014:
sandiegocounty.gov/content/sdc/dpw/watersheds/susmp/lid

County of San Diego – Standard Urban Stormwater Mitigation Plan Requirements for Development Applications, 2012:
sandiegocounty.gov/dpw/watersheds/susmp/susmp

DDOT – Greening DC Streets, 2014:
ddot.dc.gov/GreenInfrastructure

City of Los Angeles – Green Streets and Green Alleys Design Guidelines Standards, 2009:
nacto.org/docs/usdg/green_streets_and_green_alleys_la.pdf

Montgomery County, MD - Environmental Site Design Implementation in Montgomery County, Maryland: Image Library,2011:
http://www.montgomeryplanning.org/environment/documents/esd_implementation_graphics_201108.pdf

This page was left intentionally blank.