Class 2:
SW Quality Design, LID & Green Infrastructure

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CITY OF TOPEKA UTILITIES

Stormwater Design Handbook
Webinar Training Series

Topic

Manual Section #

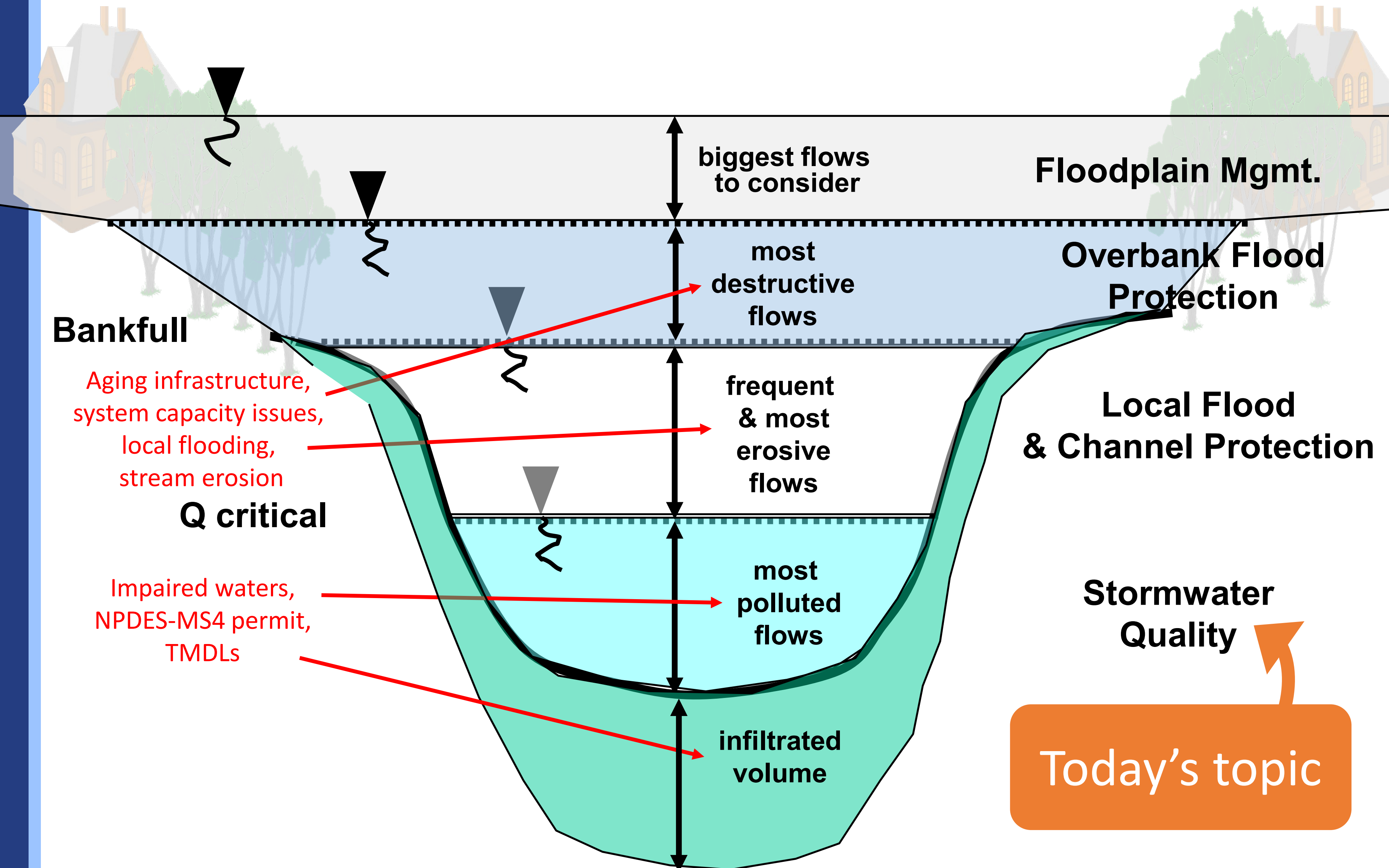
Topeka Stormwater BMP Design Handbook

What topic is the trainer discussing

Where to find this topic in the Augusta Manual

Stormwater Quality Design Compliance

Today's Stormwater Regulation Program



Important Terms for Today

Stormwater Quality BMP

A ***structural*** BMP that "treats" runoff to protect streams and properties from pollutants in runoff

Treatment methods:

- Volume removal; or
- Pollutant removal

Bioretention BMP on Jackson Street in Topeka

Extended Dry Detention BMP

Important Terms for Today

Green Infrastructure BMP (GI-BMP)

A stormwater quality BMP designed to treat runoff using **volume removal**

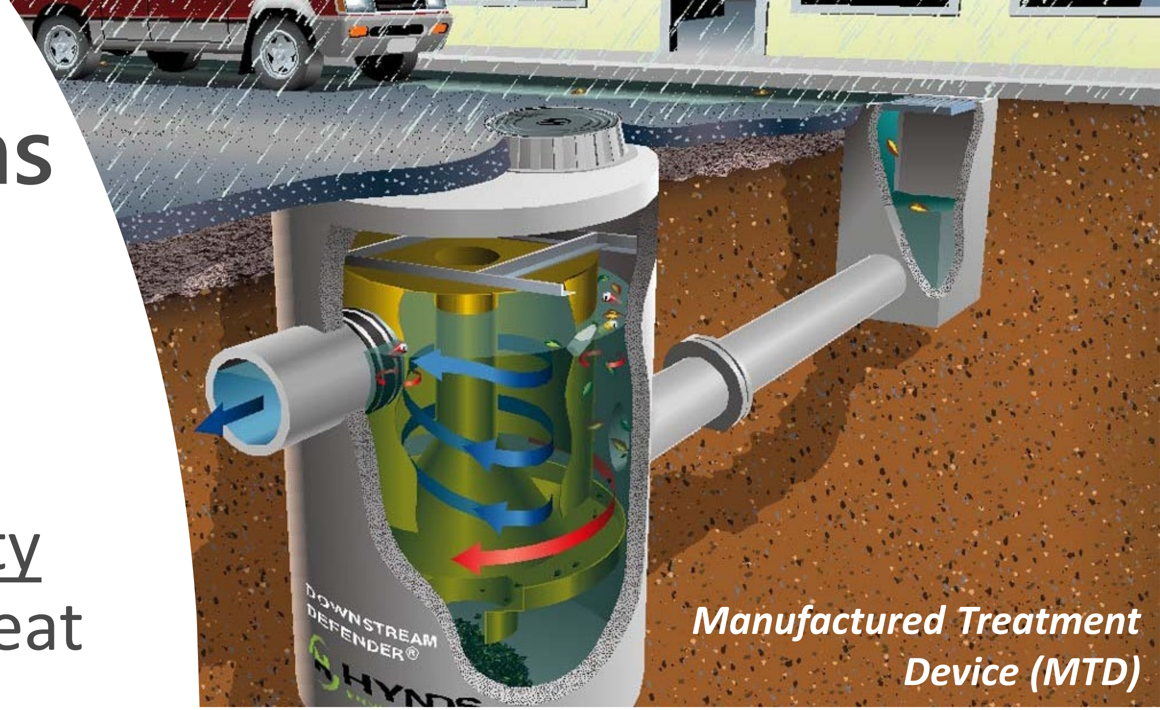
Bioretention BMP on private property in Topeka

Bioretention BMP on Jackson Street in Topeka

Important Terms for Today

Traditional BMP

A stormwater <u>quality</u> BMP designed to treat runoff using **pollutant removal**



Manufactured Treatment Device (MTD)

Native vegetated dry detention BMP in Topeka

Important Terms for Today

Low Impact Development (LID)

A ***nonstructural*** site planning technique that to promote runoff volume reduction using the land’s natural hydrology

Commercial Green Space

Pocket Prairie

Stormwater Quality Applicability (Who's in?)

Driver: NPDES-MS4 Permit requirements

- Applies to new/redevelopments > 1 acre land disturbance
- Consider structural and non-structural strategies
- Ensure the long-term BMP maintenance and operation

Original EPA requirements
(circa 2003)

Stormwater Quality Applicability

Chapter 13.35

Section 010

Topeka Municipal Code

Who's In for Stormwater Quality?

- Subdivision plats & site plans that
  - Disturb 1 acre or more

    or
  - Disturb less than 1 acre but discharge to an impacted waterbody
- Does this include subdivisions with private roads? YES, if the subdivision project meets the above criteria.
- Excludes plats/plans approved before January 1, 2021
  - Must comply with current rules

Stormwater Quality Applicability

Chapter 13.35

Section 020

Topeka Municipal Code

Exemptions

- When a plat or site is not required
- 1 or 2-family residences on a lot
  - Located in a residential subdivision
    - Platted before August 29, 2011; or
    - Served by a BMP that already meets the stormwater quality rule
  - Must be designed to safely drain to a vegetated area or channel before discharging to the public system

Stormwater Quality Applicability

Chapter 13.35

Section 020

Topeka Municipal Code

Can I get a waiver?

- Maybe
  - if BMPs will cause problems *(not likely)*
  - if a downstream BMP can provide compliance before discharge to stream

BE AWARE!

Topeka is required by KDHE's municipal stormwater permit to regulate stormwater quality.

The permit does not include exemptions or waivers!

A waiver of stormwater quality compliance for an applicable site is highly unlikely.

Downstream BMP Waiver

Stormwater Quality Applicability

Chapter 13.35

Section 020

Topeka Municipal Code

- Runoff must:
  - Drain to downstream BMP before public system or waterbody
  - Not cause negative impacts between the project and the downstream BMP
- BMP must be fully functional or improved to fully function ***prior*** to site construction
  - Full function = meets current stormwater rules
- Applicant is responsible for coordinating with downstream BMP Owner
- Applicant must obtain an agreement from BMP Owner authorizing discharge and establishing maintenance responsibilities
  - Must be recorded with County Register of Deeds

How do I comply?

Stormwater Quality Compliance

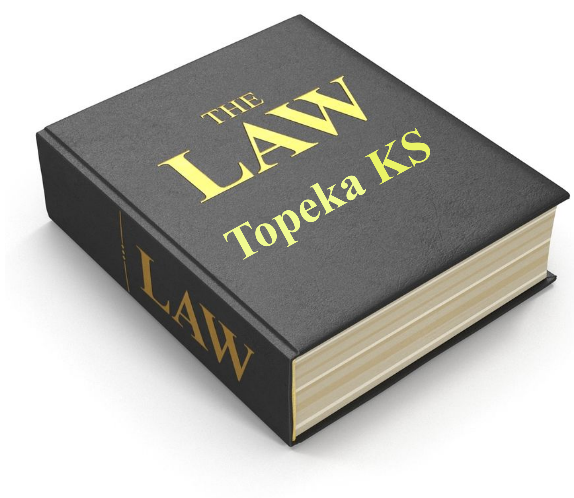
Chapter 13.35

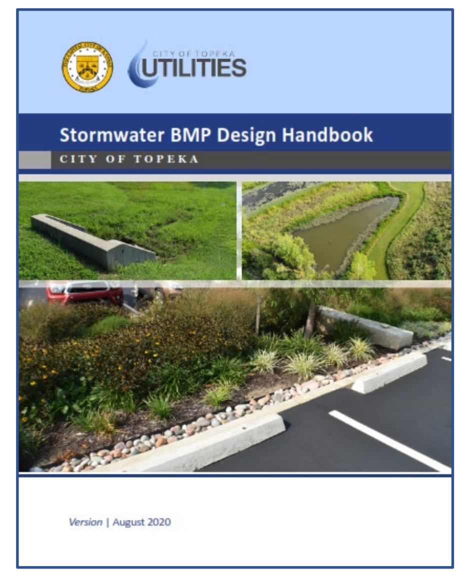
Section 030

Topeka Municipal Code

Applicable projects **SHALL**:

- Be designed for *natural* infiltration to the maximum extent possible using LID
- Provide stormwater quality treatment
- As specified in the BMP Design Handbook





The Handbook says

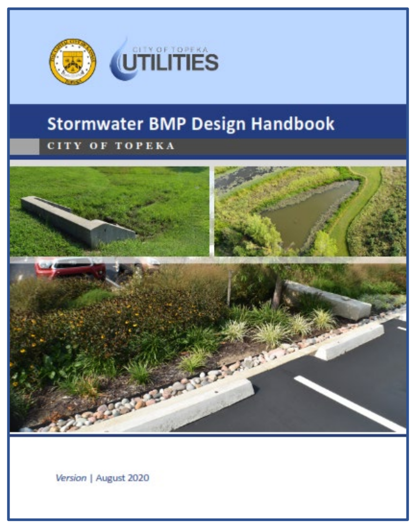
Stormwater Quality Compliance

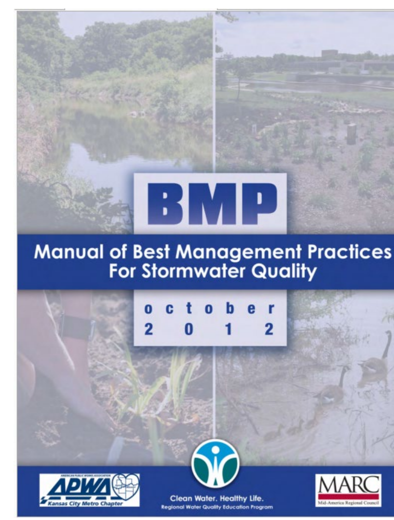
Chapter 3

Section 3.3

Topeka Stormwater BMP Design Handbook

- Project designs <u>**shall**</u> meet or exceed the Level of Service (LS) using the method and BMP design specs in the MARC Manual
- *Note – one BMP spec is the Handbook (cisterns)*





Complimentary Documents for BMP Design

Use the MARC Manual for:

- Guidance of the Level of Service Method
- Required equations & calculations
- Level of Service worksheets
- Design Mitigation Package worksheets
- BMP Design Specifications

Use the Handbook for:

- New Value Rating Table
  - Non-native Extended Dry Detention Basin
  - Non-native Vegetated Swale
- Cistern BMP design specification
- New policies for:
  - Manufactured Treatment Devices
  - Landscape Credits
  - Infiltration feasibility & test reqmts
  - Underdrain use policies
  - Vegetated BMPs policies
- BMP Design Procedure Forms for all BMPs aligned w/ Topeka reqmts

Stormwater Quality Compliance

Chapter 3

Table 3.1

Topeka Stormwater BMP Design Handbook

Use the Handbook's Value Ratings!

Table 3-1. Stormwater Quality BMP Value Ratings (adapted from *MARC/APWA BMP Manual*, 2012)

Cover Type or BMP	*Median Expected Effluent EMC TSS (mg/L)**	*Value Ratings*				*Overall Value Rating*
		Water Quality Value	*Volume Reduction*	*Temp. Reduction*	*Oils/ Floatables Reduction*	
Native Vegetation Preserved/Established	N/A	5.25	2	1	1	**9.25**
Rain Garden	< 10	4	2	1	2	**9.0**
Infiltration Basin	< 10	4	2	1	2	**9.0**
Infiltration Trench	< 10	4	2	1	2	**9.0**
Bioretention	< 10	4	1.5	1	2	**8.5**
Pervious Concrete	10 - 20	3	1.5	1	2	**7.5**
Porous Asphalt	10 - 20	3	1.5	1	2	**7.5**
Modular Concrete Block	10 - 20	3	1.5	1	2	**7.5**
Extended Detention Wetland	< 10	4	2	0	1	**7.0**
Surface Sand Filter	< 10	4	0	0	2	**6.0**
Underground Sand Filter	< 10	4	0	0	2	**6.0**
Pocket Sand Filter	< 10	4	0	0	2	**6.0**
Perimeter Sand Filter	< 10	4	0	0	2	**6.0**
Extended Wet Detention Basin	10 - 20	3	2	-1	1	**5.0**
Vegetated Filter Strip	10 - 20	3	1	0	1	**5.0**
Extended Dry Det. Basin (Native Veg.)	20 - 50	3	1	0	0	**4.0**
Extended Dry Det. Basin (Non-Native Veg.)	20 - 50	2	0	0	0	**2.0**
Native Vegetation Swale	10 - 20	3	1	0	0	**4.0**
Non-Native Grass Vegetation Swale	10 - 20	1.5	0	0	0	**1.5**
Other Systems *(Manufactured Treatment Devices)*	10 - 100	1 – 3	0	0	2	**3.0 - 5.0**
- Proprietary Media Filtration Devices - Hydrodynamic Devices - Baffle Boxes - Catch Basin Inserts	Approved on a case-by-case basis. See Section 3.6 for design requirements.					
Green Roofs	No VR; Post-construction CN credit; See *MARC/APWA Manual*					
Cisterns	No VR; Post-construction CN credit; See Appendix F					

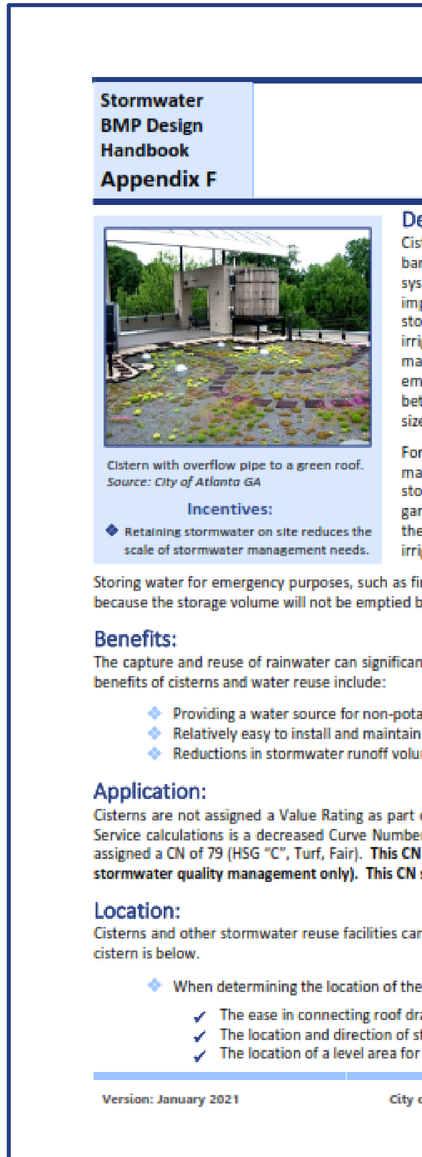
* TSS (Total Suspended Solids); mg/L (milligrams per liter); EMC (Event Mean Concentration); See *MARC/APWA BMP Manual* for more information on the derivation of the Value Ratings and source of TSS EMC data for most BMPs.

Cistern BMP Design Specification

Appendix F

Topeka Stormwater BMP Design Handbook

1/8/2021


Stormwater BMP Design Handbook
Appendix F

City of Topeka, KS
Design Specifications
Cisterns

Cistern with overflow pipe to a green roof.
Source: City of Atlanta GA

Incentives:
- Retaining stormwater on site reduces the scale of stormwater management needs.

Description:
Cisterns and other tanks with similar functions, such as rain barrels, stormwater reservoirs, and rainwater harvesting syst
impe
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Storing water for emergency purposes, such as fire
because the storage volume will not be emptied be

Benefits:
The capture and reuse of rainwater can significant
benefits of cisterns and water reuse include:
- Providing a water source for non-potab
- Relatively easy to install and maintain,
- Reductions in stormwater runoff volum

Application:
Cisterns are not assigned a Value Rating as part o
Service calculations is a decreased Curve Number
assigned a CN of 79 (HSG "C", Turf, Fair). **This CN i**
stormwater quality management only). This CN sh

Location:
Cisterns and other stormwater reuse facilities can
cistern is below.
- When determining the location of the c
  - ✓ The ease in connecting roof drai
  - ✓ The location and direction of sto
  - ✓ The location of a level area for t

Version: January 2021 City of


Stormwater BMP Design Handbook
City of Topeka KS
Design Specification - Cisterns continued

- ✓ The cistern's location relative to its intended water uses
- ✓ Location of hoses or other water distribution components
- ✓ Possible conflicts of the cistern location with buildings, roadways, or utilities
- ✓ The locations of necessary electrical connections, if applicable
- ✓ Emergency ingress/egress needs from the building, site, or cistern area
- ✓ Surrounding or nearby foliage and the need for a leaf screen option
- ✓ Aesthetic considerations

- Ensure adequate space is provided for appropriate foundation and structural support for the cistern or tank structure.
- Choose an adequate discharge location and overflow route to a vegetated landscaped area or additional GI facility (e.g., green roof, bioretention, etc.). Remember that overflow is stormwater and must be considered as a part of the land development for purposes of meeting stormwater quantity management requirements.

Design:
Cisterns must be designed to meet a specific and consistently repeatable water reuse demand. Multiple devices can be used to increase available storage and simplify routing for reuse. Devices should be of the appropriate type and have sufficient capacity for the intended application as noted.
- ✓ Rain barrel (50 to 150 gallons)
- ✓ Cistern (500 to 7,000 gallons)
- ✓ Large aboveground tank (3,000 to 12,000 gallons)

Photo: Cistern used to capture runoff from the rooftop and irrigate a nearby bioretention BMP. *(Source: Wood E&IS)*

In order to include the retained volume in stormwater design calculations, **the stormwater captured in the cistern must be fully re-used in the first 72 hours after the storm event.** Prepare a rainwater reuse schedule to confirm that the cistern:
- ✓ is allowed by City code;
- ✓ is appropriately sized to meet the demand for the intended reuse application;
- ✓ sufficiently draws down stored water within 72 hours after capture to maintain available cistern storage for the next storm event;
- ✓ accommodates the variation in storage demand as a result of season or high/low use periods;
- ✓ accounts for bypass and overflow runoff volumes in overall site design.

Other design requirements are as follows.
- ✓ Include one or more pretreatment measures to remove debris, dust, leaves, and other materials before stormwater enters the cistern.
- ✓ Fully cover or enclose the stored water to avoid potential mosquito breeding.

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Manufactured Treatment Devices

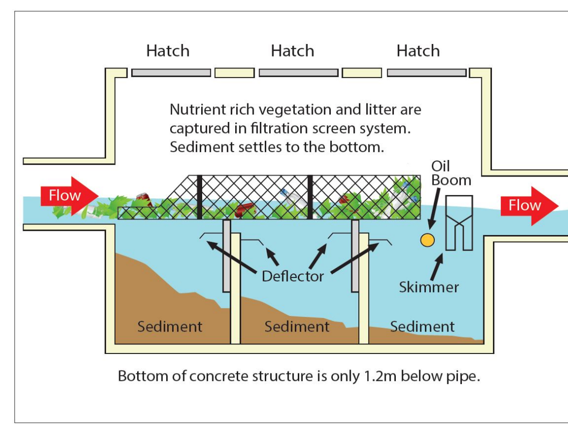
- Flow-through technology
- Effectiveness on is fiercely debated

The Good:

- Good for gross solids (litter, debris, etc.) or special pollutants (e.g., oil)
- Small footprint or underground

The Bad:

- Limited data on sediment removal
- Frequent maintenance is a must
- Some require replacement cartridges



Manufactured Treatment Device Policies

Chapter 3

Section 3.7

Topeka Stormwater BMP Design Handbook

MTD Policies

- Considered on a case-by-case basis
- City will evaluate appropriateness and capability of MTD for the pollutants, land use, and owner situation
- Encouraged to consult the City before design
- Provide make, model, size, flow rate, manufacturer and vendor information in SWMP and As-Built Plan
- Install same exact MTD as shown on approved SWMP
- See City website for MTDs that have a Value Rating

https://www.topeka.org/utilities/about-the-stormwater-utility/

Questions from last class

- For a subdivision w/ private roads:
  - Who maintains the stormwater quality BMPs?
  - The owner(s) of the property where the BMP is located.

  - Will Homeowner's Associations be required to perform BMP maintenance?
  - Yes, if the HOA is the property owner

  - Can BMPs be placed in the public ROW?
  - No, private developments cannot place BMPs in the public ROW

Introduction to LID & Green Infrastructure

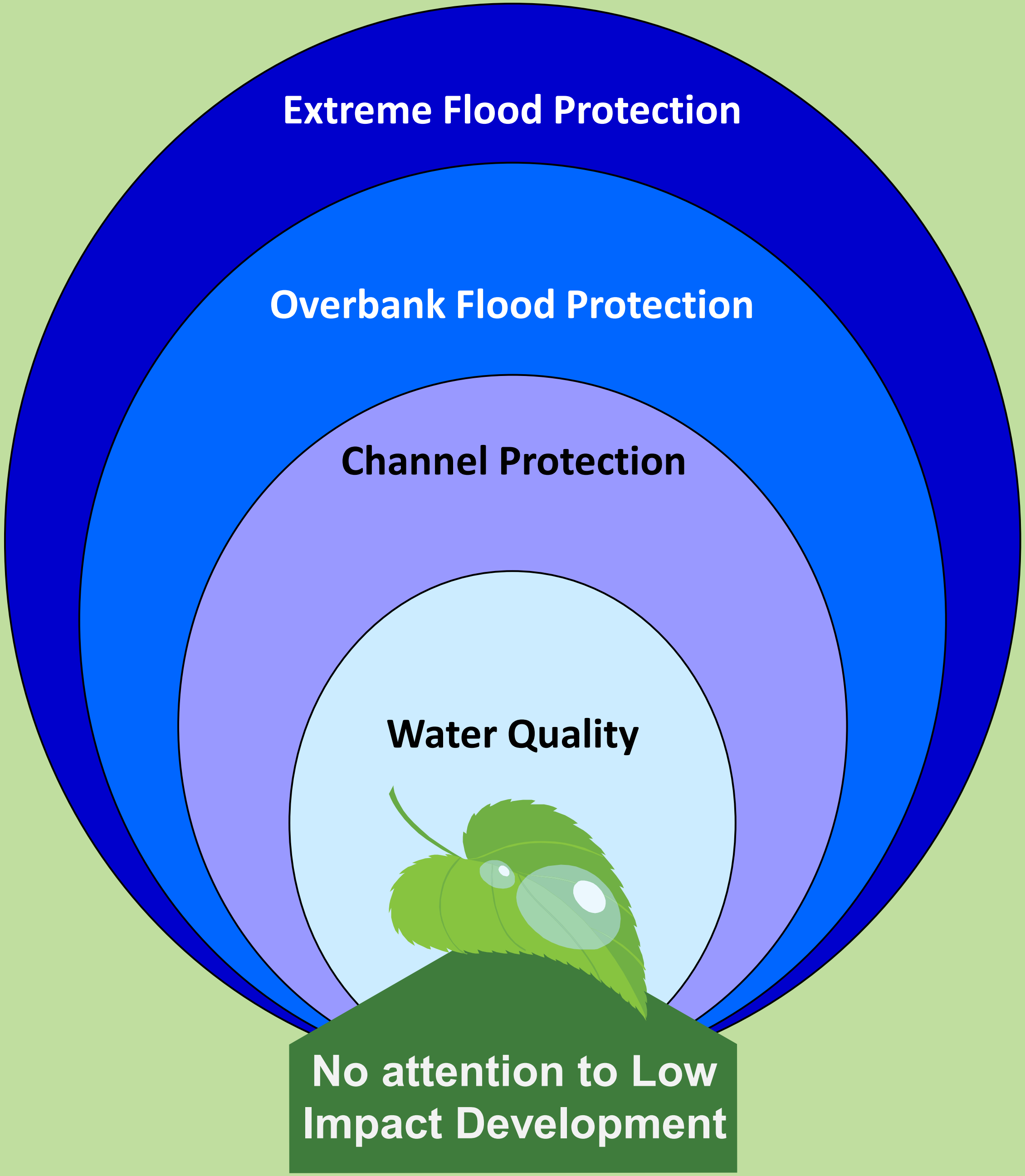


Driver: NPDES-MS4 Permit requirements

– Applies to new/redevelopments > 1 acre land disturbance
– Consider **structural and non-structural strategies**
– Ensure the long-term BMP maintenance and operation

Original EPA requirements
(circa 2003)

Typical Site-Level Stormwater Controls Since 2003



Typical Stormwater Quality BMPs

Extended Detention Ponds:
- Good for slowing runoff
- Removes pollutants through settling
- Can provide flood protection

Manufactured Treatment Devices
- Small or no footprint
- Swirling, baffling, separation, etc.

We get pollutant ***removal*** rather than pollutant ***prevention*** all by using structural BMPs only!

EPA says...

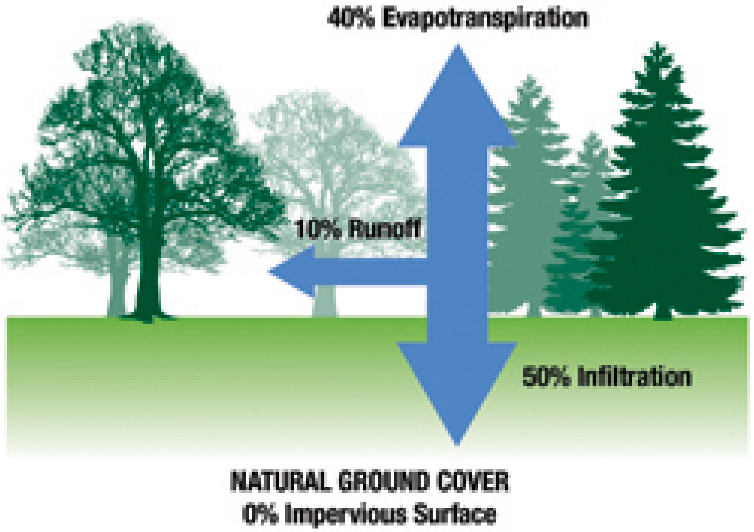
...this approach is missing the mark!

Still seeing:
- Water quality degradation
- Habitat alteration
- Eroding streambanks

We are not addressing Impervious Surfaces

- Roof, pavement, packed gravel, soils compacted by urban development, etc.
  - Impenetrable surface prohibits ***infiltration***
  - Loss of vegetation eliminates ***evapotranspiration***
  - Development means **higher peak flows and volume**
  - So, more pollutants downstream

EFFECTS OF IMPERVIOUSNESS ON RUNOFF AND INFILTRATION

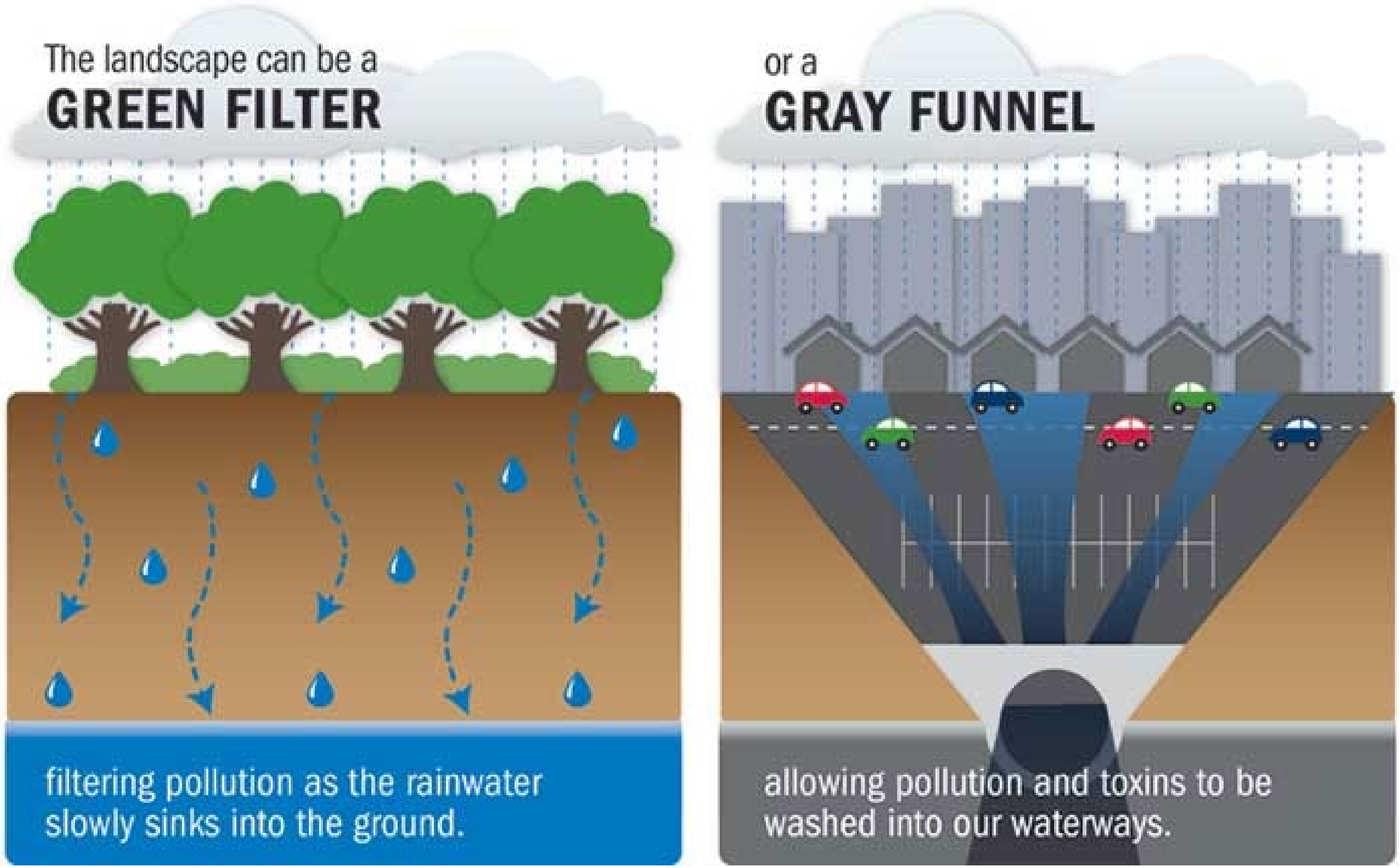


Source: Arnold and Gibbons (1996) *Impervious Surface Coverage*

EPA Introduces LID & Green Infrastructure

- Use ***soil*** and ***vegetation*** to manage ***rainfall*** where it falls
- Intent:
  - mimic pre-development, natural hydrology
  - Reduce runoff ***VOLUME***
- Why?
  - Stormwater carries pollutants
  - Less stormwater = less pollutants
  - Multiple benefits:
    - Viable habitat (vegetation and soil)
    - Healthier streams
    - Less infrastructure, reduced detention needs
    - Better air quality (trees)
    - Better quality of life

Why LID and Green Infrastructure?



Source: Chesapeake Bay Foundation

Which site will have lower runoff?

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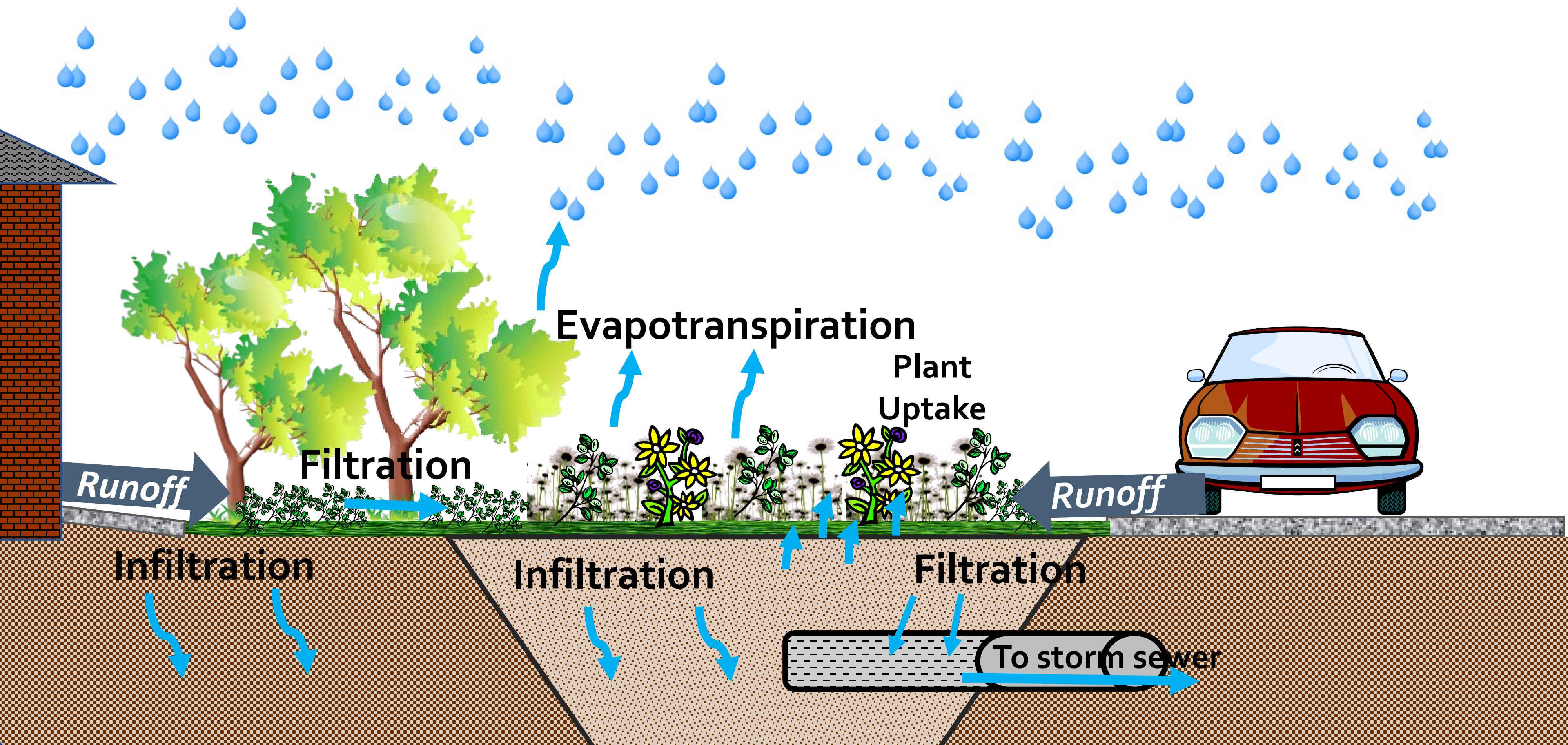
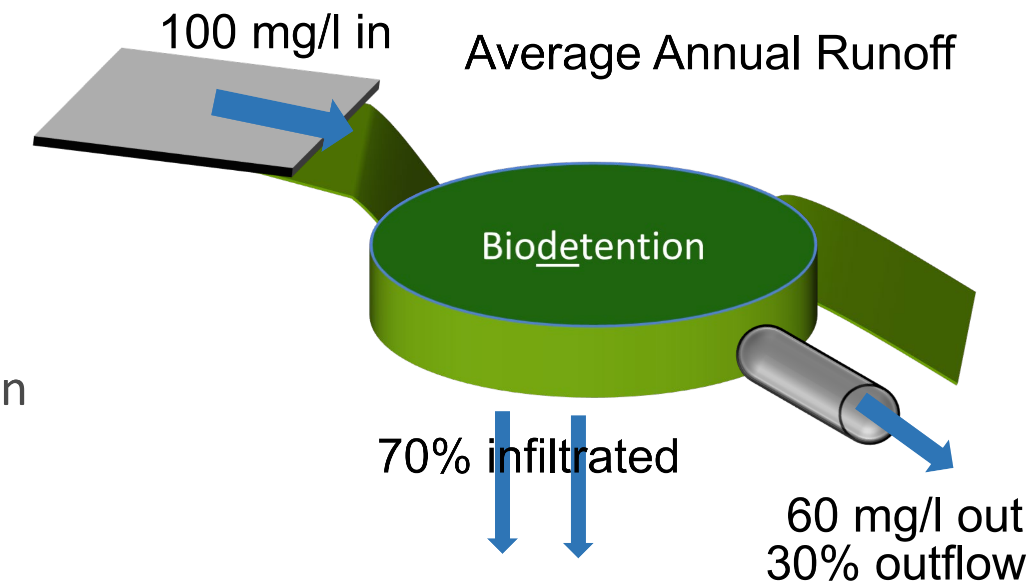
How do LID and GI work?

- **Infiltration (Soil)**: Volume reduction & pollutant removal
- **Evapotranspiration (Vegetation)**: Volume reduction
- **Plant Uptake (Vegetation)**: Volume reduction & pollutant removal
- **Filtration** (**Soil and Vegetation**): Pollutant removal & some infiltration



Volume reduction in GI-BMPs

- Help to “mimic” natural hydrology
  - Reduces stormwater discharge
  - Maintains groundwater recharge, baseflow
  - Reduces streambank erosion

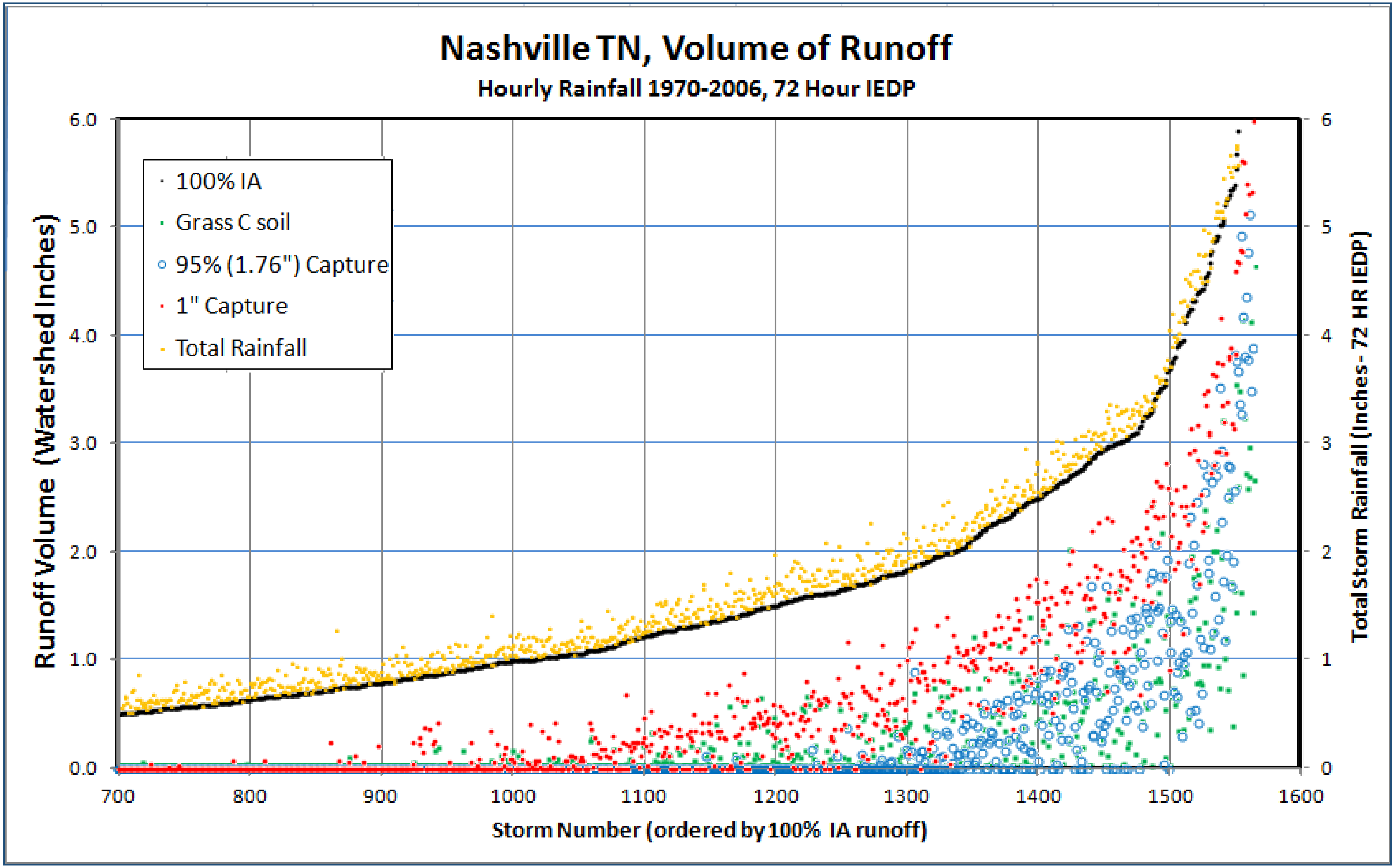


Old way = **40%** pollutant removal

New way = **82%** pollutant removal
when we account for volume removed

Why LID and GI? Hydrologic Mimicry!

Hydrologic Analysis of a Bioretention GI-BMP



Today's NPDES-MS4 Permit requirements

– Applies to new/redevelopments > 1 acre land disturbance
– Consider structural and non-structural strategies
– Ensure the long-term BMP maintenance and operation

Original EPA requirements *(circa 2003)*

– Develop and adopt a Design Manual or MARC Manual
– Stormwater Quality Protection
  • Include infiltration, evapotranspiration, & reuse
– Reduce post-development runoff to pre-dev. #'s
– Include green infrastructure BMPs (e.g., pervious pavement, native channels, bioretention, etc.)
– Stormwater Master Plan and regulate accordingly
  • Stream buffer ordinance
  • Site plan requirements
  • Minimize imperviousness/Maximize open space

DRAFT Kansas MS4 permit

Green is the New Gray

Traditional (Grey) Infrastructure

- Use basins, pipes & ditches to **reduce pollutants** in stormwater

Source: hydro-int.com

LID & Green Infrastructure

- Use soil & vegetation to **reduce stormwater volume** *(thus pollutants)*

Source: Tompkins County NY (Bioswale)

What do LID and Green Infrastructure look like?

LID (non-structural)

- Pocket/Amenity Parks
- Walking trails
- Open space plans
- Conservation areas
- Urban forests
- Water features
- Stream preservation
- Recharge zones
- Disconnection Areas

GI-BMPs (structural)

- Bioretention areas
- Rain gardens
- Urban bioretention
- Disconnection areas
- Infiltration basins
- Pervious pavers
- Permeable pavements
- Green roofs
- Cisterns

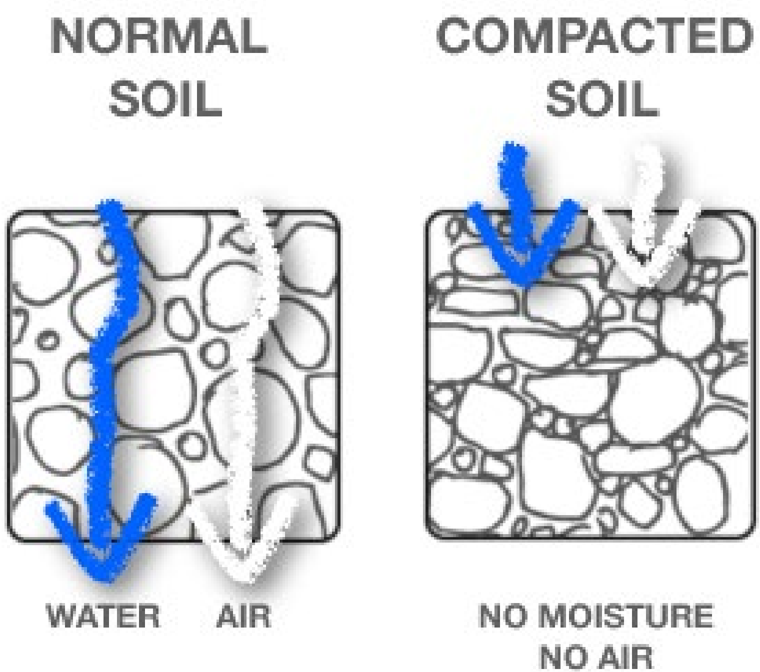
GI reliance on plants & soil

Green Infrastructure Practice (GIP)	Stormwater Quality Mechanism(s) Used
Bioretention/Urban Bioretention Water Quality Channel (Dry) Downspout Disconnection Sheet Flow	Infiltration (without underdrain) Evapotranspiration Plant Uptake Soil Filtration (with underdrain)
Infiltration Trench	Infiltration
Green Roof Grass Channel	Evapotranspiration Plant Uptake Surface Filtration
Permeable Pavement	Infiltration (without underdrain) Soil/Media Filtration (with underdrain)
Reforestation	Infiltration Evapotranspiration Plant Uptake Surface Filtration

How LID & GI reduce volume?

Healthy, Uncompacted Soil

- Allows stormwater to soak in
- *Infiltration, Filtration*



Healthy Growing Plants

- Intercepts rainfall & soaks up stormwater
- *Evapotranspiration, Nutrient Uptake*

The Paradigm Shift for Site Design

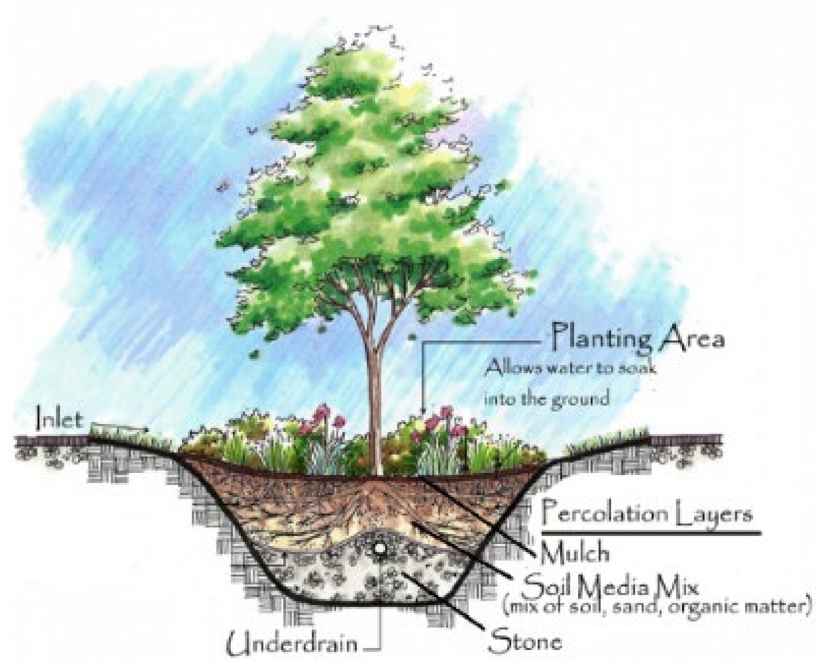
Plants & Soil are now **Infrastructure**

In community & site planning:
LID Opportunities
(considered in land use plans & site layouts)

During site design & construction:
BMP Design Elements
(have design criteria & shown on plans)

Construction Protection Areas
(clearly marked & avoided)

After construction:
BMP Maintenance Elements

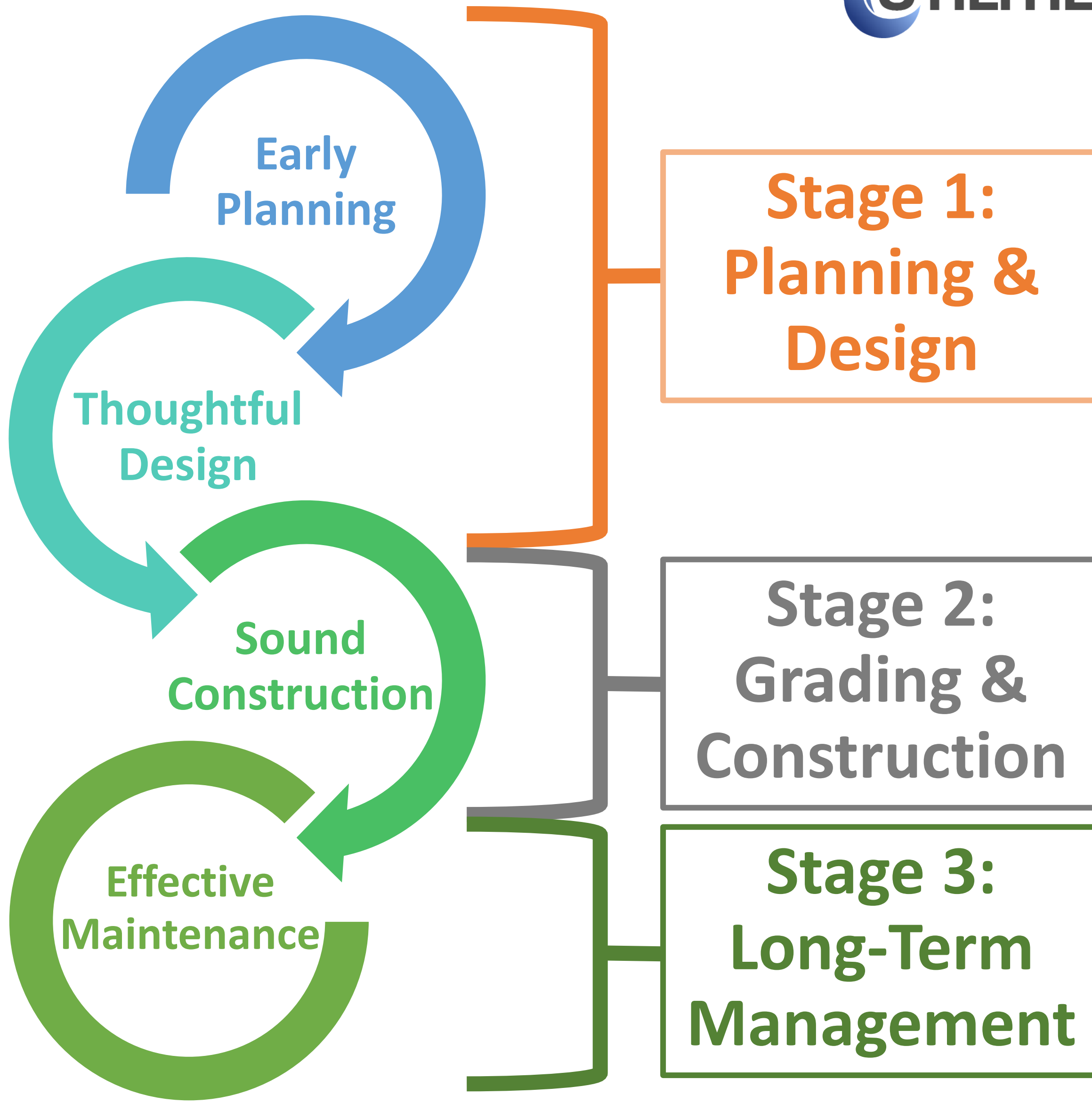


More detailed information on plants and soil is needed for design and as-built plans

Design Process & Plans

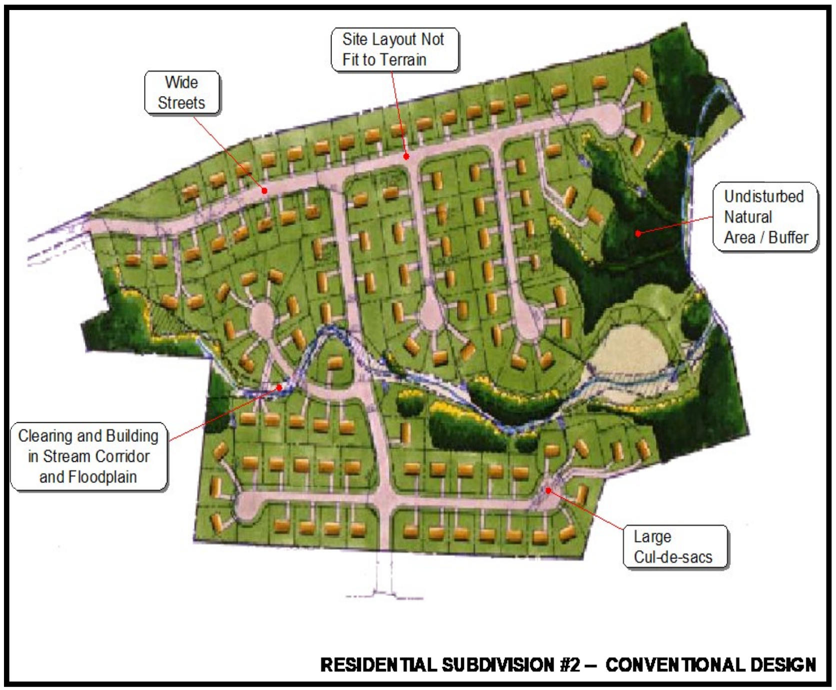
Chapter 2

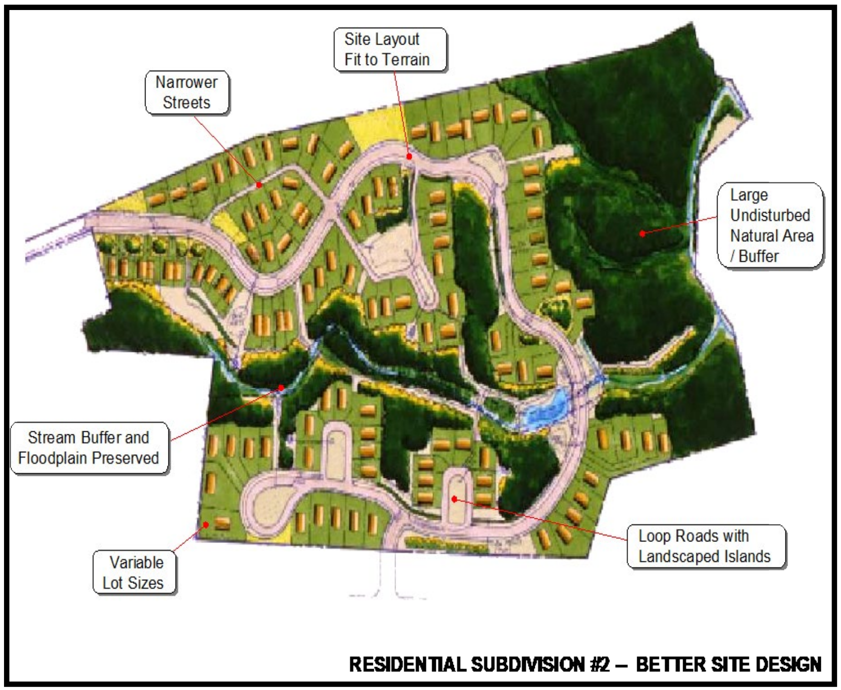
Topeka Stormwater BMP Design Handbook



LID must be applied BEFORE DESIGN!

- Before clearing and grading!!
  - Integrate the development with the ***natural*** topography
  - Reinforce the site's ***natural*** hydrologic characteristics
  - Make use of the ***natural*** soils & vegetation for stormwater control





The Early Bird Gets the Worm!

- **Consider Soil and Vegetation <u>EARLY</u>!**
  - Ideally, as early as development tract speculation
  - No later than when the site lot or building layout is being established

Why?

- Early recognition of opportunities or limitations can save time and money
- Less imperviousness = Less runoff = Less stormwater infrastructure
- Lower infrastructure costs
- Difficult to modify a site layout once its on paper
- Preservation costs less than Restoration

LID Design Process

- Gather data to characterize the hydrology of the EXISTING site
- No calculations, tests, or studies
- Layout the impervious features to preserve as much of the existing hydrology as possible

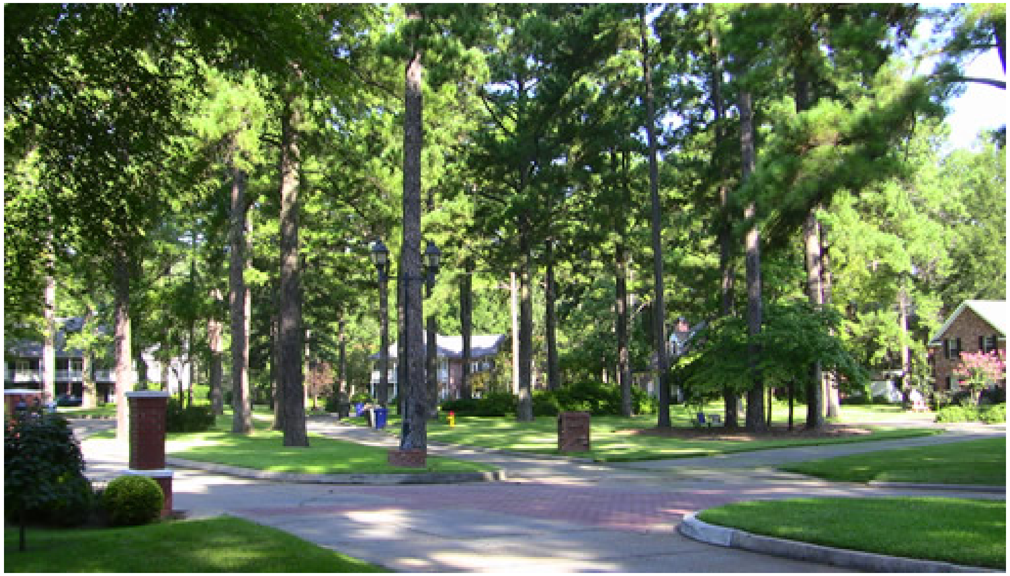
Land Cover & Vegetation	Ponds, lakes, wetlands
Hydrologic Soil Groups	Drinking water sources, well heads, etc.
Topography / steep slopes	High water table
Karst (sinkholes, drop-outs)	Shallow bedrock
Key natural areas	Historic features
Contractive or expansive soils	Site layout (if developed at the time)
Streams, seeps, springs	Relevant other data (e.g., wet basements)

Using LID techniques

- Maximize the use of ***natural*** soil and vegetation to minimize and manage stormwater

- ✓ Minimize and disconnect imperviousness
- ✓ Maximize green space
- ✓ Preserve mature trees
- ✓ Limit clearing & grading
- ✓ Avoid well-draining soils
- ✓ Use green spaces for stormwater management
- ✓ Keep stream buffers
- ✓ Fit the development to the land rather than the land to the development
- ✓ Etc…

Low-cost LID aesthetics & amenities



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LID can provide other value

GI-BMP Policies

Introduction

- Heather Williams, Senior Project Manager

Purdue University:

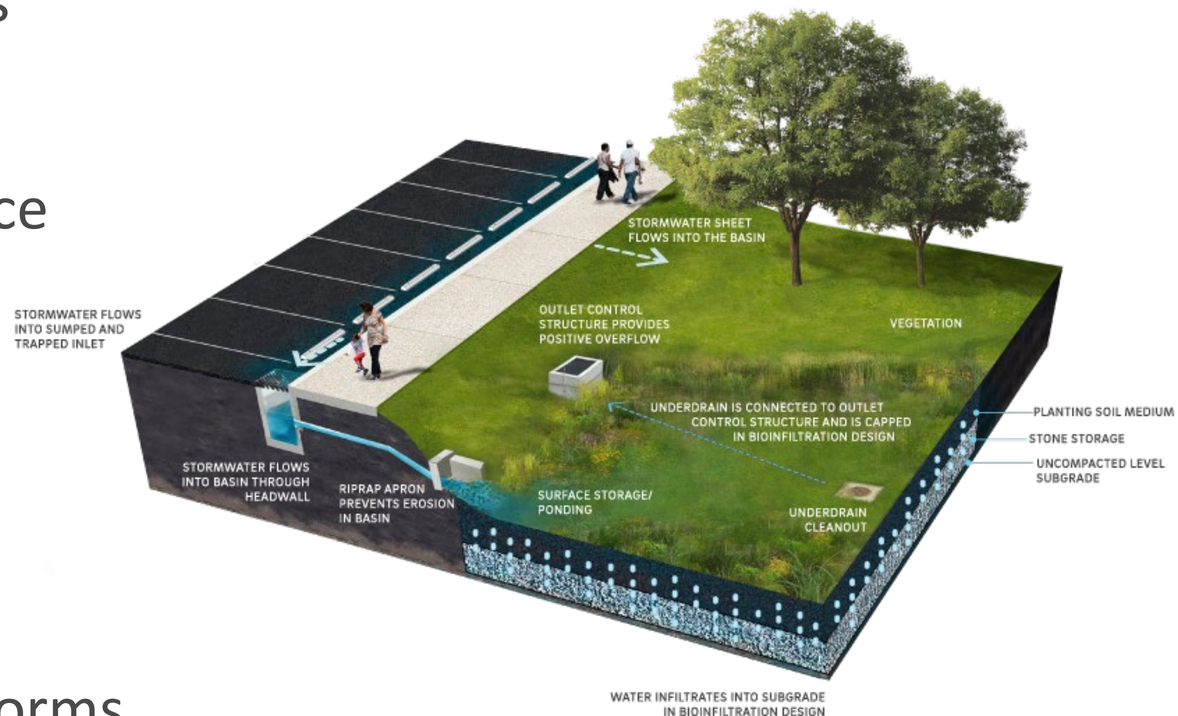
BS Civil Engineering

16 Years at Wood:

- Stormwater program development & implementation
- Construction & post-construction programs & compliance
- Green infrastructure planning & design
- Ordinance, policy, incentive reviews
- **Municipal clients include**: Atlanta, Birmingham, Auburn, Nashville, Philadelphia, Indianapolis, & Boulder

Learning Objectives

- General types of green infrastructure BMPs
  - Meeting multiple objectives
- Landscape Ordinance Incentive
- Policies
  - Soils and infiltration guidance
  - Underdrains
  - Plants
- Design Procedure Forms
- Common Problems



Polling Question

Which GI-BMP are you most familiar with and/or do you most often use in your site designs to meet water quality requirements?

- Rain Gardens
- Native Vegetation Swale
- Infiltration Basin or Trench
- Bioretention
- Permeable Surfaces
- Green Roofs
- Cisterns/Rainwater Harvesting

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Topic: Green Infrastructure BMPs

Manual Section
3.11

Topeka Stormwater BMP Design Handbook

Table 3-8. Multi-Objective GI-BMPs

GI-BMP Name & Treatment Approach	*Possible Design Objectives in Addition to Stormwater Quality Management*
Rain garden & native vegetation swale **Treatment approach: infiltration & evapotranspiration*	ually attractive landscaping leeting City code landscape requirements ublic education/support for sustainable practices
Infiltration basin & infiltration trench **Treatment approach: infiltration*	isually attractive landscaping leeting City code landscape requirements ischarge rec ublic educat
Bioretention **Treatment approach: infiltration & evapotranspiration*	isually attra leeting City ischarge rec andscaped p tormwater c ublic education/support for sustainable practices
Pervious concrete, porous asphalt, & modular concrete block **Treatment approach: infiltration & filtration*	riveways and parking lots ischarge receiving area for roof drains ttractive hardscaping tormwater quantity control *(limited)* ublic education/support for sustainable practices
Green roofs **Treatment approach: infiltration & evapotranspiration*	uilding rooftop ually attractive "roofscaping" Green space for picnics, meetings, or relaxation of building tenants ublic e
Cisterns **Treatment approach: capture and reuse*	on-pot et-wa ublic e

Design Information is found in **MARC Manual**

Policy and design defined in **Handbook**

Refer to **Section 3.11** ***Aligning Stormwater Quality and Quantity Designs*** for more information

Rain Garden

- Visually attractive landscaping
- Meeting City code landscape requirements
- Public education
- Support for sustainable practices

Native Vegetation Swale

- Visually attractive landscaping
- Meeting City code landscape requirements
- Public education
- Support for sustainable practices
- Creates pollinator habitat

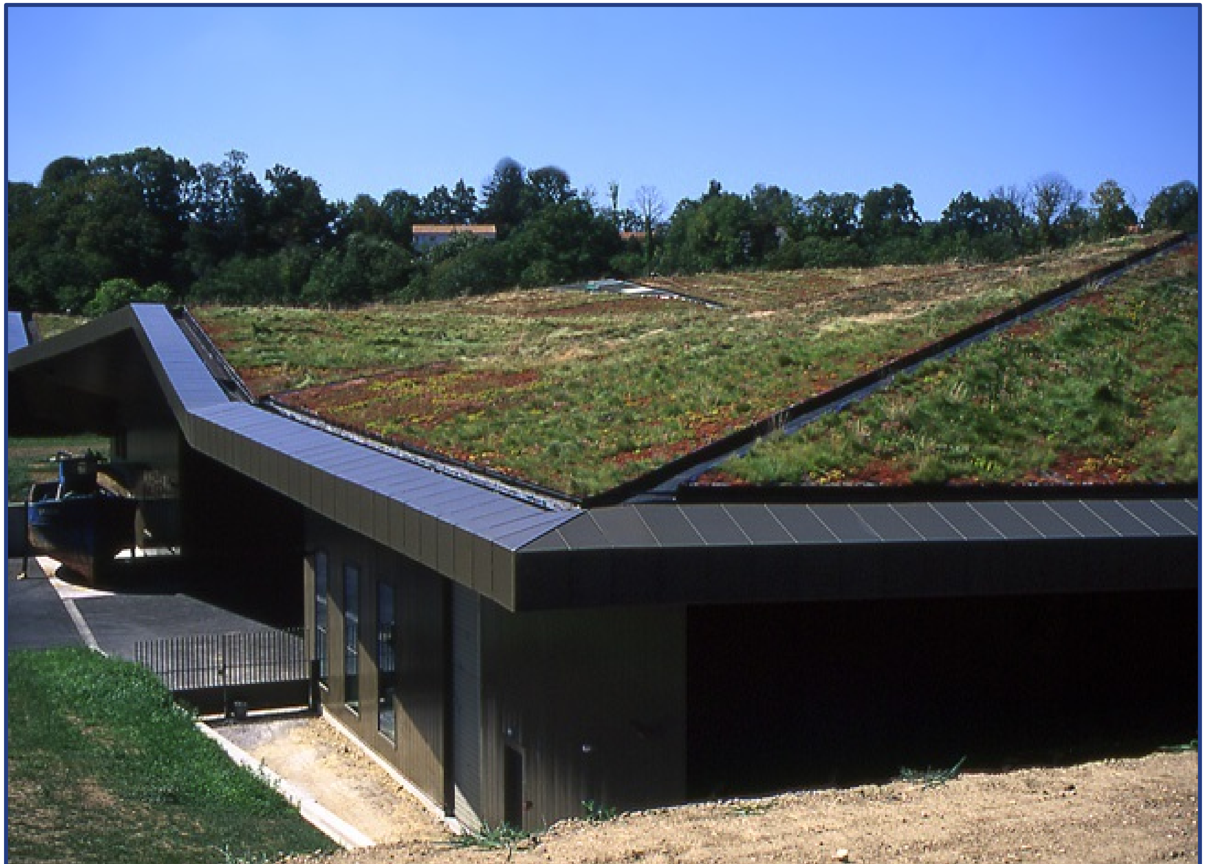
Bioretention

- Visually attractive landscaping
- Meeting City code landscape requirements
- Discharge receiving area for roof drains & parking lots
- Landscaped parking lot islands
- Stormwater quantity control *(limited)*
- Public education
- Support for sustainable practices

Permeable Surfaces

- Driveways and parking lots
- Discharge receiving area for roof drains
- Attractive hardscaping
- Public education
- Support for sustainable practices

Green Roofs



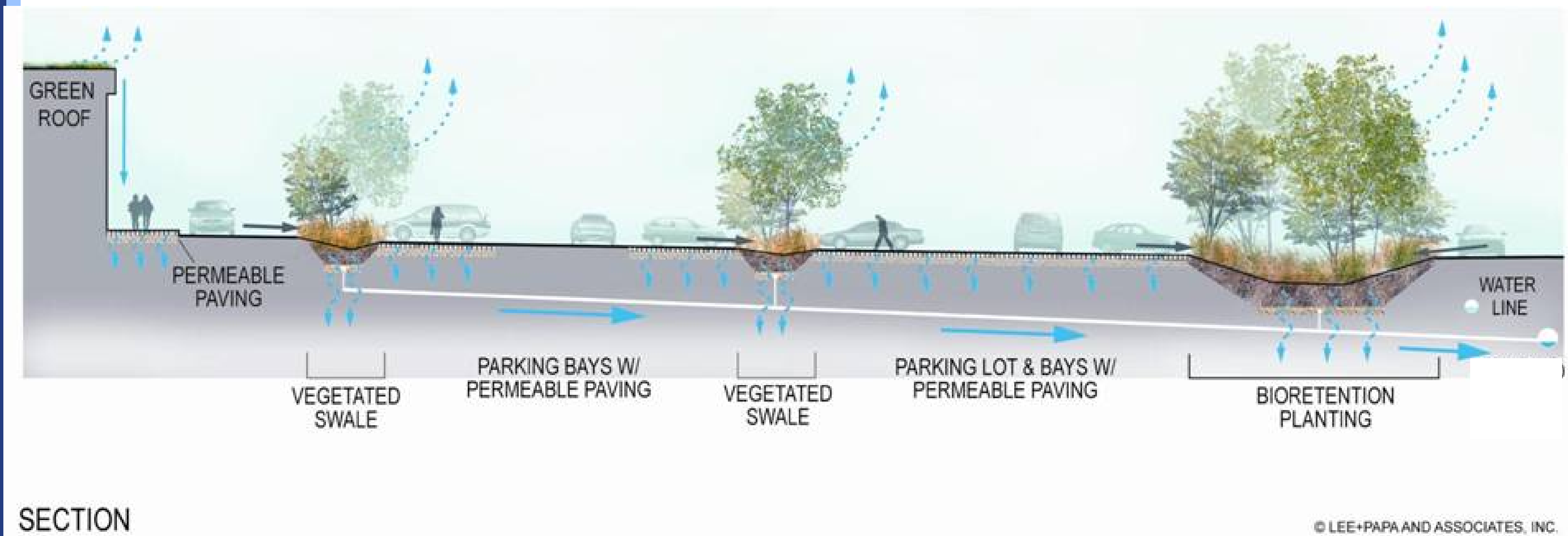
- Building rooftop
- Visually attractive “roofscaping”
- Green space for picnics, meetings, or relaxation of building tenants or workers
- Public education
- Support for sustainable practices

Cisterns

- Non-potable water source for landscape or garden water toilet-water, etc.
- Public education
- Support for sustainable practices

Refer to **Appendix F** for more information

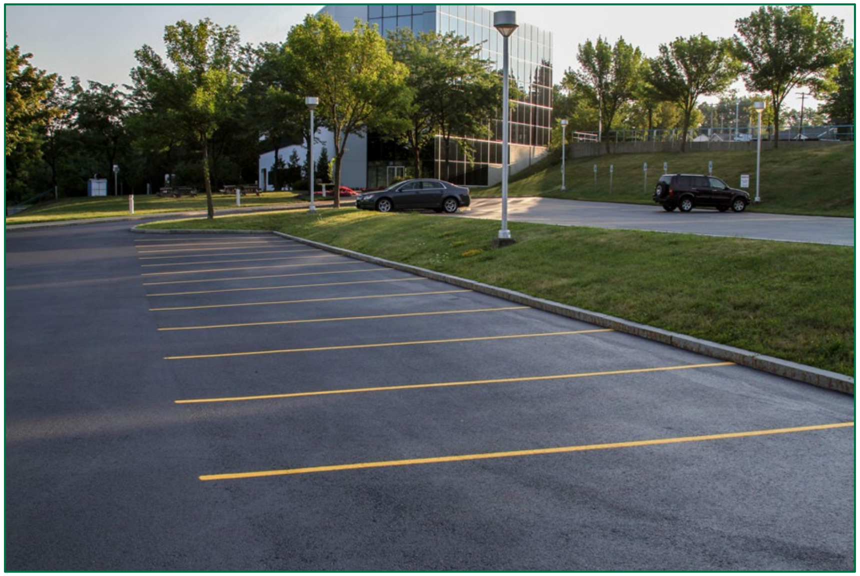
Putting it Together: Treatment Trains



GI BMP Location

- **Front and center** is better!
- Create a "**showcase**"
- Integrate it into the **property aesthetic and amenities**
- Provide easy & <u>unimpeded</u> access for **inspection & maintenance**
- Provide public education **signage**

Triple Bottom Line (TBL) Analyses



Landscape Credits (TMC Chapter 18.235)

BMP Type	Stormwater BMP Credit (see TMC Chapter 18.235.090)
VEGETATED BMPS[1]	
Native Vegetation Preserved/Established	20%
Rain Garden	
Bioretention	
Vegetated Filter Strip	
Native Vegetation Swale[2]	
BMPS THAT REDUCE IMPERVIOUS AREA	
Green Roof	10%
Pervious Concrete	
Porous Asphalt	
Modular Concrete Block	
Cistern	
INFILTRATION BMPS	
Infiltration Basin	10%
Infiltration Trench	
DETENTION BMPS[1]	
Extended Wet Detention	10%
Extended Dry Detention (native vegetation)[2]	
MEDIA FILTRATION BMPS	
Surface Sand Filtration	0%
Underground Sand Filter	
Pocket Sand Filter	
Perimeter Sand Filter	
OTHER SYSTEMS (Manufactured Treatment Devices)	
Proprietary Media Filtration	0%
Hydrodynamic Devices	
Baffle Boxes	
Catch Basin Inserts	

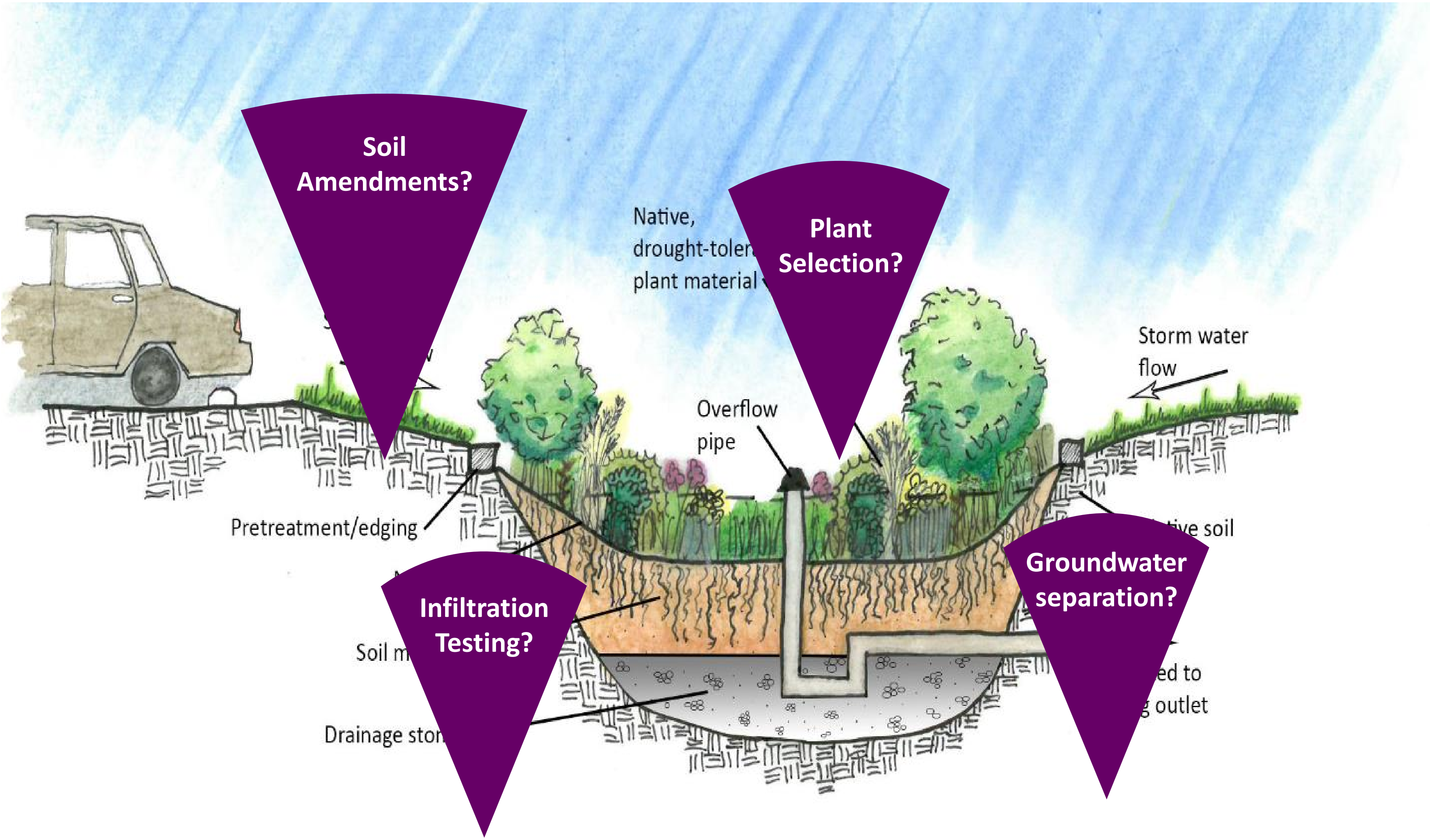
Refer to **Section 3.4.2. *Landscape Credits***

Multidisciplinary Design Team

- Involve whole team in design process
- Collaborate on site layout
- Ensure team stays involved throughout design and construction
  - Engineer
  - Landscape Architect
  - Soil Scientist
  - Forestry and Ecology

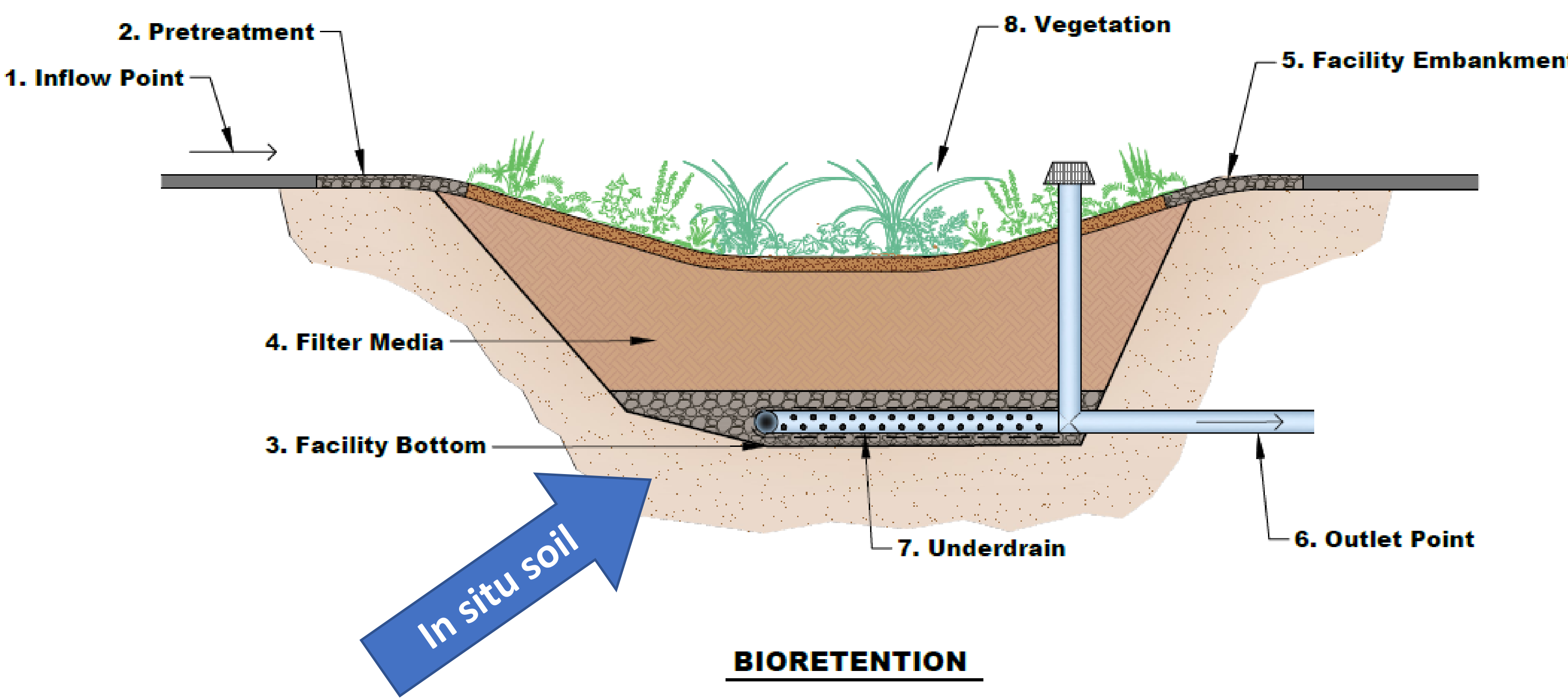
Refer to **Section 5-2.** ***Land Development Design Team Disciplines***

Vegetated GI BMPs

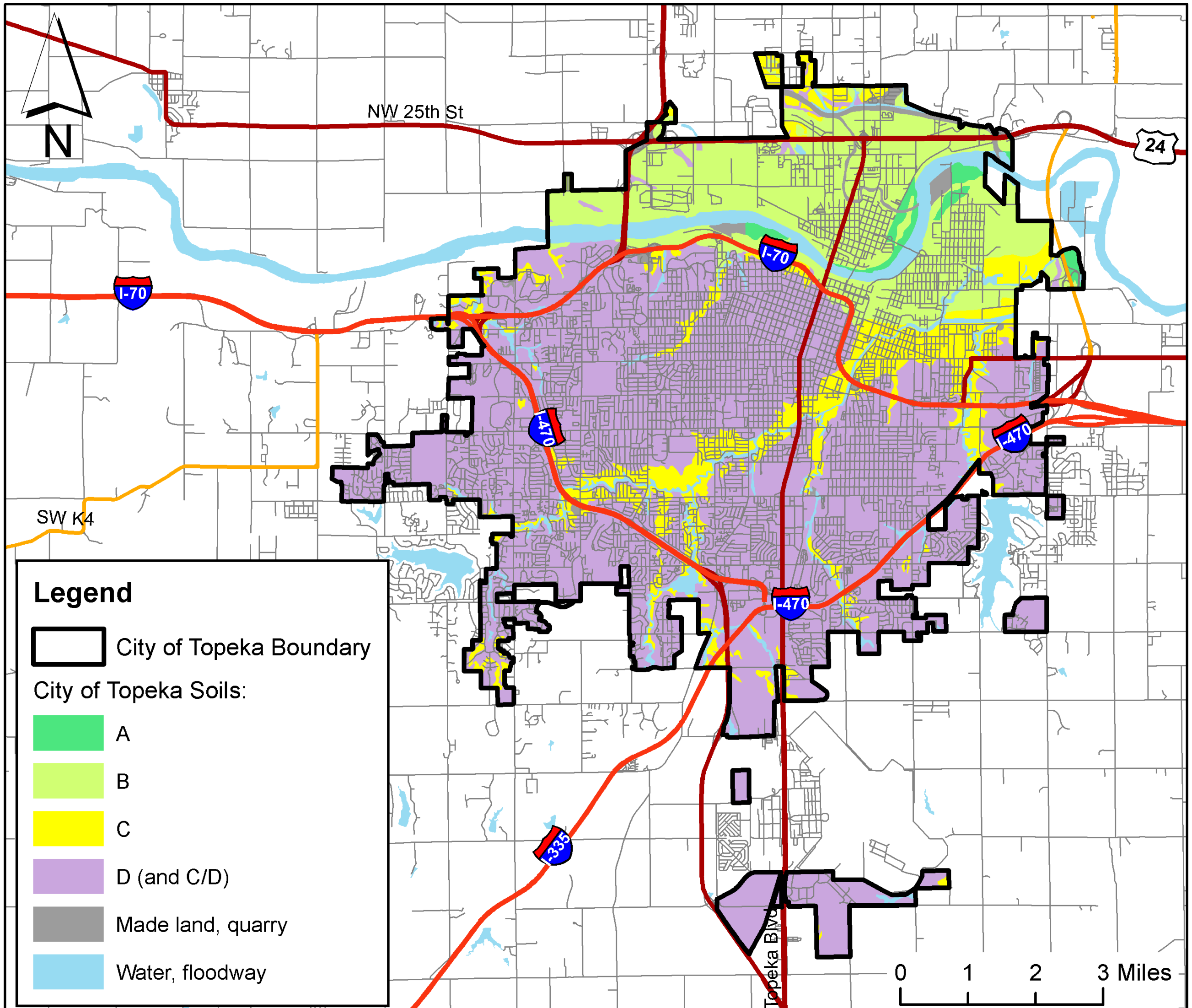


GI BMPs are like Layer Cakes

Infiltration Requirements



Topeka Soils Map



Infiltration BMPs - Underdrain

CITY OF TOPEKA UTILITIES

An underdrain is required unless ALL of the Site Suitability Criteria for Full Infiltration listed in **Policy 3** are met

Policy 3 says ALL of the following requirements must be met:

BMP must be located:

- in **HSG A, B, or C**
- **100+ feet** from drinking water supply in a sensitive aquifer, **50+** feet in a non-sensitive aquifer
- More than **1,000 feet up-gradient** or 100 feet down-gradient of karst features
- **10+ feet** away from a building/structure
- **200+ feet** from the toe of a slope that is greater than or equal to 20%
- **35+** feet away from a septic drainfield

There is more than **3ft of separation** distance from bottom of BMP to the elevation of the seasonally **saturated soils or top of bedrock**

BMP doesn't receive stormwater discharges from a stormwater **hotspot** or area of known soil contamination

A groundwater mound forming beneath the BMP doesn't extend into the BMP

In-situ **soil under the BMP is >1 in/hr and <11 in/hr**

Refer to **Section 3.5.4 *Underdrain Policy***

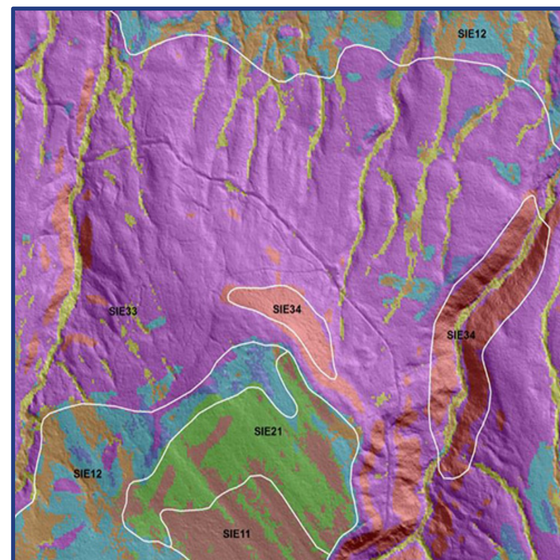
In-Situ Infiltration Requirements

BMPs w/ Underdrains: two approaches
BMPs w/ out underdrains **shall use the preferred approach**

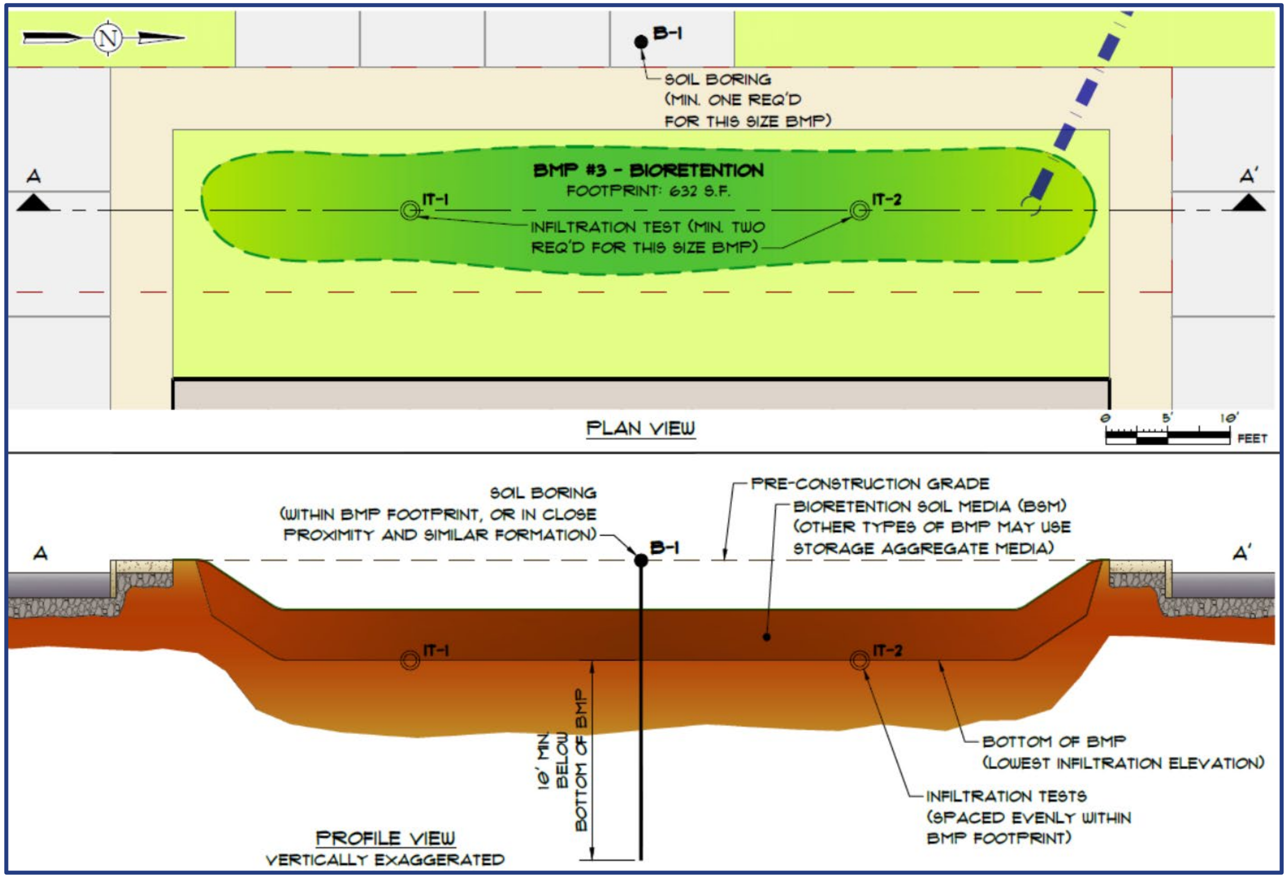
Preferred

Infiltration testing using protocols in **Section 3.5.5** (shown in a few slides)

Provide infiltration rates from the most current **USDA-NRCS Soil Survey** for Shawnee County KS



Infiltration Testing Requirements



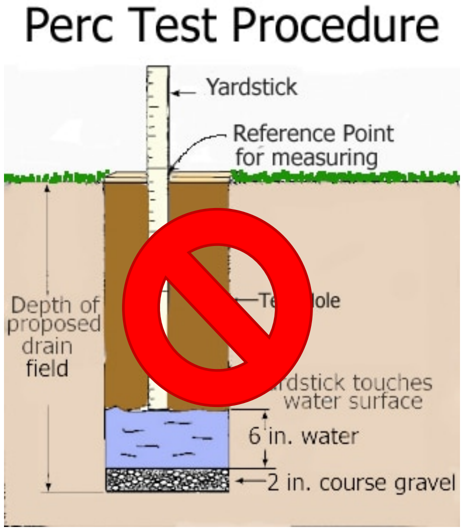
1. Professional required
2. Suitable weather conditions
3. Two tests required for every 3,000-10,000 sf of BMP area
4. Test elevations to be at or below the bottom of the BMP
5. Soil borings required
6. Double-ring infiltrometer or modified Philip Dunne infiltrometer are acceptable
7. Post-construction field infiltration tests may be required

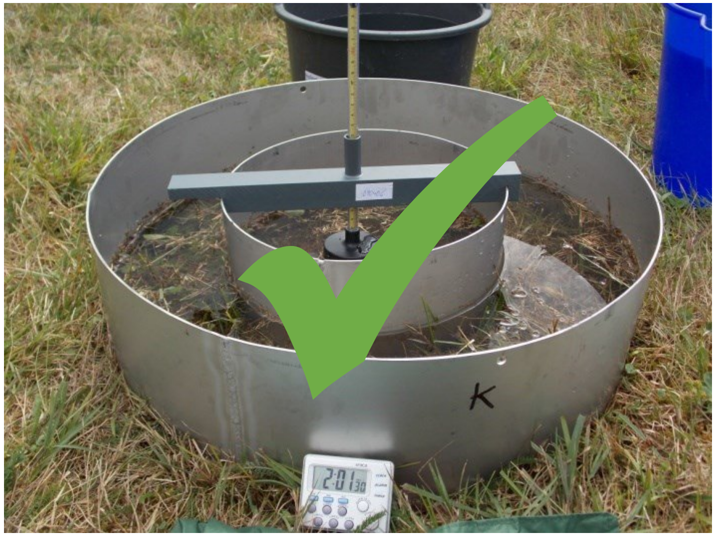
Refer to **Section 3.5.5** for more information on field infiltration testing

In-Situ Infiltration Test Rules

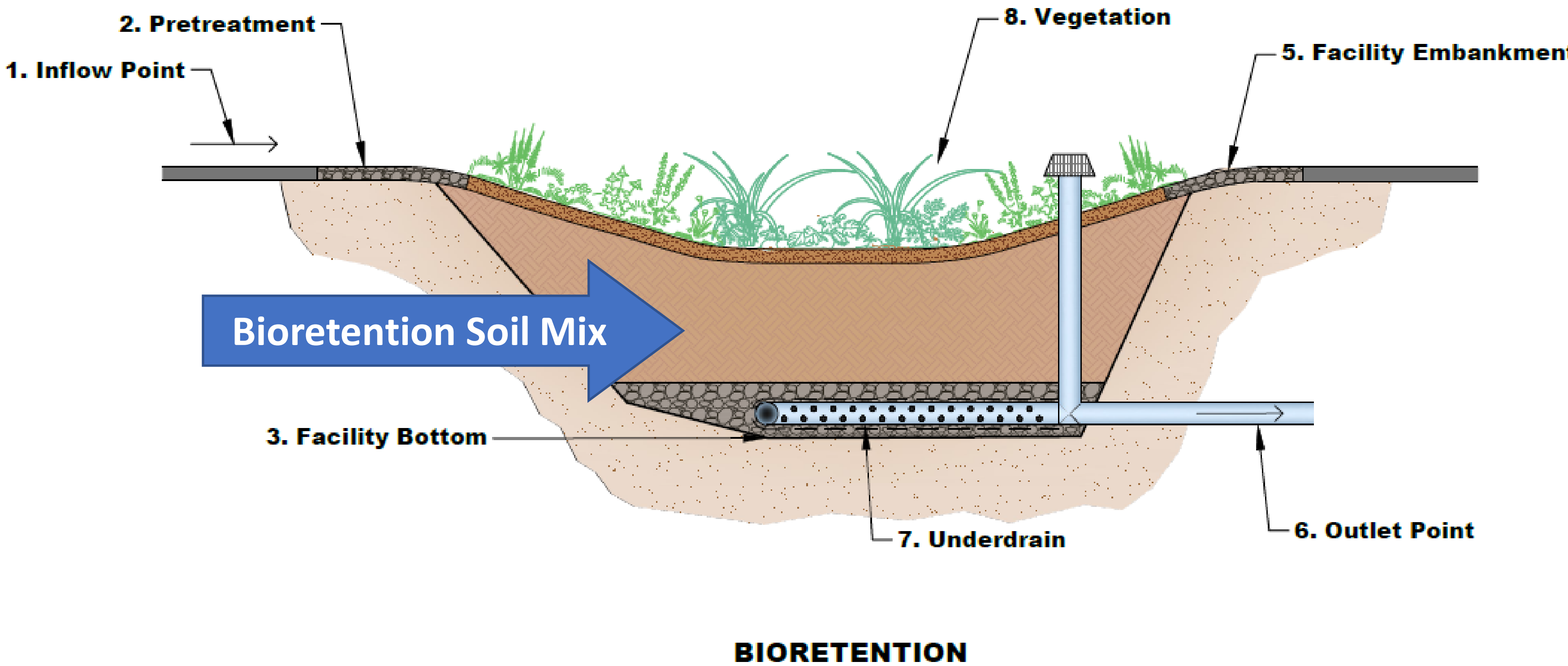
Infiltration rate vs. Percolation Rate

- Infiltration BMPs require drawdown time to avoid nuisance flooding
- Permeability rate of the “in situ” soil
- **<u>Percolation rate is NOT equivalent to an infiltration rate</u>**
- Percolation rates tend to overestimate-can be **off by a factor of 10 or more**
- Use the Double Ring Infiltrometer Test (ASTM D 3385)!!





Bioretention Soil Mix (BSM)



Bioretention Soil Mix (BSM)

- Critical to **<u>success or failure</u>**
  - Aids in infiltration
  - Natural detention
  - Plant health
- Must be properly **<u>specified, mixed and placed</u>**
  - Soil texture
  - Soil permeability
  - pH-acidic, neutral, or alkali
  - Toxicity
  - Nutrient levels
  - Minerals
  - Salinity
- **<u>Engineered soil mix shall be sufficient to support plant life and meet the desired infiltration rate for the MAIN TREATMENT AREA OF THE BASIN</u>**
- Protected **DURING** and **AFTER** Construction
- Field verified and tested

See **Appendix A Section 9003** of the MARC Manual for more info on Bioretention Facilities

Bioretention Soil Mix Specs.

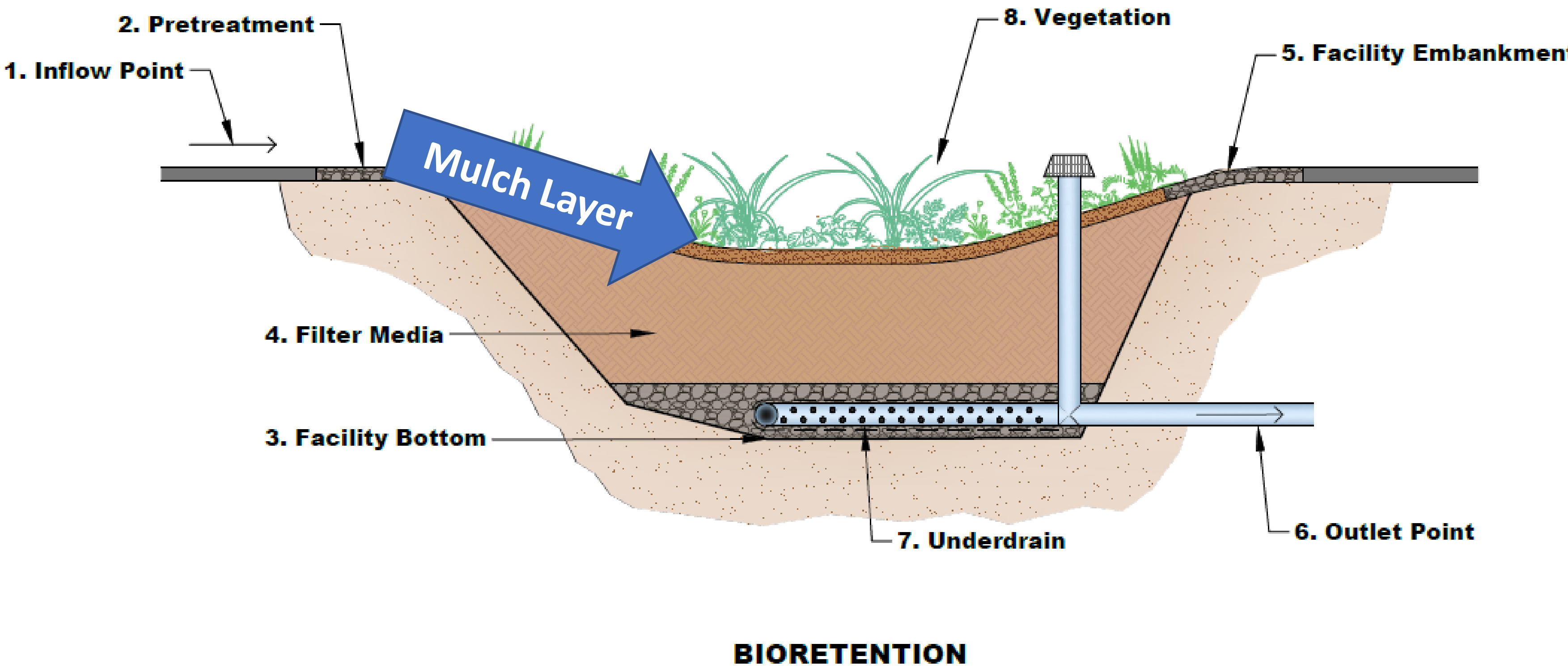
Item	Composition By Volume	Reference
Planting Soil	30%	See below.
Organic Compost	20%	See below.
Sand	50%	ASTM C33 Fine Aggregate

Planting Soil: The USDA textural classification of the Planting Soil for the BSM shall be LOAMY SAND OR SANDY LOAM. The Planting Soil shall be the best available on site material or furnished. Additionally, the Planting Soil shall be tested and meet the following criteria or as approved by the Engineer:

Item	Percent By Weight	Test Method
Sand (2.0 – 0.050 mm)	50 – 85%	AASHTO T88
Silt (0.050 – 0.002 mm)	0 – 50%	AASHTO T88
Clay (less than 0.002 mm)	2 – 5%	AASHTO T88
Organic Matter	3 – 10%	AASHTO T194

See **Appendix A Section 9003** of the MARC Manual for more info on Bioretention Facilities

Mulch



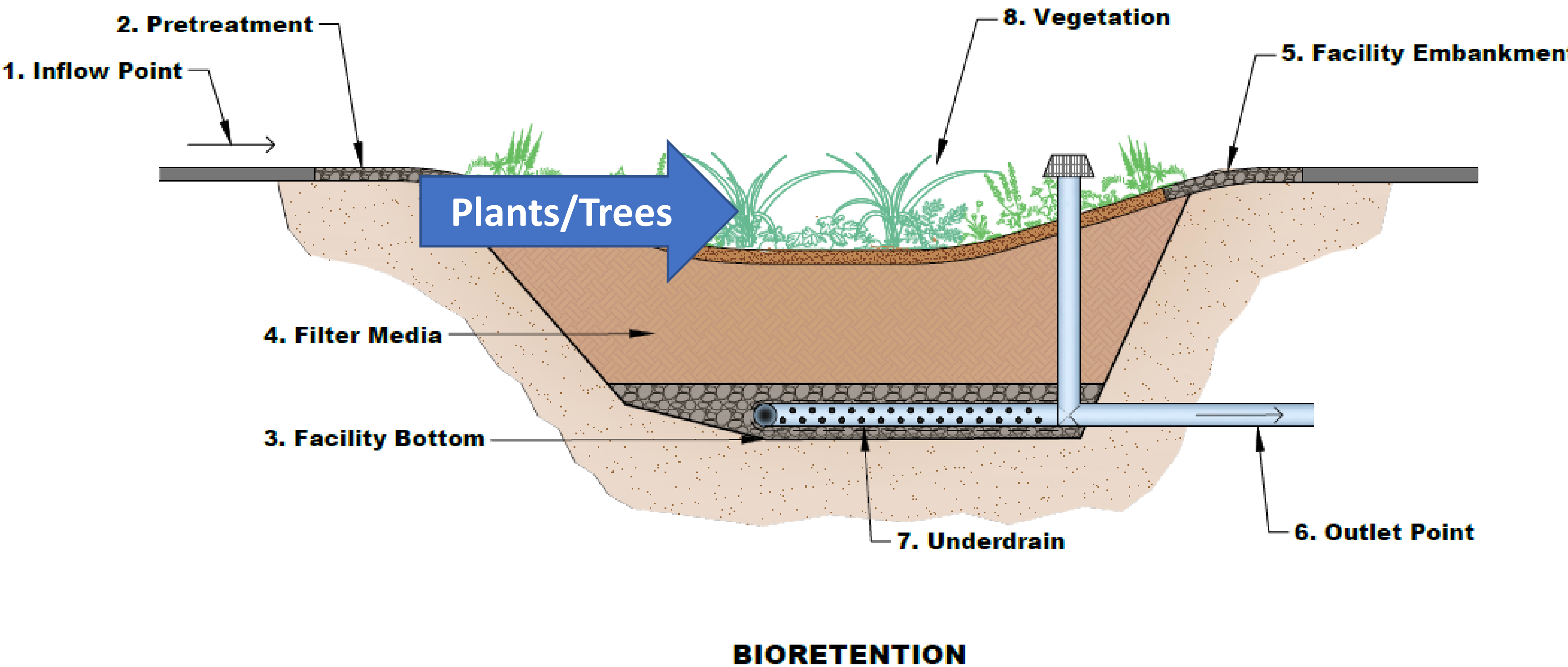
2. Pretreatment
1. Inflow Point
Mulch Layer
8. Vegetation
5. Facility Embankment
4. Filter Media
3. Facility Bottom
7. Underdrain
6. Outlet Point
BIORETENTION

Mulch

- **Twice-shredded hardwood bark**
  - Aged a minimum of 6 months
  - 50/50 bark and wood
  - Maximum of 4 inches
  - Free from sawdust, clay, soil, and other foreign materials

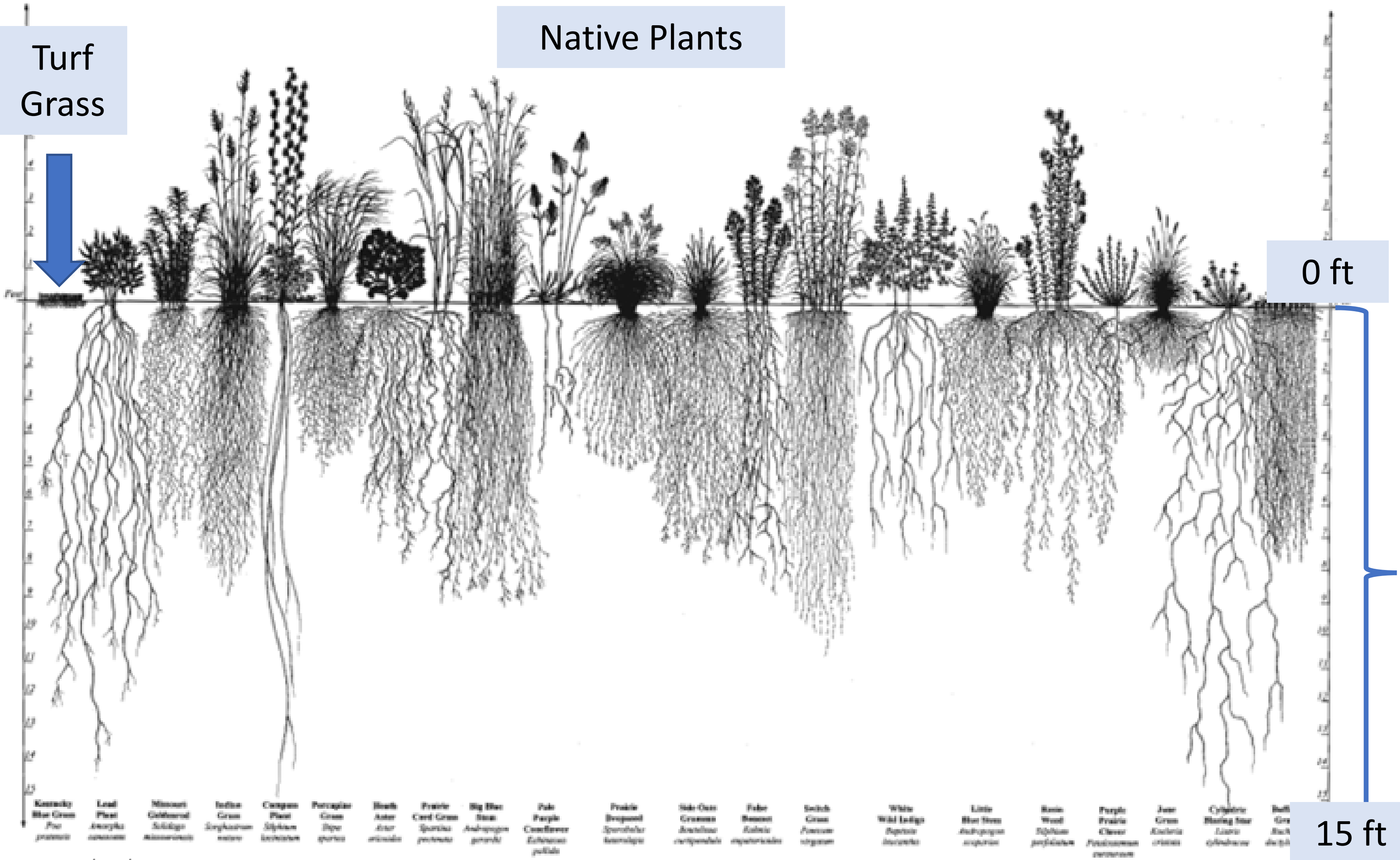
See **Appendix A Section 9003** of the **MARC Manual** for more info on Bioretention Facilities

Plants/Vegetation



See **Appendix A** of the MARC Manual for more info on Bioretention Facilities

Plants/Vegetation

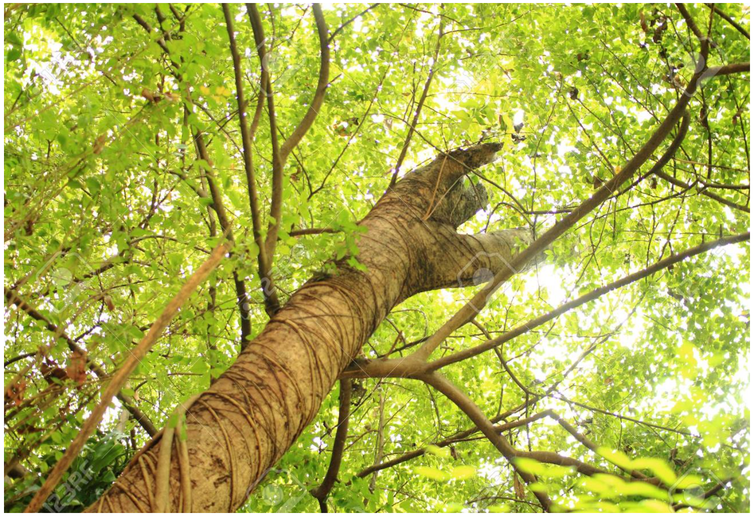


Plants/Vegetation

- Dependent on soil mix
- Native plant species are preferred
  - Adapt to environment conditions
    - Drought resistant
    - Water tolerance
  - Usually reseed
- Variety of species
- Trees, shrubs, grasses should be spaced according to mature size
- **NO** aggressive, noxious, or invasive species permitted
- **NO** woody vegetation at inflow locations
- **NO** plants or plant placement that will cause traffic safety problems
  - Preserve line of site

Plants/Vegetation

- When specifying trees:
  - Provide sufficient landscape width (rule of thumb 8 to 10ft)
  - Locate trees on side slopes not in areas that pond
  - Select trees that will tolerate salt and wet soils
  - Locate trees away from perforated pipes
  - Consider maintenance
    - Deciduous plant material that will drop leaves and can impair the function if not located properly



Plants/Vegetation

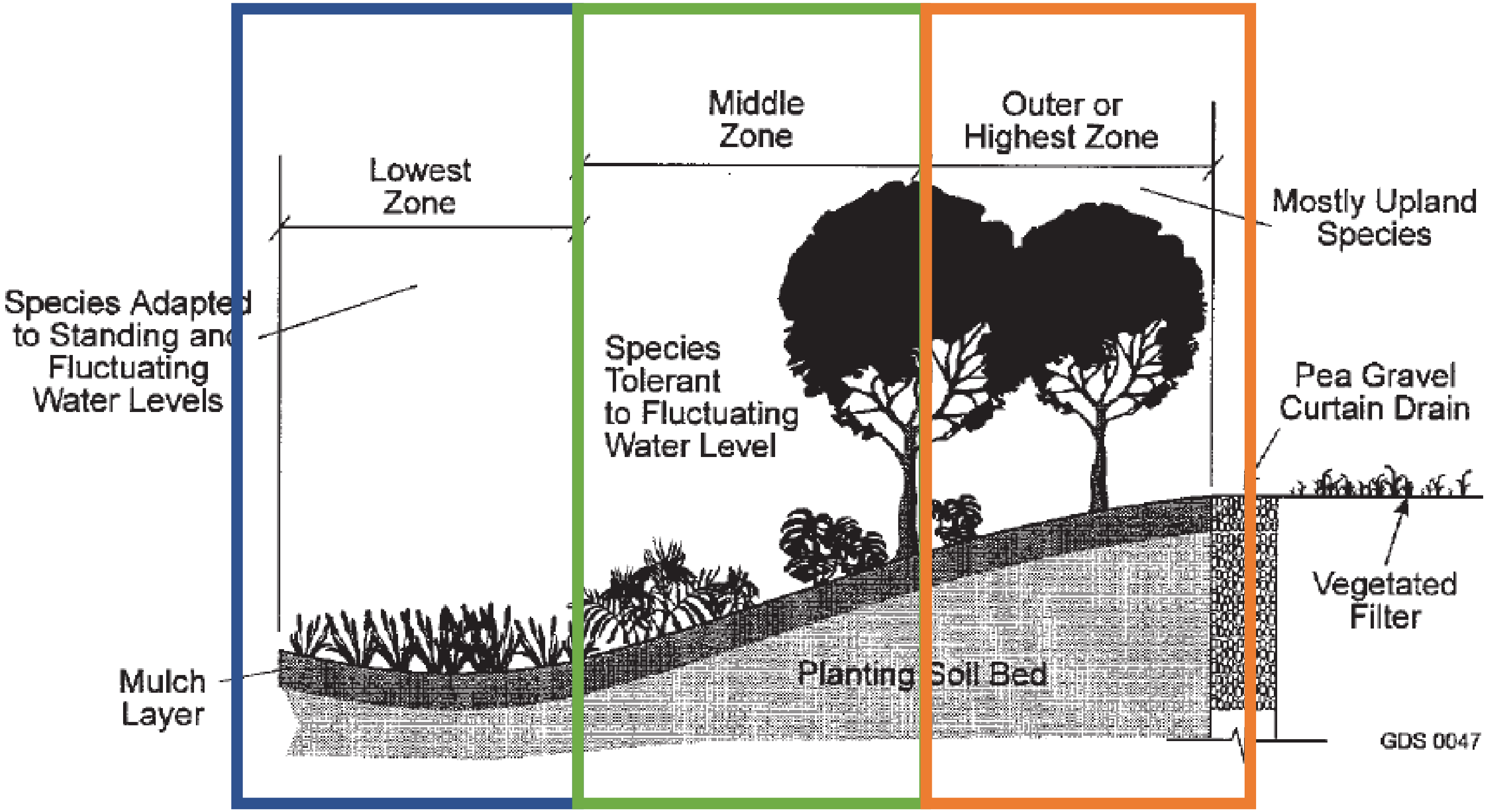
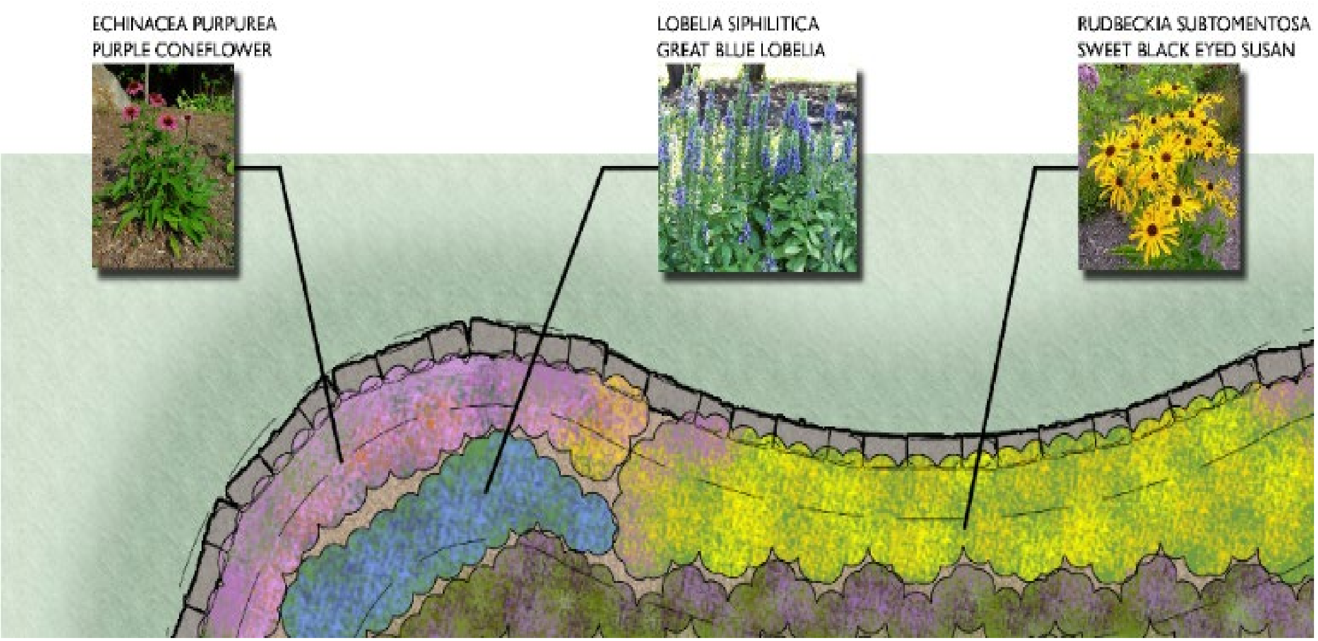


Figure D-5. Planting Zones for Bioretention Facilities
(Source: Georgia Stormwater Management Manual, 2016)

See **Appendix A** of the MARC Manual for more info on Bioretention Facilities

Plants/Vegetation



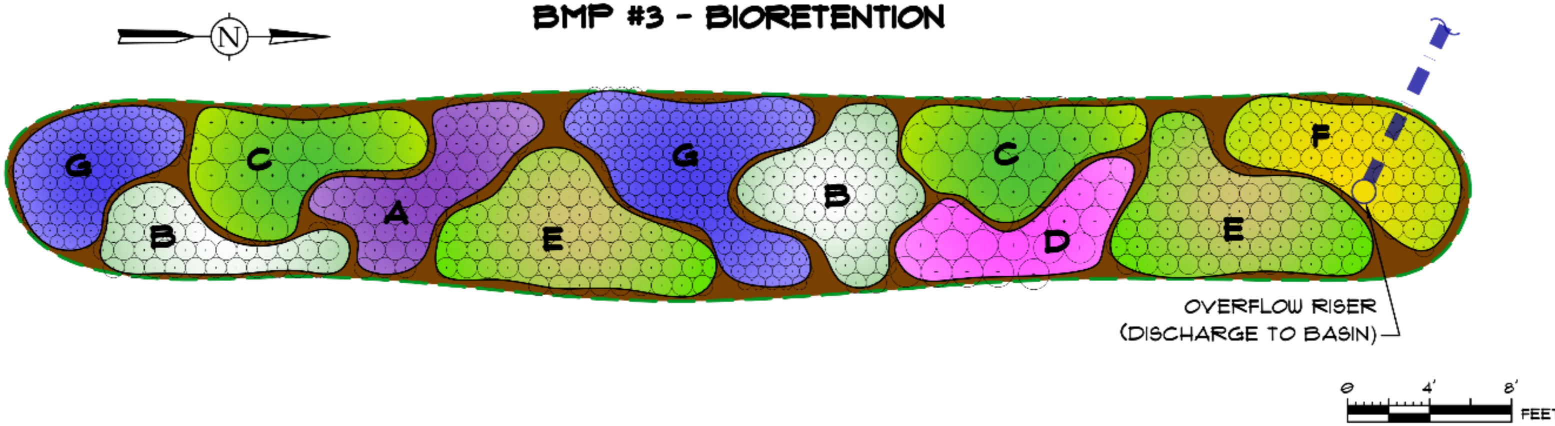
Plant choices can vary for different areas of the BMPs

Planting templates can differ for the desired aesthetic!

Planting Plan Bioretention

CITY OF TOPEKA UTILITIES

BMP #3 - BIORETENTION



PLANT SCHEDULE

IDEN.	SCIENTIFIC NAME	COMMON NAME	NATIVE	QUANTITY	COLOR	SPACING	HEIGHT
A	BAPTISIA AUSTRALIS	BLUE FALSE INDIGO	YES	50	PURPLE	12" OC	2-4 FT
B	PENSTEMON DIGITALIS	FOXGLOVE BEARDTONGUE	YES	90	WHITE	12" OC	2-3 FT
C	SPOROBOLUS HETEROLEPSIS	PRAIRIE DROPSEED	YES	49	GREEN	18" OC	1-3 FT
D	ASCLEPIAS INCARNATA	SWAMP MILKWEED	YES	20	PINK/PURPLE	18" OC	3-5 FT
E	CAREX VULPINOIDEA	FOX SEDGE	YES	142	TAN	12" OC	2-3 FT
F	RUDBECKIA FULGIDA SPECIOSA	SHOWY BLACK-EYED SUSAN	YES	54	YELLOW	12" OC	2-3 FT
G	GENTIANA ANDREWSII	BOTTLE GENTIAN	YES	262	BLUE	8" OC	1-2 FT

NOTES:

1. PLANTING SHALL TAKE PLACE IN THE SPRING (APRIL 1 TO JUNE 1) OR IN THE FALL (SEPT 1 TO OCT 1). REMOVE UNWANTED VEGETATION PRIOR TO PLANTING.
2. APPLICANTS ARE ENCOURAGED TO OBTAIN PLANT WARRANTIES (TYPICALLY THROUGH 2 GROWING SEASONS). THE WARRANTY PERIOD, TERMS, AND CONDITIONS SHOULD BE STATED IN WRITING (E.G. "THE WARRANTY PERIOD FOR ALL PLANTS IN BMP #2 IS PROVIDED BY <INSERT NAME OF WARRANTOR> AND COVERS TWO YEARS FROM PURCHASE DATE OF <MONTH, DAY, YEAR>"). BE SURE TO PRESERVE ANY WARRANTY INFORMATION NEEDED TO ACTUATE THE WARRANTY (E.G., PURCHASE RECEIPTS, PLANT INSTALLATION CONTACTOR WARRANTY STATEMENT, ETC.).

LEGEND

- STORMWATER MAINTENANCE EASEMENT (SME)
- STORMWATER PIPE
- PLANTS (REFER TO SCHEDULE FOR TYPE AND SPACING)

CITY OF TOPEKA UTILITIES	Planting Plan BMP #3 Bioretention	REVISION: 0 FIGURE: 2

Refer to **Section 2.5.3 *Stormwater BMP Planting Plan*** for more information

Plant/Vegetation: Additional Resources

- Kansas Native Plant Society
- Kansas State Extension Office – recommended plants
  - Trees and Shrubs
  - Grasses and Sedges
  - Ferns
  - Wildflowers

- The Kansas Native Plant Society (www.kansasnativeplantsociety.org)
- Kansas Wildflowers and Grasses website (www.kswildflower.org)
- Kansas Native Plants Plant Guide (www.kansasnativeplants.com)
- Appendix A of the *MARC/APWA BMP Manual* (*http://kcmetro.apwa.net/PageDetails/439*)

Design Procedure Forms

Design Procedure Forms in the **Handbook** (Appendix E)

- Infiltration Basin
- Infiltration Trench
- Permeable Pavement
- Sand Filter
- Vegetated Filter Strip
- Native Vegetation Swale
- Cisterns
- Green Roofs

Design Procedure Forms in the **MARC Manual**

- Rain Garden
- Bioretention
- Extended Detention Wetland
- Extended Wet Detention Basin
- Extended Dry Detention Basin

Refer to **Appendix E. *Stormwater BMP Design Procedure Forms*** for the full list

Design Procedure Forms

CITY OF TOPEKA UTILITIES

City of Topeka, KS
Design Procedure Form
Infiltration Basin

Designer:
Checked By:
Company:
Date:
Project:
Location:

MARC/APWA BMP Manual Assigned Value Rating: 9.0

I. Water Quality Runoff Volume, WQ_v

Step 1) Tributary drainage area, A (acres) (2 acres or less)	A (acres) =
Step 2) Percent impervious of tributary area, I (%)	I (%) =
Step 3) Volumetric runoff coefficient $R_v = 0.05 + I(0.009)$	R_v =
Step 4) Rainfall event in inches, P (in) (Water Quality Storm of 1.37 inches)	P (in) =
Step 5) Water quality volume (acre-ft) $WQ_v = \frac{(P)(R_v)(A)}{12}$	WQ_v (acre-ft) =

II. Basin Design Depth

Step 1) Soil infiltration rate, f (in/hr) (*See Section VII for how to determine infiltration rate*)	f (in/hr) =
Step 2) Design ponding time, t (hours) (Maximum ponding time 72 hours)	t (hrs) =
Step 3) Maximum design depth, d_{max} (inches) $d_{max} = (f)(t)$	d_{max} (in) =

III. Design Requirement

Step 1) Length to width ratio (3:1 or greater)	Ratio =
Step 2) Side slopes (3:1 or flatter)	Slope =
Step 3) Ponding depth (Maximum ponding depth of 2 feet)	Depth =

IV. Vegetation

A Stormwater BMP Planting Plan shall be created to meet the policy outlined in Section 2.5.3 of the City of Topeka Stormwater BMP Design Handbook. Select vegetation for the infiltration basin by its ability to withstand wet weather, drought, and short periods of ponding (refer to Appendix A of the *APWA/MARC BMP Manual*).

V. Pretreatment

Describe pretreatment to be used with infiltration basin. Infiltration basins are susceptible to high failure rate due to clogging from sediments. Pretreating stormwater is necessary to remove as many suspended solids from runoff as possible.

VI. Emergency Spillway

Describe emergency spillway design. All basins must have an emergency spillway capable of passing runoff from the 25-year and greater, 24-hour storms without damage to the impounding structure.

VII. Infiltration Rate

Determining the in situ infiltration rate. Site designers have two options when designing the in situ soil infiltration rate(s) used to design the infiltration basin, as follows:

a. **Field infiltration tests** of the in situ soil located beneath the bottom elevation of the infiltration BMP may be used to determine the design infiltration rate for the BMP. *This is the preferred approach to determining the in situ infiltration rate.* Field tests will yield results that reflect actual site conditions and allow the design to be optimized to these conditions. Tests shall be performed using the standard test protocols described in the Topeka Stormwater BMP Design Handbook*.

b. In lieu of field infiltration tests, designers may use infiltration rates provided in the most current *USDA-NRCS Soil Survey for Shawnee County, Kansas*. The survey identifies a range of expected infiltration rates for each soil type. Designers who opt to use the NRCS soil survey must use the most conservative infiltration rate (i.e., the lowest infiltration rate of the range provided for the soil type). A digital copy is available at: https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx

*See **Section 3.5.4 Design Policies** of the Topeka Stormwater BMP Design Handbook for further information on the infiltration testing requirements.

Refer to **Appendix E. *Stormwater BMP Design Procedure Forms*** for the full list