Kearney Post-Construction Stormwater Program

Stormwater Treatment Facilities (STFs)

Kearney – Public Works Office

August 10 and 17, 2017

Stormwater Treatment Facility (STF)
Session Goals

- Understand STF Function
- Understand Types of STFs and Applicability
- Overview of STFs

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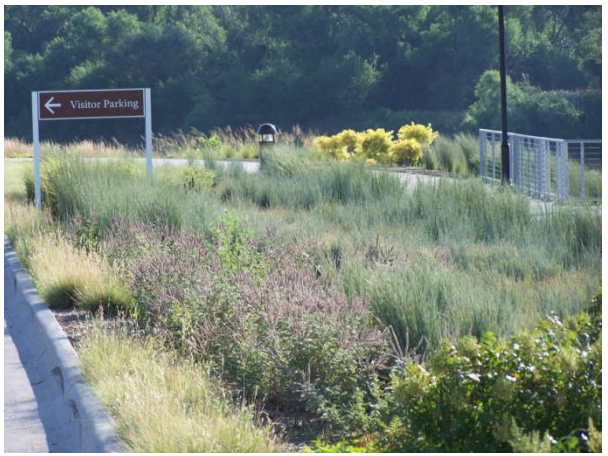
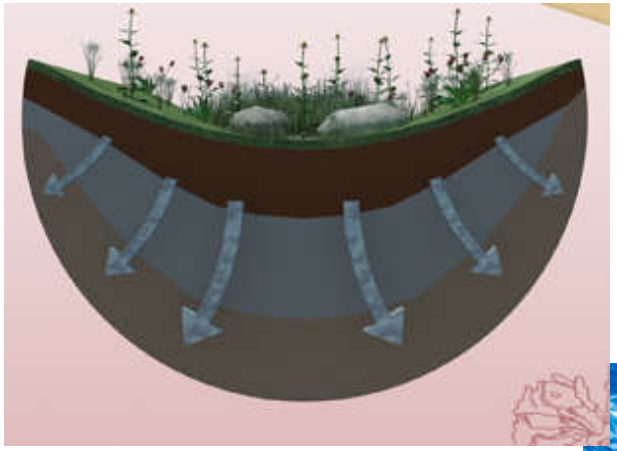
Treatment Mechanisms

- Filtration
  - Vegetative
  - Soils
  - Artificial
- Sedimentation
  - Basins
  - Traps
- Chemical
  - Natural
  - Additive
- Biological
  - Plants
  - Soil





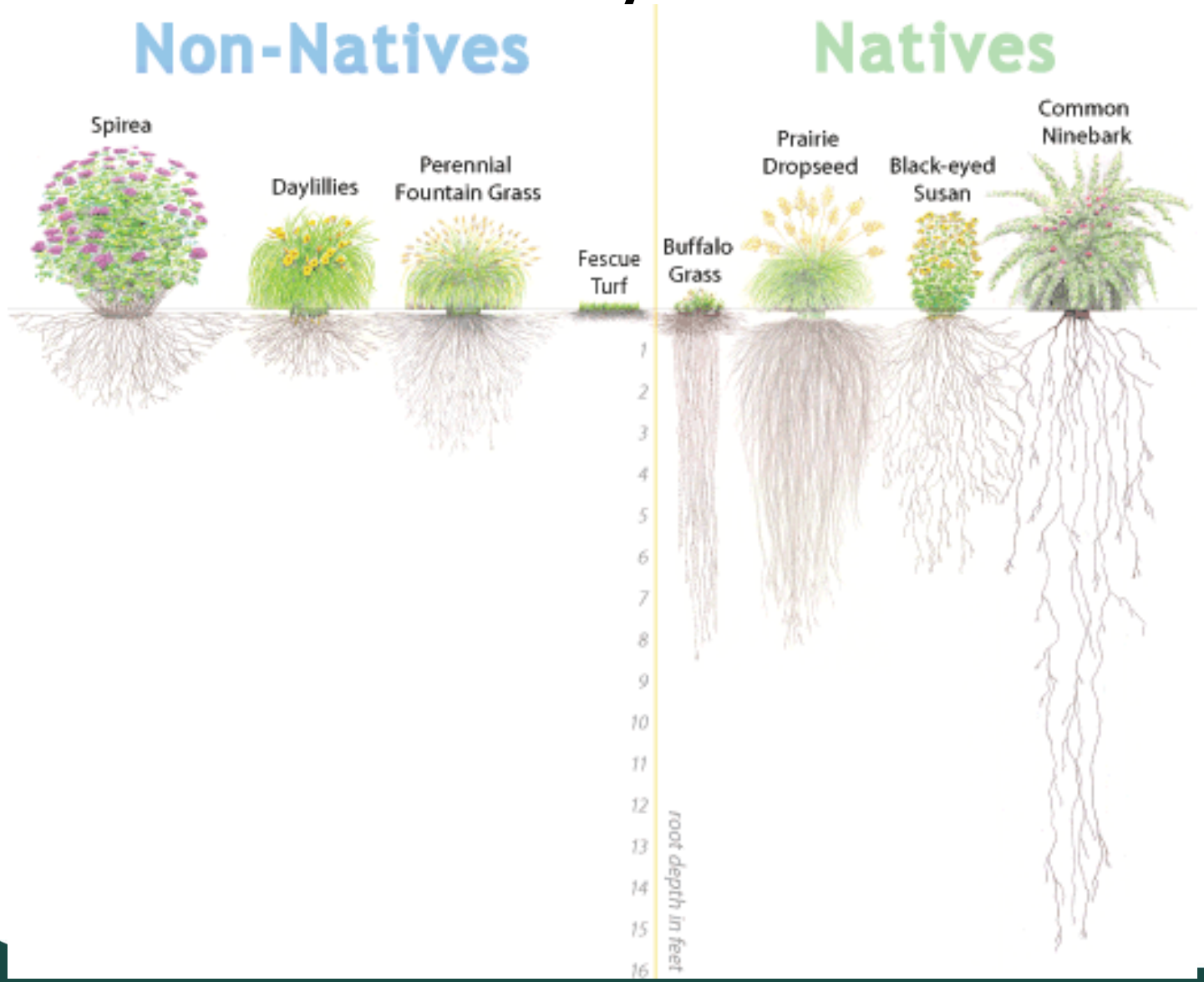
Pollutant Removal Example

Table 1. Pollutant removal mechanisms used in rain gardens

Pollutant Removal Mechanism	Pollutants
Absorption to soil particles Plant uptake	Dissolved metals and soluble phosphorus Small amounts of nutrients including phosphorus and nitrogen
Microbial processes	Organics, pathogens
Exposure to sunlight and dryness	Pathogens
Infiltration of runoff	Minor abatement of localized flooding, minor increase in localized base flow of groundwater, allowing some nutrients to be removed when groundwater flows through buffer
Sedimentation and filtration	Total suspended solids, floating debris, trash, soil-bound phosphorus, some soil-bound pathogens

(Adapted from Brix, 1993)

Root Systems



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Landscaping

- Vegetation is critical
  - Improve infiltration over time
  - Filter sediment
  - Remove pollutants
- Considerations
  - Salt and Chemicals
  - Aesthetics
  - Plant Types
    - Basin vs. Side Slopes
  - Density
    - Bunch vs. Turf Type
  - Maintenance

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STF Design Considerations

- Space Available
- Topography
- Drainage Basin Size
- Infiltration Rates
- Groundwater
- Bedrock

More BMP Design Considerations

- Online vs. Offline
- Major Storm Events
- Runon
- Types of Pollutants
- Cost
  - Capital
  - Maintenance
- Phasing and Conversions

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STF Suitability

STF	Residential	Commercial	Block	Neighborhood
Bioretention Area		x	x	x
Bioswale/Grass Swale	x	x	x	x
Dry Retention/Dry Detention		x	x	x
Filter Strip	x	x	x	x
Infiltration Trench	x	x	x	
Rain Garden	x	x	x	
Underground Storage		x		
Wet Detention		x	x	x
Roof Drain Filters		x		

*The City of Kearney may be amenable to other forms of STF's if properly presented

Design Guidance By Community

Many Similarities

A Few Differences

Community	Design Document
Omaha	Omaha Regional Stormwater Design Manual – Ch. 8 Stormwater Best Management Practices
Lincoln	Lincoln Drainage Criteria Manual - Ch. 8 Stormwater Best Management Practices
NDOT	Drainage Design and Erosion Control Manual – Ch. 3 Stormwater Treatment within MS4 Communities
UDFCD	Urban Storm Drainage Criteria Manual – Vol. 3 Best Management Practices

Design Guidance By Community

Treatment BMPs	Omaha	Lincoln	NDOT	UDFCD
Vegetated Filter Strip	X		X	X
Grass Swale	X		X	X
Infiltration Trench			X	
Infiltration Basin			X	
Bioretention Basin	X	X	X	X
Media Filter			X	
Sand Filter				X
Extended Dry Detention	X	X	X	X
Wet Detention Ponds	X	X	X	X
Stormwater Wetland *	X	X	X	X
Underground Detention		X		X
Pervious Pavement	X	X	X	X
Proprietary Structural Treatment Controls	X		X	X
Green Roofs	X	X		X
Soil Conditioning	X			

* UDFCD includes guidance on "Constructed Wetland Pond" & "Constructed Wetland Channel"

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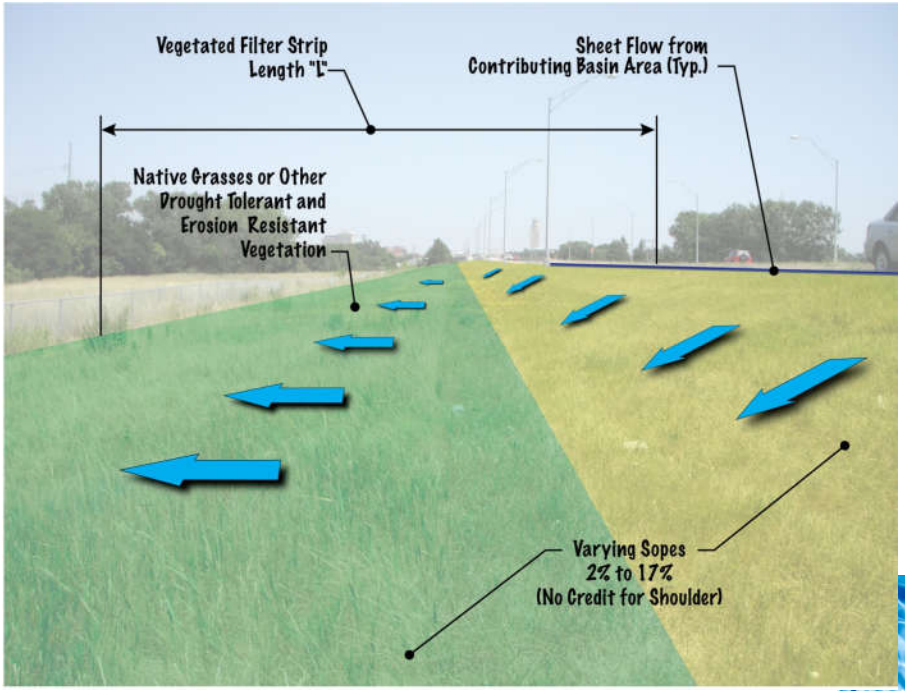
Treatment BMP Suitability Matrix

From NDOT's Chapter 3

NDOR Treatment BMP Suitability Matrix										
Treatment BMP	**Description**	**Treatment Type**	**Typical Drainage Area**	**Site**	**Soil Permeability**	**Groundwater Limitations**	**Targeted Pollutant Removal**	**Construction Cost**	**Maintenance Cost**	**Comments**
Vegetated Filter Strips	Densely vegetated strip of land designed to treat sheet flow	Water Quality Treatment Rate	Based on Sheet Flow Loading	Rural and Urban Section	Any (with soil conditioning)	≥ 2 feet	Suspended Solids	Low	Low	Maximum slope generally 6H:1V - longer filter strip needed on steeper slopes
Grass Swale	Densely vegetated drainageway designed to convey runoff slowly to allow for treatment	Water Quality Treatment Rate	≤ 5 acres	Rural and Urban Section	Any (with soil conditioning)	≥ 2 feet	Suspended Solids, Heavy Metals, Hydrocarbons	Low	Low	Limited depth of flow and velocity for effective treatment
Infiltration Trench	Aggregate-filled trench designed to capture runoff in the void space and infiltrate it	Water Quality Volume	≤ 5 acres	Rural and Urban Section	0.5 - 12 in/hr	≥ 4 feet	Suspended Solids, Nutrients, Heavy Metals	High	Moderate	Width of Trench ≥ Depth
Infiltration Basin	Shallow basin designed to capture runoff above ground and infiltrate it through natural soils	Water Quality Volume	10-20 acres	Rural and Urban Section	0.5 - 12 in/hr	≥ 4 feet	Suspended Solids, Nutrients, Heavy Metals, Hydrocarbons	Moderate-High	Moderate	Drainage area limited if constructed online
Bioretention Basin	Shallow basin designed to capture runoff above ground and infiltrate it through an amended soil and underdrain	Water Quality Volume	≤ 5 acres	Rural and Urban Section	0 - 12 in/hr	≥ 4 feet	Suspended Solids, Heavy Metals	Moderate	Moderate	Landscape plantings typical with this BMP
Media Filter	Structure that includes a sedimentation chamber and sand filtration chamber to treat runoff	Water Quality Volume	≤ 2 acres	Urban and Ultra-Urban	Any	n/a	Suspended Solids	High	High	Typically a cast-in-place structure - check hydraulic grade lines and buoyancy issues
Extended Dry Detention	Basin designed to capture runoff with drawdown to a dry condition over an extended period	Water Quality Volume	≤ 5 acres	Rural and Urban Section	0 - 12 in/hr	0	n/a	Low	Low	Only moderate treatment efficiency in general
Wet Detention	Basin with permanent pool of water designed to capture runoff with drawdown to the normal pool eleveation over an extended period	Water Quality Volume	10 acres + (typ)	Rural and Urban Section	Depends on Design	Depends on Design	Suspended Solids	Low	Low	Minimum drainage area needed to maintain permanent pool
Stormwater Wetland	Basin or drainageway with pool of water of varying depths that supports wetland vegetation and is designed to treat water flowing through the system	Water Quality Volume	10 acres + (typ)	Rural and Urban Section	Depends on Design	Depends on Design	Suspended Solids, Heavy Metals	Moderate	Moderate	Minimum drainage area needed to maintain wetland
Pervious Pavement	Various types of pavement with the ability to pass water through the surface to an underlying aggregate bed designed to capture runoff in the void space and release it slowly through an underdrain	Water Quality Volume	≤ 5 acres	Urban and Ultra-Urban	Any	≥ 4 feet	Suspended Solids, Heavy Metals, Hydrocarbons	High	High	Protect adjacent pavement
Proprietary Structural Treatment Controls	Various types of proprietary devices designed to treat stormwater runoff	Water Quality Treatment Rate	≤ 2 acres	Urban and Ultra-Urban	Any	n/a		High	High	Approval of device needed

Vegetated Filter Strip



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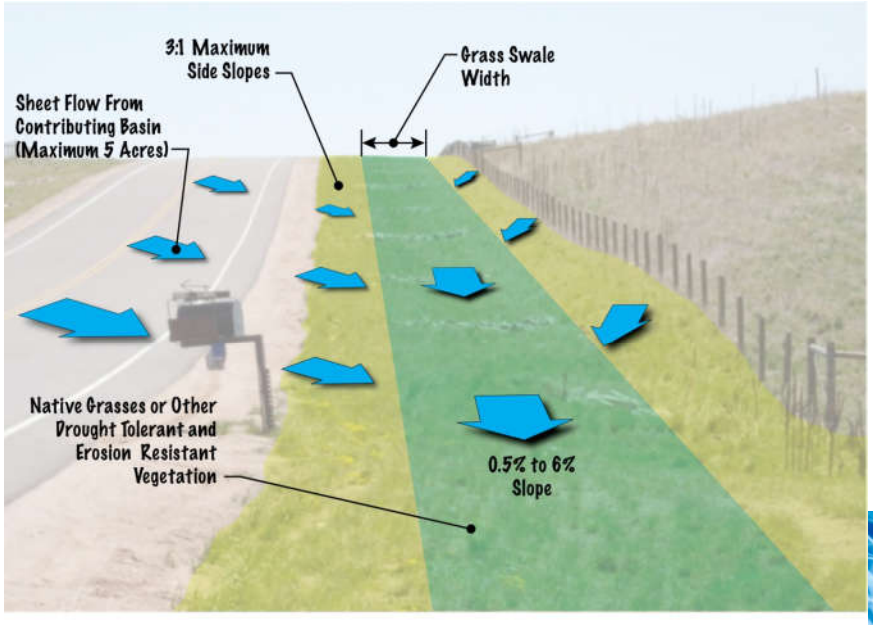
Grass Swale



Grass Swale Example

Not to Scale

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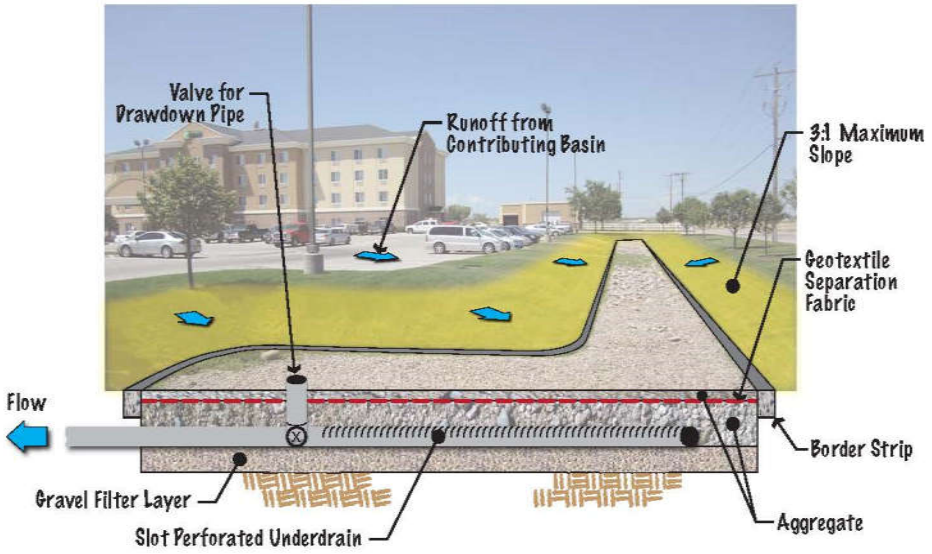
Infiltration Trench



Infiltration Trench Example

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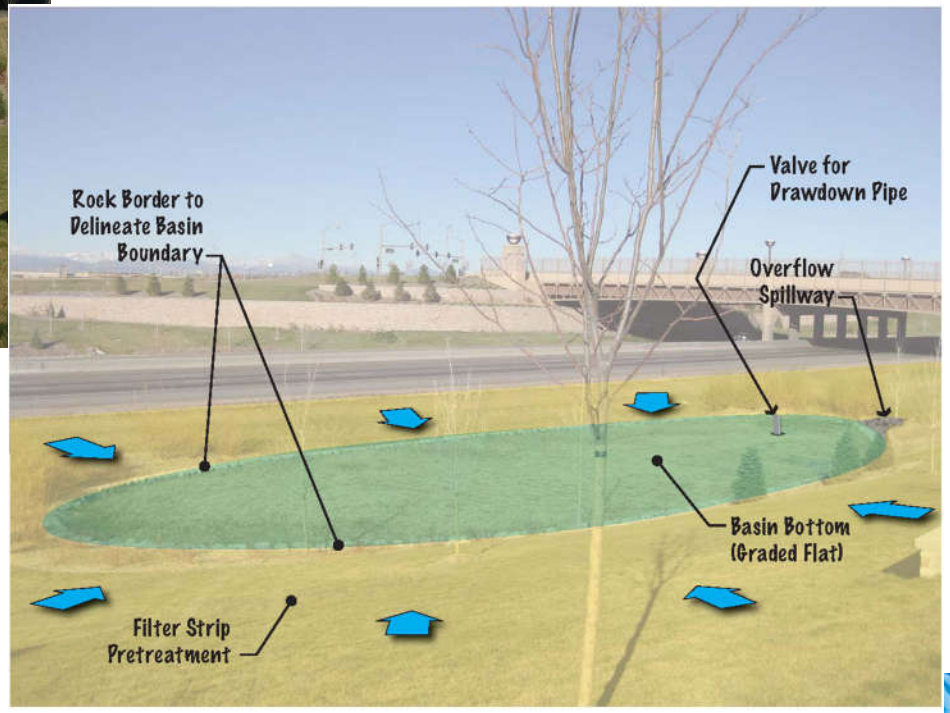
Infiltration Basin



Infiltration Basin Example

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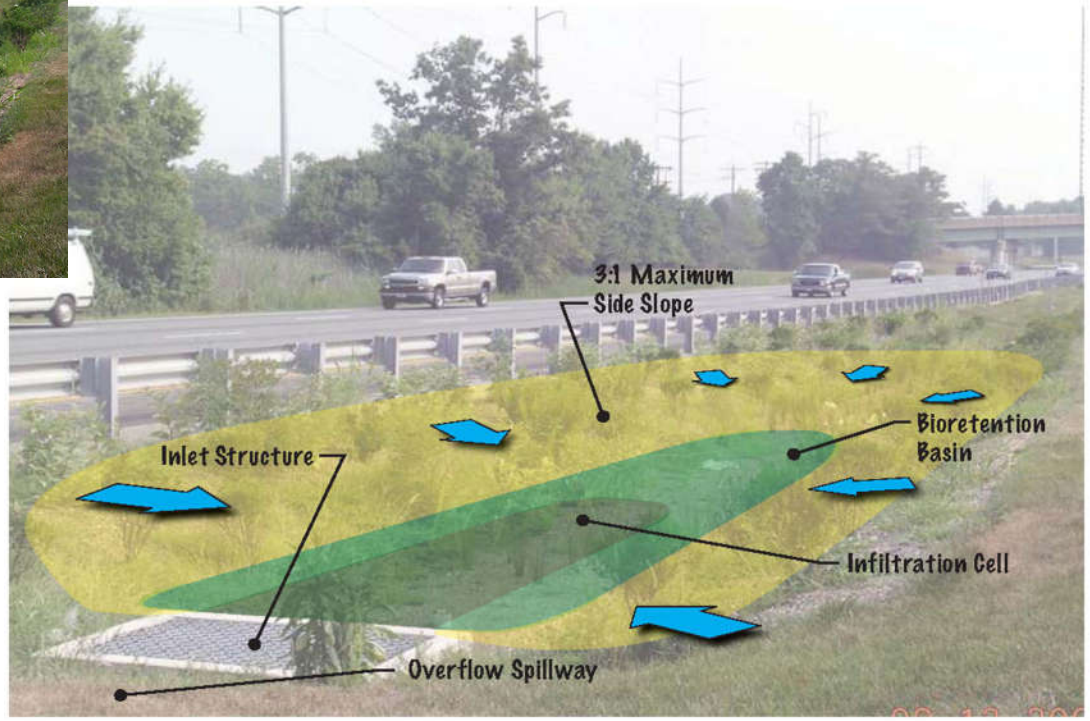
Bioretention



Bioretention Example
Not to Scale

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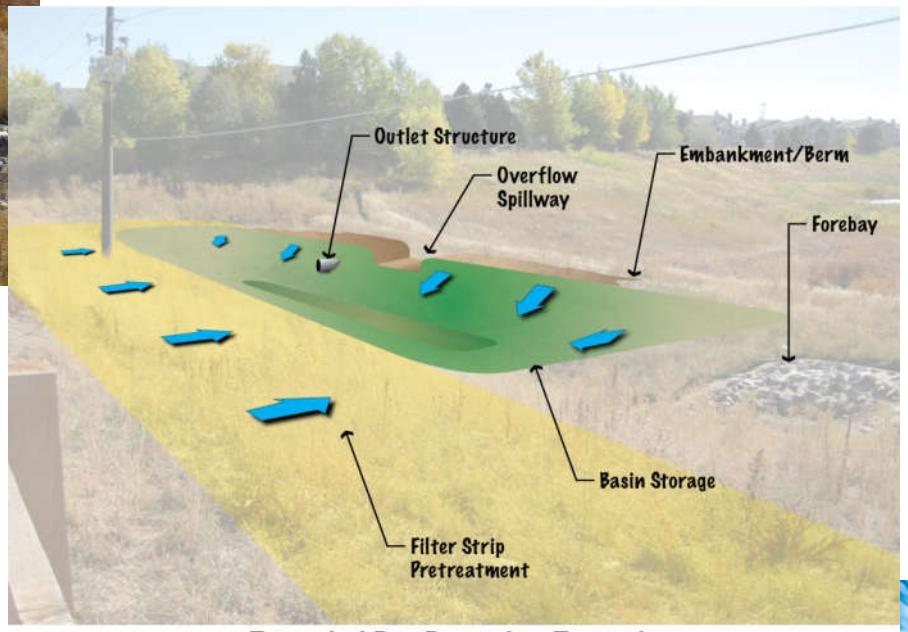
Extended Dry Detention



Extended Dry Detention Example
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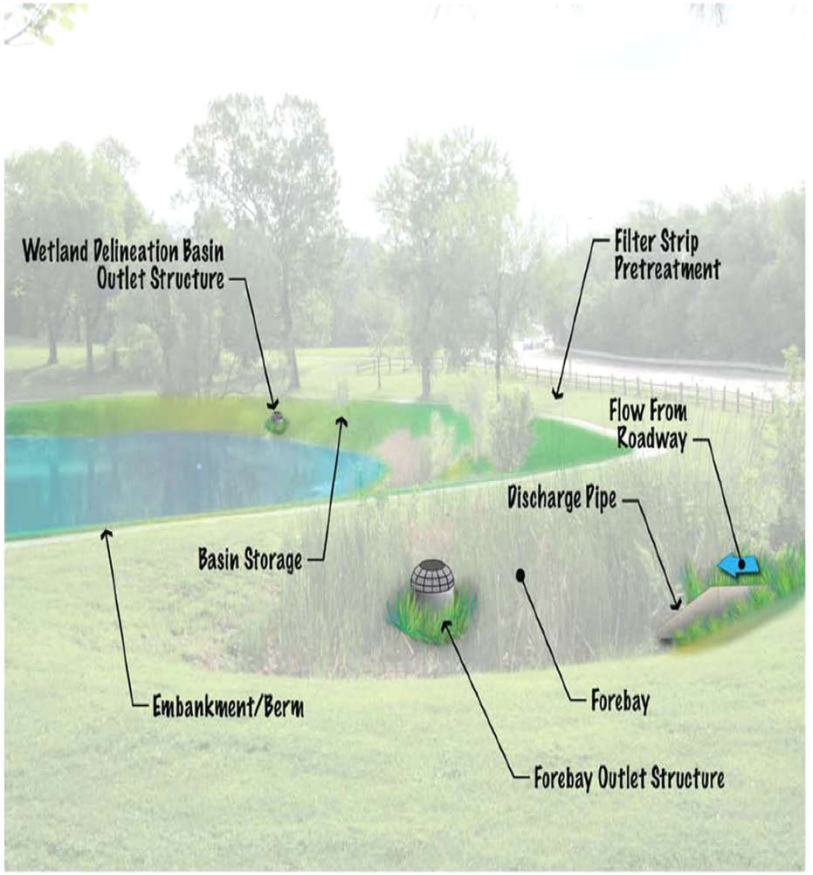
Wet Detention



Wet Detention Example

Not to Scale

Underground Storage & Roof Drain Filters

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Design Preferences Based on STF Function

Infiltration Rates (for infiltrating STFs)

- Min Rate 0.5 in/hr
- Max Rate 12 in/hr

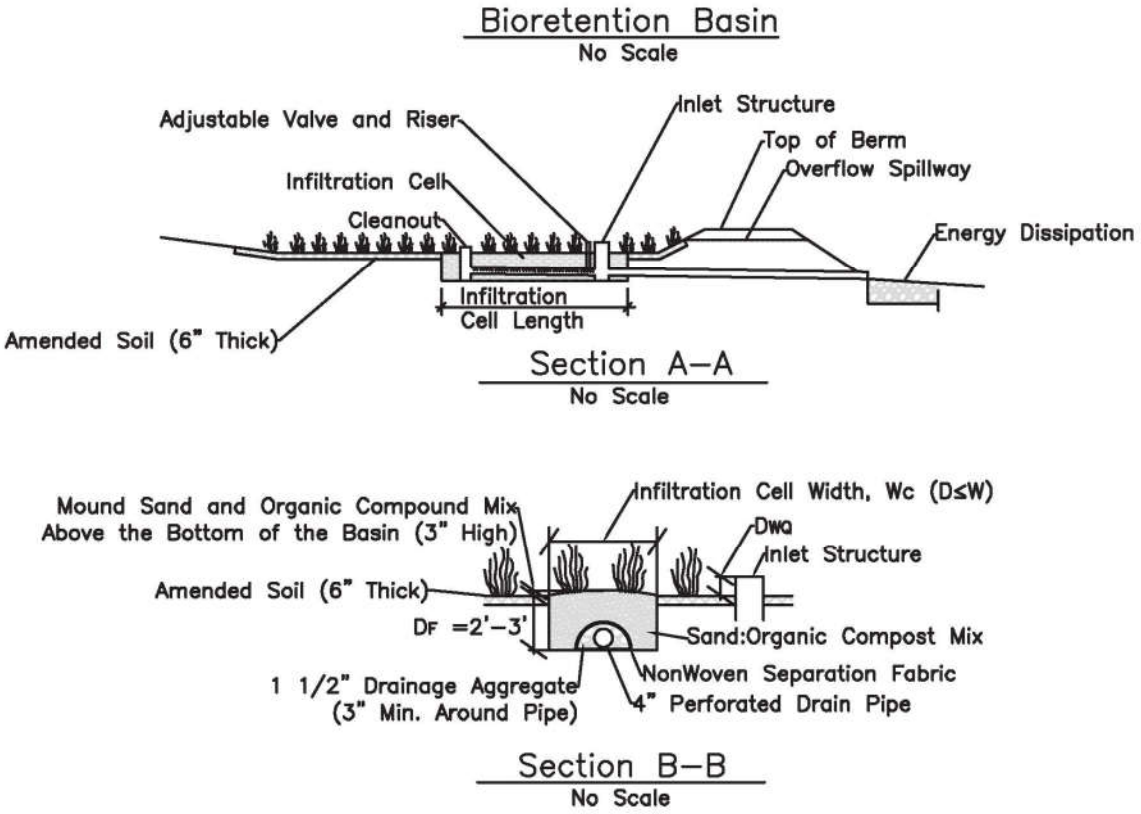
Infiltration Cells (when soils don't drain well)

Drain Time (24 hrs – use valve with infiltration cells to help control rate)

Cleanouts (with all underdrains)

Pretreatment

- Grass buffers
- Barriers
- Forebays



CONSTRUCTION CONSIDERATIONS

- Strip and stockpile topsoil before beginning earthwork and re-spread over finished areas, including the swale bottom and sides, to improve vegetative growth and infiltration.
- Perform fine grading, soil amendment, and seeding only after upgradient surfaces have been stabilized and utility work crossing the swale has been completed.
- Consider providing irrigation appropriate to the grass type.
- Weed the area during the establishment of vegetation by hand or by mowing. Mechanical weed control is preferred.
- Protect the swale from other construction activities.
- Include directions in the specifications for use of appropriate fertilizer and soil amendments based on soil properties and compared to the needs of the vegetation requirements.
- Install swales at the time of the year when there is a reasonable chance of successful vegetation establishment without irrigation; however, it is recognized that rainfall in a given year may not be sufficient and temporary irrigation may be used.
- If sod tiles must be used, place them so that there are no gaps between the tiles; stagger the ends of the tiles to prevent the formation of channels along the swale or strip.
- Use a roller on the sod to ensure that no air pockets form between the sod and the soil.
- Where seeding is used, erosion controls will be necessary to protect seeds until vegetation is well established.

MAINTENANCE AND INSPECTION REQUIREMENTS

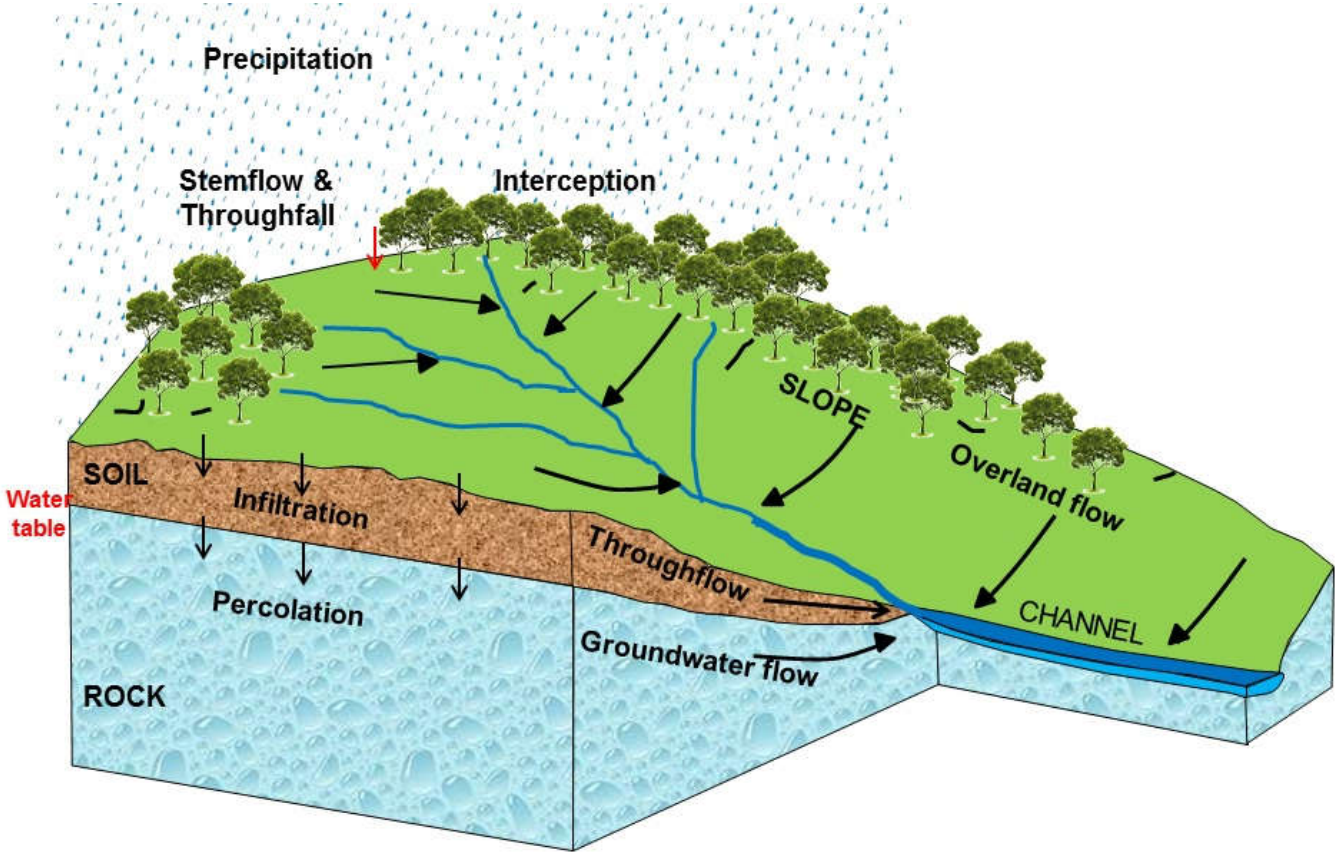
The maintenance objectives for vegetated swale systems include providing litter control, keeping up the hydraulic and removal efficiency of the swale by repairing erosion and removing sediments or other obstructions, and maintaining a dense, healthy grass cover.

Frequency	Inspection and Maintenance Activity
After Construction (While NPDES Permit is Open)	• Inspect swale bi-weekly to ensure the intended vegetation is establishing well. Consider reseeding if needed. • Inspect swale bi-weekly for erosion and any damage by equipment or vehicles after every major rainfall event (≥ ½ inch). Repair as needed. • Remove trash and debris accumulated in the swale.

Quarterly (Through First Two Years of Establishment)	• Inspect swale to ensure there is a dense, uniform stand of the intended vegetation. Consider reseeding if needed.
	• Mow grass to control weeds.
	  ○ Mow grass to a height not less than 6 inches.
	  ○ Do not let the weeds get over the 12-inch maximum height before mowing.
	• Inspect grass swale for erosion and damage by equipment or vehicles. Repair as needed.
	• Inspect swale for sediment buildup in the bottom of the swale. Remove sediment once it has accumulated.
	• Remove trash and debris accumulated in the swale.

Annually (After First Two Years of Establishment)	• Inspect swale to ensure there is a dense, uniform stand of the intended vegetation. Consider reseeding if needed. • If mowing is needed in medians or for other reasons. ○ Mow grass to a height not less than 6 inches. • Inspect grass swale for erosion and damage by equipment or vehicles. Repair as needed. • Inspect swale for sediment buildup in the bottom of the swale. Remove sediment once it has accumulated. • Remove trash and debris accumulated in the swale.

QUESTIONS?


Precipitation
Stemflow &
Throughfall
Interception
SLOPE
Overland flow
SOIL
Water
table
Infiltration
Throughflow
Percolation
CHANNEL
Groundwater flow
ROCK

References:

- City of Kearney, *"City of Kearney City Code-Chapter 9, Article 16: Construction and Post-Construction Stormwater Code"* http://citycode.kearneygov.org:8080/citycode/0/doc/1202638/Page1.aspx

- City of Omaha, *"Omaha Regional Stormwater Design Manual- Chapter 8: Stormwater Best Management Practices"* http://omahastormwater.org/orsdm/

- City of Lincoln, *"Drainage Criteria Manual- Chapter 8: Stormwater Best Management Practices"* http://lincoln.ne.gov/city/pworks/watershed/dcm/

- NDOR, *"Drainage and Erosion Control Manual- Chapter 3: Stormwater Treatment within MS4 Communities"* http://dot.nebraska.gov/media/3920/chapter-3-stormwater-treatement.pdf

- Urban Drainage and Flood Control District (UDFCD), *"Urban Storm Drainage Criteria Manual, Volume 3: Stormwater Quality"* http://udfcd.org/volume-three

*"Post-Construction Stormwater Management Program" Supplement will soon be online as a resource for design standards.