Advanced Bioretention Design Course

Moving Beyond the Basics

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Workshop Context

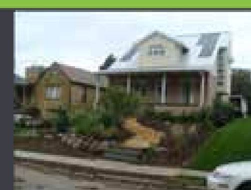
- Always improving
- Targeted design
- Multiple benefits
- Both beauty & function in simplicity
- Regulations/CSO
- Green Infrastructure…

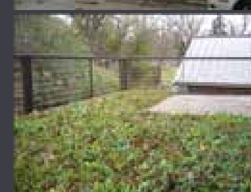
Overview for Today…

- Workshop Context & Setting the Stage
- Evolution in Bioretention
- Re-examining Bioretention Design
- Planting the Bioretention Garden
- Construction & Maintenance - The Fine Details
- Q&A & Group Discussion

Green Infrastructure: Defined

Preservation, connecting, & mimicking of natural processes that slow, sink, & spread rain where it lands





Workshop Goals

- Open dialog & discussion on current data & experiences
- To understand the fine details of bioretention design, construction, & experiences

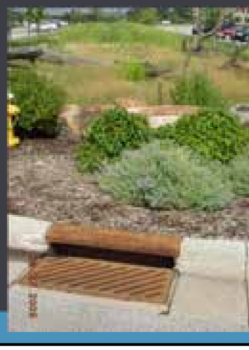
Site Specific GI Project Types

- **Bioretention system**
- Rain gardens
- Bioswales
- Xeric gardens
- Soil Conditioning
- Green roofs
- Porous/pervious pavement
- Rain barrels
- Urban forest
- Wet & dry ponds
- Wetlands
- Filter strips and level spreaders
- Sand filters

Increasing the Knowledge of Green Infrastructure

3 separate collaboration projects between the City of Omaha & the EPA

1. **EPA Office of Research & Development**: in-depth study of soils & green infrastructure
2. **Urban Waters Grant**: assessing green infrastructure's benefits on a neighborhood scale
3. **Technical Assistance**: support to develop tools for green infrastructure & improve systems



Going Forward, Keep in Mind…

My first rain garden…

- the concept
- we are dealing with living elements
- they are not No- or High-maintenance
- doesn't always have to be a 'feature'
- bioretention will continue to evolve…

Why Bioretention Continues to Be Important

- Volume…
- Quality…
- Peak flow…
- Getting familiar with it
- Costs
- Amenity
- Aesthetics
- 'Familiar' maintenance
- Habitat

From Prince George's County to Omaha

Evolution of Bioretention

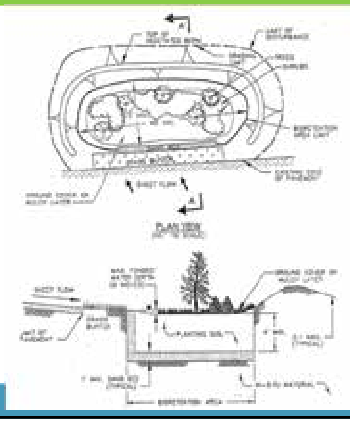
Bioretention & It's Many Names

- Bioinfiltration
- Biofiltration
- Bioretention pond
- Bioretention swale
- Rain garden
- **Bioretention garden**
- **Bioretention system**

Bioretention Definition

- A **vegetated**, relatively shallow depression with a specific soil mix & an **underdrain** to collect stormwater, maximize infiltration, & convey excess water slowly to the nearest outflow
- Rain garden = no underdrain
- ~~Wetland, pond, water feature~~

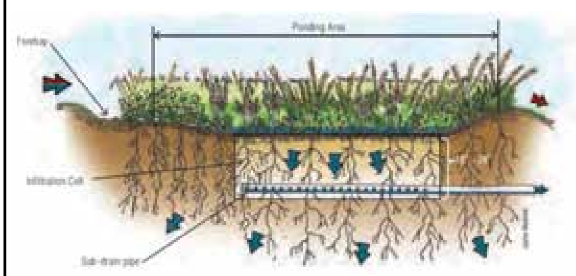
Evolution of Bioretention



Source:
Prince George's County Department of Environmental Protection, 1993

Version 1.0

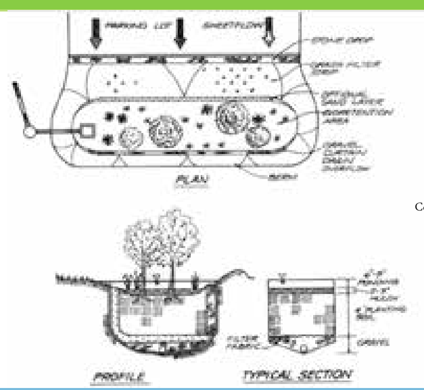
Evolution of Bioretention



Source:
Bioretention Gardens, City of Omaha, Hartsig & Rodie

Version 2.0 – Infiltration Cell

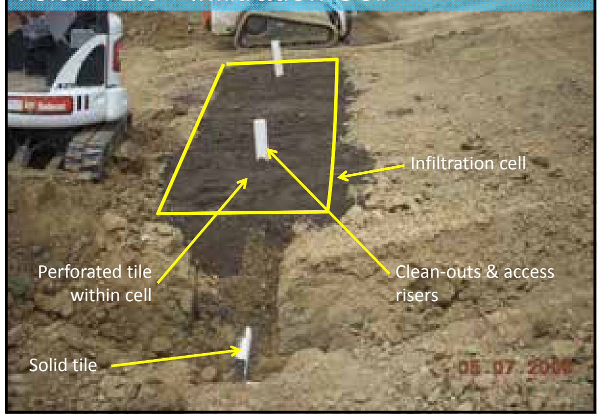
Evolution of Bioretention



Source:
Center for Watershed Protection, 1996

Version 1.5

Version 2.0 – Infiltration Cell



Evolution of Bioretention

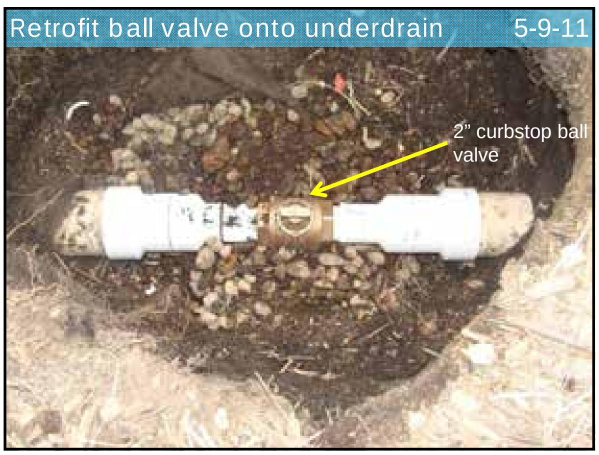
Sarpy Co. Courthouse

Version 1.5

Infiltration Study 2011, City of Omaha


4-10-10
Stream Restoration
Orchard Park: The Site


5-29-09

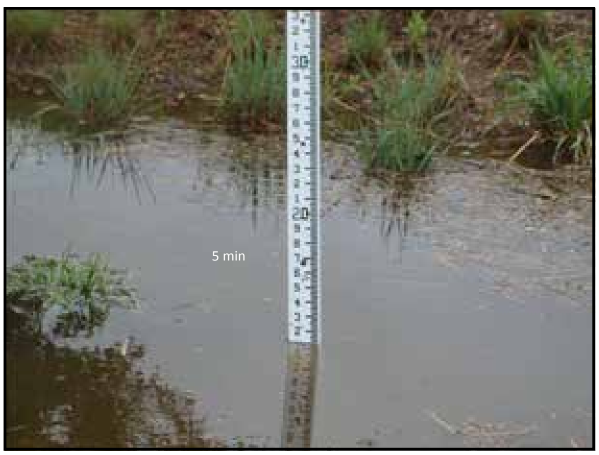

Retrofit ball valve onto underdrain
5-9-11
2" curbstop ball valve


Close valves & flood


5-20-09


Mother Nature helped out…


0 min


5 min


15 min


20 min


25 min


30 min


40 min


45 min


50 min


55 min


60 min


70 min

Plant Performance

Infiltration Results

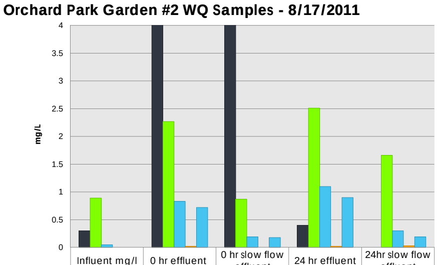
Table 4-2: Orchard Park Bioretention Garden Flooding Infiltration Results June and August 2011

	Water Elevation 0 hr (ft)	Water Elevation 24 hr (ft)	Drop (ft)	Drop (inches)	Infiltration Rate (in/hr)
June 30, 2011					
24 hr infiltration (ft):	1.7	1.47	0.23	2.76	**0.12**
August 17, 2011					
24 hr infiltration (ft):	1.465	1.22	0.245	2.94	**0.12**

- Simulations @ Orchard Park show very little infiltration into native soils
- 1.3' of ponded water drained out in 74 minutes @ Orchard Park
- Underdrain was PVC w/perforated holes on bottom of pipe w/washed river rock & non-woven geotextile

Rooting Performance

Water Quality Results

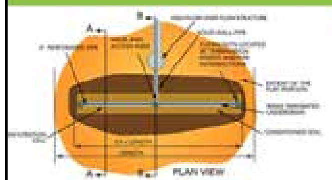


	Influent mg/l	0 hr effluent	0 hr slow flow effluent	24 hr effluent	24hr slow flow effluent
Nitrate/Nitrite Nitrogen	0.3	6.9	10.00	0.40	0
Total Kjeldahl nitrogen	0.89	2.27	0.87	2.51	1.66
Phosphorus (total)	0.05	0.83	0.19	1.10	0.3
Nitrite nitrogen	0	0.02	0.00	0.02	0.03
Phosphorus (dissolved ortho)	0	0.72	0.18	0.90	0.19

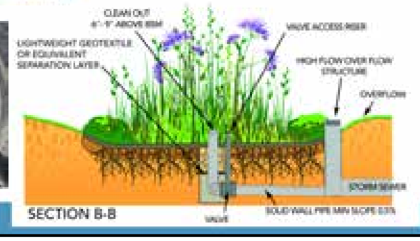
Small cell footprint & long & narrow garden

Learning the Fine Details of Version 2.0

Bioretention System



- Infiltration Cell
- **Valve**
- Conditioned soil
- "Targeted over-engineering"



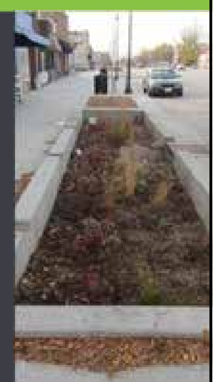
Version 3.0

- Test the system
- Underdrain & aggregate

Learning the Fine Details of Version 2.0

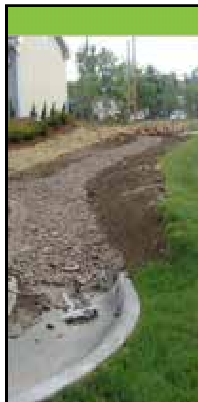
Going Forward…

- Dissolved nutrients & soil mix
- Plant suitability
- Utilize/maximize in-situ soils
- Aesthetics
- Public perception
- Maintenance
- Simplify installation & minimize potential issues
- Costs

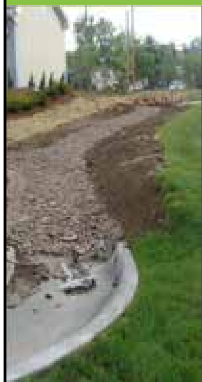


50/50 fine sand/compost mix & initial water quality

Learning the Fine Details of Version 2.0



RE-EXAMINING BIORETENTION GARDEN DESIGN



Fundamental Concepts

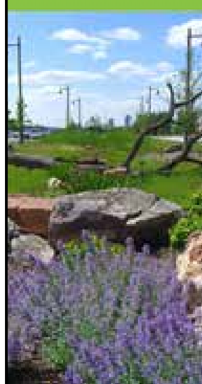
- Establish goals to direct design and performance
- Think of the entire system
  - Owner's needs
  - Surrounding environment
  - Connection of water, soil, plants
  - Long term performance and maintenance
- We are trying to re-create or restore natural hydrologic function.
- Keep it Simple!

Locating the Bioretention Garden

- Know the site(s) and surrounding areas
  - Where is runoff flowing from and to?
  - How much runoff?
  - Direct or interrupted flow?
  - Timing and location(s) of runoff concentration
- Know the environment and how it will affect drainage
  - Soils
  - Topography
  - Vegetation

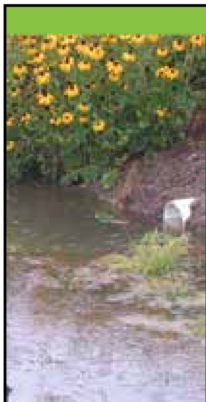
What We Are Learning

- Infiltration cells and media require close attention to detail
- Water quality improvement is highly dependent on residence time and filter media quality
- Design specifications don't always meet construction reality
  - Quality of materials
  - Contractor operations
- Managing existing soils is critical
- Right plant in the right place
- Manual controls are sometimes needed



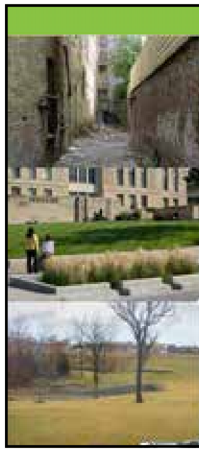
LOCATING THE BIORETENTION GARDEN

- Single point of detention, or dispersed detention
- Adequate space for the garden?
- Runoff delivery to the garden?
- Bioretention garden access



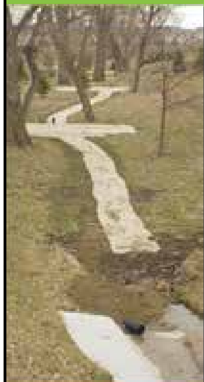
ESTABLISHING BIORETENTION PERFORMANCE OBJECTIVES

- Water quality or water quantity – or both?
- Water inflow vs. water outflow
- Surrounding area – design related to nearby land use and function



IS BIORETENTION RIGHT FOR YOUR SITE?

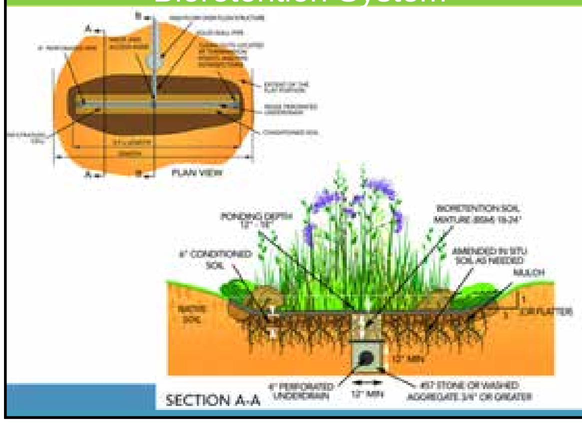
- Limited space
- Better BMP method?
- Is the geology right?
  - Depth of soil
  - Depth to groundwater
  - Bedrock
- Access for construction and maintenance, safety
- Objections/acceptance from land owner or community

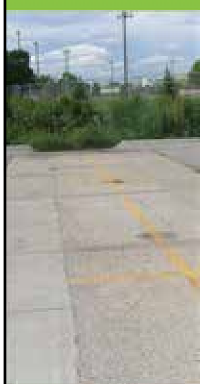


Sizing Bioretention Gardens

- In some cities, the rule is to simply collect the first 0.5 inch of rainfall runoff
- How much runoff will you have?
  - Determine the size of your drainage area in square feet. Subtract areas with native vegetation or disconnection from drainage, or landscape with conditioned soil
  - Divide that number by 24 (assume 100% runoff) (Area (Ft^2) * 0.5 in * 1 Ft/12 inches = volume (Ft^3))
  - You have the cubic feet of runoff you must collect – minimally
- For margin of safety, calculate all storage above ground
- Does runoff collect to one location, or multiple?
- Can the runoff be managed in one BMP, or in a BMP system?

Bioretention System

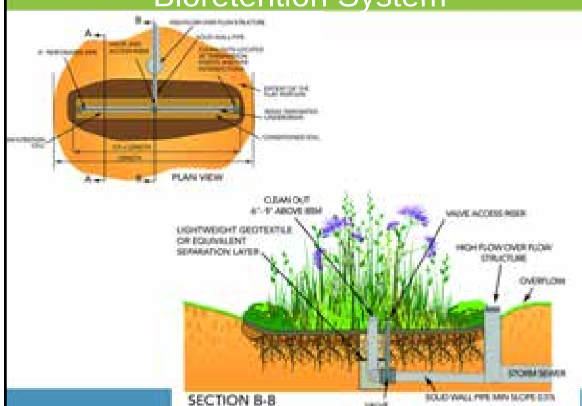




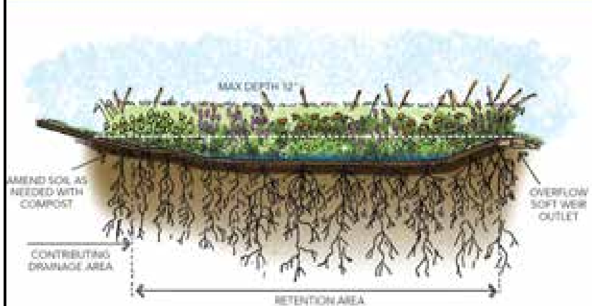
Sizing Bioretention Gardens

- Dispersed runoff – several bioretention gardens?
- Connect multiple, smaller gardens?
- One large bioretention garden
- How deep?

Bioretention System

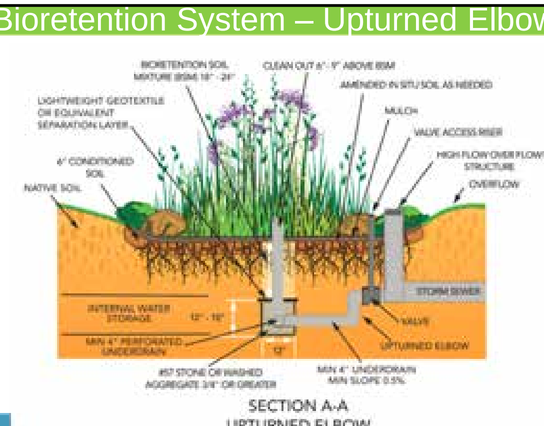


Rain Garden: Basics



No underdrain

Bioretention System – Upturned Elbow

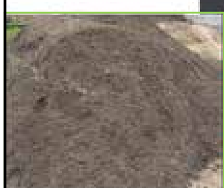


Infiltration

- Challenge: Infiltration is too fast or too slow
- Performance objectives
  - Quantity control/storage
  - Pollutant removal/filtering
  - Aesthetics and maintenance
- Common goal: infiltration into the soil
- Materials are variable
- Mechanical controls (valve)

Soil Management (design considerations)

- Conserve topsoil if possible
- Adding compost to and mixing with the BMP soil enhances plant growth
- Design construction sequence to minimize compaction
- Erosion control measures as appropriate
- The first year of infiltration into the soil will be slow – it gets better with time

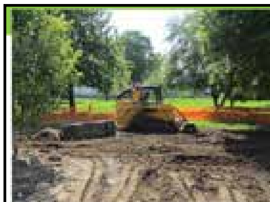


Infiltration

Sand/compost mix
- Positive: great for plants
- Negative: nutrient release

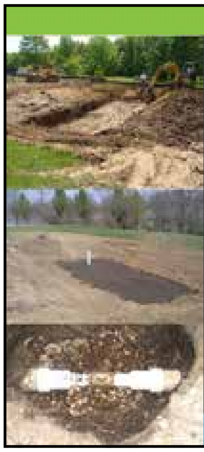
Soil mixes
- Blended soils tend to separate
- Mulch plugs the soil, retards function

Sub-layers
- Rock "sumps" typically not needed
- May restrict root growth and plant performance



Soil Conditioning:

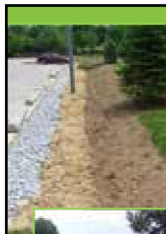
- MINIMUM SPECS: 3" of compost (OmaGro) tilled to a depth of 6"

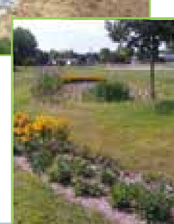


Infiltration

Infiltration Cell
- Does not have to be large
- Size of the cell is dependent on the infiltration/percolation rate of the infiltration soil media
- Does not have to be deep
- Top of the cell slightly above bioretention garden base

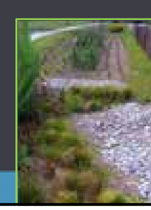
Drainage
- 4" perforated pipe
- Wrap in river rock w/ filter fabric
- Slotted pipe ok, but could clog



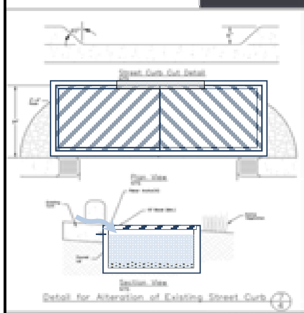


Water into and out of the Bioretention Garden

Inlets
- Curb cuts from streets, level spreaders, pipe inlets, swales
- Pretreatment: grass filters, forebays
- Offline vs. inline



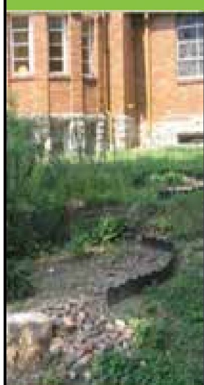
Sediment Traps



- Several types of traps work
- Maintenance – sediment removal is key
- Allow inflow to pass through chamber, slow to drop sediment

Planting Design

Water into and out of the Bioretention Garden



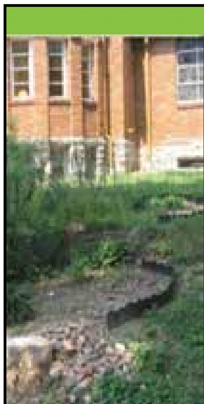
Outlets

- Must be designed to safely pass the 10-year, 24-hour storm, or other local regulations
- Excess stormwater runoff can also be diverted away from the bioretention garden
  - selective grading, smaller curb cuts, or smaller inlet pipes.
- Additional design requirements in Chapter 6 of the Omaha Regional Stormwater Design Manual

Overview

- Sustainable context
- Naturalistic landscape character acceptance
- Basic design parameters
  - Aesthetics
  - Function
  - Management
- Case study
- Bioretention plants and drought

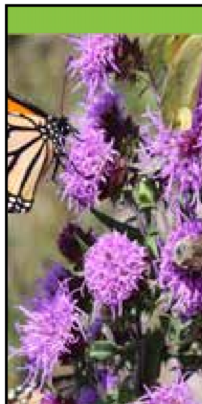
Water into and out of the Bioretention Garden



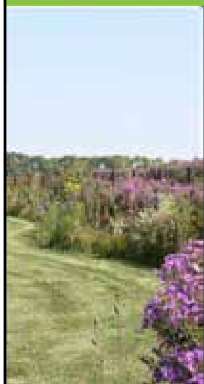
Outlets

- For overflow, an outlet can be constructed with a slightly depressed elevation in the BMP berm
- If appropriate, direct overflow to a second BMP
- Direct water to where it will not damage structures, foundations or neighboring properties.

Sustainable Design Benefits

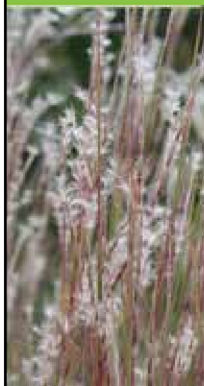


- **High aesthetic value** -- seasonal changes, diverse foliage, flower and fruit, healthy plants, year-round interest, wildlife
- **Easy on the environment** -- reduced pesticides, fertilizers, water use, habitat enhancement
- **Potential for cost savings** -- less maintenance, healthier plants, reduced resource inputs



Naturalistic Character Acceptance

- Research indicates two approaches – both important:
  - **Intelligent Care (education)**
  - **Vivid Care (obvious beauty)**
- Thoroughly integrating “neat” and “fuzzy” will tone down contrasts and help unify garden appearance with surrounding landscape

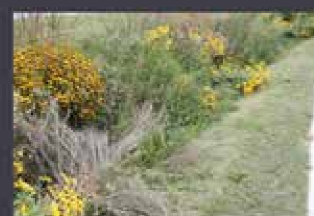


Ideal Plants - Aesthetically

- Form – distinct, upright; appropriate height and width; “well-behaved”?
- Longevity of interest/character
  - Length of flower bloom; potential for rebloom
  - Foliage texture or color – lasts all season
  - Fruit character, persistence
  - Winter interest
  - Sense of locality or region – “Nebraska-style”

Intelligent Care

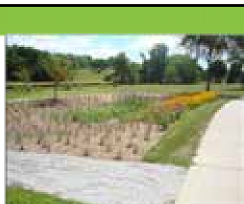
- Interpretive signage and labeling
- Provides context
- Educational value

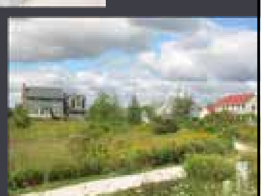


Trade-offs are inevitable….

Vivid Care

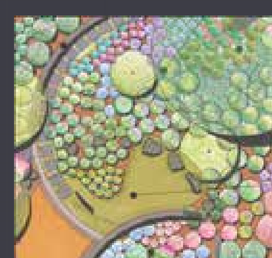
- Massing creates structure and framework
- Defined edges reflect care; also lessen maintenance

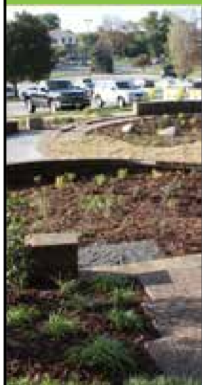




Design Parameters - Aesthetics

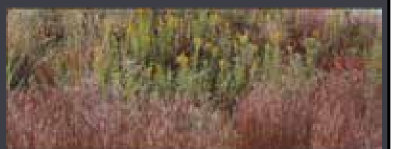
- Design elements
- Design principles
  - Order
  - Unity
  - Rhythm
- Plant arrangement
  - Massing
  - Plant heights
  - Plant types





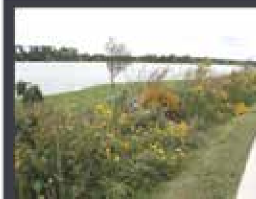
Design Elements

- Color
- Form
- Texture
- Line



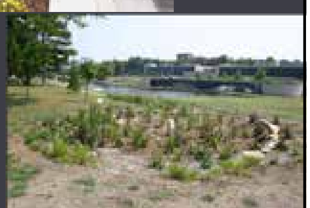
Rhythm

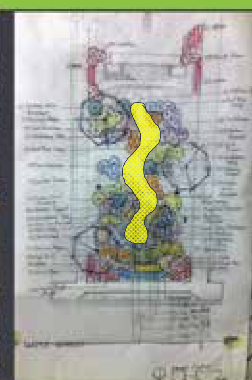
- Flowing variations in heights and widths
- Strong patterns
- Repeated repetition



Order

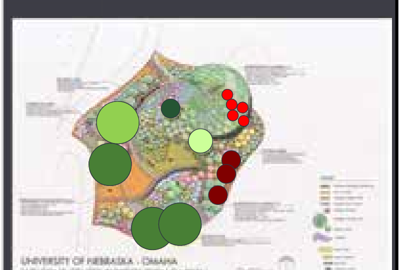
- Defined bed lines
- Massed plants, massed masses
- Appropriate plant heights





Unity

- Odd numbers
- Strategic use of emphasis and focal points
- Repetition

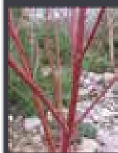


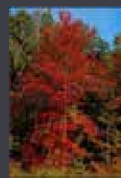
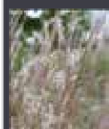
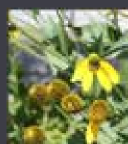
Plant Heights

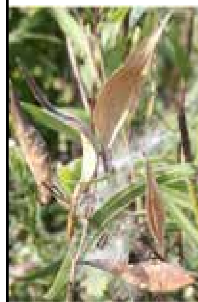
- Match with garden scale
- Relatively short better than too tall

Plant Types

- Maximize variety for aesthetics, function, biodiversity
  - Trees
  - Shrubs
  - Grasses
  - Perennial flowers
  - Sedges and rushes



Plants + Soil = the “Bio” in Bioretention

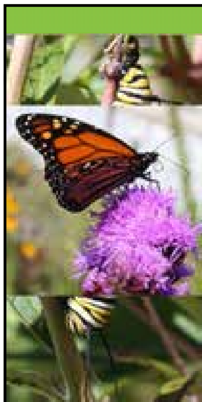
- Interception
- Settling
- Evaporation
- Filtration
- Absorption
- Transpiration
- Evapotranspiration
- Assimilation

Vegetation Types

- Evergreen versus deciduous
- Forbs versus grasses

Design Parameters - Function

- Water quantity
  - Rooting depth
- Water quality
  - Phytoremediation
  - Nitrogen
  - Phosphorus
  - Mulch vs. plants
  - Underdrain design vs. plants
  - Salt tolerance



Ideal Plants - Functionally

- deep rooting
- climate and water adaptability
- habitat value
- lack of invasiveness
- overall enhancement of soil infiltration over time

- Benedict et al., 2010
- **Interception and infiltration significantly higher w/native grasses; perennials not a significant factor**

Turf vs. Native

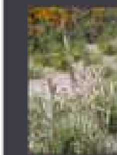
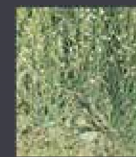
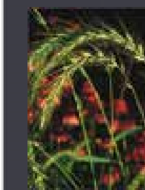
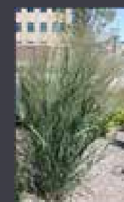
- Compared:
  - Monoculture stand of Kentucky bluegrass
  - Mixed stand of Kentucky bluegrass and smooth brome
  - Previous two + 5 native warm-season grasses
  - Previous seven + 33 forbs

- Selbig, 2010
- **Prairie vegetation had higher infiltration than turf**

Turf vs. Native

- Two rain gardens side by side
- Turf vs. native prairie species
- Also compared clay and sandy soils
- Both soils functioned, sand higher infiltration than clay

- Hydrocarbons
  - blue grama
  - buffalograss
  - Canadian wild rye
  - switchgrass
- Organic contaminants can be degraded, metals can't

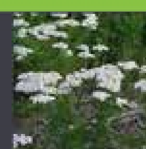
- Bartens et al., 2008
- **Increases in infiltration of 1.5x and 20+x**

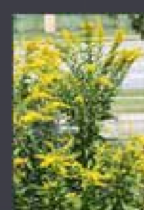
Enhanced Infiltration with Trees

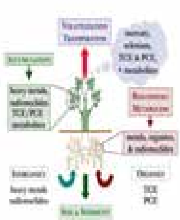
- Comparisons of infiltration related to tree rooting in compacted soils
- Black oak and red maple grown in compacted soil (bulk densities 1.3 and 1.6 g/cm^3),
- Green ash grown in CU Soil through geotextile and 1.6 g/cm^3 subsoil

- Cadmium
  - Yarrow
- Metals
  - Goldenrod
- Lead
  - Leadplant

Need to manage biomass accumulation







http://srel.uga.edu/outreach/snapshots/phytoremediation.htm

Phytoremediation

- Remove, degrade, metabolize, immobilize
- Depends on interaction between soil, contaminants, microbes and plants
- Affected by climate, soil properties, site hydrogeology

- Plant factors affecting uptake
  - Root size
  - Plant maturity
  - Plant vigor
  - Growth rate
  - Time of year
  - Soil type

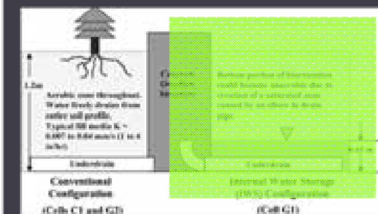
Nutrients (Nitrogen, Phosphorus)

- Bioretention removal shown highly effective:
  - total suspended solids (TSS)
  - heavy metals
  - particulate nutrients
  - hydrocarbons
- Dissolved nutrient removal performance has been much more variable

http://www.deeproot.com/blog/blog-entries/ Nathalie Shanstrom

Nitrogen

- Nitrate retention in bioretention systems is dependent on
  - adequate time for biological processes to occur, and
  - presence of plants



Hunt et al., 2006. Evaluating Bioretention Hydrology and Nutrient Removal at Three Field Sites in North Carolina.

Salt Issues

- Highly variable depending upon chemicals, design of cell, etc.
- No specific design parameters similar to metals, nutrients, etc.
- Success factors
  - Understand salt issues for site context/conditions
  - Use salt-tolerant plants (consider roots/uptake and foliage); numerous resources available
  - Higher infiltration rates help flush accumulated salt from system

Phosphorus

- Henderson, 2009
- Lucas and Greenway, 2008
- **Healthy vegetation is essential to maximizing phosphorus removal in bioretention systems**

- "**Media** for bioretention systems **should be selected for the suitability to support vegetation**, within the constraints of the desired hydraulic conductivity"
- 92% total phosphorus removal in vegetated loam, 67% in vegetated sand, 44% in vegetated gravel after 50 weeks of stormwater loading

Plants:
Concerns, Successes, Stay Tuned

Plants vs. Mulch/Soil

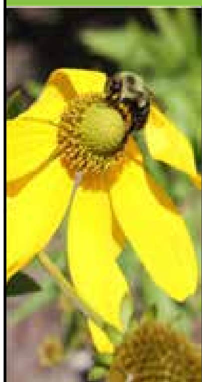
- Mulch has a significant role in uptake of heavy metals (within top few inches of cell)
- Mulch conducive to growth of microorganisms that break down hydrocarbons
- Clay in soil provides adsorption sites for heavy metals, hydrocarbons, nutrients, etc.

http://www.lid-stormwater.net/bio_benefits.htm

http://water.epa.gov/scitech/wastetech/upload/2002_06_28_mtb_biortn.pdf

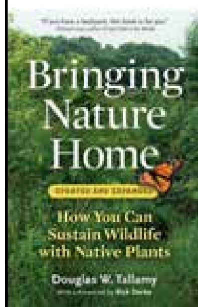
Concerns

- *Any plant not placed to maximize success*
- Potential for spreading
  - Switchgrass
  - Coneflower
  - Indiangrass
  - Loosestrife
  - Beebalm
  - Obedient Plant
- Animal damage
  - Liatris (voles eat corms)



Concerns (cont.)

- Flops (too much water, too much shade, lacks structure)
  - Liatris
  - Big bluestem
  - Little bluestem
  - many others possible

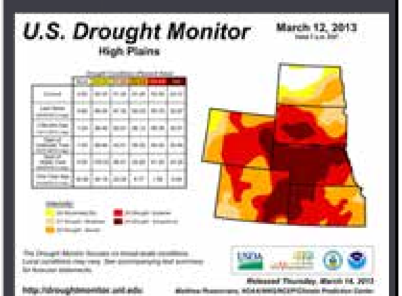


Non-Native Plant Trade-offs

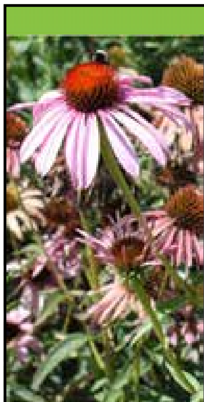
- Cultivars and hybrids are suggested for specific landscape “fit”; plant value trade-offs are possible
  - Sterile plants = no food
  - Genetic diversity decrease
  - Habitat value decrease

Drought…now what?

- Higher expectation for drought tolerance
- Consider “lowering” plants in garden location recommendations
- May increase need for supplemental irrigation (similar to other landscapes)



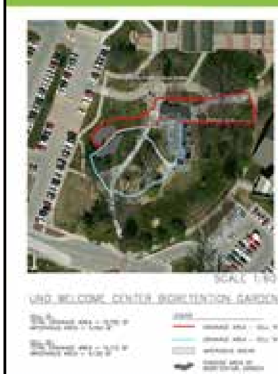
UNO Bioretention Garden

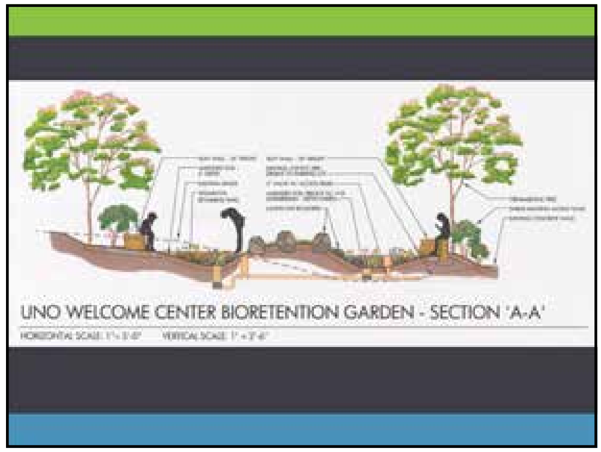


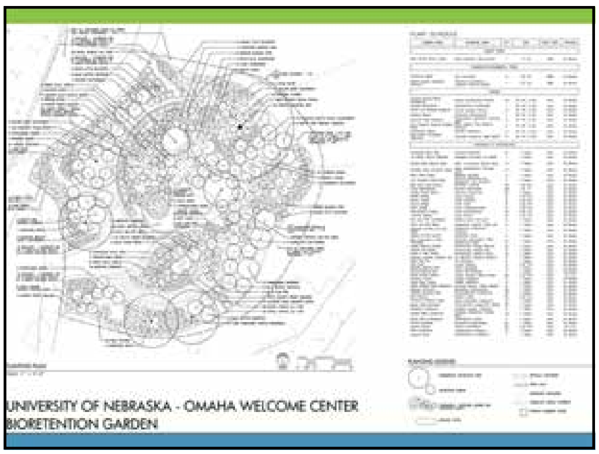
Maximize Odds of Success

- NEWANIP
  - Native [AND]
  - Ecologically well-adapted
  - Non-invasive
  - Plants

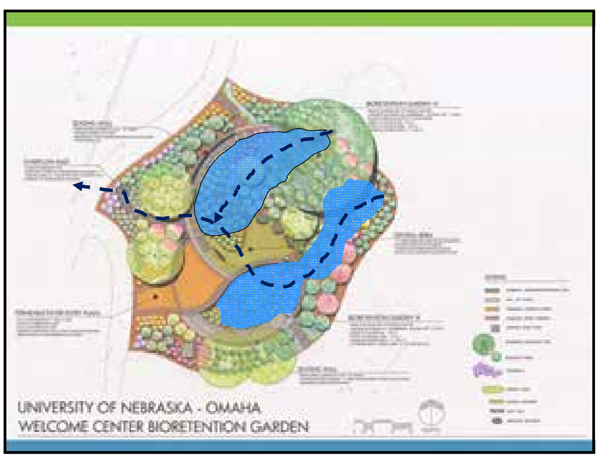
*from City of Omaha Environmental Element




UNO WELCOME CENTER BIORETENTION GARDEN - SECTION 'A-A'


UNIVERSITY OF NEBRASKA - OMAHA WELCOME CENTER
BIORETENTION GARDEN


Black Gum/Tupelo
Nyssa sylvatica
Ht. 30-50'; sp. 20-30'
Tolerant of wet soils
Potential chlorosis
Fall color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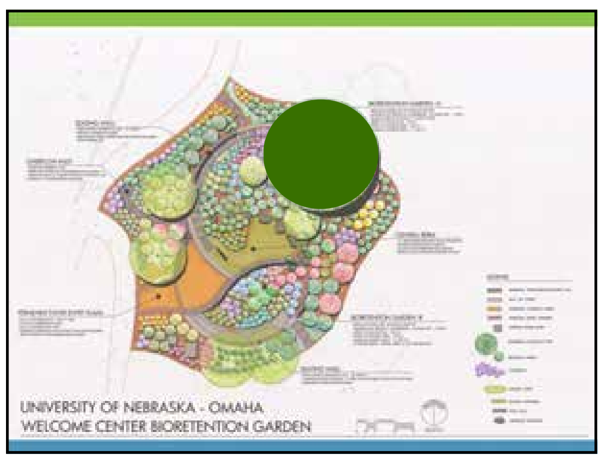
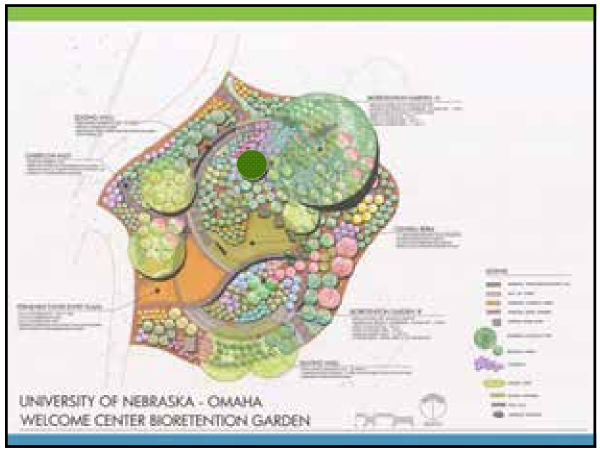
WELCOME CENTER BIORETENTION GARDEN


UNIVERSITY OF NEBRASKA - OMAHA
WELCOME CENTER BIORETENTION GARDEN

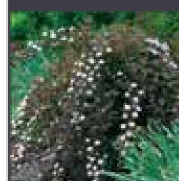
Prairie Classic Viburnum
Viburnum "Prairie Classic'

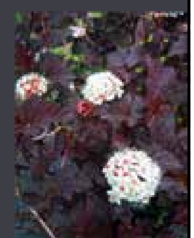
- Ht. 10-15'; sp. 10-12'
- Tolerant of variable soils
- Less suckering than species
- Fruit, fall color



Summer Wine Ninebark
Physocarpus opulifolius 'Seward' SUMMER WINE

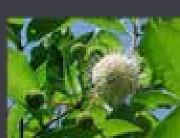
- Ht. 4-6'; sp. 4-6'
- Tolerant of dry to wet soil
- Showy flowers

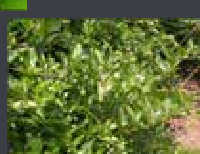




Buttonbush
Cephalanthus occidentalis

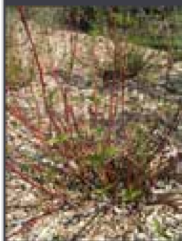
- Ht. 5-10'; sp. 4-8'
- Tolerant of wet soil
- Showy fragrant flowers
- Attracts butterflies

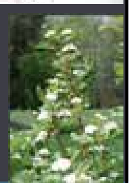


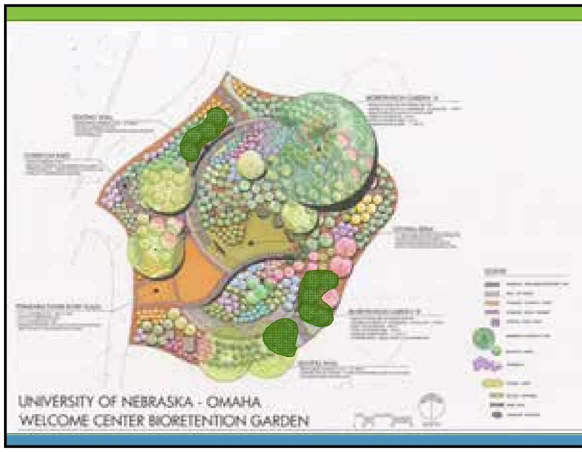


Arctic Fire Redstem Dogwood
Cornus sericea "Farrow'
ARCTIC FIRE

- Ht. 3-4'; sp. 3-4'
- Tolerant of medium to wet soil
- Showy flowers, fruit
- Red winter stems

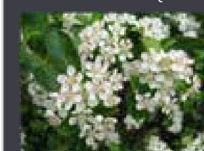
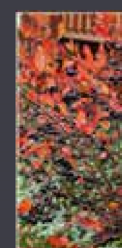
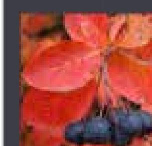






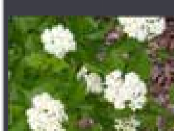
Iroquois Beauty Black Chokeberry
Aronia melanocarpa 'Morton'
IROQUOIS BEAUTY

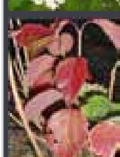
- Ht. 2-3'; sp. 4-5'
- Tolerant of dry to wet soil
- Colonizes
- Showy flowers, edible fruit
- Wildlife

Blue Muffin Arrowwood Viburnum
Viburnum dentatum 'Christom'
BLUE MUFFIN

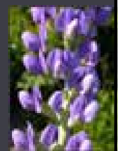
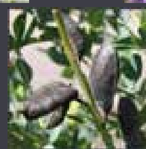
- Ht. 3-4'; sp. 3-4'
- Tolerant of dry to wet soil
- Showy flowers, fruit
- wildlife

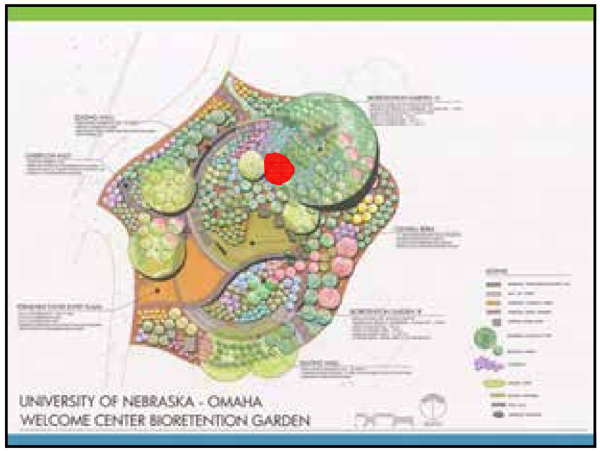




Blue False Indigo
Baptisia australis

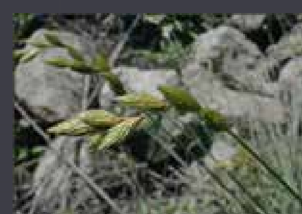
- Ht. 3-4'; sp. 3-5'
- Tolerates drought and poor soil
- Showy flowers and pods
- Naturalizes



Broom Sedge
Carex scoparia

- Ht. 1.5-2.5'; sp. 1.5-2.5'
- Wet soil
- Full sun
- Bunching, small spike flowers



Sioux Blue Indiangrass
Sorghastrum nutans 'Sioux Blue'

- Ht. 3-5'; sp. 2-3'
- Tolerates wide soil range
- Blue foliage, fall color
- May self-seed
- Winter interest


Palm Sedge
Carex muskingumensis

- Ht. 1.5-2.5'; sp. 1.5-3'
- Moderate to wet soil; tolerates drought
- Sun/shade
- Arching seed heads
- groundcover habit

Bottlebrush (Bristly) Sedge
Carex comosa

- Ht. 2-4’; sp. 2-4’
- Wet soil
- Sun/part shade
- Bristly seed heads
- Erect dense growth

Tussock Sedge
Carex stricta

- Ht. 1-3’; sp. 1-2’
- Moderate to Wet soil
- Sun/part shade
- Evergreen foliage
- Rhizomatous growth-groundcover

Pennsylvania Sedge
Carex pensylvanica

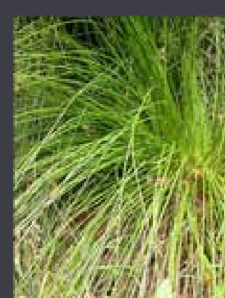
- Ht. 0.5-1.5’; sp. 1.5-2’
- Wet to dry soil
- Sun/shade
- Semi-evergreen arching leaves
- Groundcover habit - rhizomes

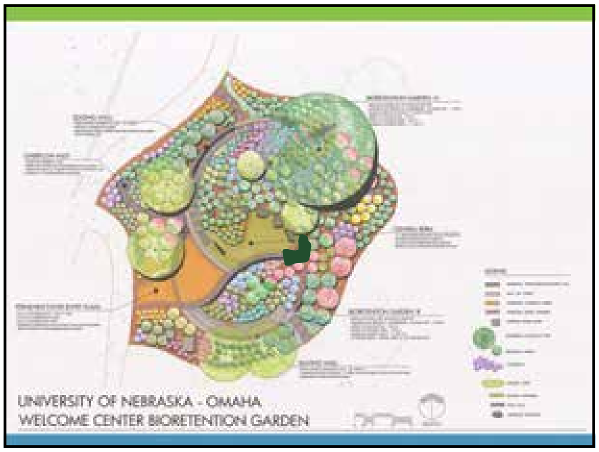
Gray’s Sedge
Carex grayi

- Ht. 2-3’; sp. 1.5-2’
- Moderate to Wet soil
- Sun/part shade
- Pale green flower heads, semi-evergreen foliage
- Dense clump habit

Soft Rush
Juncus effusus

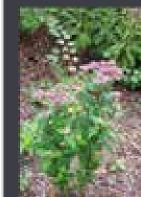
- Ht. 1.5-3’; sp. 1.5-3’
- Wet to moderate soil
- Sun/part shade
- Evergreen foliage
- Spreads by rhizomes and seed





Joe-pye Weed

- Ht. 3-5'; sp. 2-4'
- Moderate to wet soil
- Full sun/part shade
- Summer-fall bloom
- Butterflies

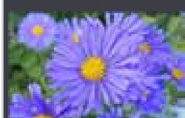


Little Joe joe-pye weed
Eupatorium dubium 'Little Joe'

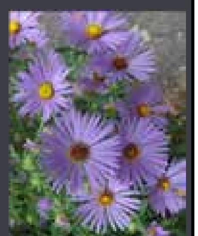
Gateway spotted joe-pye weed
Eupatorium purpureum subsp. *maculatum* 'Gateway'

Asters

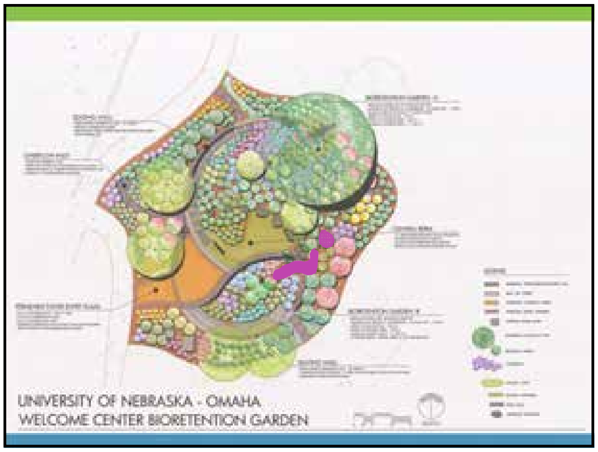
- Ht. 1-1.5'; sp. 1-1.5'
- Variable soil conditions, poor soil
- Showy late
- summer-fall flowers
- butterflies

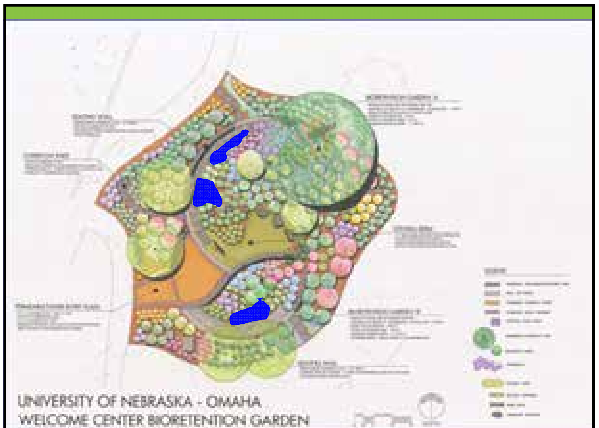


Wood's Blue Aster
Aster x dumosus 'Wood's Blue'



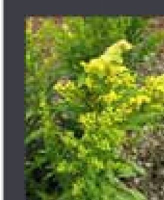
October Skies aromatic aster
Aster oblongifolius 'October Skies'





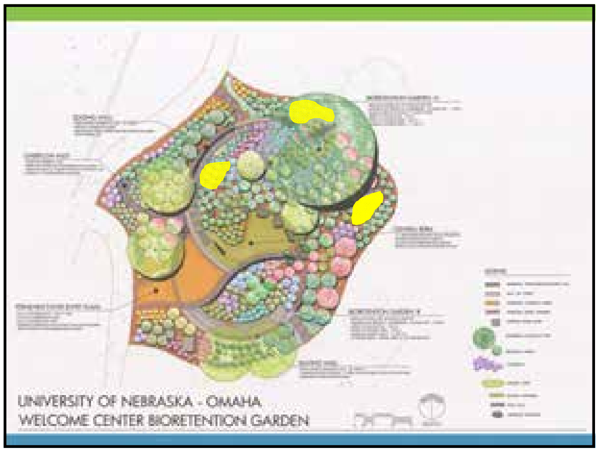
Goldenrod

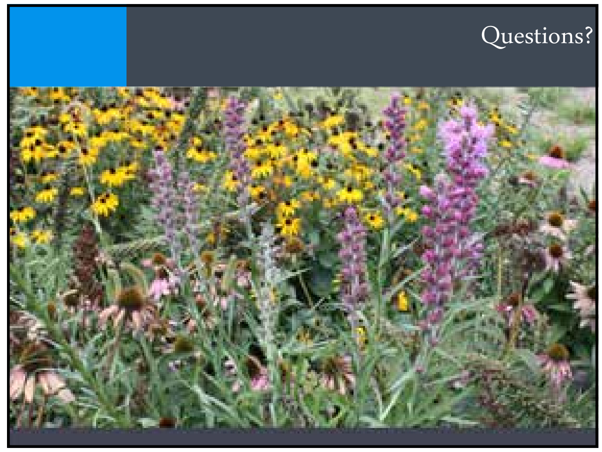
- Ht. 1.5-4'; sp. 1-2'
- Dry to wet soil
- Full sun/part shade
- Summer/fall bloom

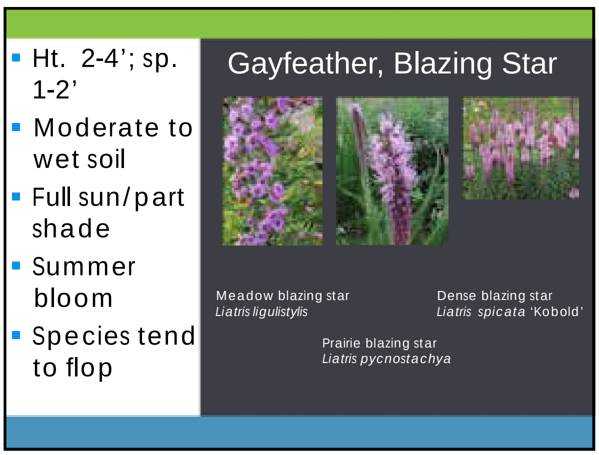


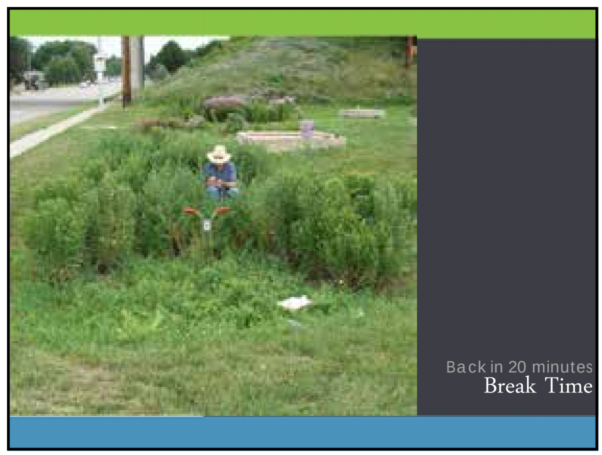
Little Lemon Goldenrod
Solidago 'Dansolitem'
LITTLE LEMON

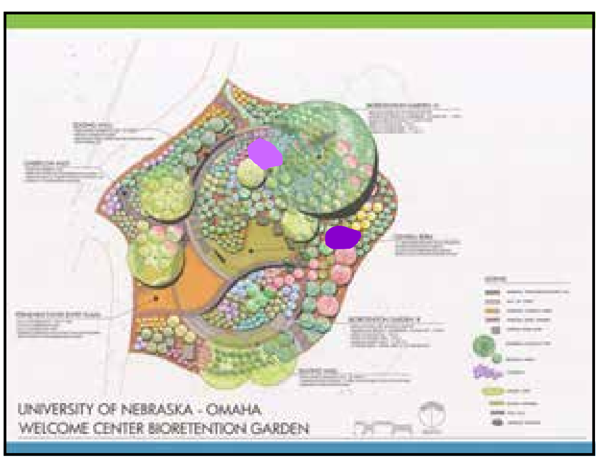
Fireworks Goldenrod
Solidago rugosa 'Fireworks'

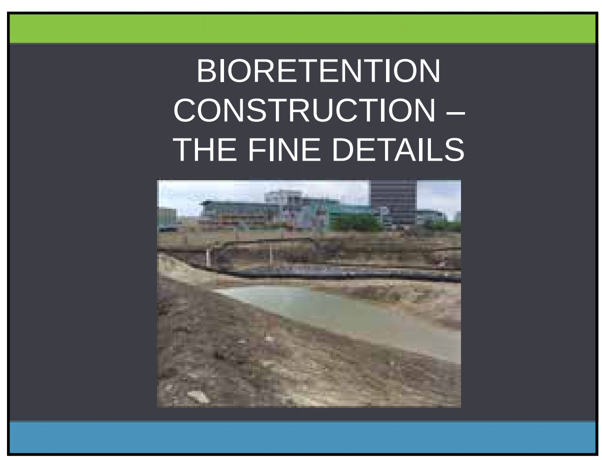

UNIVERSITY OF NEBRASKA - OMAHA
WELCOME CENTER BIORETENTION GARDEN

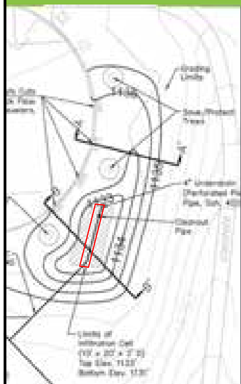

Questions?


Gayfeather, Blazing Star
Ht. 2-4'; sp. 1-2'
Moderate to wet soil
Full sun/part shade
Summer bloom
Species tend to flop
Meadow blazing star
Liatris ligulistylis
Dense blazing star
Liatris spicata 'Kobold'
Prairie blazing star
Liatris pycnostachya


Back in 20 minutes
Break Time


UNIVERSITY OF NEBRASKA - OMAHA
WELCOME CENTER BIORETENTION GARDEN


BIORETENTION CONSTRUCTION – THE FINE DETAILS



Building the Structure

- If possible, all slopes shoulld be equal to or less than 3:1
- Try to make the shape of the bioretention garden be as natural as possible
- Retainias much of the natural landscape and drainage as possible.
- Use erosion and sediment control measures
- The bioretention garden should be constructed after other major site work is completed
- Don't block the inlet or outlet of the bioretention garden
- Make sure drain pipes discharge to a well-drained area and away from buildings

Bioretention Garden Soil Management

- Soil infiltration is a primary component of bioretention
- Construction when soil moisture is less than 10 – 15 percent
- Check for compaction at surface and with depth (12" below the surface)
- Compost not only reduces bulk density (compaction), but improves plant growth and survival
- Incorporaate compost/organic matter as deep as possible – minimum 6 inches

Building the Bioretention Garden

- Before it is designed, survey the area – know the drainage and topography
- Prior to construction, stake the boundaries of all components of the bioretention garden
- Pre-construction meeting to make sure details are understood

Building the Bioretention Garden

- Infiltration cell dimension dependent on soil mix infiltration rate
- Revised thinking is to make it smaller
- Drain pipe – 4" ID perforated is recommended
- Bed the drainage pipe in 1" river rock and filter fabric
  - Sand filter may be ok
- Min 1% slope to pipe
- Valve to control drainage rate

Building the Bioretention Garden

- Excavate/grade carefully
- Drainage is critical
- Use light, tracked equipment
- Avoid compaction
  - Few passes over soil
  - Break compacted areas
  - Work when soil is dry
- Condition soil w/ compost

Building the Bioretention Garden

For Planting:

- Use live plant plugs
- Plants grow better when roots are in the soil
- Don't fertilize
- Limit traffic w/in bioretention garden
- Water immediately after planting

- First year maintenance is critical, but…
- If you prepare and construct the garden correctly, less maintenance will be needed

Building the Bioretention Garden

Elmwood Park Diversion
Metro Comm. College
Rapid Fire Round

Recent Construction Experiences

- Adjustments in the bioretention garden may be (often are) necessary

Building the Bioretention Garden

Elmwood Park Diversion (Omaha)

Google Maps 2012

- What is designed and built will take on a life of its own – and function as planned

Building the Bioretention Garden

Installation

Scheduling & site management is key
Stabilize, protect cell, compaction

Recognize areas of concern early on & address

Double check all materials, subtle changes have lasting impact

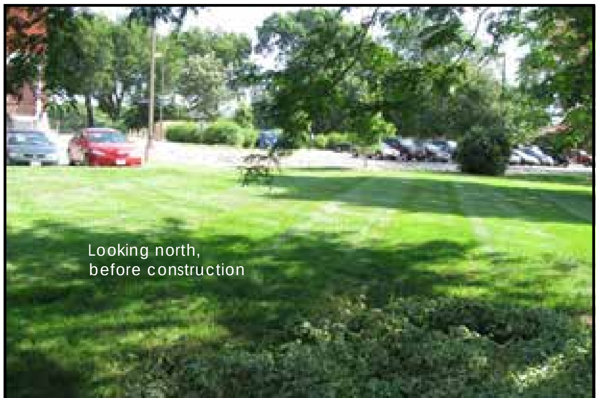
When making adjustments & modifications, don't create more problems

"Landscaping" needs as much quality control as other project components

Get buy in & get it right the first time

Metro Community College – Fort Omaha

Scheduling – installing in the right way



Availability of Contractors

Type of Contractor & Fine Details

Adaptation & Flexibility on the Fly

Contractors Favorite – Utility Box Pretreatment

A Close 2nd Place for Contractor – Vegetated Sump

ScourStop

Last Place for Contractor – Retaining Wall Block

Who fixes a 'failed' bioretention system?

Sedge Swale – Adapting to Existing Conditions

Education across the stakeholders

At the end of the day…Communication is best

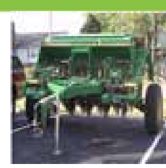
- Design concept
- Roles & Responsibility
- Adaptation
- Always learning…

Seeding

- Significant considerations
  - weeds
  - initial maintenance
  - slow establishment
  - mixed heights and textures make weed differentiation difficult
- Advance planning recommended (one year ahead)

Planting the Bioretention Garden

Seeding (cont.)



- Broadcasting
  - Smaller areas
  - Mix of seeds
- Drilling
  - typically preferred to broadcasting
  - Larger areas
  - Native seed drill for mixed seed sizes
- Hydroseed and hydromulch

Overview

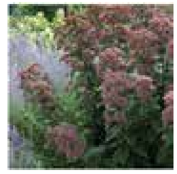
- Choices in sizes and condition
- Availability
- Procedures and precautions

Seeding (cont.)

- Purchase high quality seed from reputable source
- Seed bed preparation is critical
- Seasonal timing
- Weed seed from mulch straw can be problematic
- Tends to be less expensive (*initially*)

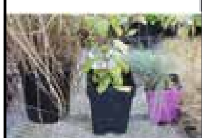
Sod

- Relatively new, still assessing potential
- Cost-effective … or expensive? *it all depends*
- Immediate soil coverage and erosion control benefit; immediate visual effect
- Fewer choices for mixtures
- Random plant patterns
- Plants will need to decide where to grow over time



Availability

- Highly variable by season, supplier
- Increasing based upon increased demand – but still challenging
- Always be ready for substitutions – reference botanical names



Potted Plants

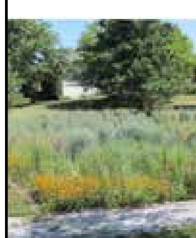
- Various sizes; deep cell-plugs provide small but deep-rooted plants
- Potential for immediate visual impact (if large plants used) and relatively quick establishment
- Small plants initially more cost effective; with good growing conditions, can establish quickly
- Quality plants significantly enhance quality establishment

Rootbound Plants

- Score or break root layer whenever possible to enhance initial root growth
- Late summer/fall planting especially important for plants held over summer

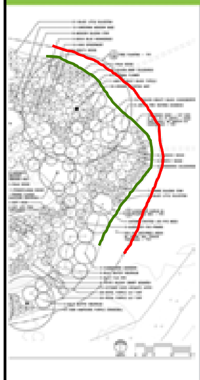
Root Maker/Grow Bags

- Significant enhancement of plant rooting over conventional containerized stock
- Consider whenever available



Plant Layout and Spacing

- Plan for approx. plant widths (which can vary by site conditions and plant cultivars)
- Adjustments typical to stretch/condense planting densities, react to actual site dimensions
- Reduced densities possible for self-seeding or suckering plants, or for cost savings (*don't overdo….*)
- Ultimately, nature will decide….

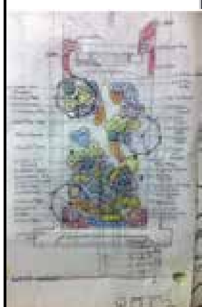


Plant Layout and Spacing (cont.)

- Plants tend to move around between staking and planting
- Garden edges and boundaries may get misinterpreted
- Complex plans = complex layout

Managing Expectations
The 1st Couple Weeks
The Mature Garden by Season

Care & Maintenance



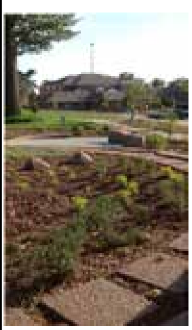
Plant Layout and Spacing (cont.)

- Will always be some on-site adjustments - check moisture and water retention before planting?

Managing Expectations

Owner

- Natural, but not in natural environment
- Not no- or high-maintenance
- Functional, not just aesthetic
- It is a living system



Planting, Initial Watering

- Dig planting holes deep and wide enough for adequate backfill and full root extension
- Assure good soil/root contact through light compaction and thorough watering
- Mulch after planting, and use care in mulch placement
- Maximize best timing for planting if possible

Managing Expectations

Designer

- Don't skimp on the plants
- Think installation in addition to form
- Think about maintenance too
- "Targeted over-engineering"
- Ordinances

Managing Expectations

Contractor

- Acknowledge experience-level
- Be ready to troubleshoot
- Quality control is key
- Warranty?
- Educate the installation crew

Spring Time

- Cutting back - March
- Edging/border maintenance
- Top-dressing mulch*
- Weeding
- Plant replacement
- Trash/debris removal

Patience is a Requirement

Establishment

- Plants or seed?
- Offline?
- Pretreatment?
- Timing
- Worst day is the first day

Spring Time & As-Needed

- Sediment removal

The First Couple of Weeks

- Watering
- Weeding (pre-emergent?)
- Redistributing mulch
- Sediment & trash/debris removal

Summer Time

- Irrigate as-needed during drought
- Continue weeding
- Dead-head flowers?
- Trash/debris removal
- Enjoy it

Fall Time

- Replace dead plants/transplant
- Continue weeding
- After 1st frost – cut back select vegetation
- Manage plant debris as-needed, especially pretreatment

Thank you very much for your time!

Confused like these 2? Now it's your turn…

- Questions?
- Comments?
- Experiences?

Thank you very much for your time!

2013 Advanced Bioretention Design Course

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