Using Community Assets Effectively
Lessons learned from KSU's stormwater management projects

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Principal Investigator / Project Manager

Konza Prairie near Manhattan, KS
Flint Hills Ecoregion

Sunset Zoo Rain-Gardens
Manhattan, KS

Urban Stormwater Concerns

Throughout Kansas stormwater is typically sent quickly away from developed areas and straight-piped into drainageways, streams, rivers, and ponds.

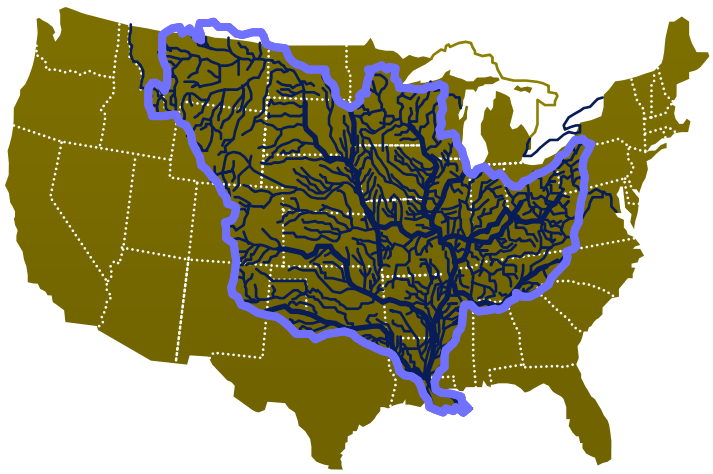
As a result of these and other land-use practices, ecosystems are being severely degraded.

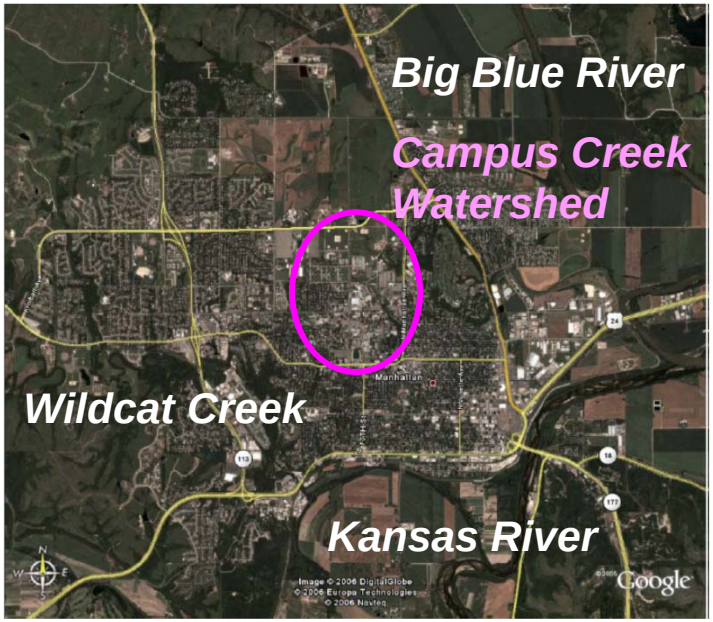
Large amounts of water are also sprayed on lawns, gardens, and other landscapes.

Often, very little water replenishes underground water reserves.

What can we do to correct these bad habits?

First, we must recognize the connections!





Per the USEPA: *Uncontrolled stormwater runoff from construction sites can significantly impact rivers, lakes and estuaries. Sediment in waterbodies from construction sites can reduce the amount of sunlight reaching aquatic plants, clog fish gills, smother aquatic habitat and spawning areas, and impede navigation.*

Phase II MS4s (municipalities between 50,000 & 100,000 people) are **required to develop a program to reduce pollutants in stormwater runoff for construction sites disturbing one or more acres** (see Appendix for more details).

This primarily includes developing:
An **ordinance**,
Requirements to **implement erosion and sediment control BMPs**,
Requirements to **control other waste at the construction site**,
Procedures for **reviewing construction site plans**,
Procedures to **receive and consider information submitted by the public**, and
Procedures for **inspections and enforcement of stormwater requirements at construction sites**.

Source: http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=min_measure&min_measure_id=5

Why worry?

Wildcat Creek flooding at Anneberg Park and many other parts of Manhattan have occurred several times since 2005, including in both 2010 and 2011.

If stormwater is allowed to move too far and too rapidly it will accumulate and create larger more concentrated flows, frequently causing soil erosion in upland landscapes and excessive streambank erosion and sedimentation along creeks, streams, and rivers. Downstream flooding is also a concern.

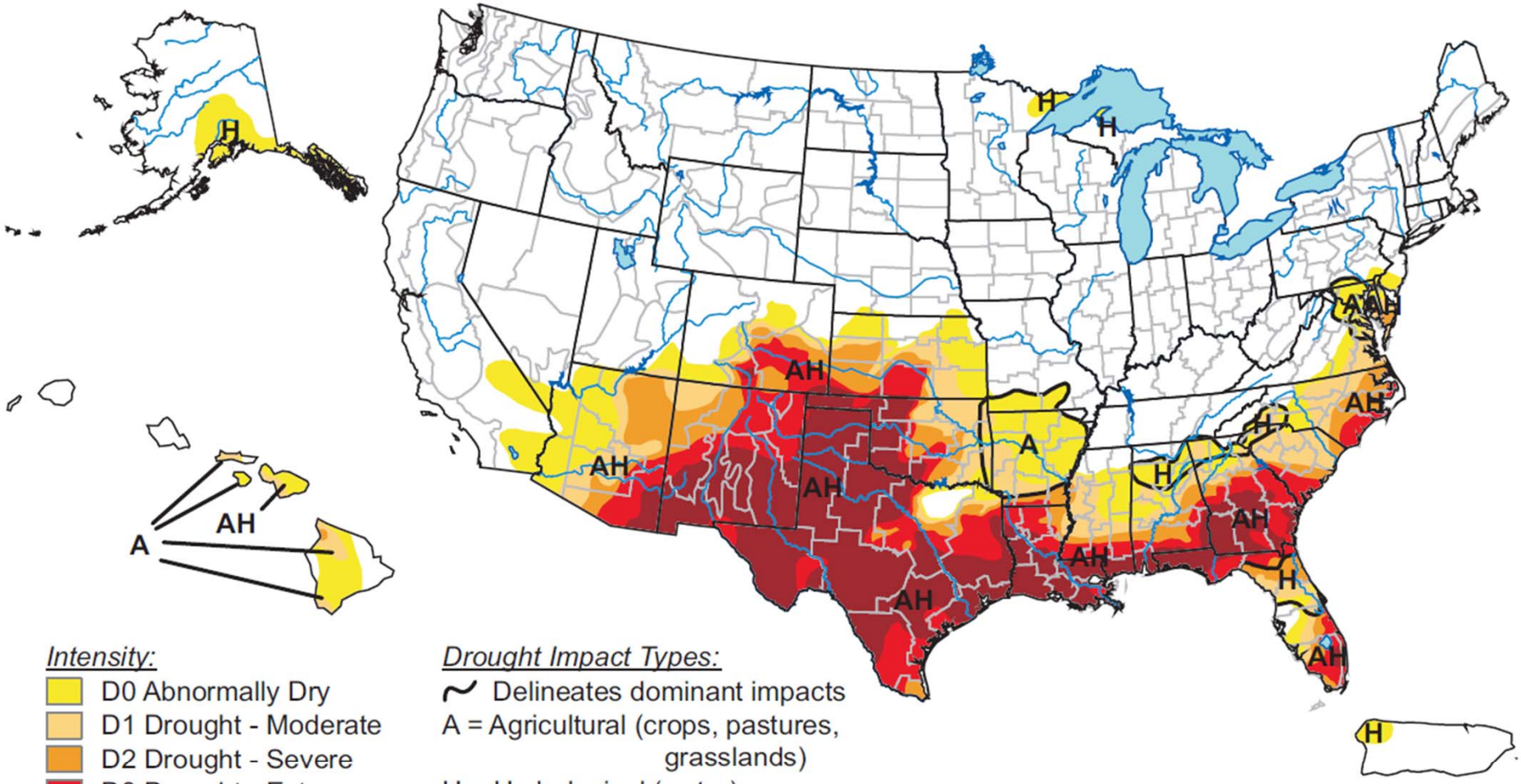
Why worry?

Lee Street May 19, 2011

Wildcat Creek near Scenic Drive Oct. 20, 2005

U.S. Drought Monitor

July 5, 2011
Valid 8 a.m. EDT



Intensity:

- D0 Abnormally Dry
- D1 Drought - Moderate
- D2 Drought - Severe
- D3 Drought - Extreme
- D4 Drought - Exceptional

Drought Impact Types:

~ Delineates dominant impacts
A = Agricultural (crops, pastures, grasslands)
H = Hydrological (water)

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

http://drought.unl.edu/dm

Released Thursday, July 7, 2011

Author: Richard Heim/Liz Love-Brotak, NOAA/NESDIS/NCDC

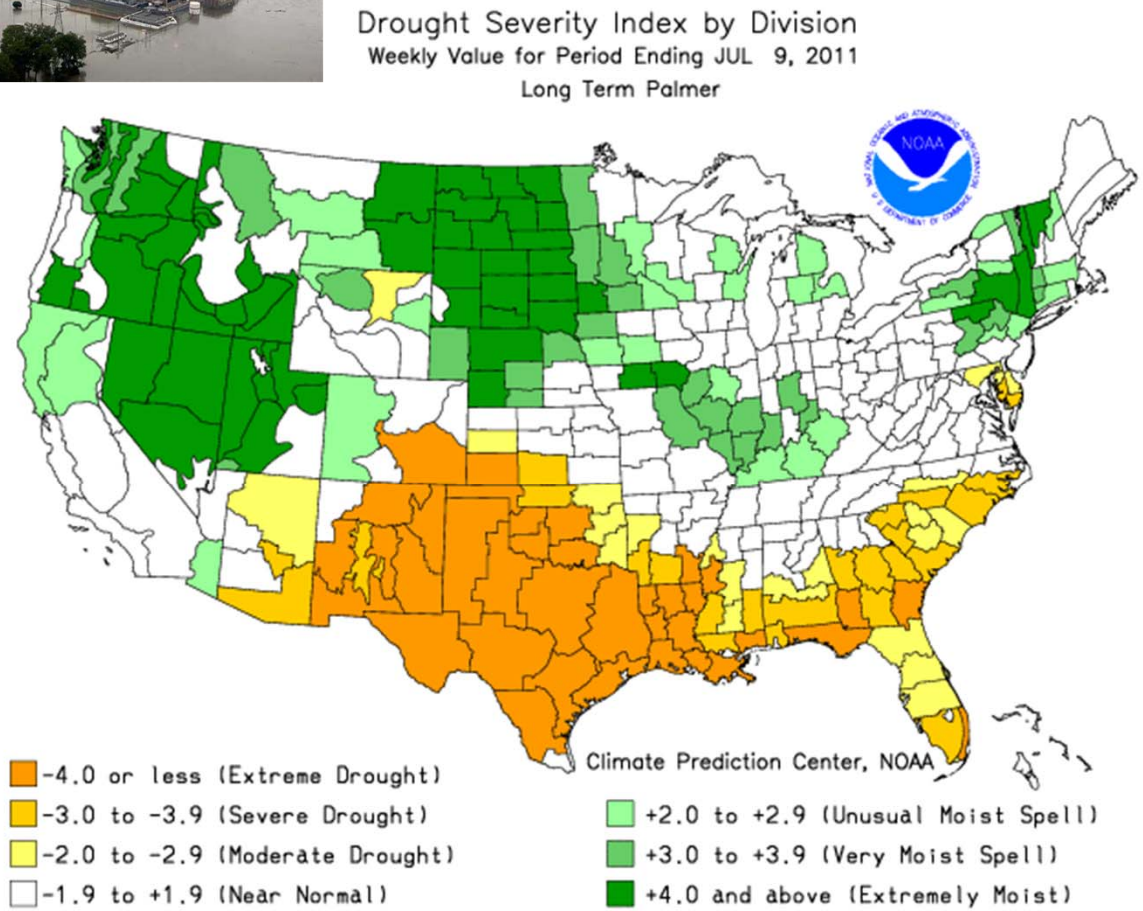
Residents recall Missouri River flood of 1993, hope history doesn't repeat

By MATT PEARCE, *The Kansas City Star*

www.kansascity.com/2011/06/14/2950966/residents-recall-missouri-river.html#ixzz1S5Cxs0gJ

Flooding Rains Prompt Evacuations In Manhattan (6/2/2011)

Authorities have evacuated three apartment complexes in Manhattan, Kan., due to flooding along Wildcat Creek.



Drought conditions are expected to persist or worsen into the summer across Southeast Texas.

http://www.srh.noaa.gov/hgx/?n=drought

http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/regional_monitoring/palmer.gif

Wildcat Creek & Manhattan Ave. - June 2, 2011

Low Impact Development (LID) and Other Green Design Strategies

Historically, the goal of stormwater planning has been to prevent localized flooding by moving large amounts of water offsite as quickly as possible. However, **experience has shown that traditional stormwater management has many limitations**.

Expensive, ever-expanding storm sewer systems strain municipal budgets. Fast moving stormwater discharges cause downstream flooding, erode stream banks, and contribute to water quality violations. Bacteria and other pathogens carried in stormwater contaminate coastal waters, often requiring beach closures.

Rainwater diverted or otherwise unable to soak into the soil cannot recharge aquifers. This reduces stream base flows, which can cause streams to dry-up for extended periods of time. Stormwater that collects in detention basins or flows over impervious surfaces is often much warmer than the streams into which it flows. This is a problem because a temperature increase of just one or two degrees can stress fish and other aquatic organisms

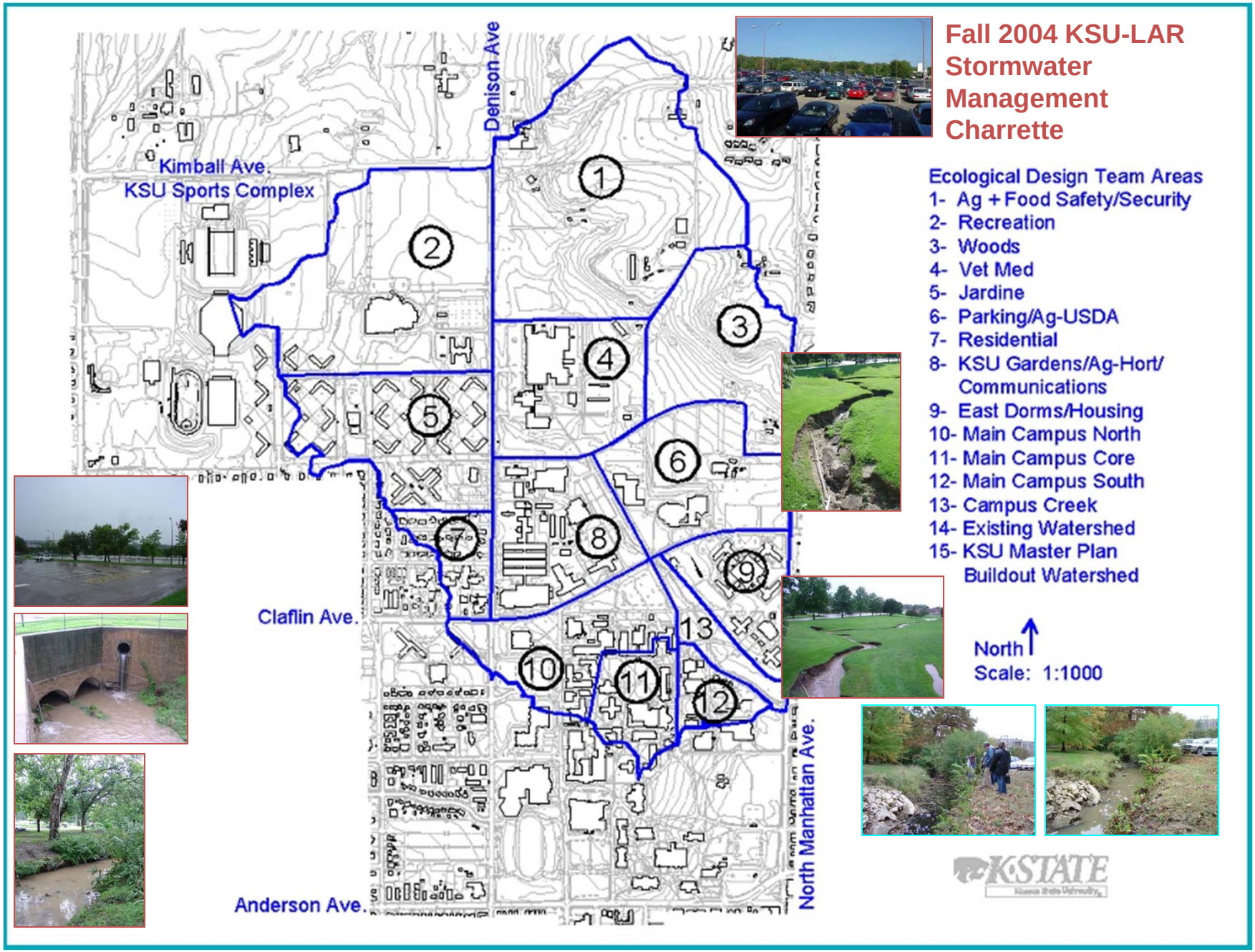
Source: http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=124

Campus Creek (KSU)

Kings Creek (Konza Prairie)

June 2, 2011 photos

Q: How do we restore hydrological processes in urban settings?



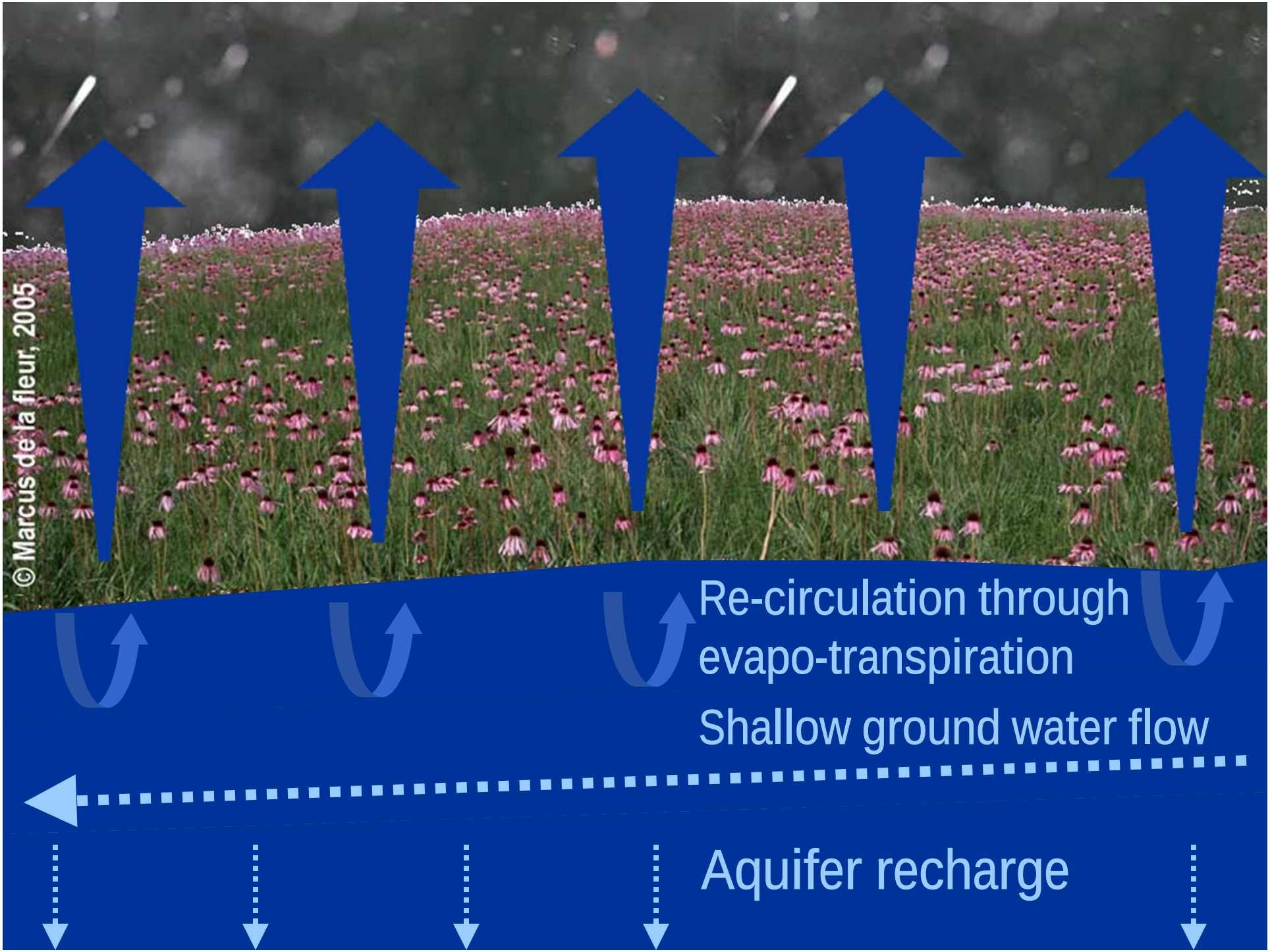
Low Impact Development (LID) and Other Green Design Strategies

Mimicking Natural Hydrology - Efforts to address stormwater problems resulting from traditional development methods have produced a number of innovative design alternatives.

For example, researchers and developers are experimenting with minimizing the distance between land uses to decrease infrastructure requirements. Another method reduces stormwater runoff by conserving forests and green spaces and protecting stream buffers. Yet another technique diminishes impervious surfaces, narrows road and sidewalk widths, reduces parking lot sizes, minimizes or removes cul-de-sacs, and replaces traditional paving materials with pervious concrete.

[Analysis / Policy / Planning & Design / Monitoring & Management]

Source: http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=124


© Marcus de la fleur, 2005
Re-circulation through
evapo-transpiration
Shallow ground water flow
Aquifer recharge

Best Management Practices (BMPs):

Municipal Program Oversight

- Construction Phase Plan Review
- Contractor Training and Certification
- Local Ordinances for Construction Site Runoff Control
- Municipal Construction Inspection Program

Construction Site Planning and Management

- Construction Sequencing
- Construction Site Operator BMP Inspection and Maintenance
- Land Grading
- **Preserving Natural Vegetation**

Erosion Control

- Chemical Stabilization
- Compost Blankets
- Dust Control
- Geotextiles
- Gradient Terraces
- Mulching
- Riprap
- **Seeding**
- **Sodding**
- Soil Retention
- Soil Roughening
- Temporary Slope Drain
- Temporary Stream Crossings
- Wind Fences and Sand Fences

Runoff Control

- Check Dams
- **Grass-Lined Channels**
- Permanent Slope Diversions
- Temporary Diversion Dikes

Sediment Control

- Brush Barrier
- Compost Filter Berms
- Compost Filter Socks
- Construction Entrances
- Fiber Rolls
- Filter Berms
- Sediment Basins and Rock Dams
- Sediment Filters and Sediment Chambers
- Sediment Traps
- Silt Fences
- Storm Drain Inlet Protection
- Straw or Hay Bales
- **Vegetated Buffers**

Source: http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=min_measure&min_measure_id=5

Low Impact Development (LID)

LID seeks to control stormwater at its source. Rather than moving stormwater offsite though a conveyance system, the goal of LID is to restore the natural, pre-developed ability of an urban site to **absorb stormwater**.

LID integrates **small-scale measures** [strategically placed] throughout the development site. Constructed green spaces, native landscaping, and a variety of innovative bioretention and infiltration techniques capture and manage stormwater on-site. **LID reduces peak runoff by allowing rainwater to soak into the ground, evaporate into the air, or collect in storage receptacles for irrigation and other beneficial uses.** In areas with slow drainage or infiltration, LID captures the first flush before excess stormwater is diverted into traditional storm conveyance systems. The result is development that more closely maintains pre-development hydrology.

LID can be simple and effective. Instead of relying solely on complex and costly collection, conveyance, storage and treatment systems, LID employs a range of economical devices that control runoff at the source.

Source: http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=124

Maximizing Retention Capacities

Merry Lea Environmental
Training Center
Goshen College, Indiana

Low Impact Development (LID)

Bioretention cells, [sometimes] known as rain gardens,
are relatively small-scale, landscaped depressions containing plants and a soil mixture that absorbs and filters runoff.

[Bioretention cells should have an under-drain only if biophysical and/or legal mandates require an under-drain; they will be more prone to drought during dry periods than rain gardens which simply use native soils and have no underdrain.]

Green roofs are roof-tops partially or completely covered with plants. Used for decades in Europe, green roofs help mitigate the urban "heat island" effect and reduce peak stormwater flows. The vegetated cover also protects and insulates the roof, extending its life and reducing energy costs.

Grass swales are broad, open channels sown with erosion resistant and flood tolerant grasses. Used alongside roadways for years primarily as stormwater conveyances, swales can slow stormwater runoff, filter it, and allow it to soak into the ground.

Source: http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=124

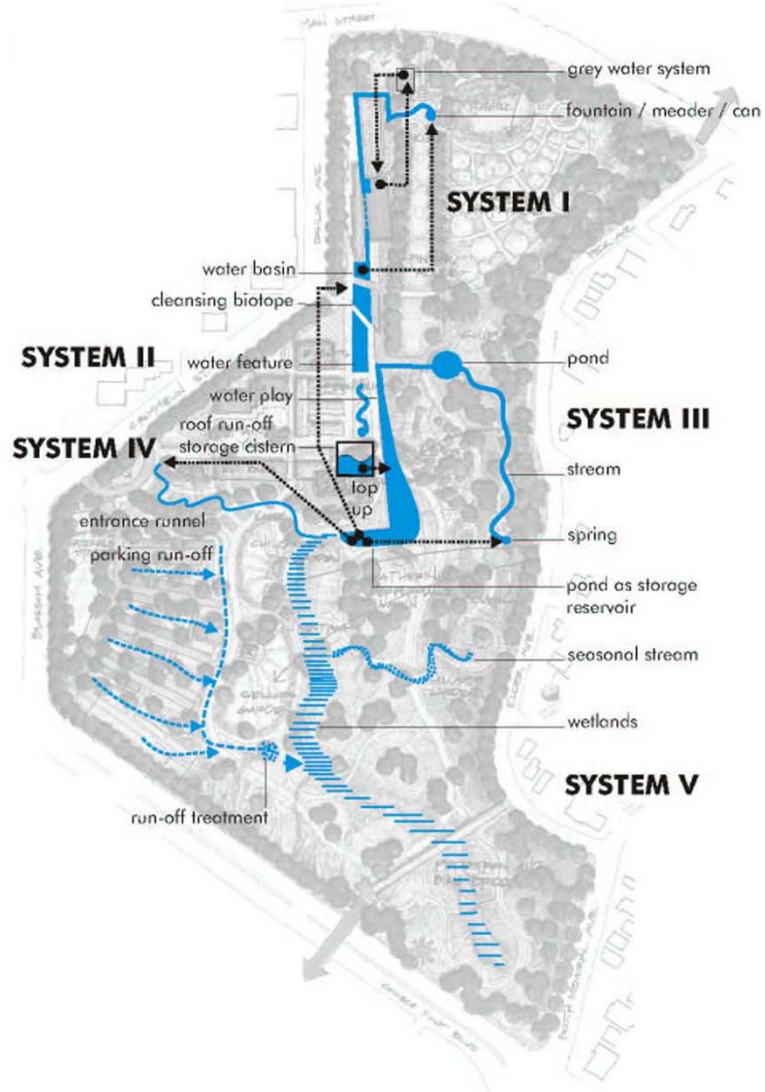
Low Impact Development (LID)

Cisterns and rain barrels harvest and store rainwater collected from roofs. By storing and diverting runoff, these devices help reduce the flooding and erosion caused by stormwater runoff. And because they contain no salts or sediment, they can provide …chemical-free water for garden or lawn irrigation, reducing water bills and conserving municipal water...

Permeable and porous pavements reduce stormwater runoff by allowing water to soak through the paved surface into the ground beneath.

Source: http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=124

Queens Botanical Garden



The website **'One Drop at a Time'** http://www.delafleur.com/168_Elm/ discusses accessible, in-the-ground examples of sustainable landscape solutions at 168 Elm Ave., such as the green roof and rain garden seen here from the street side.
(Photos: Marcus de la fleur)

http://www.asla.org/2009awards/298.html

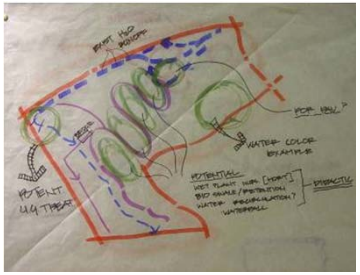
Stormwater Management Charrette at Kansas State University

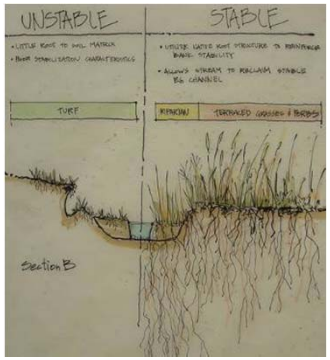
Oct. 25-27, 2006

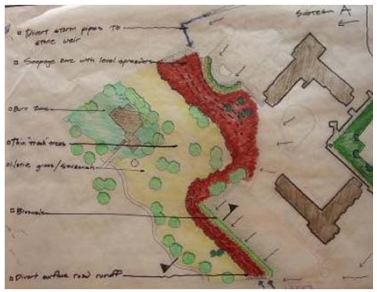
Three Guest Speakers/Reviewers and Links to KSU Classes

Integrated Teams and Many Design Ideas…

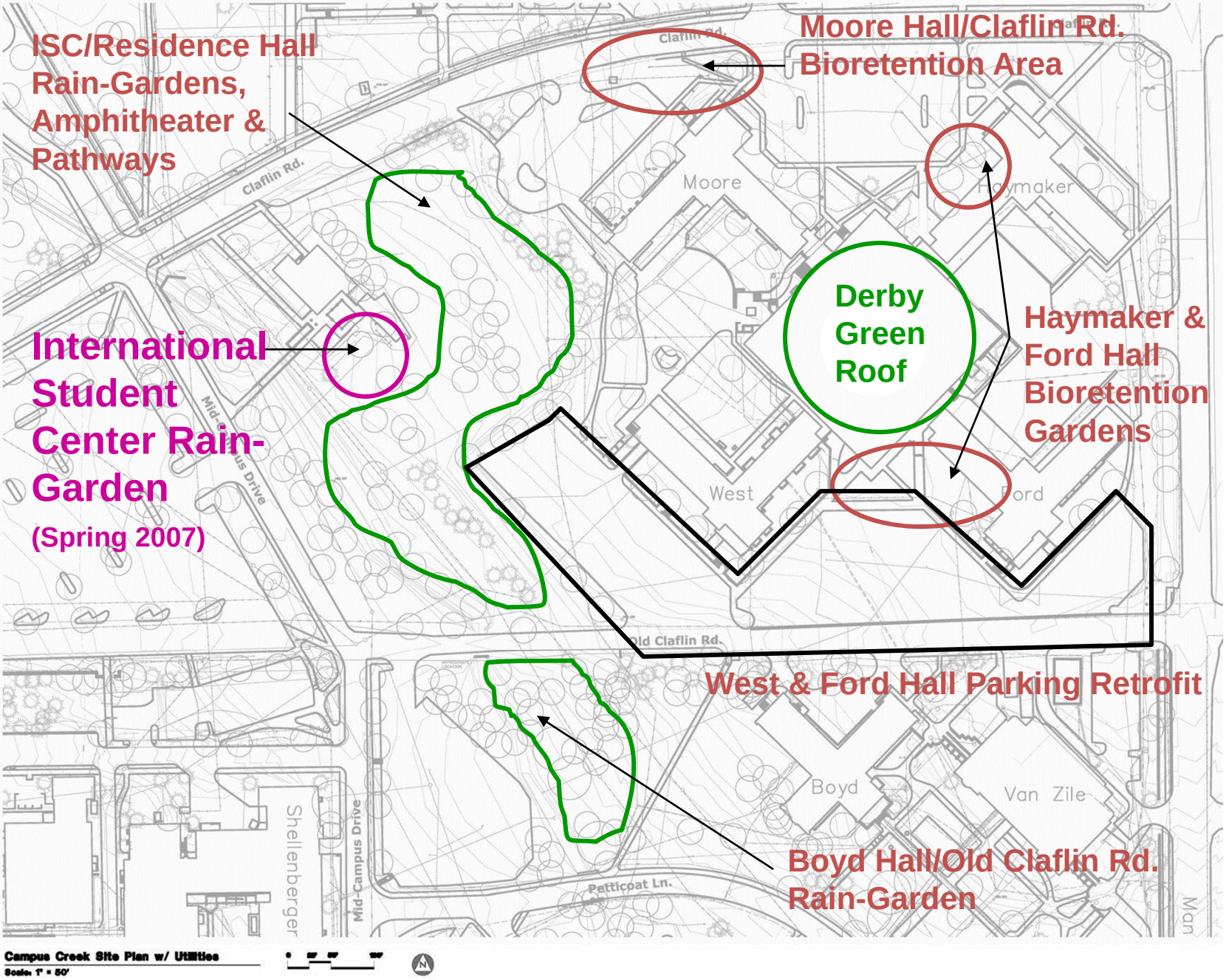
Ten Teams; Multiple Sites; Reviews & Open House







Potential Stormwater Management Retrofits near KSU's Derby Dining Complex



How can we use low-cost, existing assets to create more sustainable communities?

Low-cost strategies to save water and manage stormwater:

Slow, then absorb (infiltrate) rainwater in soils and vegetation close to where precipitation falls. Rain gardens can be readily created for less than $500.

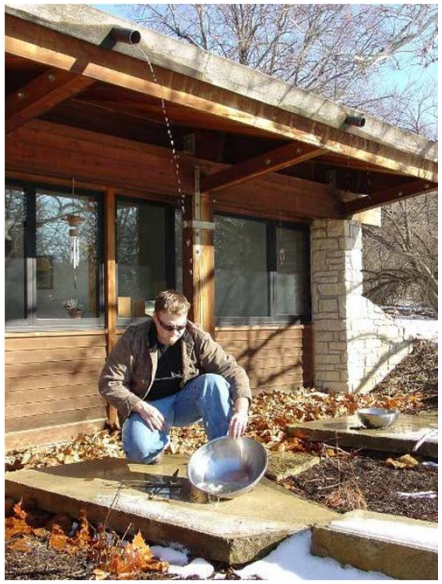
Disconnecting downspouts from underground pipes can allow for increased infiltration and reduce the amount of water moved quickly downstream (see: www.portlandonline.com/bes/index.cfm?c=54309&a=322320).

Per David Dods (URS) runoff moving from rooftop to gutter can take less than 20 seconds; from top to bottom of an impervious 50 to 100 foot driveway may take 20 seconds to roughly one minute (depending on the slope of the driveway); water moving across a lawn to a streetside gutter can take about 1 hour; traveling through a rain garden can take several hours (depending on the size, type, and age/management of the rain garden).

Source: http://texaslid.org/pdfs/DFW_Dods_Raingardens.pdf
See also: http://www.slideshare.net/Sotirakou964/david-dods-blue-thumb-guide-to-rain-gardens-brochure

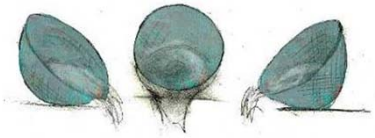
Interweaving Art and Science

K-State's International Student Center Rain-Garden



The KSU ISC Rain-Garden was constructed by faculty, students and staff in Spring 2007.

In Fall 2007 and Spring 2008 Lee Skabelund collaborated with Art students and faculty to create rain-bowls for the ISC Rain-Garden.



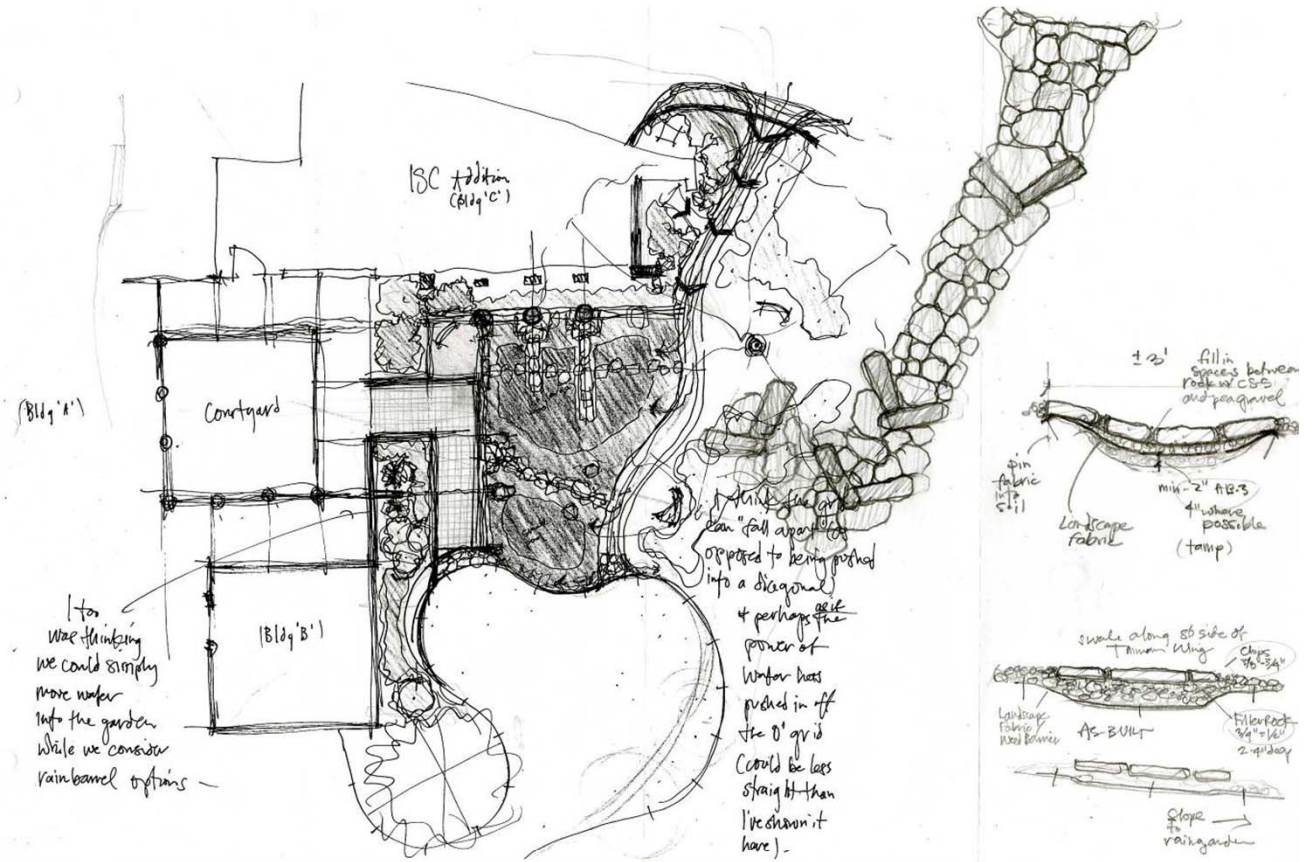
KSU ISC Rain-Garden Project

- This collaborative design-build project involved students, faculty, staff, and professionals in the task of considering ecologically sound ways to treat stormwater that falls on the Kansas State University (KSU) campus.
- In the process, two specific goals were achieved:

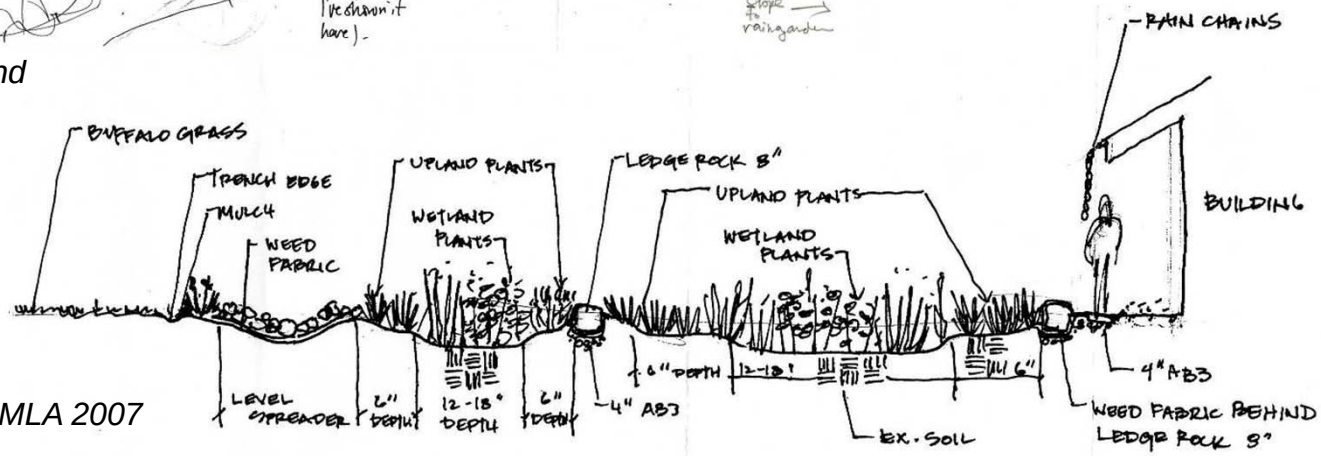
  1) Designed & created a rain-garden along Campus Creek to reduce stormwater run-off and improve water quality.

  2) Demonstrated specific ways to address urban stormwater runoff to KSU administrators, staff, faculty, students, and visitors.

The KSU International Student Center Rain-Garden Design



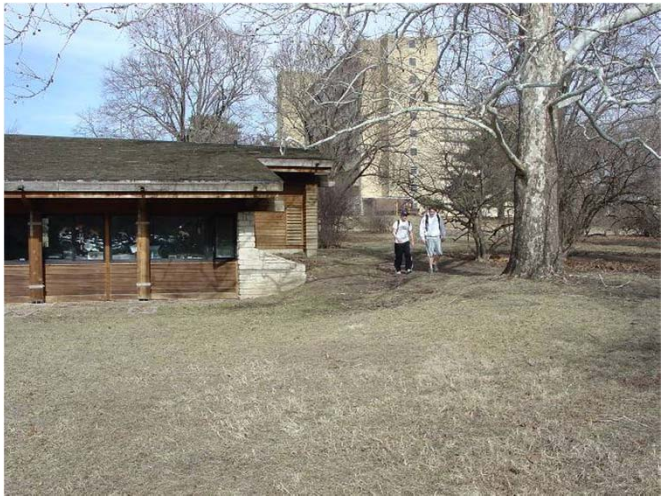
Plan & Sections by Lee Skabelund

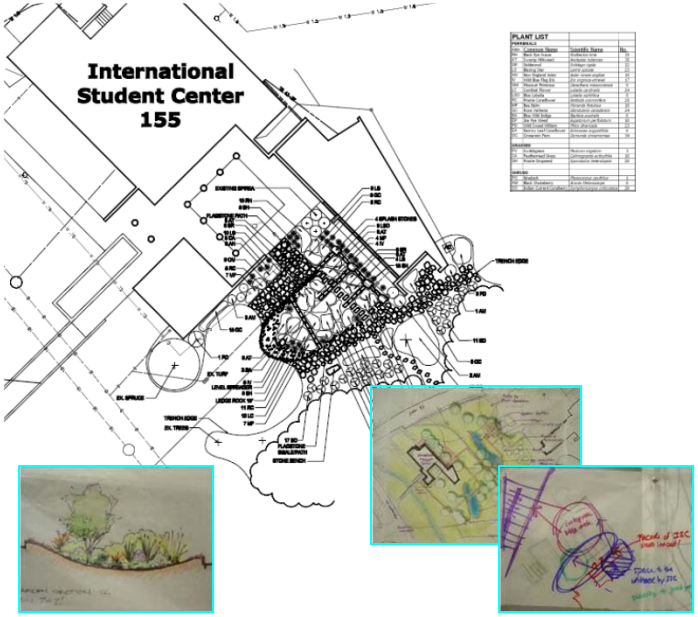


Section by Cary Thomsen, KSU-MLA 2007

Restoring Hydrologic Processes along Campus Creek

The KSU International Student Center Design/Build Rain-Garden Demonstration Project

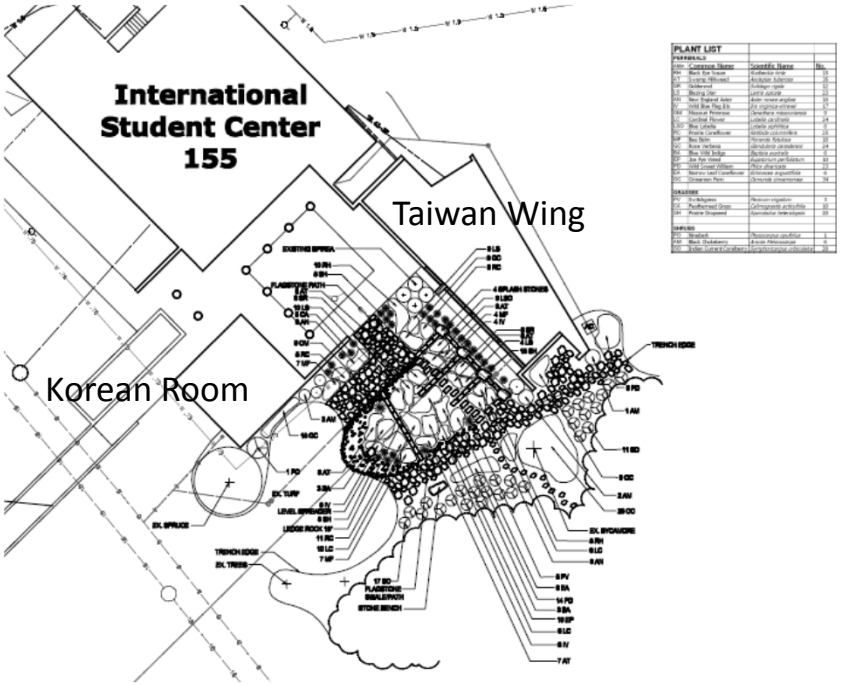




Project inspired by 2006 KSU-LAR Stormwater Management Charrette

Restoring Hydrologic Processes along Campus Creek

The KSU International Student Center Design/Build Rain-Garden Demonstration Project



Planting Plan (Cary Thomsen, KSU-MLA)

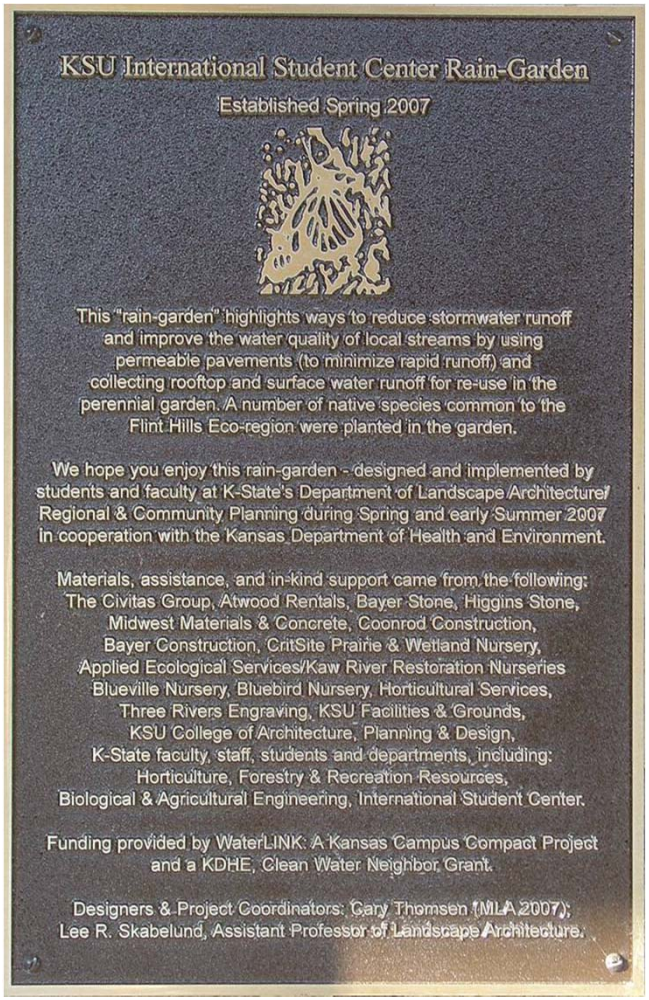
Planting & Setting Level-Spreader (4/28/07)




In-process rain-garden photos taken on 5/16/07, 6/2/07, 6/22/07, and 7/16/07.

The KSU-ISC Rain-Garden

Sep. 7, 2007 photo



Rain-Garden Sign

Sep. 26, 2007

June 5, 2009

The KSU-ISC Rain-Garden

October 2, 2007 - photos taken after a 1.2-inch storm event (approximate).

Interweaving Art and Science

K-State's International Student Center Rain-Garden

Interweaving Art and Science

K-State's International Student Center Rain-Garden

KSU ISC Rain-Garden

Results: participants and visitors clearly recognize the role of water in sustaining ecosystems—and hopefully consider ways they can harness rainwater for irrigation & ecological renewal where they live... They also recognize that ongoing maintenance (as with any landscape) is essential.

Primary Maintenance Issues:

Who maintains (weeds & clips) this living, dynamic system?

How much time does it take; how often?

Is irrigation needed? How often is mulch applied?

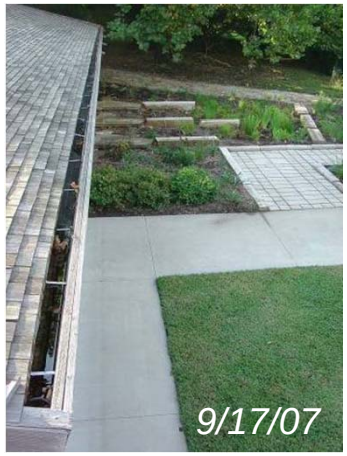
What invasive or nuisance species pose challenges?

Will soils, rain-bowls & permeable paving clog?

How do design, maintenance & aesthetics interrelate?

How do costs compare to other kinds of l. maintenance?

Note the water still in the rain-gutter, well after water soaked into heavy clay rain-garden soils



Rain-Garden Maintenance:

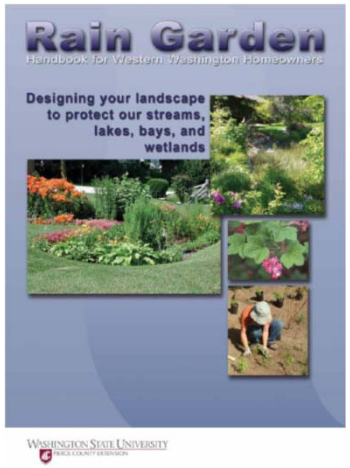
Key Ideas to Remember:

1) **Rain-Gardens need to be maintained** (there is no free lunch when it comes to maintaining gardens and other created or disrupted landscapes).

2) Weeding **is essential** (although a good hardwood mulch can reduce the number of weeds and make weeding easier).

Fertilizing is not needed esp. if you use plants adapted to the region and site. **Pruning is rarely needed**, though you will likely want to clip back perennials before spring (and transplant and water in seedlings and/or remove "aggressive" perennials if they begin to dominate your garden).

3) **Watering during the first growing season is vital** (try to strike a balance between providing too much & too little water). If you **choose plants well-adapted to your eco-region and specific site**, no watering should be needed once the plants are established.



4) Check for exposed soil and erosion and cover with an organic weed-free mulch. **If too much sediment is flowing into the garden find the source and stabilize the area**.

As needed, reduce volume and/or intensity of stormwater flowing into the garden.

5) **Draw upon the experience of others**, including folks on the east coast, mid-west, Rocky Mountains & west coast.

Ref: *http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm*

Good analysis is essential!

Bioregion/Landscape

Site

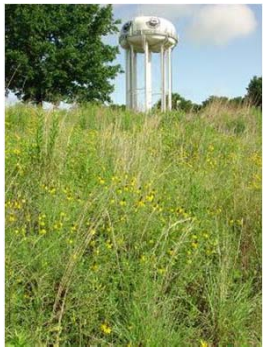
Community Context

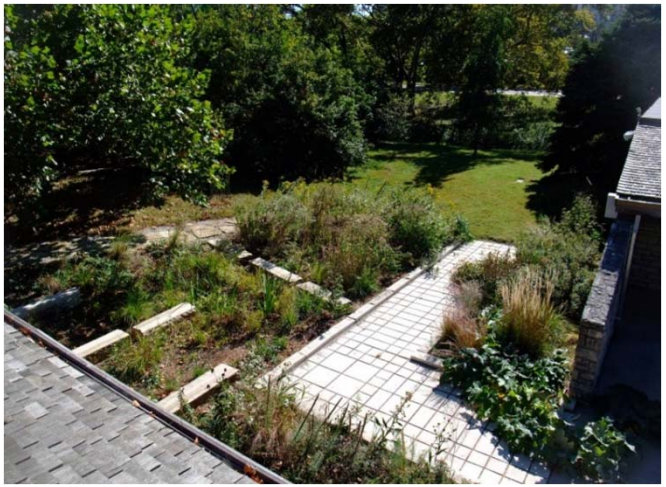
Integrate your rain-garden into both the eco-region and site

Important Design Considerations:

1a) Create a rain-garden that makes sense for your site (size of property, structures & impermeable surfaces; location; soil & sun/shade conditions; etc.).

1b) Know your maintenance needs & capabilities!





Integrate your rain-garden into both the eco-region and site

Important Design Considerations:

2a) Learn the “weeds” & invasive species in your area, and prepare to remove them from your garden as soon as possible.

2b) Budget at least a few hours a week during the first growing season for monitoring & weeding; it will save you lots of time!

8/28/09 – Before weeding...

A half-hour later…

Integrate your rain-garden into both the eco-region and site

Important Design Considerations:

3a) Choose plants that can handle water & drought. In Kansas native prairie species are typically best. Many native perennials can be obtained from nurseries such as Kaw River Restoration Nurseries in Lawrence (www.appliedeco.com/krrn/) and Prairie & Wetland Center in Belton, MO (www.critsite.com/).

3b) Encourage your local nursery to supply natives!

For more native plant nursery/supplier options refer to:
www.kansasnativeplantsociety.org/plant_resources.htm

Integrate your rain-garden into both the eco-region and site

Important Design Considerations:

4) Learn from others, and from your own experiences:

think big, think small;

be practical, ambitious & creative;

know your budget & institutional capacity;

seek to understand soil, water & plant interrelationships;

design to save water & energy;

it's a process—learn all along the way...

Rossville Rain-Garden – Spring 2008

Working with Prof. Skabelund, Brett Tagtmeyer & Aarthi Padmanabahn (LAR) designed and helped residents lay out the Rossville Rain-Garden.
Implementation & maintenance by volunteers from the local community.

Recent KSU Design-Build Projects

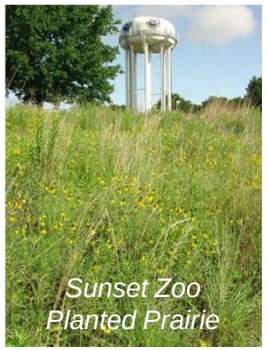
Our goal was to explore community-and-landscape-appropriate ways to address urban stormwater runoff in communities in Kansas and other locations.

The WaterLINK program played a pivotal role in allowing us to design and implement projects and work across disciplines to address stormwater management concerns.

During Spring 2008 interdisciplinary student teams developed proposals for implementing the first green roof in the Flint Hills Eco-region.

During Fall 2008 a number of designs for addressing stormwater management were proposed.

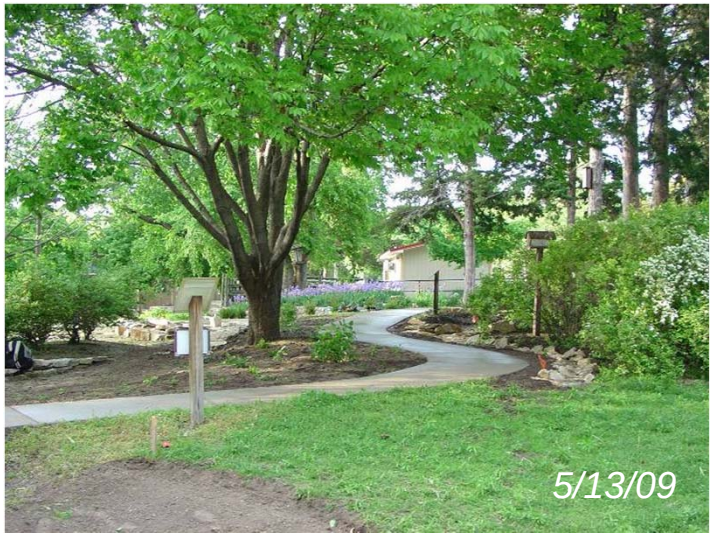
Green roof & rain-garden designs were then refined & implemented.



Sunset Zoo Prairie-and-Rain-Garden Design >

Contributors: Emily King & Lee Adams (Fall 2008)
Chris Enroth & Andrew Schaap (Spring 2009)

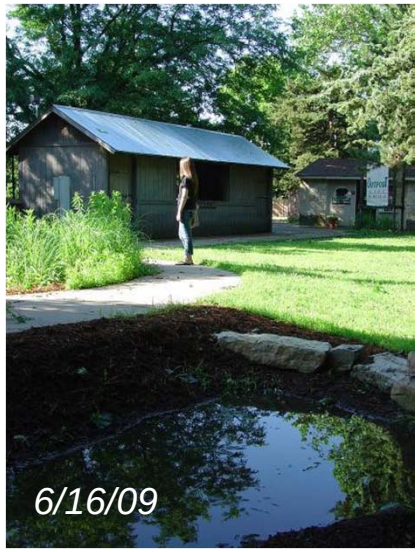
Sunset Zoo Rain-Gardens – Manhattan, KS



Within one good growing season small, live native species can take hold.

Sunset Zoo Rain-Gardens – Manhattan, KS

Strategically-timed, located & planted pocket rain-gardens can eliminate most erosion.



Sunset Zoo Rain-Gardens – Manhattan, KS

8/12/09 & 7/8/11 photos –
visual & psychological beauty...

Challenges & Opportunities:

Adjacent trees & shrubs (seeds, berries, sprouting roots, shade/sun).

Creeping turfgrass of many kinds; Adjacent natives (seeds & roots).

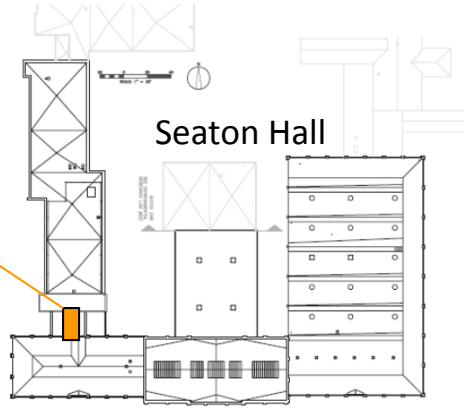
Wildlife, house pets & other critters; Mini-rain-gardens, micro-topography, increased habitat & biodiversity.

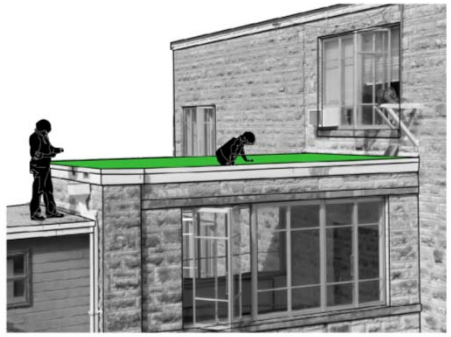
Different maintenance procedures…

Sunset Zoo Rain-Gardens – Manhattan, KS

7/8/11 photo - lrs

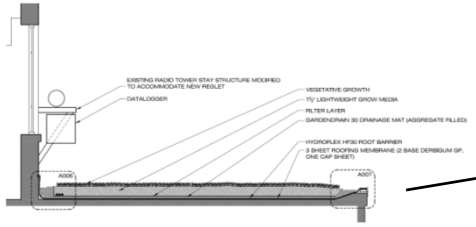
Seaton Hall Green Roof – Manhattan, KS





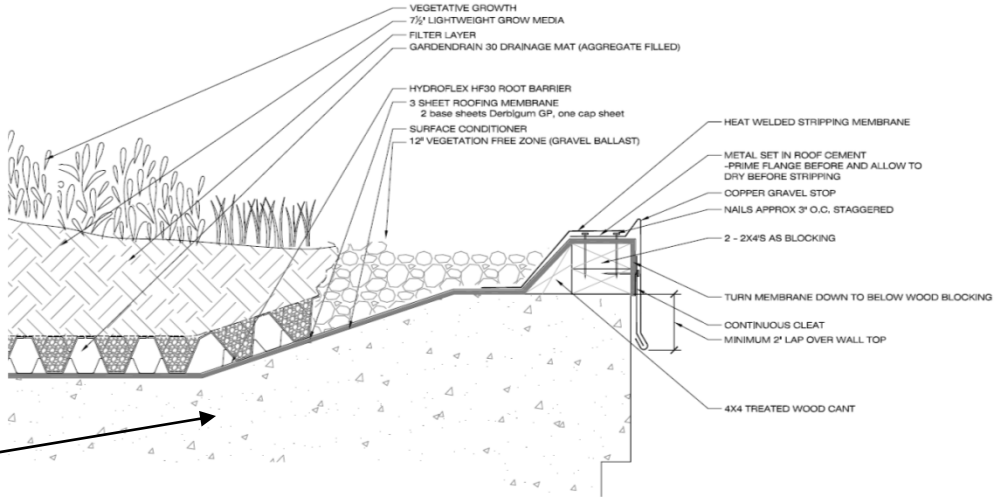
Green Roof Proposal

Upper Roof,Seaton Hall
Kansas State University



Seaton Green Roof
exposed upper rooftop

Structural calculations by Jessica Wiles & Dr. Sutton Stephens (Arch. Engineering). Details by Michael Knapp & Mark Neibling, with guidance from professors Todd Gabbard, Lee Skabelund, KSU Facilities, Greg Pfau (BNIM), and others. Monitoring support from Stacy Hutchinson (BAE), Mary Knapp & Carol Blocksome (Agronomy), and Rhonda Janke (Hort). Materials and labor donated by KSU-Facilities, Derbigum, Danker Roofing & American Hydrotech.



Upper breezeway roof – 300 sf; can hold ~64 lbs/sf

Low roofs to east & west – each ~350 sf; can hold ~51 lbs/sf

The nearest conditioned space is one floor down…

KSU Seaton Hall Green Roof

Demonstration & Research Project

Seaton Complex
Green Rooftops
Kansas State University

The Seaton Hall Complex offers several spaces ideal for green roofs.

Green Roofs:

- Often outlast traditional roofs (Waterproofing can last 2-4 times longer)
- Typically require less maintanence than traditional roof tops
- Absorb solar energy, reduce heat loads, and cool micro-climates
- Control stormwater runoff
- Provide oppertunities for gardens and food production
- Provide aesthetically pleasing green space

Contact Us:

- Lee R. Skabelund, ASLA lskab@ksu.edu
- Green Roof Team KSUgreenroof@gmail.com

2008

What is a Green Roof?

Green roofs are vegetated rooftops. The green roof is actually a very old concept dating back thousands of years from ancient times; the Hanging Gardens of Babylon are one example of ancient green roofs.

Why use a green rooftop?

Green roofs have several advantages over a traditional rooftop. Green roof advantages include everything from sheer aesthetic pleasure to storm water runoff management, climate cooling, water filtration, food production, and habitat restoration. Green roofs often double the expected lifetime of traditional roofs and if designed well require less roof maintenance.

How do you Build a Green Roof?

Important factors to consider before designing a green roof include:

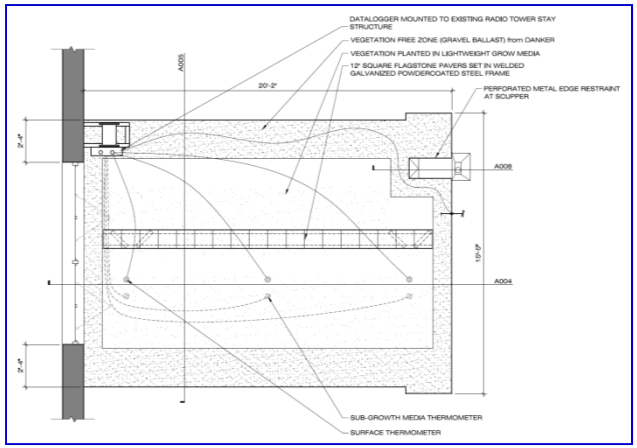
- Building structure;
- Roof load-bearing Capacity;
- Plant selection;
- Regional climate and roof top micro-climate;
- Soil (growing medium) depth and type;
- Excellent water proofing and appropriate drainage.
- Potential for water capture and re-use

All green roofs consist of the following:

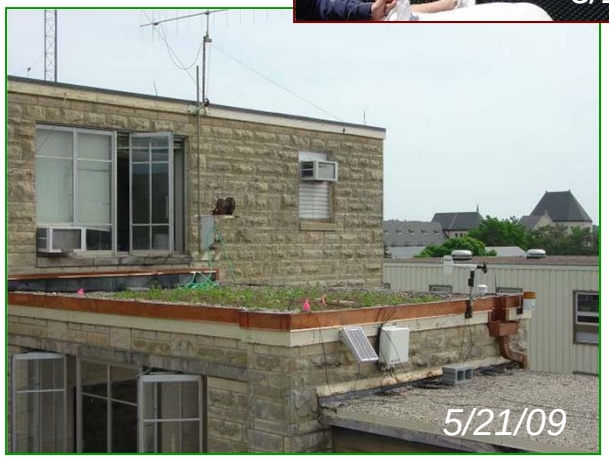
- Waterproofing and root barrier
- Drainage and filter layer
- Soil/ growth medium and plants
- Foam insulation is optional (can increase insulating capacity)

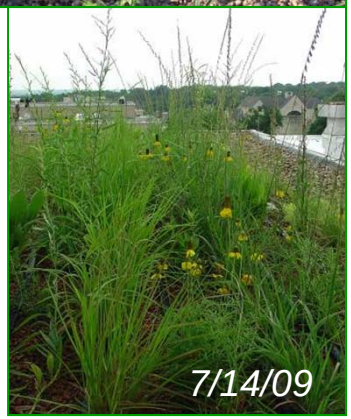
- The roof is first stripped to the concrete sub-surface;
- Next, a waterproofing layer is placed and tested for leaks;
- Once tested (and waterproof), a root barrier is placed over the waterproofing;
- Foam layers (if used) are placed slightly slanting to allow for drainage;
- A cap sheet must then be placed to prevent root penetration before adding soil and plants.

With proper attention to installation, green roofs can last more than twice as long as a conventional rooftop, require less frequent repairs, and provide numerous environmental benifits.



Yes, living rooftops typically require maintenance & weeding!





Seaton Hall Green Roof Monitoring

Seasonal Changes & Aesthetics – Summer 2009

7/14/09

Seaton Hall Green Roof Monitoring

Seasonal Changes & Aesthetics – Winter 2009

12/28/09

Seaton Hall Green Roof Monitoring

Seasonal Changes & Aesthetics – Spring 2010

5/31/10

Seaton Hall Green Roof Monitoring

Seasonal Changes & Aesthetics – Summer 2010

6/30/10

Seaton Hall Green Roof Monitoring

Seasonal Changes & Aesthetics – Fall 2010

9/24/10

Seaton Hall Green Roof Monitoring

Seasonal Changes & Aesthetics – Fall 2010

11/10/10

Seaton Hall Green Roof Monitoring

Seasonal Changes & Aesthetics – Summer 2011

(to test species resilience the west side is not being irrigated)

7/4/11

Funding for the KSU-ISC Rain-Garden and Other Projects

The Kansas Department of Health and Environment provided financial assistance to the KSU-ISC Rain-Garden Project through EPA Section 319 Nonpoint Source Pollution Control Grant #C9007405-12. WaterLINK (Water Quality Restoration and Protection Service Learning Mini-Grants awarded to KSU by KDHE utilizing EPA funds) provided financial assistance for the KSU Campus Creek Planning/Design Charrette, KSU-ISC Rain-Garden Construction, Rossville Rain-Garden implementation, Seaton Hall Green Roof design and construction, Sunset Zoo Prairie-and-Rain-Garden implementation, and other stormwater management projects by KSU faculty and students.

Not including volunteer time by KSU faculty and students, total donations from external partners and non-academic departments during Spring and Summer 2007 were estimated at approximately $7,800. Hundreds of hours of donated time were also provided to construct and then maintain the ISC Rain-Garden. Generous contributions (both external and internal to KSU) were made to implement the KSU Seaton Hall Green Roof and the rain-gardens at Rossville's City Park and Manhattan's Sunset Zoo.

There are many ways to slow, hold, filter and/or infiltrate stormwater, including:

temporarily **storing water on rooftops** (generally not favored due to concerns about preserving waterproofing membranes atop buildings),

green roofs to capture and use a portion of the precipitation that lands on a roof during storm events for watering vegetation (an increasingly popular but more expensive way to treat stormwater given the need for adequate structural support, excellent rooftop waterproofing, and other technical requirements),

cisterns and/or rain barrels to store rooftop or other surface water runoff,

dry wells (holes in the ground filled with gravel),

bio-retention cells (areas typically having a combination of engineered soils, plants and mulch – and when necessary an under-drain),

porous pavement atop a compacted washed gravel base

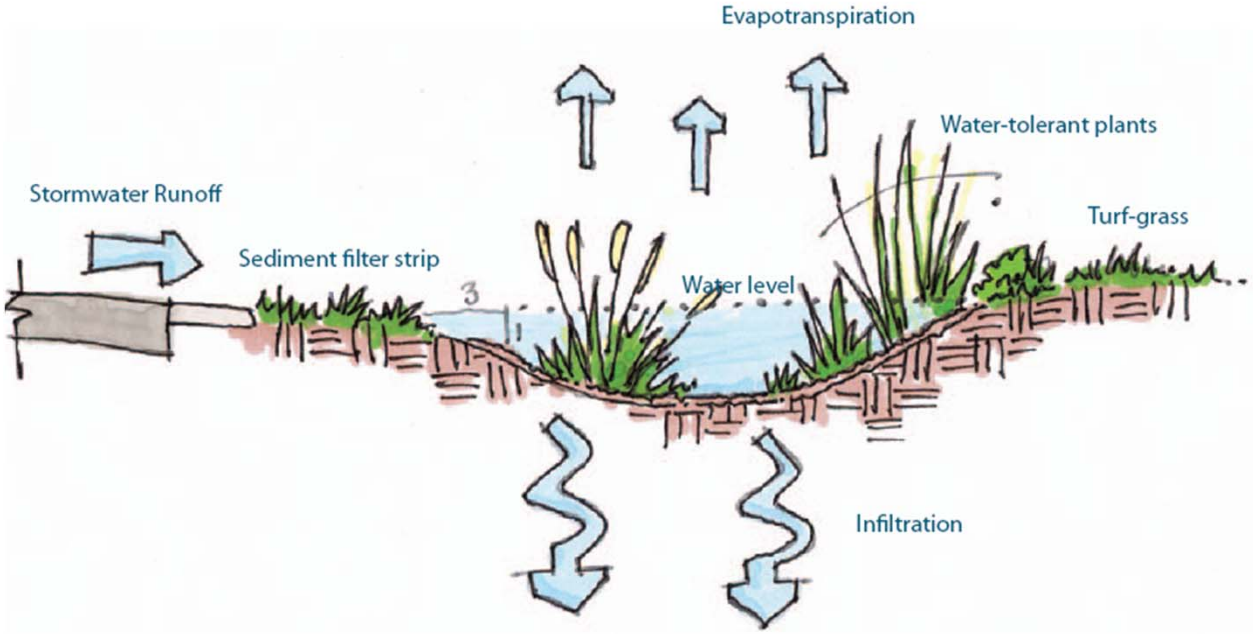
rain-gardens (shallow depressions that collect water from nearby impervious surfaces and then infiltrate the water into existing, plant-mediated soils).

See City of Portland., Oregon's "How to Build a Rain Garden" video:
http://www.portlandonline.com/bes/index.cfm?c=54309&a=337963

Rain-Garden Design and Implementation for Kansas Property Owners

With a Discussion of Lessons Learned from Kansas State University's International Student Center Rain-Garden Design-Build Demonstration Project in Manhattan, Kansas

"Rain-gardens are a solution that can be readily adapted to capture and infiltrate stormwater on nearly every property, no matter the type of soils or slopes." (p 3)



Rain-Garden sketch by Tim Merklein (KSU-LA/RCP 2008)

http://faculty.capd.ksu.edu/lskab/KSU-LARCP_Rain-Garden-Guidebook-lrs.pdf

RETROFITTING APPLIED: property Ideas

Sustainable Stormwater Management must necessarily be approached in a holistic and integrated way

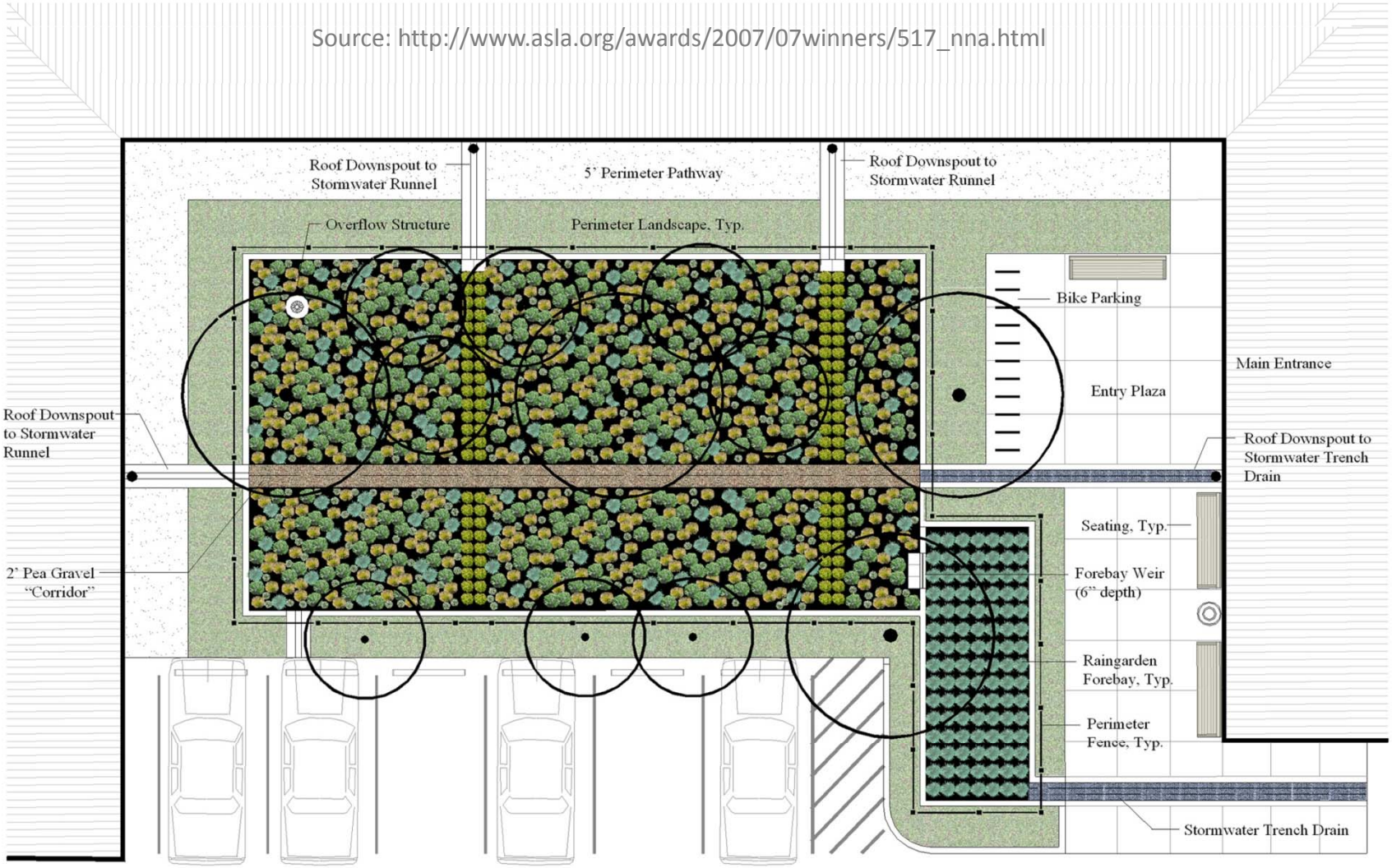
The southern end of the promenade looking north. Meandering along the waterline in the residential area of the neighborhood, the promenade becomes more informal and intimate as it winds south.

Source of text & images: http://asla.org/awards/2007/07winners/366_sai.html (ASLA Landmark Award)

~ Mount Tabor Middle School Raingarden ~

Portland, Oregon

Source: http://www.asla.org/awards/2007/07winners/517_nna.html



Illustrative Site Plan

N


Source: http://www.asla.org/awards/2007/07winners/517_nna.html


Source: http://www.asla.org/awards/2007/07winners/517_nna.html

Mount Tabor Middle School Rain Garden, Portland, Oregon

Kevin Robert Perry, ASLA, Portland, Oregon

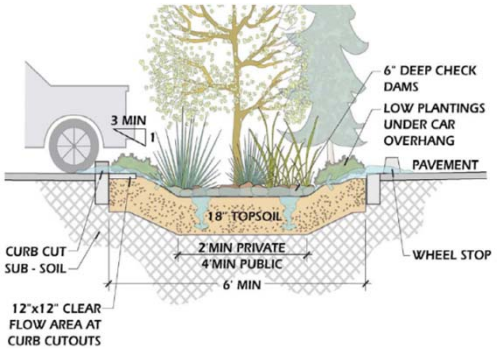
Brandon Wilson, City of Portland Environmental Services

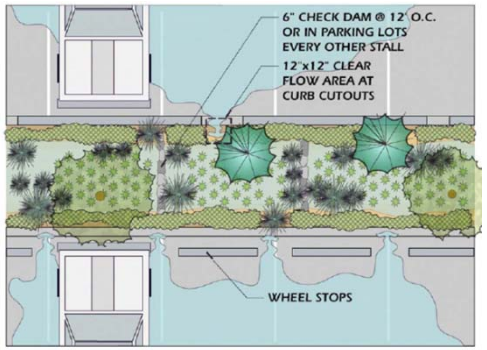
Client: City of Portland, Sustainable Stormwater Management Program

Source: http://www.asla.org/awards/2007/07winners/517_nna.html

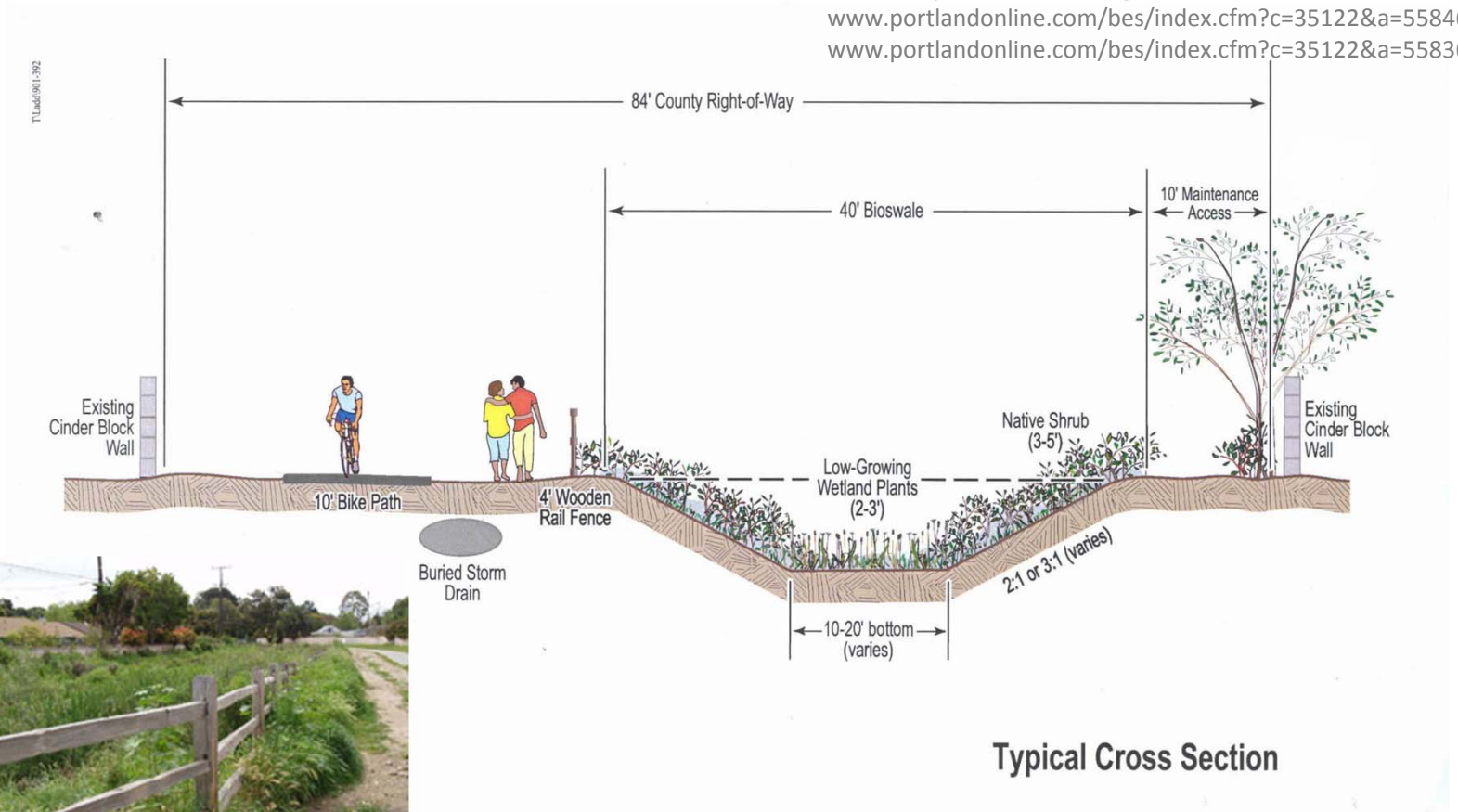
Vegetated Swales *or* Bioswales

urban to rural…



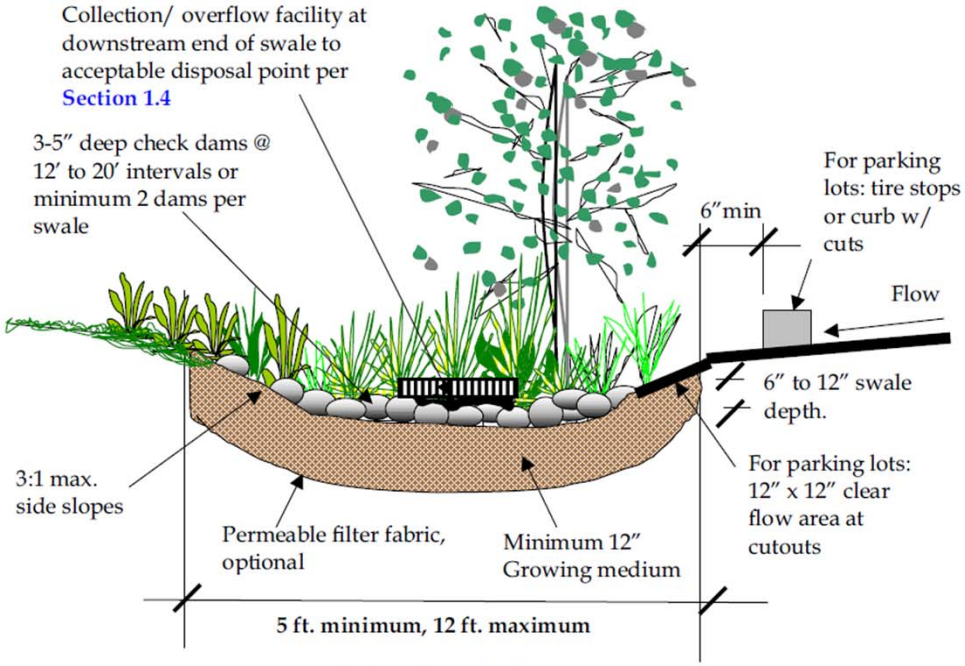


Source of photo and drawings: Portland, OR
www.portlandonline.com/bes/index.cfm?c=35122&a=55846
www.portlandonline.com/bes/index.cfm?c=35122&a=55836



Source of images: Santa Barbara County, CA
www.sbprojectcleanwater.org/improvements.html

Vegetated Swale



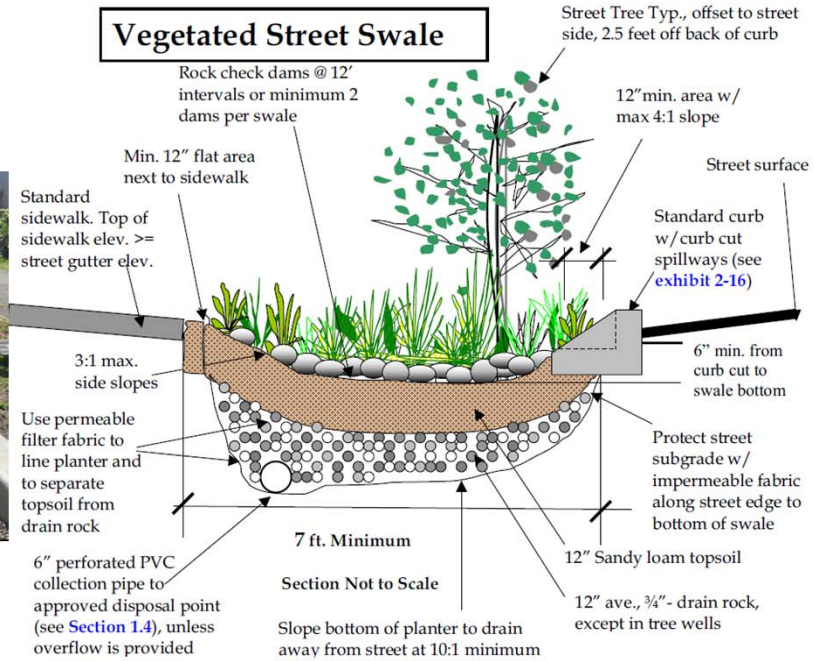
Section Not to Scale


PCC Annex (SE Water Ave.)

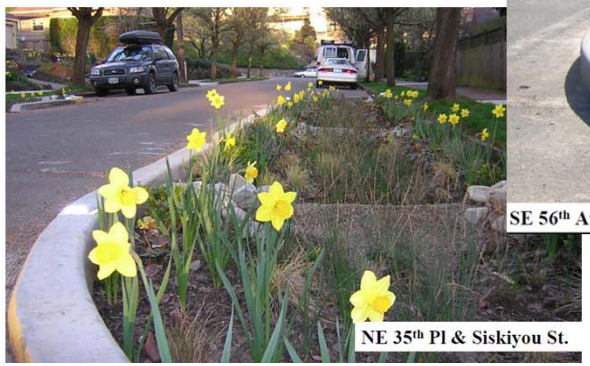
Source of sections and photos: Portland, OR
www.portlandonline.com/bes/index.cfm?c=35122&a=55791
www.portlandonline.com/bes/index.cfm?c=35122&a=55846
www.portlandonline.com/bps/index.cfm?a=115328&c=42113

Street Swales

Vegetated Street Swale

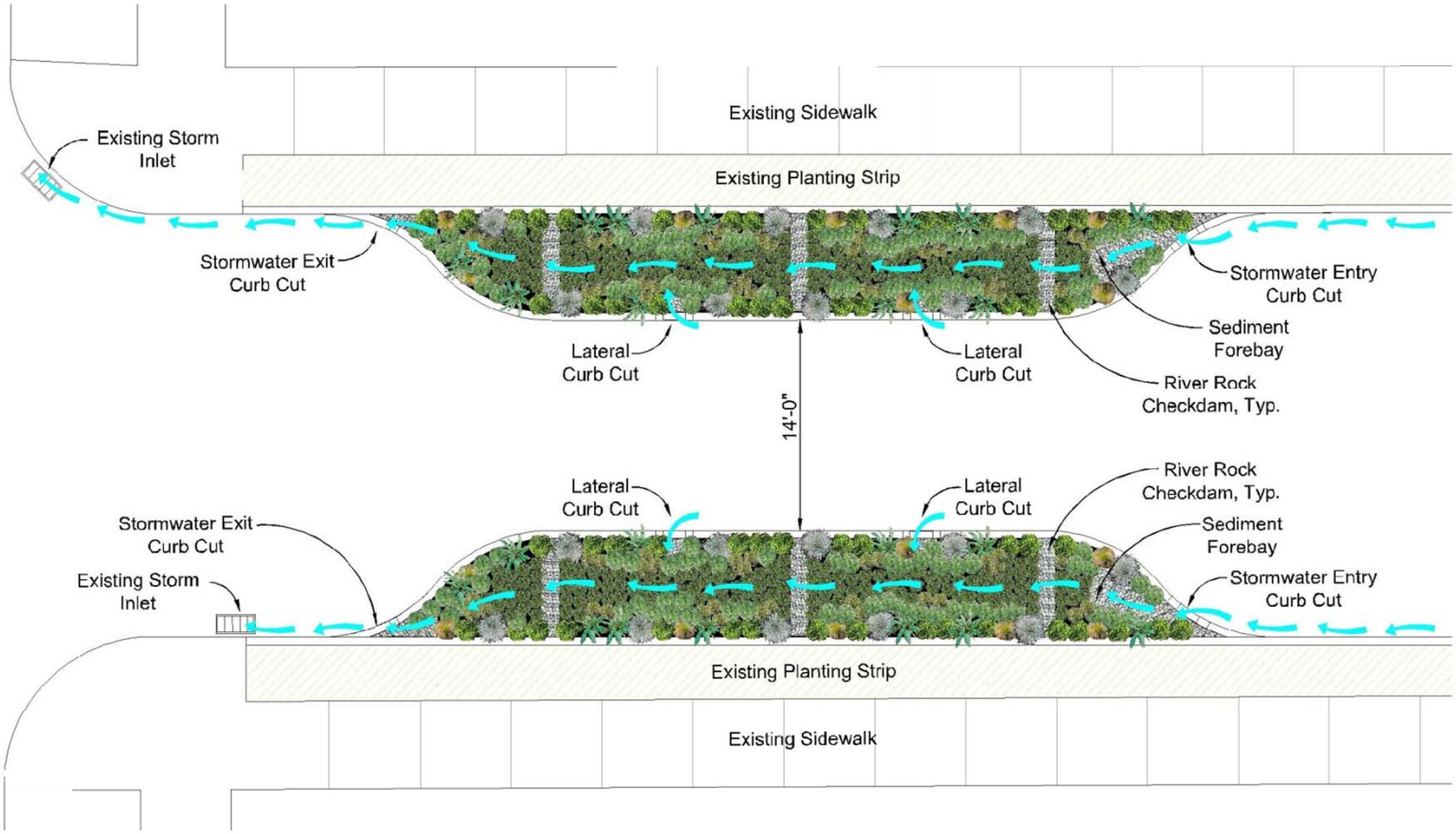



SE 56th Ave. & Ankeny St.


NE 35th Pl & Siskiyou St.

The NE Siskiyou Green Street Project

http://www.asla.org/awards/2007/07winners/506_nna.html



Stormwater Curb Extensions Flow Diagram

OMSI (1945 SE Water Ave)

BES Water Pollution Control Lab (6543 N. Burlington)

Vegetated Swales *or* Bioswales

more and less formal…

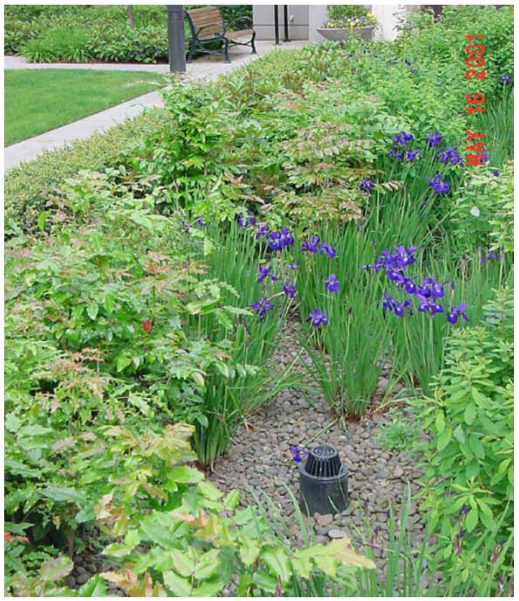
Hawthorne Ridge Subdivision (SE 162nd, South of Foster)

Source of photos: Portland, OR
www.portlandonline.com/bes/index.cfm?c=35122&a=55846

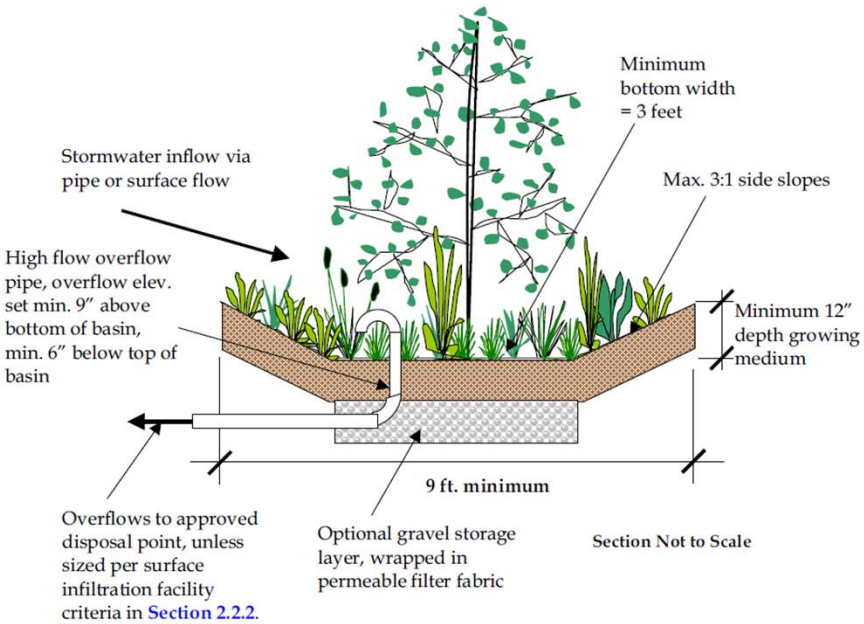
Vegetated Infiltration Basins

design in creative ways based on site, context and budget…

Buckman Heights courtyard infiltration basins (430 NE 16th Ave.)



Vegetated Infiltration Basin



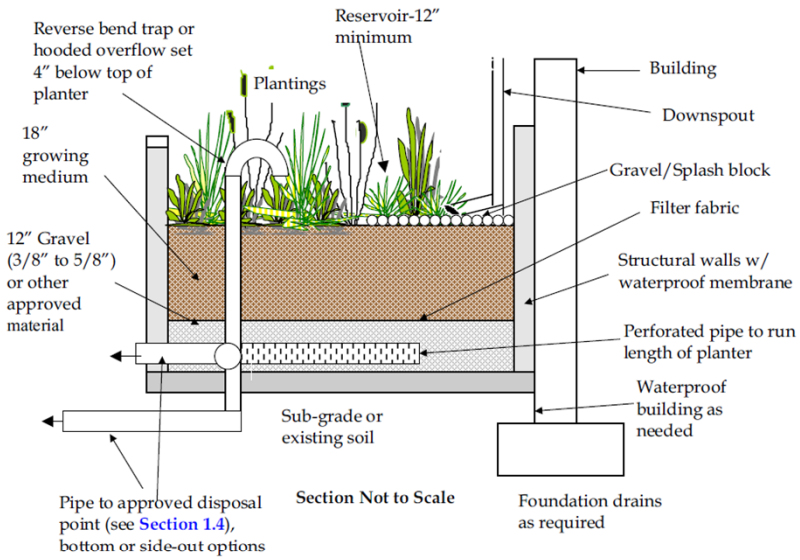
Wattles Boys and Girls Club (9330 SE Harold)

Macintyre Estates Subdivision (SE 139th & Steele)

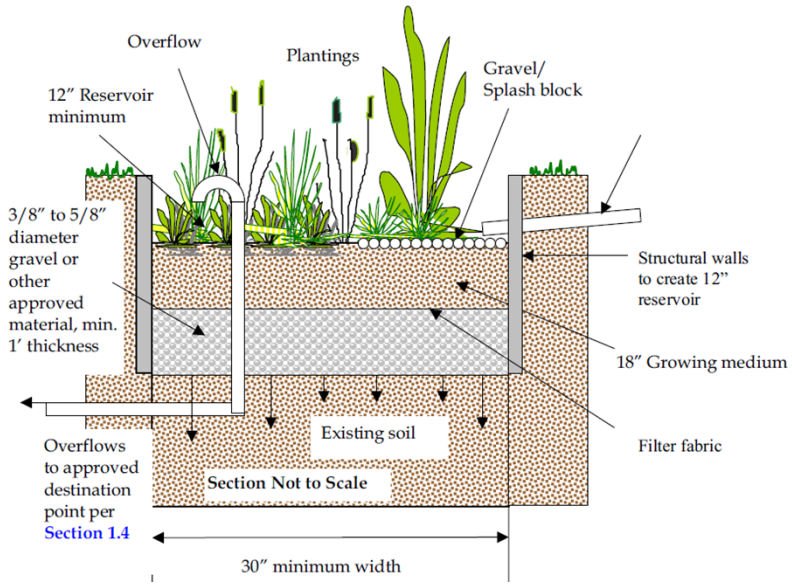
Glencoe Elementary School (825 SE 51st)

Source of sections and photos: Portland, OR
www.portlandonline.com/bes/index.cfm?c=35122&a=55846
www.portlandonline.com/bps/index.cfm?a=115328&c=42113

Flow-Through Planter



Infiltration Planter



Source of sections and photos: Portland, OR
www.portlandonline.com/bes/index.cfm?c=35122&a=55846
www.portlandonline.com/bps/index.cfm?a=115328&c=42113

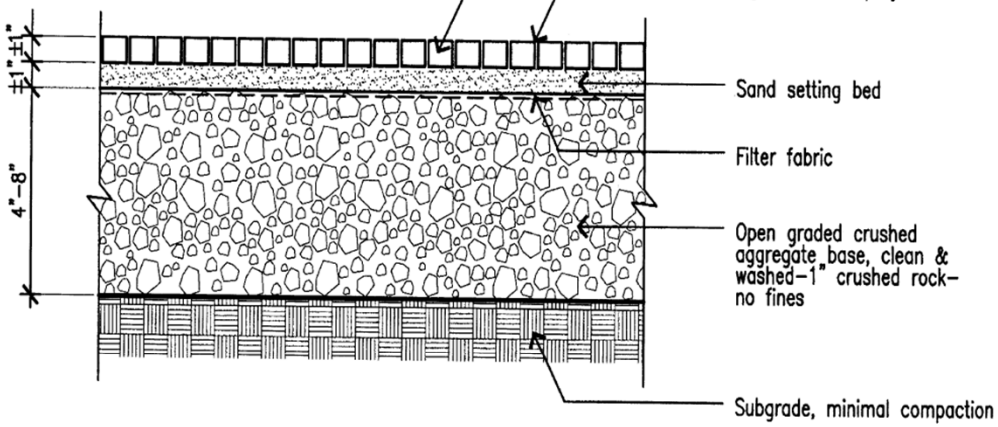

Liberty Center Parking Garage (650 NE Holladay)

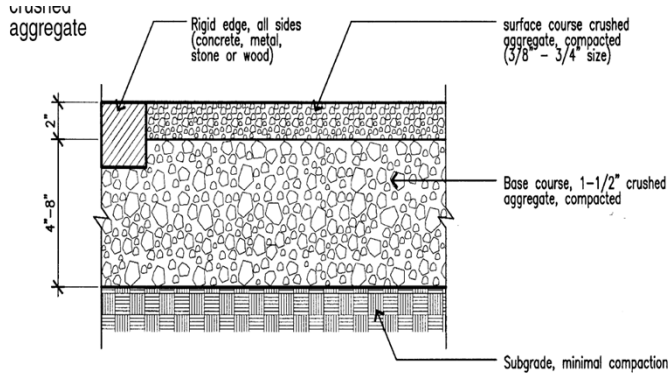

Liberty Center Parking Garage (650 NE Holladay)


Buckman Terrace Apartments (303 NE 16th Ave.)

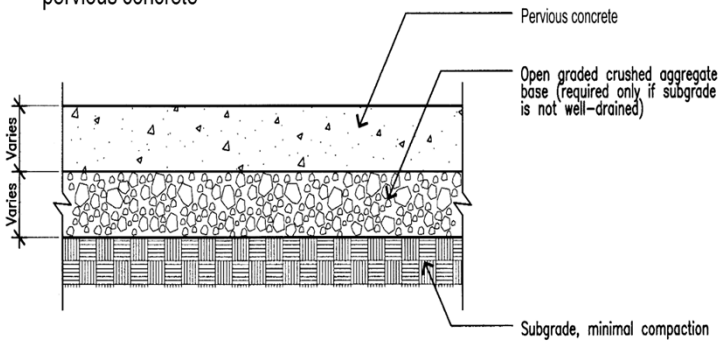

Wattles Boys and Girls Club (9330 SE Harold)

unit pavers on sand





pervious concrete

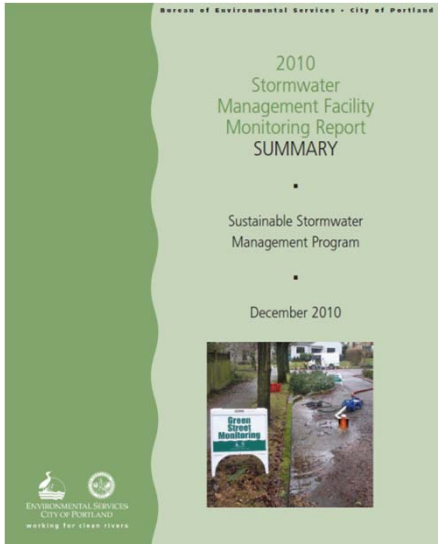


Source of drawings and photos: Portland, OR
www.portlandonline.com/bes/index.cfm?c=35122&a=55846
www.portlandonline.com/bes/index.cfm?c=35122&a=55836

Pervious pavers at ONRC (5825 N. Greeley)

Installation of Eco-Loc Paver Parking Lot in Washington

Pervious concrete installation at NE 94th & Broadway pump station site



Monitoring Performance

Environmental Services promotes low-impact, sustainable approaches to stormwater management. We use natural systems and functions to manage stormwater runoff as close to the source as possible.

Gathering performance data on sustainable stormwater facilities is critical to quantifying benefits, improving design and function, and lowering maintenance costs.

Long term monitoring of these facilities is an important part of the Sustainable Stormwater Program.

Source of text & images :
www.portlandonline.com/bes/index.cfm?c=36055&
http://www.portlandonline.com/bes/index.cfm?c=36055&a=343463

Infiltration Basins – Monitoring Summary

• Infiltration rates have met or exceeded expectations at all facilities.

• One older facility showed higher infiltration rates after 10 years, strengthening the concept that vegetated infiltration facilities can improve over time. Roots from vegetation – especially woody plants – have extensive root structures that counter siltation and can loosen soils compacted during construction. (pg S-9)

***Green Street** facilities…provide a notable reduction in flow volume entering the combined sewer. For one facility, annual runoff over a four-and-a-half year period has been reduced by over 85%. (pg S-4; chart S-5)*

Peak Flow Reduction and Volume Retention of Green Street projects

Facility	Monitoring Period	Drainage Area (ft^2)	25-Yr Peak Flow Reduction	Annual Runoff Retention	CSO Flow Volume Retention
12th & Montgomery	4 flow tests Sep 2005 – Jun 2008	7,000	80%+	N/A	75%
Fremont & 131st	1 flow test Aug 2006	4,500	94%	N/A	95%
Glencoe Rain Garden	4½ years Jan 2004 – Jun 2008	34,800	80%+	87%	56% +
21st & Tibbetts	1 flow test Aug 2007	5,500	100%	N/A	70%
Siskiyou & 35th	3 flow tests Jan 2004 – Dec 2005	9,300	82%	N/A	61% - 83%

***Filter fabric** has shown a 10% greater retention when compared to the pea gravel separator lens, indicating that the filter fabric is more of a barrier to water movement and creates more retention. (pg S-11)*

Source: www.portlandonline.com/bes/index.cfm?c=36055&a=232644

“The solution [to conservation and wise use of earth’s ecosystems, water and other resources] has to come up from the people, through persuasion, enlightenment, and the creation of new norms, until the powerful are swept irresistibly along in the new social reality.”

“The weak”
(those who are poor and other common citizens)
“often have more at stake in the loss of nature,
a closer relationship to its gifts,
and a greater capacity to recognize when
a certain level of material wealth is enough.”

Charles Wohlforth - *Orion* magazine July/August 2010

Appendix:

USEPA's
Municipal Separate Storm Sewer Systems
Regulations
(Excerpts)

Stormwater Discharges From Municipal Separate Storm Sewer Systems (MS4s)

Polluted stormwater runoff is commonly transported through Municipal Separate Storm Sewer Systems (MS4s), from which it is often discharged untreated into local waterbodies. **To prevent harmful pollutants from being washed or dumped into an MS4, operators must obtain a NPDES permit and develop a stormwater management program.**

Phase I, issued in 1990, requires *medium* and *large* cities or certain counties with populations of 100,000 or more to obtain NPDES permit coverage for their stormwater discharges.

Phase II, issued in 1999, requires regulated small MS4s in urbanized areas, as well as small MS4s outside the urbanized areas that are designated by the permitting authority, to obtain NPDES permit coverage for their stormwater discharges.

[Manhattan, Kansas falls under the 1999 MS4 rules; ideally, all municipalities would seek to reduce harmful pollutants from entering stormwater systems and/or nearby lakes, ponds, streams and rivers.]

Source: http://cfpub1.epa.gov/npdes/stormwater/munic.cfm

Note: emphasis added by LRS (typical)

Background on the USEPA's Stormwater Phase II Rule

Published on December 8, 1999, the Stormwater Phase II Rule generally requires operators of small MS4s in urbanized areas to develop and implement a stormwater management program that addresses six minimum control measures…

[the focus of this presentation has been on measures #4 and #5 – runoff during and after site construction]

Implementing these minimum control measures typically requires the application of one or more BMPs [Best Management Practices].

It is important to recognize that there is site-specific, regional, and national variability associated with the selection of appropriate BMPs, as well as in the design constraints and pollution control effectiveness of practices.

Sources: http://cfpub.epa.gov/npdes/stormwater/menuofbmps/bmp_background.cfm

Background on the USEPA's Stormwater Phase II Rule

EPA has found the practices listed in the menu of BMPs to be representative of the types of practices that can successfully achieve the minimum control measures. **The list of BMPs is not all-inclusive, and does not preclude MS4s from using other technically sound practices.** However, in all cases the practice or set of practices chosen needs to achieve the minimum measure.

EPA also recognizes that some MS4s may already be meeting the minimum measures, or that only one or two additional practices may be needed to achieve the measures. Existing stormwater management practices should be recognized and appropriate credit given to those who have already made progress toward protecting water quality. There is no need to spend additional resources for a practice that is already in existence and operational.

Sources: http://cfpub.epa.gov/npdes/stormwater/menuofbmps/bmp_background.cfm

40 CFR 122.34(b)(4)

(4) Construction site stormwater runoff control.

(i) You must develop, implement, and enforce a program to reduce pollutants in any stormwater runoff to your small MS4 from construction activities that result in a land disturbance of greater than or equal to one acre. Reduction of stormwater discharges from construction activity disturbing less than one acre must be included in your program if that construction activity is part of a larger common plan of development or sale that would disturb one acre or more.

If the NPDES permitting authority waives requirements for stormwater discharges associated with small construction activity in accordance with Sec. 122.26(b)(15)(i), you are not required to develop, implement, and/or enforce a program to reduce pollutant discharges from such sites.

Source: http://cfpub.epa.gov/npdes/stormwater/menuofbmps/bmp_regulatory.cfm

40 CFR 122.34(b)(5)

(5) Post-construction stormwater management in new development and redevelopment.

(i) **You must develop, implement, and enforce a program to address stormwater runoff from new development and redevelopment projects that disturb greater than or equal to one acre, including projects less than one acre that are part of a larger common plan of development or sale, that discharge into your small MS4.** Your program must ensure that controls are in place that would prevent or minimize water quality impacts.

(ii) You must:
(A) Develop and implement strategies which **include a combination of structural and/or non-structural best management practices (BMPs)** appropriate for your community;
(B) Use an ordinance or other regulatory mechanism to **address post-construction runoff from new development and redevelopment projects** to the extent allowable under State, Tribal or local law; and
(C) **Ensure adequate long-term operation and maintenance of BMPs**.

Source: http://cfpub.epa.gov/npdes/stormwater/menuofbmps/bmp_regulatory.cfm