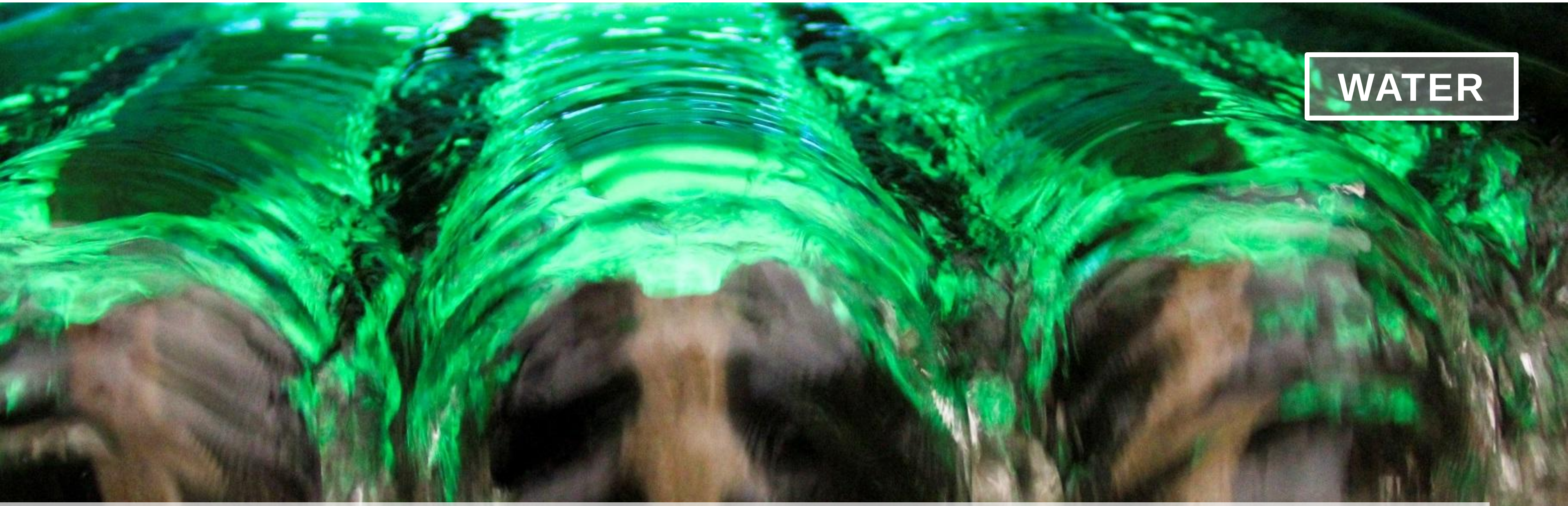


Managing Stormwater and Saving Money in Urban Transportation Corridors with Green Infrastructure

HRGreen

Bio – Aaron Gwinnup

- Farm Boy
- Carpenter
- Contractor
- Engineer
- Stream Nerd
- Daddy

Big Picture

Urban Environments Shed Water

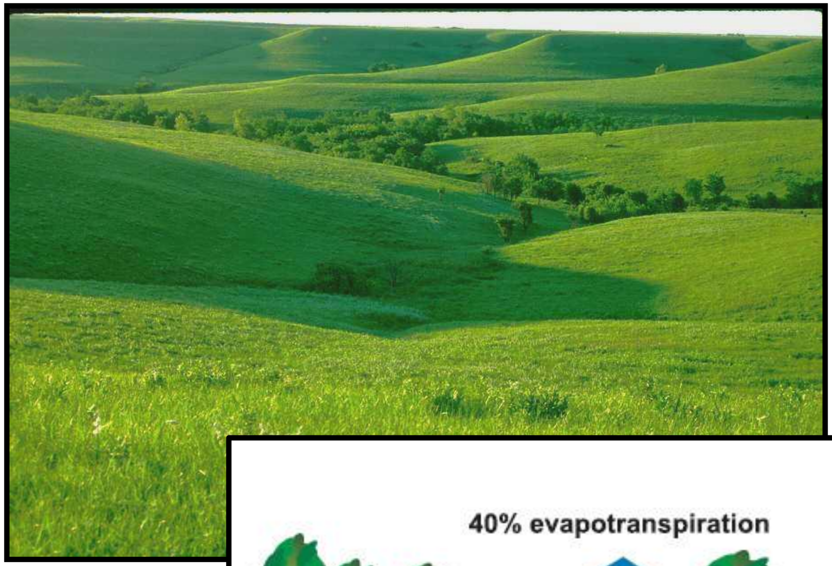
- Faster
- More
- Dirtier

…than they used to

…this is bad

(The good news is, reducing the impact isn't so hard after all)

Development of Impervious Cover



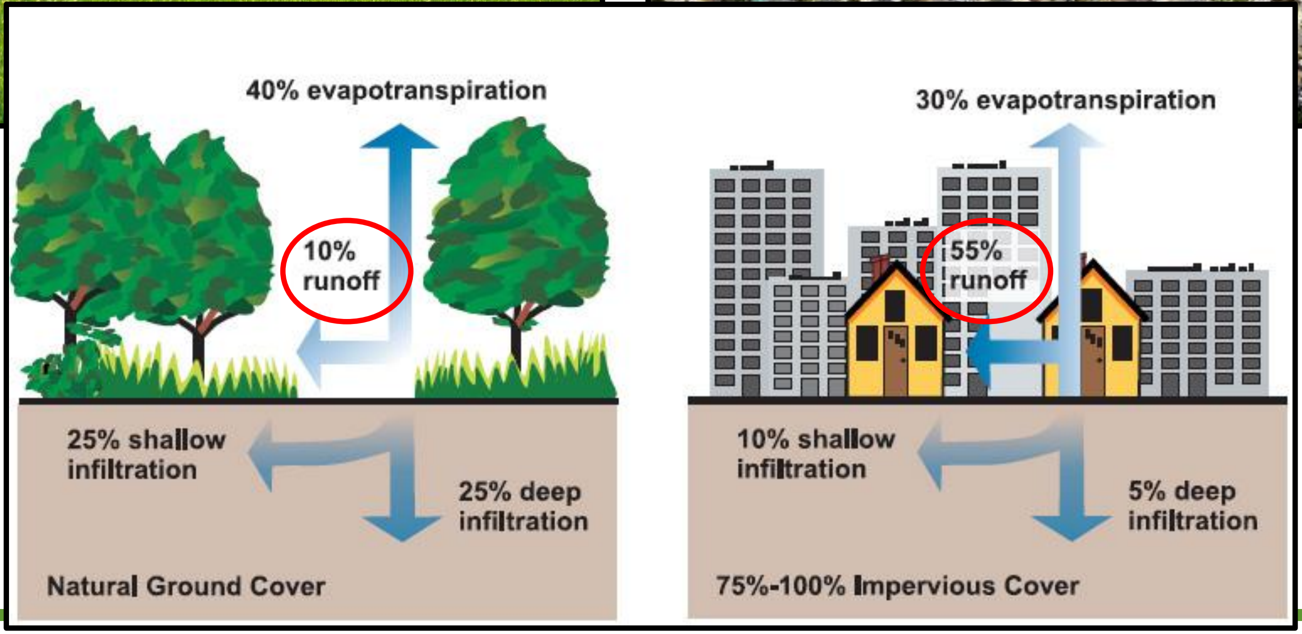
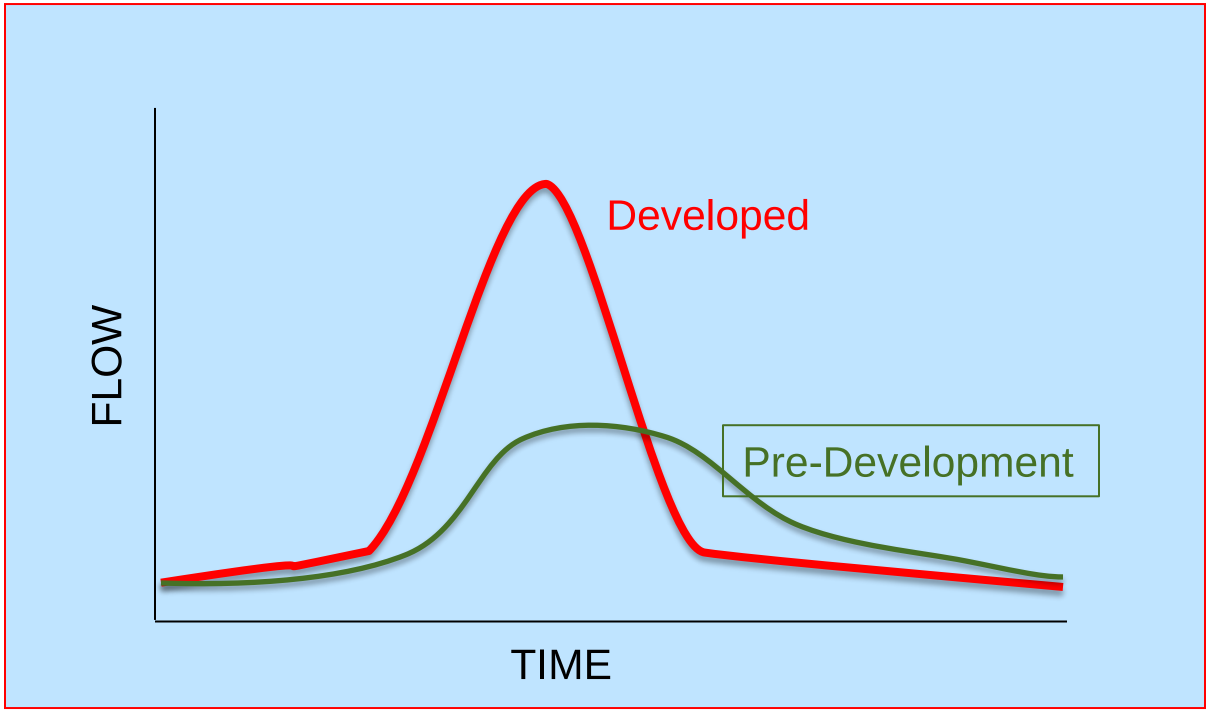


Image Credit:

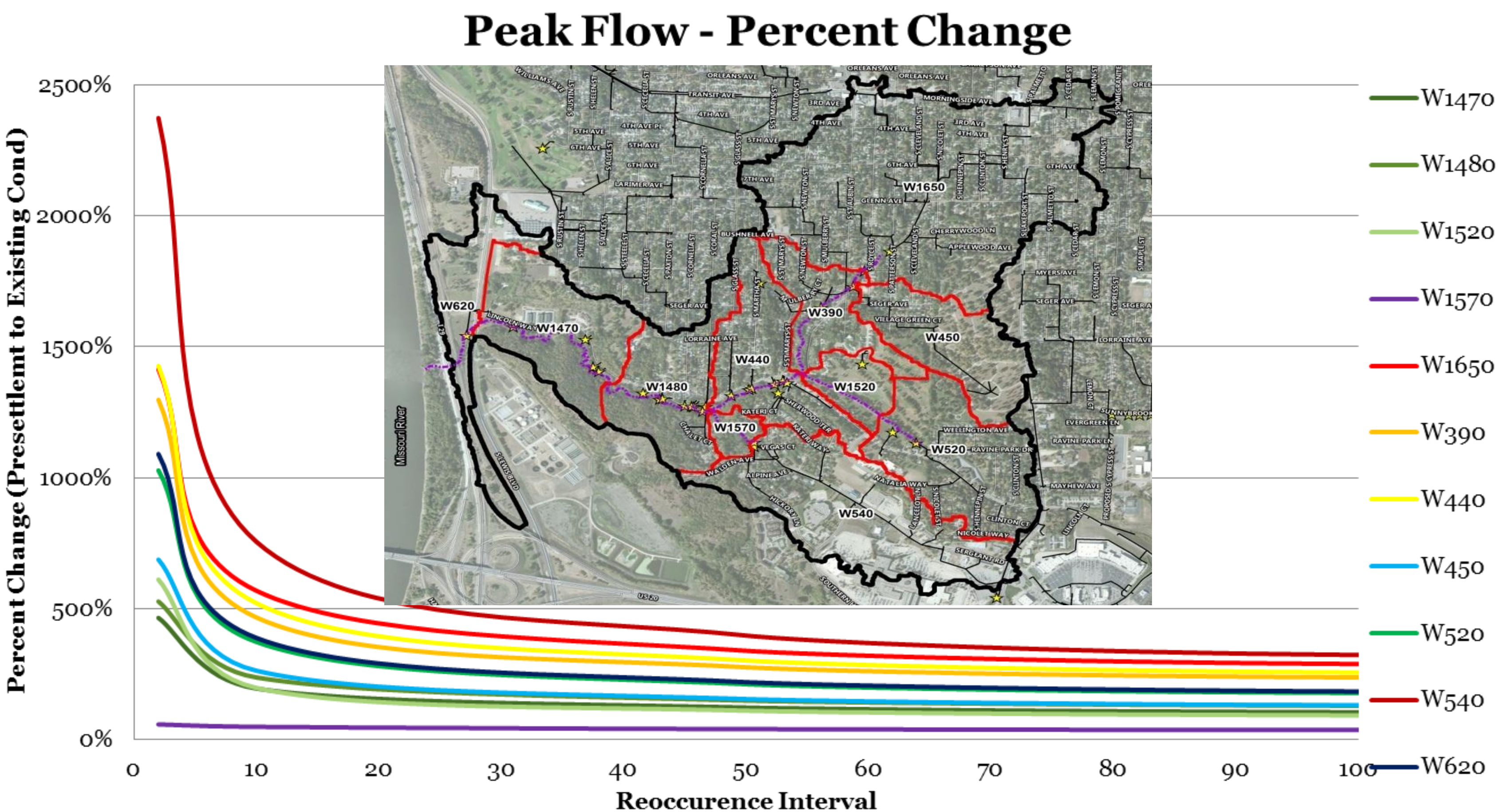
- Shutterstock
- Konza Prairie – Kansas State Univ.
- Iowa Stormwater Management Manual

…Changes to Hydrograph

More water faster



One Urban Watershed in Sioux City



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Altered Urban Hydraulics

Urban streams act somewhat like desert streams

- Low baseflow and high storm flows

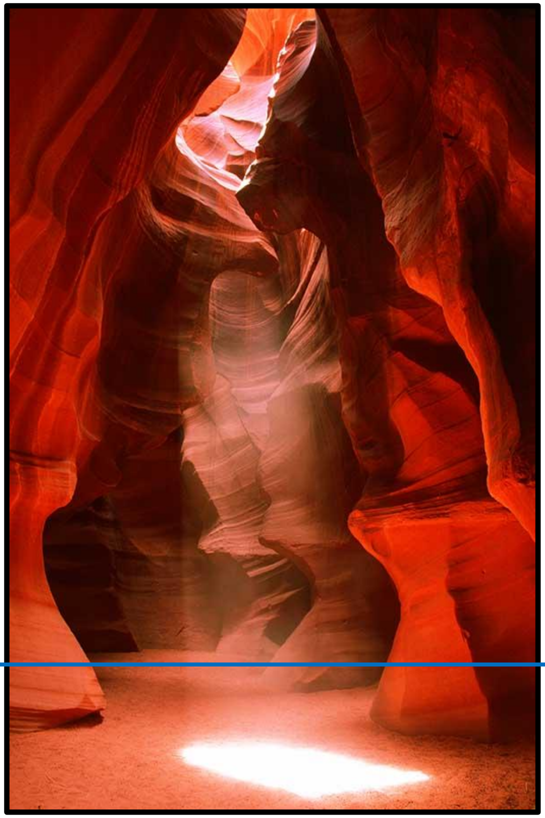
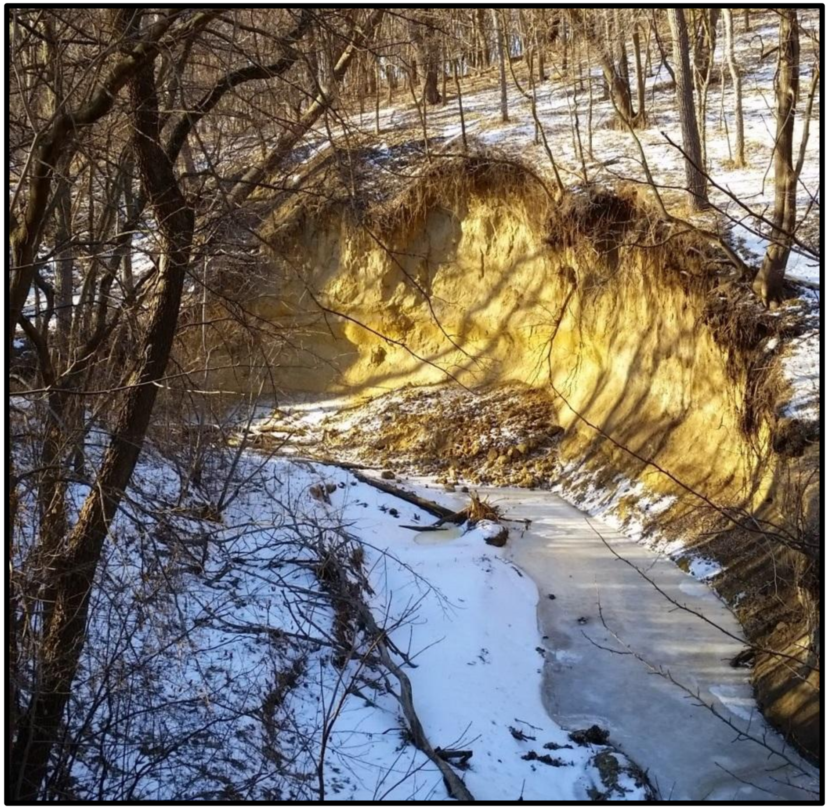


Image Credit:
- Pete Merten
- Marty Melchoir

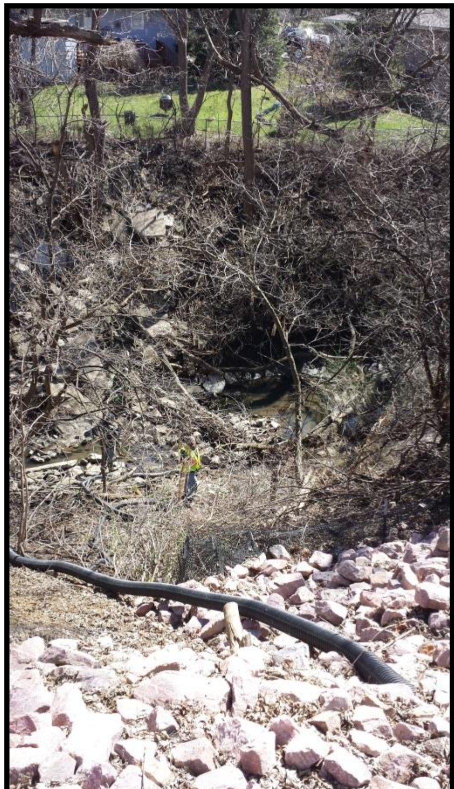
So what…Who cares?

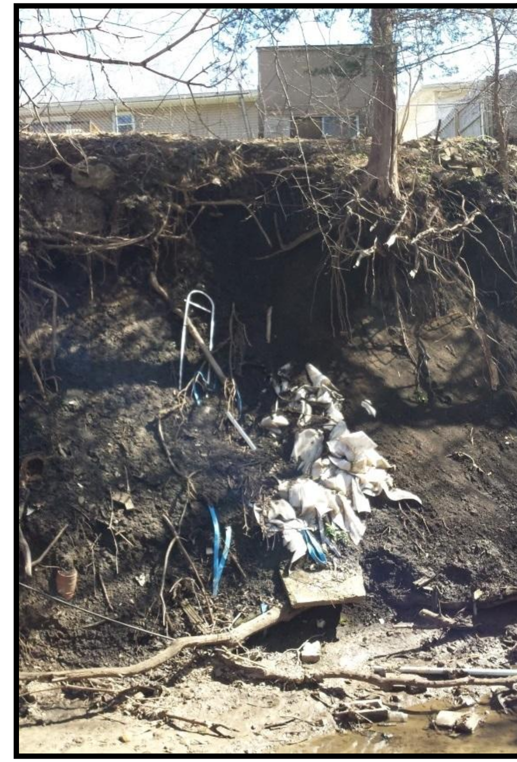
Streams at Risk



Infrastructure at Risk

Property at Risk





Impacts Affect Everyone

Runoff Rate Impacts –

Receiving-stream channel instability

Flooding

Reduced aquifer recharge

Runoff Quality Impacts –

Urban contaminants

Heavy metals, hydrocarbons, and bacteria, oh my!)

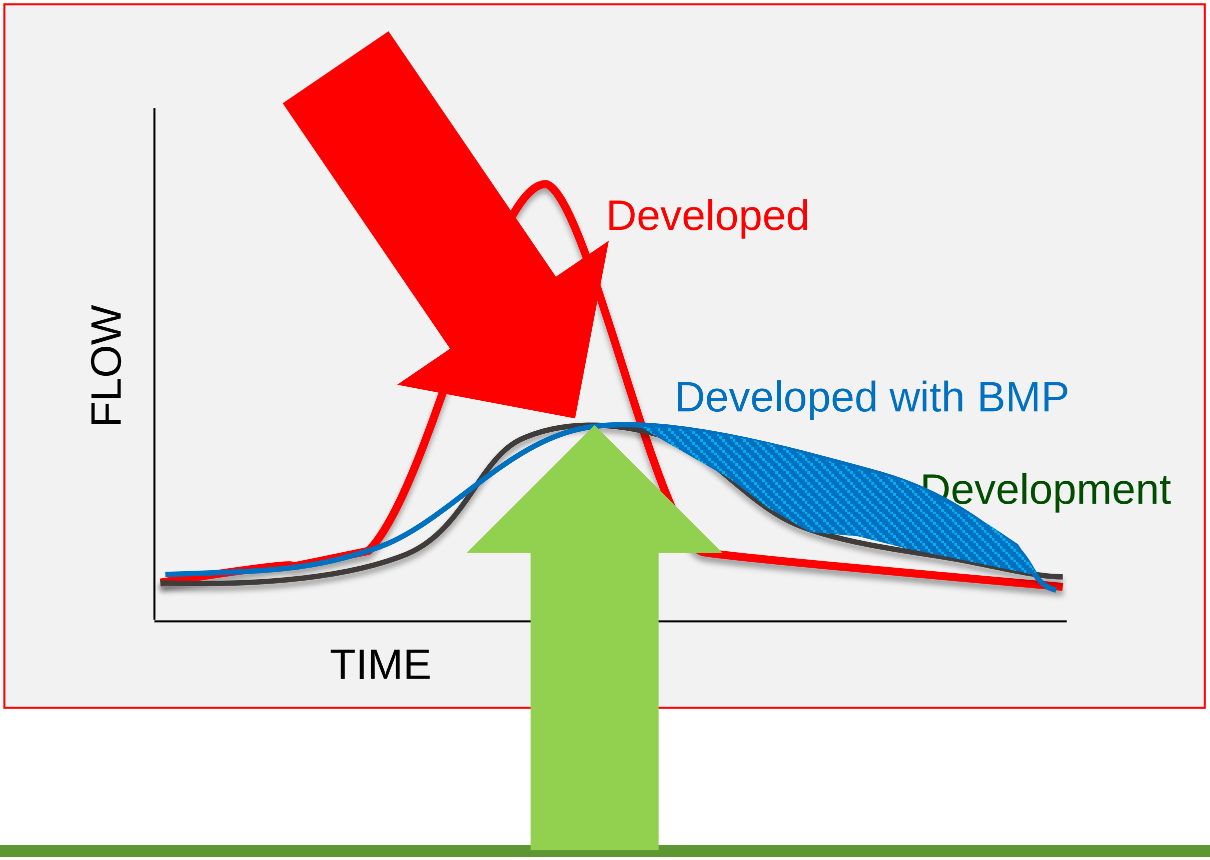
Nutrients = lost assets upstream

+ downstream algae blooms

+ dead zones and other ecological impacts

So what can we do?

-Green Infrastructure can help



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So what can we do?

Modern Stormwater Management Options

- Start with the basics – **Widely Distributed Infiltration**:
  - TOPSOIL - strive for 5 (% Organic Matter)
    - 1% additional OM holds 0.6" additional rainwater
  - Detention / Retention / Rain Barrels
  - Basic Infiltration

- Work toward the "frosting":
  - Green roofs, bioswales, raingardens, permeable paving…

Case Studies – Green vs Gray

Coralville

- West Land Use Area
- Coral Ridge Avenue

Hinsdale – The Woodlands

External Research

Coralville's ~~New~~ Stormwater Ordinance

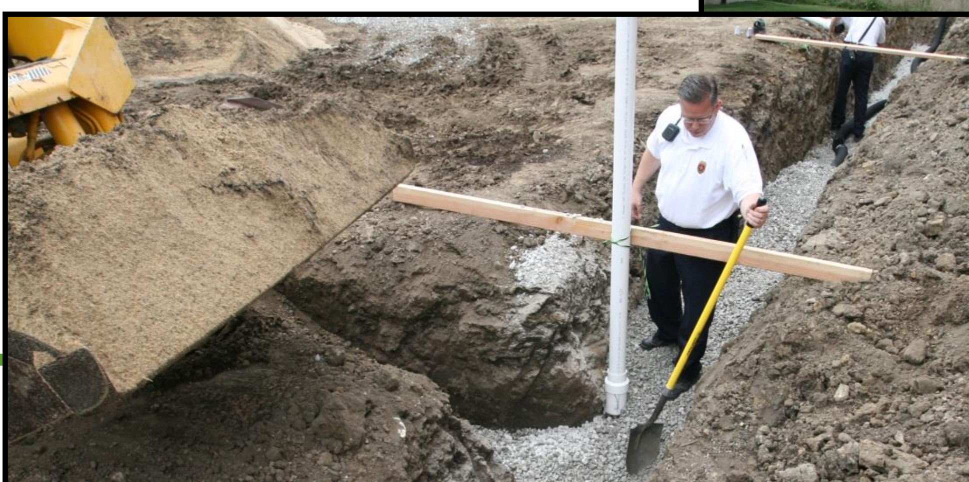
- Commercial and Residential Development

  (more than single parcel)

  - Stream buffers
  - Detention requirements (5-yr / 100-yr)
  - 6 inches topsoil (!)
  - Infiltrate Water Quality volume onsite (**1.25" Storm Runoff**)
  - AND infiltrate or extended detention of Channel Protection volume onsite (**2.4" Storm Runoff**)

Coralville's ~~New~~ Stormwater Ordinance

- Practicing what they preach
- The City adds stormwater BMPs to roadway and other municipal improvements whenever feasible (even if barely!) with the same standards as the ordinance
- The fire chief and staff are some of the best practitioners…

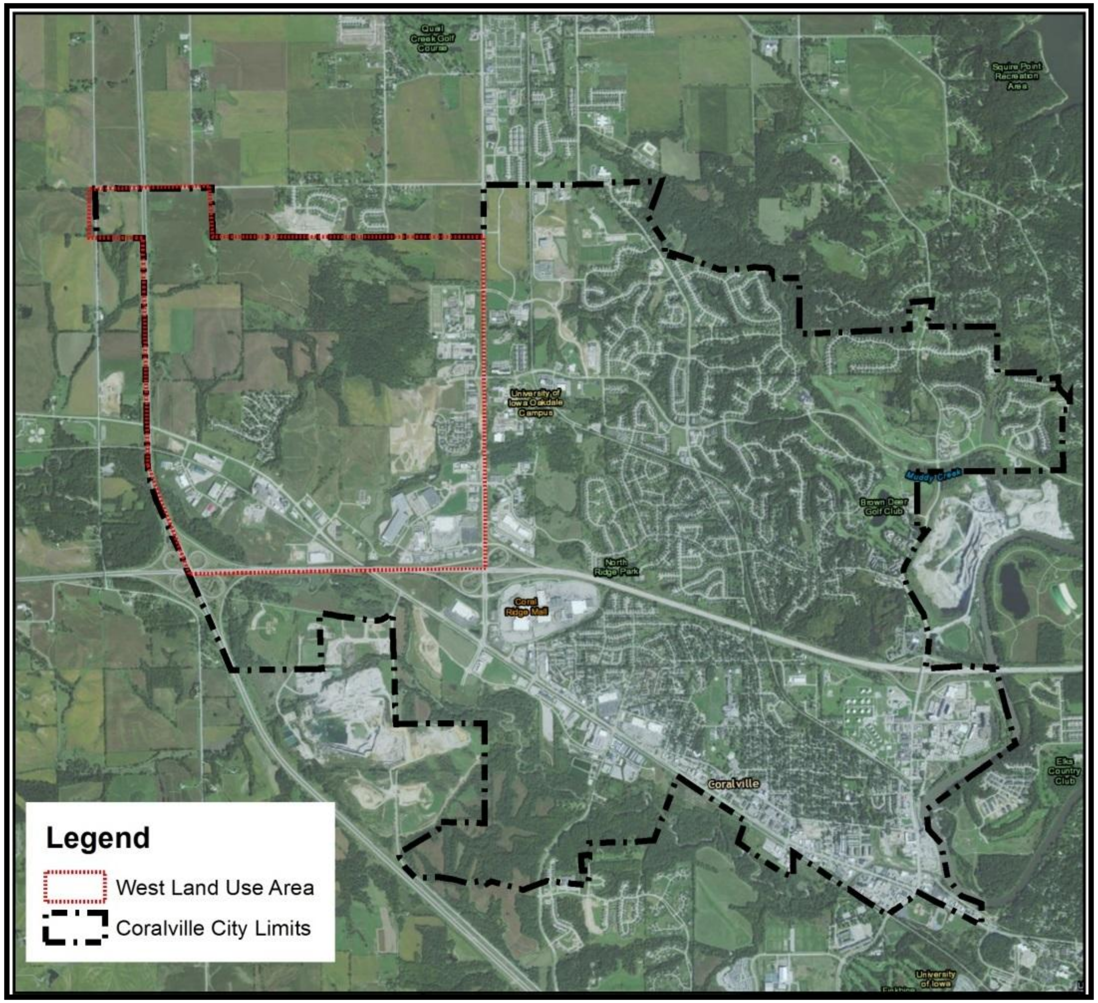


Case Study #1 – West Land Use Area

~3 square miles

Last large area to develop

Mostly agricultural, some woodland, some already developed



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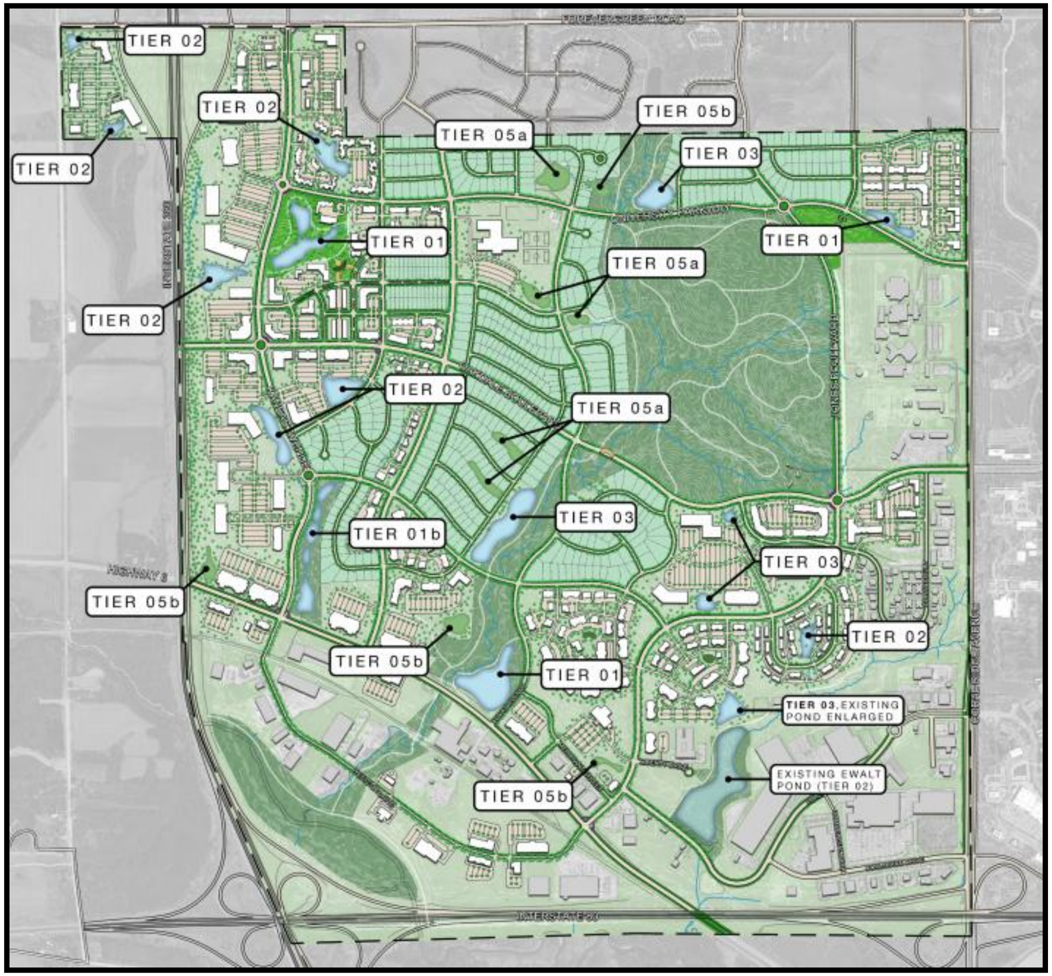
Case Study #1 – West Land Use Area

Some Results of Master Plan Study –

Enforcing onsite CPv results in:

- ~40% less regional detention required
  (more space to develop!)
- Smaller storm sewer trunk lines
- Smaller culverts
  (lower SW utility connection fees!)
- Less stream maintenance
- Enhanced aesthetics…



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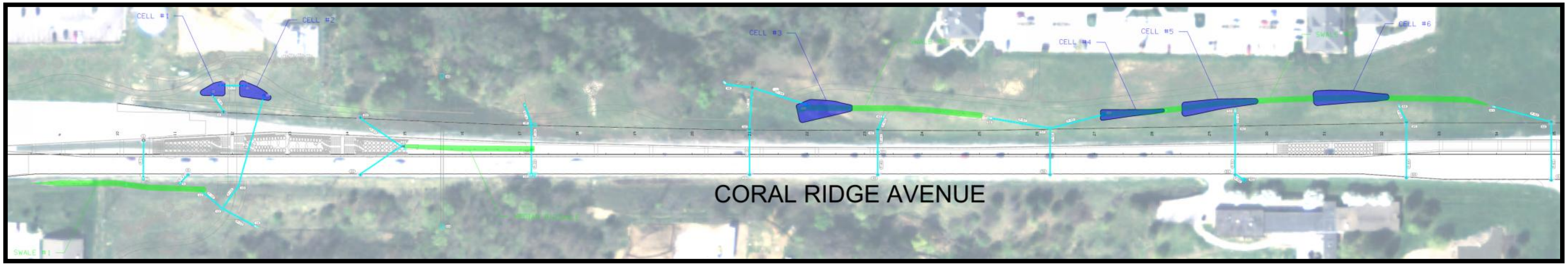
Case Study #2 – Coral Ridge Avenue



- City of Coralville needed to rebuild ½ mile arterial gateway
  - Increase from one lane each way to two, with turn lanes
  - Add 10’ recreational trail with underpass tunnel
  - Upgrade to traditional curb and gutter
  - Add streetscaping and aesthetic elements
  - Maintain progressive stormwater management standards

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Coralville's ~~New~~ Stormwater Ordinance

- Stormwater design goals for Coral Ridge Avenue
  - Treat Water Quality volume at a minimum
  - Prefer to treat Channel Protection volume from entire 10 acre site
  - Make BMPs unobtrusive and aesthetically appealing

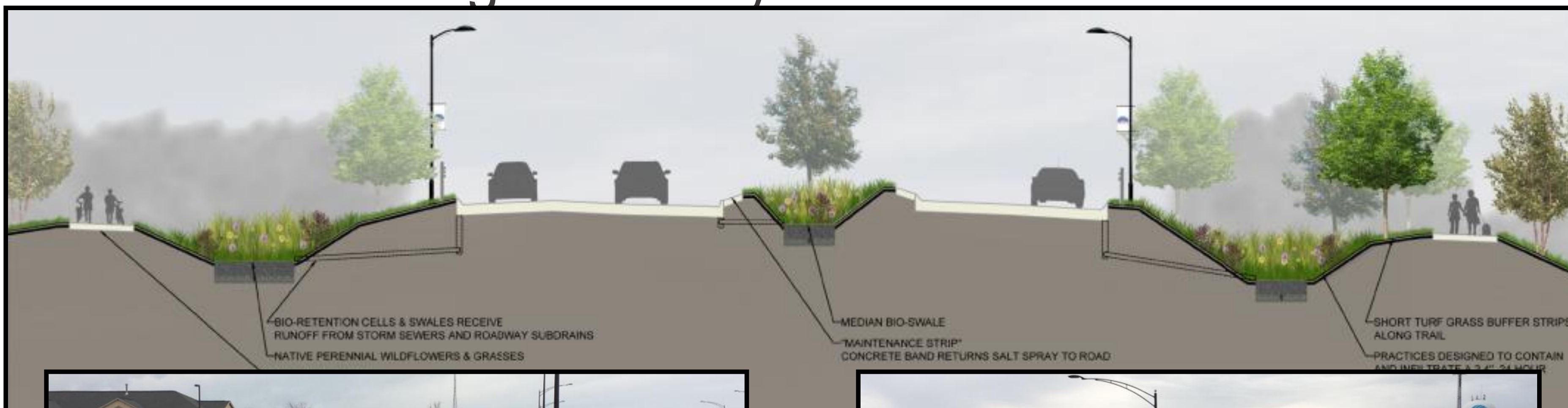
- OK, will do

  - Save money vs traditional infrastructure

- Wait, is that possible?

Functional, Appealing, Unobtrusive

6 large bioretention cells and 6 bioswales added to medians and rights-of-way



Functional, Appealing, Unobtrusive

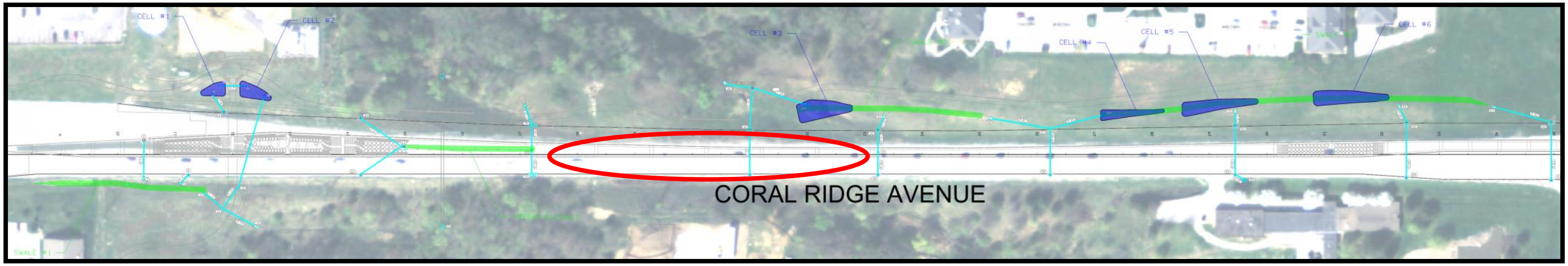
How did we do?

- 84% of area drains to BMPs

✓ 160% of WQv Treated

✓ 123% CPv Treated

SUMMARY STATISTICS	
Total Project Area	10 acres
Area Draining to BMPs	8.4 acres
BMP Footprint Compared to Impervious Area	
This Project	8.8%
Typical Green Infrastructure Footprint	10%
Total Retention Volume	34,000 cu ft.
Native Plant Plugs	8,609 plugs
Native Plant Seed	4 acres
Reduction in 5-yr Storm Runoff Volume	47%
Reduction in 10-yr Storm Runoff Volume	38%
Reduction in 100-yr Storm Runoff Volume	19%



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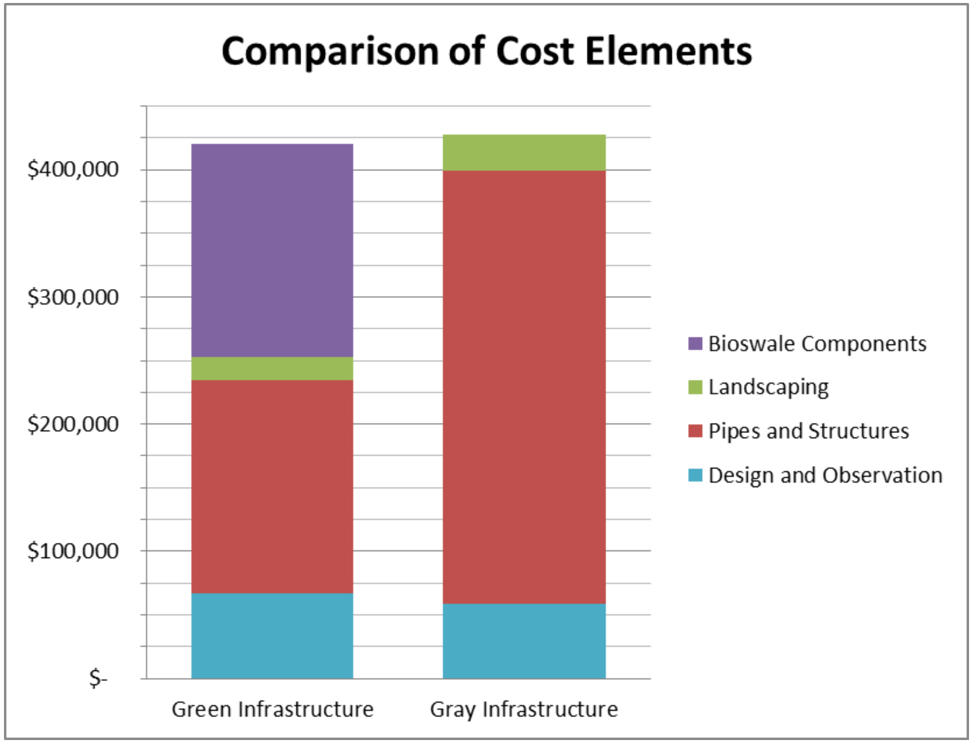
Lower Cost?

- 10% lower stormwater cost than traditional gray infrastructure only*
- How?
  - Few long large pipes
  - Less storm structures
  - Smaller pipes



* Includes fair assumptions

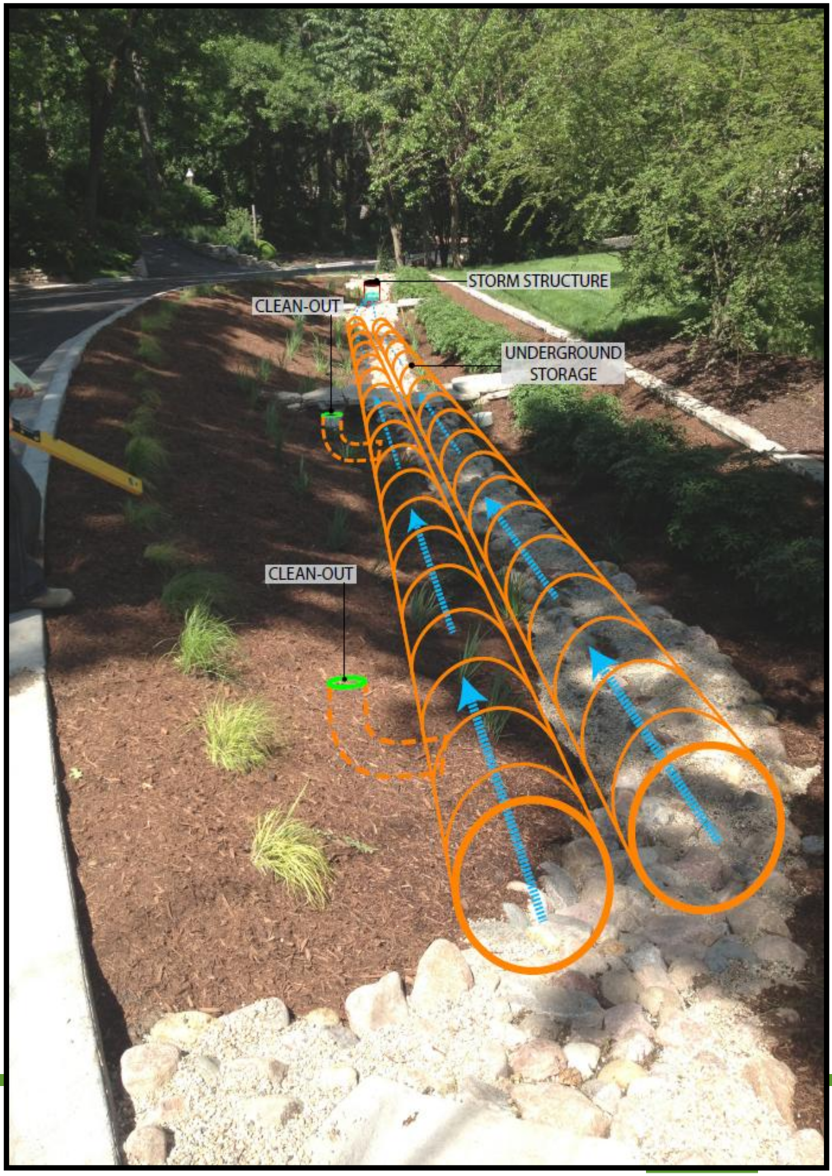
Case Study 3 – Hinsdale-The Woodlands

The Woodlands neighborhood had non-existent drainage with recurring flooding, deteriorated roadway conditions and aging infrastructure

2008 Study - Traditional gray infrastructure to collect and convey the 100-yr storm including other improvements (water, sewer and roadway) was **$24.4 Million**



Case Study 3 – Hinsdale-The Woodlands



Case Study 3 – Hinsdale-The Woodlands

2009 Study (and subsequent designs):

– Hybrid green / gray / underground detention system:

$15 Million

a **39% savings** in capital cost alone

SUMMARY STATISTICS - PHASE 1	
Decrease in Peak Outflow from Storm Sewer with BMPs compared to existing conditions	
50-year 2-hour event	66% flowrate reduction
10-year 1-hour event	58% flowrate reduction
Green Infrastructure Footprint	
Rain Gardens	35,020 square feet
Bioswales	8,410 square feet
Underground Storage Volume	27,827 cubic feet

Case Study 4 (Actually 1.1)

Based on Coralville's WLUA Master Plan Results:

If onsite CPv results in ~40% detention reductions…

…Can developers actually save money using GI?

Assuming:

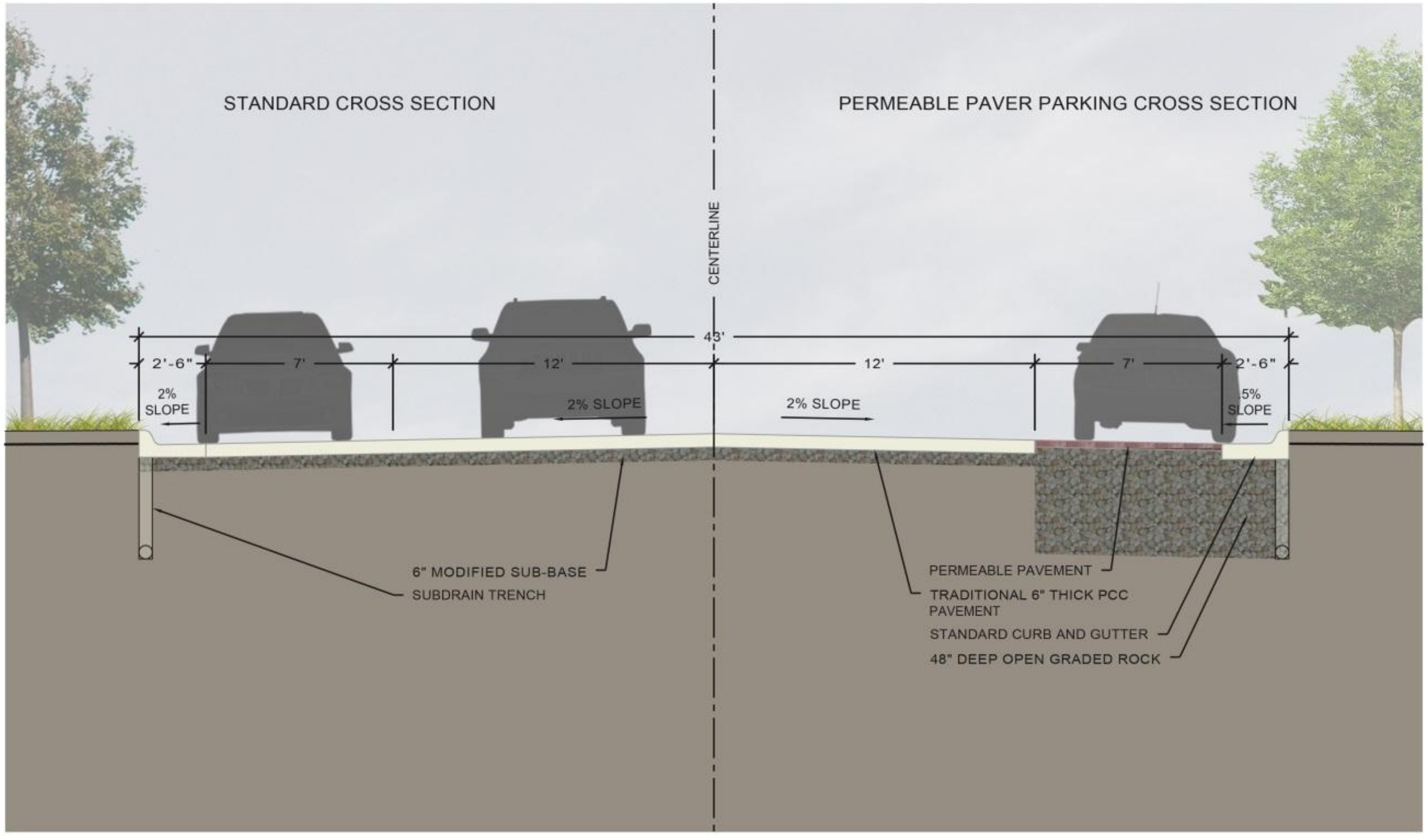
Developers typically pay for:

local streets and related infrastructure

onsite practices

(and maybe local detention)

Case Study 4 (Actually 1.1)



Hypothetical case comparison:

Traditional local roadway section (with on-street parallel parking)

vs. Same roadway with permeable pavers in parking lanes

Case Study 4 (Actually 1.1)

Assumptions:

WQv or CPv is treated onsite

100-yr / 5-yr detention is required

Streets designed per SUDAS 5-yr precipitation standard

(net volume per unit length should pass into rock chamber below permeables, thus requiring **no inlets or storm pipes at all** except at roadway sag low points to capture major storm runoff)

Rainfall at Coralville

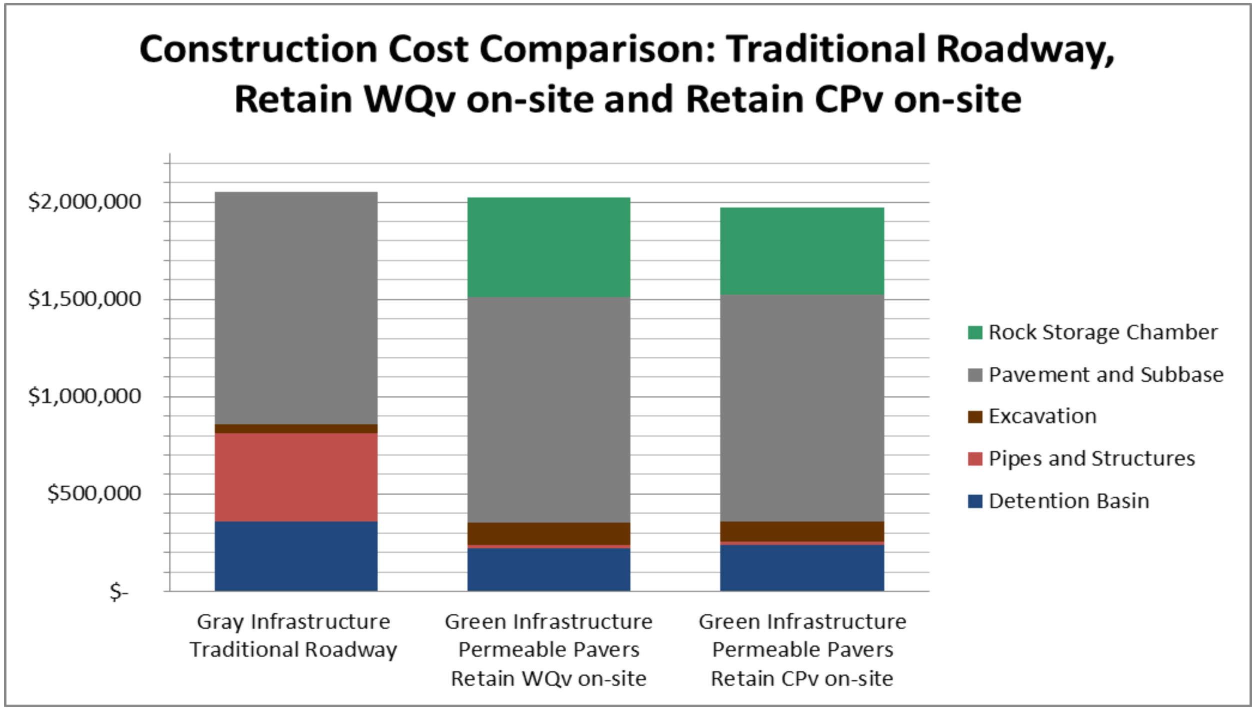
Water Quality volume event = 1.25”

Channel Protection volume event = 2.4”

5-yr event(Atlas 14) = 3.78”

Case Study 4 (Actually 1.1)

Results: Nearly identical total costs, slight savings with green infrastructure



1.4% total savings with onsite WQv

4.1% total savings with onsite CPv

External Research

Don't just take my word for it:

A recent survey[1] of 300+ registered Landscape Architects found that **75% of green infrastructure projects reduced or did not influence costs**, and over half of these projects (59%) cost less than a comparable grey infrastructure design.

- data from nearly 479 projects
- across 43 states
- including, schools, universities, parks, streetscapes, commercial and residential construction.

1- "Banking on Green", April 2012, AR, ASLA, ECON, WEF

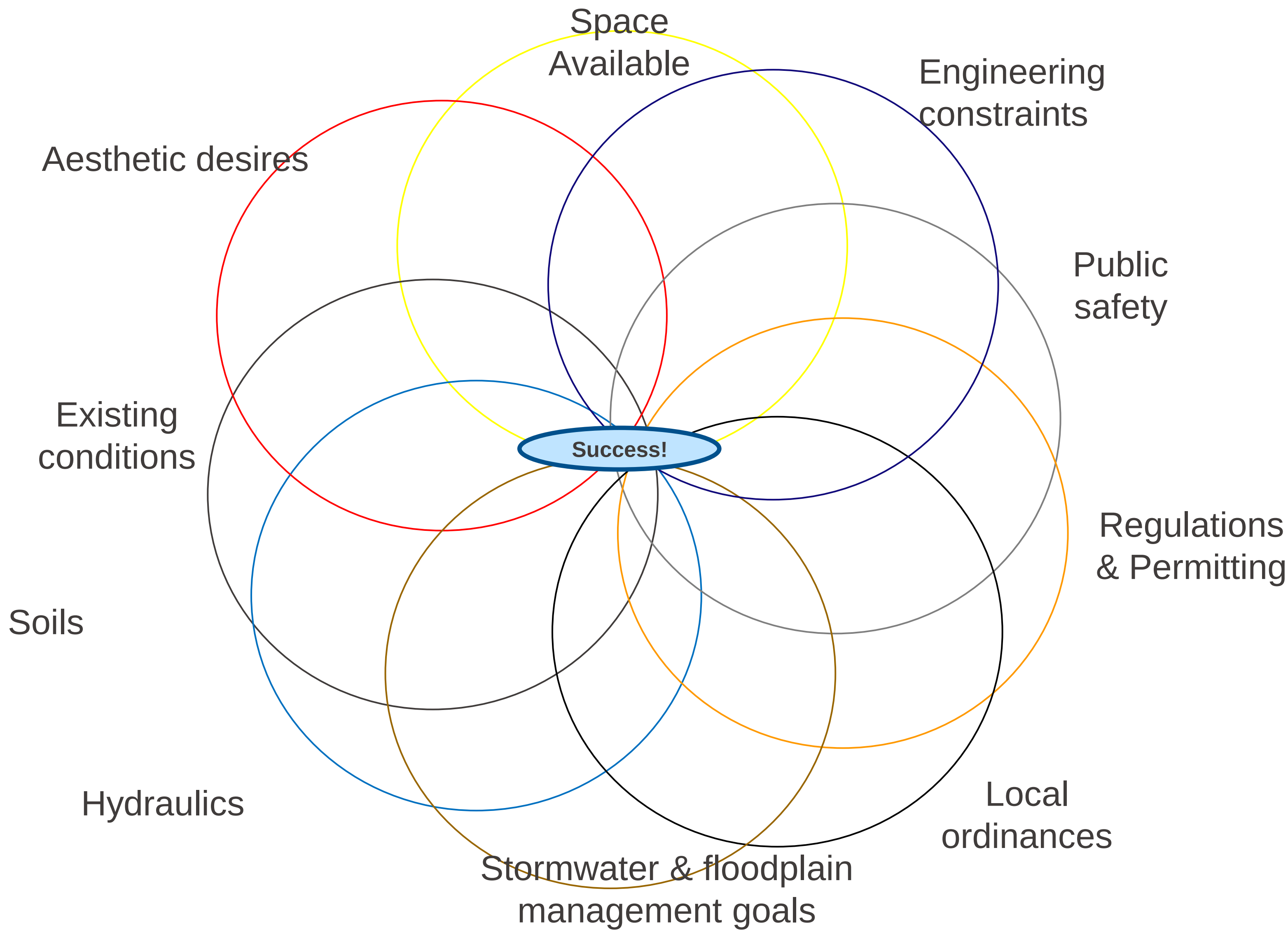
Summary of Case Studies

The blanket argument "green infrastructure costs more than traditional"

does not hold water

Certainly it CAN cost more, but it CAN also cost less

MAIN VARIABLES ARE:



but not necessarily cost, because…

…cost is only part of the balance!

Green Infrastructure can deliver “Triple Bottom Line” benefits

As my dad once said to me:

“What’s the ‘payback period’ on the lunch you ate today?

…not everything needs to be a financial transaction…”

Triple Bottom Line Benefits of Green Infrastructure (besides cost)

- Ecosystem and habitat (trees, plants and animals)
- Neighborhood (aesthetic, livability and property values)
- Local watershed (water quality, stream stability, hydrologic cycle restoration and flood hazard mitigation)
- Improved quality of life
  - people (air quality, safety, recreation, increased environmental awareness)
  - society (public health, environmental education)

Triple Bottom Line Benefits of Green Infrastructure (besides cost)

Improved Air Quality/Climate Change

Urban Heat Island
Green infrastructure practices that include trees and other vegetation can reduce the urban heat island effect, which reduces energy use and the incidence and severity of heat-related illnesses.

Air Quality
Green infrastructure improves air quality by increasing vegetation, specifically trees, that absorb air pollutants, including CO_2, NO_2, O_3, SO_2, and PM_{10}.

Greenhouse Gases
Green infrastructure's ability to sequester carbon in vegetation can help to meet greenhouse gas emission goals by contributing to a carbon sink.

Water Quality and Quantity

Water Conservation
Green infrastructure that incorporates locally adapted or native plants reduce the need for irrigation, which reduces demand for potable and recycled water. Rain barrels and cisterns that capture rainwater also reduce water use.

Water Quality and Flood Mitigation
Green infrastructure can decrease the frequency and severity of local flooding by reducing stormwater discharge volumes and rates.

Habitat
Vegetated green infrastructure can provide habitat for wildlife, particularly birds and insects, even at small scales of implementation.

Quality of Life

Public Health
Residents have more recreational opportunities in the presence of large-scale green space in their community, which can improve public health and well-being.

Public Safety
Green streets that include curb bump-outs at pedestrian crossings improve pedestrian safety by slowing traffic and decreasing the distance that pedestrians must travel in the roadway.

Recreational Opportunities
Larger-scale green infrastructure facilities that include public access, such as constructed wetlands, offer recreational opportunities.

Property Aesthetics
Green infrastructure that includes attractive vegetation can improve property aesthetics, which can translate into increased property values.

Educational Opportunities

Public Education
The visible nature of green infrastructure offers enhanced public education opportunities to teach the community about mitigating the adverse environmental impacts of our built environment. Signage is used to inform viewers of the features and functions of the various types of facilities.

Figure 3. Additional green infrastructure benefits

Source – The Value of Green Infrastructure, Center for Neighborhood Technology, American Rivers, 2010

Triple Bottom Line Benefits of Green Infrastructure (besides cost)

Benefit	Reduces Stormwater Runoff											Improves Community Livability						
	Reduces Water Treatment Needs	Improves Water Quality	Reduces Grey Infrastructure Needs	Reduces Flooding	Increases Available Water Supply	Increases Groundwater Recharge	Reduces Salt Use	Reduces Energy Use	Improves Air Quality	Reduces Atmospheric CO_2	Reduces Urban Heat Island	Improves Aesthetics	Increases Recreational Opportunity	Reduces Noise Pollution	Improves Community Cohesion	Urban Agriculture	Improves Habitat	Cultivates Public Education Opportunities
Practice										CO_2								
Green Roofs	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes	Yes	Maybe	Yes	Maybe	Maybe	Yes	Yes
Tree Planting	Yes	Yes	Yes	Yes	No	Maybe	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Maybe	Yes	Yes
Bioretention & Infiltration	Yes	Yes	Yes	Yes	Maybe	Maybe	No	No	Yes	Yes	Yes	Yes	Yes	Maybe	Maybe	No	Yes	Yes
Permeable Pavement	Yes	Yes	Yes	Yes	No	Maybe	Yes	Maybe	Yes	Yes	Yes	No	No	Yes	No	No	No	Yes
Water Harvesting	Yes	Yes	Yes	Yes	Yes	Maybe	No	Maybe	Maybe	Maybe	No	No	No	No	No	No	No	Yes

Yes   Maybe   No

Source - Green Infrastructure Opportunities that Arise During Municipal Operations, USEPA, December 2015

Questions?

Want to challenge my findings?

Want more info?

Wondering how Green can save you money and help your water?

Contact me!

Aaron Gwinnup, PE
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319-841-4357

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Maintenance Comparison

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Additional Material

References for Material Reproduced Herein

Coral Ridge Avenue, The Woodlands, and the permeable pavement cost studies were conducted for HR Green-designed projects.

References

1. **Economic** – Banking on Green: A Look at How Green Infrastructure Can Save Municipalities Money and Provide Economic Benefits Community-wide, April 2012, page 8, joint report by American Rivers, American Society of Landscape Architects, ECONorthwest and Water Environment Federation (http://www.americanrivers.org/assets/pdfs/reports-and-publications/banking-on-green-report.pdf)

2. **Economic** – Reducing Stormwater Costs through Low Impact Development (LID) Strategies and Practices (http://www.epa.gov/green-infrastructure/stormwater-costs), December 2007, report by the Environmental Protection Agency

3. **Economic** – Photo of Seattle's 2nd Ave SEA project – Urban Streetwater: A comprehensive analysis of aesthetic stormwater design for urban streets, Ally Hangartner, (https://issuu.com/allyhangartner/docs/hangartner_stormwaterthesisbook_pag)

4. **Economic** – Photo of Seattle's 2nd Ave SEA project – Small Streets Blog, (http://smallstreets.org/tag/sustainability/)

5. **Environmental / Social** – The Value of Green Infrastructure: A Guide to Recognizing Its Economic, Environmental and Social Benefits, 2010, Center for Neighborhood Technology, American Rivers (http://www.cnt.org/sites/default/files/publications/CNT_Value-of-Green-Infrastructure.pdf)

6. **Environmental / Social** – Green Infrastructure Opportunities that Arise During Municipal Operations (https://www.epa.gov/sites/production/files/2015-09/documents/green_infrastructure_roadshow.pdf), December 2015, US EPA.

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Additional Material

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And conducted by HR Green

For the City of Coralville

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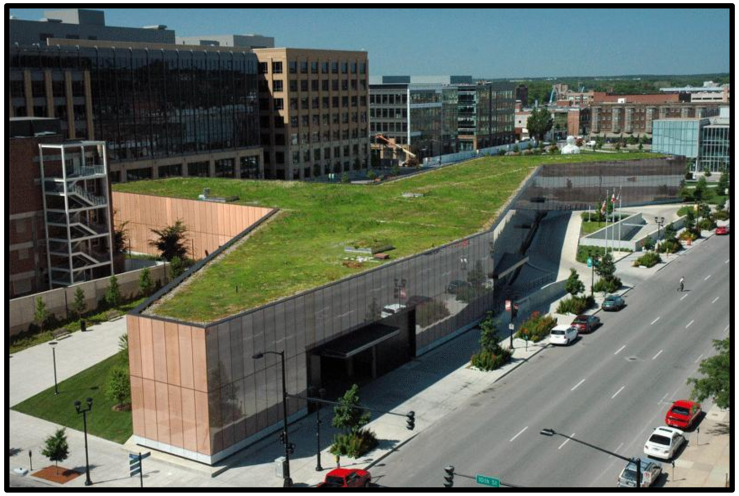
Stormwater Management Options - Turf Bioretention cell?

STORMWATER MANAGEMENT OPTIONS



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