

# Green Infrastructure: Best Practices and Construction Management

Kelsey Hoffman




## The Rise of Green Infrastructure



### Lessons Learned

- Understand green infrastructure components and implementation
- Ensure success with sound construction management practices
- It has to be built right to work right

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## Best Practices



## Legislation and Growth





# The Rise of Green Infrastructure





**Legislation & Governance**

- The process of creating laws and regulations.
- Involves the legislative branch of government.
- Key components include:
  - Drafting bills
  - Committee review
  - Floor debate
  - Voting
  - Signing into law

# Legislation and Growth



**Key to the Future**

- Focus on innovation and technology.
- Encourage entrepreneurship and startups.
- Invest in education and workforce development.

**A New Paradigm**

- Shift from traditional to modern business models.
- Emphasis on sustainability and social responsibility.

**Building a Strong Foundation**

- Establish clear legal frameworks and regulations.
- Ensure transparency and accountability in governance.

**Partnership & Growth**

- Foster collaboration between government and private industry.
- Create incentives for investment and job creation.

**Results**

- Increased economic growth and employment.
- Improved infrastructure and public services.
- Enhanced quality of life and social well-being.





**Innovative Stormwater  
Infrastructure Act**

S.1677 and H.R. 3449

Guides stormwater strategies to  
manage runoff and overflows

Relieves pressure on aging inf



- **S. 1677** introduced on Nov. 12, 2013
- Referred to the Senate Committee on Environment and Public Works
- **H.R. 3449** introduced on Nov. 11, 2013
- Referred to the House Subcommittee on the Environment

**Legislation is Supported  
By:**

- Water Environment Federation (WEF)
- American Society of Landscape Architects



# ***Innovative Stormwater Infrastructure Act***

S.1677 and H.R. 3499

Guides stormwater strategies to effectively manage runoff and overflows

Relieves pressure on aging infrastructure



The nation's largest and most comprehensive set of infrastructure legislation in decades, aimed at modernizing the nation's infrastructure, is included in the bill. The bill also includes provisions for the transportation trust funds, the state highway trust funds, and other water-related programs.





*"The reason behind using a more sustainable type of infrastructure is to reduce the demand, stress and strain on the pipes. By controlling stormwater at the source, it reduces stress on the pipes, which then leverages the infrastructure. The idea is trying to work with what nature wants to do."*

Chris Crockett, deputy commissioner, Philadelphia Water Dept





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## ***Legislation is Supported By:***

- Water Environment Federation (WEF)
- American Society of Landscape Architects
- Environmental Protection Agency's (EPA) Office of Water
  - American Rivers
- Natural Resource Defense Council (NRDC)
- National Association of Clean Water Agencies (NACWA)
  - American Planning Association
- National Parks and Recreation Association





### Estimated value of green nonresidential building construction

By 2015: estimated between \$120 billion to \$145 billion

2010: Between \$43 billion and \$54 billion

2005: About \$3 Billion

Source: GreenSource Construction



### for Growth

Environmental regulations

Reduce the number of



### Benefits

Management of green community spaces  
Environmental footprint  
or cost savings



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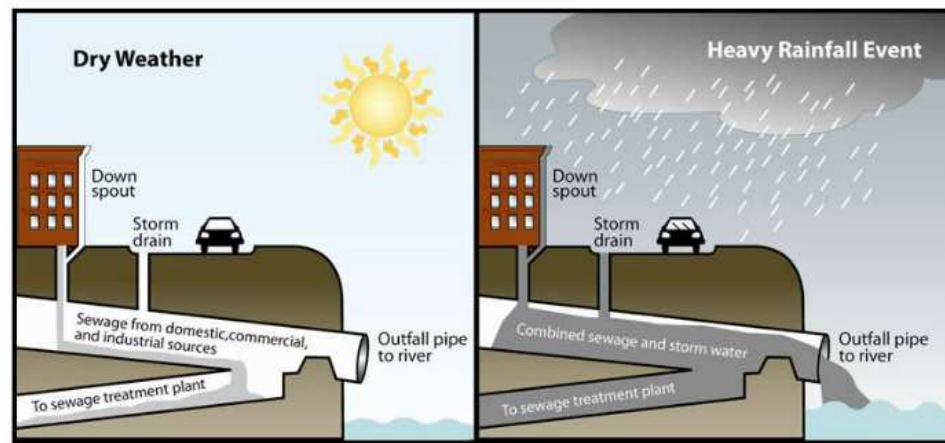
2005: About \$3 Billion

statistics from McGraw-Hill Construction



# Reasons for Growth

- Tighter environmental regulations
- Potential to reduce the number of CSO events



akroncso.com



# Benefits

- Public engagement
- Creation of green community spaces
- A lighter environmental footprint
- Potential for cost savings

## Seattle Public Utility Natural Drainage System

- Streets and street right-of-way alterations that decrease impervious surface area, slow stormwater flows, and increase infiltration
- Estimated to be approximately **25 percent** less expensive
- Decreased construction and infrastructure maintenance costs



## Metropolitan Sewer District of Greater Cincinnati

- Must eliminate 1.70 billion gallons of CSOs from the MR creek by 2028
- Lower Mill Creek Partial Remedy uses both green and gray projects
  - street reconstruction
  - facades
  - stormwater detention basins
  - new storm sewers
- Total cost estimated: \$246 million (in 2006 dollars), \$200 million less expensive than deep tunnel solution





## Metropolitan Sewer District of Greater Cincinnati

- Must eliminate 1.78 billion gallons of CSOs from the Mill Creek by 2018
- Lower Mill Creek Partial Remedy uses both green and gray projects
  - stream restoration
  - bioswales
  - stormwater detention basins
  - new storm sewers
- Total cost estimated: \$244 million (in 2006 dollars). \$200 million less expensive than deep tunnel solution



[projectgroundwork.org](http://projectgroundwork.org)



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"We need to be careful of saying that green is always the solution. There should be a hybrid approach. Solar and other renewables do have a role, but we have to be realistic. The goal should be to control green construction as government design."  
- Seth F. Brown, AEC, executive program and public director for the Water Environment Federation



"Green and traditional infrastructure must together be used to address water supply, flood, and other risks in the next century. People often try to make a false choice between green and gray infrastructure management."  
- Chris Brinkley, Deputy Commissioner with the Maryland Water Commission



## Philadelphia

Average of 45 inches of rain per year

Managed through green and gray infrastructure

roofs → act like grass



# Not just the latest trend...

*"We need to be careful of thinking that green is always the solution. There should be a hybrid approach. Soils and other constraints in ultra-urban areas can limit the applicability. You just don't want to 'oversell' green construction or 'green wash' things."*

- Seth P. Brown, P.E., stormwater program and policy director for the Water Environment Federation



*"Green and traditional infrastructure work together. It only makes sense to work together – that's where there is the most benefit. People often try to make it gray versus green, but it's not – especially with stormwater management."*

- Chris Crockett, deputy commissioner with the Philadelphia Water Department





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## A case in Philadelphia



- Average of 45 inches of rain per year
- Managed through green and gray infrastructure

Pervious pavement and green roofs → act like grass

*"In the end, we put 32 inches of the 45 inches each year into the ground! That means the system is only dealing with 13 inches of rain per year."*

- Chris Criswell, deputy commissioner with the Philadelphia Water Department



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### Ensuring project success

- Experienced team for onsite management and quality assurance
- Knowledge of project specifications, plans and standards
- Project team communication

Green infrastructure components are tools in the tool box and must be constructed properly to be effective

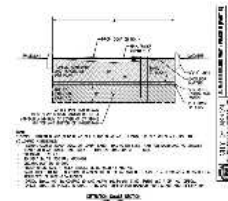


# Best Practices

### What are permeable pavements?



### What is a bioswale?



## Ensuring project success

- Experienced team for onsite management and quality assurance
- Knowledge of project specifications, plans and standards
- Project team communication

Green infrastructure components are tools in the tool box and must be constructed properly to be effective



Contractor must understand the importance of using specified soils and surface finish of drainage



Think location of the bioswale must be maintained properly



Use appropriate equipment  
Use appropriate flow rate  
Avoiding an erosion hole  
to the bioswale

Consideration and cost for retention  
type for bioswale

Minimize sedimentation by using a 1/4" to 1/2" sand filter mat to filter  
sediment from the bioswale



The soils must be non-compacted

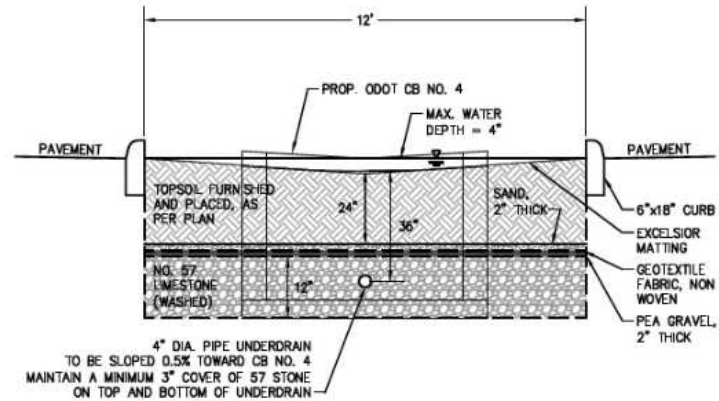
Use heavy equipment to compact  
soils in the bioswale



Submit the soil test results to the  
appropriate authority for approval  
of the soil



# What is a bioswale?



NOTE:  
 \*TOPSOIL FURNISHED AND PLACED, AS PER PLAN\* IN AREAS UTILIZING THIS SECTION SHALL HAVE THE FOLLOWING ATTRIBUTES:

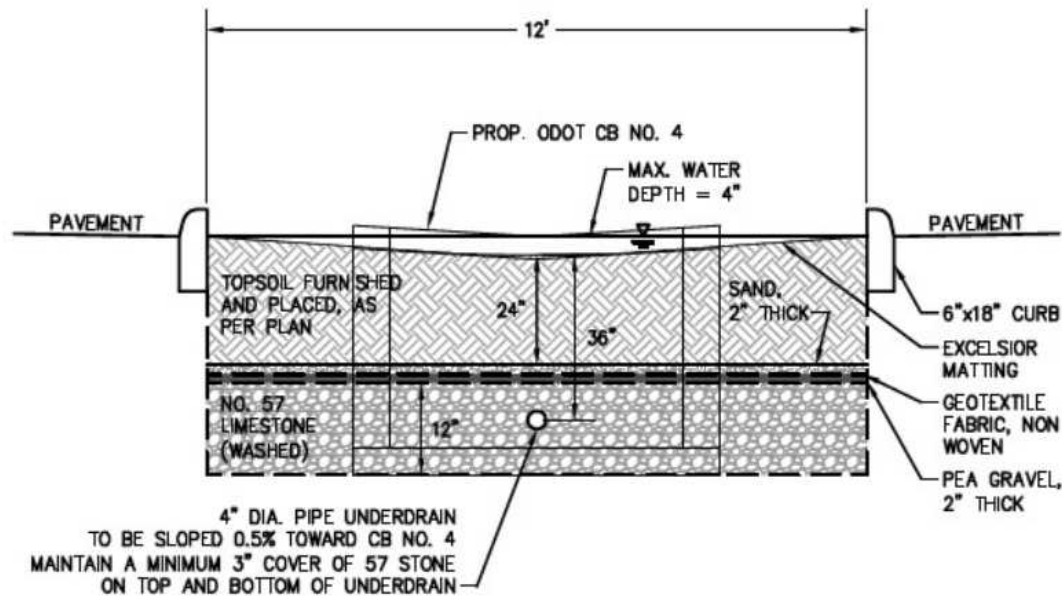
- TEXTURE CLASS: SANDY LOAM OR LOAMY SAND. HAVING NO LESS THAN 72% SAND AND NO GREATER THAN 10% CLAY CONSIDERING ONLY THE MINERAL FRACTION OF THE SOIL.
- PH RANGE: 5.2-7.0.
- SOLUBLE SALTS: 500 PPM MAXIMUM.
- ORGANIC MATTER: 5-20%
- PHOSPHORUS: SOIL P-INDEX SHOULD BE BETWEEN 15 AND 40.
- SAND ADDED TO MEET TEXTURAL CLASS SHALL BE CLEAN AND MEET AASHTO M-6 OR ASTM C-33 WITH A GRAIN SIZE OF 0.02-0.04 INCHES.
- TOPSOIL SHALL NOT BE COMPACTED AND HEAVY EQUIPMENT IS NOT PERMITTED ATOP THE TOPSOIL.
- TOPSOIL SHALL BE PLACED IN SMALL LIFTS AND FLUFFED FOR MAXIMUM PORE SPACE AND INFILTRATION.

**DETENTION SWALE SECTION**  
 SCALE: NONE

CITY OF AKRON  
 DEPARTMENT OF PUBLIC SERVICE  
 AKRON ENGINEERING BUREAU  
 SUM-SEIBERLING WAY - PHASE II (PART B)  
 2008-048-01



# What is a bioswale?



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CITY OF AKRON  
DEPARTMENT OF PUBLIC SERVICE  
AKRON ENGINEERING BUREAU



## Contractor must understand the importance of using specified soils and correct timing of plantings

- The type of soil is important for filtration and proper drainage







## Cross-section of the bioswale must be constructed properly



- Maximize removal of pollutants
- Maximize residence time of stormwater runoff
- Knowledge of plans and intent of design is important

## Construction sediment must be removed from the bioswale

- If bioswale is used as temporary sediment basin, it is crucial that sediment is removed
- Sediment can clog the bioswale and inhibit proper drainage



## The soils must be non-compacted

- Promotes good root growth and biological organism development
- Important for water retention during dry periods
- Aids in filtering and infiltration
- Reiterate importance in project meetings



## Select the proper native plants to provide year-round cover without need for supplemental irrigation

- Have an arborist or landscape architect onboard during the process to pick the variety of plants
- Quality assurance that plants are per plan
- Recognize in schedule when planting is to occur





# What are permeable pavements?

Figure 2.5: Three-Dimensional View of Permeable Pavement

## Permeable Asphalt

Stormwater on surface seeps through permeable asphalt



Stone or other storage media provides structural support and stormwater storage

## Permeable Concrete

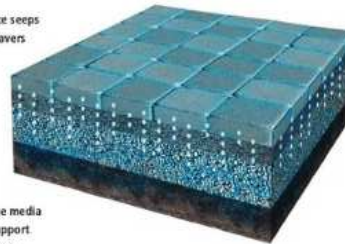
Stormwater on surface seeps through permeable concrete



Stone or other storage media provides structural support and stormwater storage

## Permeable Paver

Stormwater on surface seeps through permeable pavers



Stone or other storage media provides structural support and stormwater storage

**Placement of permeable concrete**

- Verify finished elevations
- Formed without rebar/reinforcing
- Use pump truck like conventional
- Use proper curing techniques

**Quality assurance during construction**

- Inspect and test subgrade for proper sloping
- Check concrete thickness from sloping permeable pavement

**Lowest Infiltration Areas, Ohio**

- Reduced stormwater runoff
- Increased water infiltration
- Reduced impervious surface
- Low maintenance & costs

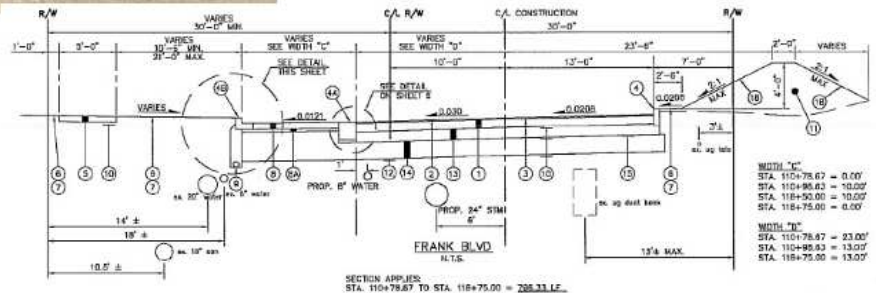




# Placement of pervious concrete

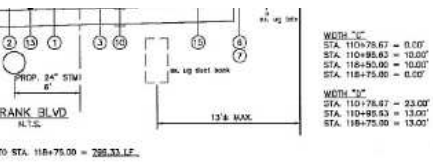


- Verify batched concrete mix
- Screed without overcompacting
- Cut joints soon after consolidation
- Use proper curing techniques



from City of Akron, OH Frank Blvd project





from City of Akron, OH Frank Blvd project

## Quality assurance during construction

- Ensure uniform subgrade for proper draining
- Prevent construction debris from clogging permeable pavement



## Lessons learned from Akron, Ohio



- Technical representative from manufacturer on site
- Implement design features that aid in better results
- Use selectively in projects



# Lessons Learned

- Understand green infrastructure components and implementation
- Ensure success with sound construction management practices
- It has to be built right to work right



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