Green Infrastructure for Volume Reduction and Water Quality Improvement

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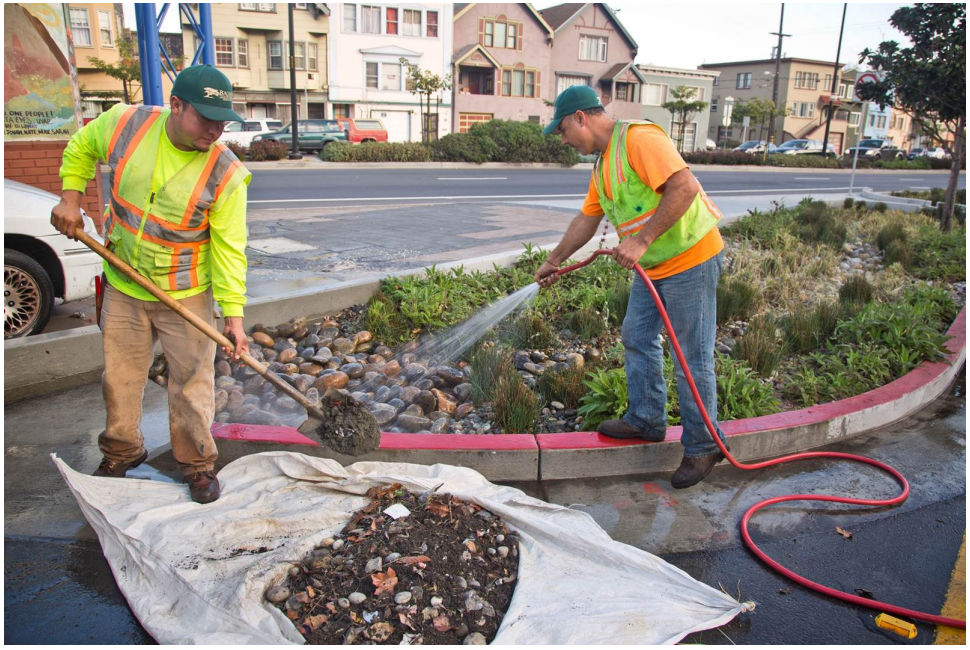
Today's Discussion

- What is Green Infrastructure?
- Benefits of using GI
- Examples where GI is used for volume control
- Examples where GI is used for water quality
- Putting it all together



What is Green Infrastructure?

Green infrastructure is a cost-effective, resilient approach to managing wet weather impacts that provides many community benefits. Green infrastructure reduces and treats stormwater at its source while delivering environmental, social, and economic benefits.

-EPA

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What is Green Infrastructure?

- Natural and managed green areas in both urban and rural settings
- Strategic connection of open green areas
- Treating rainwater as a resource
- Transforming “grey” infrastructure to green through restoration of watersheds to slow and store water

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Various Forms of GI

- Stormwater Green Infrastructure
  - Used to address stormwater runoff
  - Typically located outside 100-year floodplain
  - May provide flood risk reduction for smaller storms
- Floodplain Preservation or Enhancement
  - Typically located in floodplain or stream
  - May provide flood risk reduction for any size storms
- Coastal Green Infrastructure

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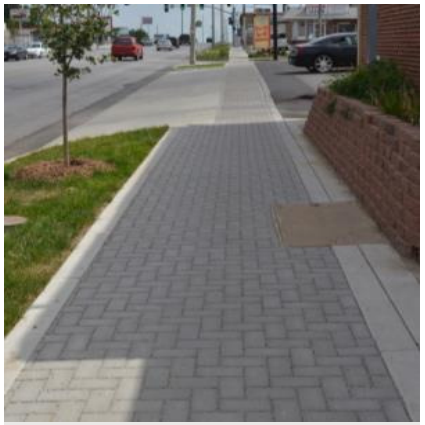
Examples of Green Stormwater Infrastructure

Bioretention

Rain Garden



Permeable Pavements

Green Roof

Tree Canopy

Rain Barrels

Tree Boxes

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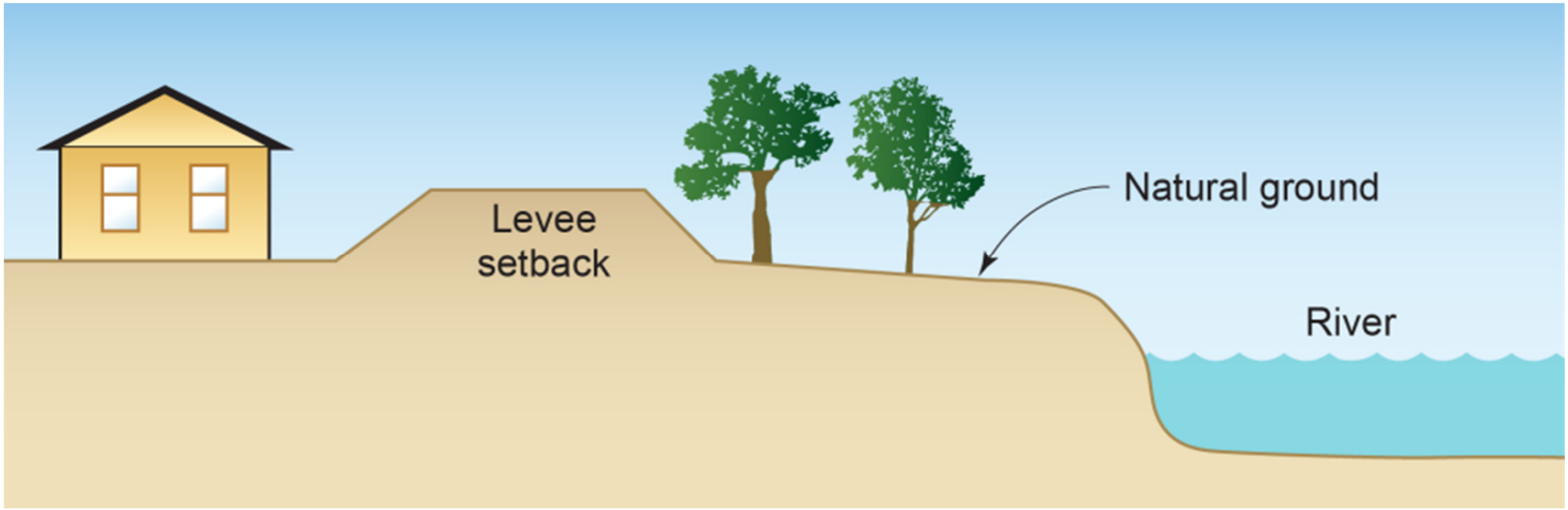
Examples of Floodplain Preservation or Enhancement

- Floodplain preservation
  - Zoning
  - Transfer of development rights
  - Acquisition
- Stream or floodplain restoration
- Wetland creation
- Levee set-back



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Examples of Coastal Green Infrastructure

Dunes and Beaches

Benefits/Processes

- Break offshore waves
- Attenuate wave energy
- Slow inland water transfer

Performance Factors

- Berm Height and width
- Beach slope
- Sediment grain size and supply
- Dune height, crest, weight
- Presence of vegetation

Vegetated Features: Salt Marshes, Wetlands, Submerged Aquatic Vegetation (SAV)

Benefits/Processes

- Break offshore waves
- Attenuate wave energy
- Slow inland water transfer
- Increase infiltration

Performance Factors

- Marsh, wetland, or SAV elevation and continuity
- Vegetation type and density

Oyster and Coral Reefs

Benefits/Processes

- Break offshore waves
- Attenuate wave energy
- Slow inland water transfer

Performance Factors

- Reef width, elevation and roughness

Barrier Island

Benefits/Processes

- Wave attenuation and/or dissipation
- Sediment stabilization

Performance Factors

- Island elevation, length, and width
- Land cover
- Breach susceptibility
- Proximity to mainland shore

Maritime Forests/ Shrub Communities

Benefits/Processes

- Wave attenuation and/or dissipation
- Shoreline erosion stabilization
- Soil retention

Performance Factors

- Vegetation height and density
- Forest dimension
- Sediment composition
- Platform elevation

Source: USACE. Detailed information available at http://www.nad.usace.army.mil/CompStudy.aspx

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Typical Drivers for GI

- National Pollutant Discharge Elimination System (NPDES) Permit
- EPA requirements
- Combined sewer overflow problems
- CRS 450 Credits – Stormwater Management
- Triple Bottom Line – social, environmental, and financial

Potential Benefits

- Reduced runoff
- Improved water quality
- Improved air quality
- Reduced water usage during droughts
- Improved aesthetics
- Improved habitat
- Reduced costs
- Increased property values
- Permit credits

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Project Examples – Volume Reduction

- Alexandria, VA
- RiverSmart DC
- Philadelphia, PA
- Louisville MSD
- Kansas City, MO
- Columbus, OH
- Cuyahoga Falls HMGP

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Alexandria, VA

- Evaluating potential areas within the CSS drainage area
- 3 sites for Green Infrastructure demonstration projects
- Evaluating what types of Green Infrastructure practices will be the most cost effective and functional
- Ranking the projects to help the City prioritize their efforts
- Projects designed to capture up to 1.7 inch storm events
- Processes are intended to be adapted and used by the City for future Green Infrastructure efforts, such as in their MS4 area.

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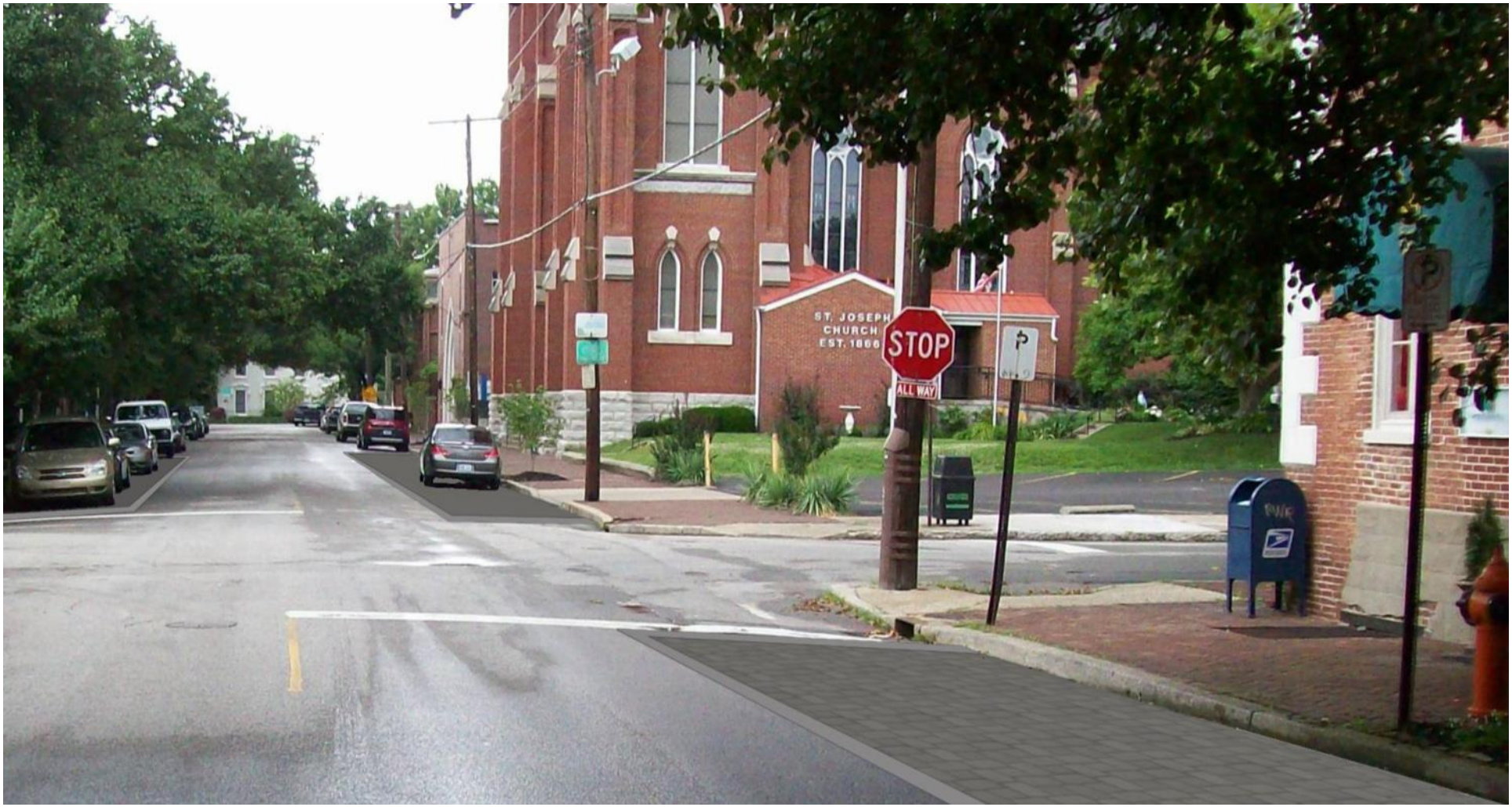
Using Rights-of-Way



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RiverSmart DC

- Implementing LID practices on urban roadways
- Demonstrate that a diverse grouping of LID strategies can provide decentralized stormwater management and stormwater runoff reduction.
- Not only reduced stormwater runoff, they have also provided visual enhancements and community assets in public space
- Project won several awards for innovation

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Philadelphia, PA

- Controlling CSO through greening of City spaces
  - McPherson Square GSI Design
  - Lawncrest Green Streets GSI Design
  - Trenton & Auburn Playground GSI Design
  - Elmwood Ave. Medians Design
  - Erie & Rising Sun Ave. GSI Design
- Providing Support to Raincheck Program
- Designed GSI
  - Rain Gardens
  - Tree Trenches
  - Stormwater Bumpouts
  - Bioswales

Philadelphia, PA

- Rain Gardens
- Tree Trenches
- Stormwater Bumpouts
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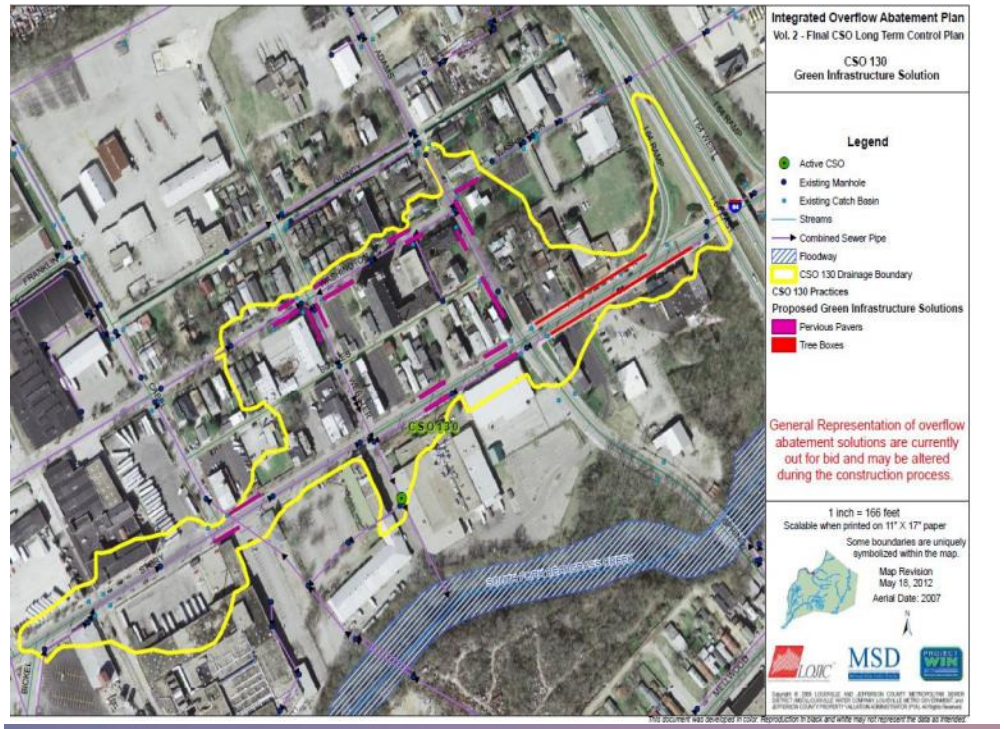
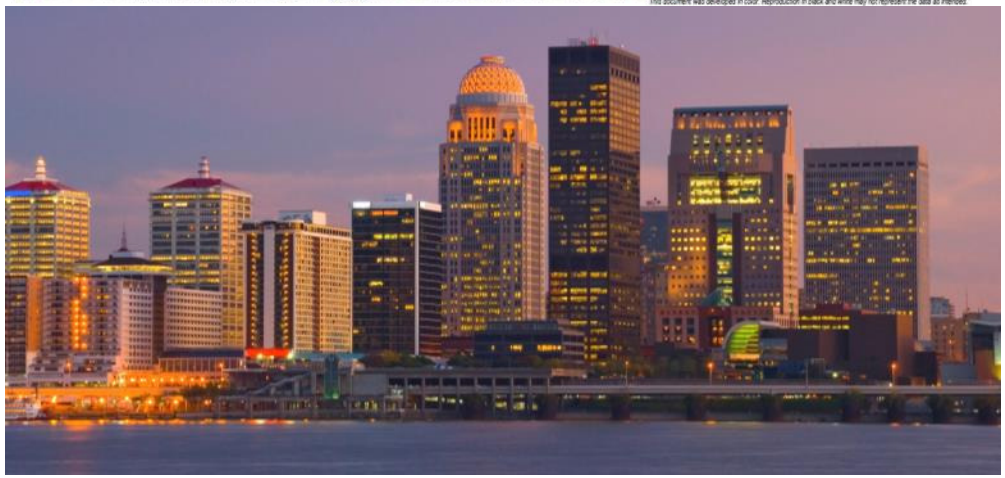
Louisville MSD

- $850 million EPA consent decree obligation that includes GI
- Developed the GI design manual
- Green programs are successful if the entire community is involved
- CRADA with URS-EPA ORD





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Techniques

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Kansas City, MO

- Over 150 rain and bioretention gardens, sidewalk planters, curb extensions, swales, below-grade storage systems, and porous pavements were evaluated
- Custom GI designs were developed to address major challenges such as working in narrow rights-of-way, clay soils, and numerous utility conflicts
- Because this project supported community revitalization that extended beyond stormwater management, community involvement was a significant component of the process

Bioretention Gardens:
Rain Gardens with Engineered Soil + Underdrains

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Curb Extensions with Below-Grade Storage

- Stormwater Collection Focal Points
- Traffic Calming

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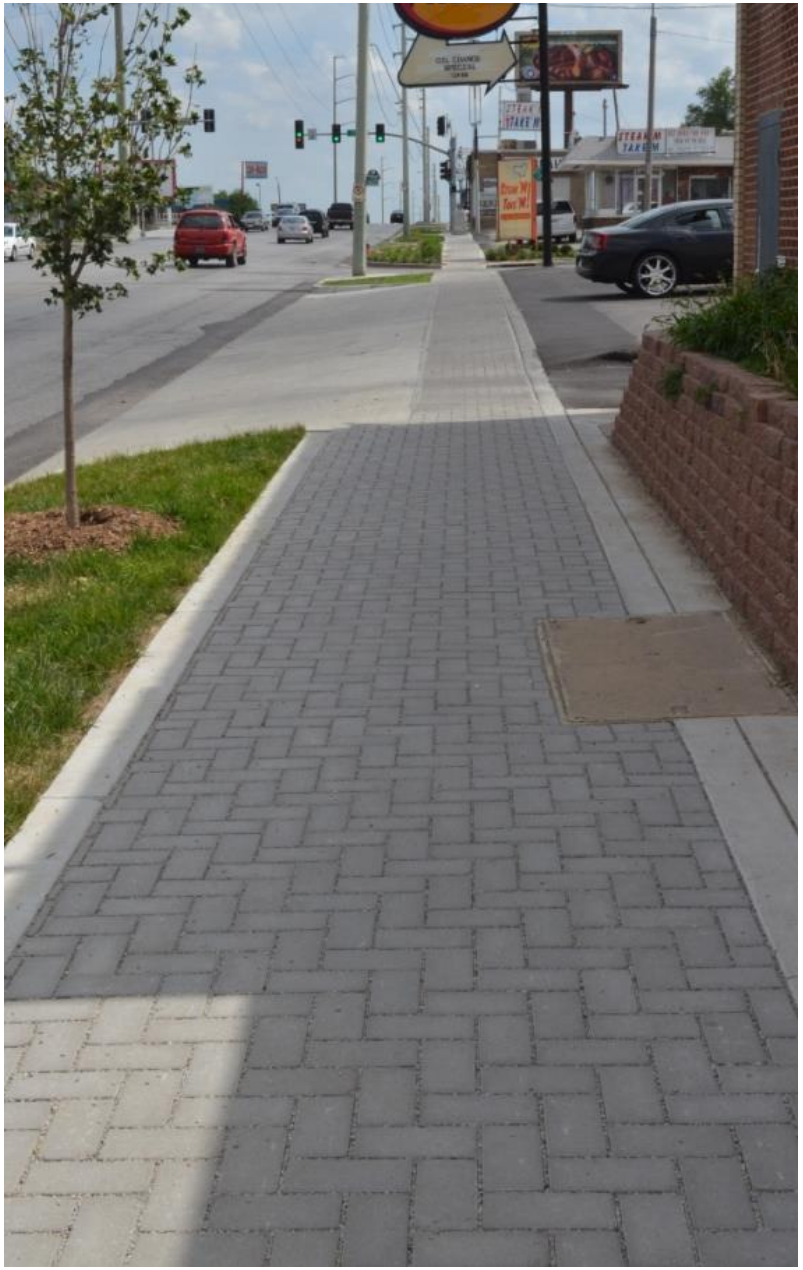
Pervious Sidewalk with Storage

Below-Grade Storage



Pervious Sidewalks

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Neighborhood Improvements

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Neighborhood Improvements

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City of Columbus, Ohio

- Evaluated Green Infrastructure in CSO and SSO areas
- Public and private properties
- Preferred techniques:
  - pervious sidewalks
  - street trees
  - traffic-calming bump-outs
  - rain gardens

BLUE PRINT COLUMBUS
Clean streams.
Strong neighborhoods.

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Example Engineered GI Success Story

Cuyahoga Falls Green Infrastructure Mitigation Park Project

- FEMA grant to acquire 4 homes
- Space converted into green infrastructure
- Reduced flooding for remaining homes

Source: http://planning.co.cuyahoga.oh.us/infrastructure/pdf/raingarden.pdf

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Project Examples – Water Quality

- Montgomery County, MD
- Maryland State Highway
- Washington Metropolitan Area Transit Authority
- Suttons Bay, MI
- Kids Creek, MI
- Confidential Client

Montgomery County, MD RainScapes Program

Developed the design and implementation guidance for:

- Rain barrels
- Cisterns
- Dry wells
- Rain gardens
- Conservation landscaping techniques
- Permeable pavers
- Pavement removal
- Tree canopy
- Green roofs

RainScapes

Environmentally-Friendly Landscapes for Healthy Watersheds

Tree Canopy

Why should I plant trees?

Planting trees is an easy, affordable way to benefit the environment. Tree canopies reduce storm water runoff by absorbing and collecting rainfall on leaves and branches. Water evaporating off the surface of leaves returns to the atmosphere. Tree roots promote rainwater infiltration through the soil. Studies that have measured the storm water benefits of trees found that over 700 gallons of rainfall can be captured each year by a single mature tree with a 30-foot radius crown.

What is a tree canopy?

A tree canopy is the crown of one or many trees that create an "umbrella" or cover of leaves. The leaves and branches shade paved surfaces, such as sidewalks, driveways, and patios, reducing the temperature of rainwater runoff. Tree canopy intercepts rainfall before the water hits the ground and becomes stormwater runoff. Trees provide many benefits to the health and well-being of communities. Often, trees can easily be added to the landscape to provide stormwater benefits.

Tree Canopy Intercepting Rainfall

Tree Canopy

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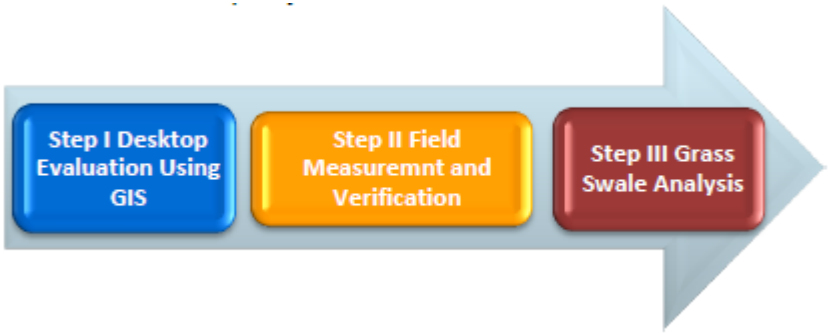
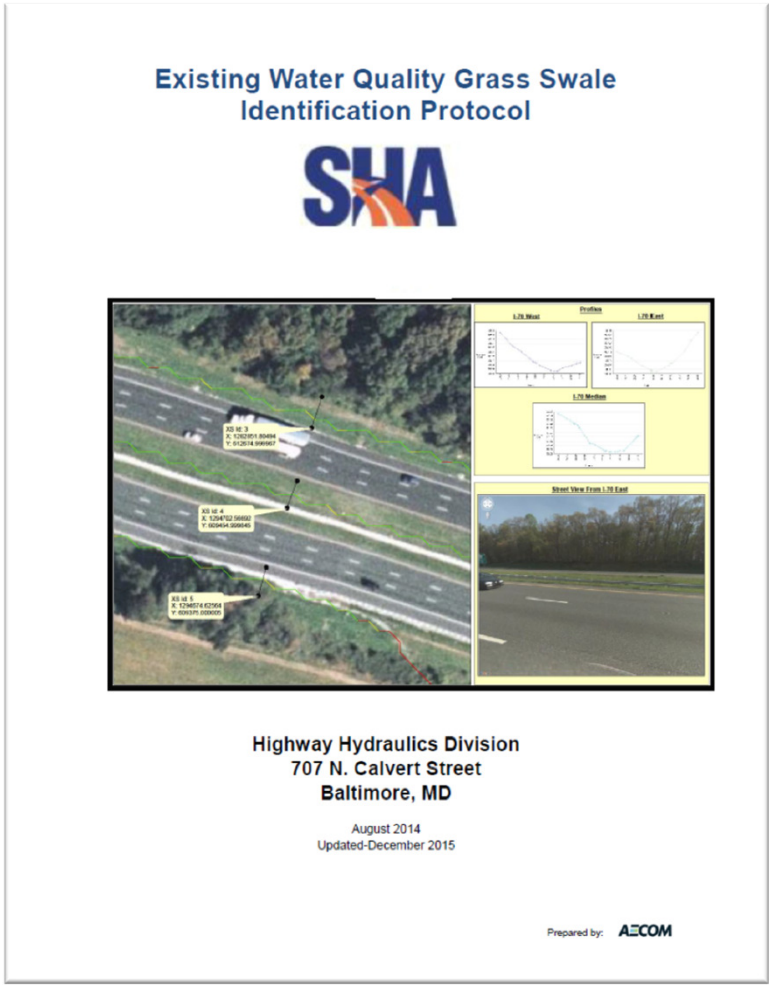
Maryland State Highway

- Developed a guidance for obtaining credits for existing water quality swales
- Support the Phase II WIP and NPDES MS4 Permit




Existing Water Quality Grass Swale Identification Protocol

SHA

Highway Hydraulics Division
707 N. Calvert Street
Baltimore, MD

August 2014
Updated-December 2015

Prepared by: AECOM

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Washington Metropolitan Area Transit Authority

- GI Practices to meet Chesapeake Bay TMDL goals
  - Maryland
  - Virginia
- Proposed GI Practices
  - Bioretentions
  - Retrofitting Inlets with Tree Box Filters
  - Green Roofs
  - Rain Gardens

Suttons Bay, MI – Bacteria Impairment

- Stormwater is major pathway for E. Coli to enter water
  - Pet waste, ducks/geese, parking lot runoff, human waste (leaking sanitary or septic systems)
  - Storm drain pipes are a good medium for cultivating bacterial growth
- Beaches frequently located near stormdrain outlets
- GI restoration techniques included
  - Raingardens
  - Hydrodynamic separators
  - Engineered wetland
  - Subsurface infiltration basins
  - Outfall relocation
  - Filtration or retention in low DO zones

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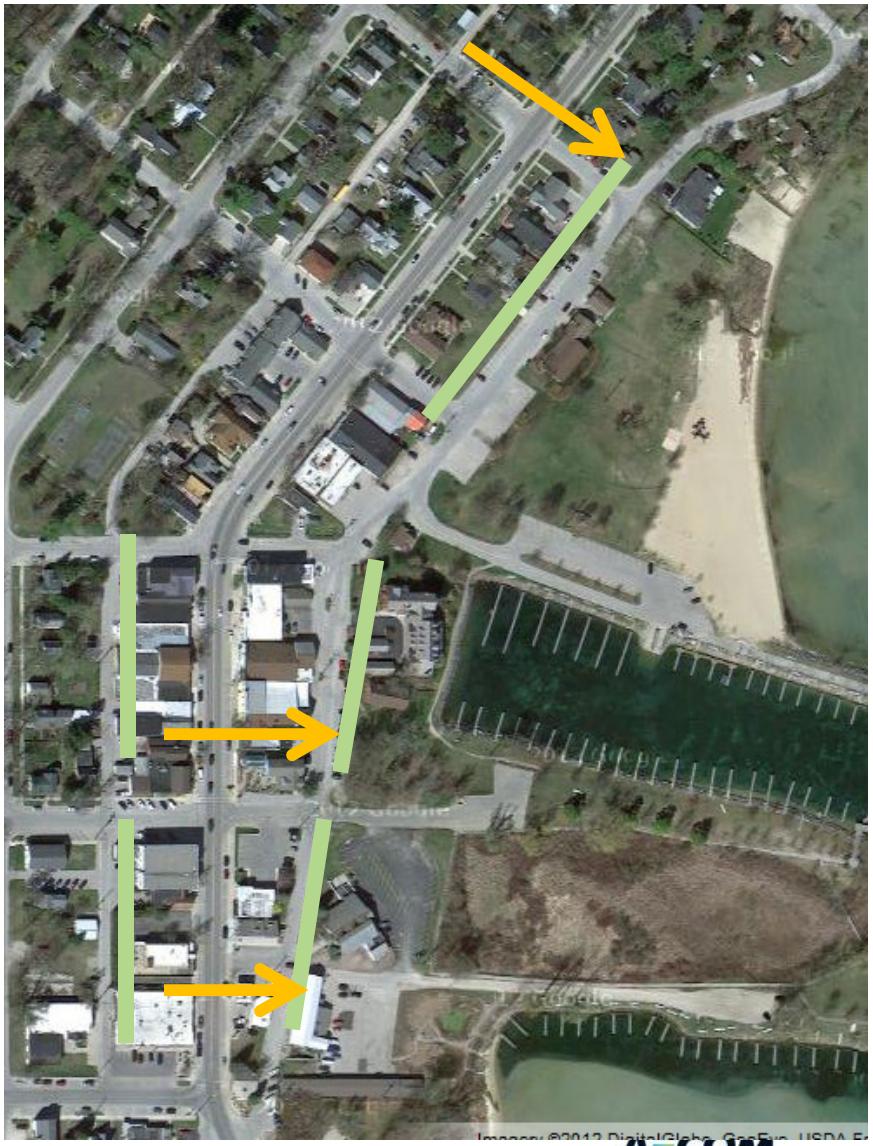
Suttons Bay, MI – Infiltration Trenches

- **Reduce volume of discharge through infiltration**

About 3,612 feet of infiltration trench installed
~nearly ¾ mile
~96% removal rate



Kids Creek, MI – Aquatic Life Impairments

- 303(d) list for aquatic life impairments
- Volume reduction goals
- Sediment removal

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Kids Creek, MI – GI Restoration Techniques

- Creek Restoration
- Green Roof
- Raingardens
- Pervious Pavement
- Planter Boxes

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Confidential Client – Heavy Metals Impairment

- Sources
  - Roadway runoff
  - Parking lot runoff
  - Rooftop runoff
- TMDLs for
  - Copper
  - Iron
  - Lead
  - Zinc
- TMDL requirement
  - Up to 80 percent reductions in concentrations
- GI restoration techniques
  - Retrofitting inlets
  - Downspout disconnections and installation of downspout treatment

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Putting It Together

Integrated planning—identify opportunities to incorporate Green Infrastructure into planned projects

Communication up front is key!

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Maintenance Matters!

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Maintenance Matters!

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Planning
and Modeling

Quantification
and Design

Construction
Oversight and
Implementation

Maintenance/O&M
Strategies

Questions?

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