Introducing Green Infrastructure for Coastal Resilience

National Oceanic and Atmospheric Administration (NOAA)
Office for Coastal Management
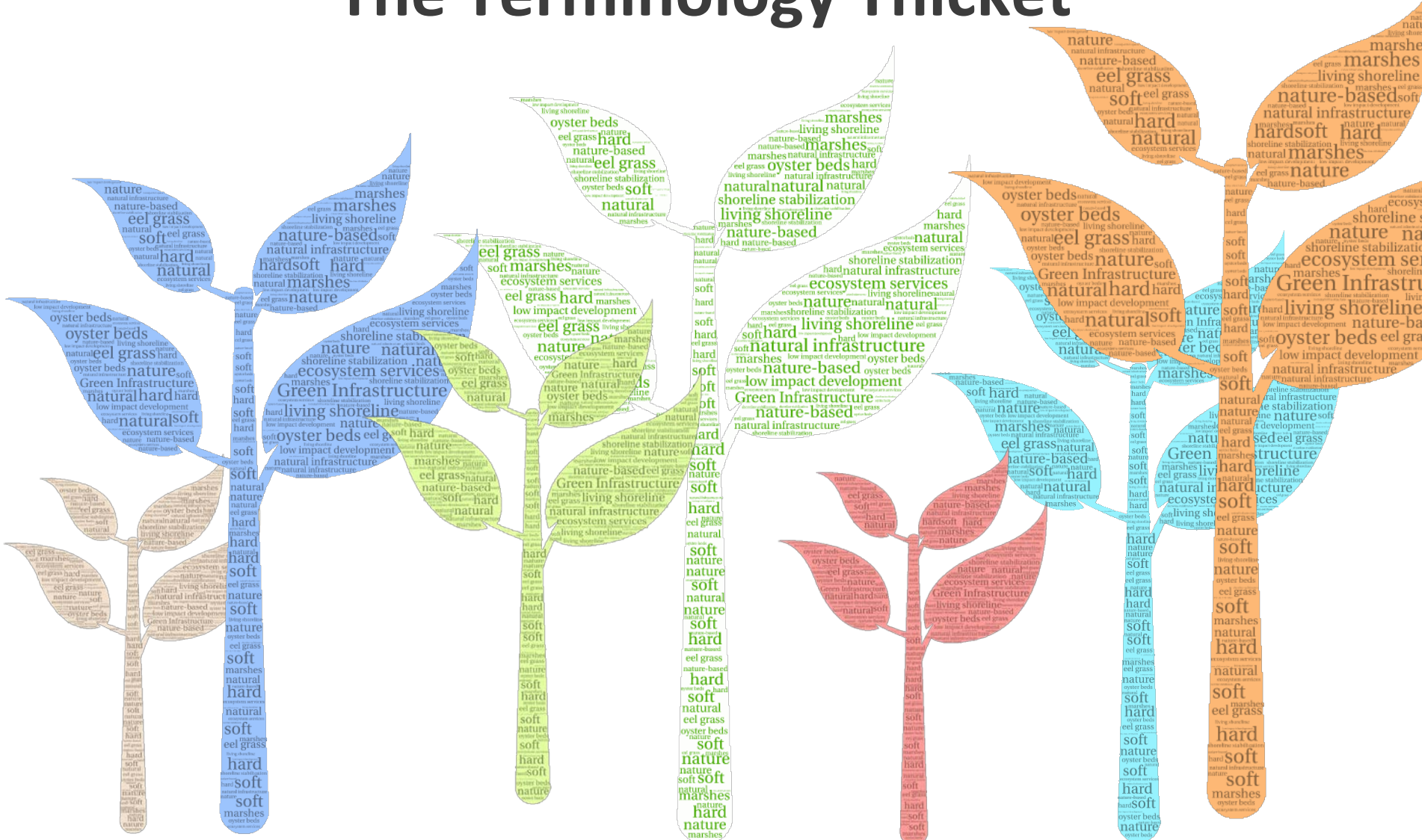
What we'll talk about today

1. **Green infrastructure concepts**
2. **Practices**
3. **Getting to Implementation**

A Quick Hello!

- **Name**

- **Affiliation**

- **One Word** you think of when you hear the term "Green Infrastructure"

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The Terminology Thicket

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Green infrastructure

Natural *and* nature-based approaches work together to mimic natural processes such as absorbing rainfall, lessening wave energy, and reducing erosion

What Is "Resilience"?

Introducing Green Infrastructure for Coastal Resilience

Credit: Justin Selden, Michigan Sea Grant

"Resilience is our ability to prevent a short-term hazard event from turning into a long-term community-wide disaster."

Section 1: Green Infrastructure Concepts and Principles

Foundations of Green Infrastructure

Green Infrastructure Concepts and Principles

| Landscape Architecture 1860s | Landscape Ecology 1930s | Design with Nature 1960s | Conservation Biology 1970s | Clean Water Act 1970s |

Foundations of Green Infrastructure

Green Infrastructure Concepts and Principles

Landscape approach?

Site-level approach?
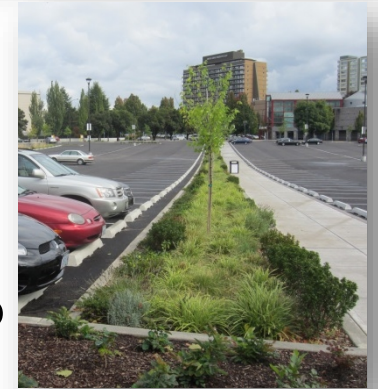
Works at all scales

Landscape

Watershed

Community

Site

Shoreline
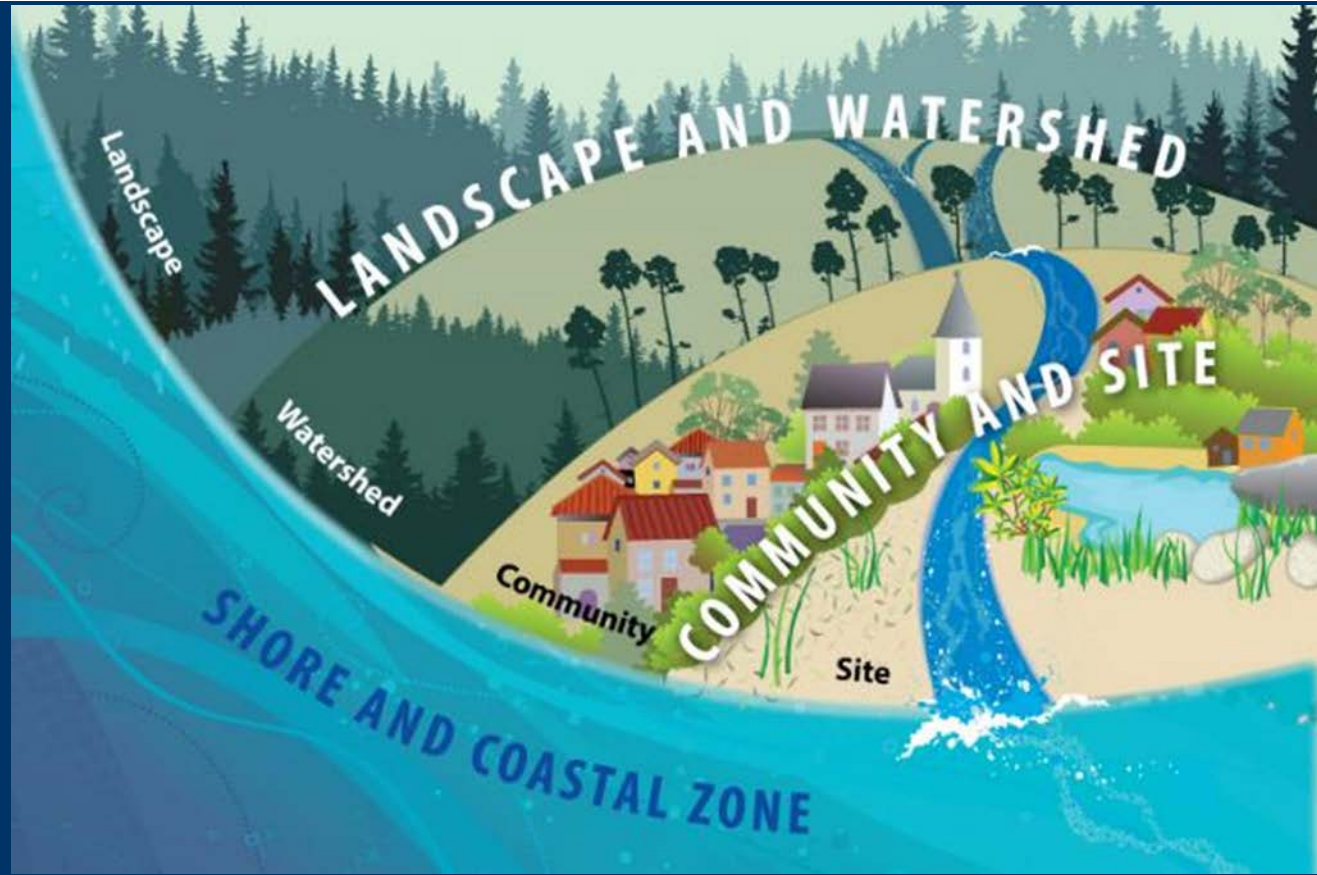
The Importance of Context

Green infrastructure practices are context sensitive.
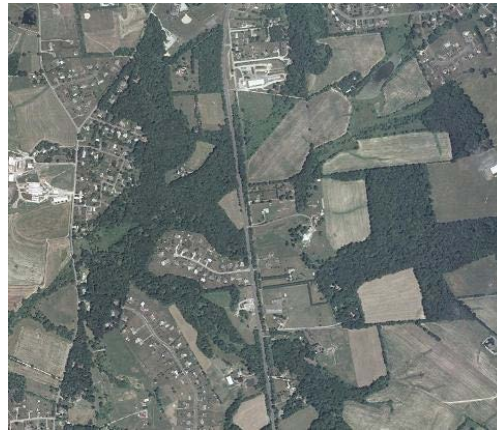
Rural →→→→→→→→ Urban

Coastal ←←←←←←←← Upland

Why Green Infrastructure?
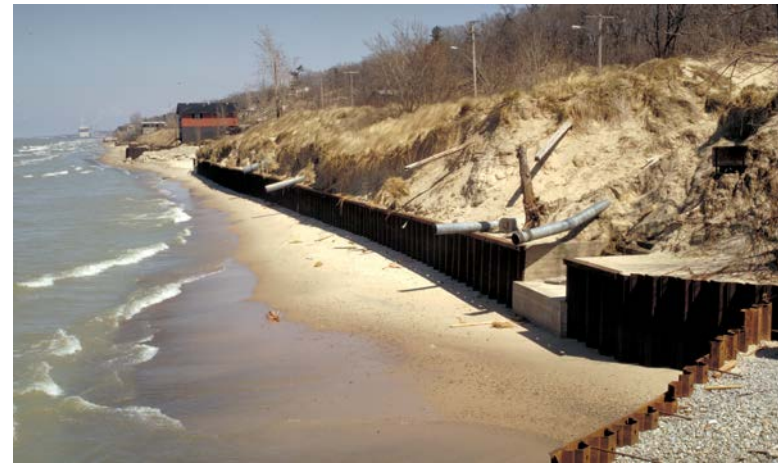
Photo credit: Michigan Sea Grant

Lake Level Viewer

Green Infrastructure Concepts and Principles

6 Feet Increase – 584.8 ft
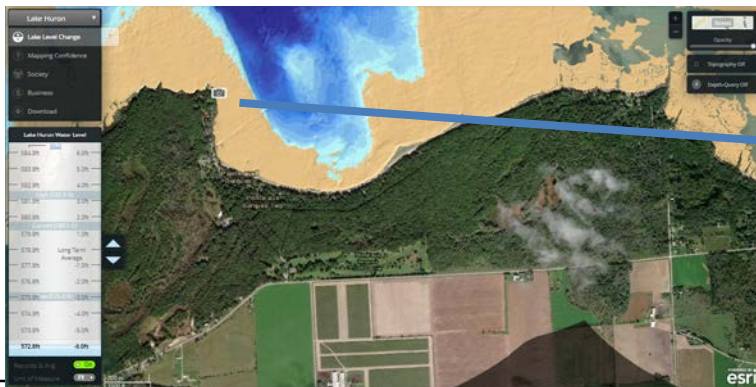
6 Feet Decrease – 572.8 ft

coast.noaa.gov/digitalcoast/tools/llv

Flood Exposure Snapshot

Green Infrastructure Concepts and Principles

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Ecosystem Services

Green Infrastructure Concepts and Principles

Natural ecosystems provide multiple benefits to people, including food and water production, improved air and water quality, and recreation and spiritual inspiration.

Multiple Benefits

- Environmental

- Societal

- Economic

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Whose Benefit

Green Infrastructure Concepts and Principles

A wide variety of stakeholders stand to benefit. Engaging stakeholders is an essential part of understanding the benefits and how they are valued by people.

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Table Activity

List coastal hazards impacting your community

Identify what ecosystem services will reduce coastal hazard impacts

10 minutes

Section 2: The Practice of Green Infrastructure

Design Concepts

The Practice of Green Infrastructure

Successful green infrastructure practices incorporate

- Multi-functionality

- Resilience

- Sense of place

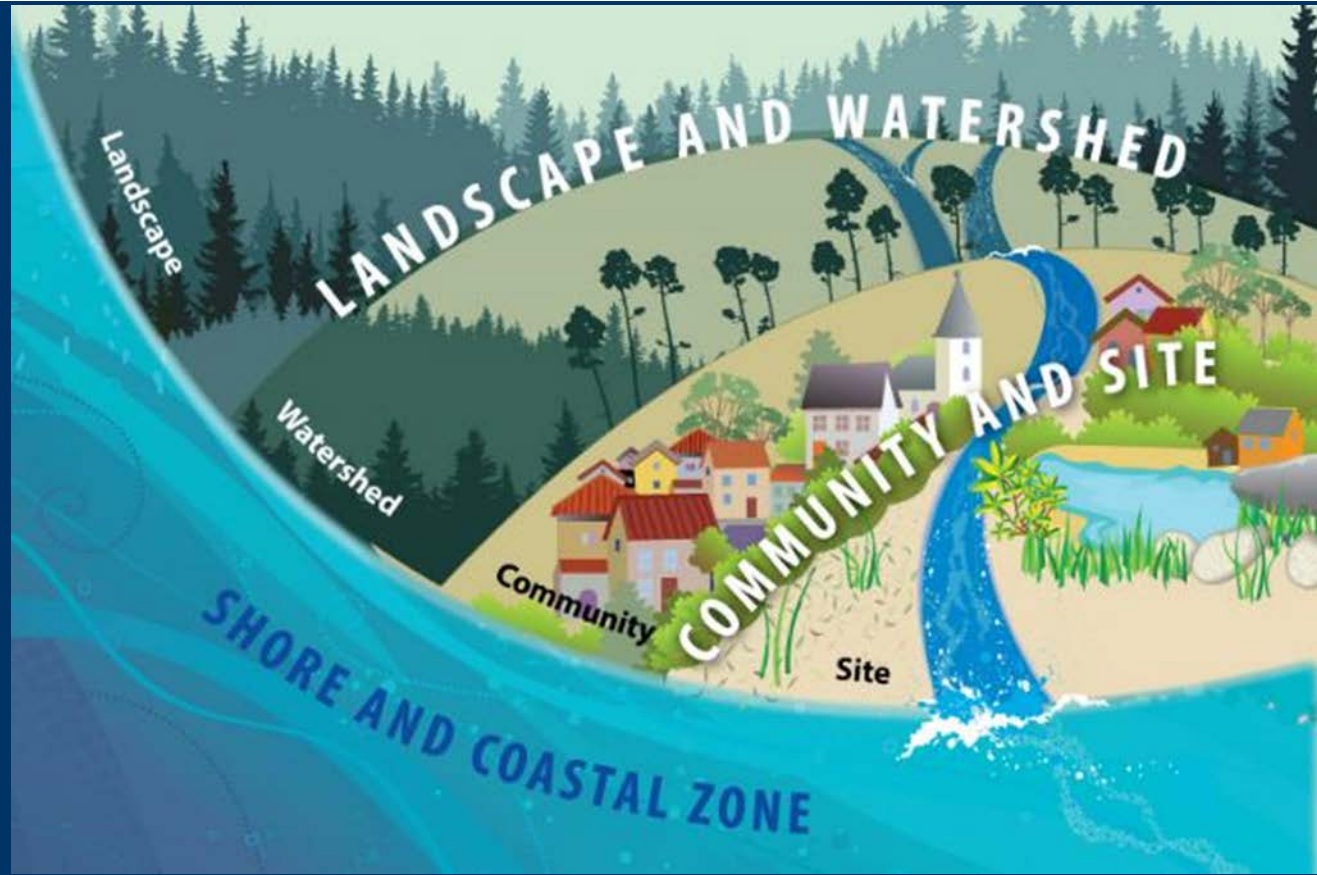- Return on investment

Landscape and Watershed Practices

Landscape

Watershed

Community

Site

Shoreline

Landscape Design Concepts

	BETTER	WORSE
Area		
Proximity		
Connectivity		

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Landscape Approaches and Resilience

The Practice of Green Infrastructure

- Recent study* on flood reduction during Hurricane Sandy showed:
  - Coastal wetlands saved more than $625 million in flood damages
  - Where they exist, coastal wetlands reduced damages by more the 10% on average
  - In Ocean County, NJ wetland conservation reduces average annual losses by more than 20%
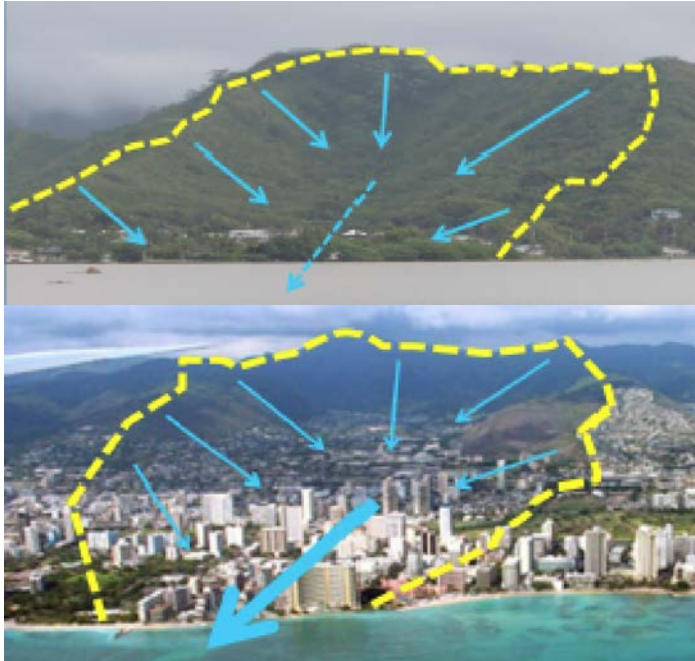

*Coastal Wetlands and Flood Damage Reduction: Using Risk Industry-Based Models to Assess Natural Defenses in the NE USA, 2016.

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Watershed Design Concepts
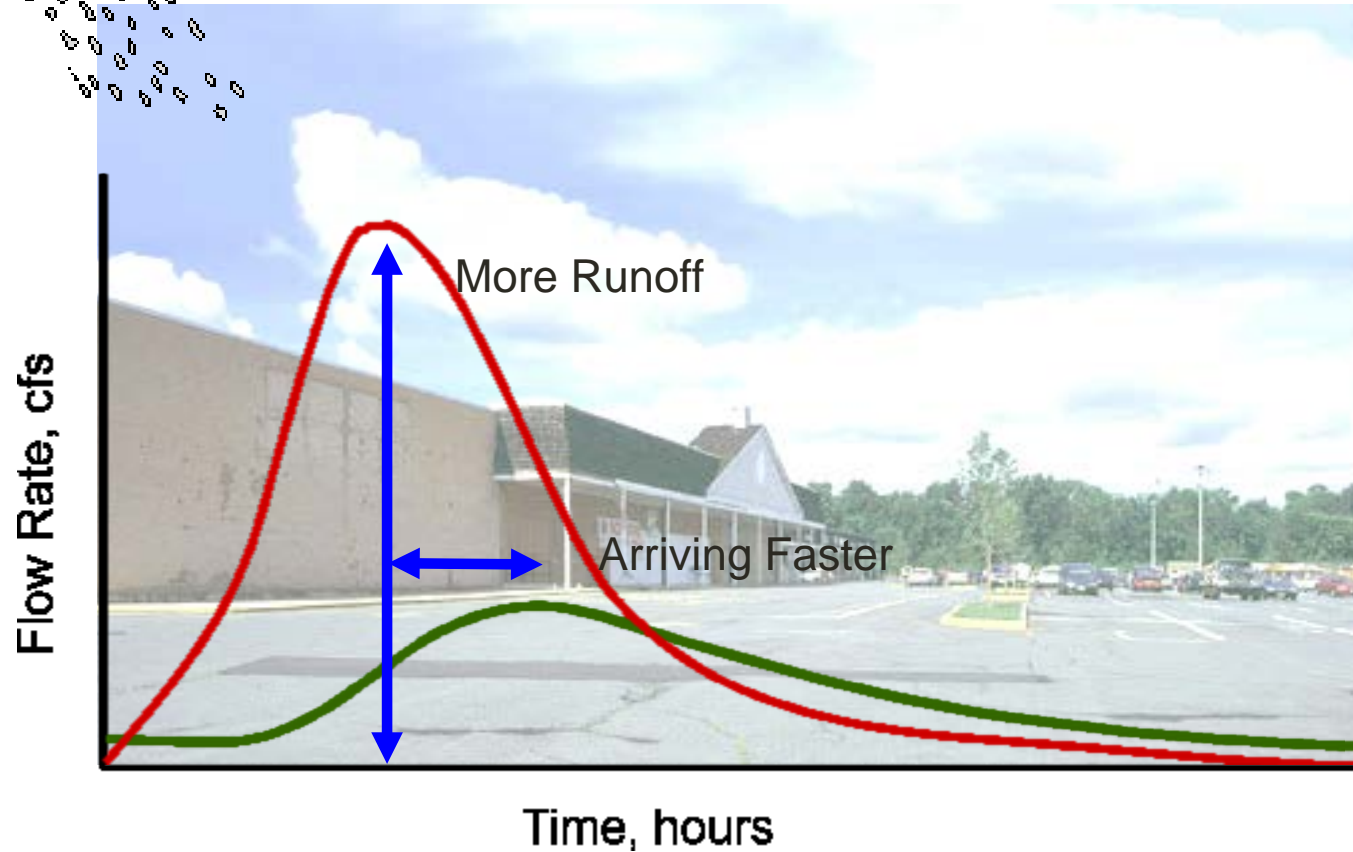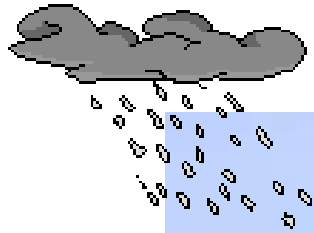
The Practice of Green Infrastructure

Source: Horsley Witten Group; Center for Watershed Protection

- Preserve native vegetation
- Protect steep slopes
- Buffer stream channels
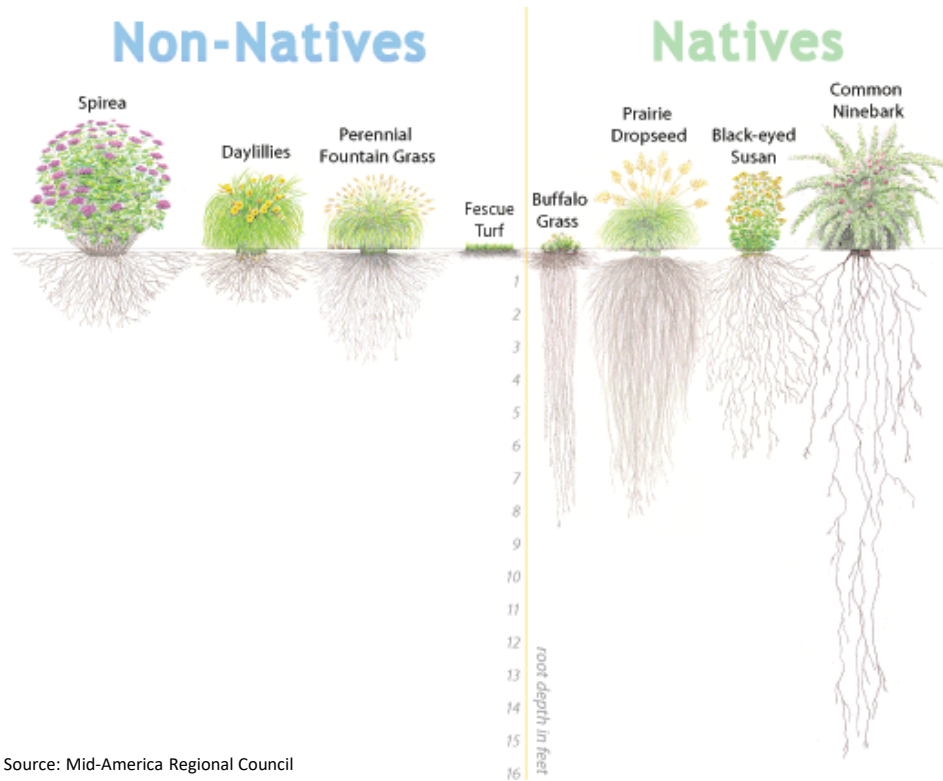- Reduce <u>connected</u> impervious cover
- Seek multiple benefits

Hydrologic Impacts of Development

The Practice of Green Infrastructure

Preserve native plants and trees

Source: Mid-America Regional Council

Native Plant Society of Texas List – *https://npsot.org/wp/southtexas/resources/*

Reduce impervious surfaces

Approaches:

- Narrow streets
- Replace curb and gutter with bioswales
- Bioretention in parking lots
- Multi-story parking garages
- Smaller driveways
- Green roofs
- Keep or plant trees

Create and conserve open spaces

Example: golf course converted to wetland park

Exploration Green

- 178 acres being converted to wetlands and open space

- 3000 homes will be protected

- Half billion gallons of stormwater drained

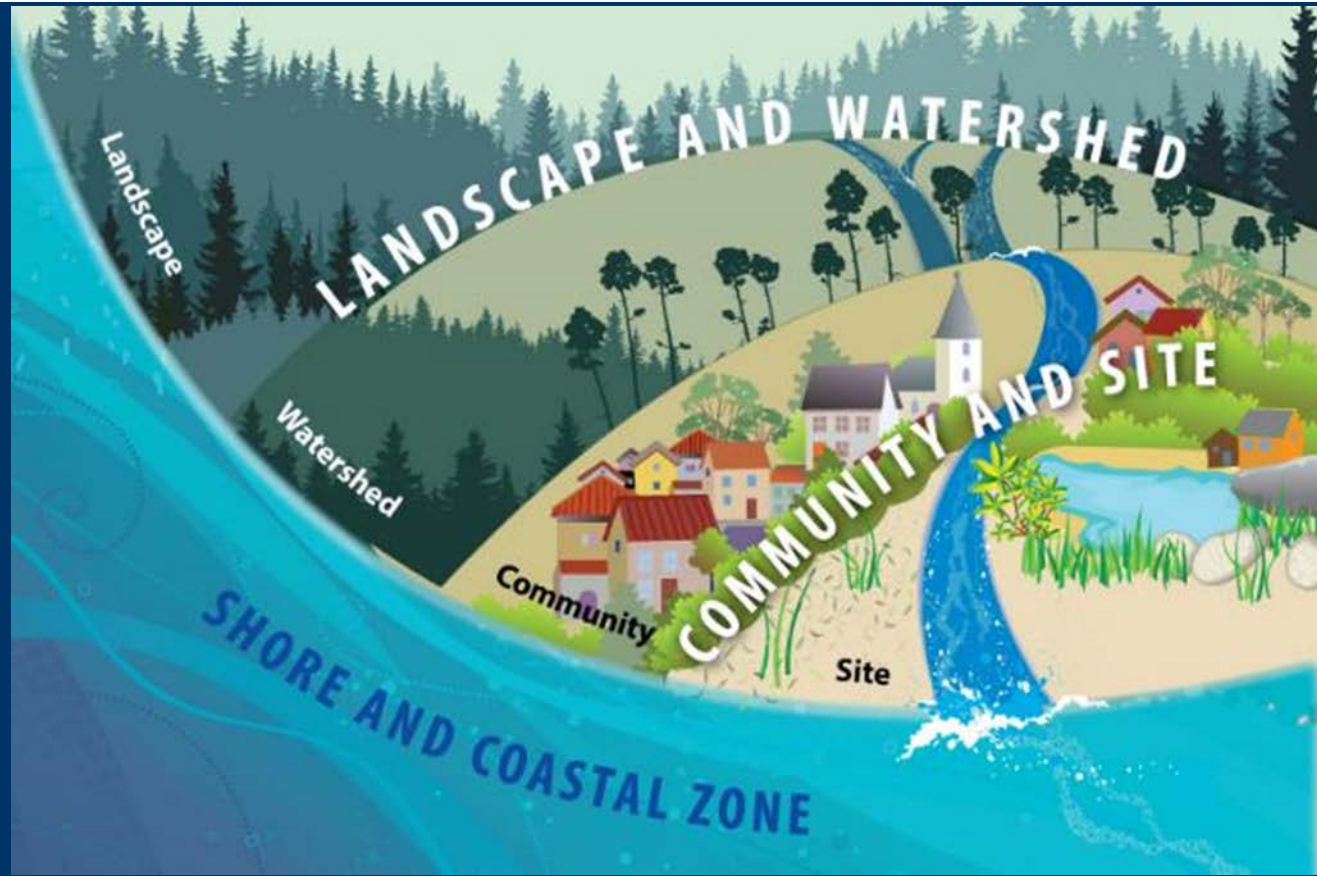www.explorationgreen.org/

Community and Site Practices

Landscape

Watershed

Community

Site

Shoreline

Community and Site Design Concepts

The Practice of Green Infrastructure

- Natural areas and open spaces should serve multiple functions

- Connect people to open areas through greenways and trails

- Preserve or mimic the natural hydrological functions of a site or drainage area

- Use urban streetscapes to provide ecosystem benefits in urban areas

Community and Site Approaches

The Practice of Green Infrastructure

Urban Forestry

- Trees provide enormous environmental, economic, and societal benefits

- Develop a tree planting program designed to maximize benefits

- To the extent possible, protect existing forested areas, particularly large specimen trees

Re~~dic~~...~~blo~~gspot.com

A leafy green tree can drink 500-2000 gallons.

A single evergreen can absorb more than 4,000 gallons of water a year.
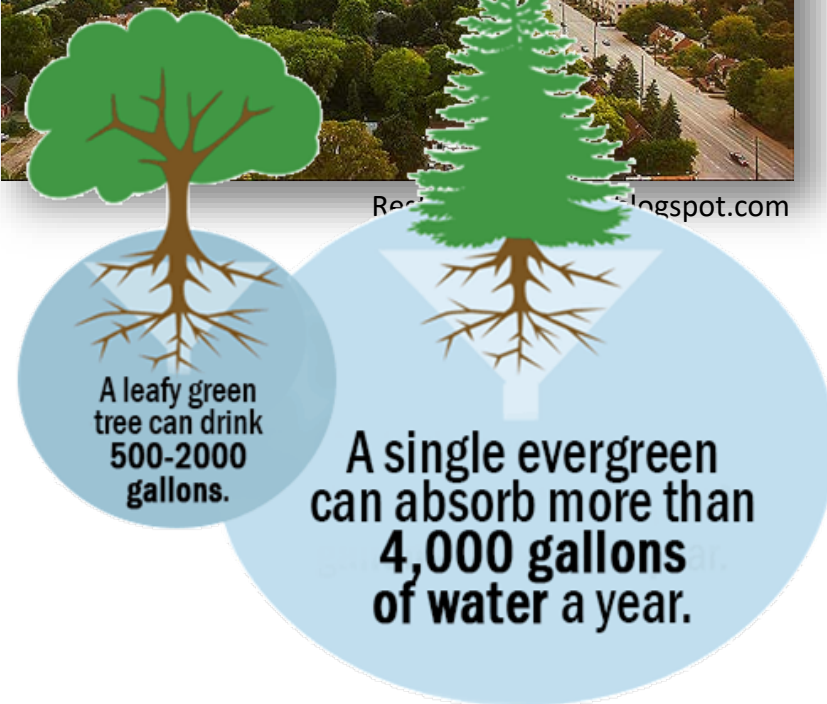
Street trees/urban forestry

"Shoppers claim they are willing to pay 9%-12% more for goods in business districts having a quality urban canopy and landscape" - Texas A&M University

Community and Site Approaches

The Practice of Green Infrastructure

Green Streets

- Key linking component in green infrastructure network

- Design dependent on local conditions but generally include

  - Alternative street widths
  - Swales
  - Bioretention
  - Permeable pavements

- Provides multiple benefits

Great Lakes Green Streets Guidebook

A Compilation of Road Projects Using Green Infrastructure

Great Lakes Green Streets Guidebook

SEMCOG . . . *Shaping the future of Southeast Michigan*
Southeast Michigan Council of Governments
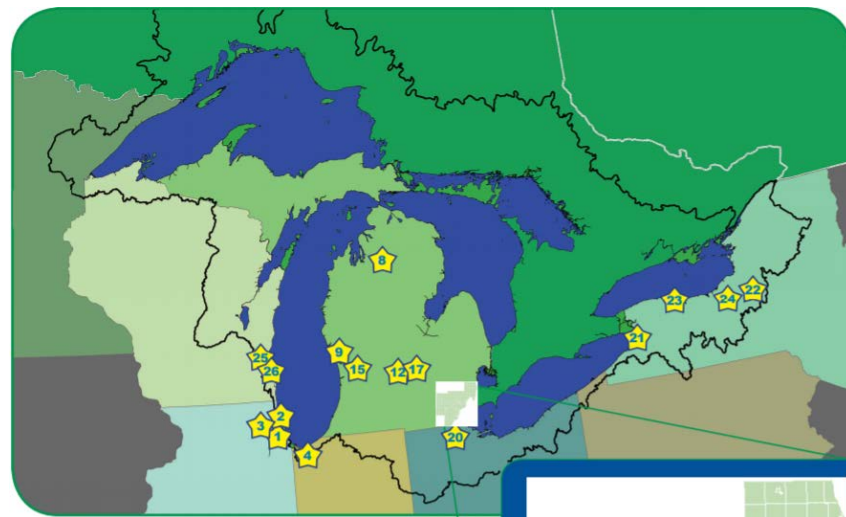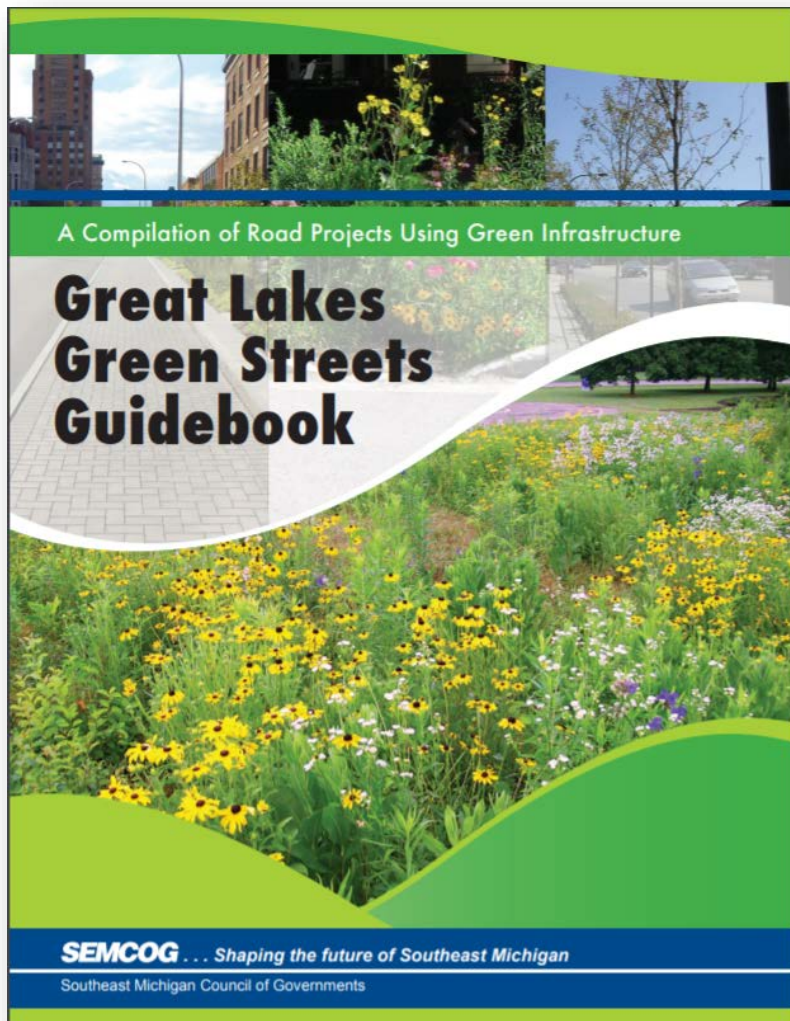
- **Case Studies**
  - Project summary
  - Benefits, Challenges, Maintenance
  - Sponsor, designer, contractor
  - Design and construction cost
  - Partners
  - Contact Information

https://semcog.org/Reports/GLGI_Guidebook/files/assets/basic-html/page-1.html#

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Community and Site Approaches

The Practice of Green Infrastructure

Environmental Site Design

- Place the site in context to greater community

- Preserve and enhance natural features

- Mimic or enhance existing hydrology

- Minimize impervious cover

- Key component of low impact development (LID)

TrockWorks Architectural Services

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Community and Site Approaches

The Practice of Green Infrastructure

Low Impact Development Practices

Bioretention (Infiltration and Filtering)
- Rain gardens
- Bioswales
- Stormwater planters

Green Roofs (Storage and Evapotranspiration)
- Blue roofs
- Cisterns

Permeable Pavements (Infiltration)
- Porous asphalt/concrete
- Grass or gravel pavers
- Pavers

Bioretention

Design Components:
- Ponding area
- Plants
- Soil
- Stones
- Underdrain
- Inlet
- Overflow device or outlet
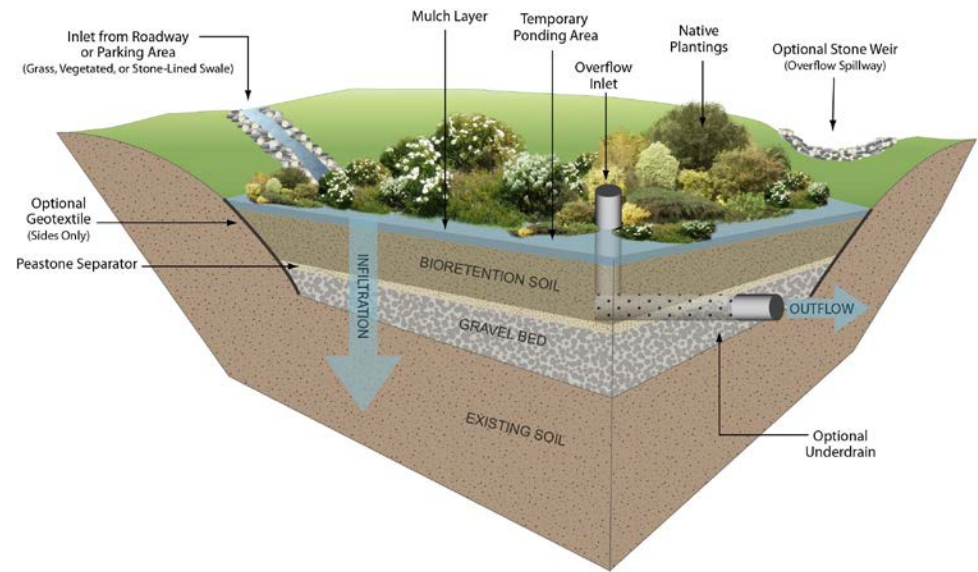
Bioretention inspection and maintenance

- Look for standing water

- Water plants during dry times

- Maintain health of plants

- Overflow bypass is functional

- Look for erosion along banks

- Aerate compacted areas to restore infiltration

UNH Stormwater Center Maintenance Checklist
goo.gl/Xbj2Wu

Green Roof Detail

plants
growing medium
filter fabric
drainage/storage layer
insulation
waterproof membrane
protection board
roof deck
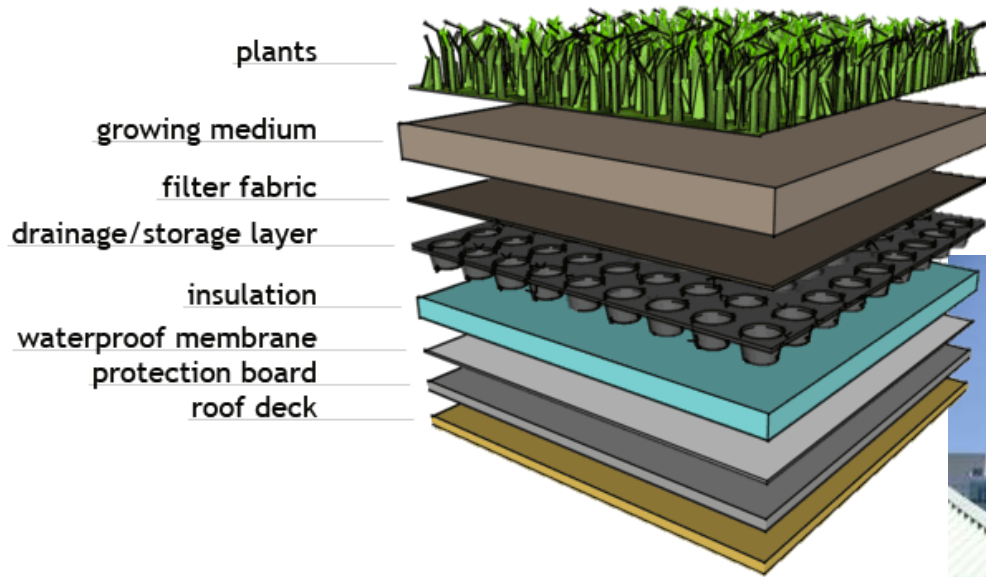
Green roof maintenance

- Weed

- Fertilize

- Check for standing water

- Check structural components

- Check soil depth

- Inspection checklist -
  (The link provided was broken and has been removed)

Green roofs example:
River Rouge Truck Plant

- 10.4 Acres
- Installed 2003
- Monitoring performance
- Extensive roof-type
- Plantings created biodiversity

Pervious pavements

Concrete or asphalt that has larger void spaces to allow water to seep through

Porous Pavement Detail
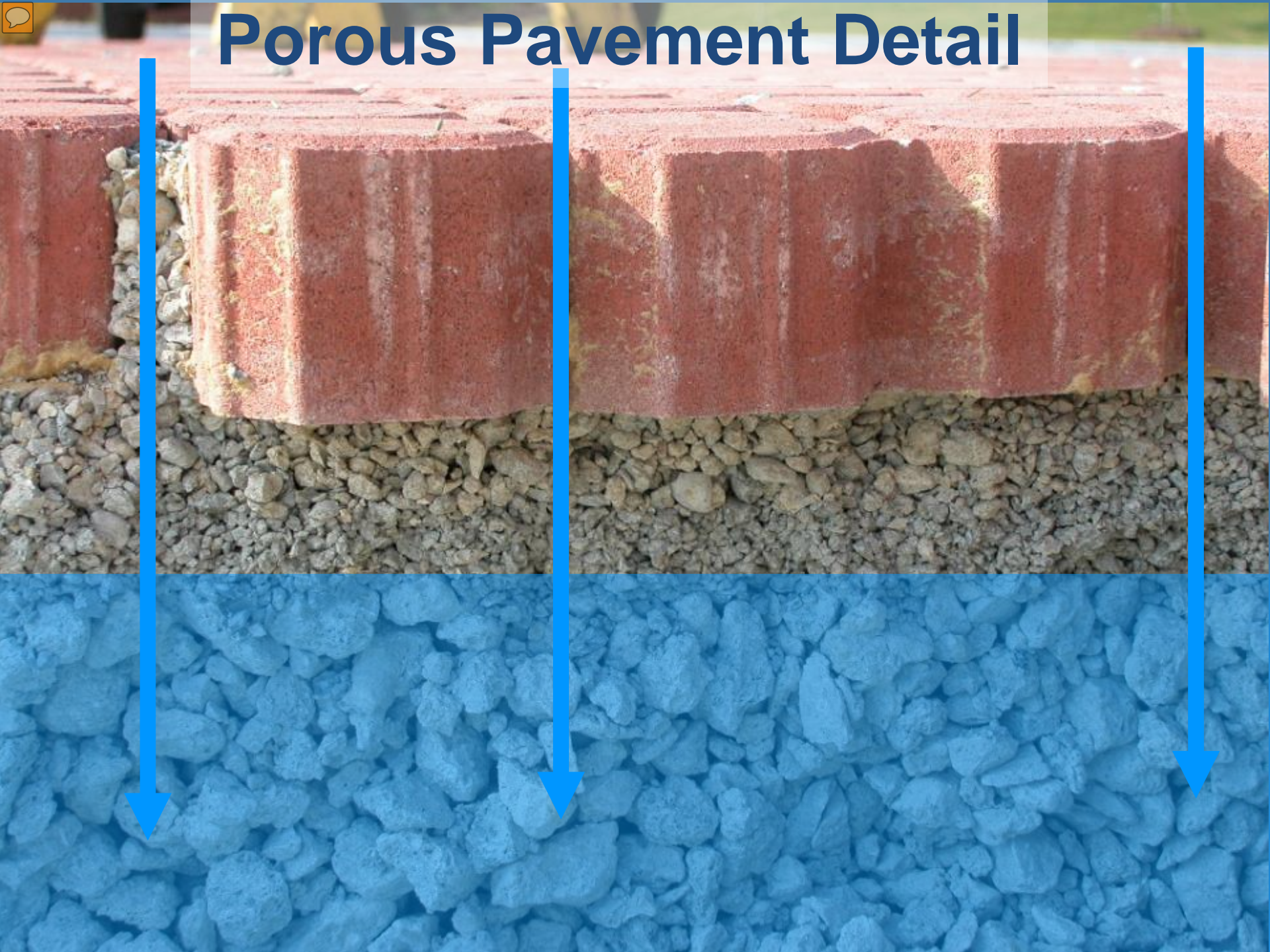
Pervious pavement inspection and maintenance

- Remove sediment and organic debris via vacuum street sweeper (2-4x/year)

- Inspect for deterioration (unraveling) (2-4x/year)

- Maintenance of nearby landscaping to prevent debris

- UNH Stormwater Center Checklist *goo.gl/jsV7pD*

Community and Site Approaches and Resilience

The Practice of Green Infrastructure

- Many studies on the effectiveness of these practices for
  - Reducing the heat island effect
  - Improving water quality
  - Recharging groundwater
  - Providing societal benefits

- For LID, flood reduction is a 'co-benefit'
  - City of Portland, OR reduced peak flow of stormwater runoff by 93%, cooling costs by 27%, and heating costs by 15%.

BREAK

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Speaker: Landscape-Scale Green Infrastructure

Detroit River Area of Concern: GLRI Restoration Projects

Mary Bohling

Michigan Sea Grant

Speaker: Community/Site Scale Green Infrastructure

Terry Croad and Brandy Siedlaczek

City of Southfield

Share Your Green Infrastructure Projects

Discuss green infrastructure projects (or ideas) that can provide ecosystem services to reduce hazard impacts

Write on flipchart:

- Table #
- Brief description
- "P" for Project OR "I" for Idea
- Location
- Contact info (name and email)

Share Your Green Infrastructure Projects

Write on flipchart:

- Table #
- Brief description
- "P" for Project OR
   "I" for Idea
- Location
- Contact info:
   (name and email)

Table 1

- Rain garden at Jefferson Elementary with signage (I)
- Jefferson Elementary School, Montpillier
- POC: T. Jefferson

_____

- Educational Outreach (P)
- Anytown, USA
- Anytown Extension System

Shoreline Practices

Landscape

Watershed

Community

Site
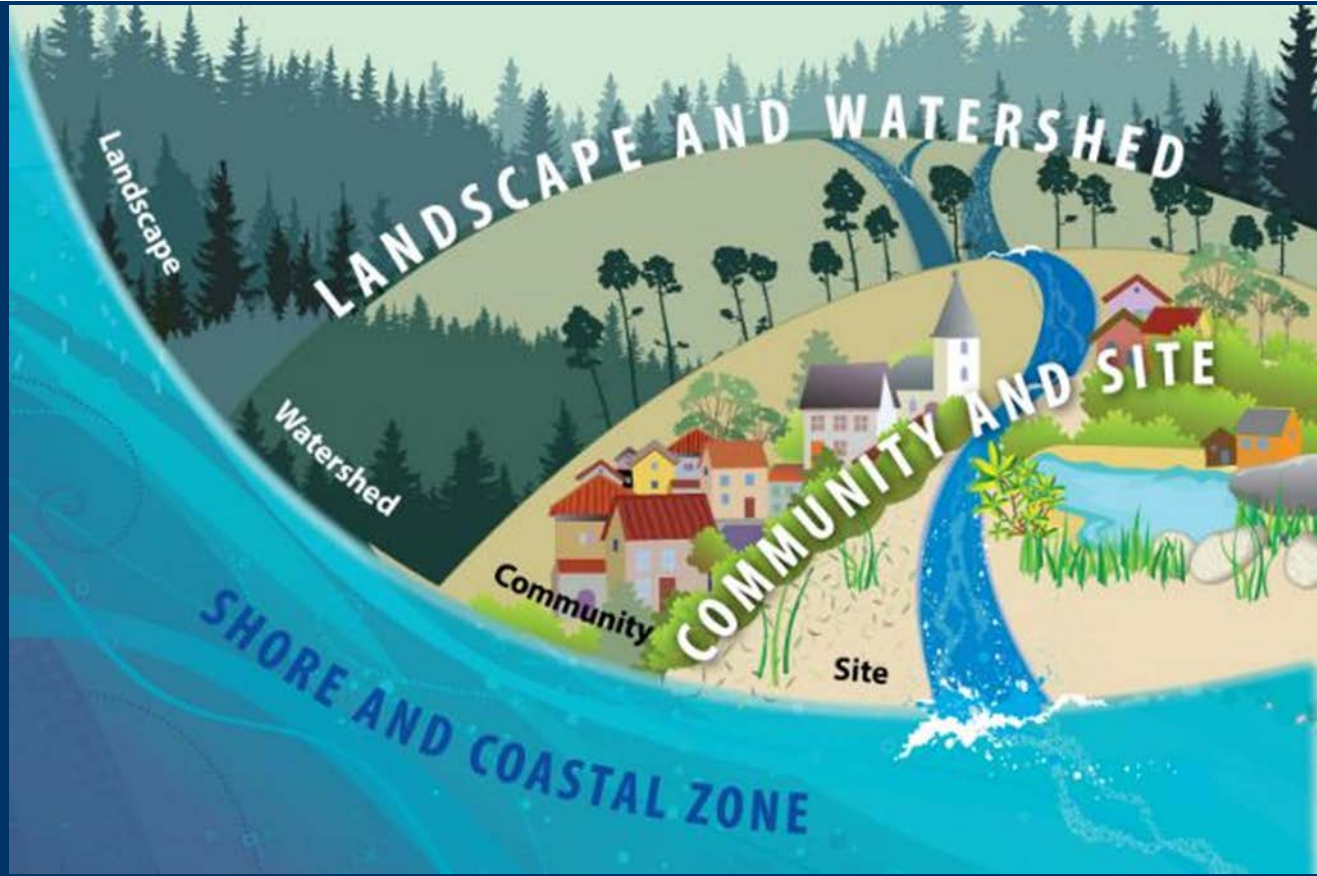
Shoreline

Shoreline Design Concepts

- Natural or Nature-Based
  - Dunes and beaches
  - Vegetated features (salt marsh, wetlands, submerged aquatic vegetation)
  - Oyster and coral reefs
  - Barrier islands
  - Maritime forest/shrub communities

- Hybrid
  - Natural and structural features

- Nonstructural
  - Floodplain policy and management
  - Flood proofing

Marysville, Michigan Shoreline Restoration, (Before and After). Courtesy Brian Majka

Natural or Nature-Based Shorelines

Dune and Beach Creation

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

Wetlands, Vegetation, SAV

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

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Hybrid Living Shorelines

rock sill & marsh plants
REDUCE WAVE ENERGY

marsh plants
SLOW WATER MOVEMENT

water is
STORED IN SOIL

Courtesy, NYDOS
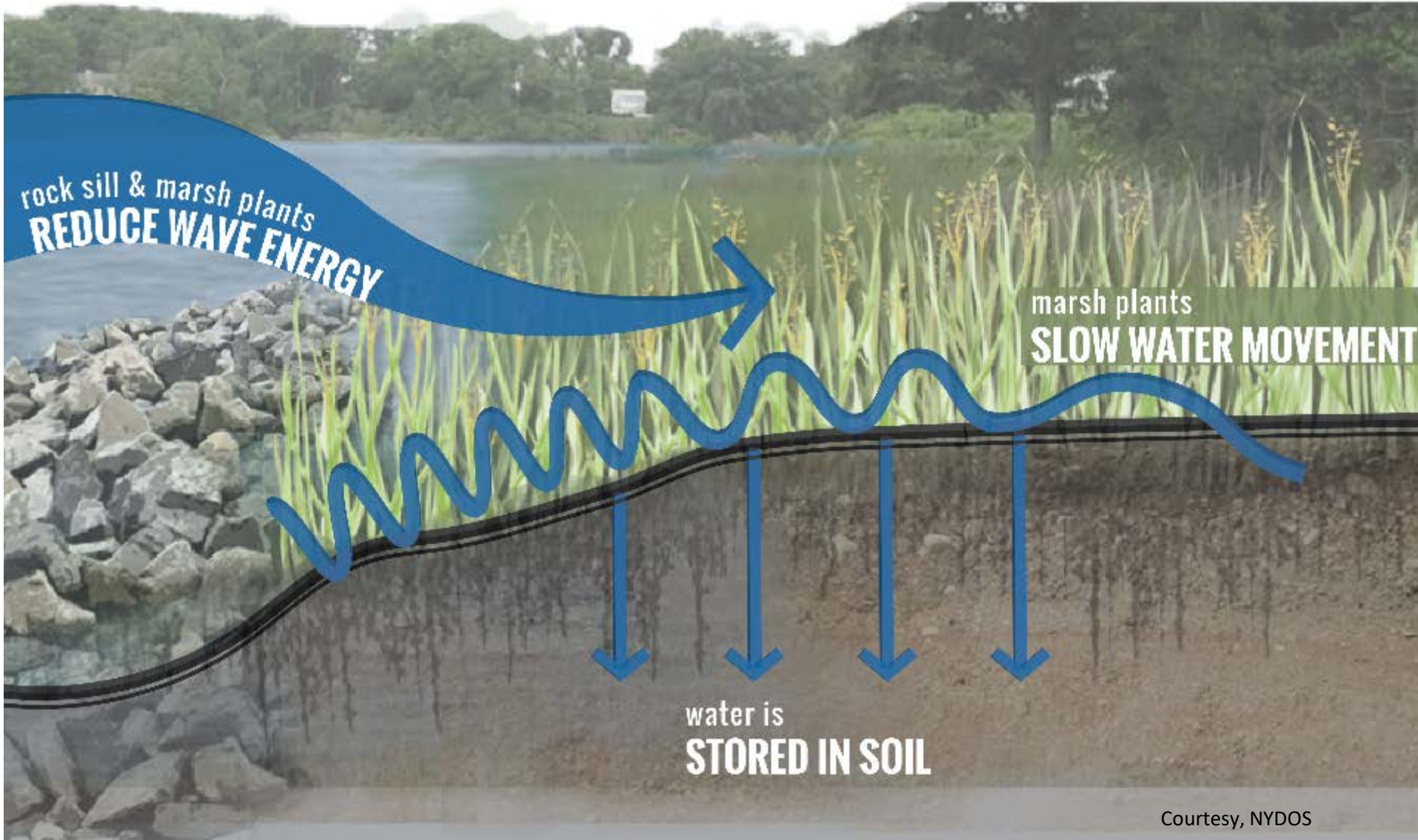
Shoreline Approaches and Resilience

The Practice of Green Infrastructure

Hurricane Irene, North Carolina

Before

After

76% of bulkheads were damaged in the storm
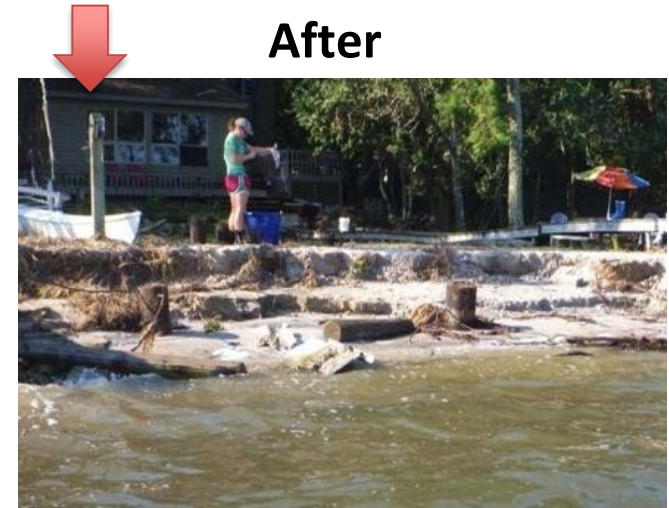
No damage occurred to shorelines with or without sills

*Marshes with and without sills protect estuarine shorelines from erosion better than bulkheads during a Category 1 hurricane, 2014

Speaker: Shore and Coastal Green Infrastructure
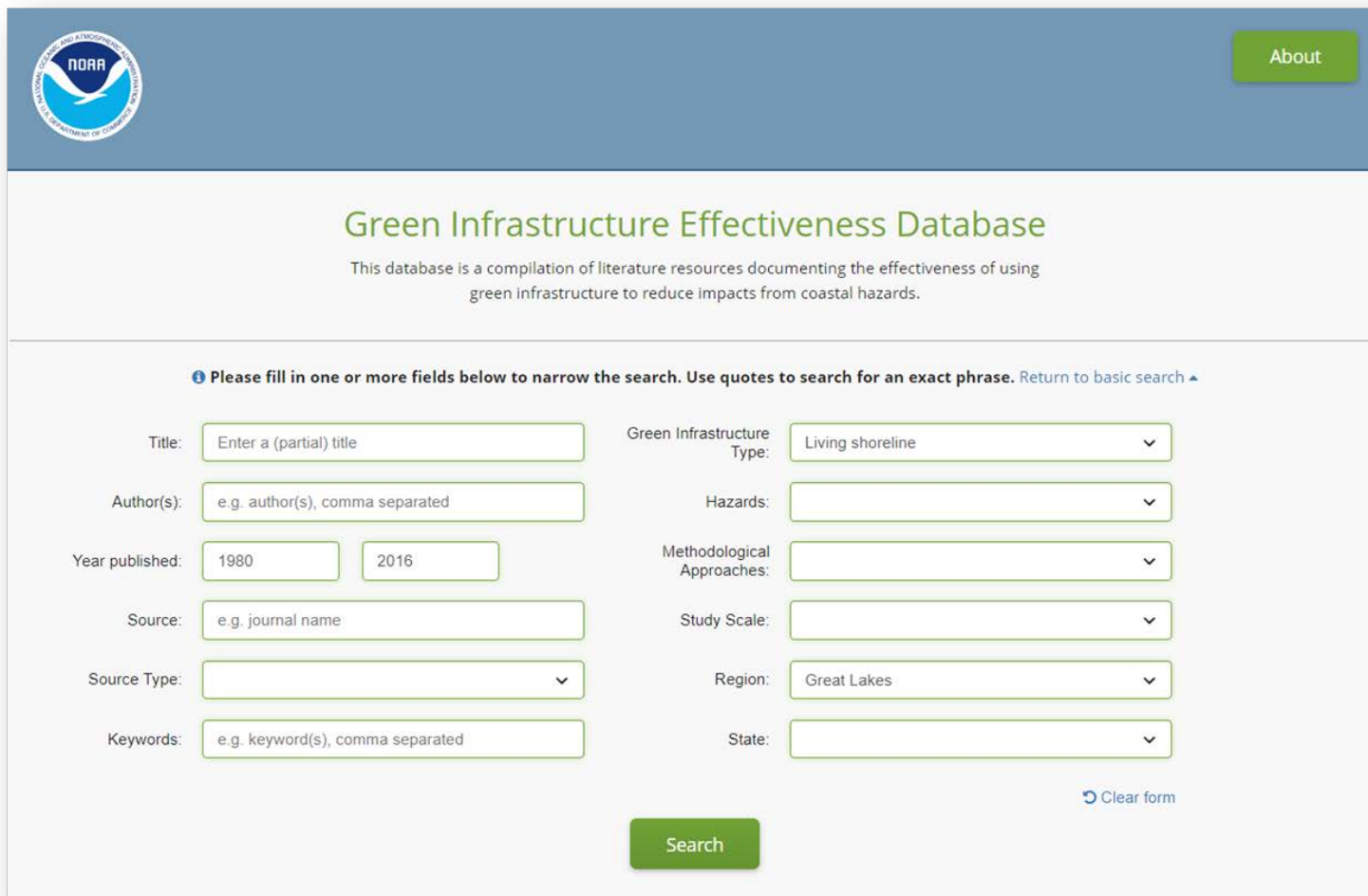
Natural Shoreline Protection
in the Great Lakes

Scott Dierks

GEI Consultants

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Green Infrastructure and Resilience

The Practice of Green Infrastructure

coast.noaa.gov/digitalcoast/training/GI-database

Section 3: Getting to Implementation

Green Infrastructure Can Inform Planning

Incorporate green infrastructure into planning efforts:

- Comprehensive
- Transportation
- Smart growth
- Watershed
- Conservation
- Hazard mitigation

- Stormwater
- Climate change adaptation
- Resilience
- Land use

Plan CC
Comprehensive Plan

PLAN CC
COMPREHENSIVE PLAN

CITY OF CORPUS CHRISTI, TEXAS | SEPTEMBER 2016
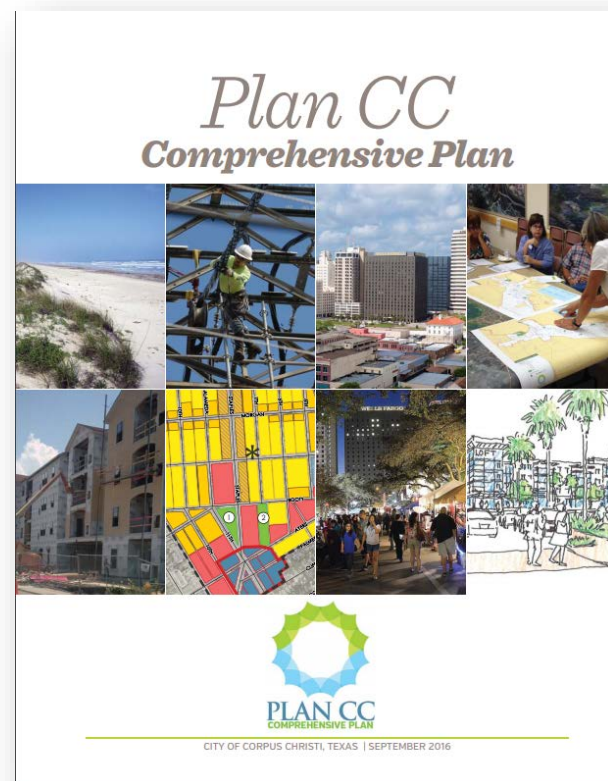
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Integrate into planned improvement projects

- What planned road or drainage projects do you have?

- What parks and recreation projects do you have?

- What economic development projects do you have?

Local Codes and Ordinances

Implementing Green Infrastructure
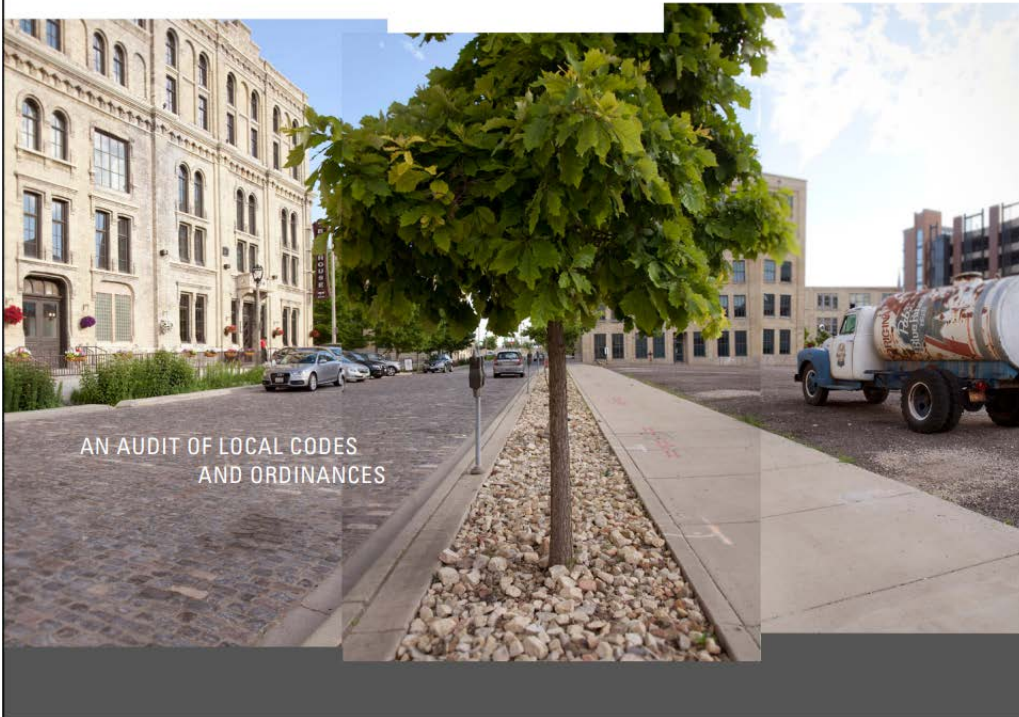
seagrant.wisc.edu/home/Portals/0/Files/Coastal%20C ommunities/Green_Infrastructure/DRAFT_GIworkbook _complete.pdf

Learning from Others

Implementing Green Infrastructure

Engaging Stakeholders

Implementing Green Infrastructure

- Have a plan

- Speak to their interests, not yours

- Explain the hazard risk and offer solutions

- Use multiple ways to communicate

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Engaging Stakeholders

Implementing Green Infrastructure

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Engaging Stakeholders

Implementing Green Infrastructure

Nrcsolutions.org

Engaging Stakeholders

Implementing Green Infrastructure

Funding for Green Infrastructure

- US Environmental Protection Agency
- NOAA
- Federal Emergency Management Agency
- National Park Service
- National Endowment for the Arts
- US Department of Transportation
- Economic Development Administration
- National Recreation and Parks Association
- Funders Network for Smart Growth and Livable Communities
- Qualified Energy Conservation Bonds

BREAK

Credit: Todd Marsee, Michigan Sea Grant

Speaker: Plans, Regulations, or Policies Supporting Green Infrastructure

Green Infrastructure Planning for Southeast Michigan

Katherine Grantham

Southeast Michigan Council of Governments

Table Discussion 3

- **Part 1:** What barriers have you run into around implementing green infrastructure?

- **Part 2:** How can you overcome these barriers?

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One Last Thing . . .

Photo: MI Sea Grant

Please fill out the Evaluation!
https://www.surveymonkey.com/r/L1_IntroGI_17MAY2019

Thank You!

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