STORMWATER CHALLENGES and INNOVATIONS
When It Rains, It Pours

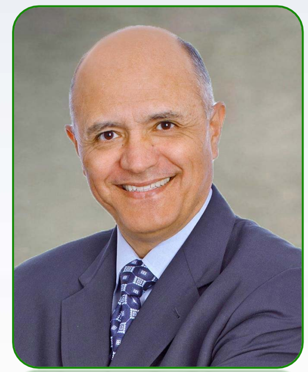
Introduction

ARCADIS Panel

Sandra Ralston

John Atkinson

Fernando Pasquel



John Mastracchio

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Presentation Outline

- Stormwater Requirements and Green Infrastructure
- Show Me the Money!
- Discussion
- Building Resiliency in Your City

"It is my goal for Atlanta to become one of the top tier sustainable cities in the nation"

- Mayor Kasim Reed

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Water Resources Regulatory Background

- Flood Management
- Point Source Controls (Treatment Plants)

1950s – 1970s

1970s - 1980s

- Erosion and Sediment Control
- Drinking Water Protection

- Non-Point Source Controls
- Stream / Channel Protection
- CSO and SW Management
- SDWA

1980s - 1990s

2000s

- Sustainable Watersheds
- SSO and TMDLs
- Habitat Protection

Too Much – Too Little – Keep it Clean!

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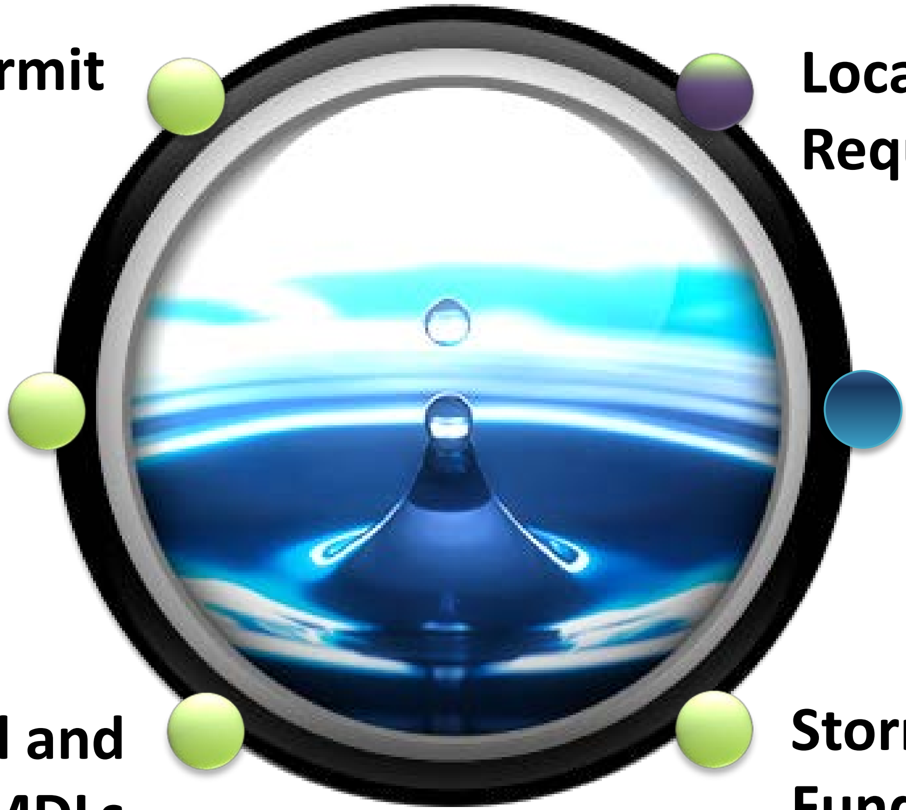
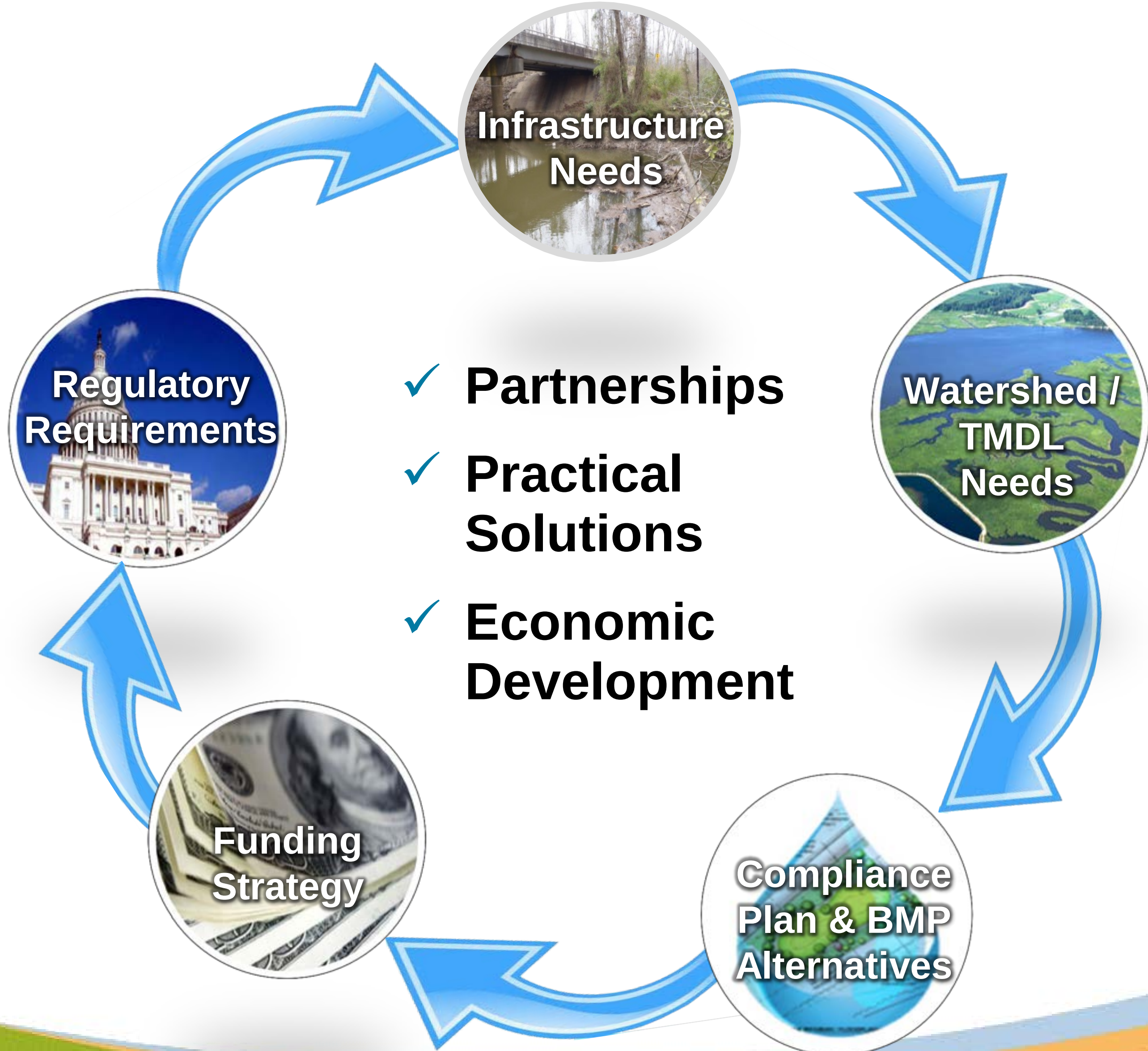
Stormwater Regulatory Requirements



Municipal Drivers



- ✓ **Partnerships**
- ✓ **Practical Solutions**
- ✓ **Economic Development**

The Challenge – Beyond compliance
From projects to an integrated program

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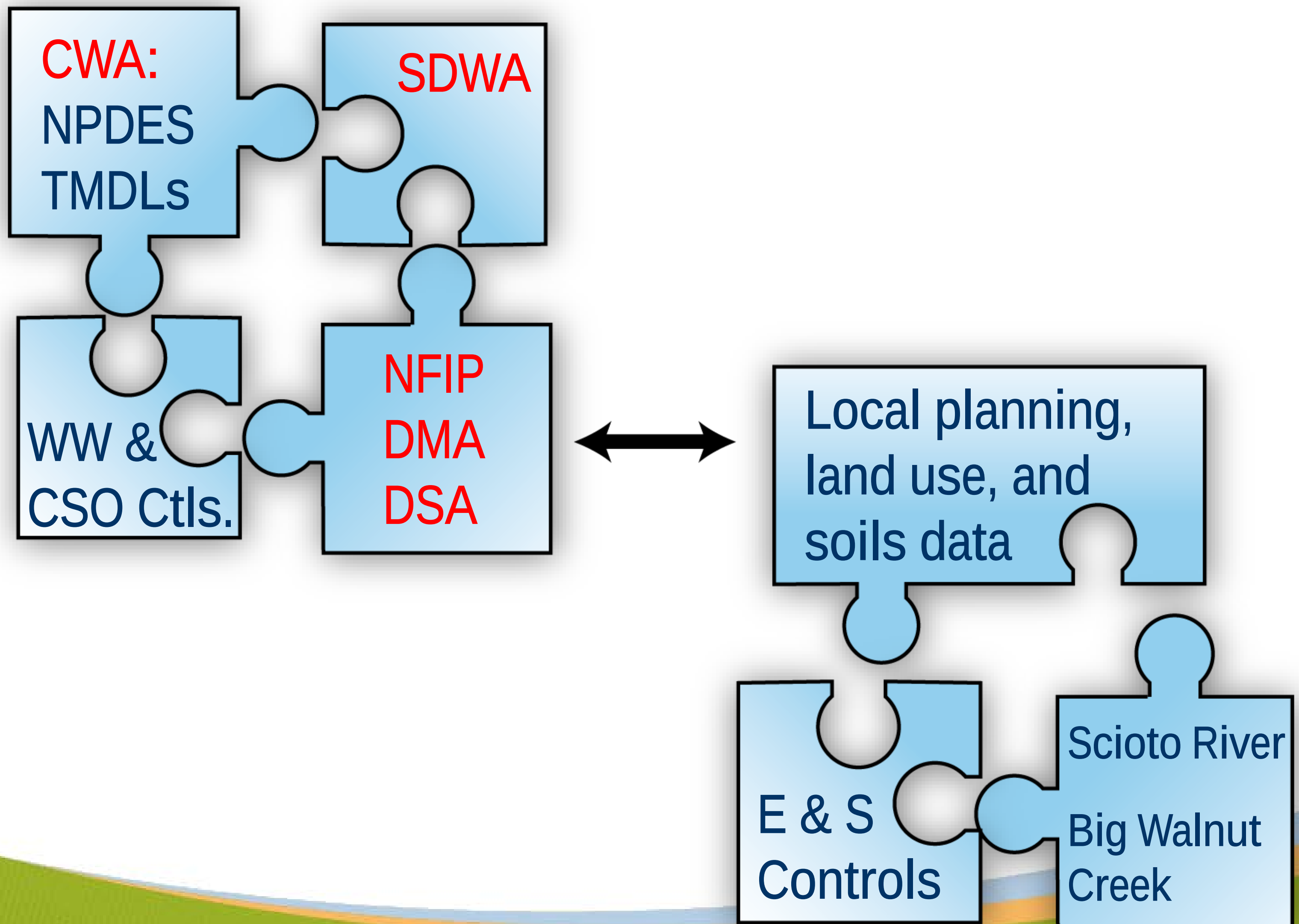
An Integrated Approach Addresses Federal, State, and Local Needs



Single Purpose Public Works Projects

Gray Infrastructure

Wastewater, water, and gas utilities; roadways, parking lots, and bridges

Green Infrastructure

Stream restoration, park systems, conservation land, and recreational facilities

Blue Infrastructure

Stormwater and flood control facilities

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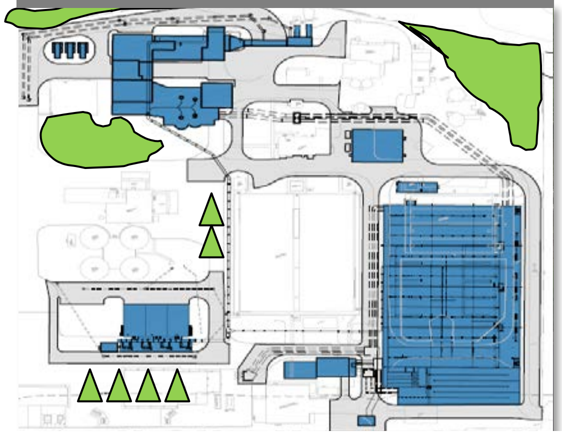
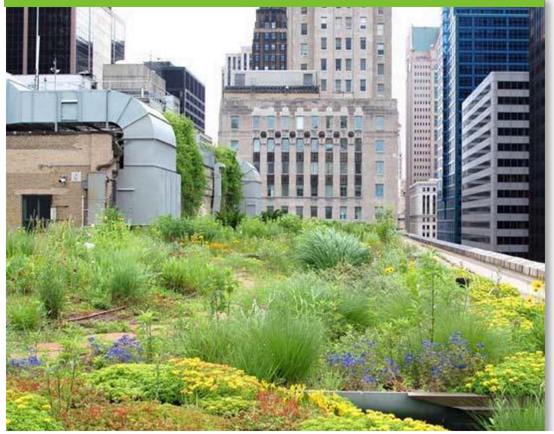
Integrating various types of infrastructure

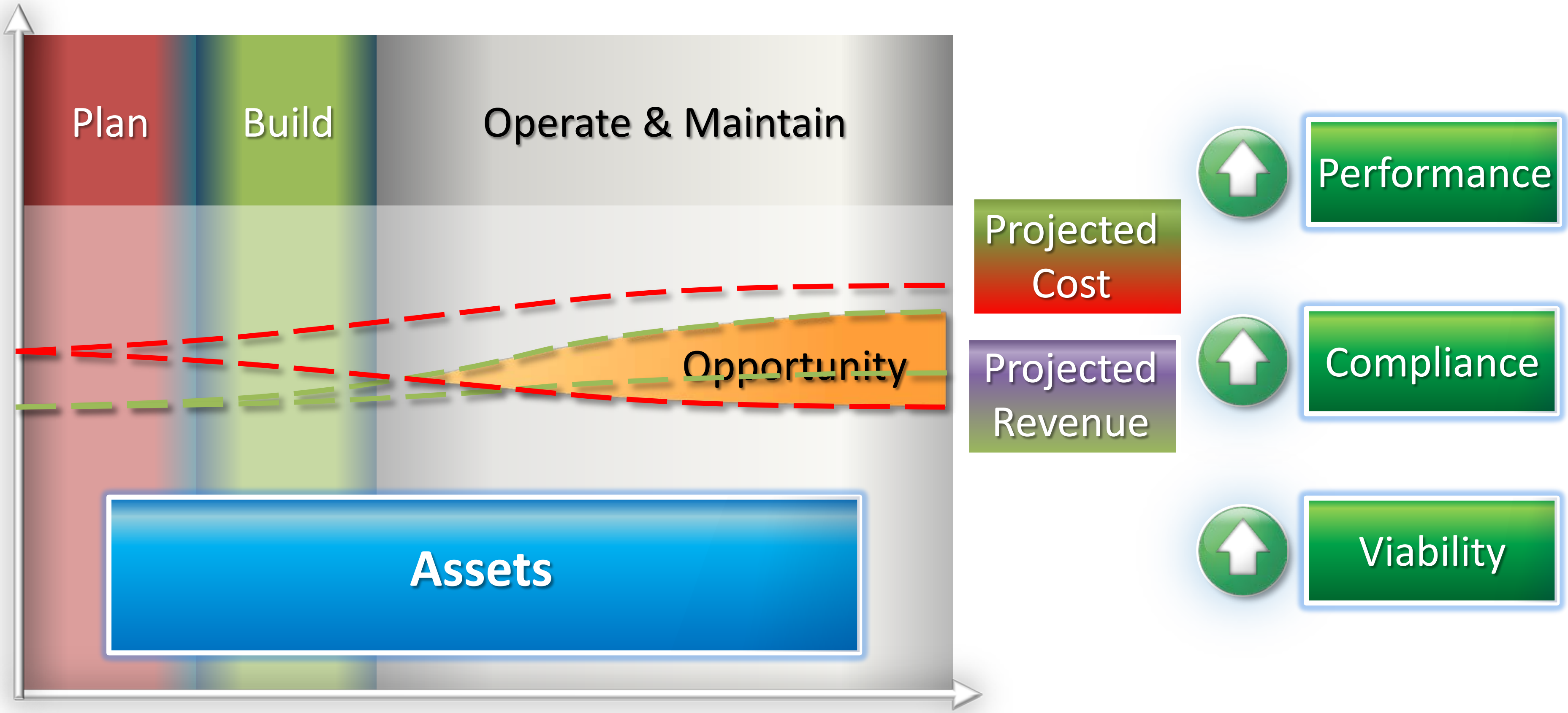
Gray Infrastructure	Green Infrastructure	Blue Infrastructure


Create a multi-use network of open spaces



Why Green Infrastructure (GI)

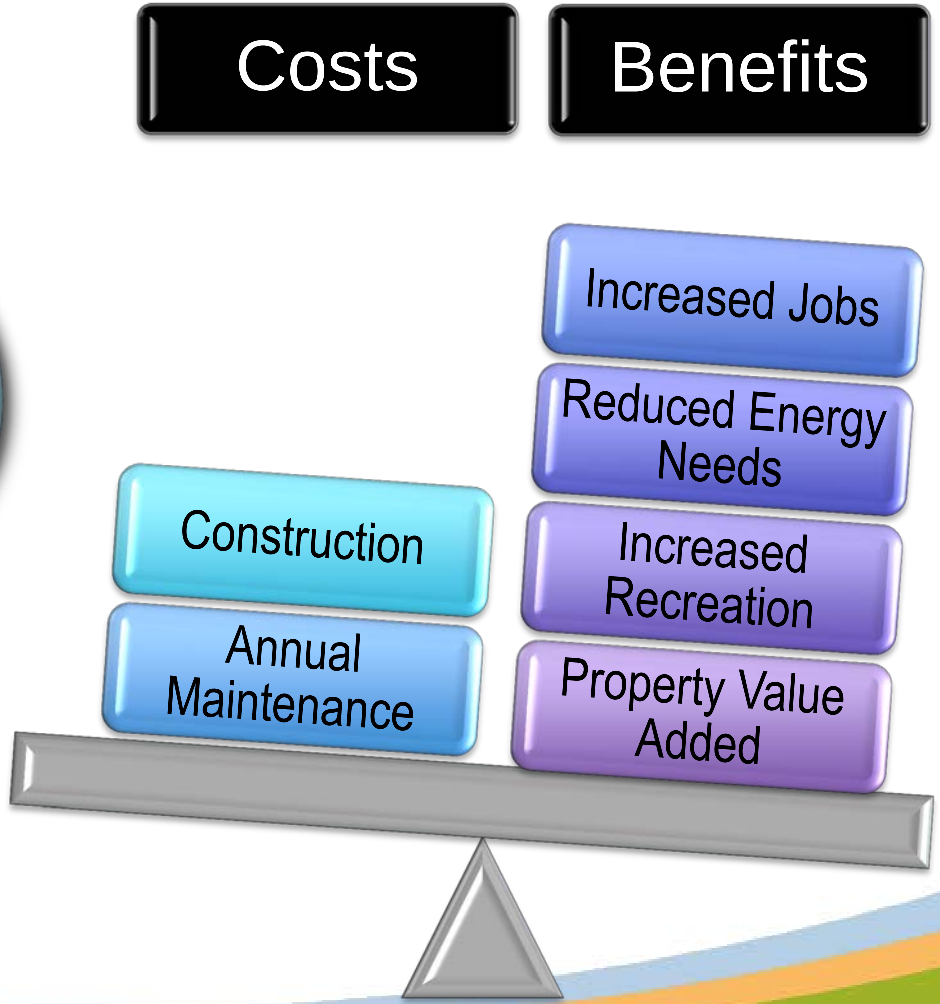


GI

Increases Level of Service

At Reduced Cost

A Holistic View of Cost and Benefits for Long Term Stormwater Compliance



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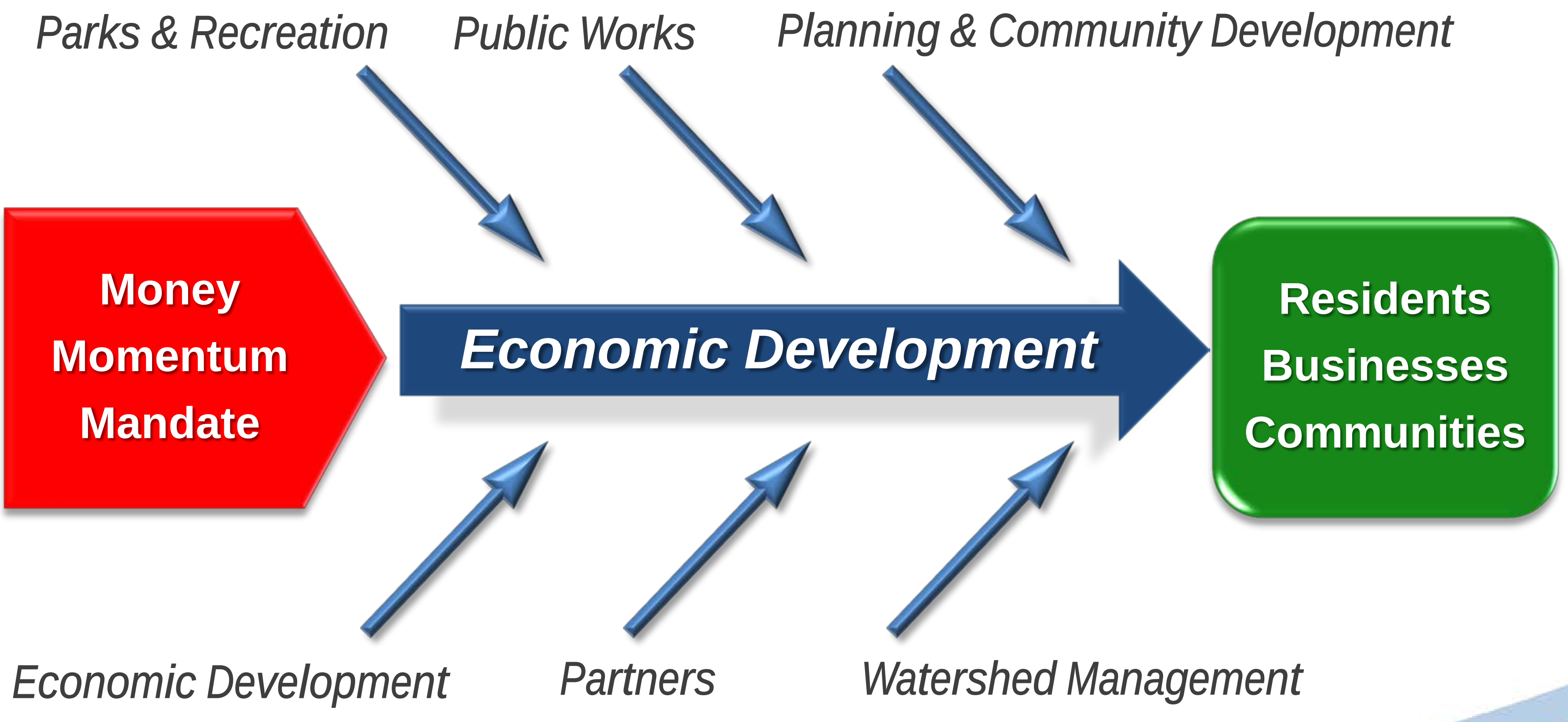
Focused Collaboration

Green Infrastructure – a common medium for revitalization, economic development, and SW compliance



Stormwater and Transportation Infrastructure: Identifying Opportunities in Philadelphia

Stormwater and Transportation Infrastructure: Compliance Elements in the Right-of-Way

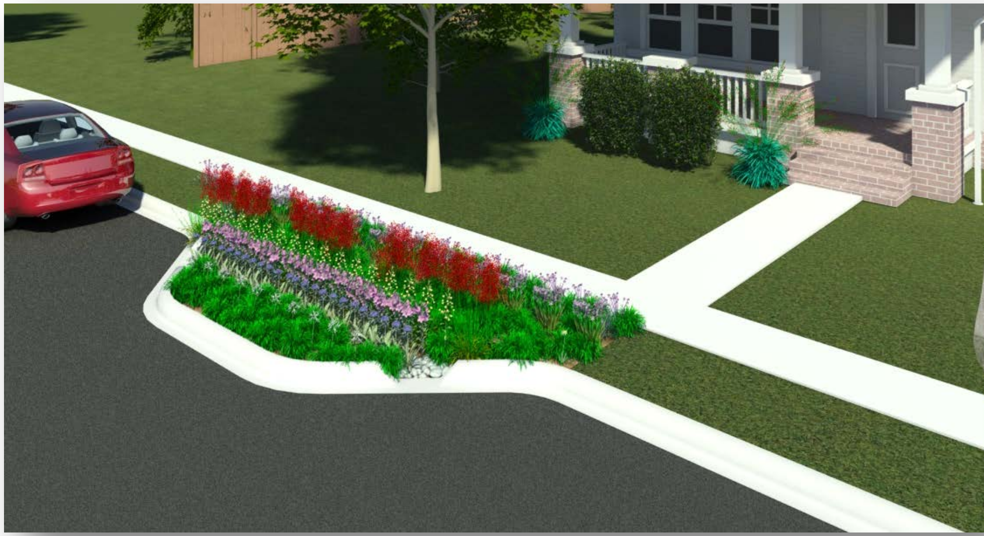
Public-Private Opportunity – Chattanooga, TN

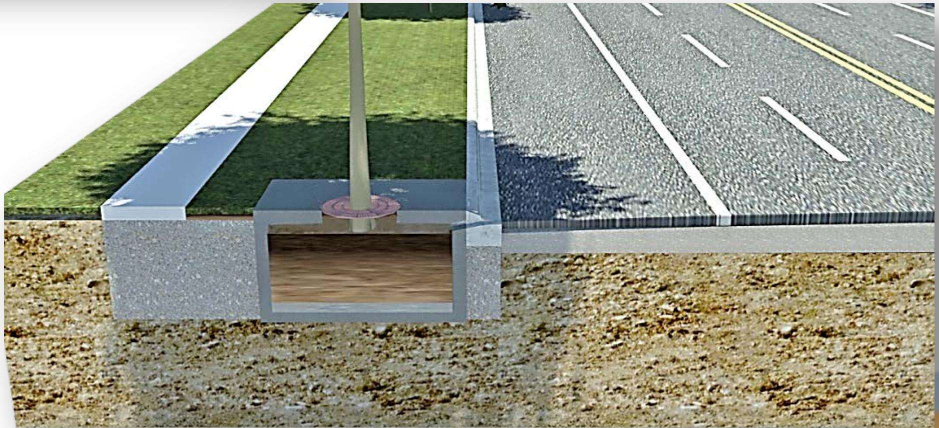
Keystone revitalization – Leverage Partnerships

Jay Hollingsworth Speas Airport Award for 2014

"Improving environmental relationships between airports and community"

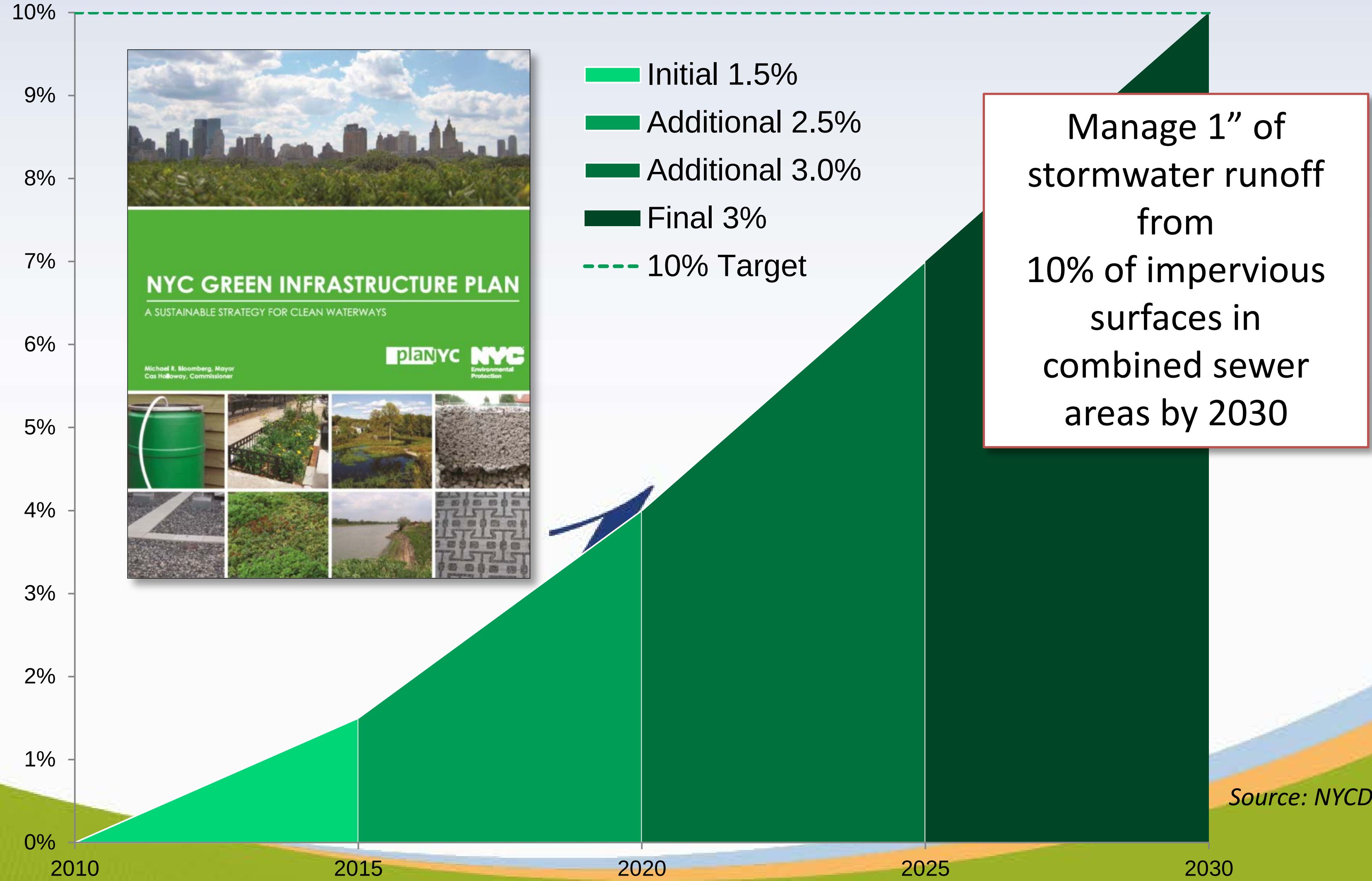
Integrating Stormwater in Our Neighborhoods





GI Plans, Metrics, and Milestone Schedule

$730 Million in the 10-year capital plan for green infrastructure



Source: NYCDEP

Tracking System

Project Initiation → Site Selection → Geotechnical & Design → Construction & Inspection → Operations & Maintenance

Project Tracking Spreadsheet

Project Information	DEP Contract No.
	Project Description
	GI Type
	GI ID
	Managing / Partnering Agency
	Agency Contact Information
	Managing Agency Contract Number
Location	Borough
	CSO Tributary
	Waterbody
	Front (F), Side (S), or Across (X) from Address
	Street Number
	Street
	Cross Street
	BBL (On-Site only)
	Community Board No.
	City Council District
	X-Coordinate (GPS)
	Y-Coordinate (GPS)
Status	Status
	Reason For Rejection (if applicable)
	Monitored (Y/N)

ROWB / SGS Info	Date of Initial Walkthrough
	Date of Second Walkthrough (with DOT)
	ROWB Length
	ROWB Width
	ROWB Type
	Soil Depth (ft)
	Drainage Layer Depth (ft)
	Stone Column Depth(s) (ft. below ground surface)
	Sidewalk Width (ft)
	Curb Type
	Tree Species
	Tree Cultivar Name
	Planting Plan
	Tree Guard Type
Hydraulics	GI Asset Area (sq ft)
	Impervious Tributary Area (sq ft)
	Calculated Volume of Rainfall Managed (CF)
Geotech and Survey	Boring / Permability Test ID Number
	5' Permeability Coefficient (k) (cm/s)
	10' Permeability Coefficient (k) (cm/s)
	Cost of Permeability Test
	Date of Permeability Test
	Soil Type 0' - 5' Depth
	Soil Type 5' - 10' Depth
	Soil Type 10' - 15' Depth
	Soil Type 15' - 20' Depth

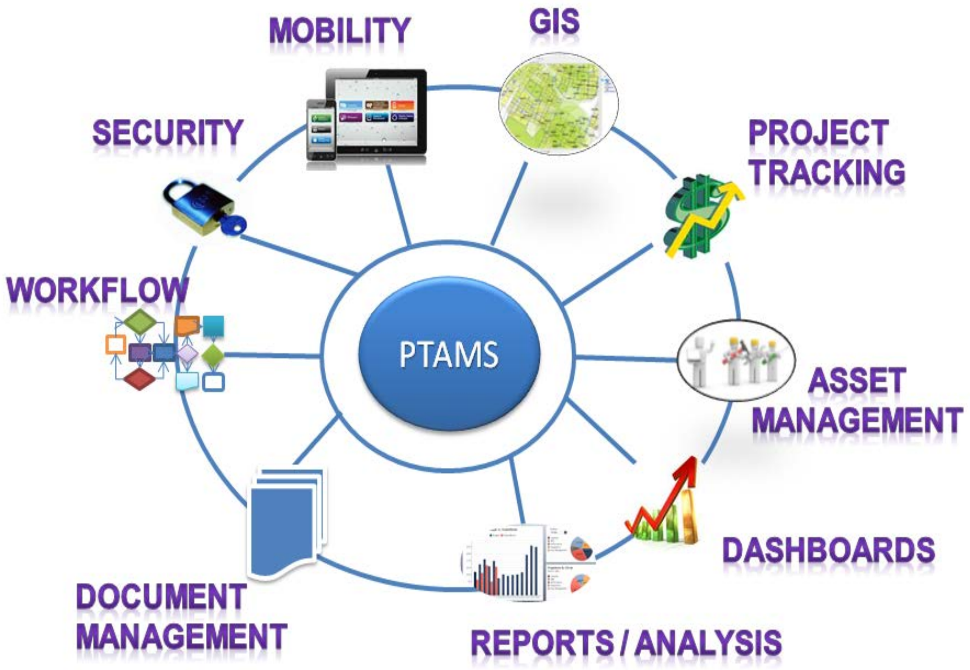
Geotech and Survey	GWT Depth (ft)
	Bedrock Depth (ft)
	Cost of Boring
	Date of Boring
	Geotech Notes
	Cost of Survey
	Date of Survey
Project Management	Date Stamped Analysis Received
	Cost of Construction for Individual GI Asset
	Construction Contract No.
	Bid Date
	Contract Registration Date
	Notice to Proceed Date
	Design Agency/Consultant
	Construction Contractor
	Construction Start (Actual or projected)
	Construction Duration
	Construction End (Actual or projected)
	Final Inspection Date
	Final Maintenance Start Date
	Guarantee Period Duration (months)
Outreach	Outreach Category
	Primary Outreach Issue
	Outreach Notes
	Notes

Source: NYCDEP

Components and Features

Key Components and Required Features

- User friendly, secure, web-based
- Integration of data and functionality
- Smart data entry
- Accommodate future growth as required
- Focus on usability, maintainability and performance



Keys to Program and Compliance Success

Recognize ...

- ... that the Green Infrastructure project or program is a component of urban revitalization
- ... that the decision to ***go green*** is not a cost decision but a value proposition
- ... that the Green Infrastructure decision is strategic and not tactical
- ... that executive leadership is essential
- ... that success requires seamless inter-organizational cooperation

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Building Flooding Resiliency

John Atkinson

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What is Resiliency ?

- Ability to keep functioning under stress
- Ability to withstand disturbance without breaking

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  - That’s “*social resiliency*”
  - Folks committed to sticking it out in flood-prone areas

What is Resiliency ?

- Ability to keep functioning under stress
- Ability to withstand disturbance without breaking
- It ***doesn't*** mean to bounce back and rebuild
  - That's "*social resiliency*"
  - Folks committed to sticking it out in flood-prone areas
- Here we mean **infrastructure resiliency**

What Happens Without Resiliency ?

- Systems become overwhelmed and can no longer function as needed
- Cannot keep up with demand
- Cannot keep up with other changes in the system

STRESSORS

- **Population growth**
- **Urbanization**
- **Inadequate maintenance**
- **Climate Change**
- **Sea Level Rise**

STRESSORS

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Predictable and Controllable

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STRESSORS

- Population growth
- Urbanization
- Inadequate maintenance
- **Climate change**
- **Sea level rise**

Not much control over these…

STRESSORS

- Popu
- Urb
- Ina
- Cli
- Sea

If a system does not have adequate resiliency, it can become overwhelmed.

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Examples of Inadequate Resiliency

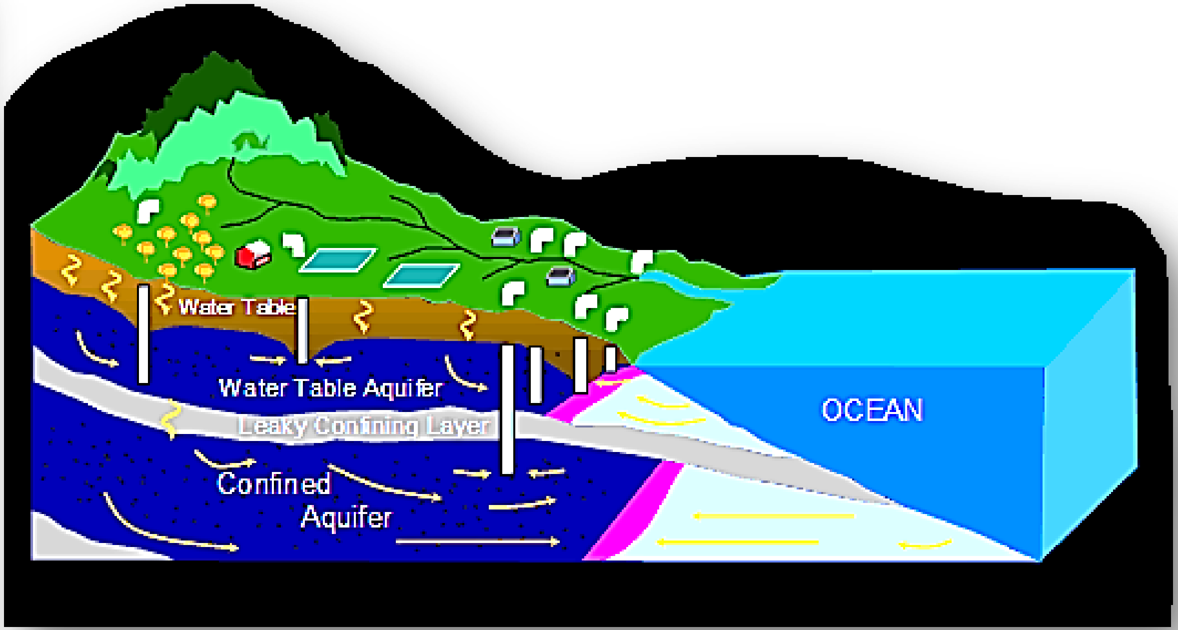
- Municipal drainage no longer works at high tide
- Increasing frequency of nuisance flooding
- Inundated roads


Increasing frequency of these conditions …

Impact on daily traffic safety and evacuation

Other Impacts

- Salt-water intrusion
- Re-location of municipal drinking wells



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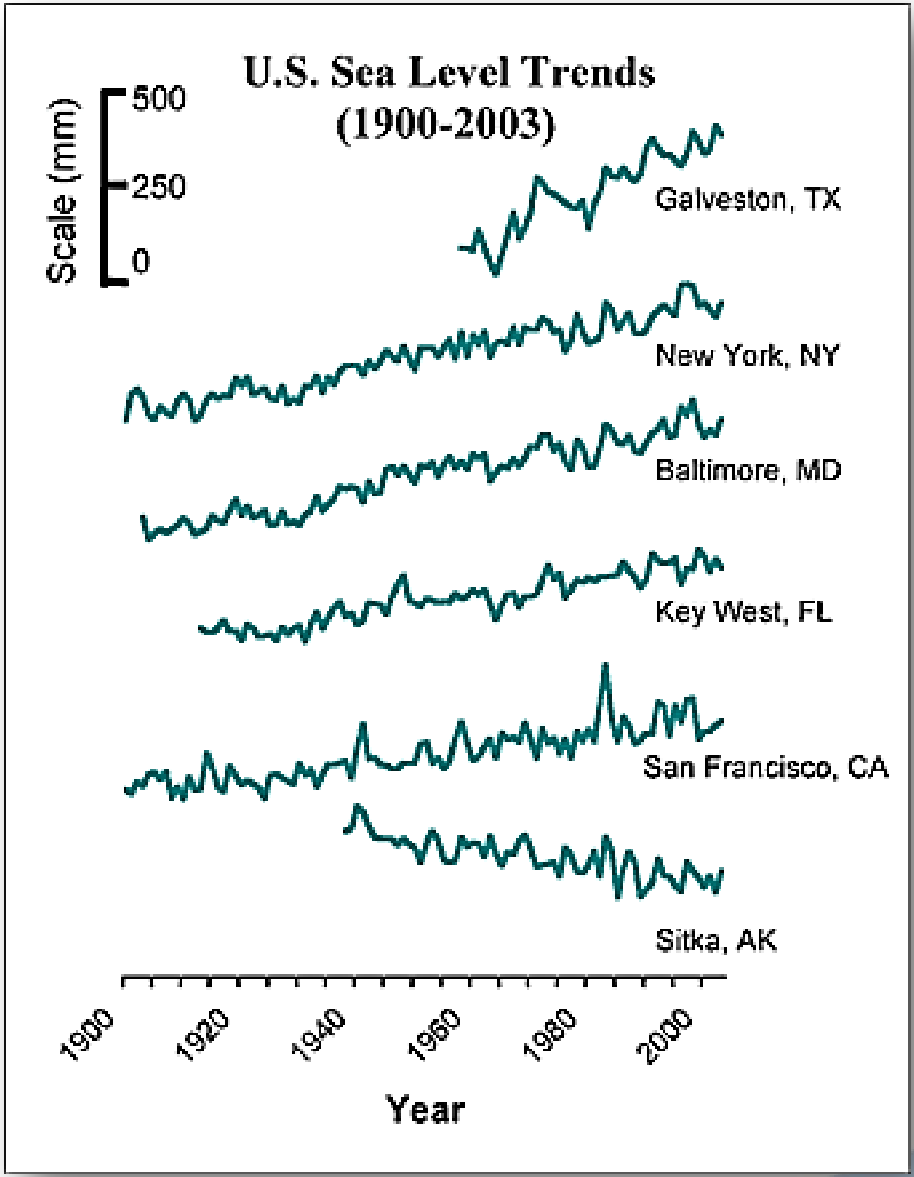
Other Impacts

- Rivers and aquifers becoming more saline
- Plant and tree mortality (ghost forests)
- Lowland fields no longer suitable for agriculture

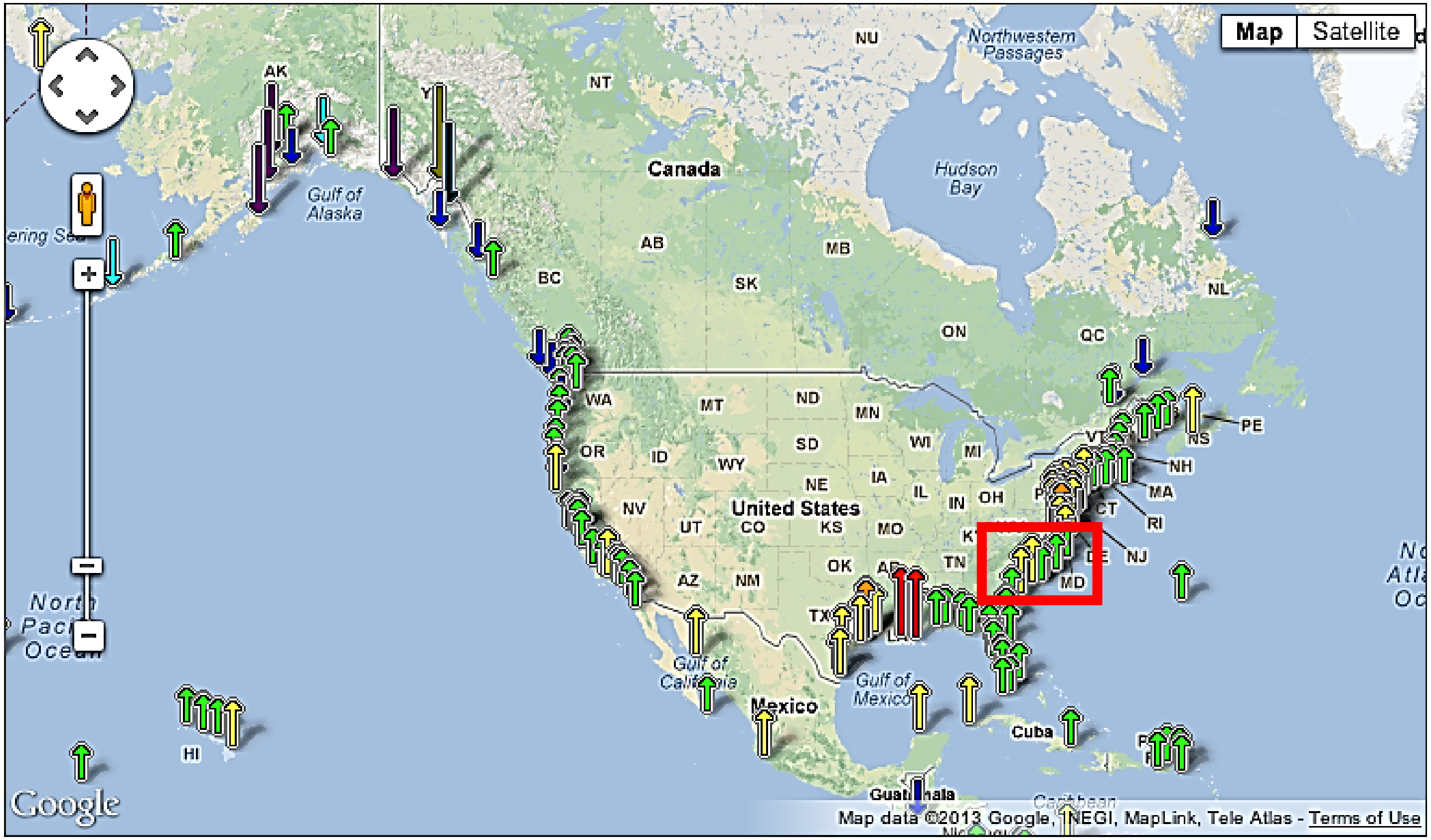
Effects are *not* uniform!

- Need local data
- Not one-size-fits-all SLR



Source: National Ocean Service

NOAA Sea Levels Online



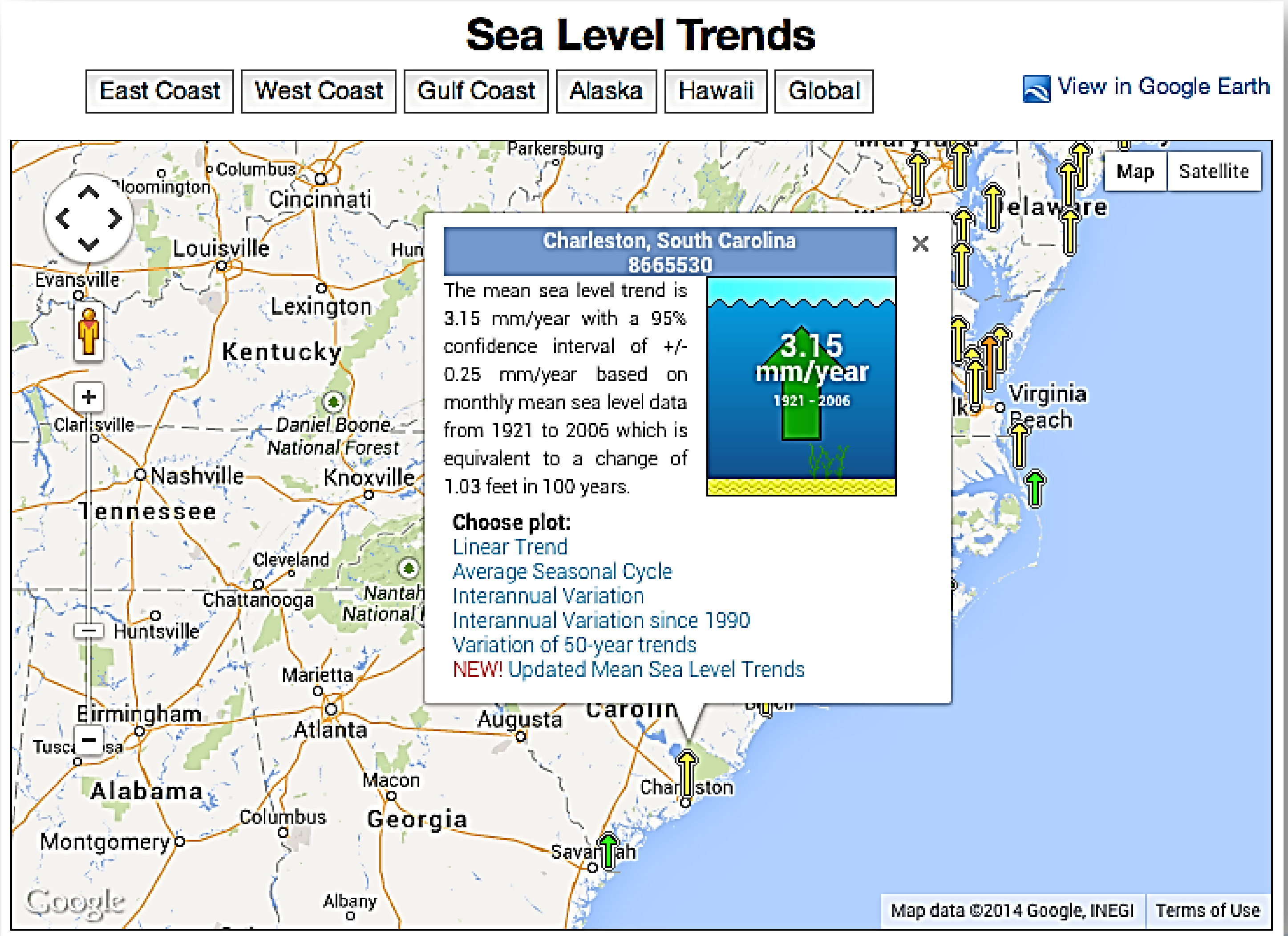
The map above illustrates regional trends in sea level, with arrows representing the direction and magnitude of change. Click on an arrow to access additional information about that station.

Sea Level Trends
mm/yr (feet/century)

9 to 12 (3 to 4)	3 to 6 (1 to 2)	-3 to 0 (-1 to 0)	-9 to -6 (-3 to -2)	-15 to -12 (-5 to -4)
6 to 9 (2 to 3)	0 to 3 (0 to 1)	-6 to -3 (-2 to -1)	-12 to -9 (-4 to -3)	-18 to -15 (-6 to -5)

http://tidesandcurrents.noaa.gov/sltrends/

NOAA Sea Levels Online



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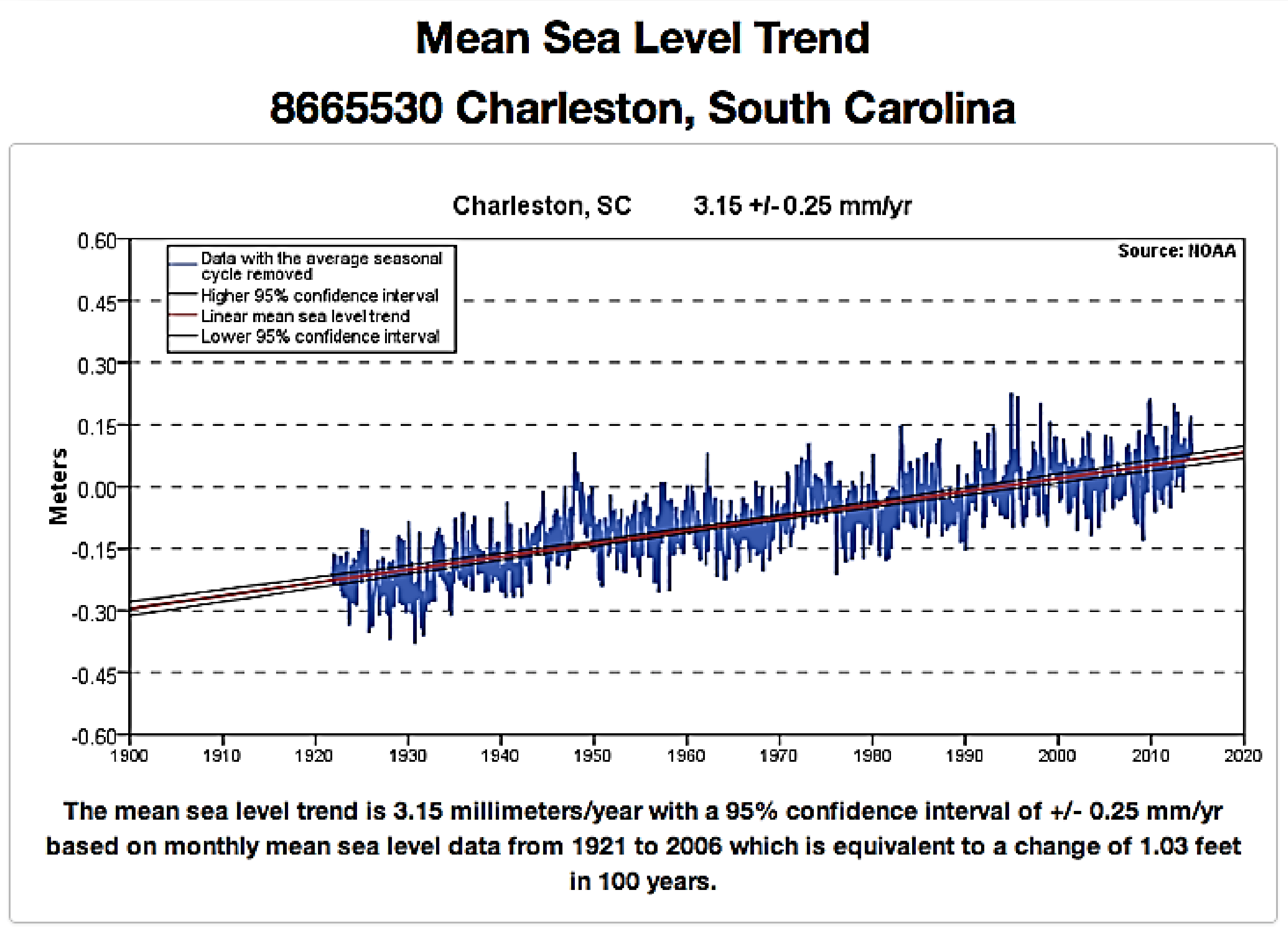

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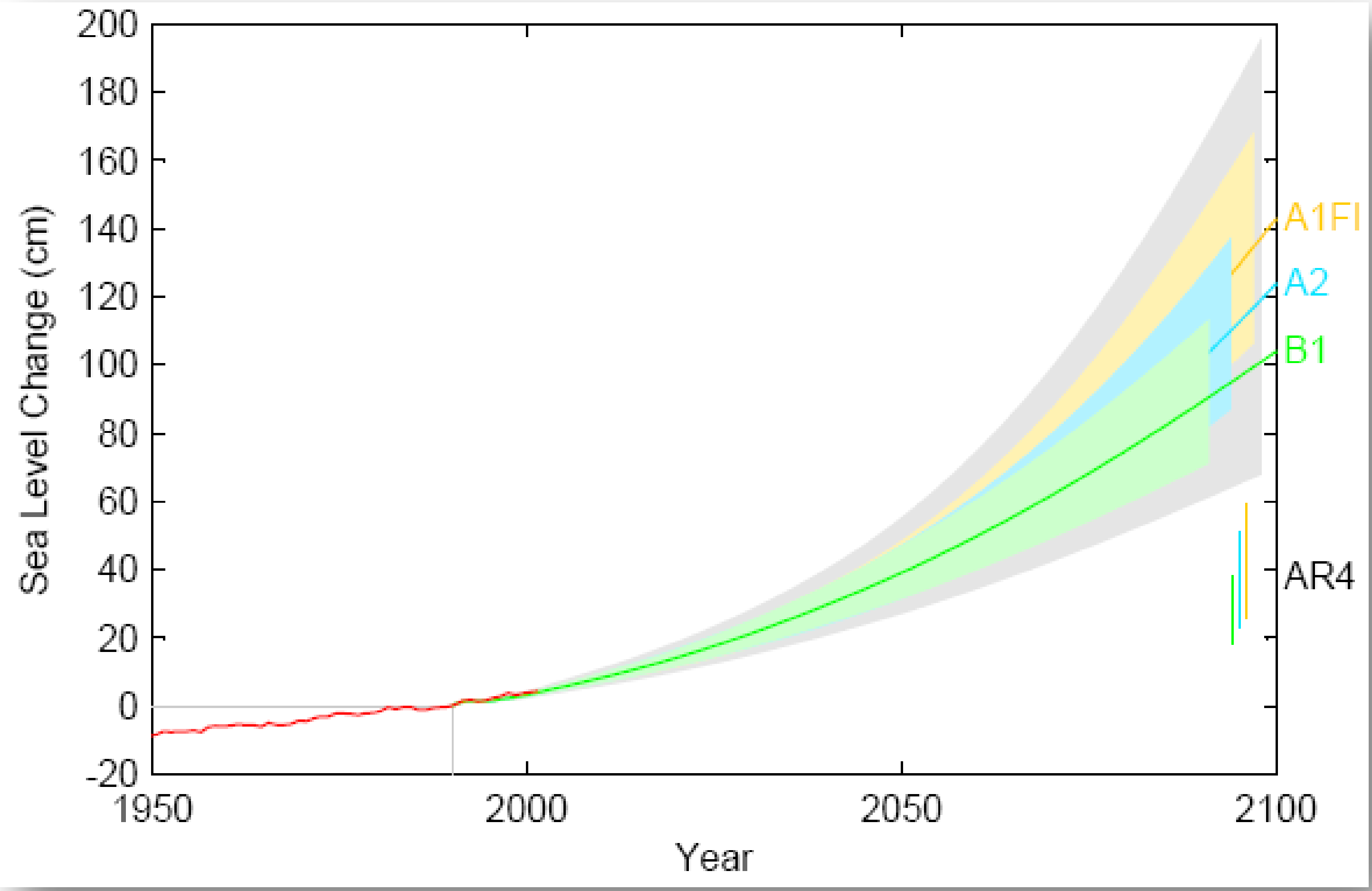
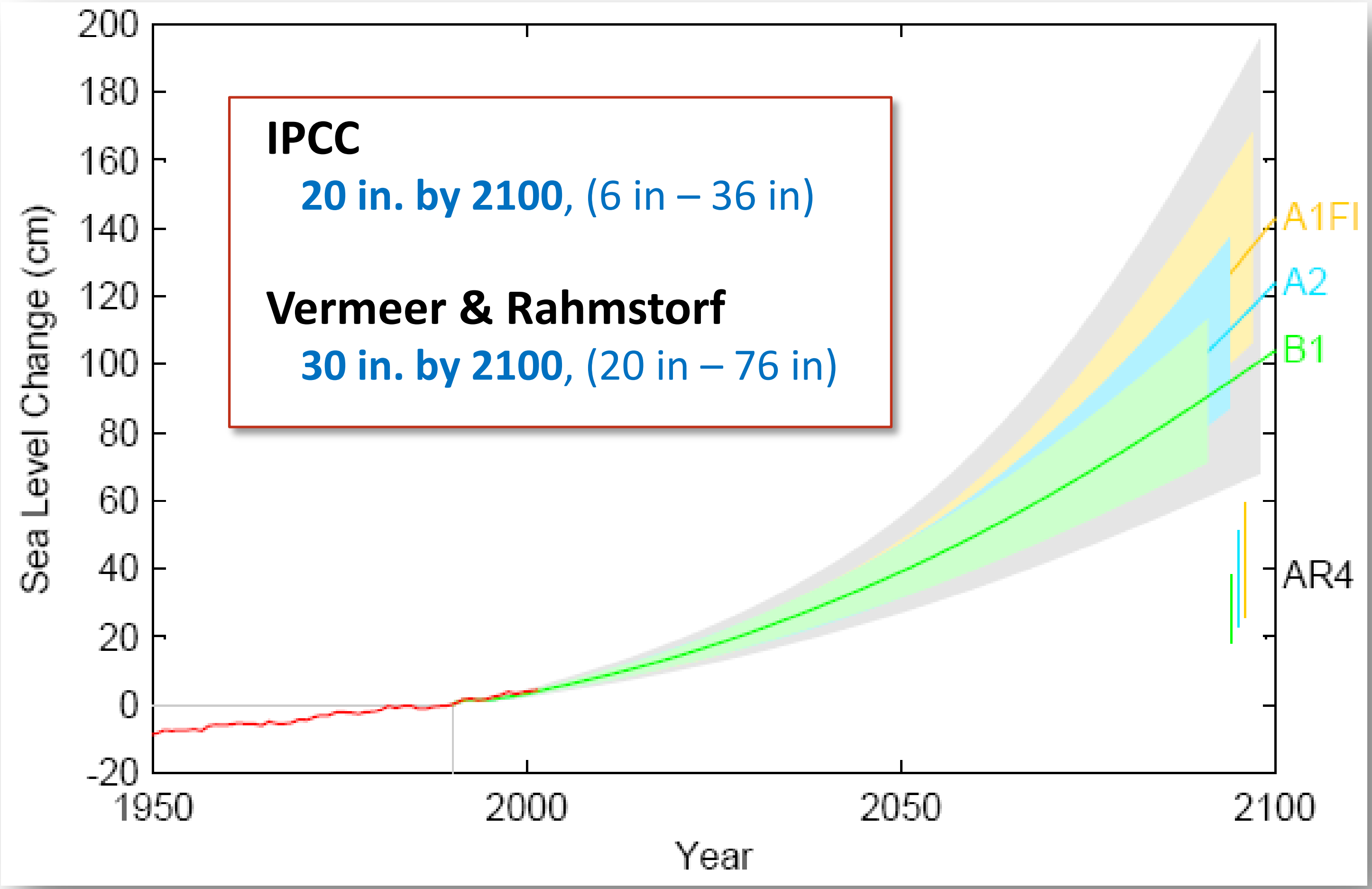
Estimate of Future Sea Levels



Vermeer and Rahmstorf (2009)

Estimate of Future Sea Levels



Vermeer and Rahmstorf (2009)

Changing Storm Risk

- Future storm characteristics unknown
- Amplification of surge and waves with SLR

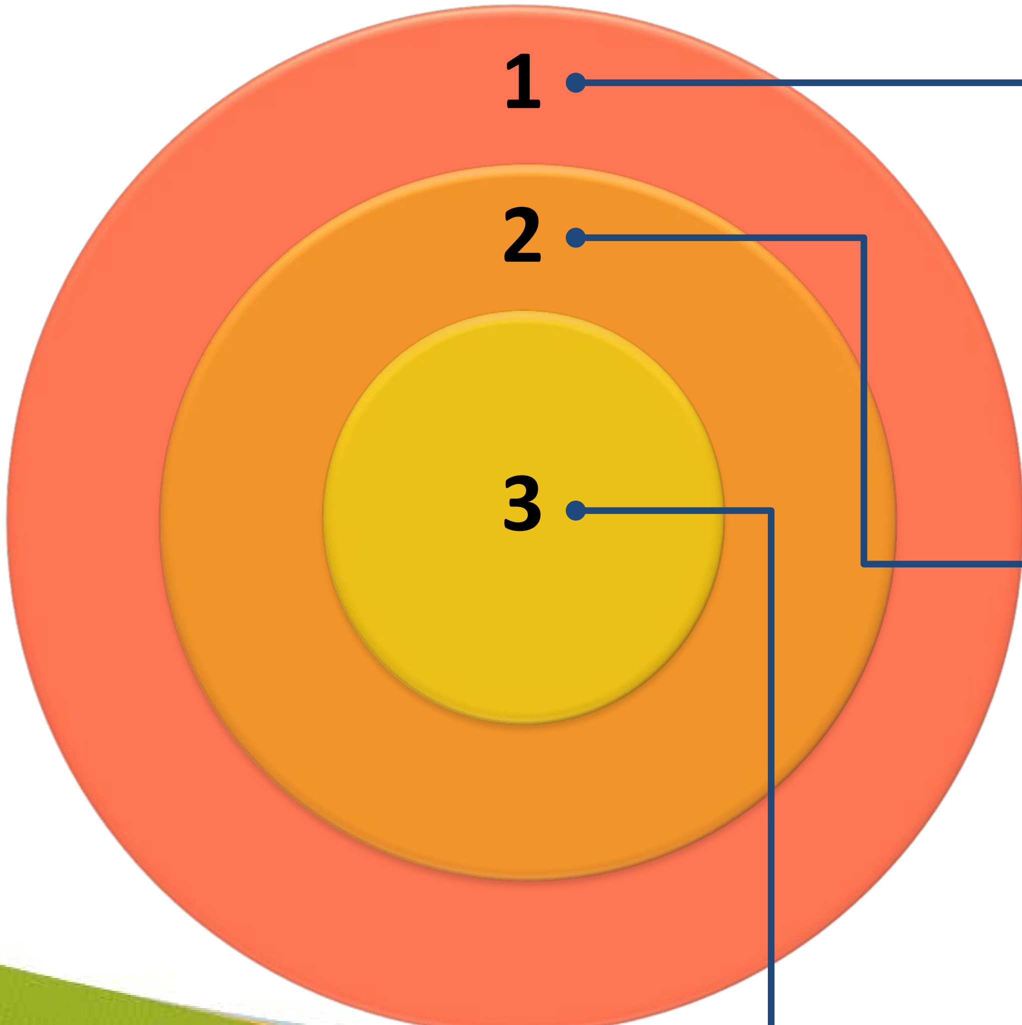
Uncertainty

Resiliency is a Response to Uncertainty

- Build redundancy into plans
  - Multiple lines of defense
  - Integrated stormwater / flood plan for community and region
- Adaptive Design
  - Build out of a long term strategy over time

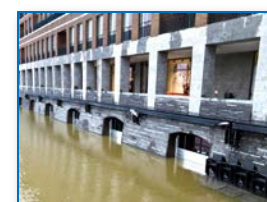
Multiple Lines of Defense

A Dutch approach for *integrated* water management



<u>Outer Layer of Defense</u> (Regional) –
Larger, engineered solutions

<u>Middle Layer of Defense</u> (NY Region) –
Connecting “transition” zone



<u>Inner Layer of Defense</u> (Local) –
Smaller-scale solutions, green infrastructure

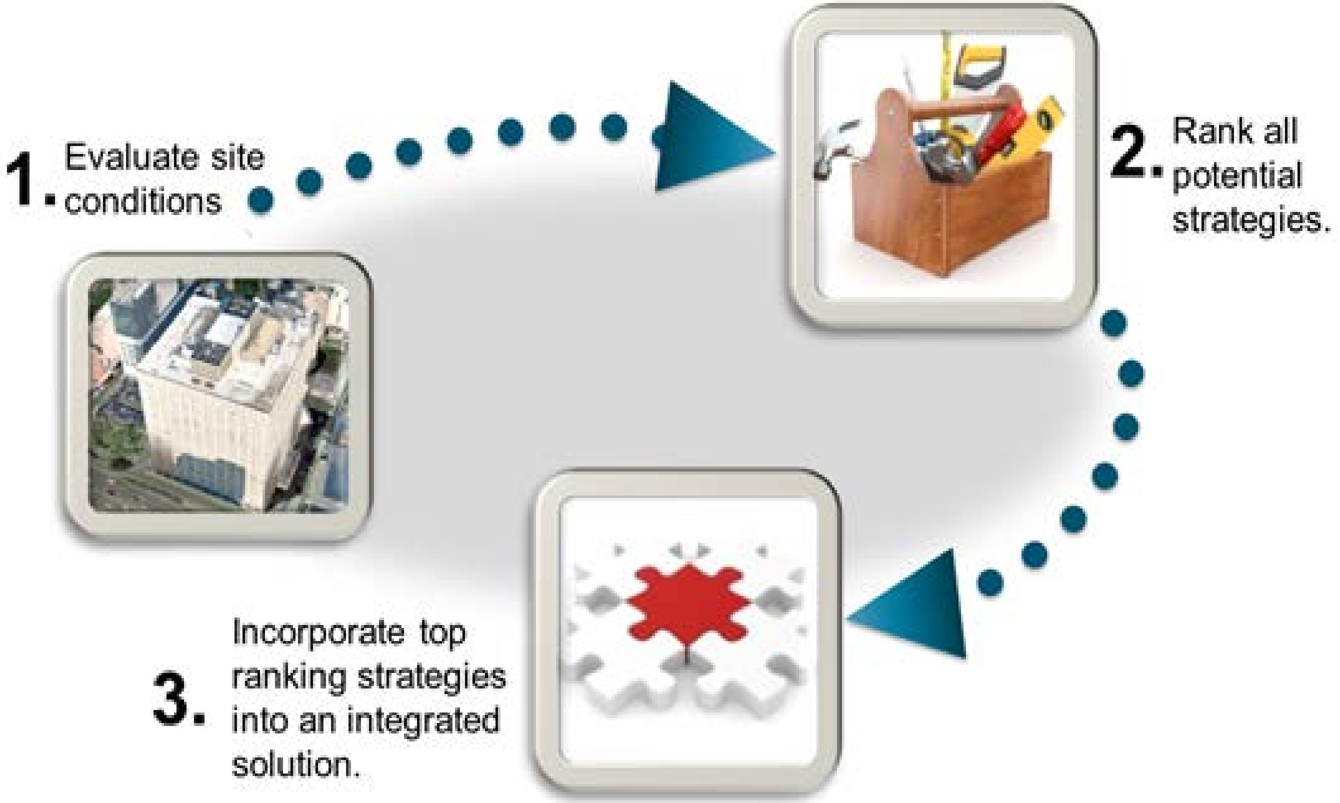
Levees and Flood Walls
Movable Barriers
Flood Gates

Water Plaza

Water Plaza

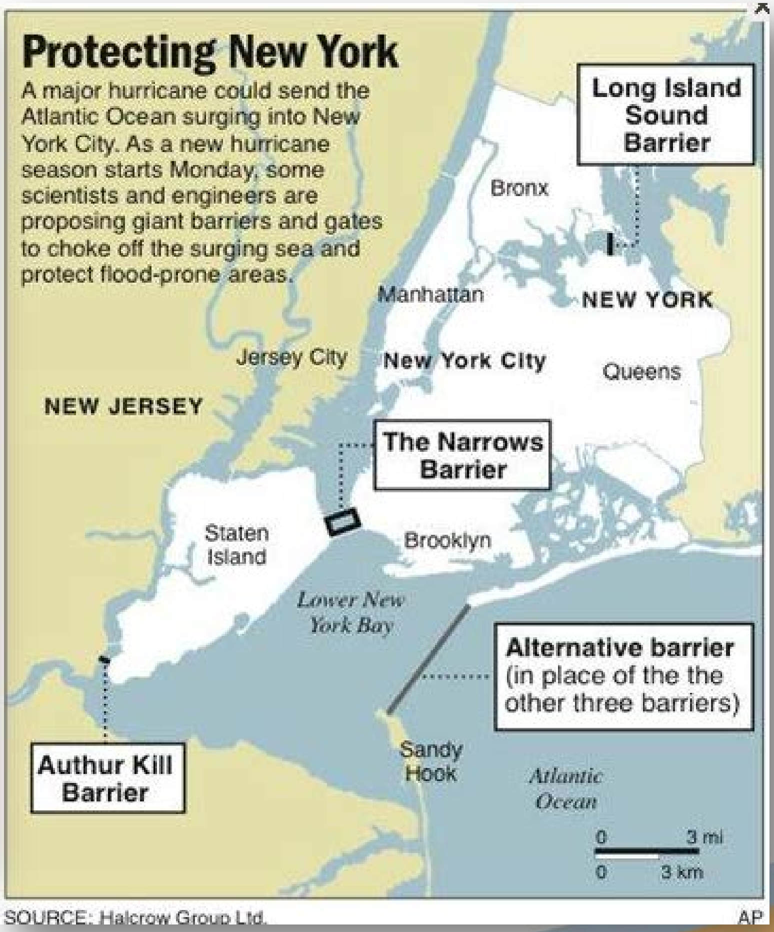
Designing Resiliency

Computer modeling is an essential tool for approximating future conditions.



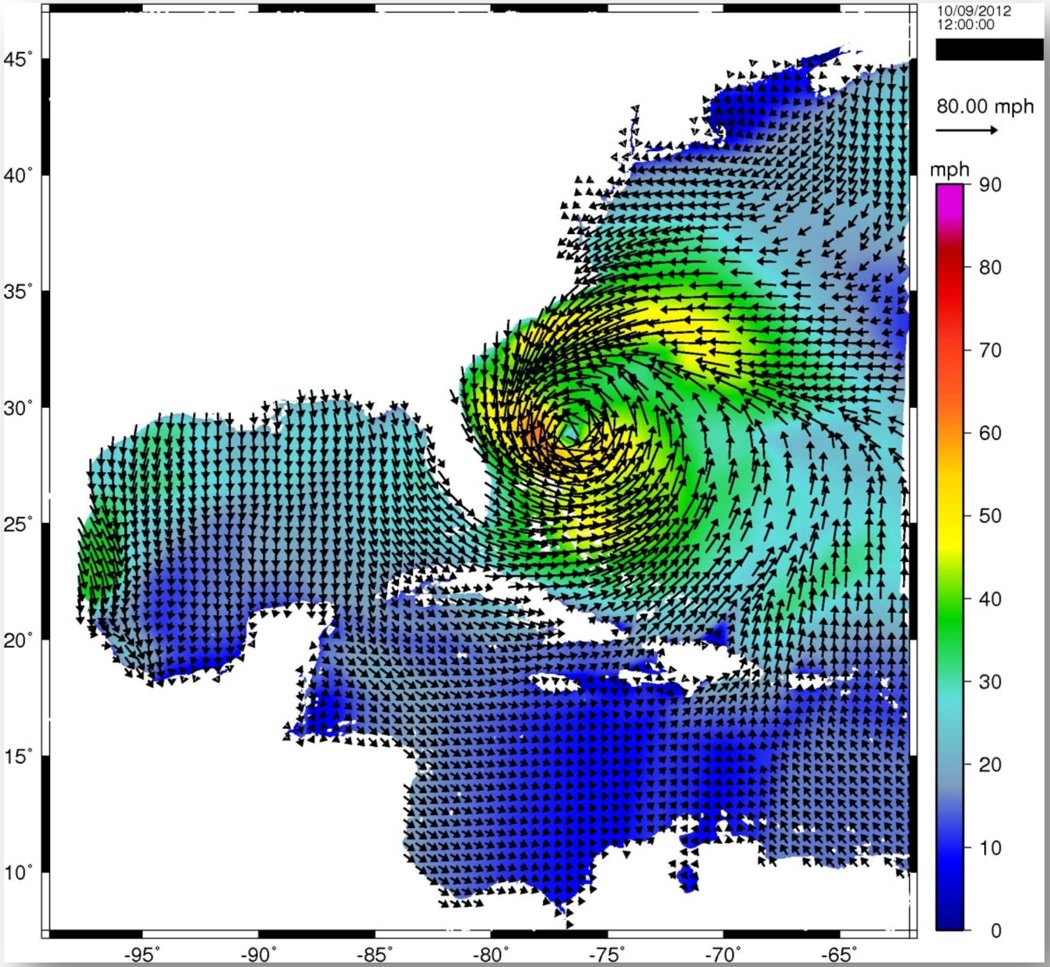
EXAMPLE: Hurricane Sandy – Atlantic City

Proposal: Dutch approach to flood protection. **NYC Barriers?**

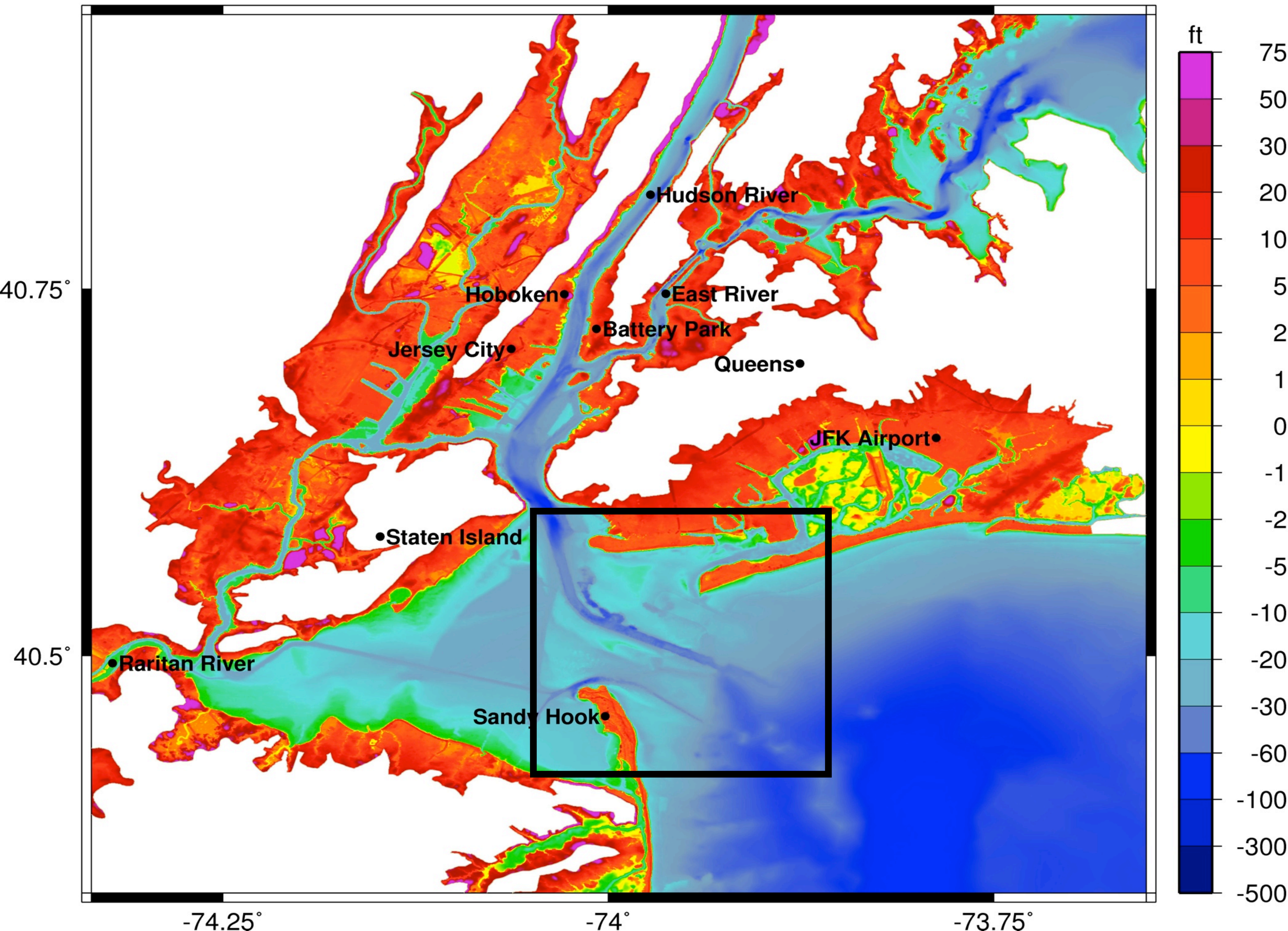


Sandy Wind Field

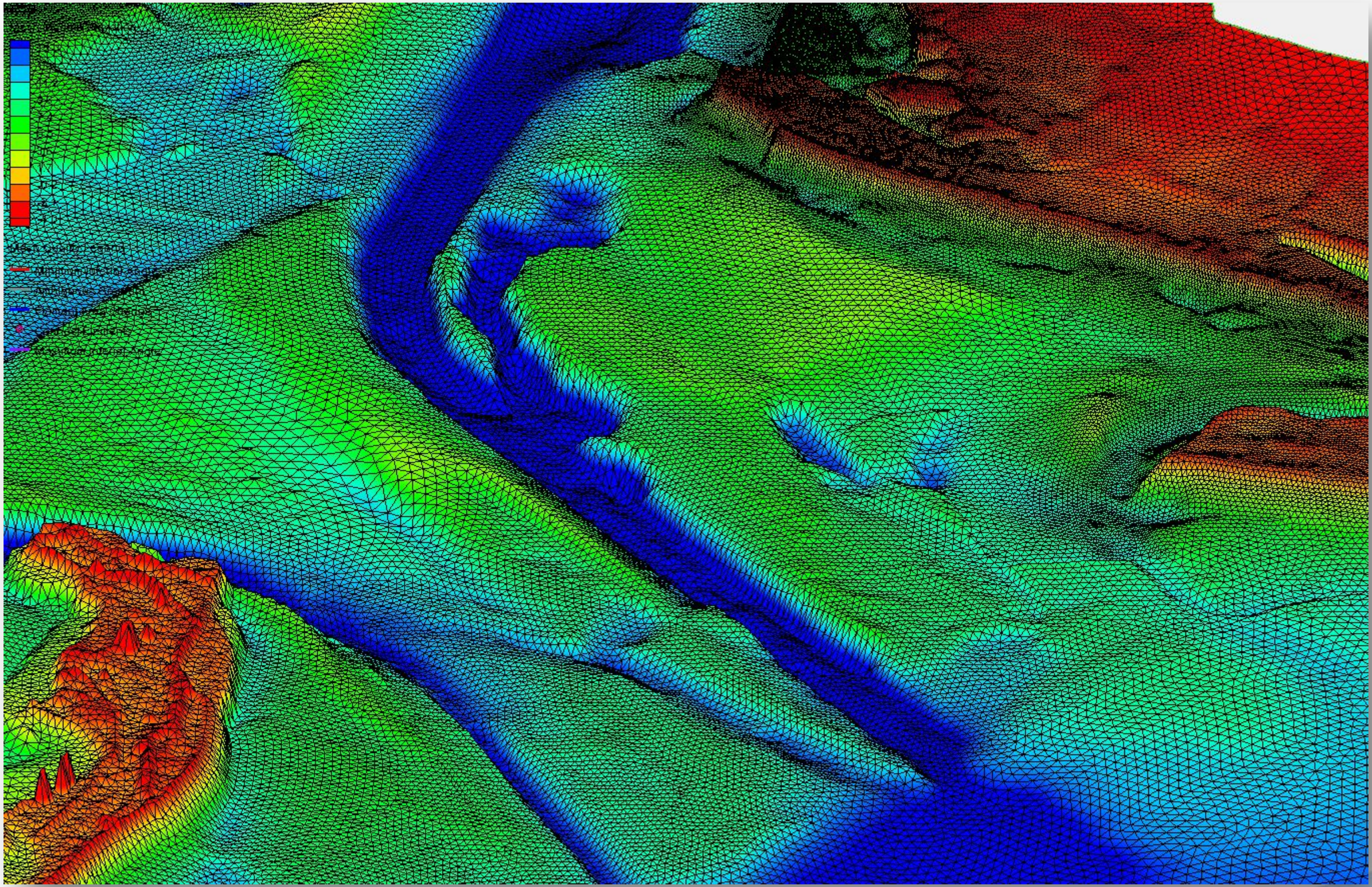
Remote forcing due to enormity of the storm requires basin-scale model



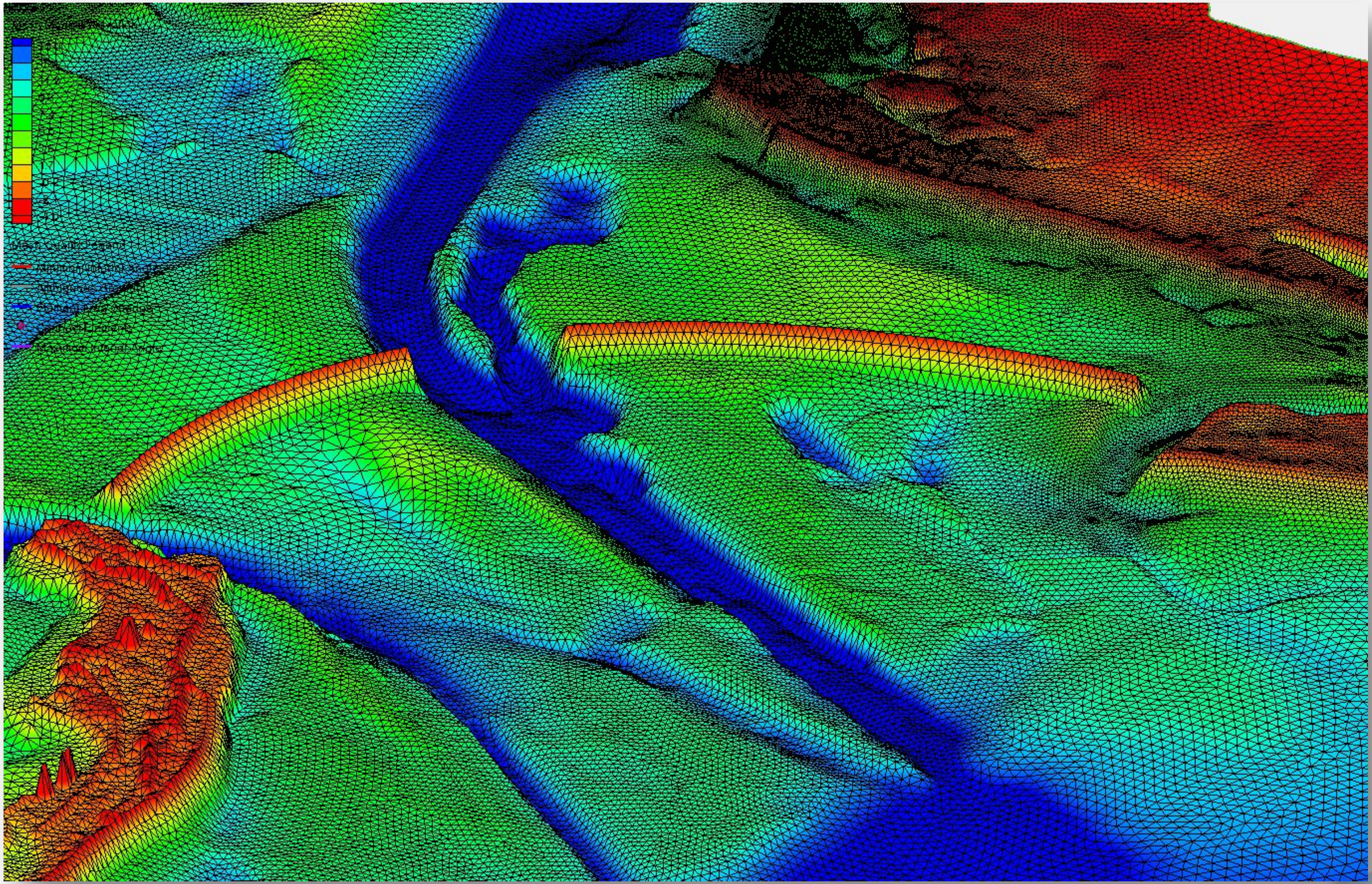
FEMAR2 Mesh Bathy



City Wide Barrier – Before



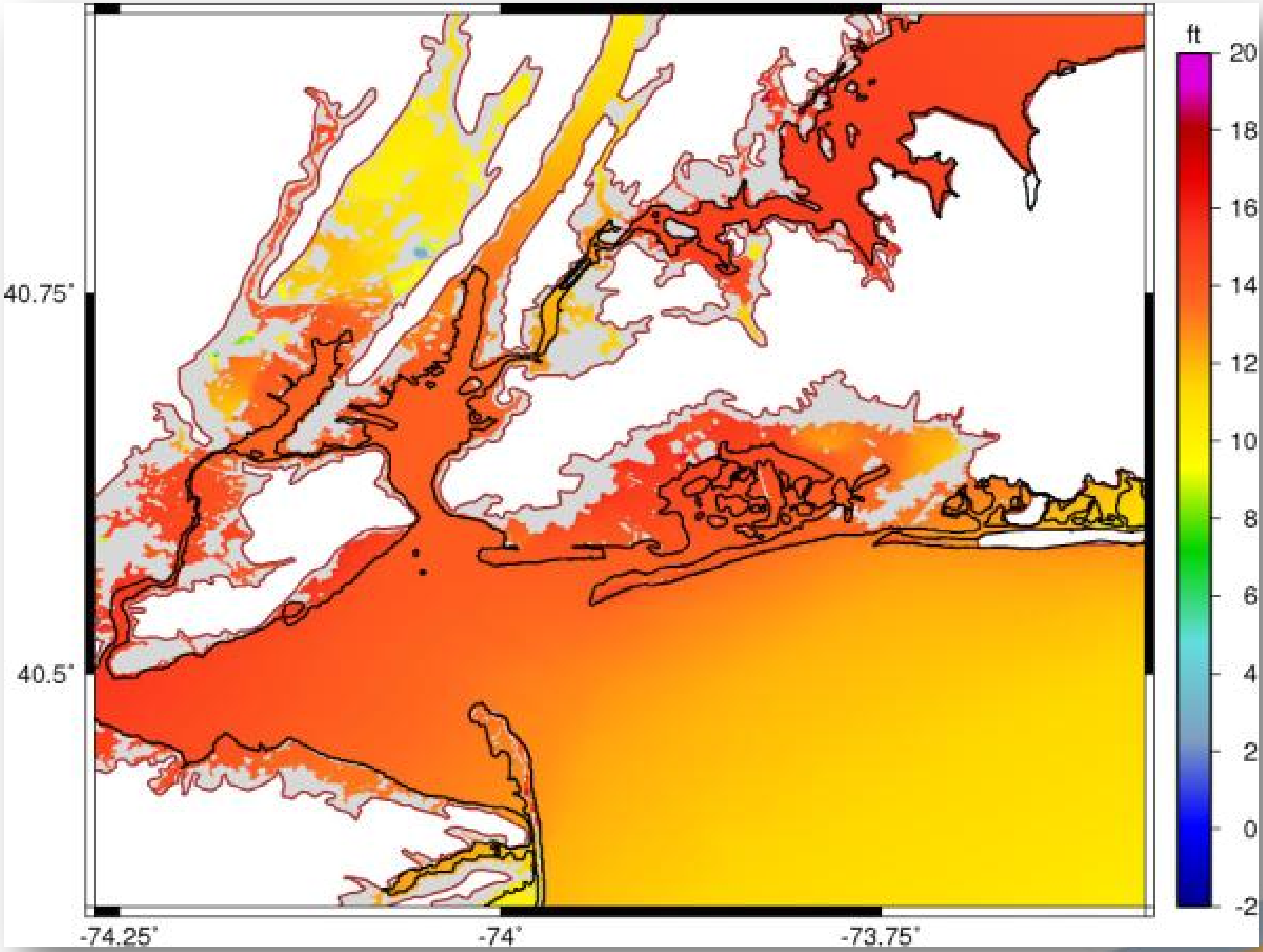
City Wide Barrier – MSL+12



Sandy 2050

Without project

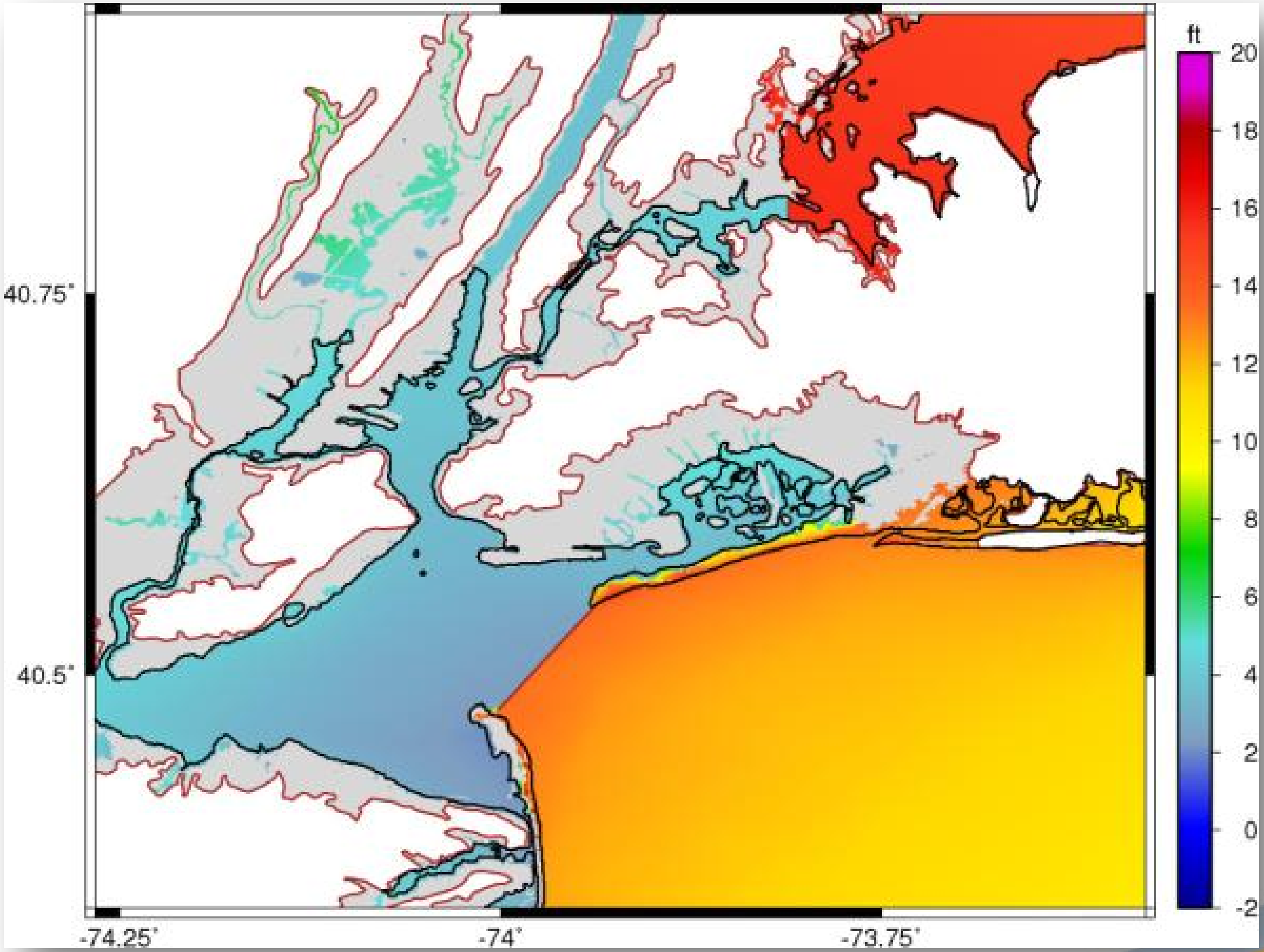
Storm Surge (ft)



Sandy 2050

City-wide surge barrier

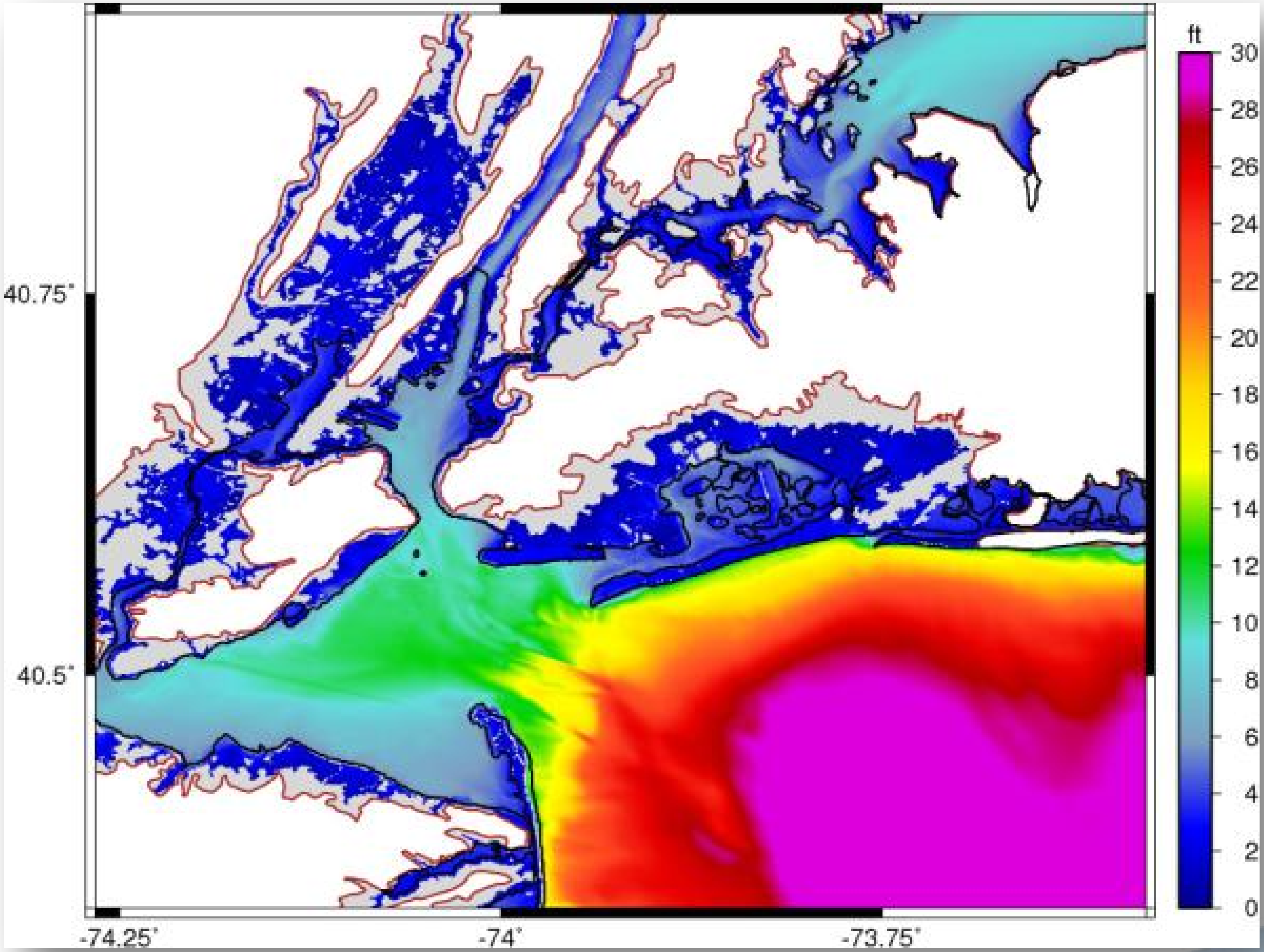
Storm Surge (ft)



Sandy 2050

Without project

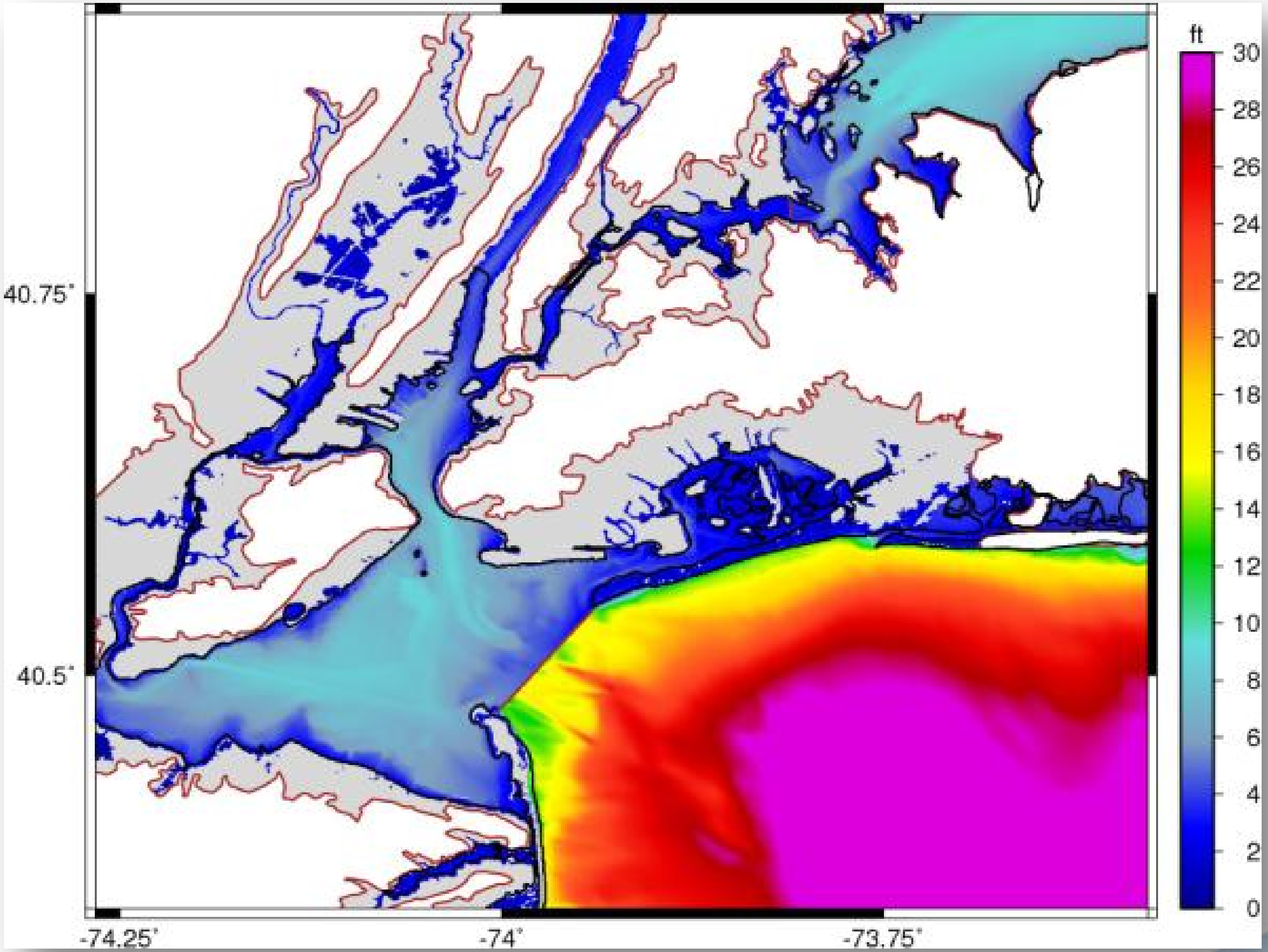
Wave Height (ft)



Sandy 2050

City-wide surge barrier

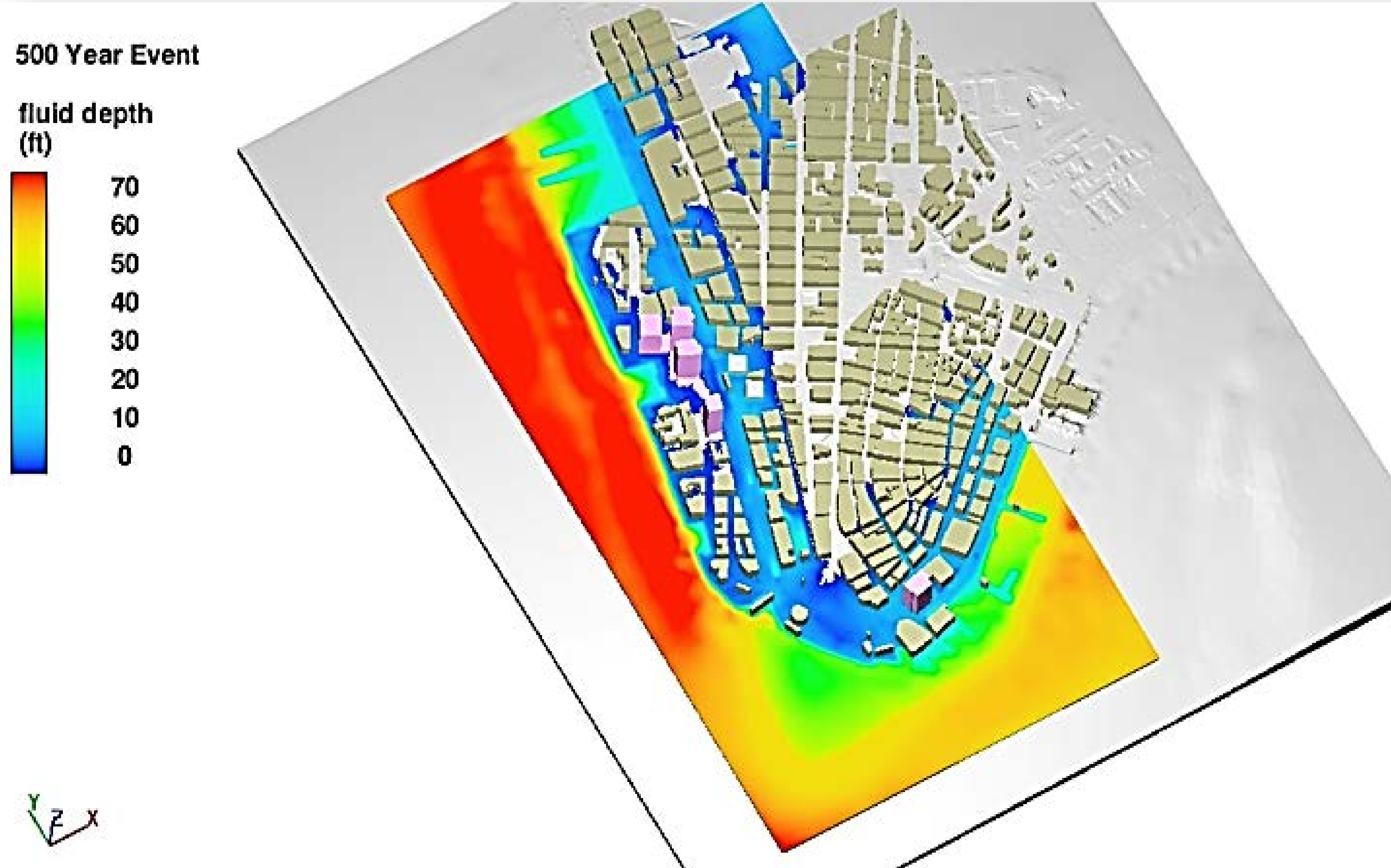
Wave Height (ft)



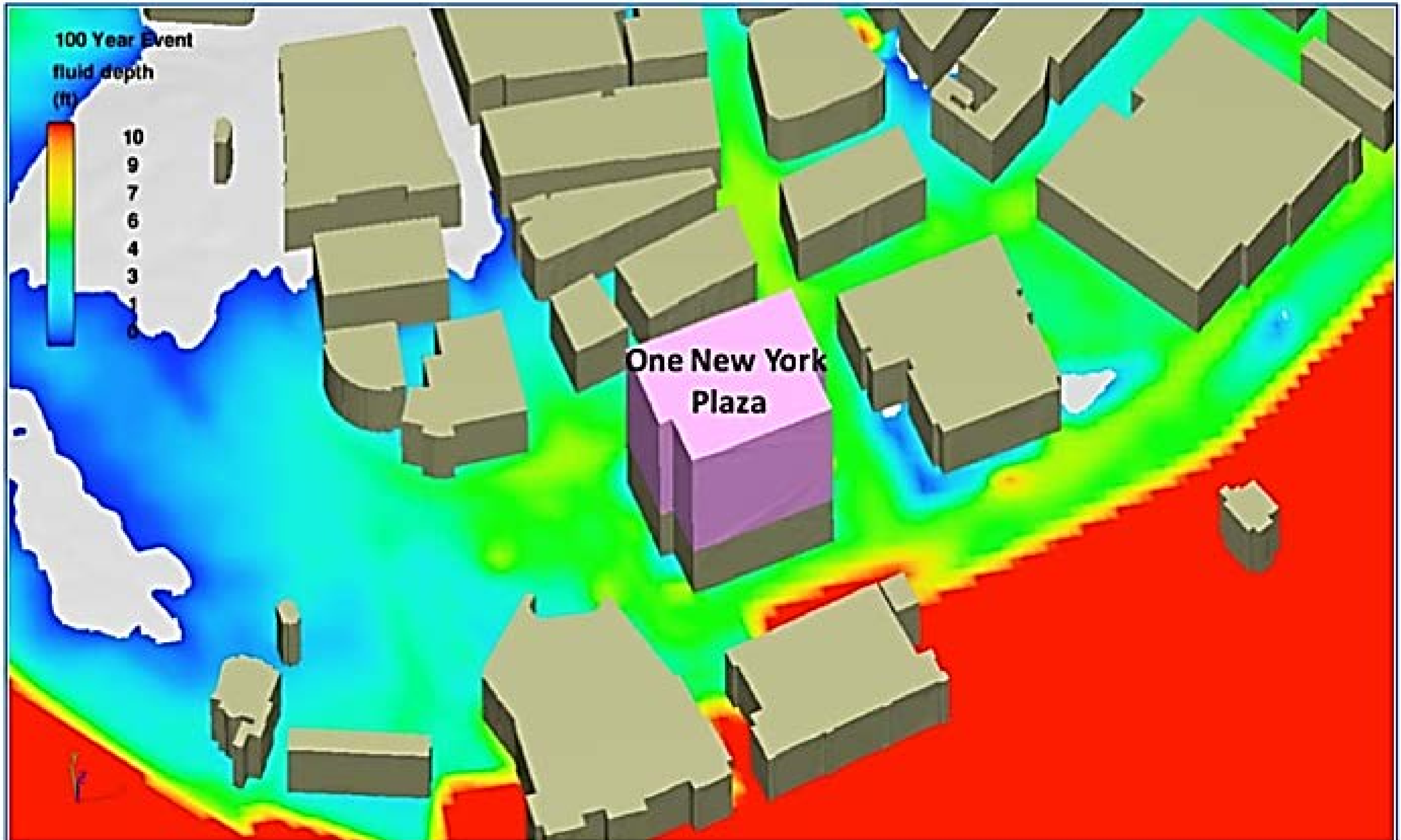
Flood Propagation through Urban Area

- Three-dimensional model
- Computes fine detail of flow dynamics and forces
- Used to design structures to accommodate flooding

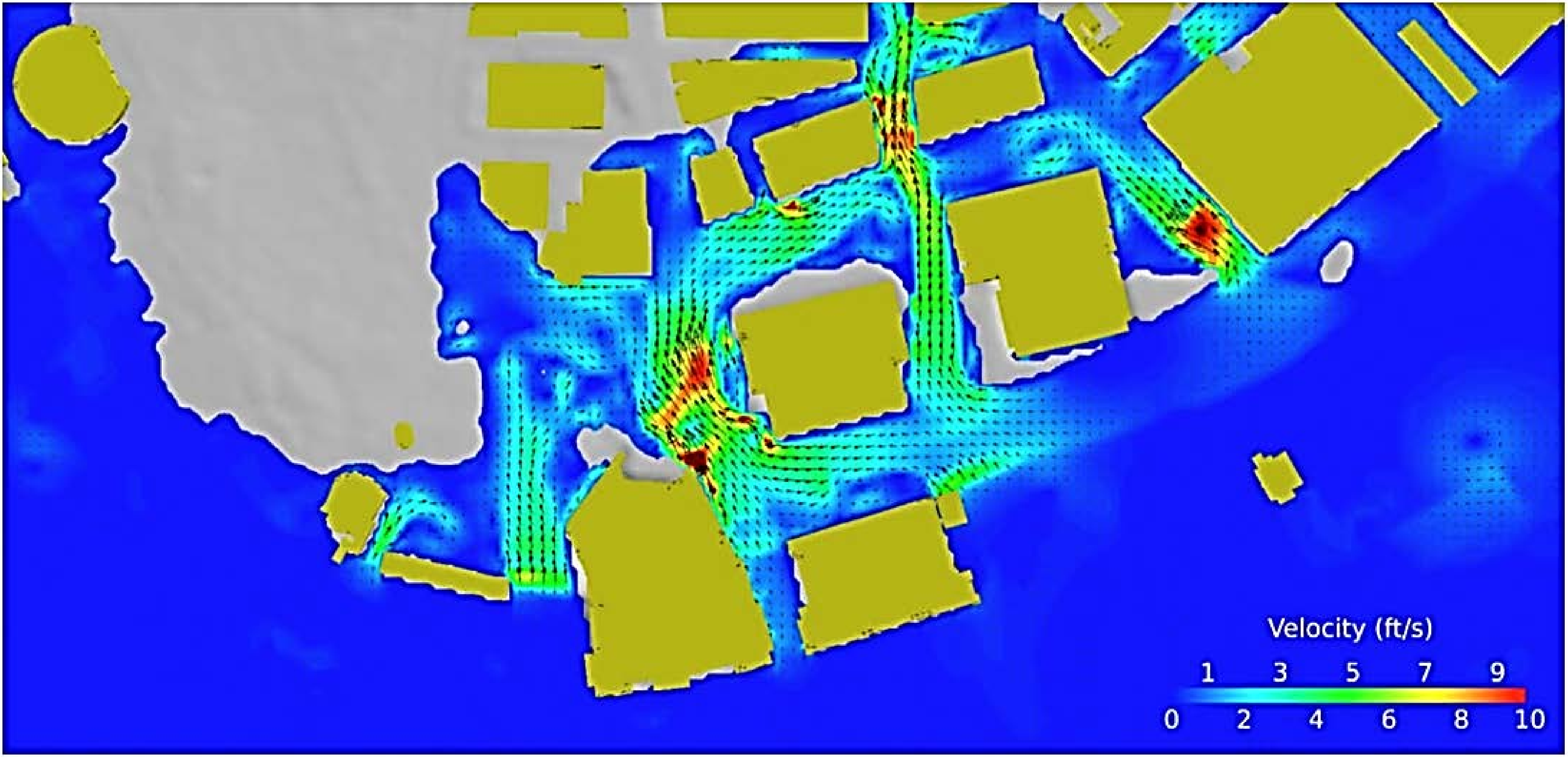
Urban Flow Model


500 Year Event
fluid depth
(ft)
70
60
50
40
30
20
10
0
Y
Z
X

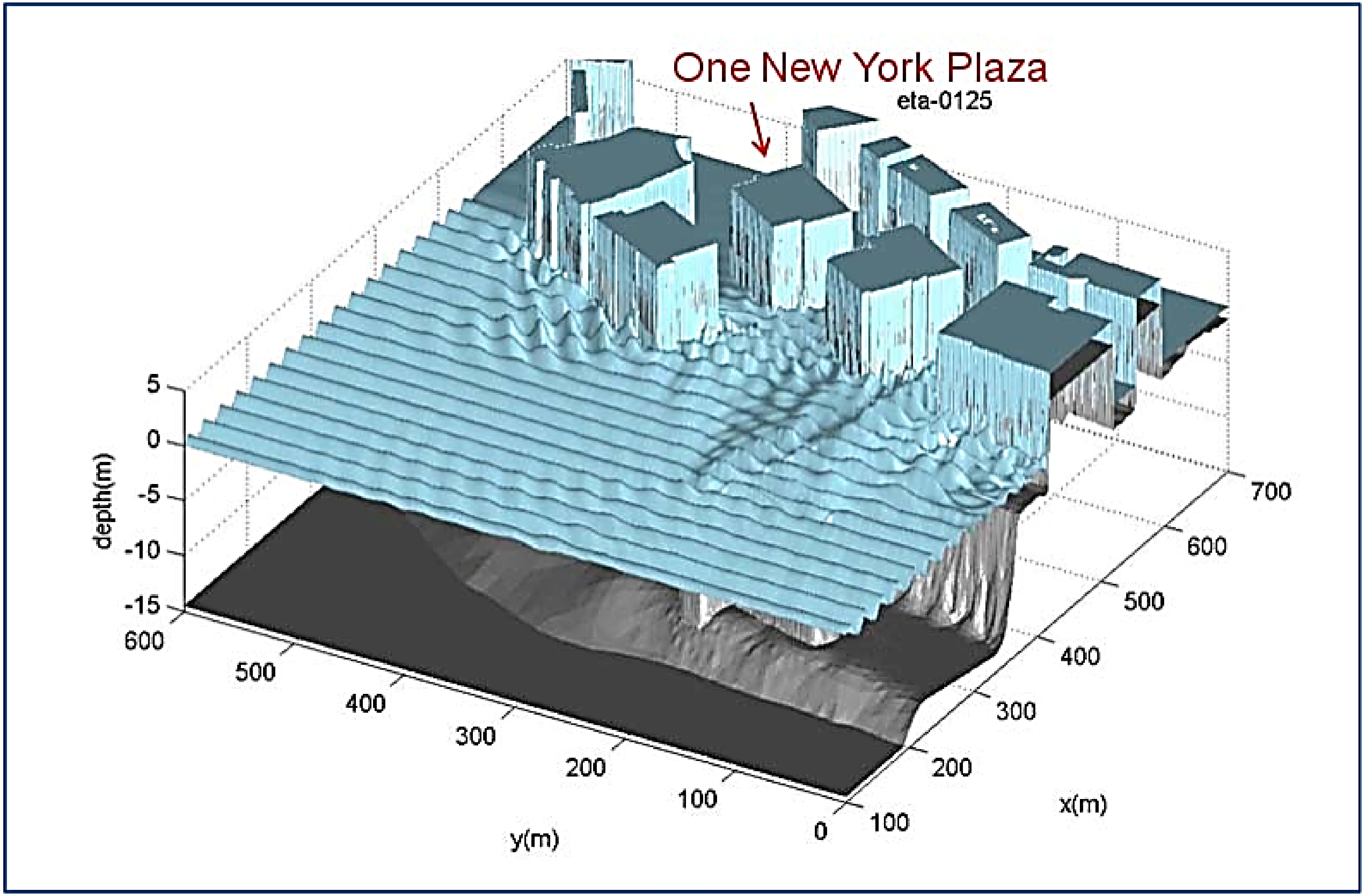
Water depth for 500-year event



Water velocity for 500-year event



Wave conditions for a 500-year event



RESILIENCY

- Requires pro-active planning for an uncertain future
- Flood proofing with multiple lines of defense
- But its more than that …

Not just new construction…

- Maintenance
- Check valves
- Consider gravity drainage of treatment plants
- Can we relocate essential items (generators, communication equipment, etc.)
- Zoning to control development
- Update evacuation plans

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RESILIENCY

- Requires pro-active planning for an uncertain future
- You don't have to build everything right now …
- *But you <u>must have</u> a long-term strategy*
- Adaptive Design

RESILIENCY

- Requires consideration of whole system
- Need realistic and physically correct modeling
- Evaluate protection and mitigation options
- Site-specific details …
- … within a comprehensive regional strategy

Many Funding Alternatives Available

John Mastracchio

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Show Me the Money!

Funding Approaches

- General Fund / Direct Taxation
- Stormwater Utility Fees
- Watershed Improvement Districts
- Permit and Plan Review Fees
- System Development Charges

Capital Funding/Financing Options

- PayGo
- Long-Term Debt
- Grants
- Public-Private Partnerships

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A Systematic Process to Develop a Funding Strategy Leads to Successful Implementation

- 4 Steps to identifying and evaluating funding alternatives

STEP 1
ID and Prioritize Goals and Objectives

STEP 2
ID Candidate Alternatives and Strategies

STEP 3
ID Revenue-Generating Capabilities of Alternatives

STEP 4
Recommend and Implement Funding Strategy

Funding Approaches

Funding Approach:

Ad Valorem Tax (Real Estate)

- Direct tax on real estate property values
  - E.g., $0.01 per $100 of assessed property value
- Advantages
  - Simple to set up and administer (e.g., billing on tax bill)
    Tax deductible from State and Federal taxes
- Disadvantages
  - Equity (poor relationship to stormwater impact)
  - Limited incentive to reduce stormwater impact
  - Revenue fluctuates with property value
  - Competition for use of tax dollars

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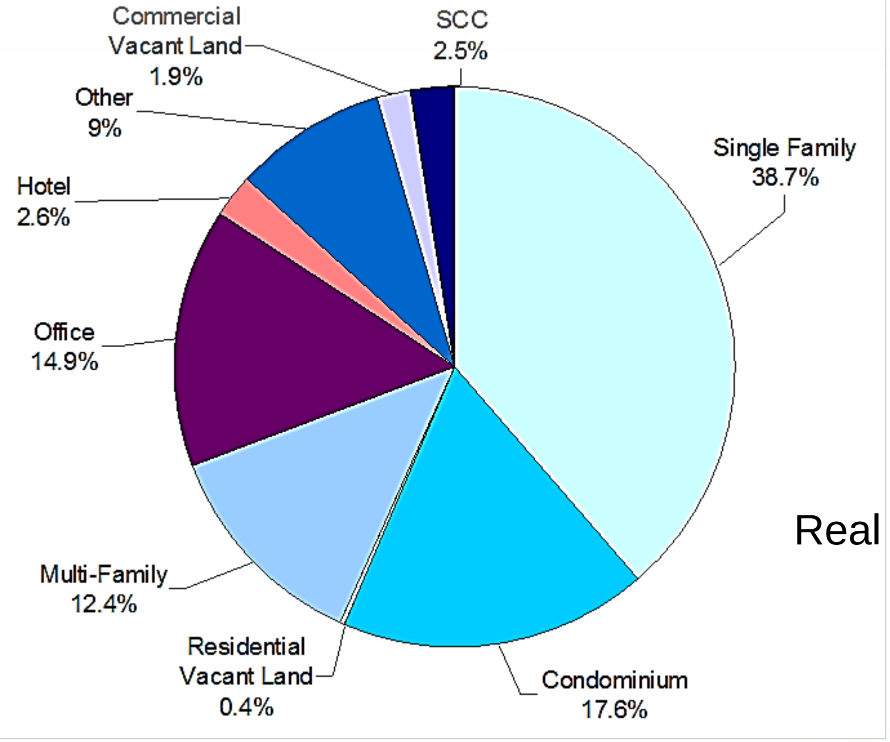
Funding Approach:

Ad Valorem Tax (Real Estate)

- Implementation Issues
  - May require a vote as part of budget process
  - Public involvement
- Examples
  - Arlington County ($.013)
  - Fairfax County ($0.02)
  - City of Alexandria ($0.005)

Example: Dedicate $0.01/$100 Assessed Value for Stormwater

Assessment Year	Estimated Revenue for Dedicated $0.01 per $100 Assessed Value
2014	$ 3,502,609



Real Estate Tax Base

Funding Approach: Stormwater Utility Fees

Definition:

A method of providing a dedicated funding source for a municipality's stormwater management program

Features:

- **Typically set up as an enterprise fund**
- **Enabling legislation varies state by state**

Funding Approach:
Stormwater Utility Fees

- Advantages
  - Equity (Fees based on impervious area)
  - All properties pay (including tax exempt properties)
  - Billing could be included on the tax or utility bill
  - Dedicated funding source
  - Reduces reliance on the General Fund
- Disadvantages
  - All properties pay (including tax exempt properties)
  - More complicated to set up initially
  - Potential Initial Public resistance to a “rain tax”
  - Ongoing administrative burden

Funding Approach:
Stormwater Utility Fees

- Implementation issues
  - Requires ordinance adoption
  - Public outreach needed
- Applicability
  - All stormwater-related services

Typical Steps to Establish a SWU

1. **Develop a feasibility study**
   - Program revenue requirements
   - Infrastructure and staffing needs
   - Rate structure
   - Public outreach
   - Policy and regulatory issues
   - Implementation strategy
2. **Adopt ordinances**
3. **Implement billing procedures**
4. **Provide services**

Policy Considerations

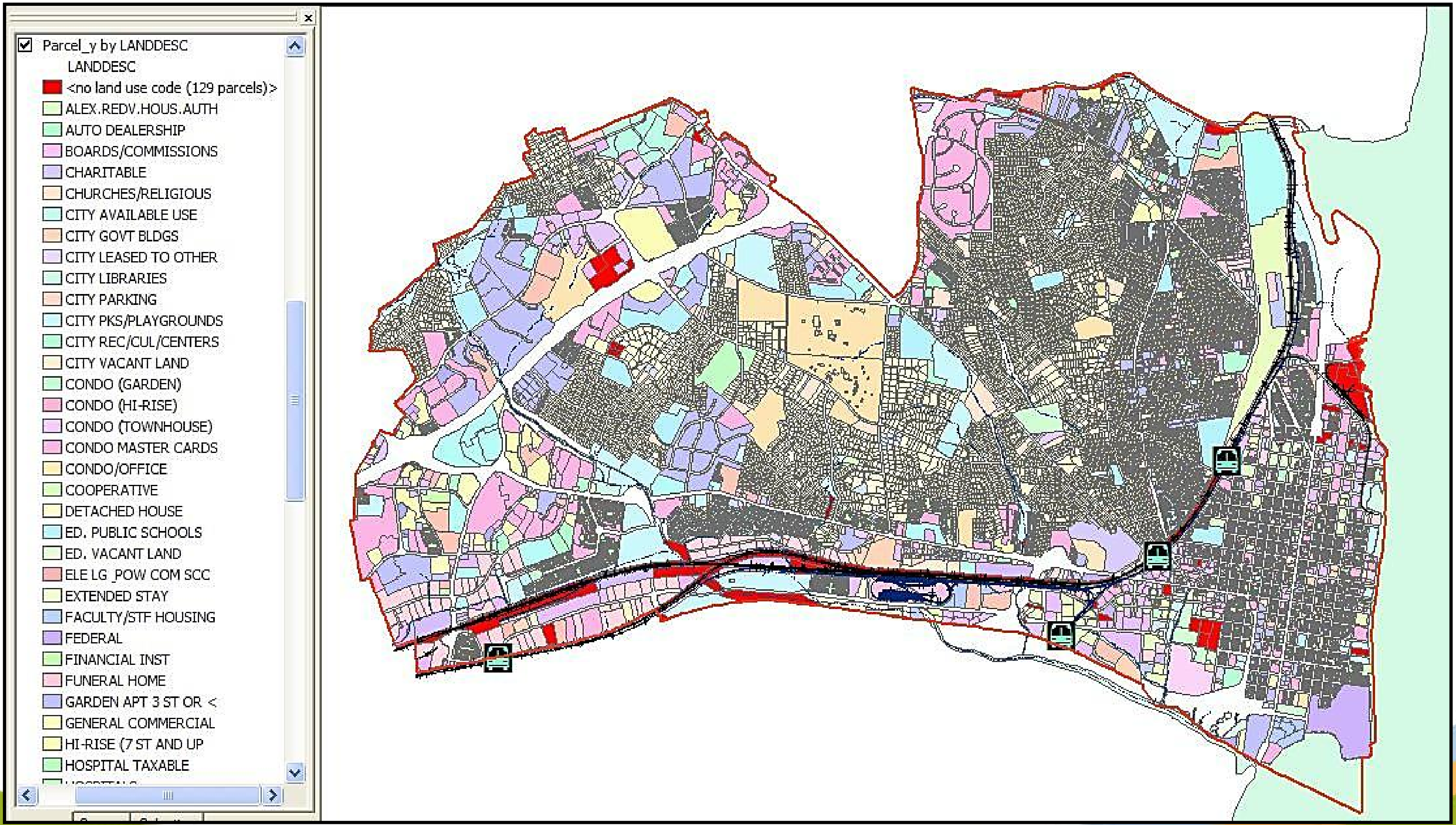
Address Impacts on Rate Structure and Revenue Estimates

- Should tax-exempt parcels be billed?
- How would the utility impact organization and staffing?
- What is the definition of an improved property?
- How should facility maintenance issues be handled?
- What options / requirements do developers have?
- What are the criteria for credits/fee adjustments?

How Are Fees Determined?

- The stormwater fee is based on…
  - Contributions to stormwater runoff
    - Amount of impervious area of each property
    - Pollutant load from each property
  - The types of services and the cost of the program
  - Policy decisions

GIS Data – the Foundation for the Rate Structure



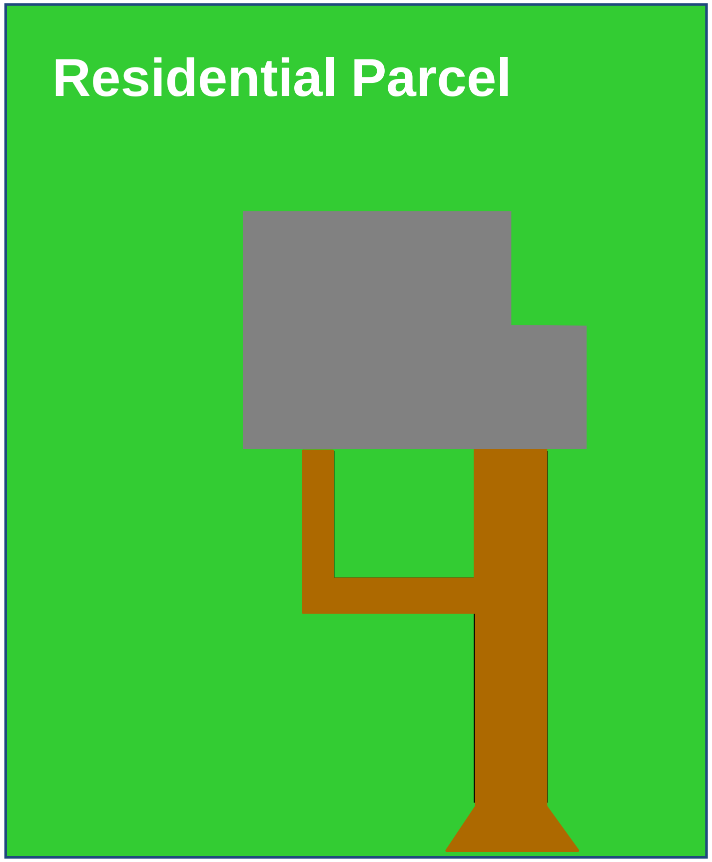
The Selected Rate Structure Should be Fair and Simple

Residential →	Flat Fees
Nonresidential & Multi-Family Residential →	Actual Impervious Area
Undeveloped →	No Fees

Range of fees Nationwide: $9 - $210 / yr / unit

The Typical Residence Defines the Base Unit (*equivalent residential unit*)

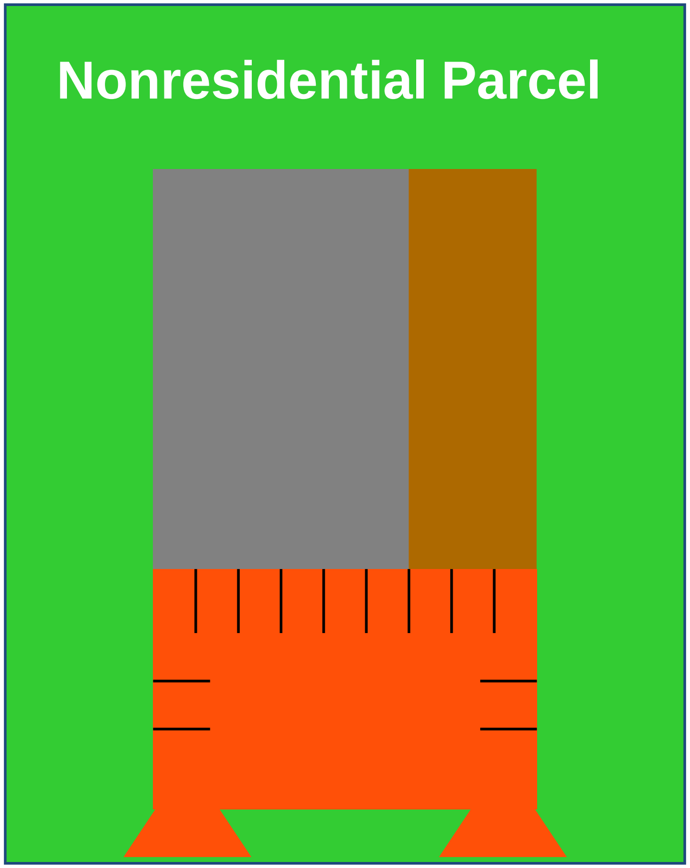
House Area	1,550 ft^2
Other Impervious Area	420 ft^2
Total	**1,970 ft^2**



Single Family Detached

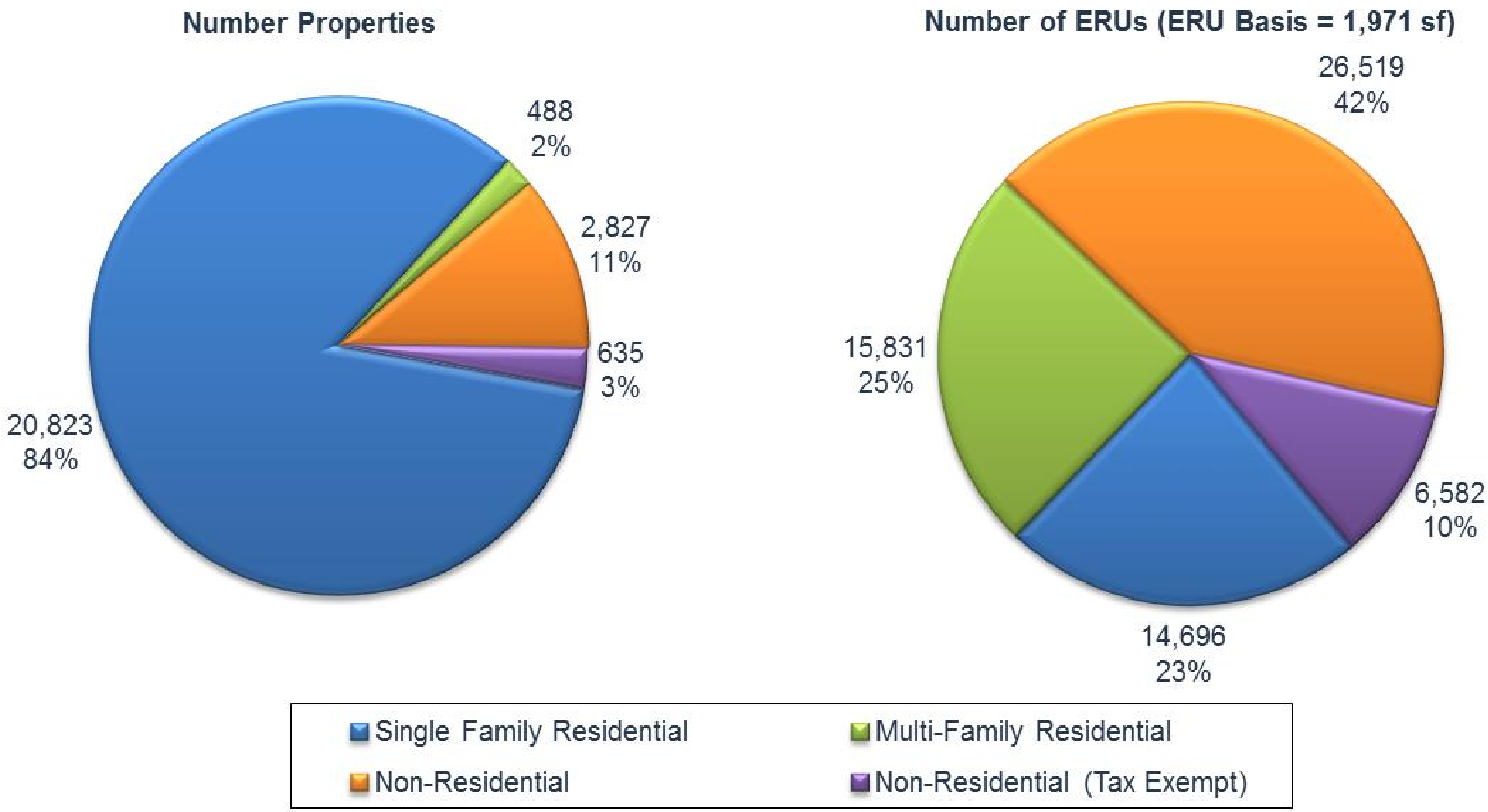
Non-Residential & Multi-Family Billed as Multiples of the Base Unit

Building Area	6,000 ft^2
Parking	10,000 ft^2
Other Impervious Area	3,700 ft^2
Total	**19,700 ft^2**



Equitable Contribution

Based on Impervious Area Distribution



Show Me the Money!

Funding Approaches

- General Fund / Direct Taxation
- Stormwater Utility Fees
- Watershed Improvement Districts
- Permit and Plan Review Fees
- System Development Charges

Capital Funding/Financing Options

- PayGo
- Long-Term Debt
- Grants
- Public-Private Partnerships

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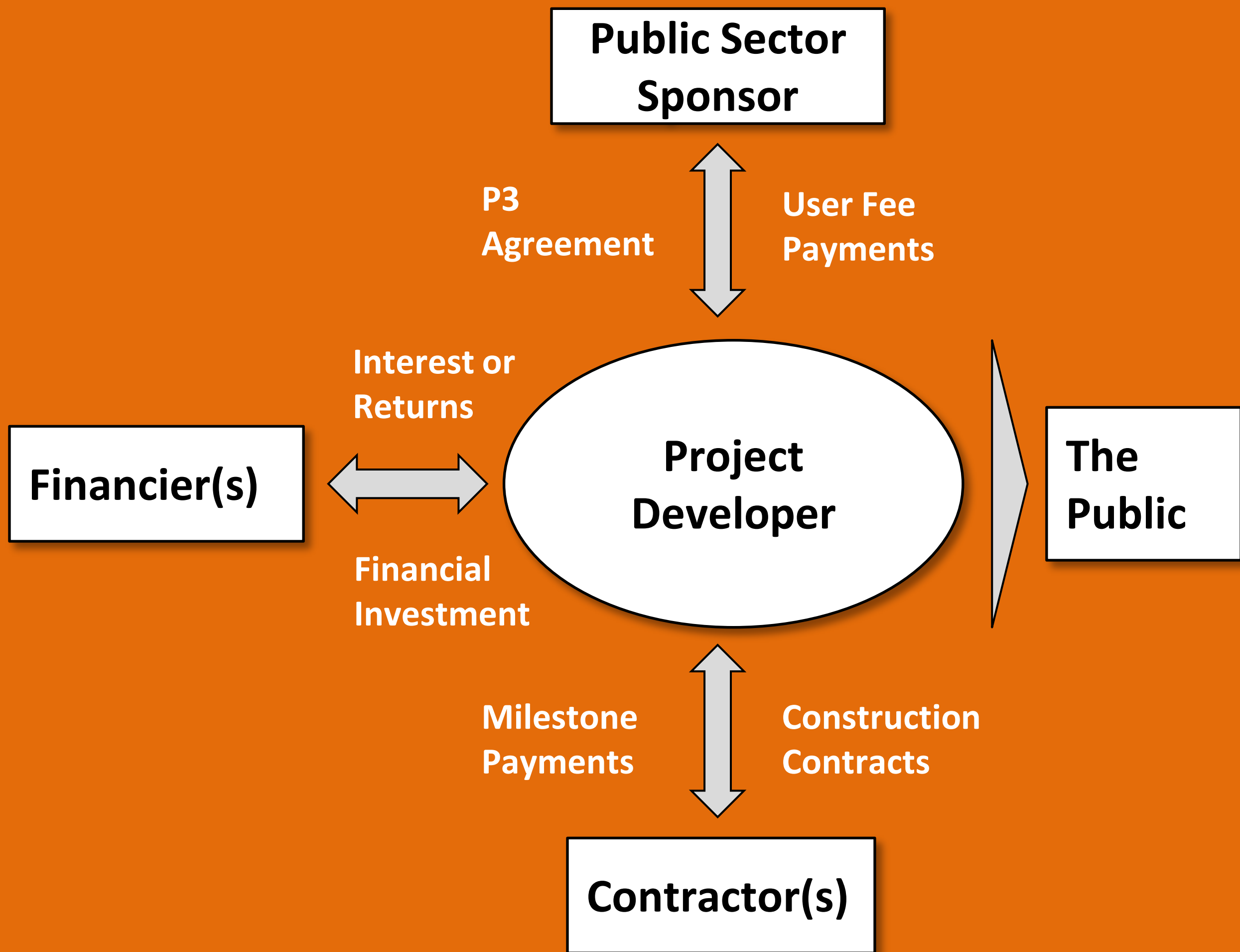
Funding Alternative - P3s



Key Considerations

Maintain Public Control

Public sector holds ultimate ownership of asset, regardless if it is newly constructed or existing prior to lease

Deliver Much-Needed Assets

Public sponsors can leverage P3 to deliver assets in a tight budget environment

Drive Value Creation

P3 projects must provide public value creation and satisfy numerous project, government, and general public requirements

Public-Private Partnerships

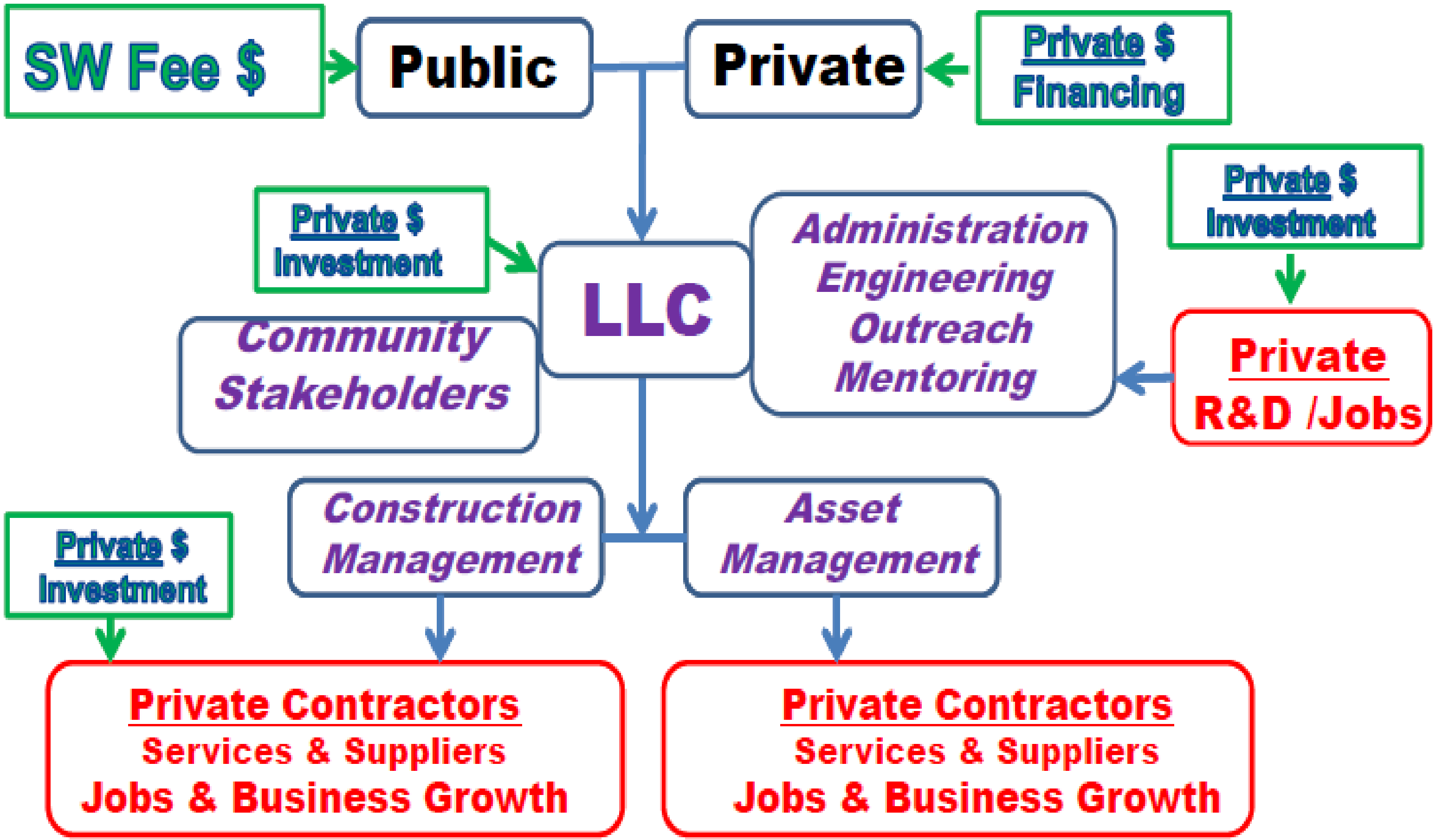
Advantages

- Potentially lower capital and maintenance costs
- Accelerated capital implementation
- Preserve financing capacity
- Risk transfer

Disadvantages

- Private financing costs typically higher than tax-exempt municipal debt

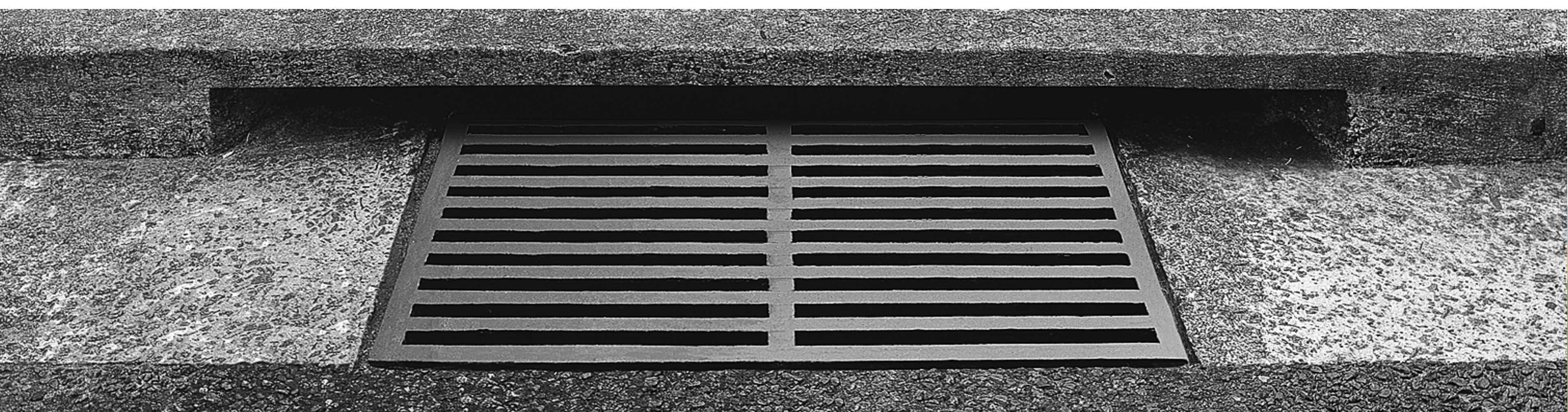
Prince George's County P3 Model



Source: Prince George's County, MD Urban Retrofit P3 Model

Takeaways

- Several funding approaches and alternatives
- Successful funding strategies tend to include multiple funding sources
- Implementation requires significant planning and stakeholder input
- Practical funding alternatives will facilitate acceptance



Discussion

- What are my City's resiliency needs?
- What are the barriers for green infrastructure implementation?
- How is my City addressing stormwater MS4 permits and TMDL compliance?
- What are my concerns and/or lessons learned in implementing stormwater funding mechanisms
- Open Q&A

Contact Information

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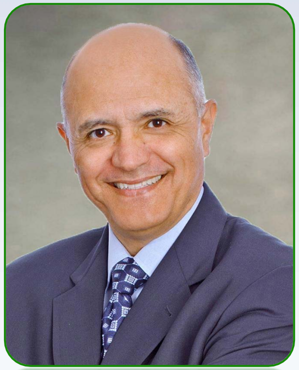

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