

# Modeling BMP Design under a Changing Climate

2017 STAC Workshop

Monitoring and Assessing Impacts of Changes in Weather Patterns and Extreme Events on BMP Siting and Design

Annapolis, MD | September 7-8, 2017

*Scott Job, Tetra Tech*

*Maureen Harris\*, Susan Julius+, Britta Bierwagen+, Jon Butcher\**

*\*Tetra Tech, +USEPA ORD*

# Climate Change and Urban Stormwater Guide

- Goal of the Guide
  - Develop information for stormwater control that advances adaptation planning in the stormwater community to potential changes in climate
- Information draws on literature review and simulation modeling
- Today's presentation
  - Describe the simulation modeling approach
  - Share results and conclusions from the modeling

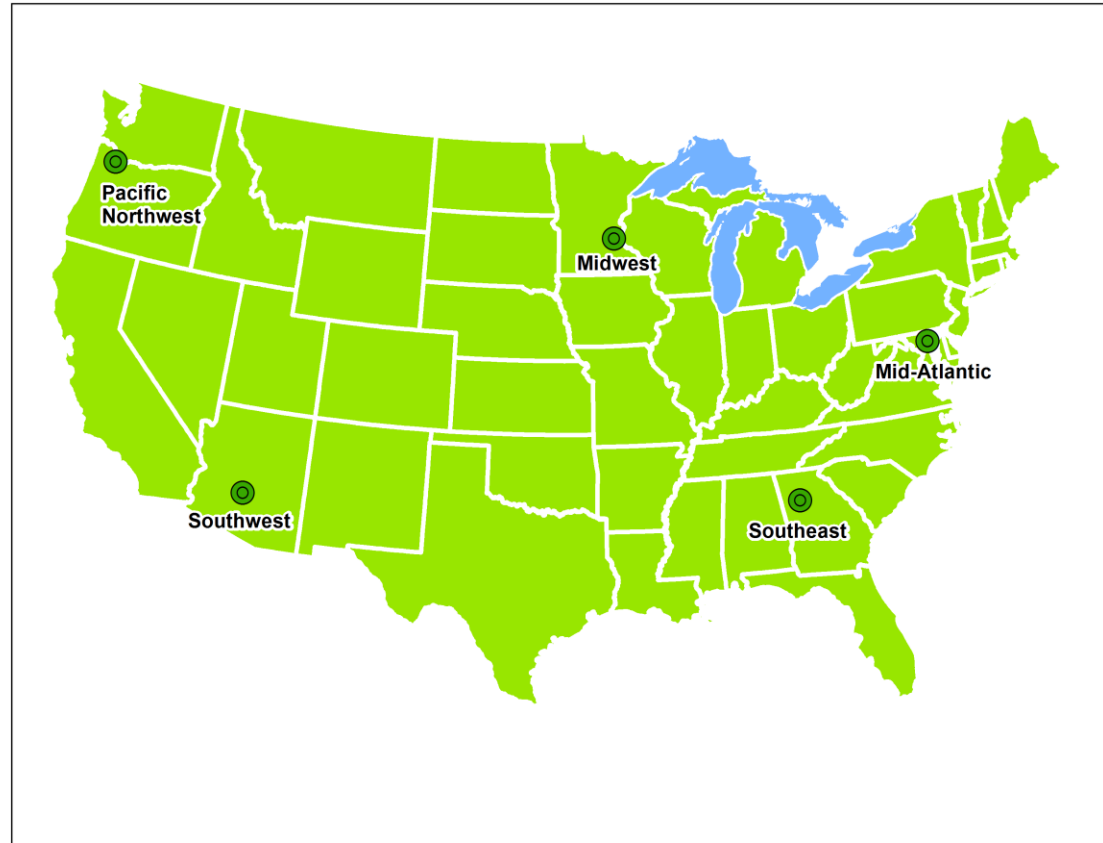
# Study Questions

1. Climate change impacts on stormwater infrastructure performance
2. Adapt stormwater infrastructure so site performance under future climate achieves current performance
3. Compare adaptation of gray infrastructure to green infrastructure (GI)

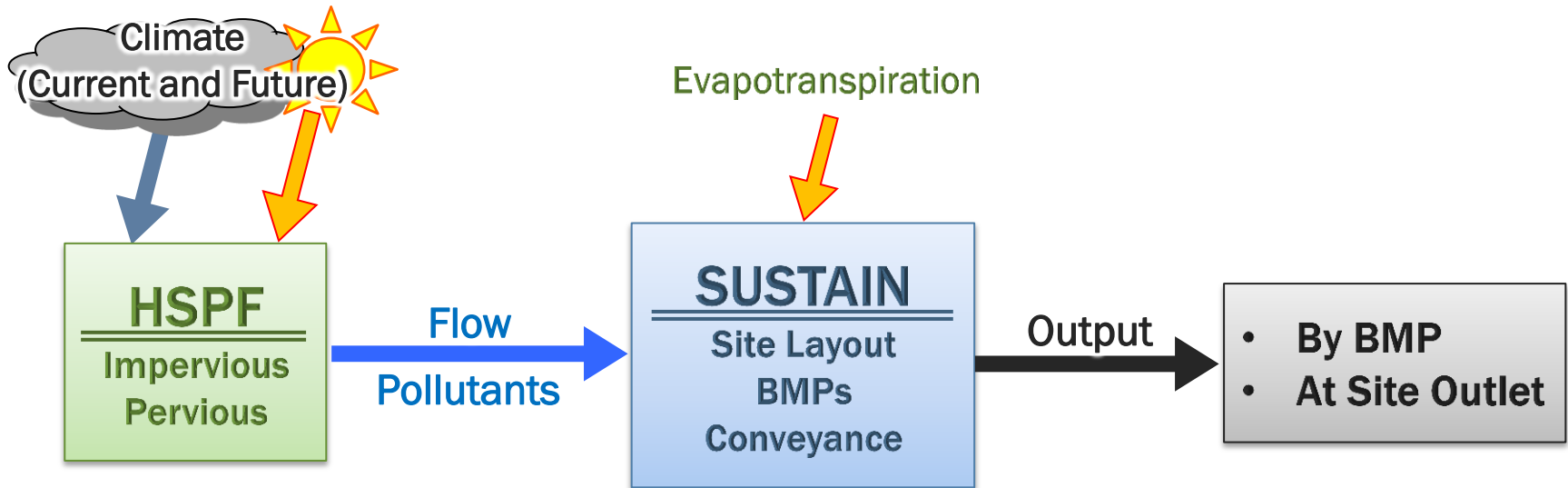


# Continuous Simulation Modeling Approach

- Site-scale focus
  - Five development types
  - Five geographic regions
- For each site
  - Different stormwater management approaches
  - Current and future climate
- Adaptation
  - modify BMPs to achieve current performance
- Performance metrics
  - Annual outflow volume
  - channel erosion risk and flooding risk
  - TSS
  - TN
  - TP



# Modeling Approach – Framework

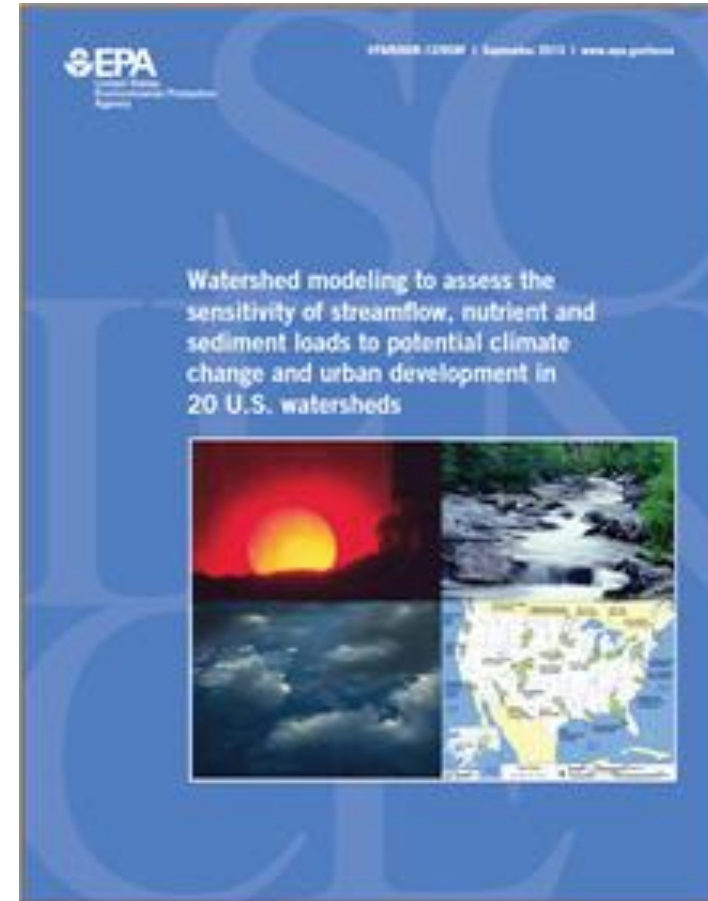


# Modeling Approach – Scenario Matrix

Region	Location	Development Scenario	Management Approach		
			Gray	Mixed	GI only
Midwest	Scott County, MN	Residential	X	X	X
Southeast	Atlanta, GA	Ultra-urban	X	X	
Mid-Atlantic	Harford County, MD	Mixed Use	X	X	
Arid Southwest	Maricopa County, AZ	Commercial	X		X
Pacific Northwest	Portland, OR	Green Street			X

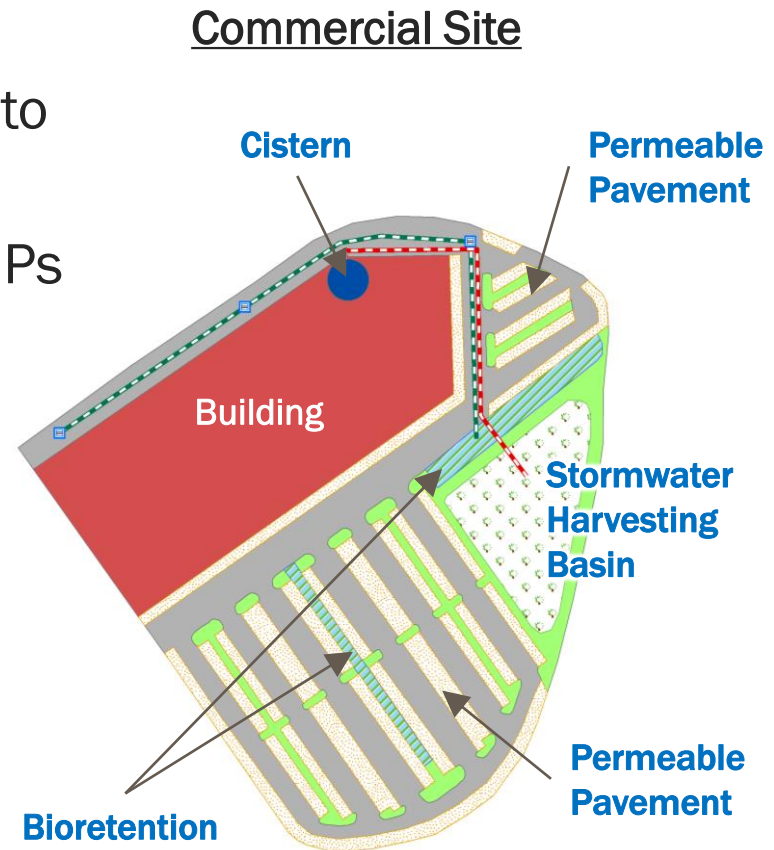
# Modeling Approach – Climate Scenarios

- Global Climate Models (GCMs)
  - From EPA “20 Watersheds” project
  - All locations: greatest increase in precipitation intensity
  - Midwest: additional low and medium intensity change
- Percent Change Scenarios
  - Midwest and Mid-Atlantic
  - Percent change factors to entire precipitation record
  - Evapotranspiration also adjusted



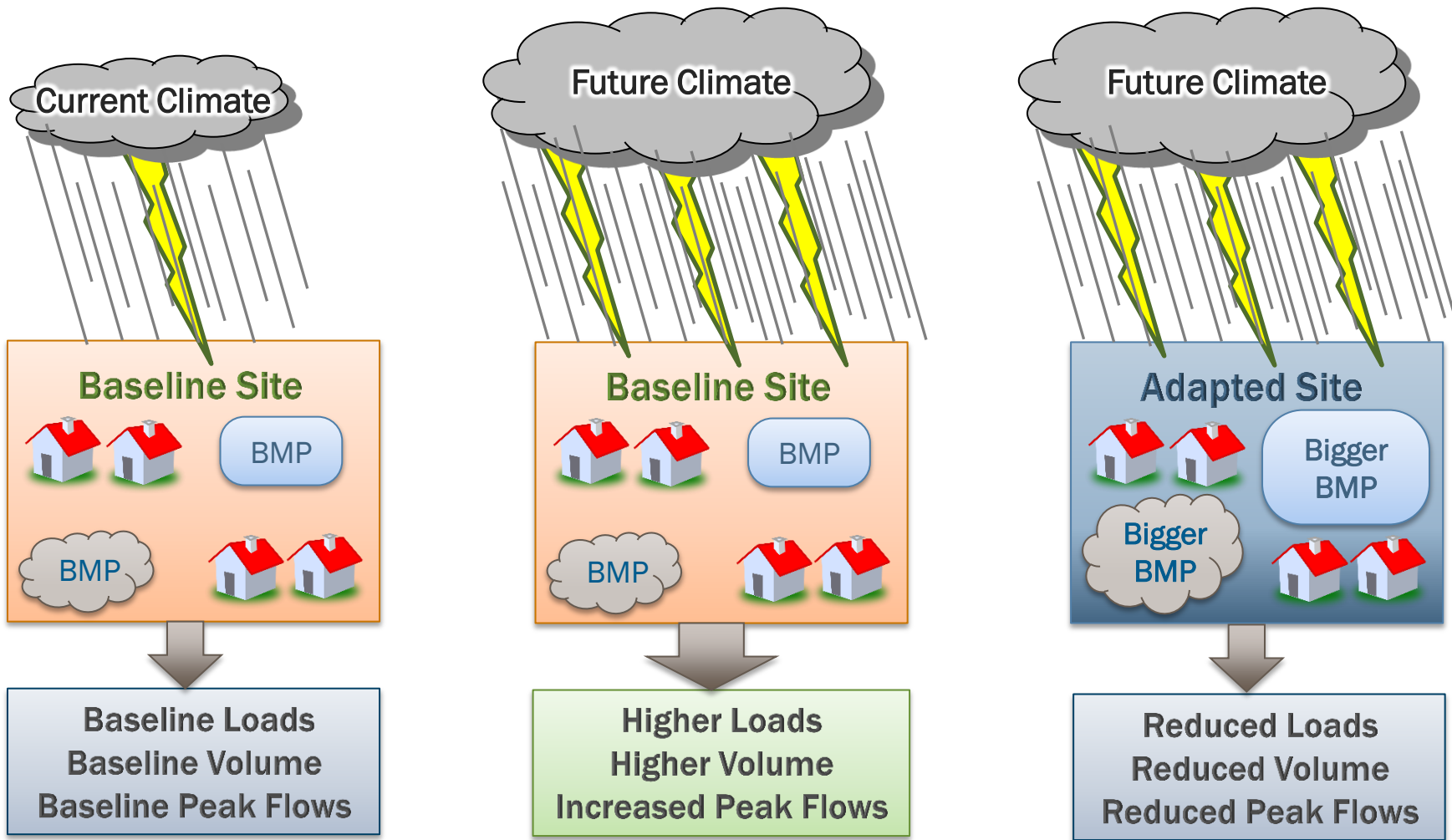
# Modeling Approach – Site Configurations

- Reviewed stormwater manuals/requirements for specific city/county
- Selected appropriate BMPs and routing to meet criteria/requirements
- Scoping-level engineering design for BMPs
  - Volume
  - Depth
  - Outlet structure
  - Media properties
  - Treatment
  - Etc.
- Developed cost estimates



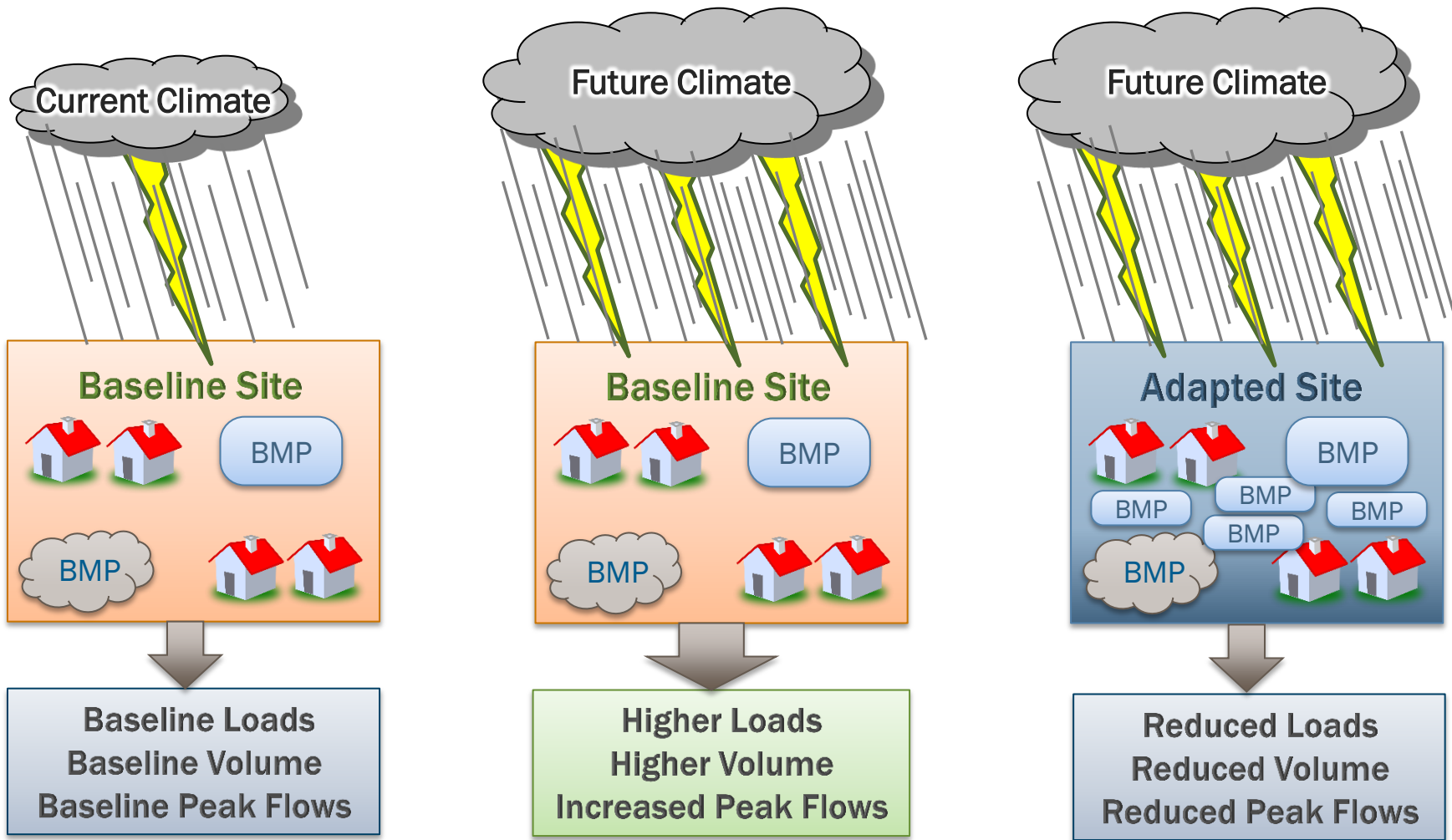
# Modeling Approach: Adaption to Projected Future Climate Conditions

## Resize Existing BMPs (all geographic locations)



# Modeling Approach: Adaption to Projected Future Climate Conditions

## Add Distributed GI BMPs (Midwest and Mid-Atlantic)

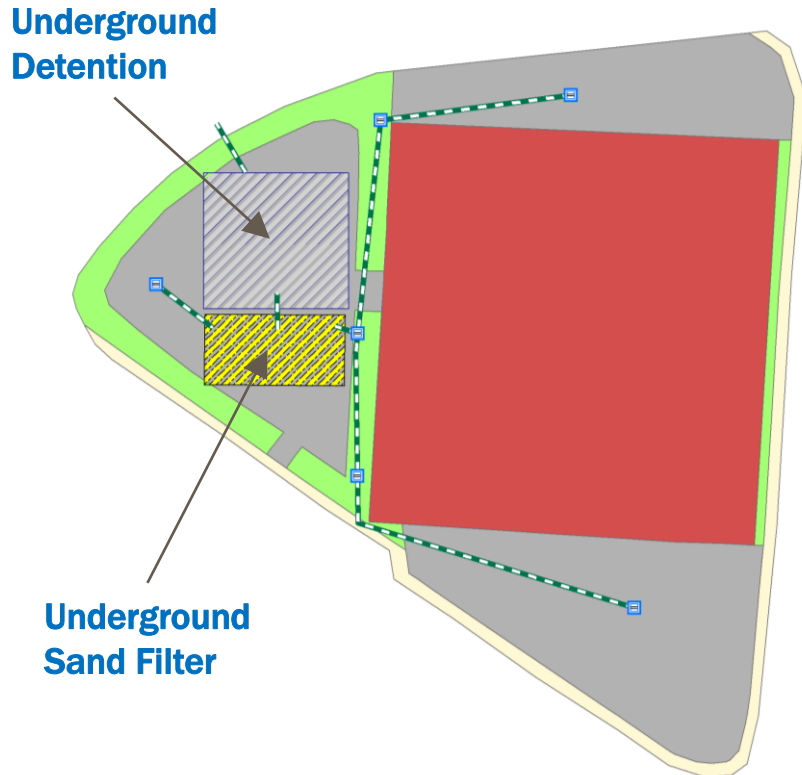


# Site Example – Southeast (Atlanta, GA)

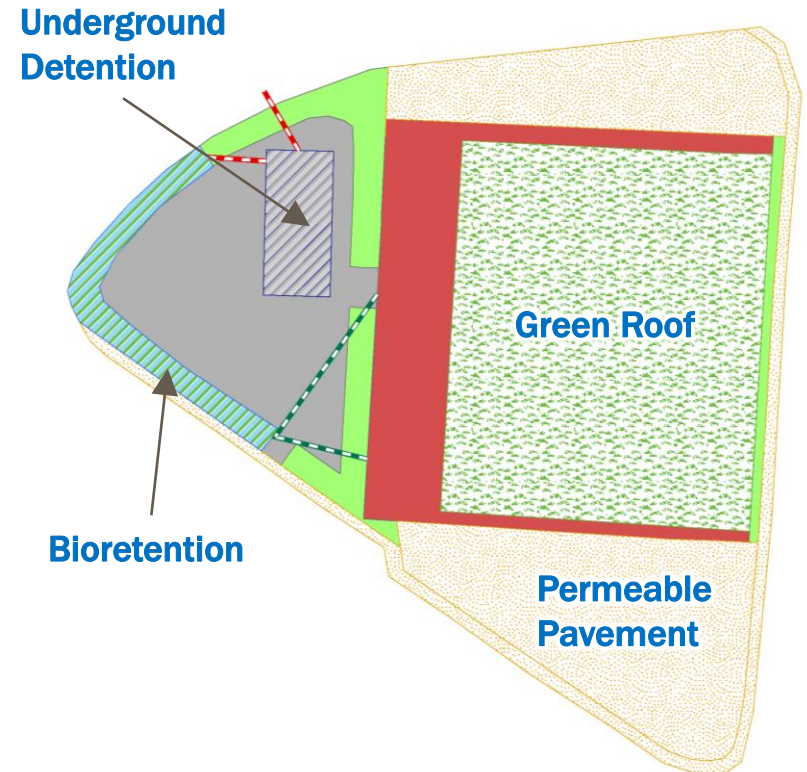
- Ultra-urban, 2 acres, 90% impervious
- Stormwater requirements
  - Retain runoff from 1<sup>st</sup> inch of rainfall ~or~ 80% TSS removal
  - Detain runoff from 1-yr 24-hr storm, release over 24 hours
  - Match pre-development peaks for 2-yr through 100-yr 24-hr events
- Future climate scenario
  - 20% increase in large storm event depth
  - 90<sup>th</sup> percentile event increases from 1.03 in to 1.15 in
  - 7% increase in annual rainfall

# Atlanta, GA – BMP Configurations

## Conventional (Gray)

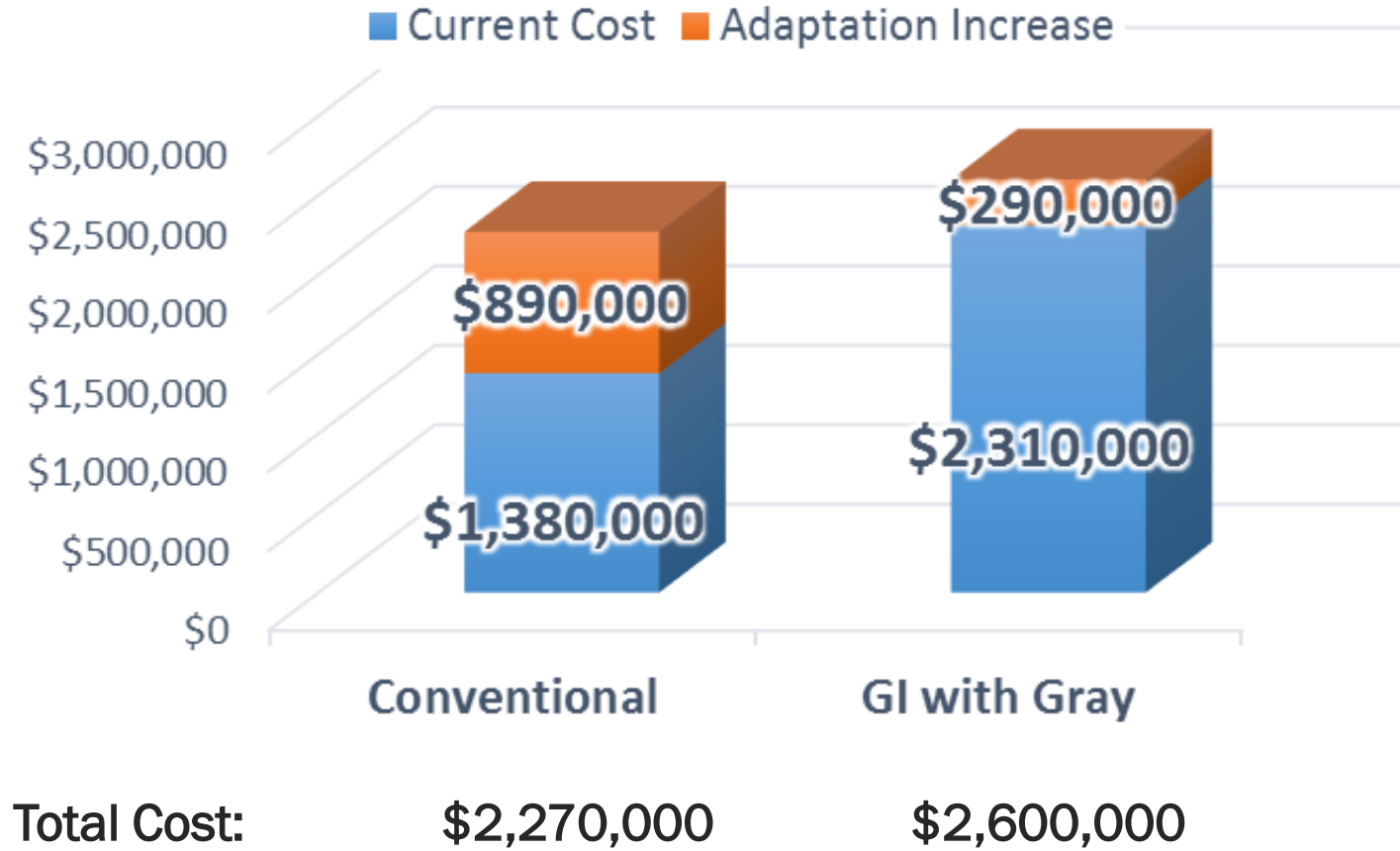


## GI with Gray

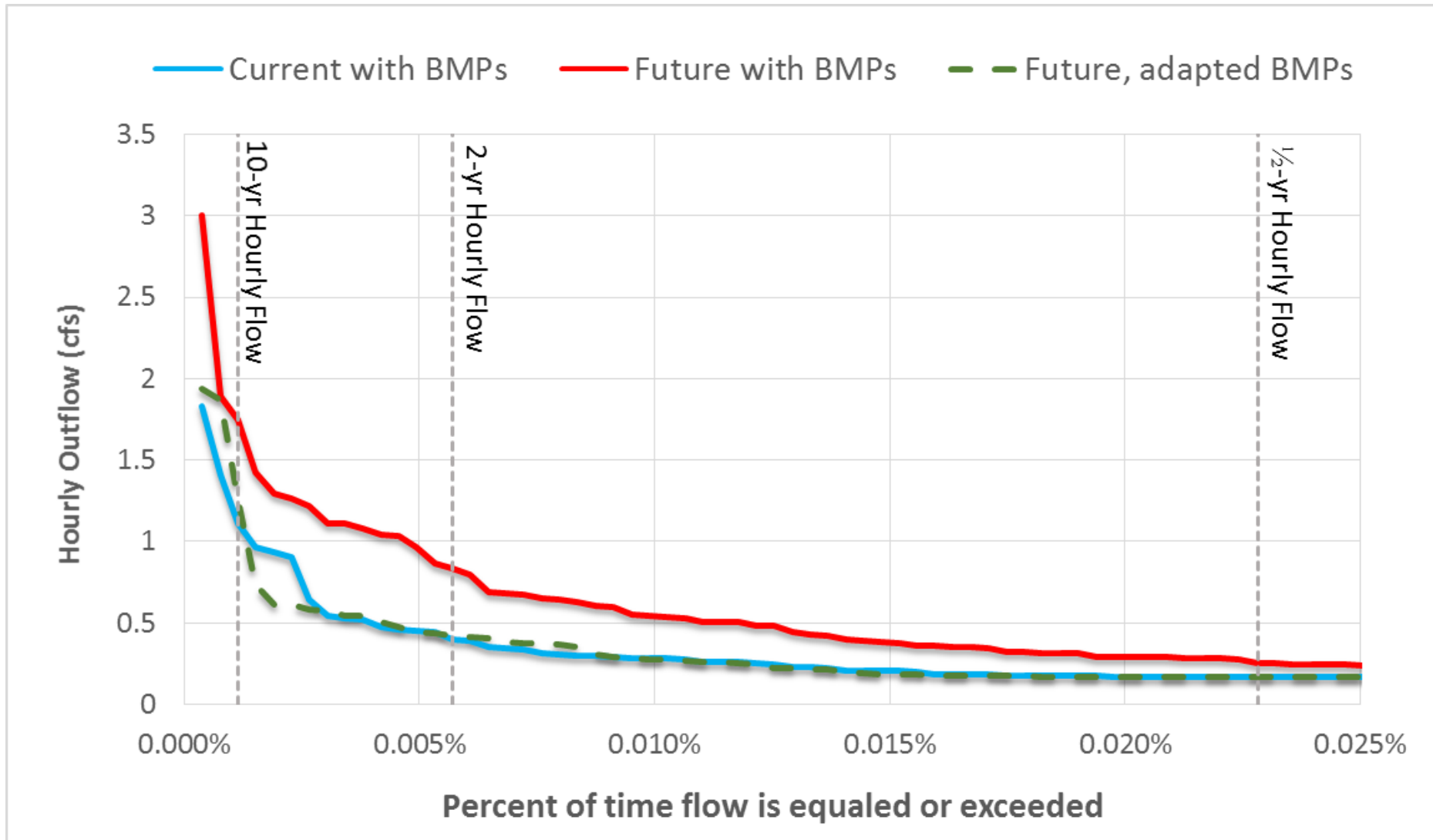


# Atlanta, GA – Adaptation to Achieve Current Performance

## Stormwater Infrastructure Cost

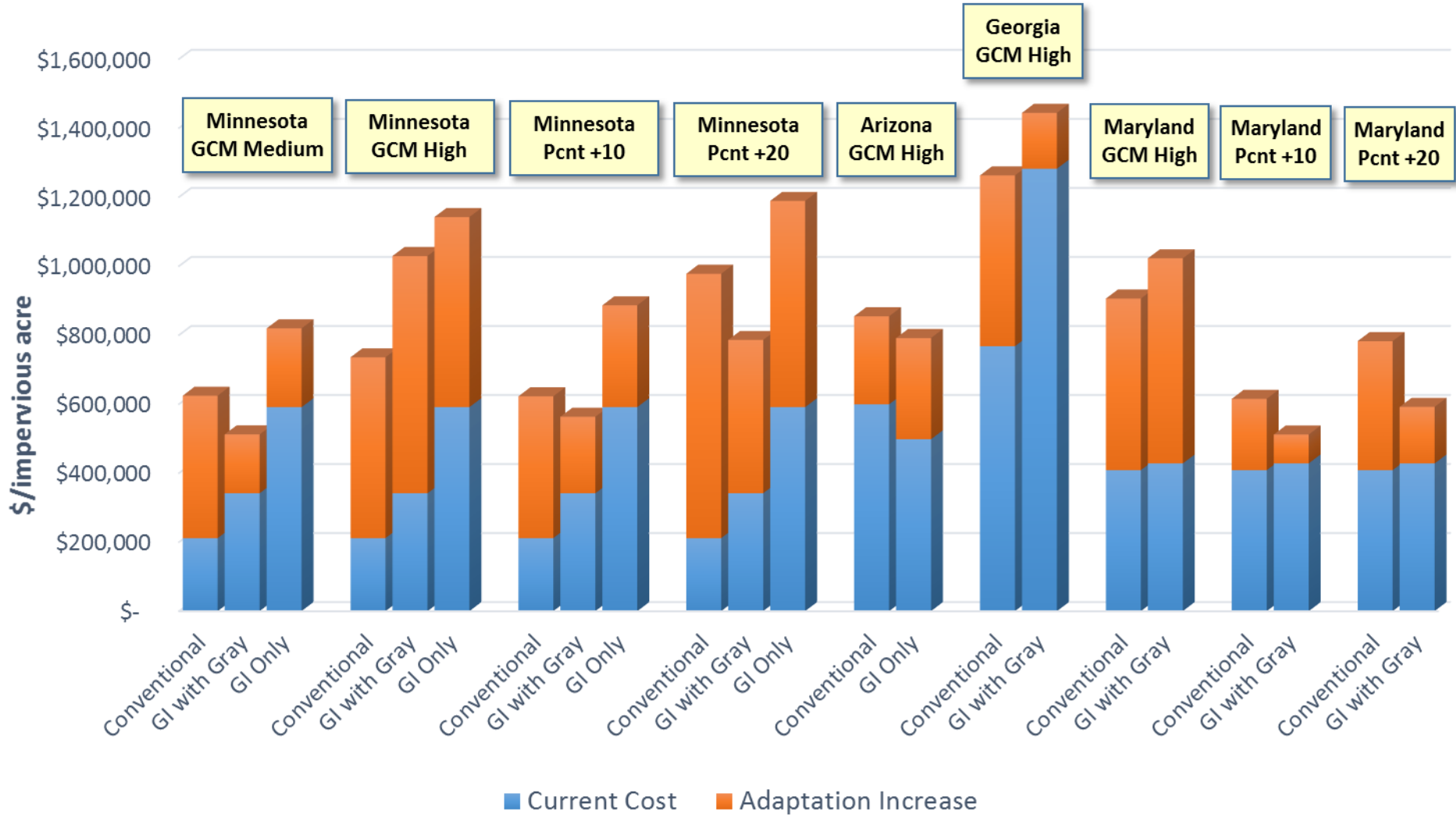


# Atlanta, GA – Bankfull/Flooding Event Performance



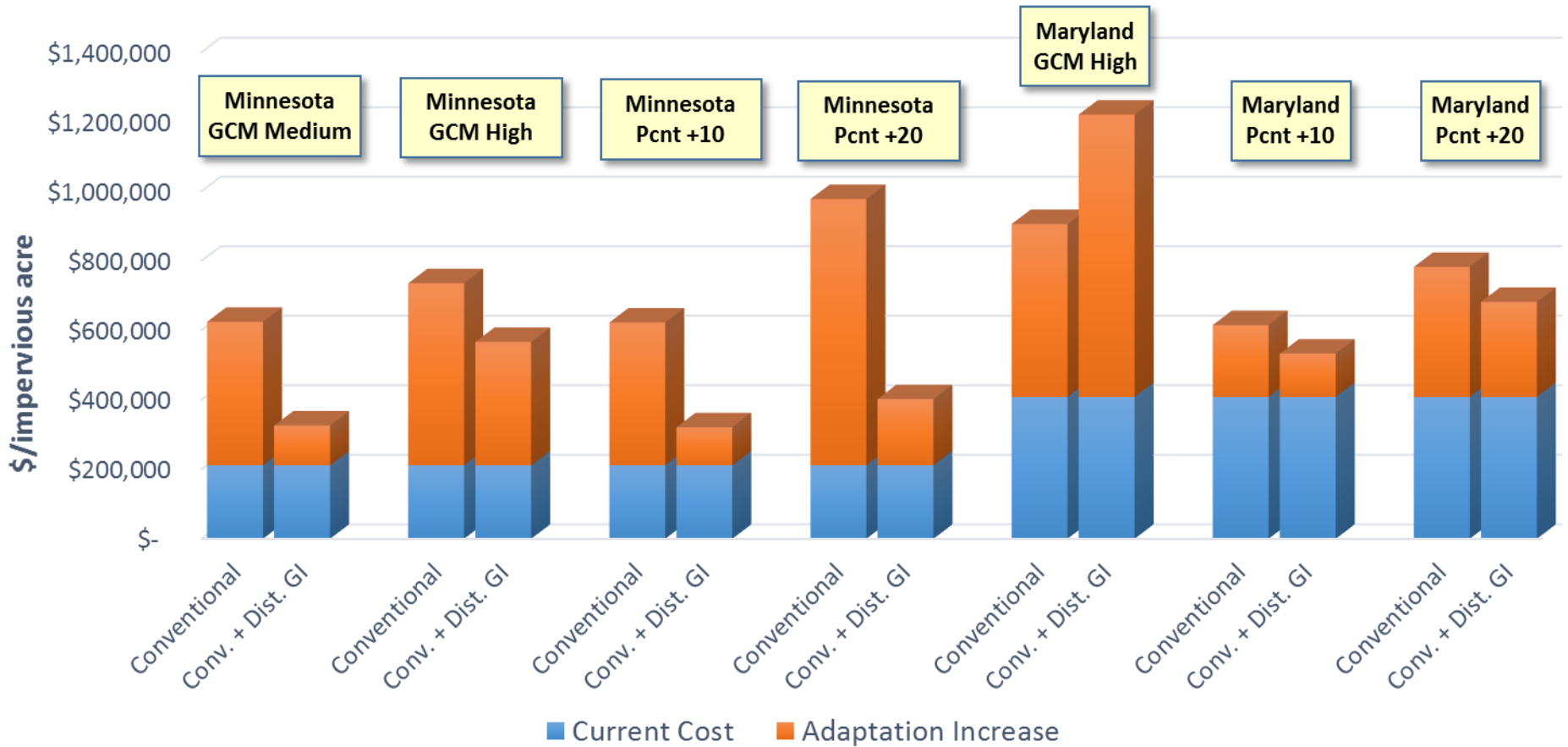
# Adaptation Cost – Resize Practices

## Stormwater Infrastructure Cost



# Adaptation Cost – Add Distributed GI

## Stormwater Infrastructure Cost



# Modeling Conclusions

- Volume/load increase generally 2% to 27%, while highest peak flows increase from 42% to 91%
- Gray infrastructure with detention storage more effective for mitigating extreme event volume increase
- GI has greater flexibility for addressing multiple objectives
- Stormwater management that combines gray and green approaches tends to have better cost resiliency



# Acknowledgments



Funding for this work was provided by U.S. EPA, Office of Research and Development's Air, Climate and Energy Research Program (ACE).

The views expressed in this presentation represent those of the authors and do not necessarily reflect the views or policies of the U.S. Environmental Protection Agency.

**Contact: Scott Job**  
scott.job@tetrattech.com  
919-485-2061