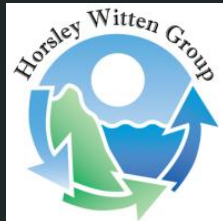


Assessment of Climate Change Impacts on Stormwater BMPs and Recommended BMP Design Considerations in Coastal Communities

Ashley Green, NOAA Coastal Management Fellow
MA Office of Coastal Zone Management

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GREEN INFRASTRUCTURE CLIMATE RESILIENCY BENEFITS

**managing
flooding**

**preparing
for drought**

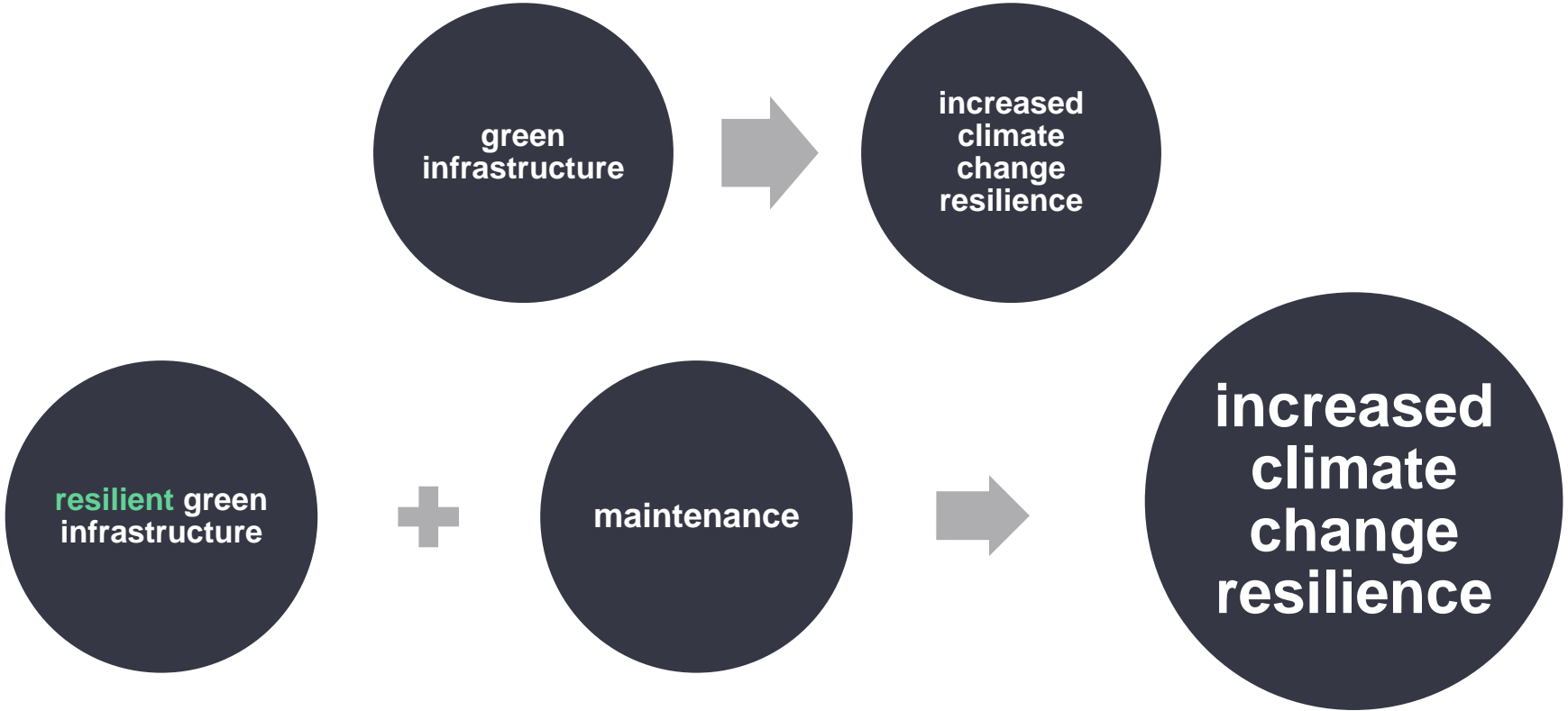
**spending
less energy
managing
water**

**reducing
urban heat
island effect**

**lowering
building
energy
demands**

**reducing
greenhouse
gas
emissions**

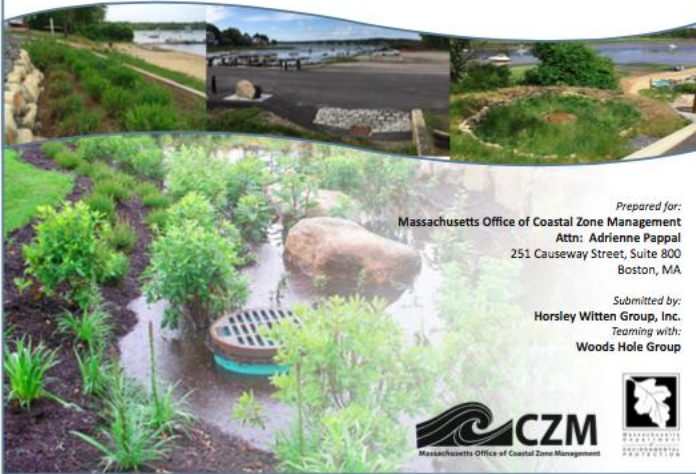
GREEN INFRASTRUCTURE CLIMATE RESILIENCY BENEFITS





Assessment of Climate Change Impacts on Stormwater BMPs and Recommended BMP Design Considerations in Coastal Communities

December 2015

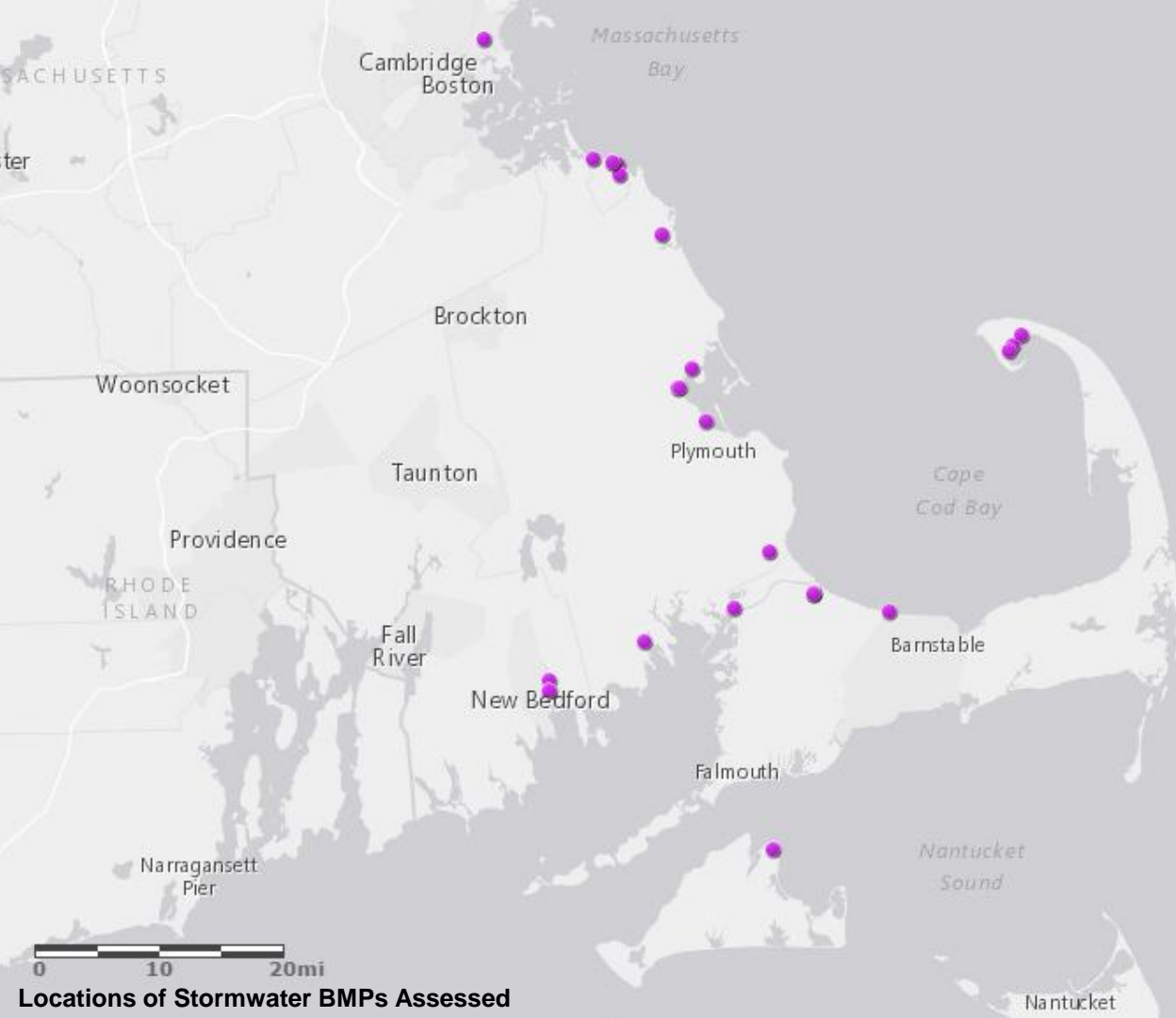


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Submitted by:
Horsley Witten Group, Inc.
Teaming with:
Woods Hole Group



REPORT



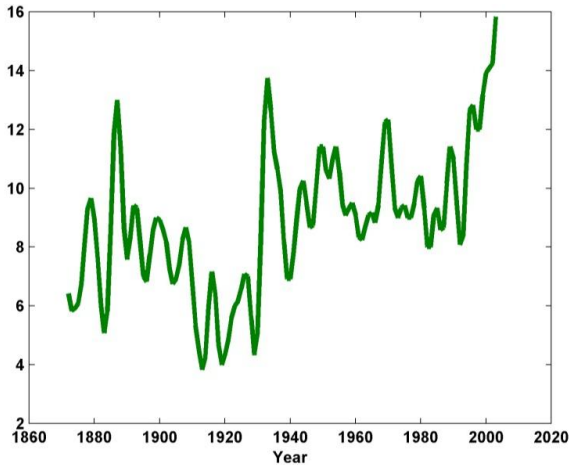
METHODS

- Review of climate change impacts
- Field evaluation of existing BMPs
- Review of sea level rise, storm surge, and flood risk modeling results

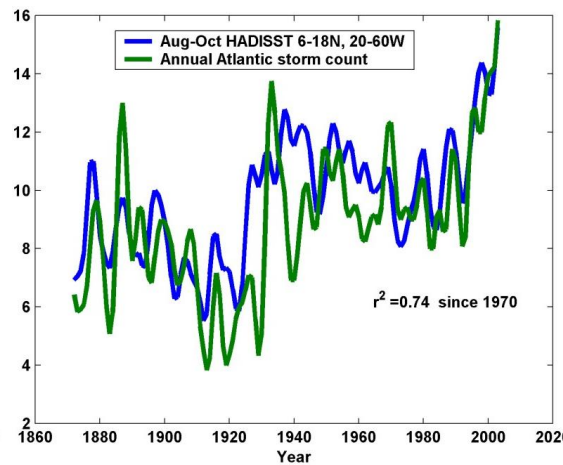
ANTICIPATED CLIMATE CHANGE IMPACTS: sea level rise



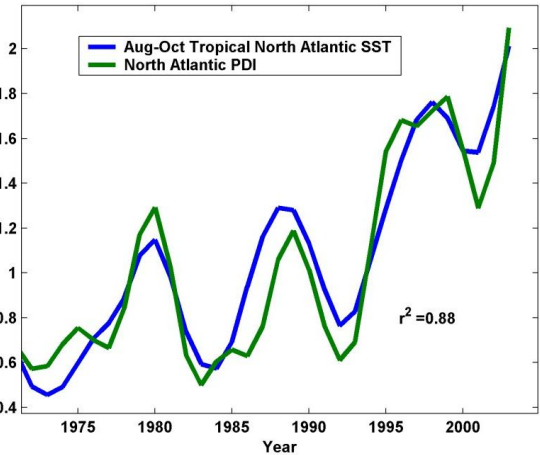
ANTICIPATED CLIMATE CHANGE IMPACTS: increased hurricane intensity and frequency



Annual number of tropical cyclones in the North Atlantic (Emanuel 2005)



Annual number of tropical cyclones vs SST Aug - Oct (Emanuel 2005)

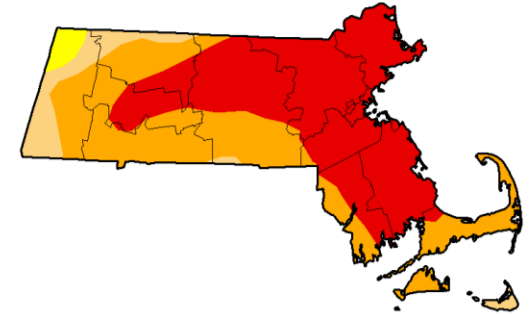


Post-1970 PDI v SST in the Atlantic (Emanuel 2005)

ANTICIPATED CLIMATE CHANGE IMPACTS:

increase in annual precipitation; increase in precipitation extremes; longer droughts

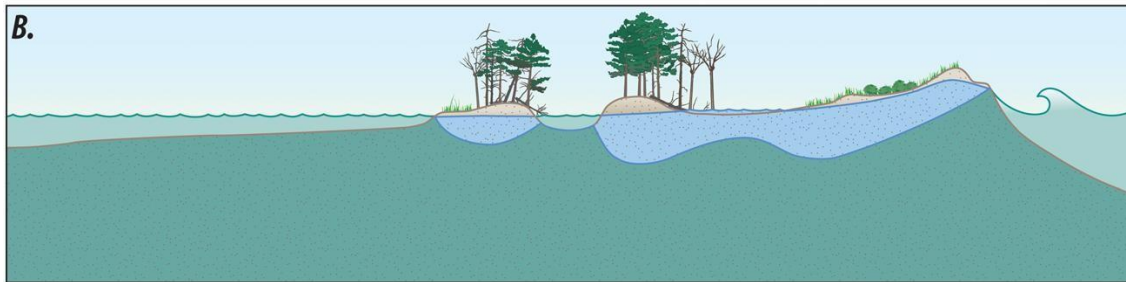
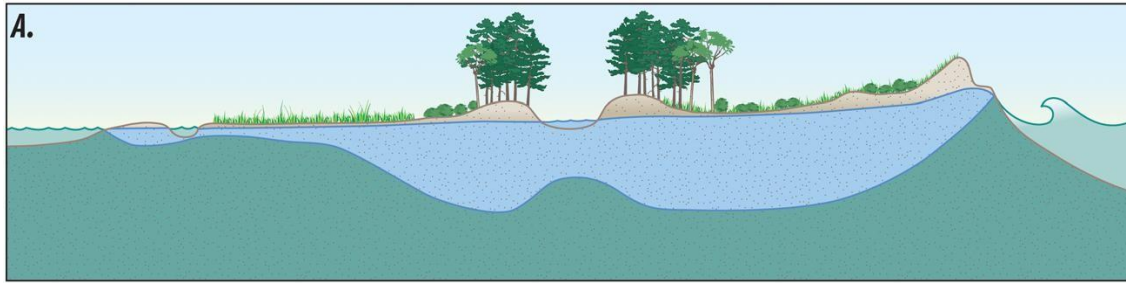
Anticipated Climate Change Impact	Current Conditions	20 Year Planning Horizon (2035)	50 Year Planning Horizon (2065)
Annual Precipitation (Hayhoe et al., 2006) and (MA EEA, 2011) (All estimates rounded to the nearest whole number.)	Existing conditions for the period 1961-1990: Total: 41 inches Winter: 8 inches; Summer: 11 inches	Estimated changes by 2035-2064: Total: 5-8% increase Winter: 6-16% increase ; Summer: 1-3% decrease An increase in annual precipitation is expected to occur in fall, winter and spring, with a slight decrease in rainfall volume in the summer.	Estimated changes by 2070-2099: Total: 7-14% increase Winter: 12-30% increase; Summer: 0-2% decrease An increase in annual precipitation is expected to occur in fall, winter and spring, with a slight decrease in rainfall volume in the summer.
Precipitation Extremes (Design Storm Event Precipitation Depths)	1-year, 24-hour storm: 2.71in 2-year, 24-hour storm: 3.26 in 10-year, 24-hour storm: 4.90 in 25-year, 24-hour storm: 6.19 in 50-year, 24-hour storm: 7.39 in 100-year, 24-hour storm: 8.82 in (NRCC/NRCS, 2010-2015)	1-year, 24-hour storm: NA 2-year, 24-hour storm: 3.35 in 10-year, 24-hour storm: 5.55 in 25-year, 24-hour storm: 6.90 in 50-year, 24-hour storm: 8.15 in 100-year, 24-hour storm: 9.45 in (Estimated from Figure 7-18 in CH2MHill, 2014, DRAFT)	Projection for 2060: 1-year, 24-hour storm: NA 2-year, 24-hour storm: 3.50 in 10-year, 24-hour storm: 5.75-6.00 in 25-year, 24-hour storm: 7.20-7.55 in 50-year, 24-hour storm: 8.40-8.90 in 100-year, 24-hour storm: 9.70-10.40 in (Estimated from Figure 7-18 in CH2MHill, 2014, DRAFT)



Sept 2016 Drought Conditions
(<http://droughtmonitor.unl.edu/>)

Table 2.1 (<http://www.mass.gov/eea/docs/czm/cwq/cpr/climate-change-sw-bmps-report-no-appendix.pdf>)

ANTICIPATED CLIMATE CHANGE IMPACTS: increase in groundwater elevation



Masterson et al., 2014

RESULTS: BMP Vulnerabilities

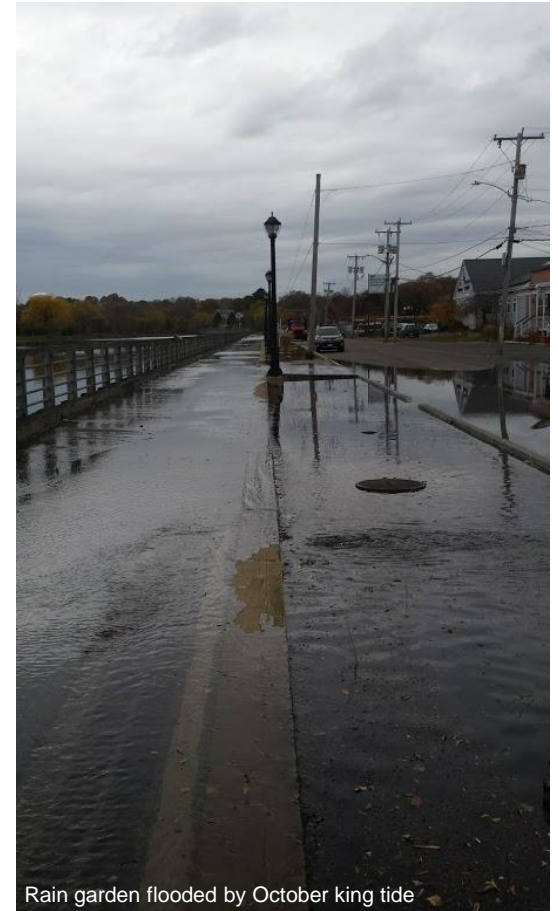
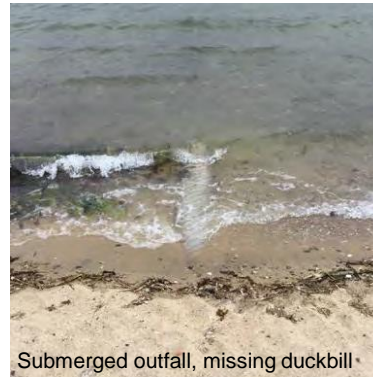
Rising sea level and submerged outfalls

Rising groundwater and shrinking separation distances

Physical impact of storm surge inundation

Increased flooding and drought

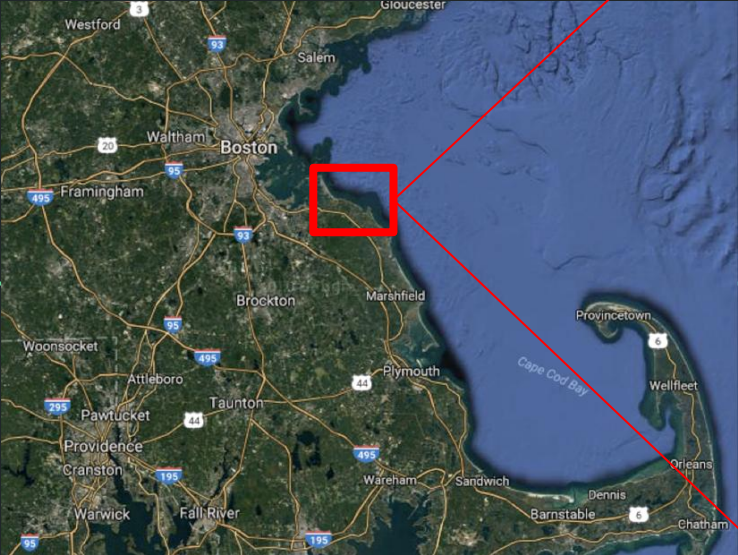
Chronic wind, sand and salt exposure



RESULTS: Sites 8 & 9

Cohasset, MA

BMP: Infiltration Basin, Stormceptor



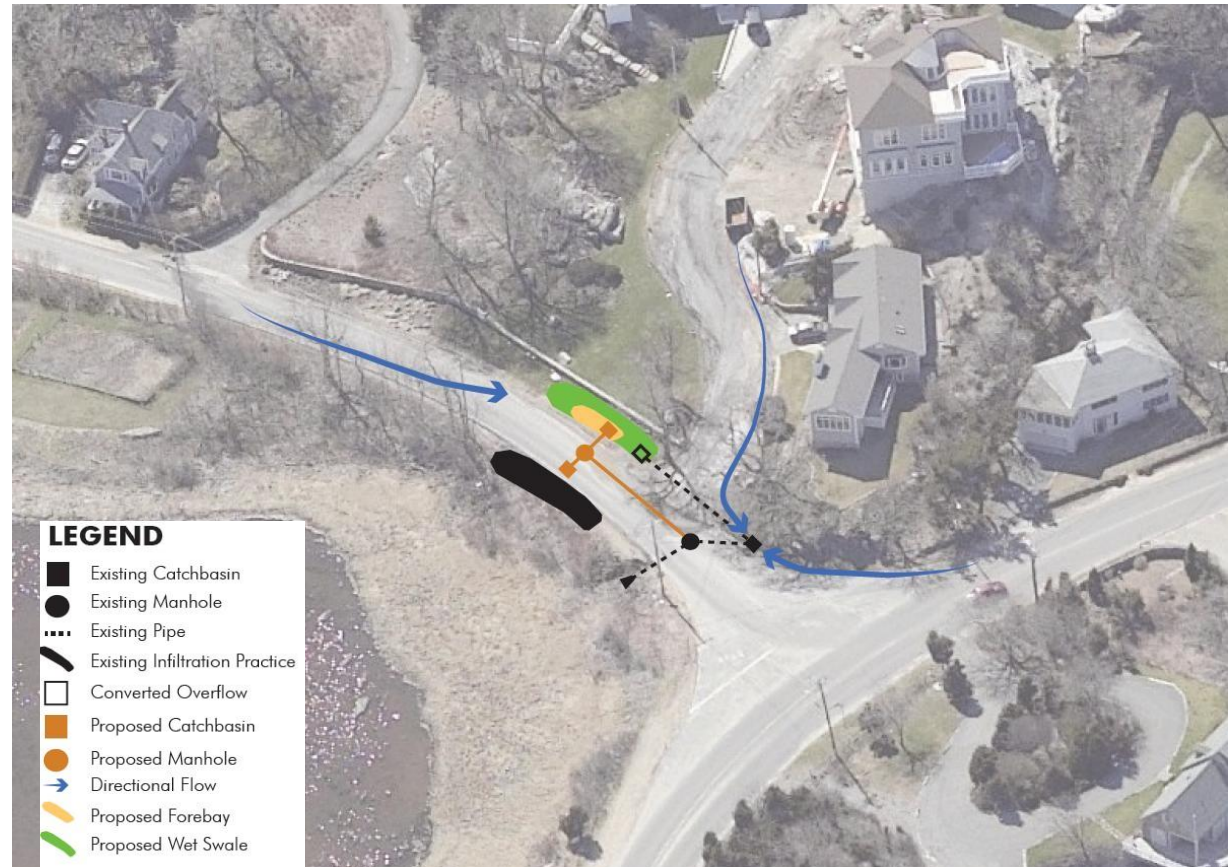
RESULTS:

Sites 8 & 9

Cohasset, MA

Vulnerabilities

- Flooding
- SLR
- Storm surge
- Rising groundwater
- Wind, sand, salt exposure



RESULTS:

Sites 8 & 9

Cohasset, MA

Vulnerabilities

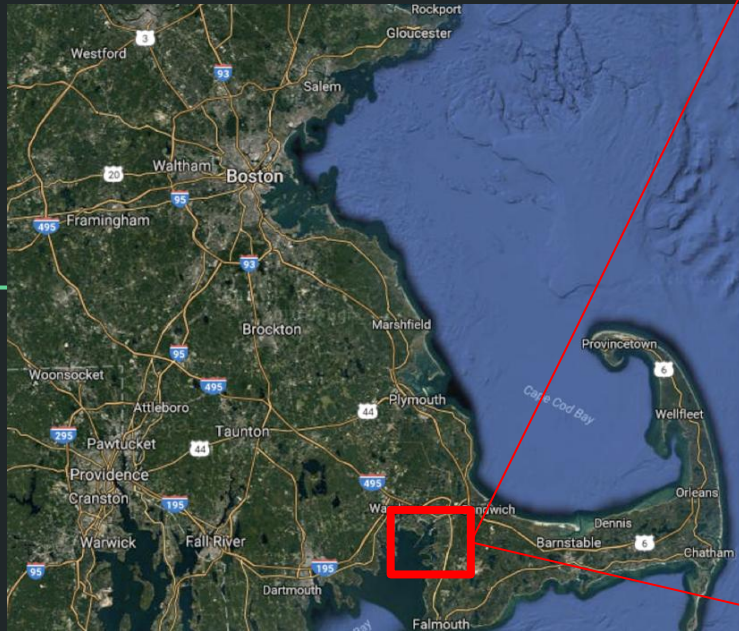
- Flooding
- SLR
- Storm surge
- Rising groundwater
- Wind, sand, salt exposure



RESULTS: Site 32

Bourne, MA

BMP: Cultec Infiltration



RESULTS: Site 32

Bourne, MA

Vulnerabilities

- SLR
- Rising groundwater

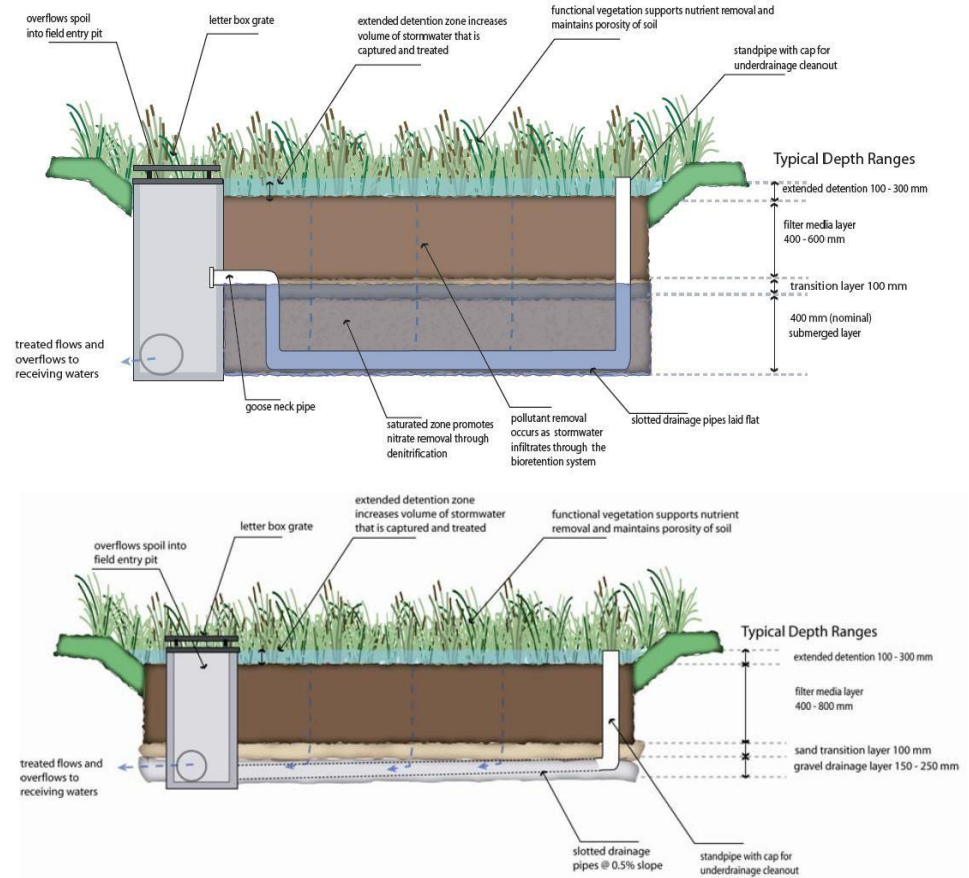


RESULTS: Site 32

Bourne, MA

Vulnerabilities

- SLR
- Rising groundwater



CONCLUSIONS: Design Recommendations

Using a 50-year planning horizon

Proper siting of practices

Selecting appropriate practices

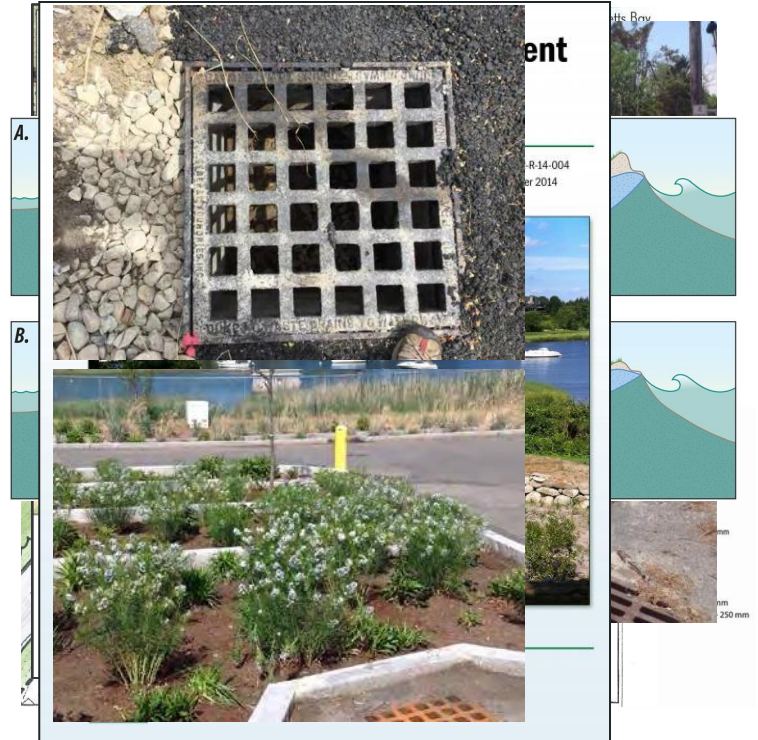
Selecting BMP construction and landscape materials

Ensuring redundancy in design

Increasing flexibility in design

Choosing “green” over “grey”

The even greater importance of maintenance



TOOLS FOR IMPLEMENTATION

BMP Siting

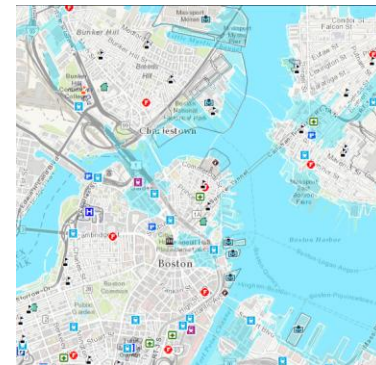
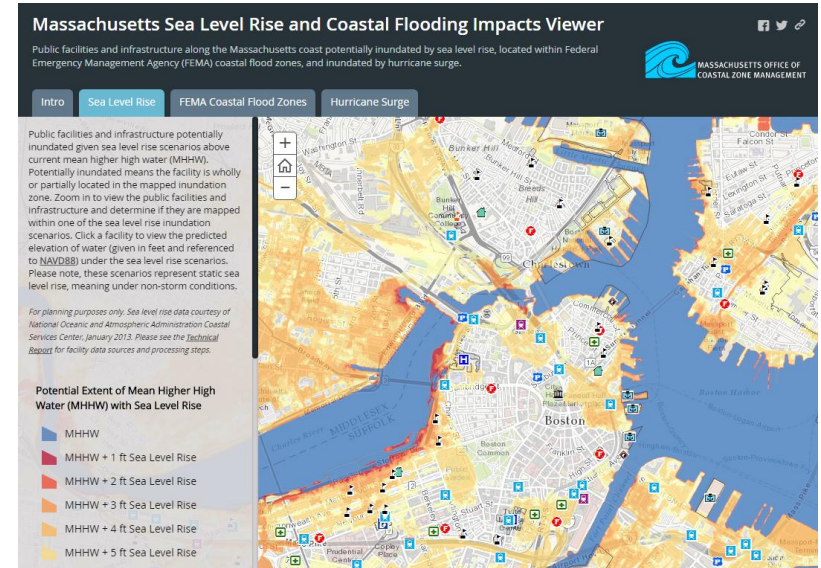
- CZM Sea Level Rise and Coastal Flooding Impacts Viewer (soon!)
- CZM's MORIS:
<http://www.mass.gov/eea/agencies/czm/program-areas/mapping-and-data-management/moris/>
- NOAA's Digital Coast:
<https://coast.noaa.gov/digitalcoast/topics/coastal-storms.html>

BMP Selection

- CZM Stormwater Solutions BMP Selection Tool (Spring 2017)
- EPA and MassBays Green Infrastructure Handbook:
<http://www.mass.gov/eea/docs/mbp/publications/massbays-green-infrastructure-handbook.pdf>

Landscaping Tips

- <http://www.mass.gov/eea/agencies/czm/program-areas/stormsmart-coasts/coastal-landscaping/tips.html>
- <http://ag.umass.edu/landscape/fact-sheets>



FEMA Flood Zones



Hurricane Surge

Questions?

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