Center for Climate Preparedness and Community Resilience
Antioch University
Baltimore, April 4, 2016

Conducting Vulnerability Assessments

Heat

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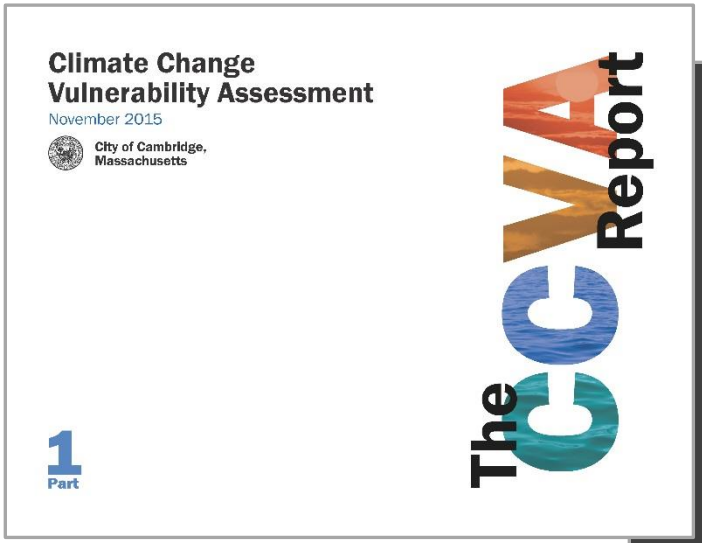
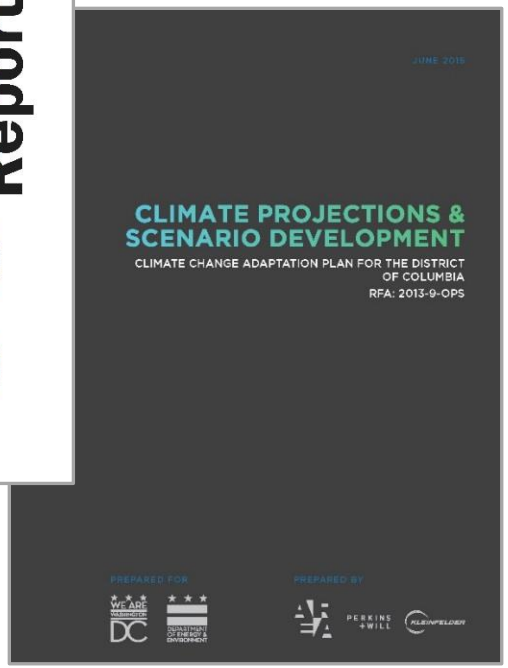
Kleinfelder

A Tale of Two Cities

- Implication of Climate Change – why cities are focusing on heat?
- Two case studies:
  1. Cambridge, MA
  2. The District of Columbia





Climate Change Vulnerability Assessment

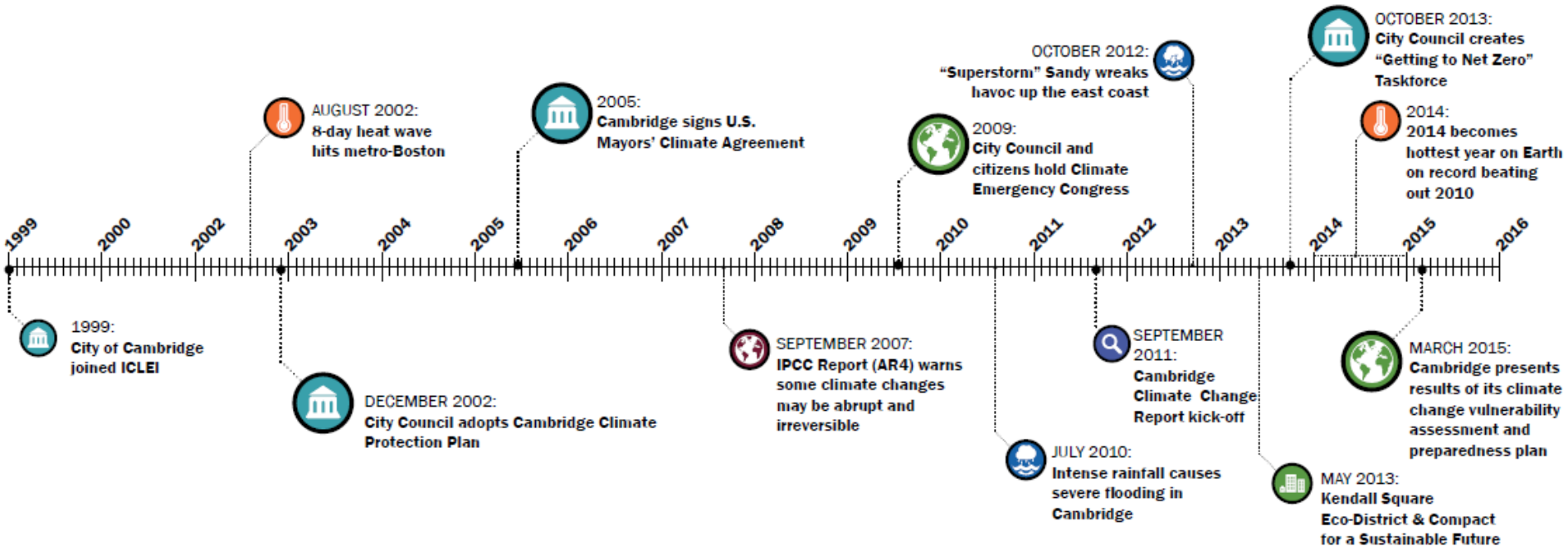
November 2015

City of Cambridge, Massachusetts

1 Part

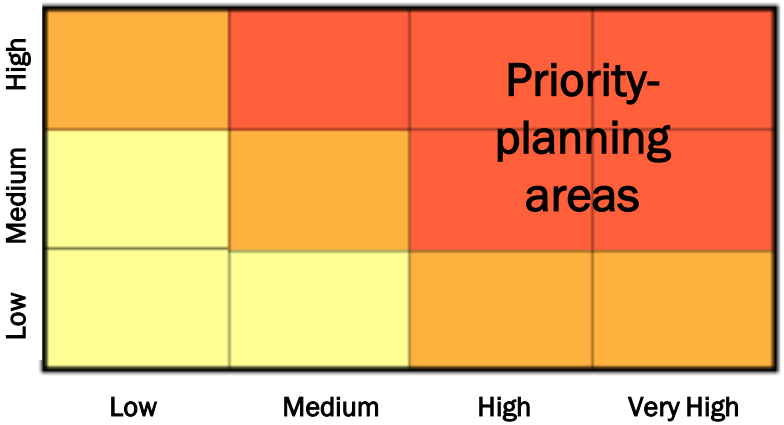
The Report and Technical Appendices online at www.cambridgema.gov/climateprep

Cambridge Sustainability & Resiliency Timeline



Project's Framework

Phase I: Vulnerability Assessment



Step 1

Climate Scenarios

Step 2

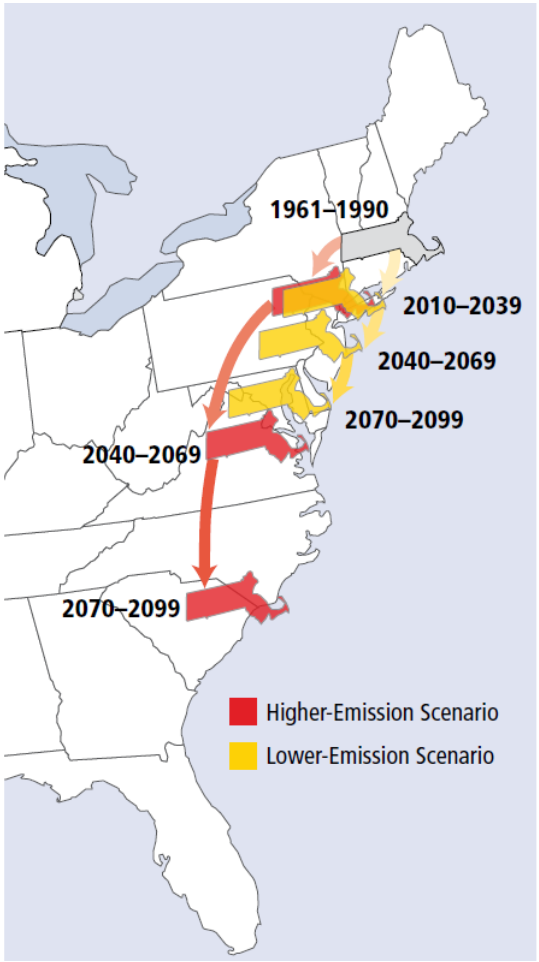
Vulnerability & Risk Assessment

Step 3

Preparedness Plan

Step 1: Climate Scenarios

Temperature

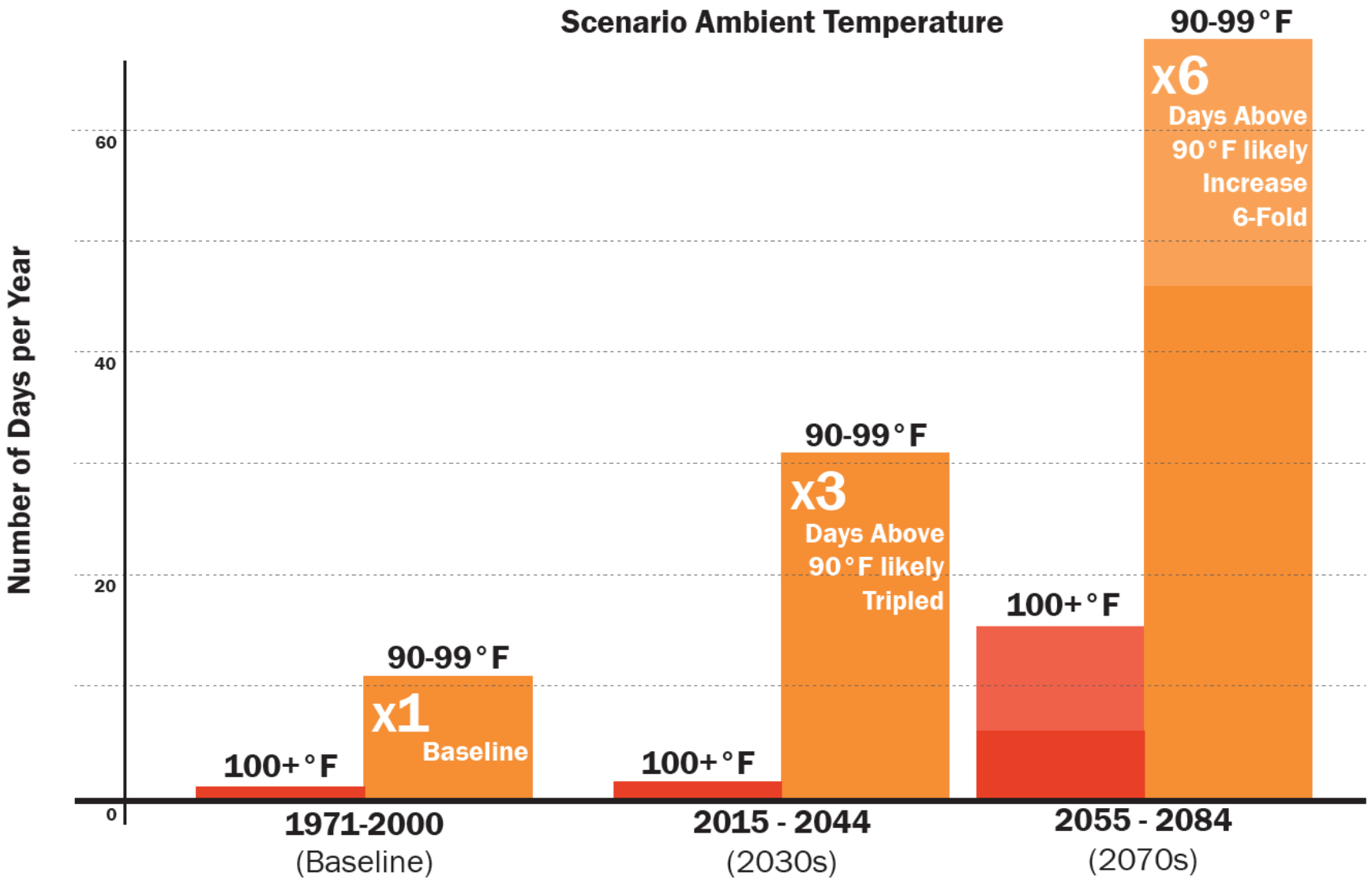


Precipitation

More extreme events

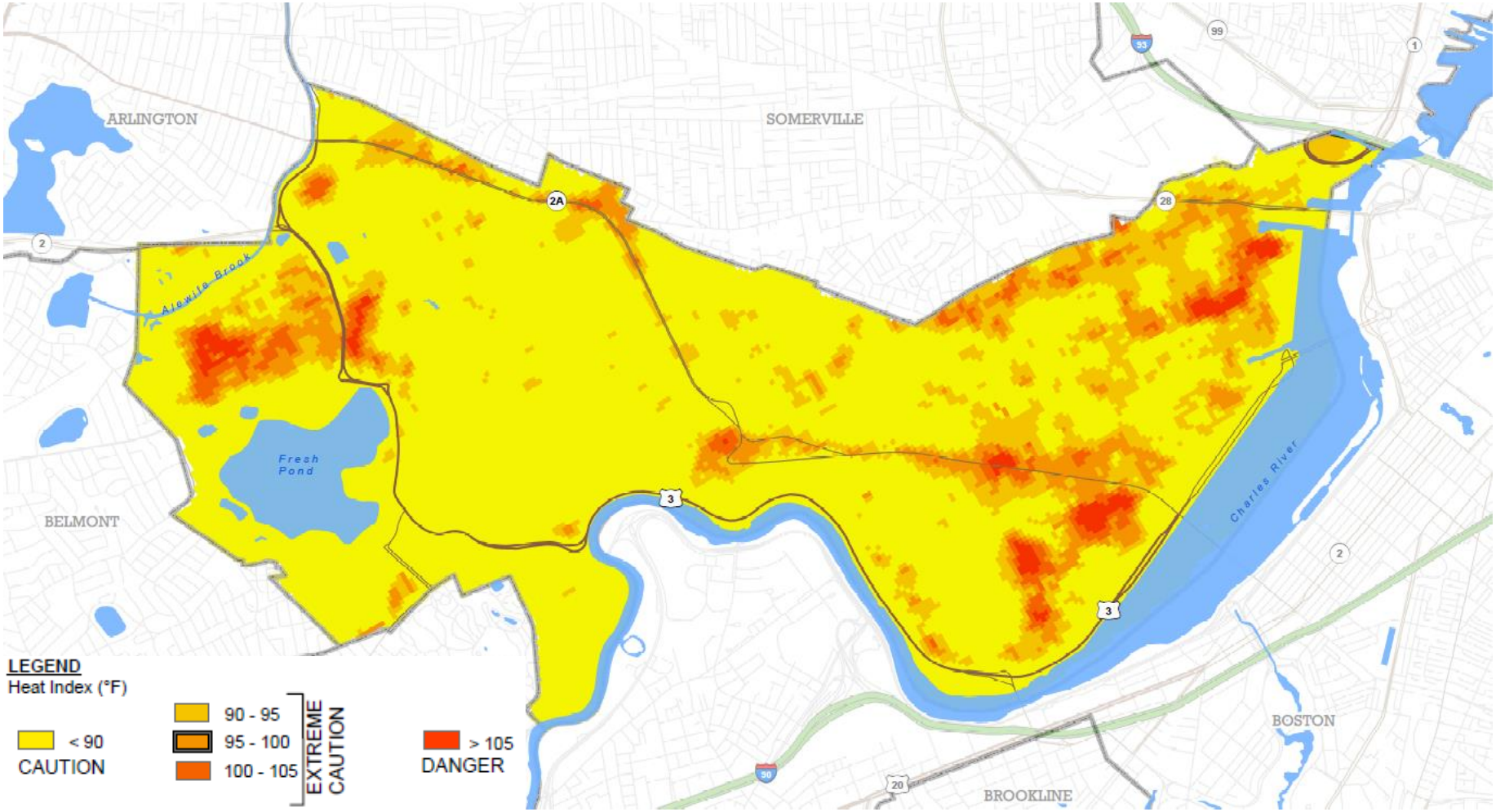
Sea level rise

Temperature Projections



Temperature Projections

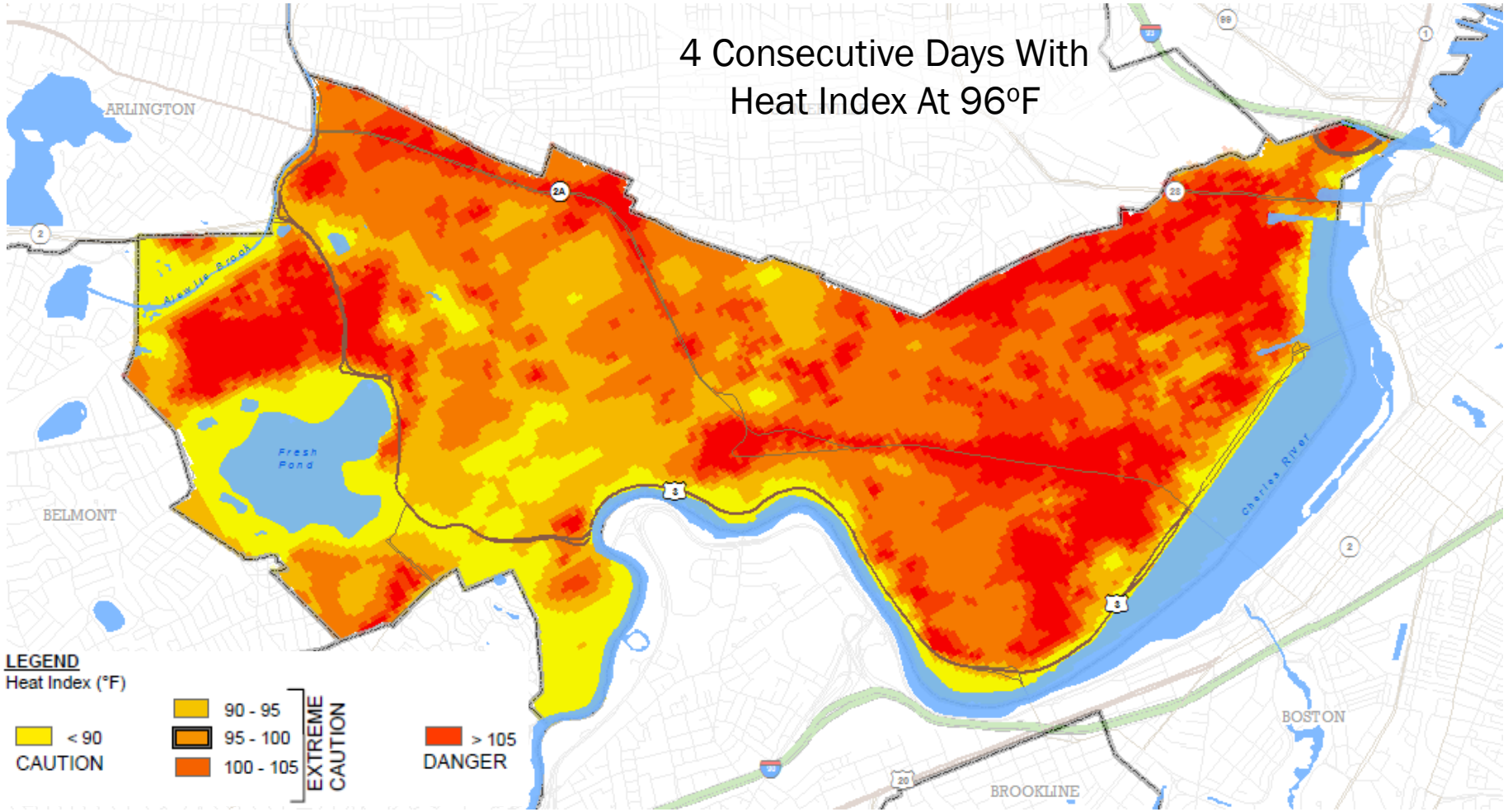
Heat Index - Present Conditions



"Feels-like" temperature variability when ambient temperature is 83°F day (8/30/2010 at 11:15am)

Heat Index - 2030s Scenario

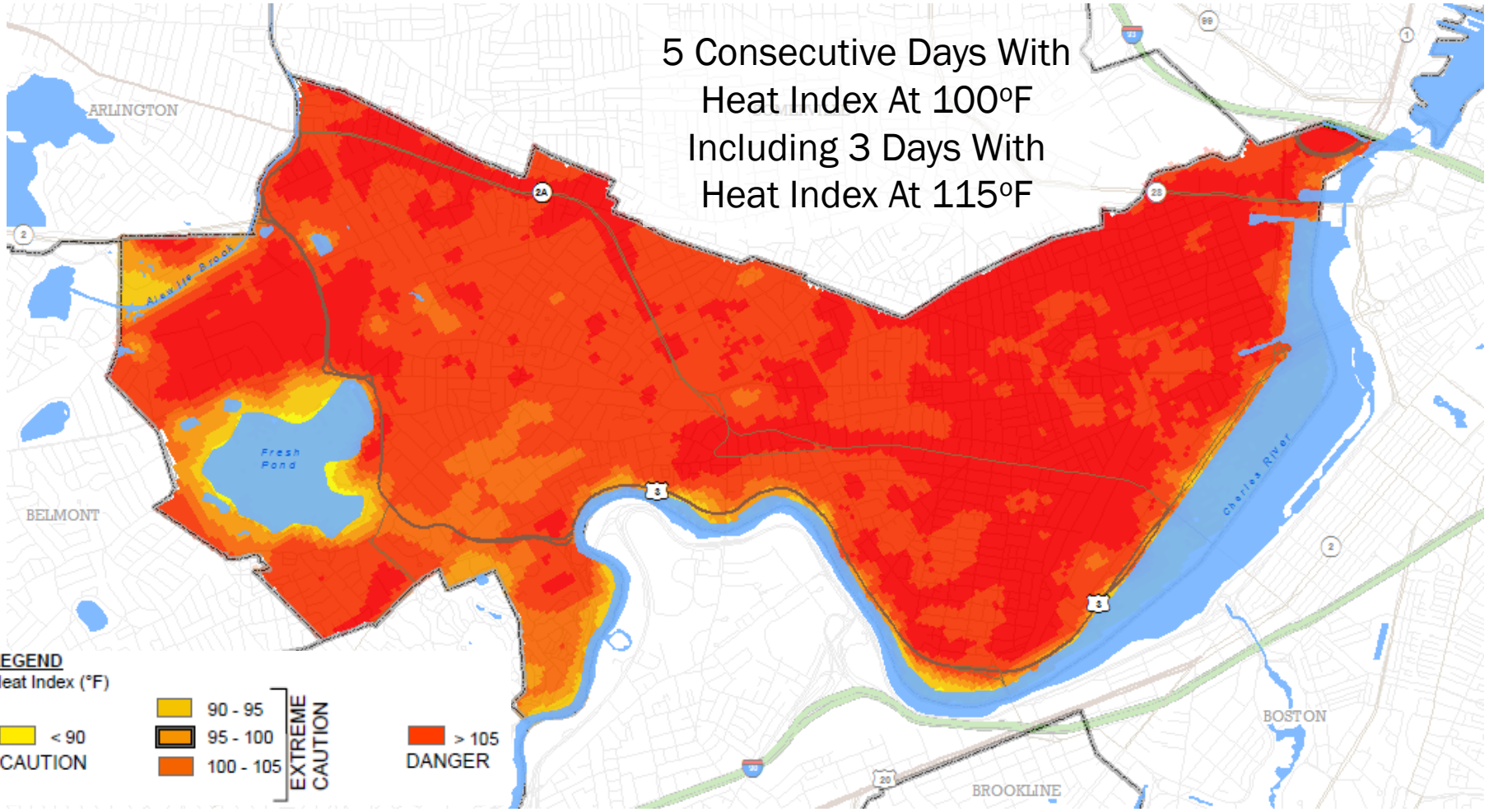
for Social Environment



"Feels-like" temperature variability on a day when heat index is 96°F
(90°F with relative humidity 50 – 55%)

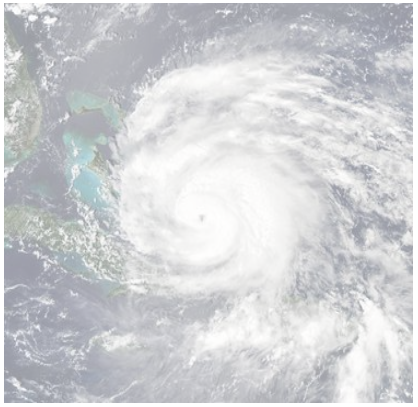
Heat Index - 2070s Scenario

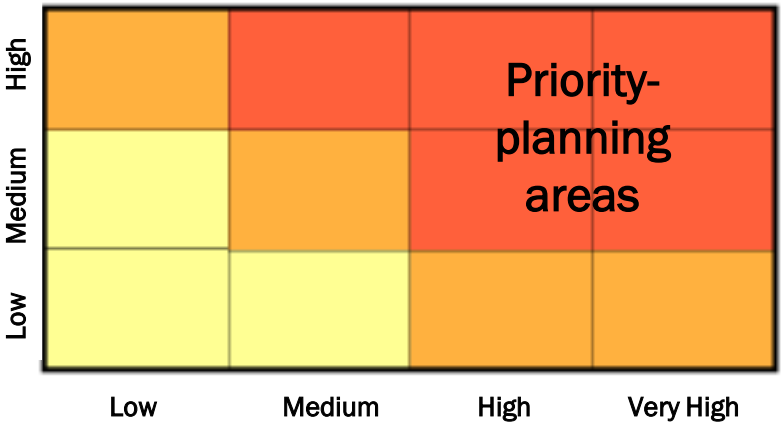
for Social Environment



"Feels-like" temperature variability on a day when heat index is 115°F
110°F ~ (90°F with 60-65% RH) 115°F ~ (100°F with 45-50% RH)

Step 2: Vulnerability and Risk Assessment





Step 1

Climate Scenarios

Step 2

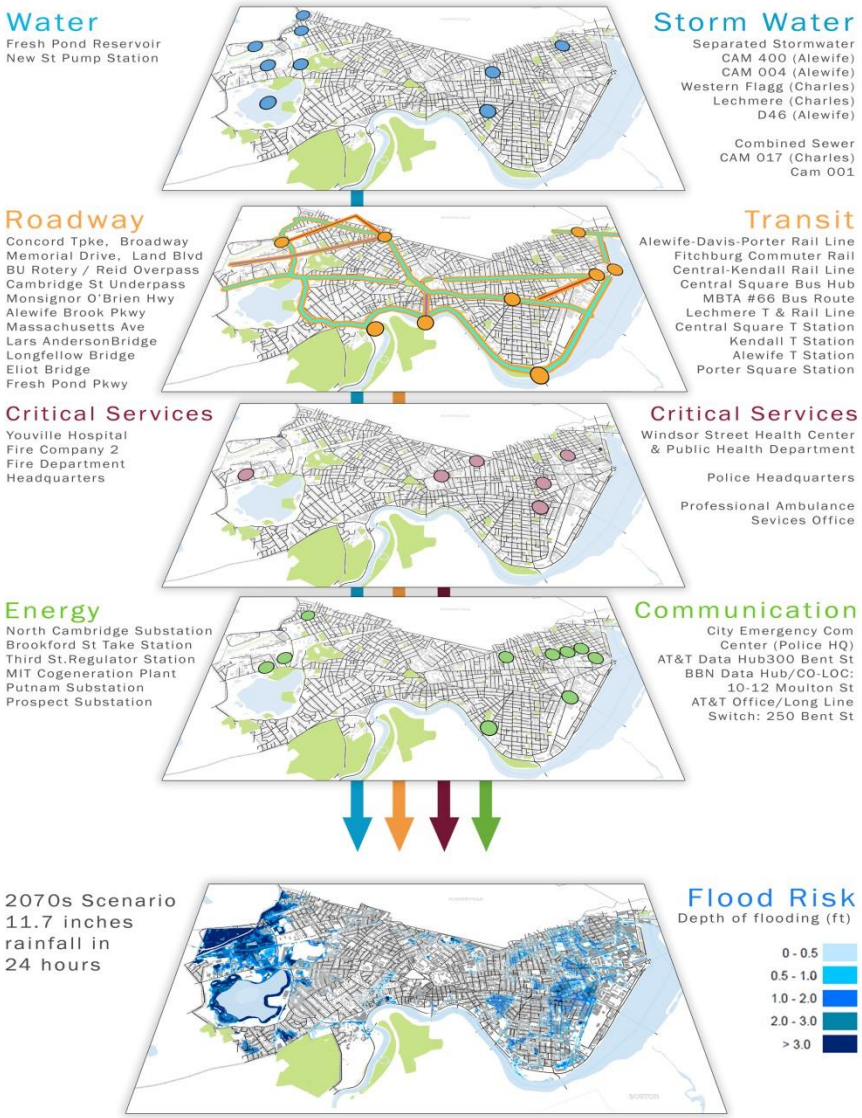
Vulnerability & Risk Assessment

Step 3

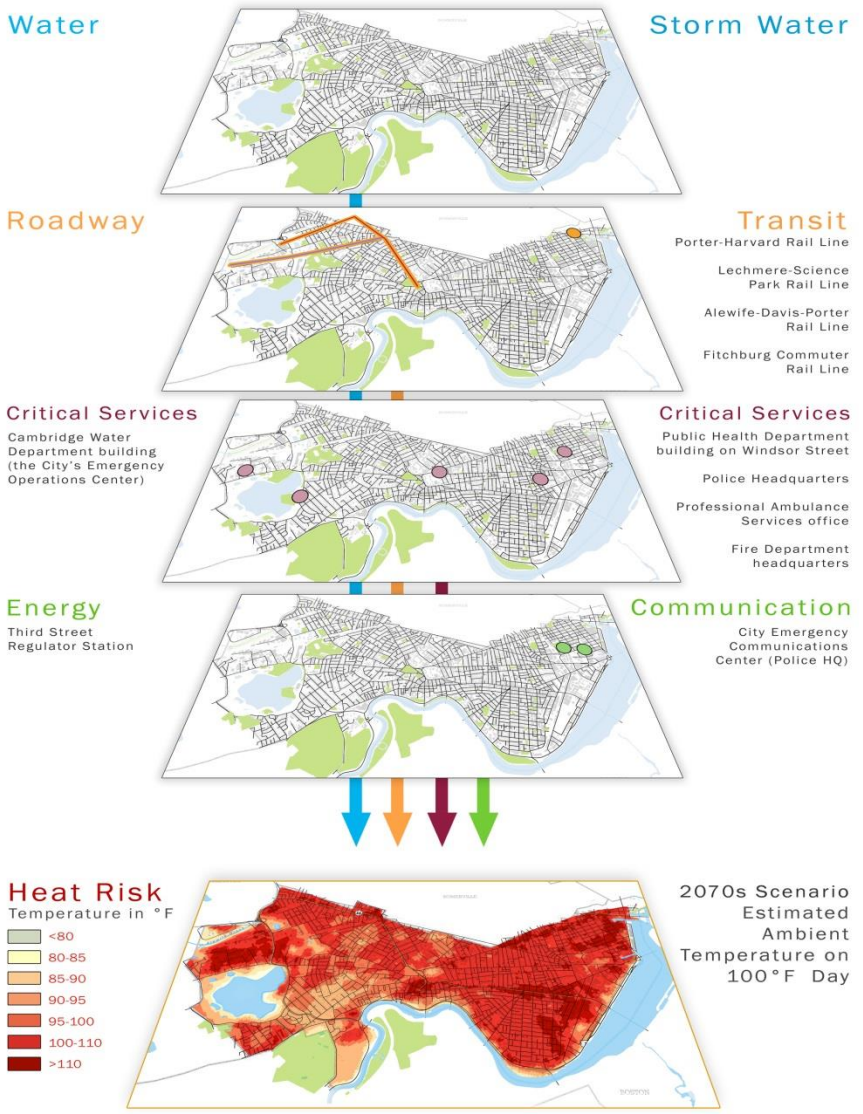
Preparedness Plan

Urban infrastructure & services

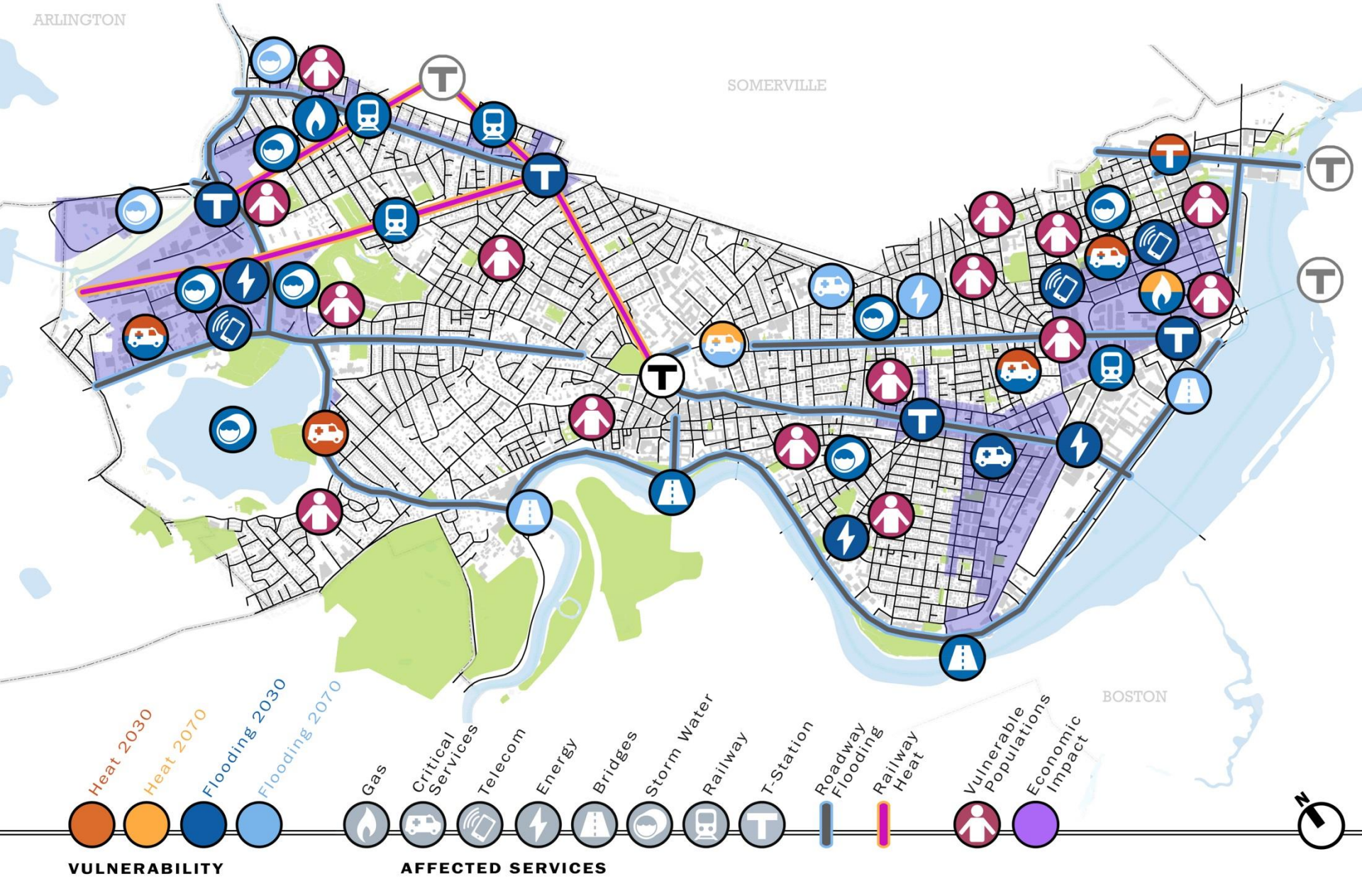
Flooding stress test



Heat stress test



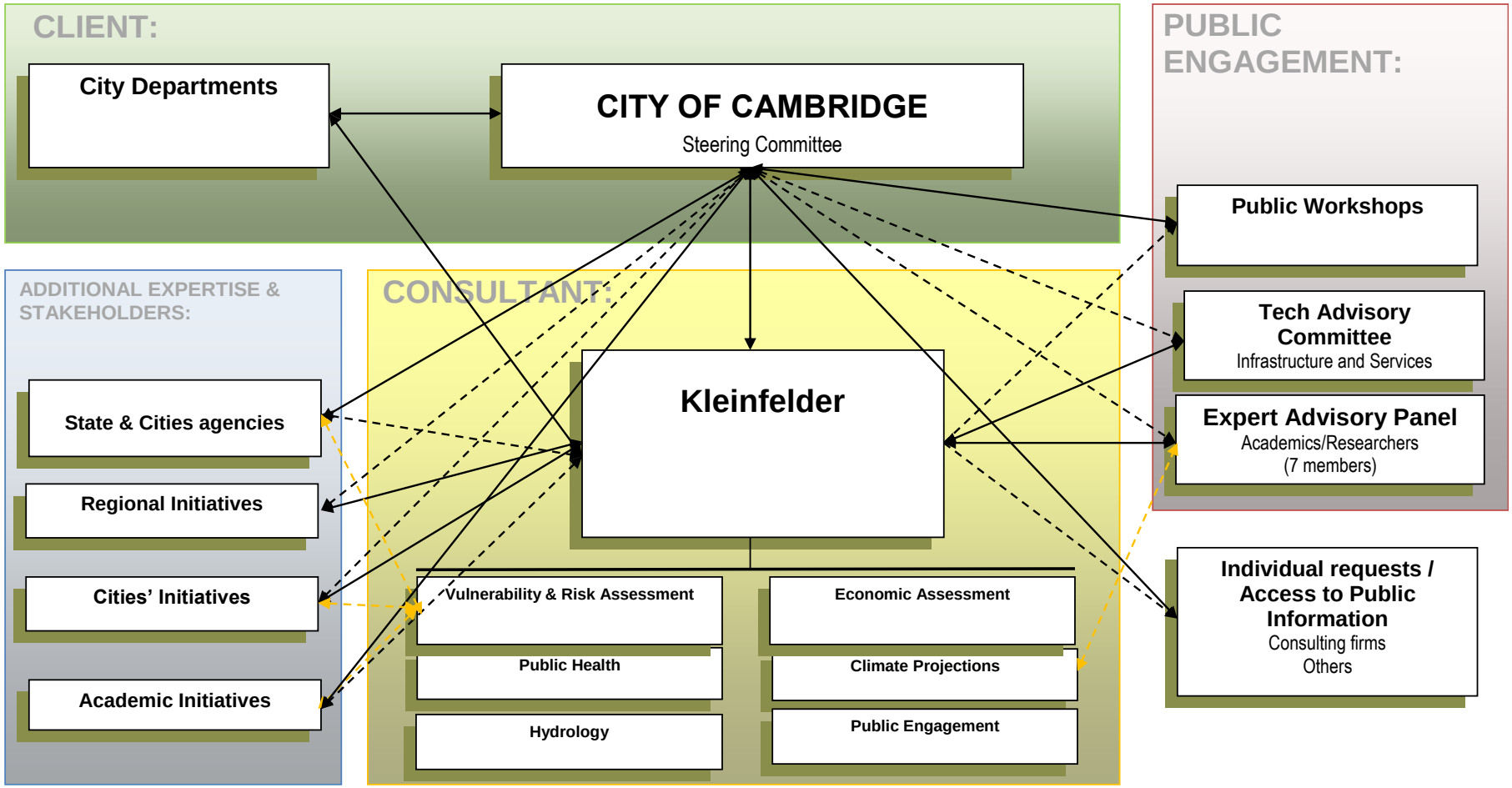
Climate Change Priority Planning Areas



Preliminary Key Findings

- Cambridge is unlikely to be impacted by **sea level rise or storm surges** by 2030, due to flood protection from both the Charles River and Amelia Earhart dams.
- **Heat vulnerability** and **inland flooding** are more imminent.
- **Social vulnerability** is not evenly distributed among the neighborhoods.
  - Heat waves and indoor air quality are the most challenging public health implications in the near future
- **Key infrastructure assets** are vulnerable in the near-term.
- **Economic losses** from a flood event or an area-wide power loss would be significant.
  - Disruption of **economic** activity could be greater than property damage.
- . Extreme heat events are likely to increase in frequency, intensity and duration
- Precipitation driven flooding is likely to increase in frequency, extent, and depth

Cambridge org chart



Climate Adaptation Planning

The District of Columbia

The Department of Energy & Environment

KLEINFELDER

PERKINS + WILL

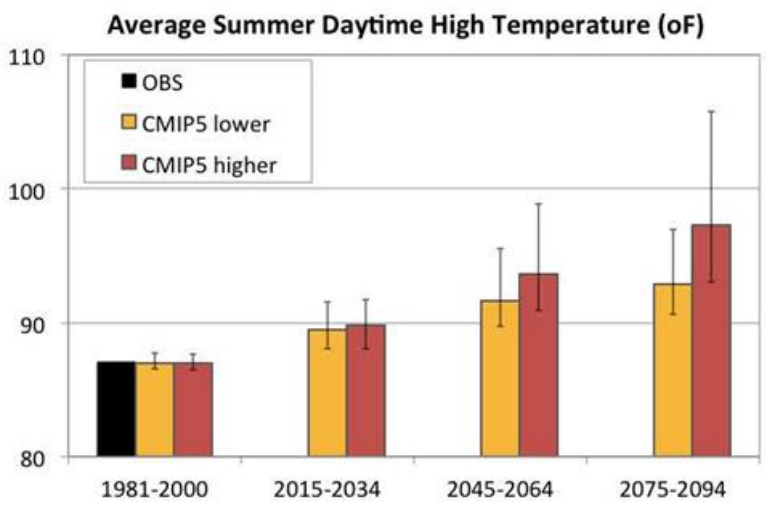
DISTRICT DEPARTMENT OF THE ENVIRONMENT

green forward

WE ARE WASHINGTON DC

Downscaled climate projections

(a)



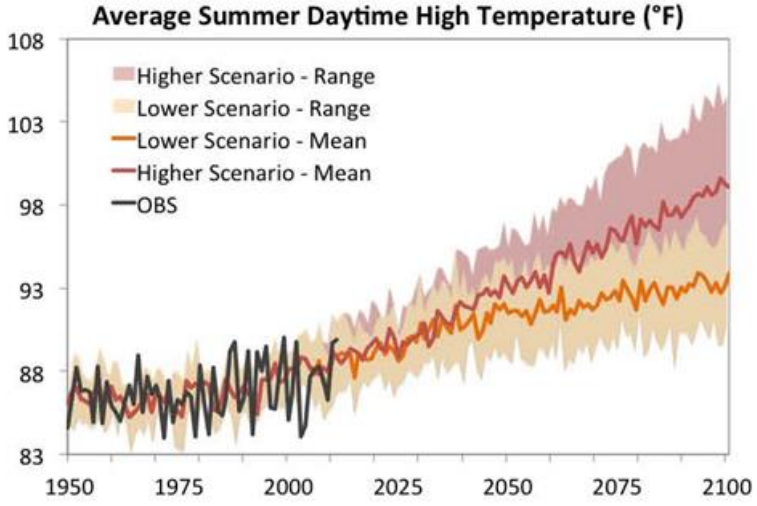
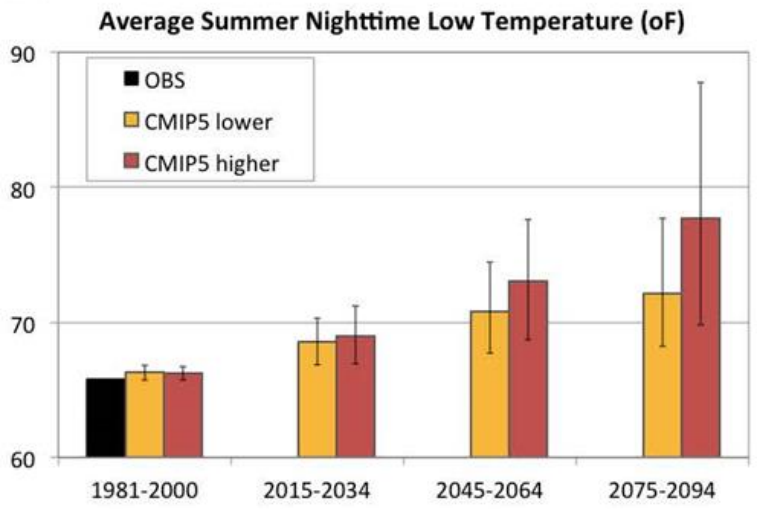


Figure 2: Historical and projected summer maximum or high temps used in this analysis under higher (red) and lower (orange) future scenarios.

(b)



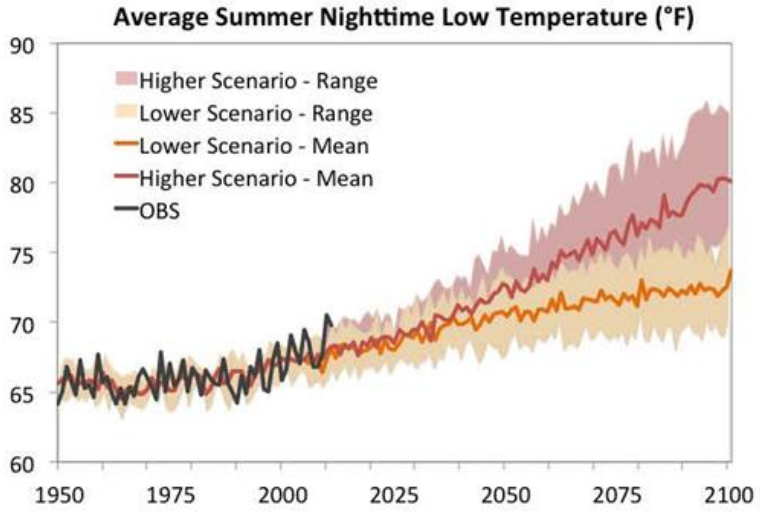


Figure 3: Historical and projected summer average nighttime minimum or low temps used in this analysis under higher (red) and lower (orange) future scenarios.

Vulnerable populations

Ward	% Unemployment 2005-2009	Rank	% without HS diploma 2005-2009	Rank	% poverty prevalence 2005-2009	Rank	% obesity prevalence 2007	Rank	%adult asthma prevalence	Rank	% senior in 2010 *	Rank	Sums across wards**	Rank	Sensitivity Score
1	7.2	6	19.0	3	16	5	18.8	6	8.4	6	7.1	7	33	6	S3
2	4.0	7	8.1	6	15	6	12.5	7	9.7	5	8.2	5	36	7	S1
3	3.4	8	3.4	7	6.9	8	11.7	8	8.3	7	14	2	40	8	S1
4	7.6	5	17.0	4	9.9	7	22	4	11.6	2	15	1	23	4	S2
5	13.0	3	19.0	3	19	3	30.1	3	10.8	3	15	1	16	3	S2
6	8.4	4	12.0	5	18	4	19.1	5	8.2	8	10	4	30	5	S3
7	19.0	1	20.0	2	26	2	39.9	2	12.2	1	13	3	11	1	S4
8	17.0	2	21.0	1	35	1	41.9	1	9.9	4	8.1	6	15	2	S4

Source: As reported in Sustainable DC Plan for 2005-2009 . Quoted source: http://www.neighborhoodinfodc.org/wards/wards.html

* source: http://www.neighborhoodinfodc.org/wards/wards.html

**lower numbers = more vulnerable

Sensitivity scoring per ward.

Ward	% Unemployment 2005-2009	Rank	% without HS diploma 2005-2009	Rank	% poverty prevalence 2005-2009	Rank	Sums across wards**	Rank	Adaptive Score
1	7.2	6	19.0	3	16	5	14	5	AC2
2	4.0	7	8.1	6	15	6	19	7	AC2
3	3.4	8	3.4	7	6.9	8	23	9	AC3
4	7.6	5	17.0	4	9.9	7	16	6	AC2
5	13.0	3	19.0	3	19	3	9	3	AC1
6	8.4	4	12.0	5	18	4	13	4	AC2
7	19.0	1	20.0	2	26	2	5	2	AC1
8	17.0	2	21.0	1	35	1	4	1	AC1

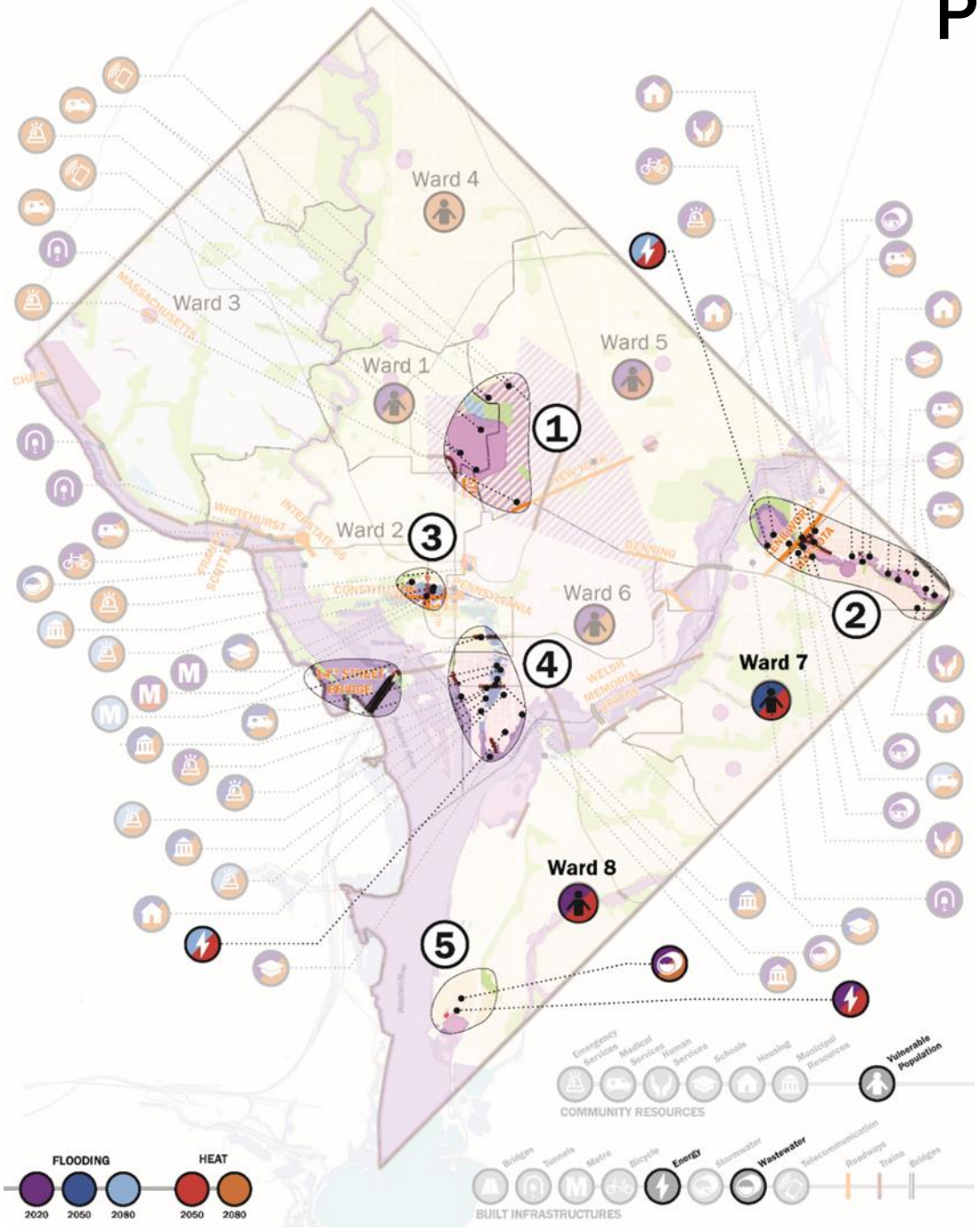
Source: As reported in Sustainable DC Plan for 2005-2009 . Quoted source: http://www.neighborhoodinfodc.org/wards/wards.htm

* source: http://www.neighborhoodinfodc.org/wards/wards.html

**lower numbers = lower adaptive capacity

Adaptive capacity scoring – per ward.

Planning priority areas



Ward	Sensitivity Score	Adaptive Score	Vulnerability ranking
1	S3	AC2	V3
2	S1	AC2	V1
3	S1	AC3	V0
4	S2	AC2	V2
5	S2	AC1	V4
6	S3	AC2	V3
7	S4	AC1	V5
8	S4	AC1	V5

Reported vulnerable scoring for population per ward
(Adapted ICLEI Vulnerability Assessment Matrix)

The Challenge

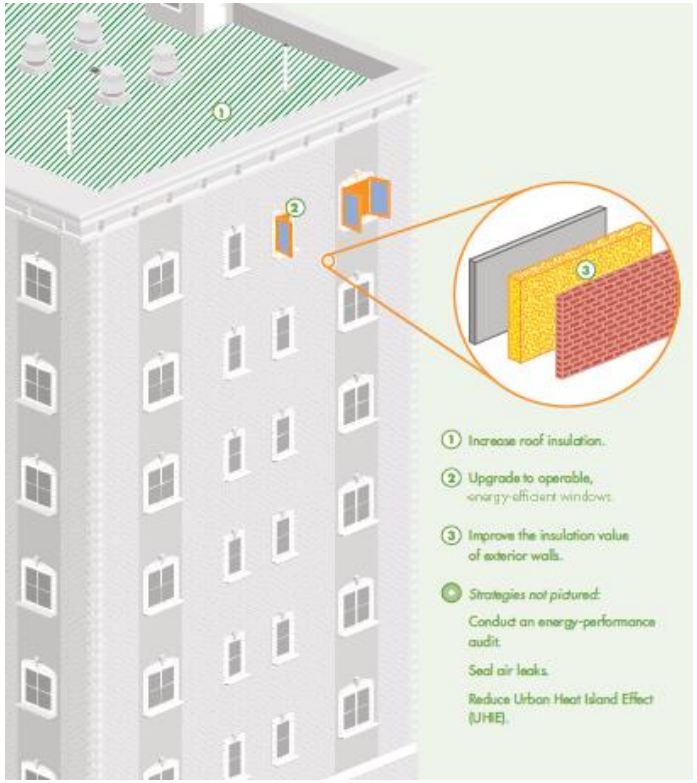
How do you translate climate risk into planning and design?

Master Adaptation Action List *(Draft)* -

	ACTION (SUB-ACTION)
TU – Transportation + Utilities Goal: Improve the transportation and utility infrastructure to maintain viability during periods of extreme heat, extreme weather and flooding.	
TU 1.0	**Develop site-level adaptation plans** for all transportation, energy, water & wastewater, telecommunications + data (internet) facilities, functions and service areas identified as at-risk from sea level rise and flooding based on the Vulnerability Assessment.
TU 2.0	Increase the resilience of all types energy systems
TU 3.0	Increase Resiliency of both Potable and Non-Potable Water Systems
TU 4.0	Increase Resilience of Communication Systems
TU 5.0	Increase Resilience of Transportation Systems
BD – Buildings & Development Goal: Upgrade existing buildings and design new buildings and development projects to withstand climate change impacts.	
BD 6.0	Provide back-up power for emergencies at all identified critical facilities. Ensure that existing back-up power systems are located above projected flood elevations.
BD 7.0	Improve thermal safety + indoor building temperatures to increase resilience to extreme heat, especially in the event of a power outage.
BD 8.0	Pursue deep energy and water efficiency for all buildings
BD 9.0	Incorporate Climate Resilience into Development Planning and Review Processes
BD 10.0	Leverage land-use planning to promote resiliency
BD 11.0	Provide incentives to encourage private property owners and developers to implement flood resiliency measures.
BD 12.0	ADDITIONAL BD ACTIONS
NC – Neighborhoods & Communities Goal: Make neighborhoods and communities safer and more prepared by strengthening community, social, and economic resiliency.	
NC 13.0	Improve emergency preparedness and planning with a particular focus on vulnerable populations.
NC 14.0	Reduce risks of extreme heat and the urban heat island
NC 15.0	Strengthen Community Cohesion for Safety + Resilience
NC 16.0	Develop Eco-Resiliency Districts and Community Resiliency Hubs
NC 17.0	ADDITIONAL NC ACTIONS
GI – Governance & Implementation Goal: Establish the policies, structures, and monitoring and evaluation procedures to ensure successful implementation of the adaptation plan.	
GI 18.0	Conduct additional analysis of climate vulnerability and adaptation strategies based on gaps identified in the reports associated with this larger study.
GI 19.0	Align Climate Adaptation Plan with related planning efforts including Hazard Mitigation, Comprehensive Land-Use, Comprehensive Energy, and Capital Budget Planning.
GI 20.0	Establish the necessary structures to ensure successful implementation of the Climate Adaptation Plan

Source: DC Climate Change Adaptation Plan, 2016 (Draft)

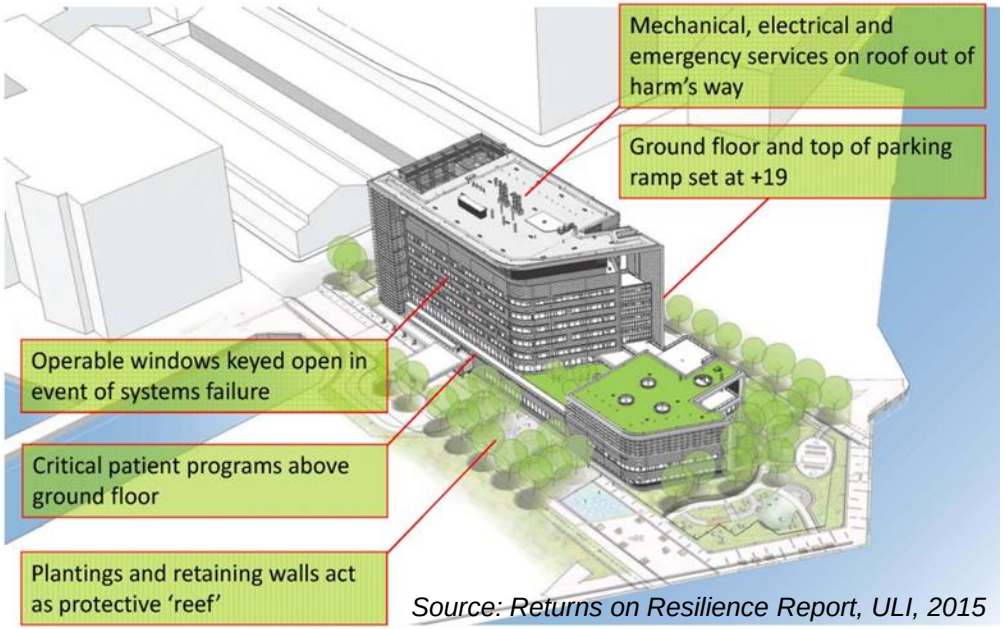
Resiliency at the Building Scale



Source: Strategies for Multifamily Building Resilience, Enterprise green communities, 2015

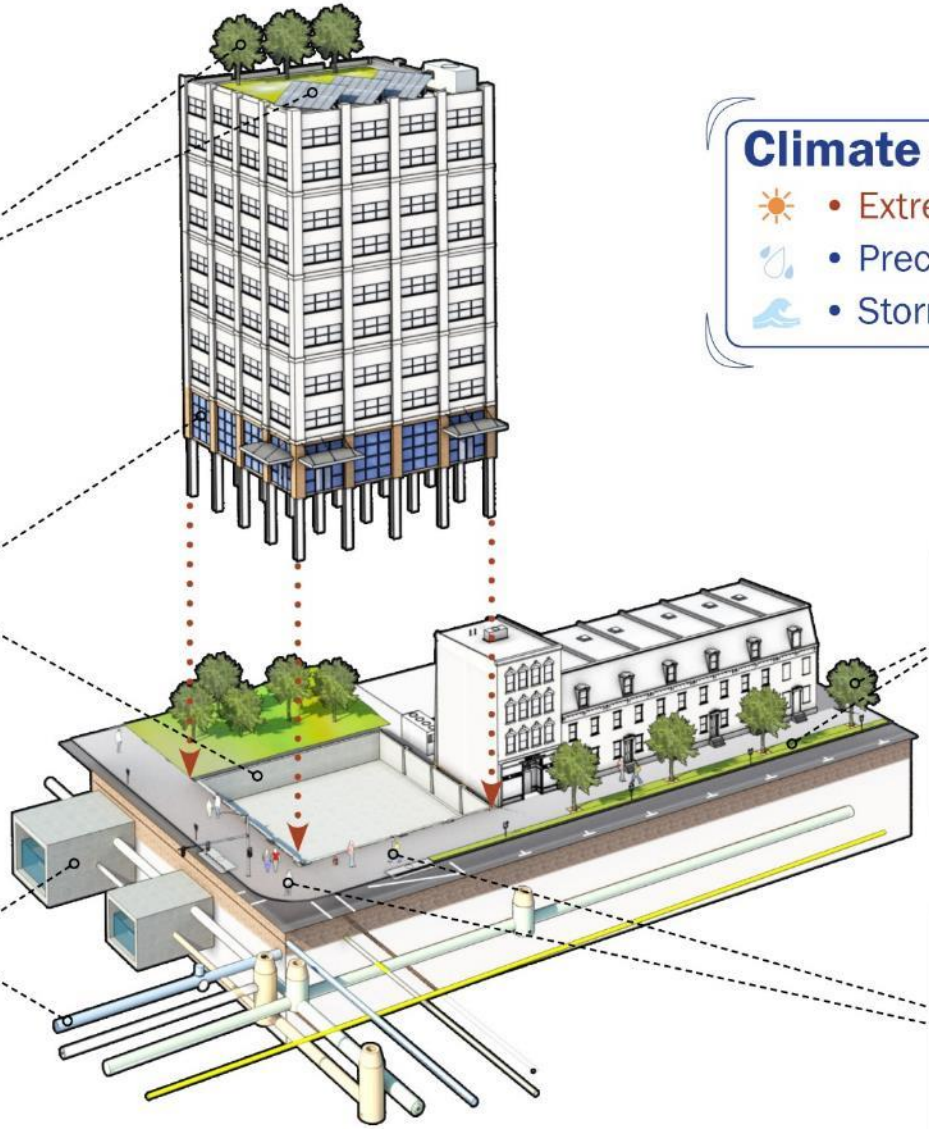
Heat Resiliency for Multifamily Housing

Flood Resiliency for Institutional Building



Source: Returns on Resilience Report, ULI, 2015

Resiliency at the Neighborhood Scale



Roof
- Green roof
- Raised utilities
- Solar panels

Building and structure
- Flood proofing
- Passive energy
- Passive cooling

Infrastructure
- Detention tanks
- Larger pipes
- Protected utilities

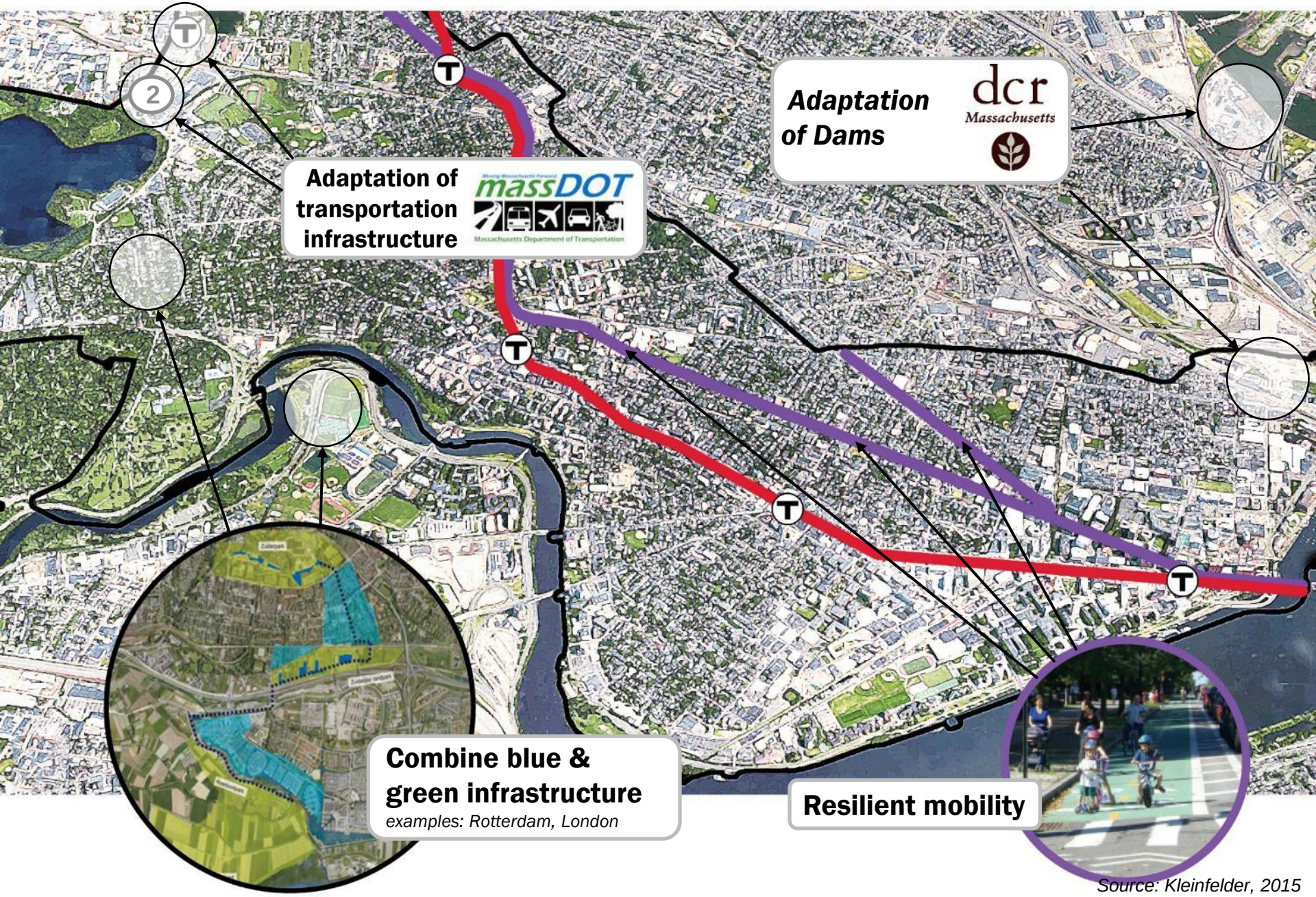
Climate stresses
- Extreme heat
- Precipitation
- Storm surge

Green Infrastructure
- Porous pavement
- Rain gardens
- Shaded streets

Community
- Network
- Shelter
- Contingency plan
- Pre-ID people at risk

Source: Kleinfelder, 2015

Resiliency at City & Regional Scale



Source: Kleinfelder, 2015

Resources:

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Cambridge Climate Change Vulnerability Assessment

http://www.cambridgema.gov/CDD/Projects/Climate/climatechangeresilianceandadaptation.aspx

Contact: John Bolduc jbolduc@cambridgema.gov

Climate Adaptation Plan, Climate Change The District of Columbia Department of Energy & Environment

http://doee.dc.gov/service/climate-adaptation-and-preparedness

Contact: Kate Johnson (DOEE) katherine.johnson@dc.gov