MassDOT-FHWA Pilot Project:

Climate Change and Extreme Weather Vulnerability Assessments and Adaptation Options of the Central Artery

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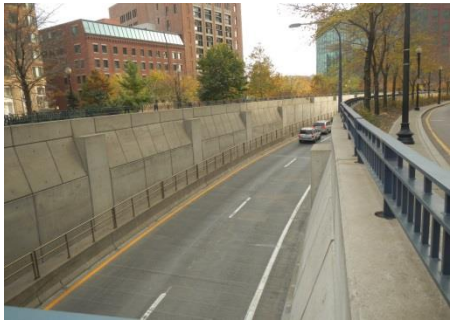
The Central Artery/Tunnel (CA/T) system is a critical link in regional transportation and a vitally important asset in the Boston metropolitan area with 160 lane miles half of them in tunnels, six interchanges, and 200 bridges.

Tip O'Neill Tunnel Exit & Entrance Ramps

Tip O'Neill Tunnel Exit & Entrance Ramps



Tip O'Neill Tunnel Exit Ramp

Vent Building 1

Vent Building 4– Detail of 15KV Electrical Conduit

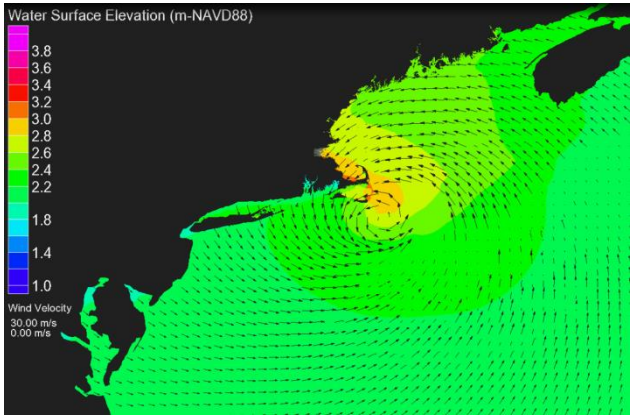
What have we been working on?

The CA/T Pilot Project Timeline

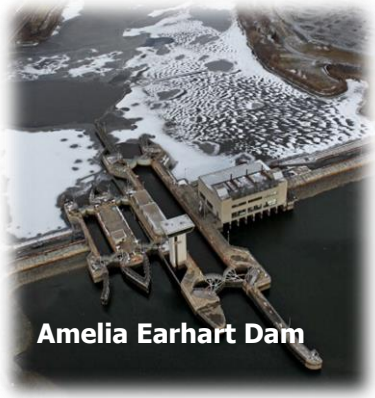
- October 22, 2012: Superstorm Sandy makes landfall.
- November 16, 2012: MassDOT Highway convenes a Storm Awareness Meeting at the District 6 Administration Building
- January 22, 2013: MassDOT submits its proposal to evaluate the Central Artery for climate change and extreme weather events
- April 16, 2013: Notice to Proceed given to UMass Boston
- Final Report to FHWA: May 2015

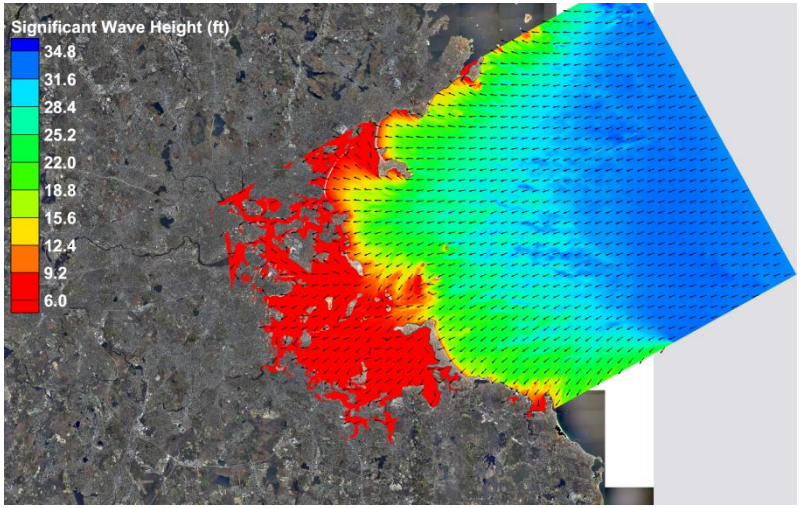
High Resolution Hydrodynamic Modeling

- Includes relevant physical processes (tides, storm surge, wind, waves, wave setup, river discharge, sea level rise, future climate scenarios)



- **Currents**
- **Storm Surge**
- **Tides**
- **Water Levels**
- **Winds**
- **SLR**
- **Discharge**
- **Infrastructure**





- **Waves**
- **Wave Setup**

Tightly Coupled

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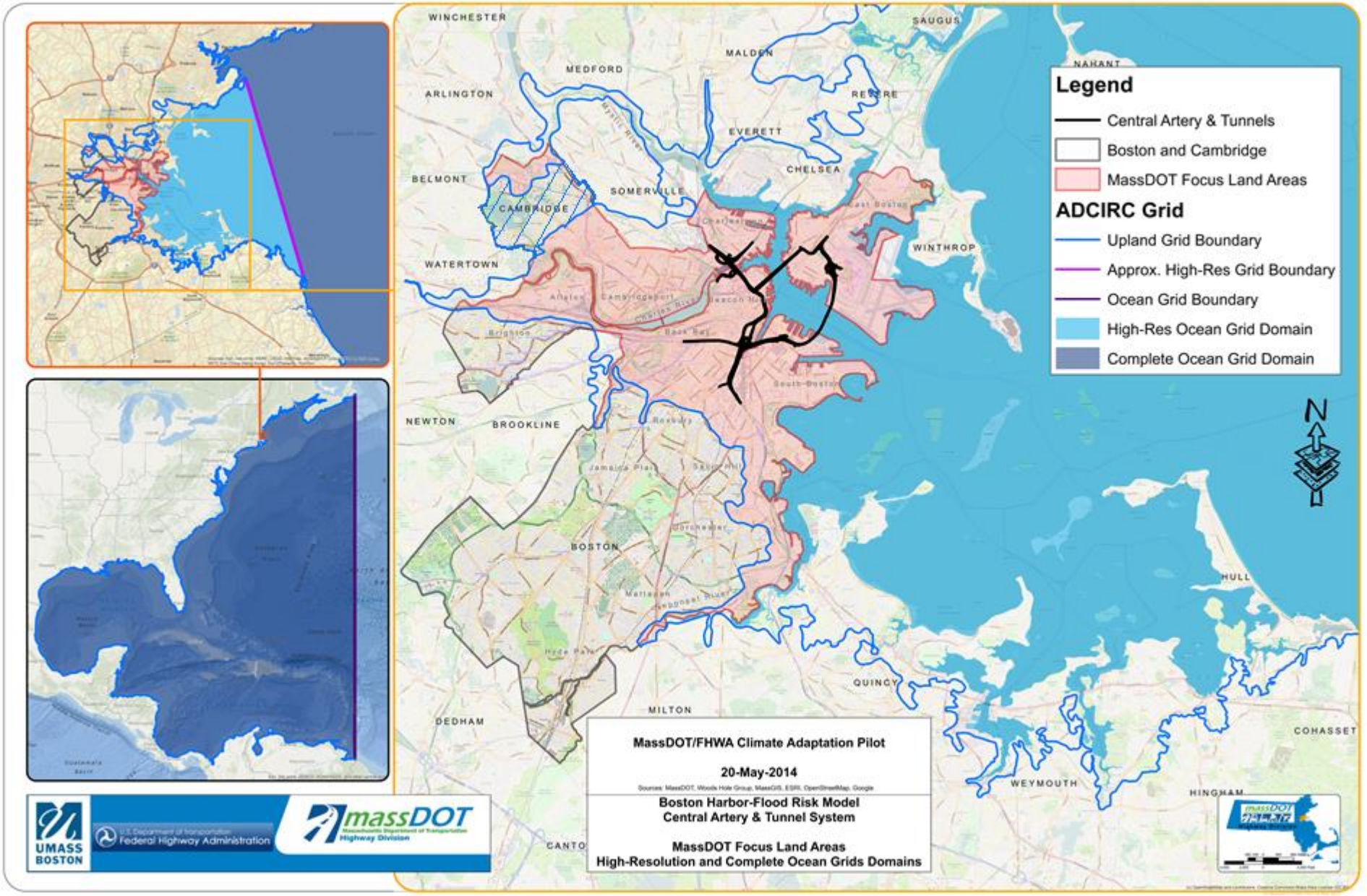
WINCHESTER
MEDFORD
MALDEN
SAUGUS
NAHANT
ARLINGTON
REVERE
EVERETT
BELMONT
SOMERVILLE
CHELSEA
CAMBRIDGE
WINTHROP
WATERTOWN
NEWTON
BROOKLINE
BOSTON
QUINCY
MILTON
DEDHAM
HULL
COHASSET
WEYMOUTH
HINGHAM
Legend
Central Artery & Tunnels
Boston and Cambridge
MassDOT Focus Land Areas
ADCIRC Grid
Upland Grid Boundary
Approx. High-Res Grid Boundary
Ocean Grid Boundary
High-Res Ocean Grid Domain
Complete Ocean Grid Domain
N
MassDOT/FHWA Climate Adaptation Pilot
20-May-2014
Boston Harbor-Flood Risk Model
Central Artery & Tunnel System
MassDOT Focus Land Areas
High-Resolution and Complete Ocean Grids Domains
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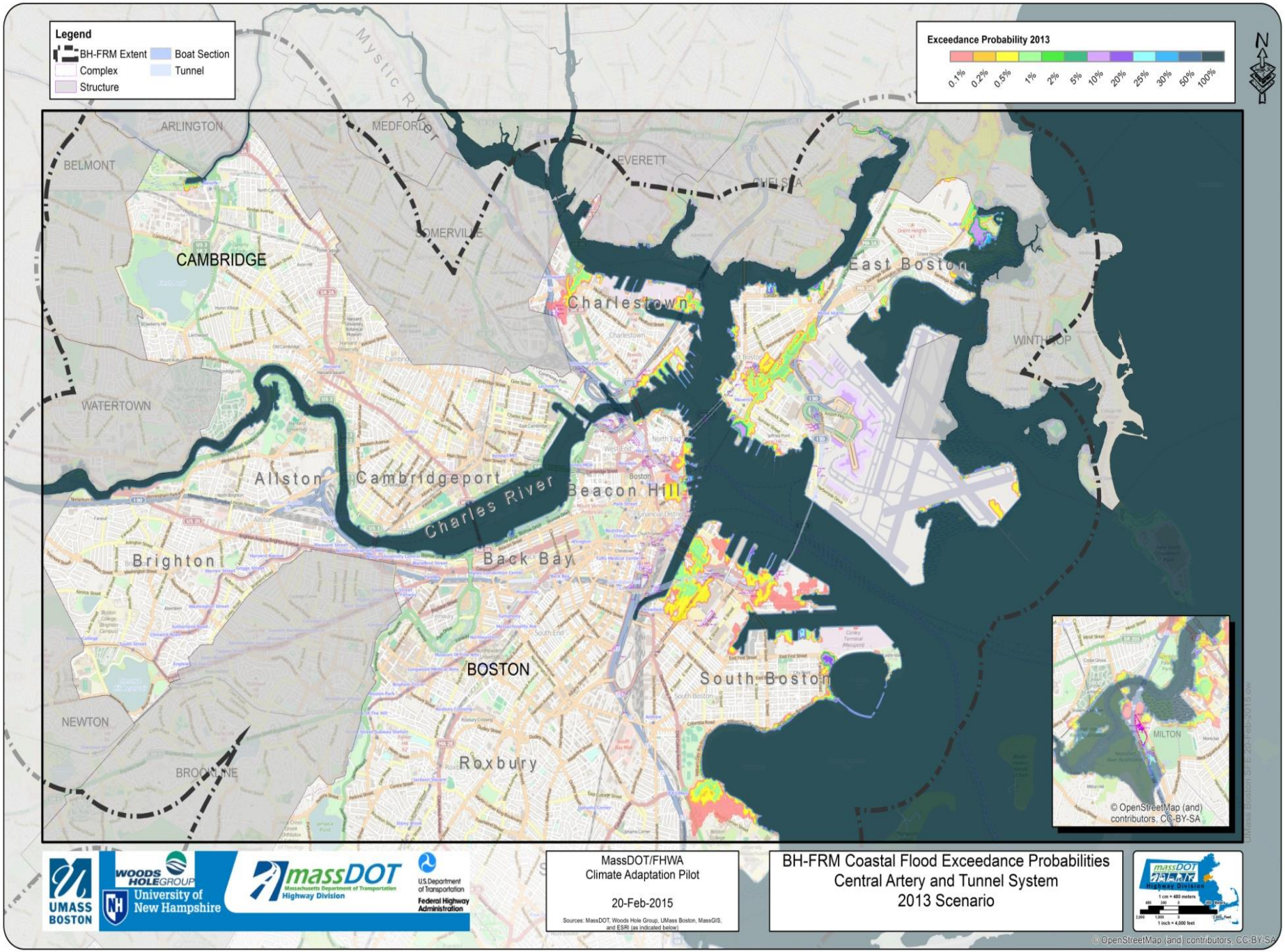
Legend
BH-FRM Extent
Complex
Structure
Boat Section
Tunnel
Exceedance Probability 2013
0.1%
0.2%
0.5%
1%
2%
5%
10%
20%
25%
30%
50%
100%
N
Mystic River
ARLINGTON
MEDFORD
BELMONT
EVERETT
CHELSEA
SOMERVILLE
CAMBRIDGE
East Boston
Charlestown
WINTHROP
WATERTOWN
Allston
Cambridgeport
Charles River
Beacon Hill
Brighton
Back Bay
BOSTON
South Boston
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Federal Highway Administration
MassDOT/FHWA
Climate Adaptation Pilot
20-Feb-2015
Sources: MassDOT, Woods Hole Group, UMass Boston, MassGIS, and ESRI (as indicated below)
BH-FRM Coastal Flood Exceedance Probabilities
Central Artery and Tunnel System
2013 Scenario
1 cm = 400 meters
1 inch = 4,000 feet
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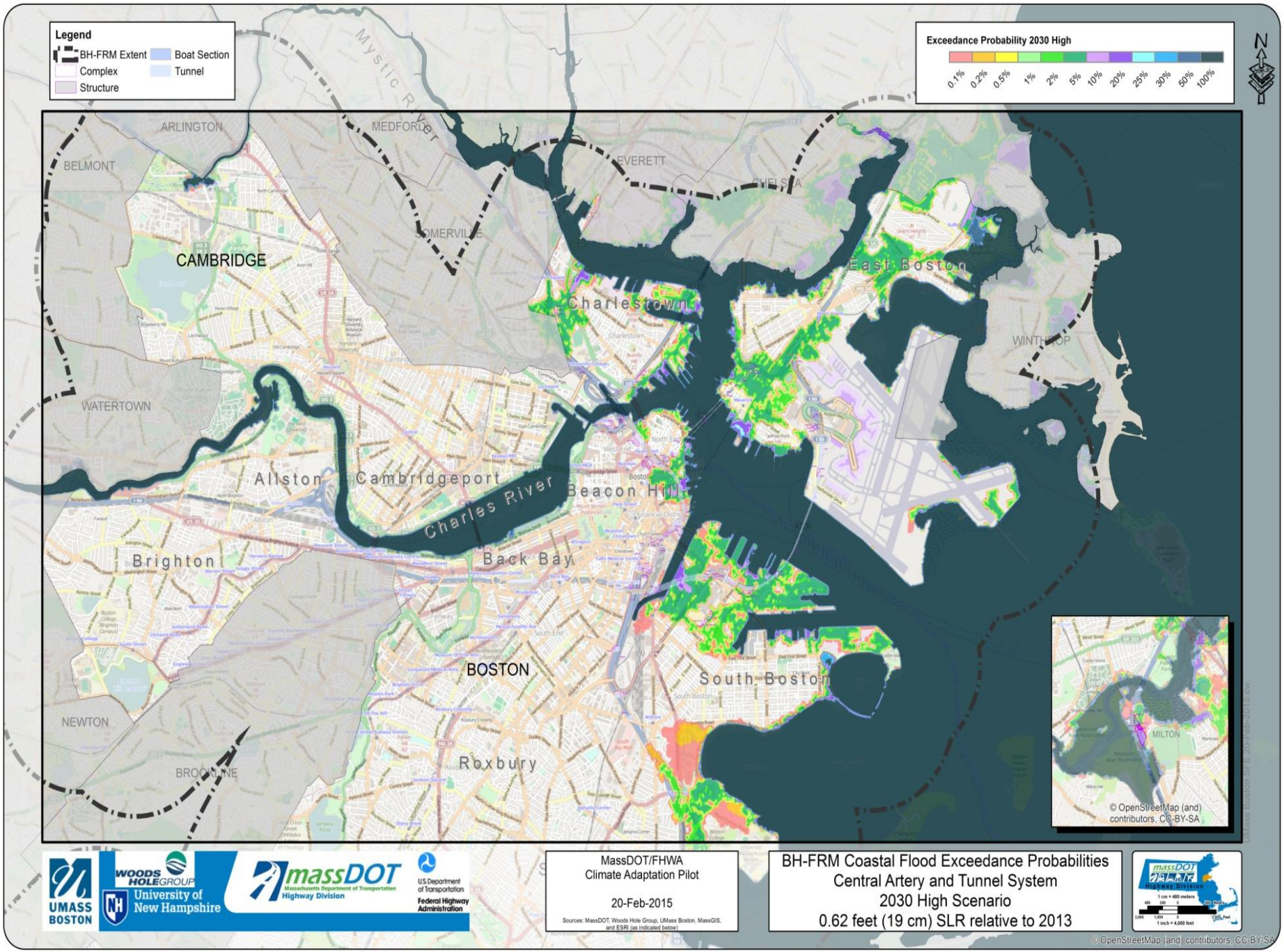

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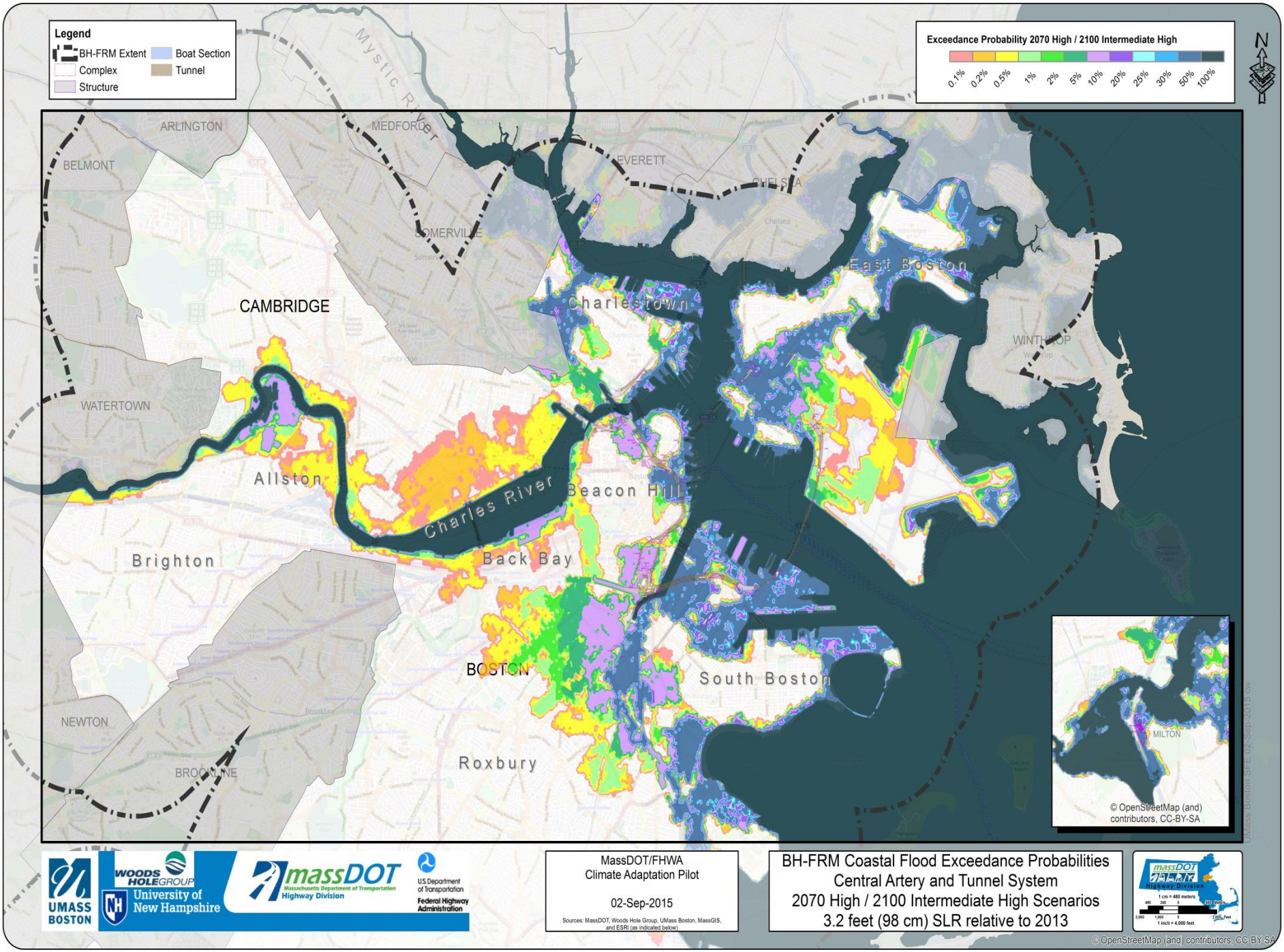
BH-FRM Coastal Flood Exceedance Probabilities
Central Artery and Tunnel System
2030 High Scenario
0.62 feet (19 cm) SLR relative to 2013



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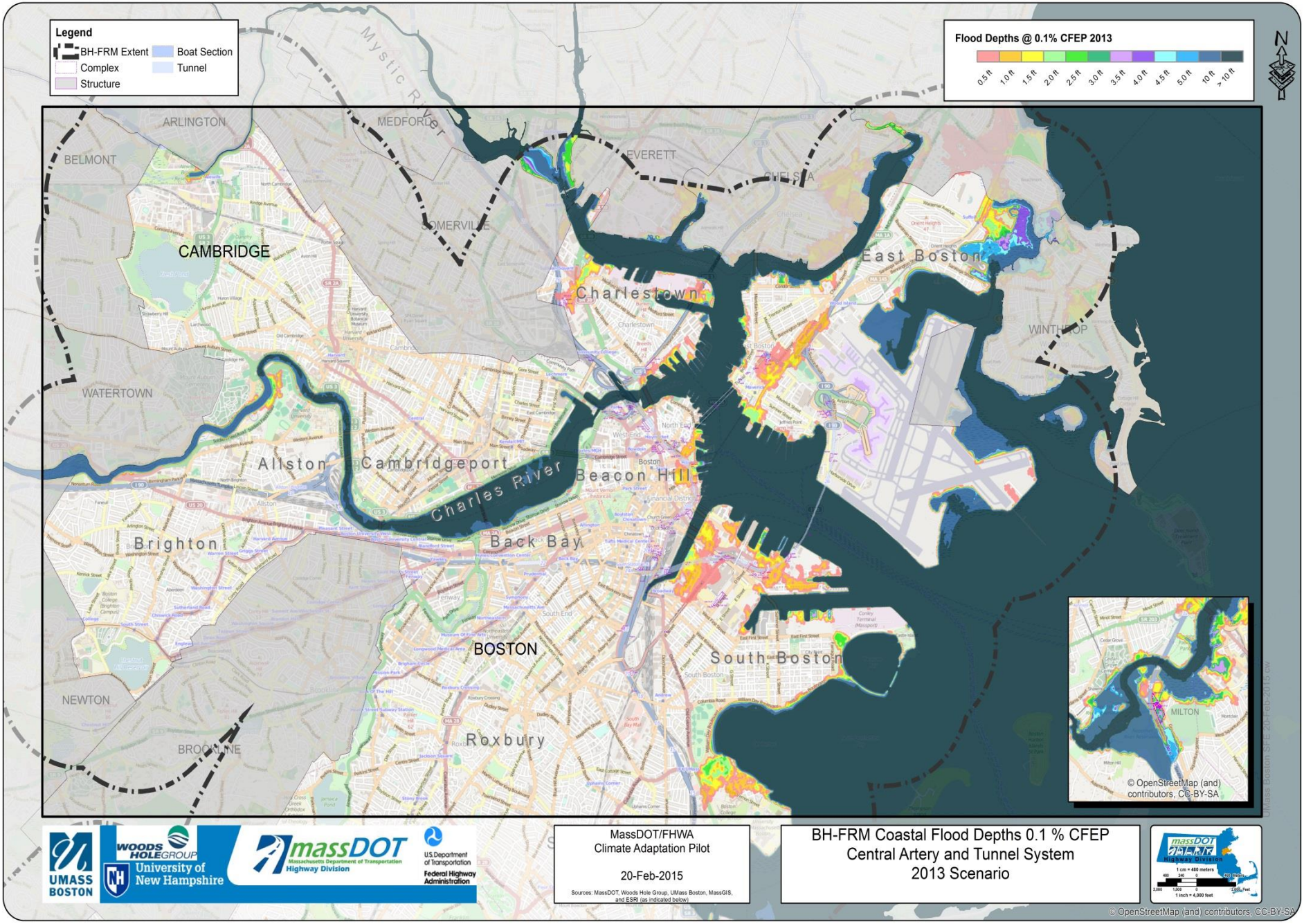
02-Sep-2015

Sources: MassDOT, Woods Hole Group, UMass Boston, MassGIS, and ESRI (as indicated below)

BH-FRM Coastal Flood Exceedance Probabilities
Central Artery and Tunnel System
2070 High / 2100 Intermediate High Scenarios
3.2 feet (98 cm) SLR relative to 2013



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Sources: MassDOT, Woods Hole Group, UMass Boston, MassGIS, and ESRI (as indicated below)

BH-FRM Coastal Flood Depths 0.1 % CFEP
Central Artery and Tunnel System
2013 Scenario

massDOT Highway Division
1 cm = 480 meters
1 inch = 4,000 feet

Vulnerability Assessment

While considering exposure, sensitivity, and adaptive capacity it became apparent during the IK meetings that there is a high sensitivity to flooding to almost all structures with little redundancy in the system “any water at grade is a problem”.

Therefore, all structures have an equal priority

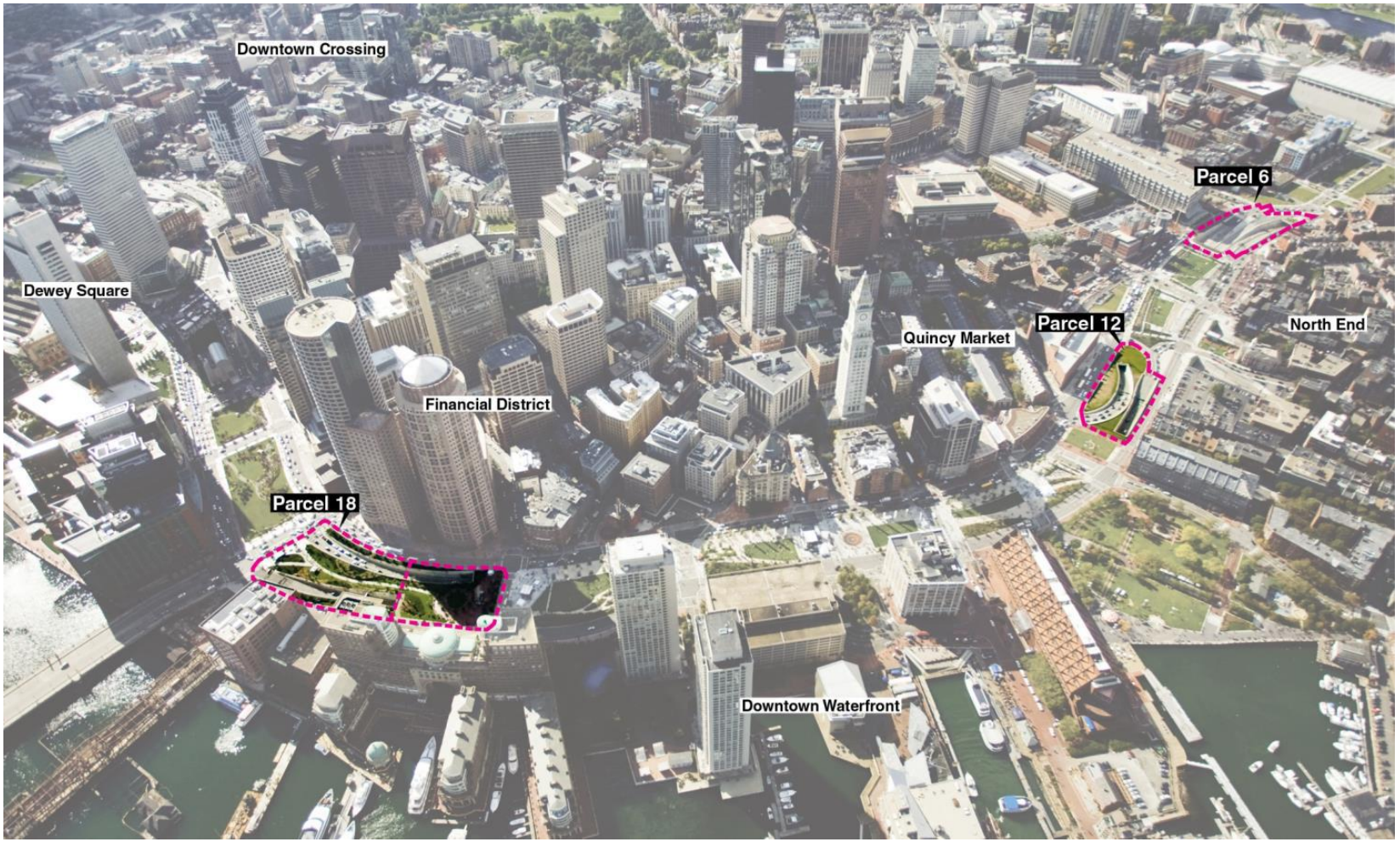

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Table 5-2. The vulnerability results of non-Boat Section Structures for 2013 and 2030 flooding scenarios. "2013" indicates present vulnerability and "≤2030" indicates vulnerability over the period from the just past the present to 2030.

Note: when a range of depths is shown, it means that flood depth varies along the perimeter of the structure.

Structure_ID	2013 1 % Depth (ft)	≤ 2030 1 % Depth (ft)	Structure Location
D6A-DC03	0	0 to 0.3	Depot-Main Complex SMF Rutherford Street, Charlestown
D6D-DC01	0 to 0.5	0 to 1.5	Depot-Main Complex - 93 Granite Ave, Milton
D6D-D1-B	0 to 0.4	0.7	D6 Granite Ave Building B
D6D-D1-C	0	0.2	D6 Granite Ave Building C
HOC-D6	0	0 to 0.2	Complex HOC / ES02 / I-90 ML Massport Haul Road, South Boston
D6-ES02-FAC	0	0 to .03	Emergency Response Station 2
D6-SWO4-FAC	0	Flooded[d]	Storm Water Pump Station 4
TB03-D6	0 to 0.1	0.1	Complex TB03 / ERS07 Bulfinch Triangle, East Boston
D6-TB03-FAC	0	0.1 to 0.45	Toll Facility Building Sumner Tunnel
ERS07	0	0.25 to 0.7	Emergency Response Station 7
TA03-D6	0 to 0.1	0.1 to 0.8	Complex TA03 Havre Street, East Boston
D6-TA03-FAC	0	0.4 to 0.8	Sumner/Callahan Tolls/Administration/Engineering
D6-VB11-FAC	0	0 to 0.25	Vent Building 11 - Liverpool Street, East Boston
D6-VB13-FAC	0	0.05 to 0.7	Vent Building 13 - Decatur Street, East Boston
D6-VB1-FAC	0	0 to 1	Vent Building 1 - 55 Dorchester Avenue, Boston
D6-VB6-FAC	0	0.4	Vent Building 6 - 2 Fid Kennedy Drive, S. Boston
TE061W	0	0.4	Tunnel Egress 61W at VB6
MBTAAQ	0.4	0.5 to 1.5	MBTA Aquarium Station

MBTA Aquarium Station-MBTAAQ

Notes:
[a] Inside (downstream) of Portal BIN62B-POR, so protected if portal protected
[b] Outside (upstream) of Portal BIN7UG-POR, floods if Boat Section floods
[c] See note b. Also in 2030, 1% flood, there is only minor flooding of the Boat Section.
[d] Door to pump station located in boat section, south and outside of Portal 7J8-POR. Portal is flooded under 1% flood level in 2030.

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Possible Regional Adaptation Strategies

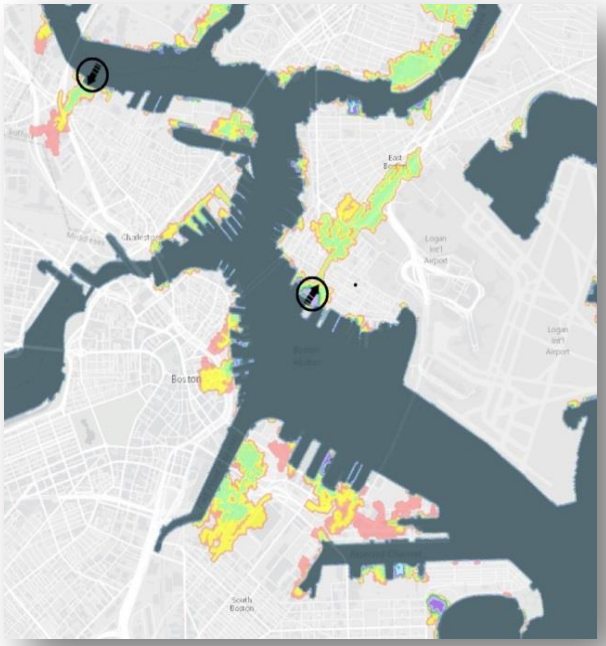

Figure 6-1. Flood entry point locations that are viable sites for regional adaptations under the 2013 scenario (Milton site not shown).

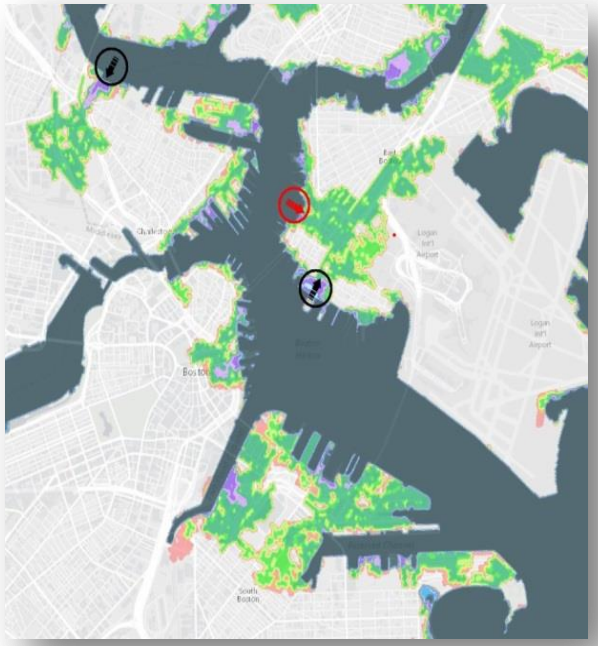

Figure 6-2. Flood entry point locations that are viable sites for regional adaptations under the 2030 scenario.

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MassDOT is Expanding the model to entire coast and islands:

This work will assess the vulnerability of MassDOT's transportation systems (primarily roads, bridges, and railways) along the entire Massachusetts coastline. This 2 year project has 3 main phases:

- Phase 1: Pilot-scale analysis to develop methodologies and test modeling schemes.
- Phase 2: Extension and refinement of BH-FRM to the entire coastline. The new model will be called the Massachusetts Coastline Flood Risk Model (MC-FRM) and will be used for the regional analysis.
- Phase 3: Regional scale vulnerability analysis and conceptual adaptation strategies.

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