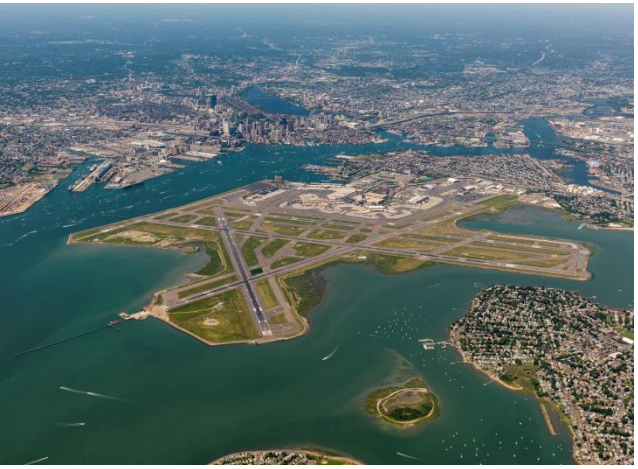


Resiliency | Massport

A pathway to a more resilient future

NAS 9/16/15

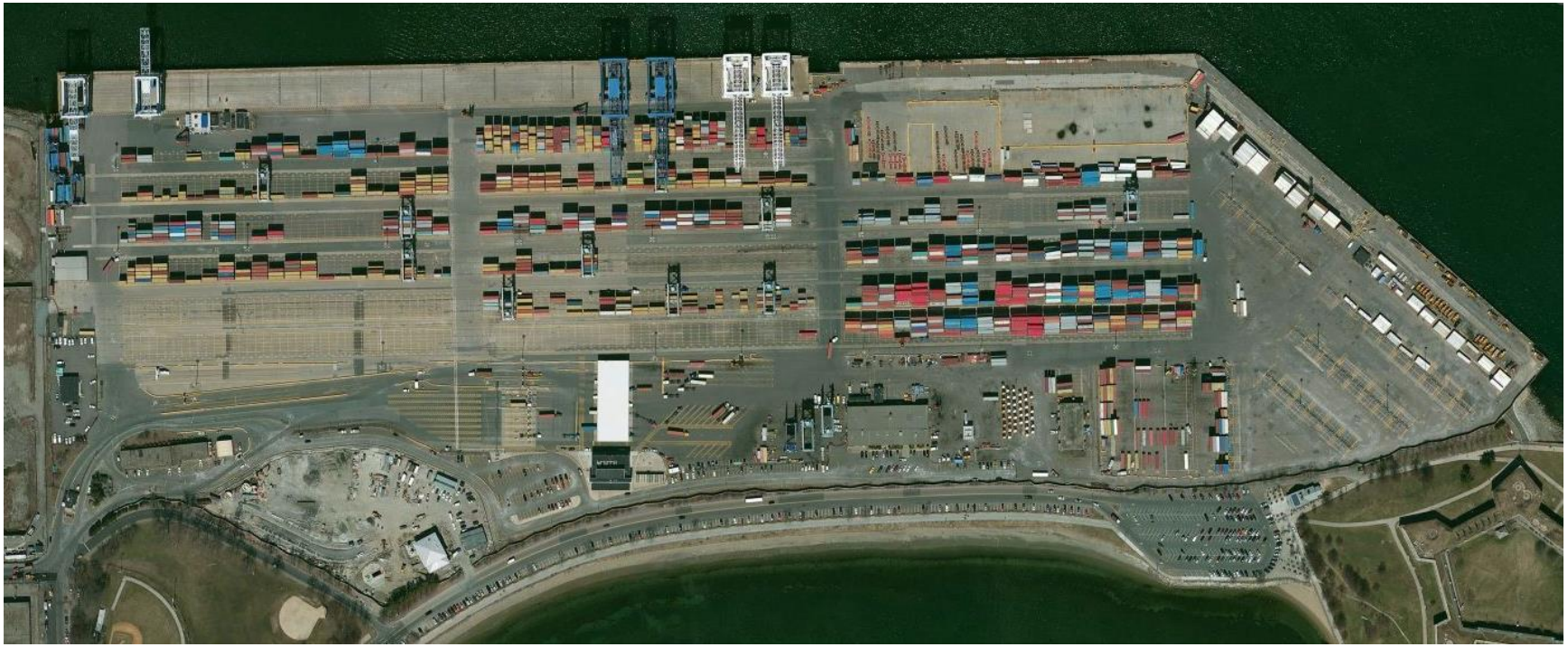
MASSPORT'S FACILITIES

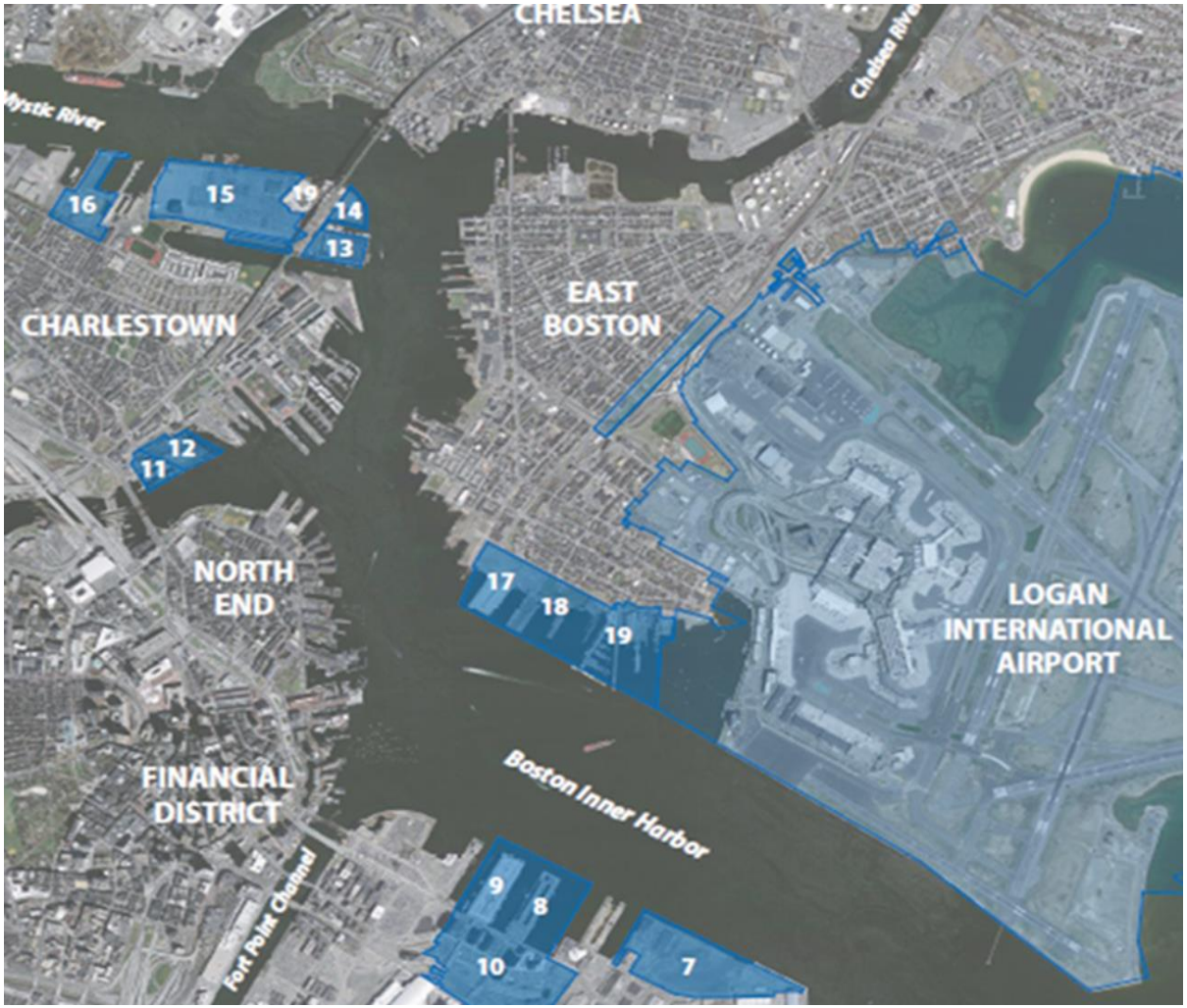
- Massport is an independent authority governed by a board of directors, appointed by the state's governor
- Massport owns and operates
  - Boston-Logan International Airport
  - Hanscom Field, Bedford, MA
  - Worcester Airport
  - Conley Container Terminal
  - Black Falcon Cruiseport
  - Various real estate assets

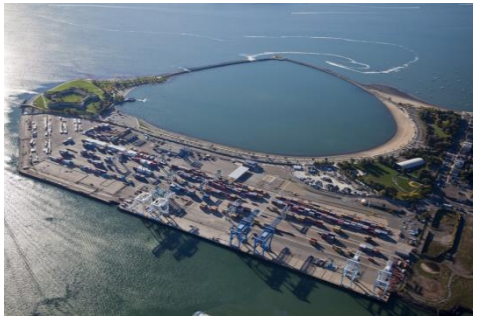
Boston Logan International Airport

Port of Boston

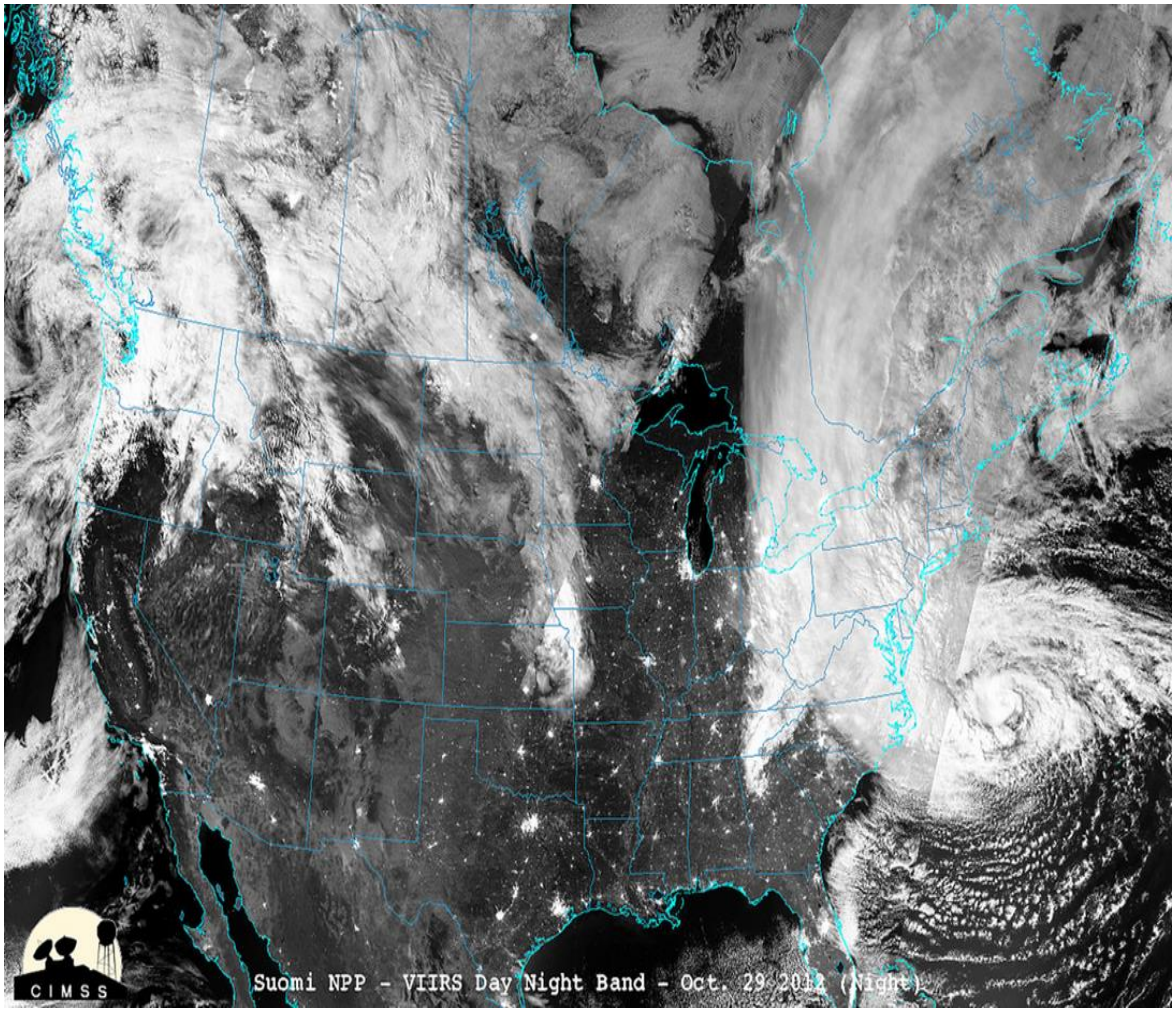
Conley Terminal




CHELSEA
Mystic River
Chelsea River
16
15
19
14
13
CHARLESTOWN
EAST
BOSTON
12
11
NORTH
END
17
18
19
LOGAN
INTERNATIONAL
AIRPORT
FINANCIAL
DISTRICT
Boston Inner Harbor
Fort Point Channel
9
8
10
7



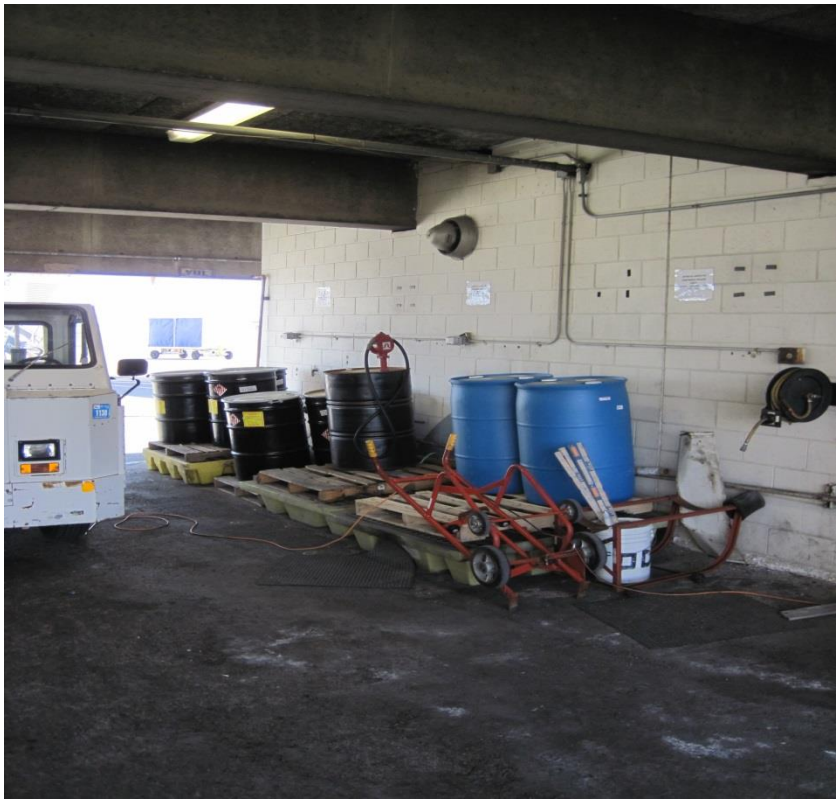
Drivers for Action



Preparation for Superstorm Sandy

- Resident Engineers on-site inspections
- Construction scaffolding removed
- Tie-downs on bridge
- Cleaned screens for storm drains
- FOD removed before (and after)
- Secure doors

Hazardous waste moved inside

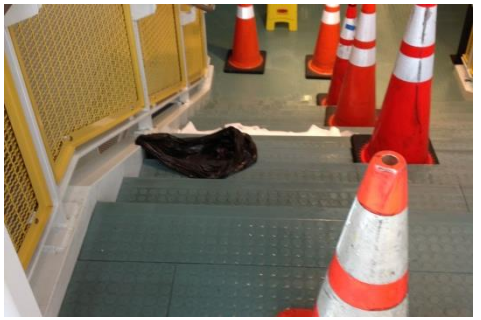


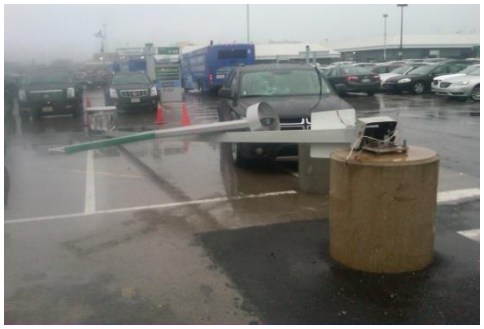
Hazardous waste moved inside

- Massport essential personnel
  - Fire
  - Safety
  - Operations
  - Resident Engineers

- Term-contractors on-site
  - Roofing
  - Electrical
  - Mechanical
  - Pumping
  - Cleaning

- Solar panels destroyed
- Terminals flooded
- Standards and signs blown over
- Vehicles destroyed
- Roofing membranes peeled off





OUR PROCESS

Resiliency Program Goals

- Become an innovative and national model for resiliency planning and implementation within the port authority.
- Take responsibility for improving our overall infrastructure and operational resilience.
- Increase our business value and (contextual community responsibilities) through improved resiliency.
- Engage our stakeholders to better understand and address their concerns.
- Incorporate resilient design and construction practices in the development of our airports, maritime systems, and real estate.
- Monitor, measure, and adapt/modify our progress.

Program Manager of Resiliency

- First position of its kind at Massport and possibly at any national port authority.
- Directs and coordinates resilience assessment and adaptation preparedness activities of Massport.

- Pursues two complementary objectives:
  - Making the resilience plan and its principles part of business strategy and operations everywhere; and
  - Facilitating cooperation among internal staff
  - External stakeholders promoting partnership &collective action.

Defining Resiliency

"Resiliency is the ability of a system to withstand a major disruption within acceptable degradation parameters, recover within an acceptable time, and balance composite costs and risks."

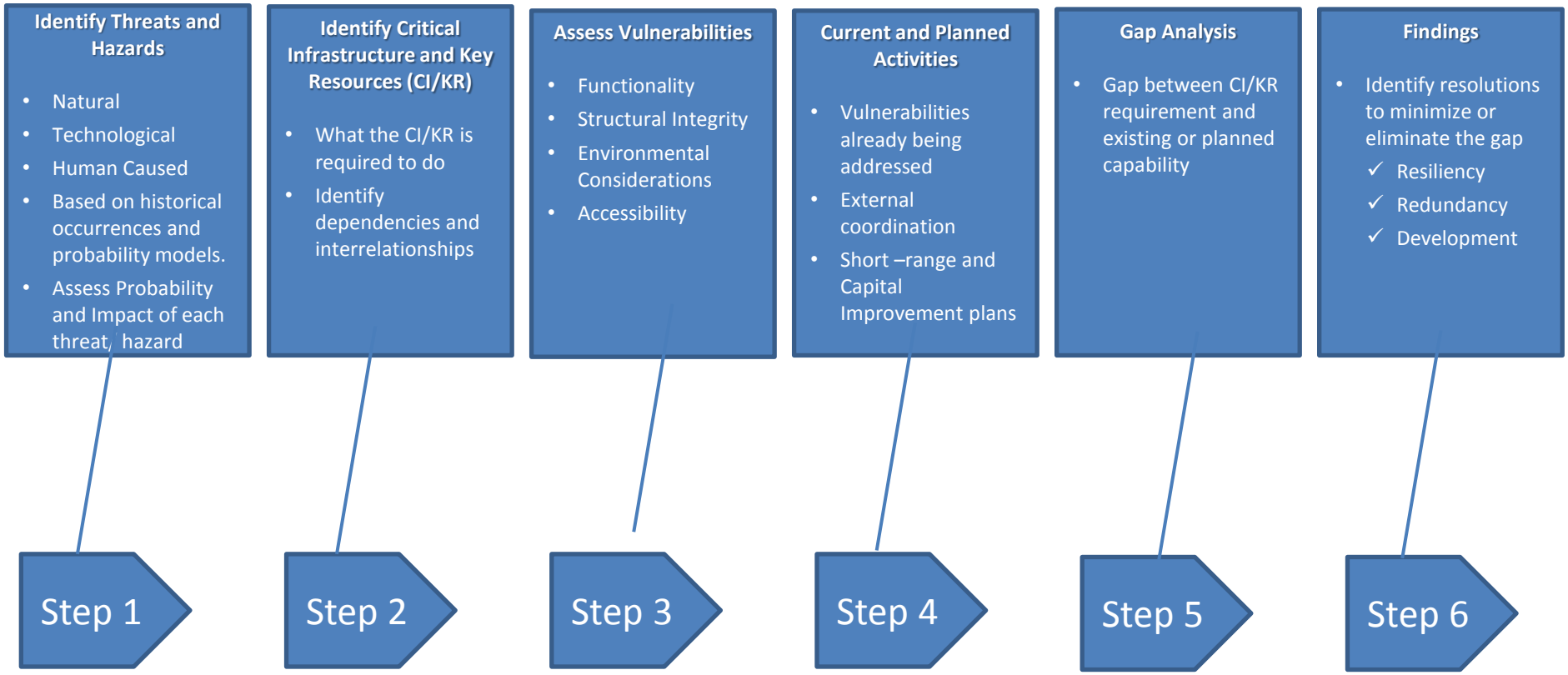
- How to protect Massport facilities against long-term sea-level rise, storm surges, intense storm events, other unplanned events and threats?
- How to maintain and restore operational capabilities during and after disruptive events?
- How to implement a balanced composite cost and risk plan?

Working Group Charge

- Identification
  - Threat event
  - Threat level
  - Impacted facilities
  - Effect of impact
  - Critical facilities needing protection
- Devise a Plan
  - Avoid, minimize, recover
  - Short term
  - Long term

Methodology

Modified DHS Threat and Hazard Identification and Risk Assessment (THIRA) Model



Threats & Hazards to Critical Infrastructure

NATURAL	TECHNOLOGICAL	HUMAN-CAUSED
Resulting from acts of nature	Involves accidents or the failures of systems and structures	Caused by the intentional actions of an adversary
• Earthquake • **Flood*** • **High winds*** • **Hurricane*** • **Sea Level Rise*** • Tornado • Tsunami • Fire • **Winter Storm*** *** Addressed in Kleinfelder Study for Logan and Maritime**	• Data Loss • Power Loss	• Fire/Accident • Sabotage • Terrorism Acts (Bomb Blast)

Critical Infrastructure/Key Resources

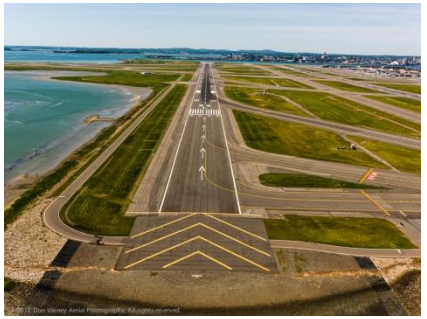
Utilities	Transportation	
Electrical/Vaults/Sub Stations/Distribution etc.	Parking	Transit
Drainage	Surface Roads	Taxi
Generators	Elevated Roads	Shuttle
Water	Tunnels	Rental Car
	Bridges	
Fuel Systems	**Human Capital**	
Aviation Fuel	Workforce	
Ground Fuel	HR Functions	
Generator Fuel	Qualified Maintenance	
	Security	
IT	**Equipment/Buildings**	
ATC – Tower	Terminals	Operating Cranes
Telecommunications	Runway/Taxiway	Processing Gates
Network	Apron	
Software	Tower	
Hardware	Security Gates	
Enterprise	Berths	

Probability

High Probability/High Impact		
Natural	Technological	Human-Caused
Flood High Winds Hurricane Fire Extreme Temps	Data Loss	
Low Probability/High Impact		
Natural	Technological	Human-Caused
Tsunami Tornado Earthquake		Terrorism Sabotage Epidemic

Consequence: Criticality Score

Description	Criticality Score
Assets required for **bare-bones functionality** for disaster preparedness, response, and recovery	**3**
Assets required for **disaster response** in the immediate aftermath of a flood event	**2**
Assets required for facility to **recover to acceptable level of service**	**1**



Disaster Infrastructure Resiliency Planning (DIRP)

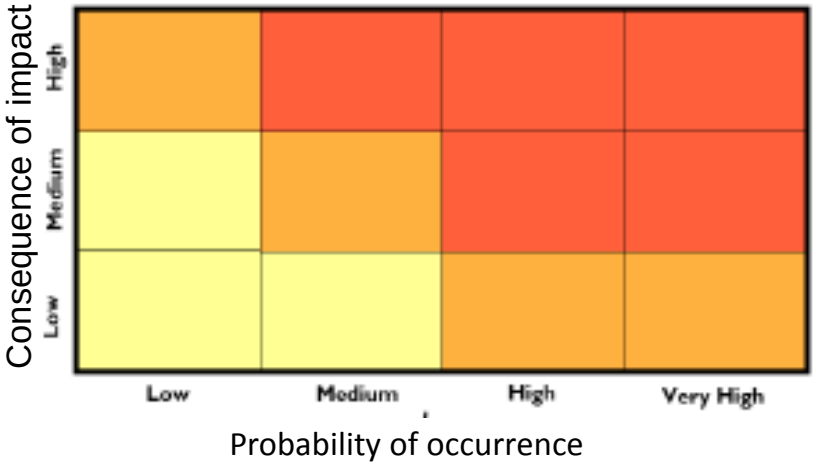
Goals of the project:

- Understand Massport's vulnerability to climate impacts
- Develop short-term and long-term resiliency strategies

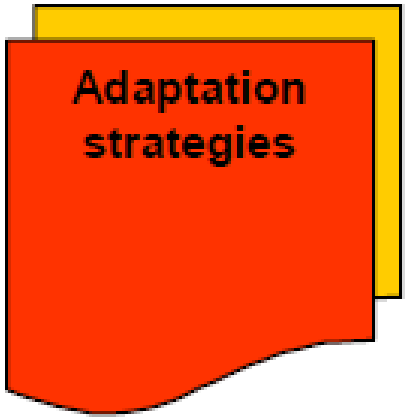
Project approach:

1 Climate projections

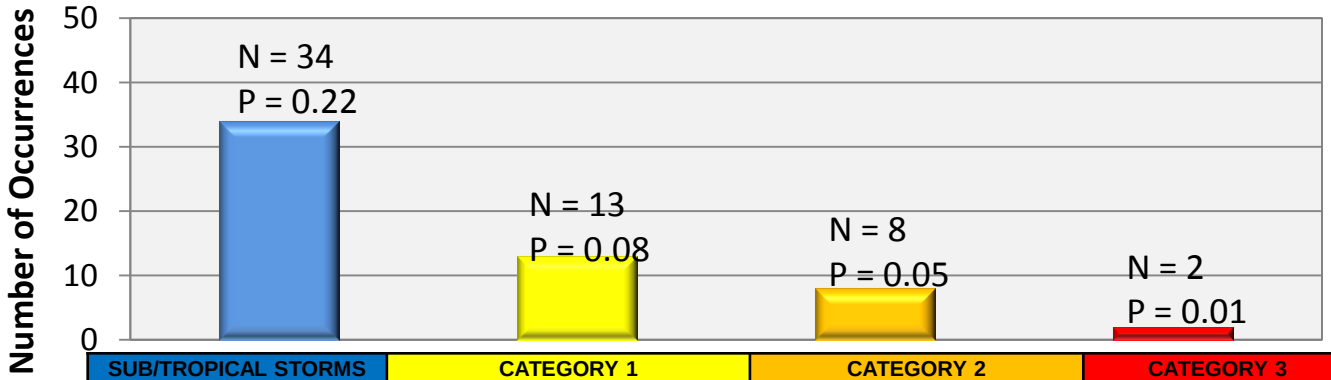
2 Vulnerability and risk assessment



3 Adaptation planning & design



Historic Occurrence of Hurricanes – Boston (1858-2013)

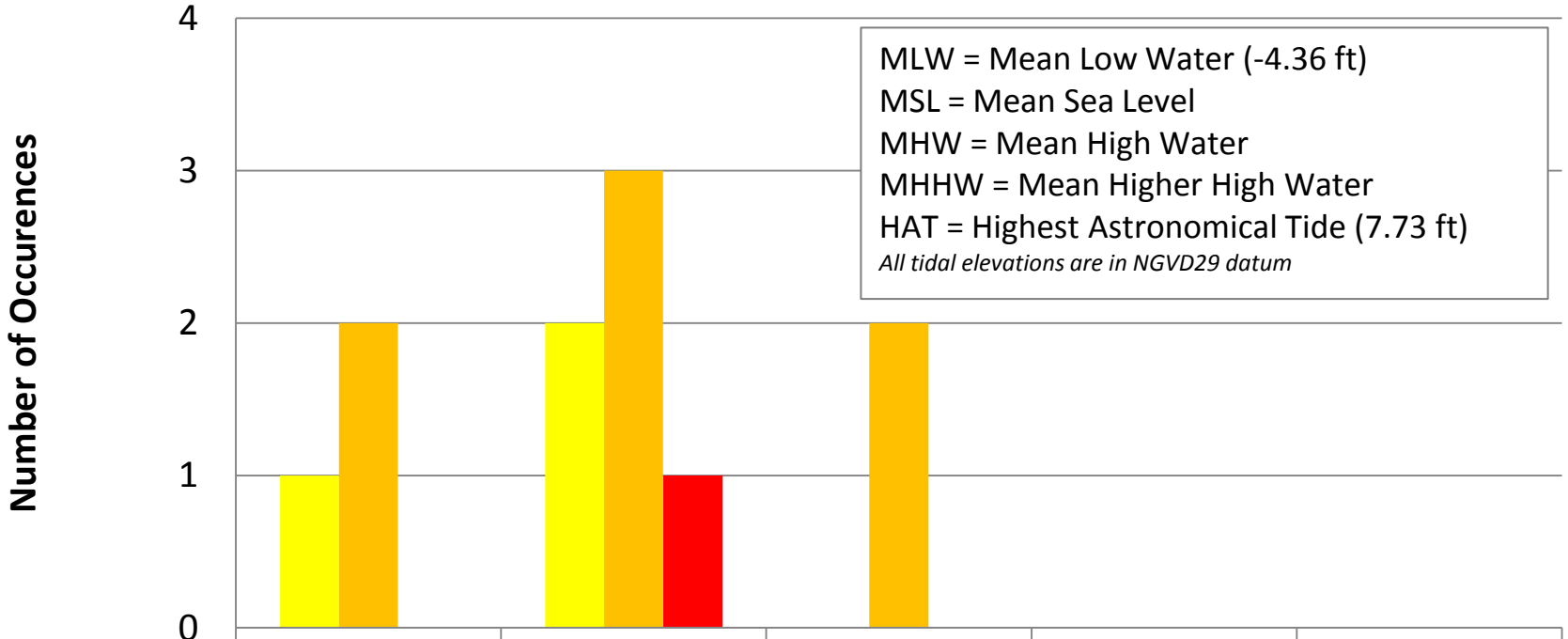


N = Number of Occurrences
P = Annual Probability

SUB/TROPICAL STORMS & DEPRESSIONS	CATEGORY 1 HURRICANE	CATEGORY 2 HURRICANES	CATEGORY 3 HURRICANES
	Hurricane Sandy [1]**:** October 29-30, 2012	**Hurricane Bob:** August 16 - 29, 1991	**Hurricane Esther:** September 10 - 27, 1961
	Great Atlantic Hurricane of 1944: September 9 - 16, 1944	**Hurricane Gloria:** September 27,1985	**Hurricane of 1869:** September 7 – 9, 1869
	Unnamed (1936): September 8 - 25, 1936	**Hurricane Donna**: September 12, 1960	
	Unnamed (1924): September 27 - 30, 1924	**Hurricane Edna**: September 11, 1954	
	Hurricane of 1916: July 10 - 22, 1916	**Hurricane Carol**: August 31, 1954	
	Unnamed (1904): September 8 - 15, 1904	**Great New England Hurricane**: September 21, 1938	
	Unnamed (1896): August 30 - September 11, 1896	**Unnamed** (1924): August 16 - 28, 1924	
	Unnamed (1894): October 1 - 12, 1894	**Unnamed (1869)**: October 4 - 5, 1869	
	Unnamed (1893): August 15 - 26, 1893		
	Unnamed (1888): September 23 - 27, 1888		
	Unnamed (1885): September 17 - 23, 1885		
	Unnamed (1879): August 13 - 20, 1879		
	Unnamed (1858): September 14 - 17, 1858		

[1] All storms listed above tracked within 150 miles of Boston, except Hurricane Sandy.

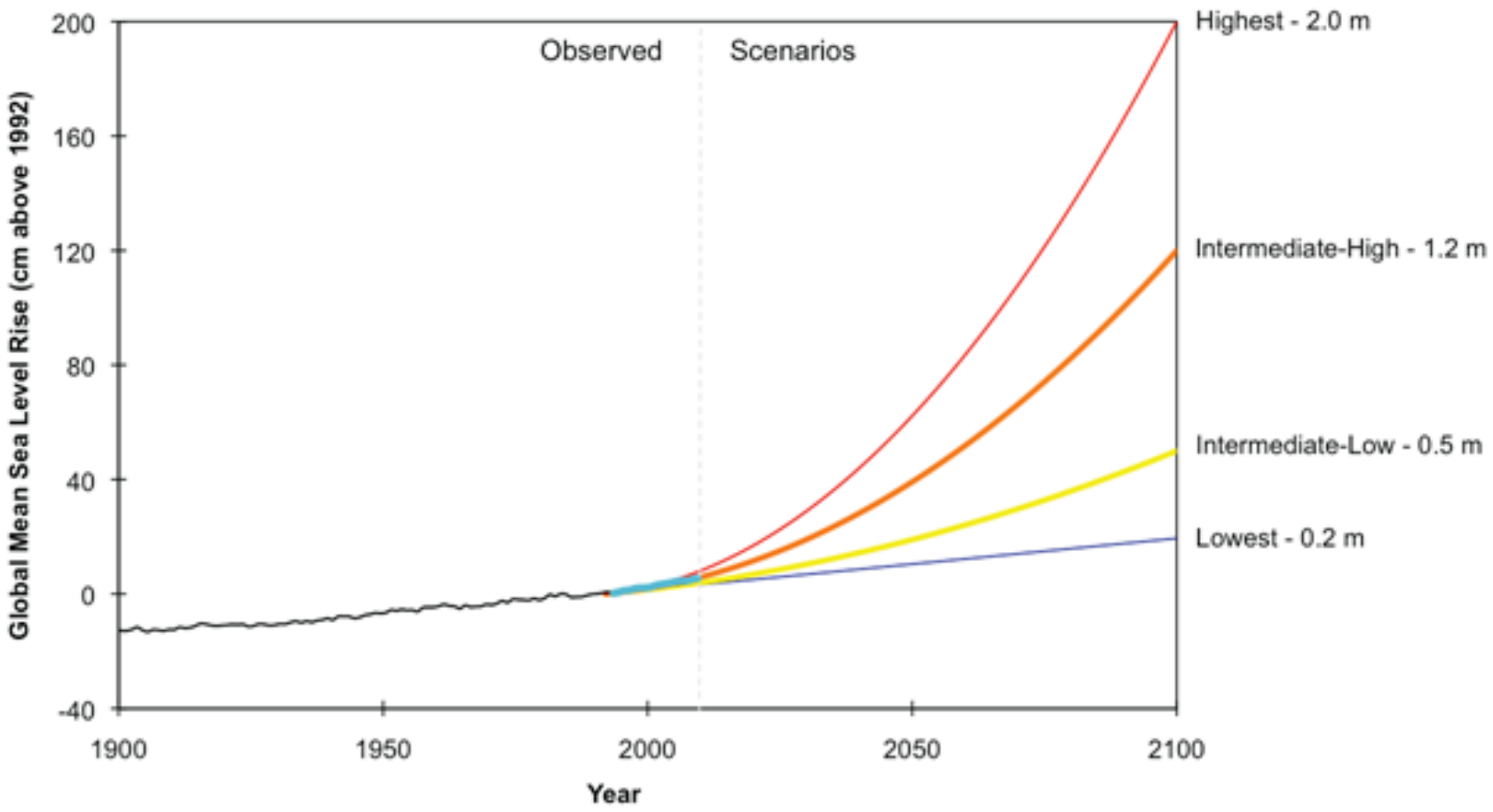
Tide Levels at Peak Hurricane Storm Surge - Boston (1923-2013)



	MLW	MSL	MHW	MHHW	HAT
Category 1	1	2	0	0	0
Category 2	2	3	2	0	0
Category 3	0	1	0	0	0

Sandy made final landfall near Atlantic City, NJ on 10/30/2012 00:00 GMT as a Category 1 hurricane at MHW (NOAA, 2013)

Sea Level Rise Projections

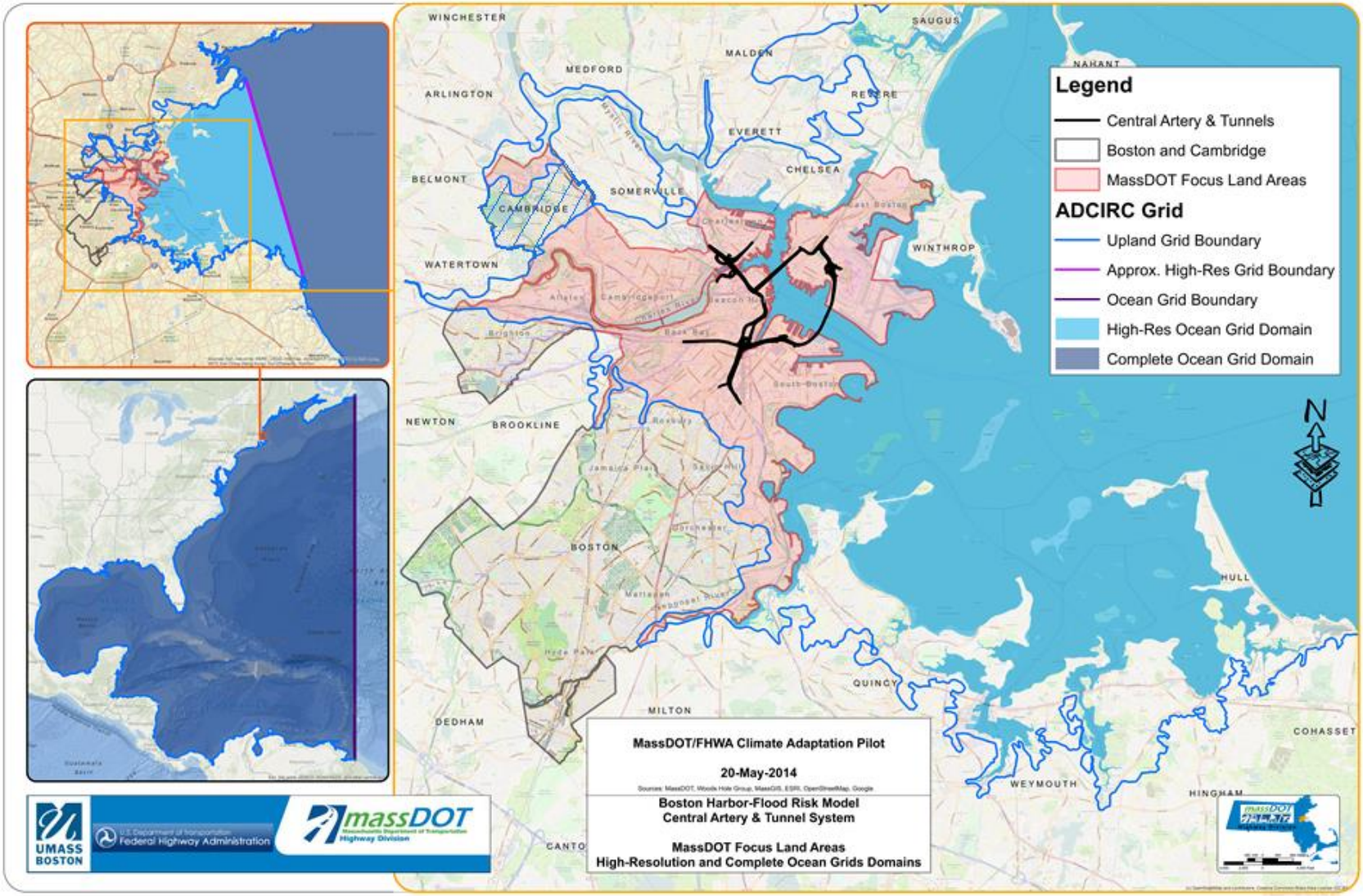


Global mean sea level rise scenarios provided by NOAA as part of the National Climate Assessment report published in December 2012.

Logan - Flooding from Category 2 Hurricane at MHHW

Logan - Flooding from Category 3 Hurricane at MHHW

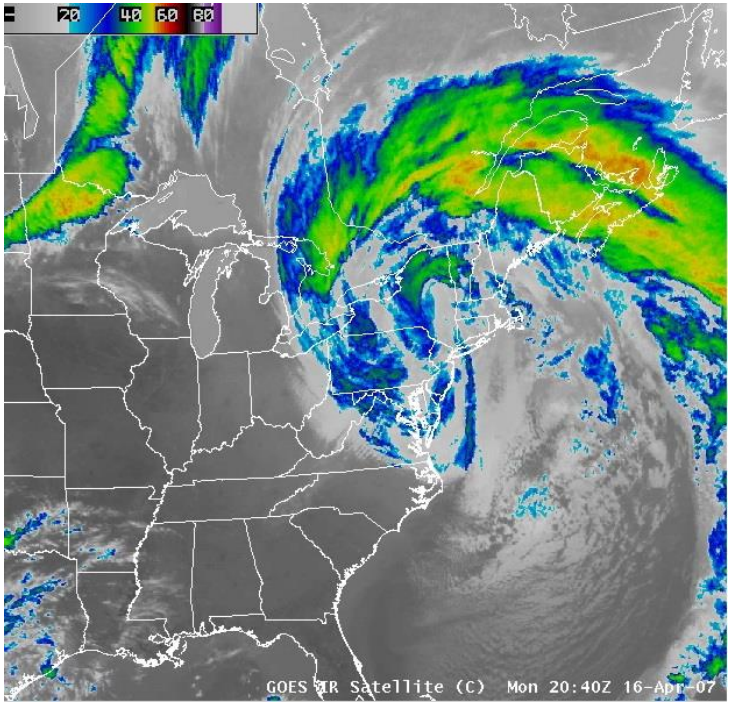
BH-FRM Focus Area

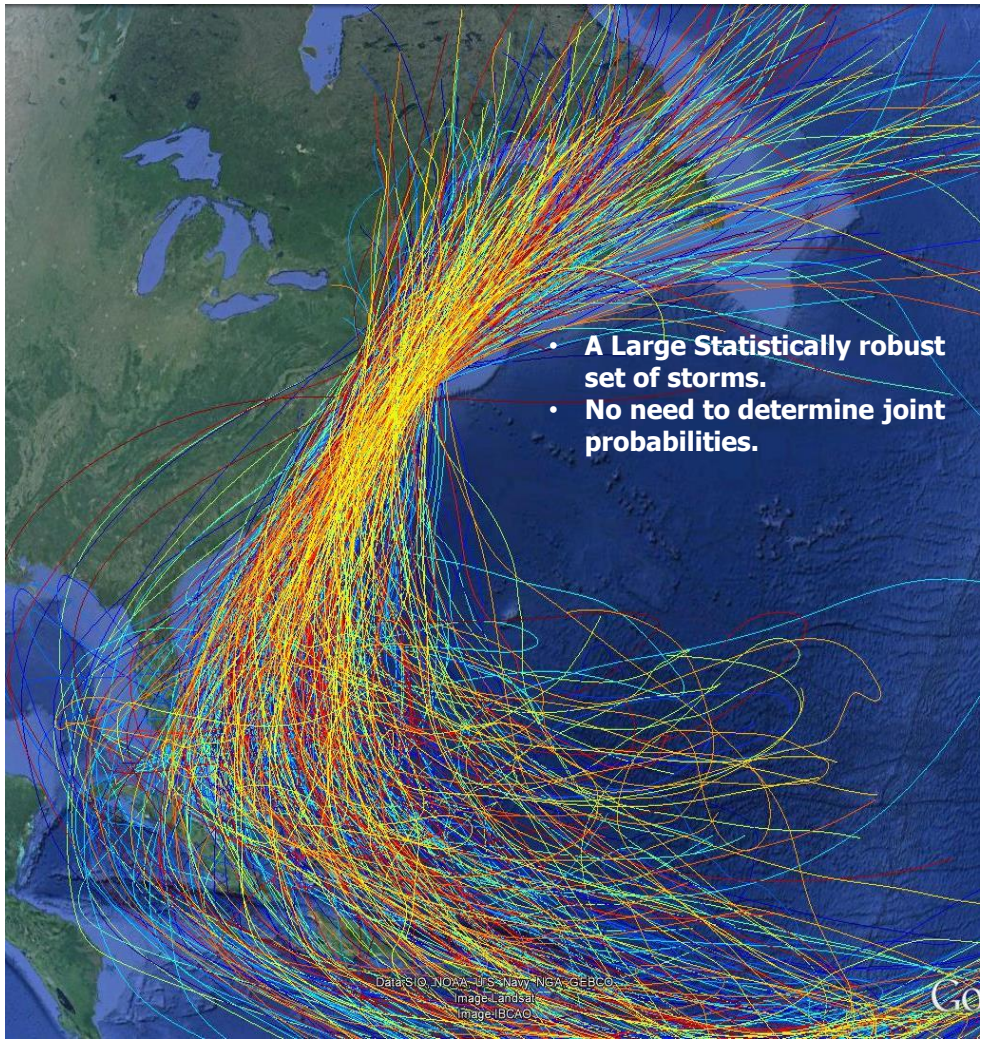


Source: Woods Hole Group

Storm Climatology

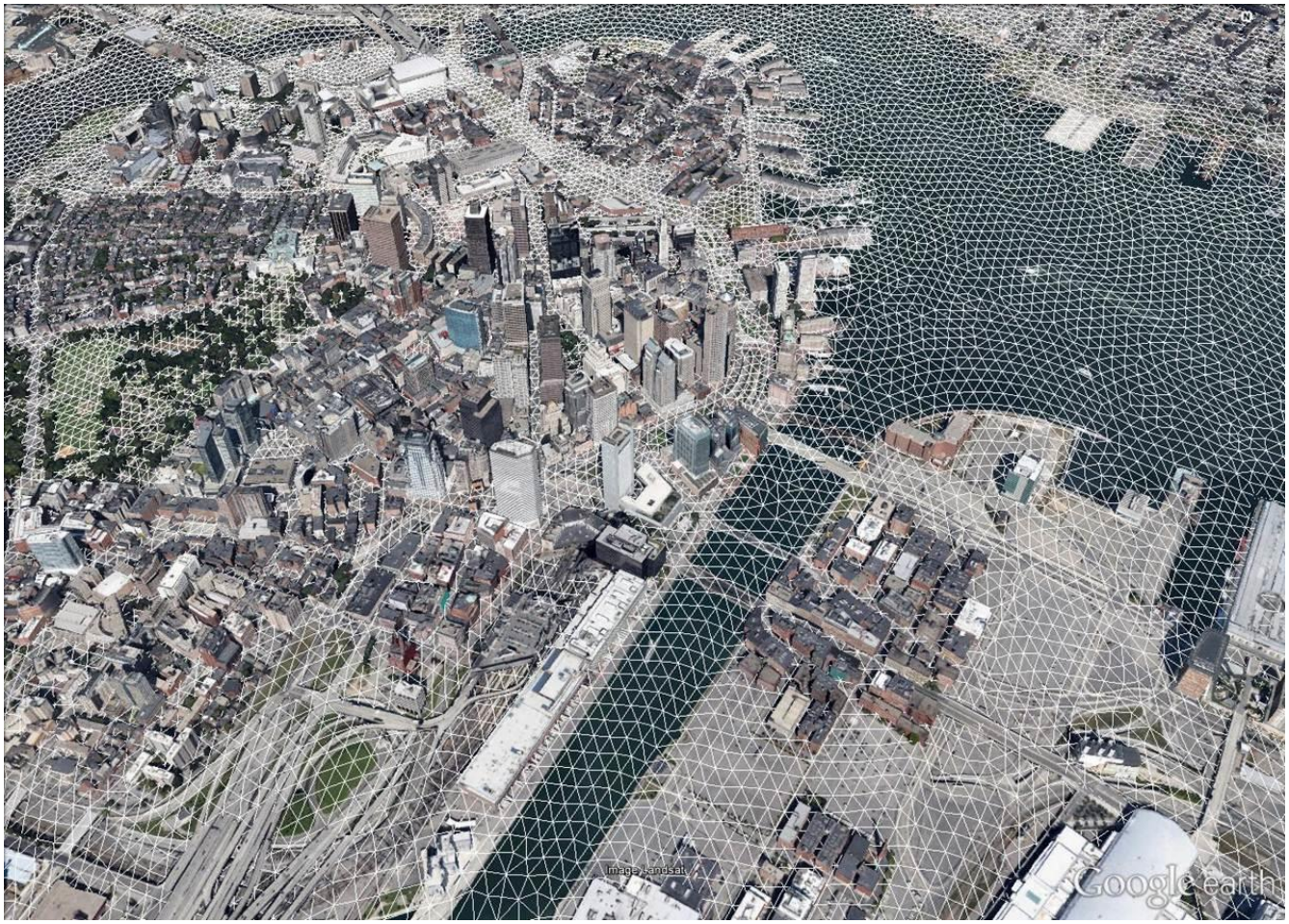
– Includes both tropical and extra-tropical storm sets





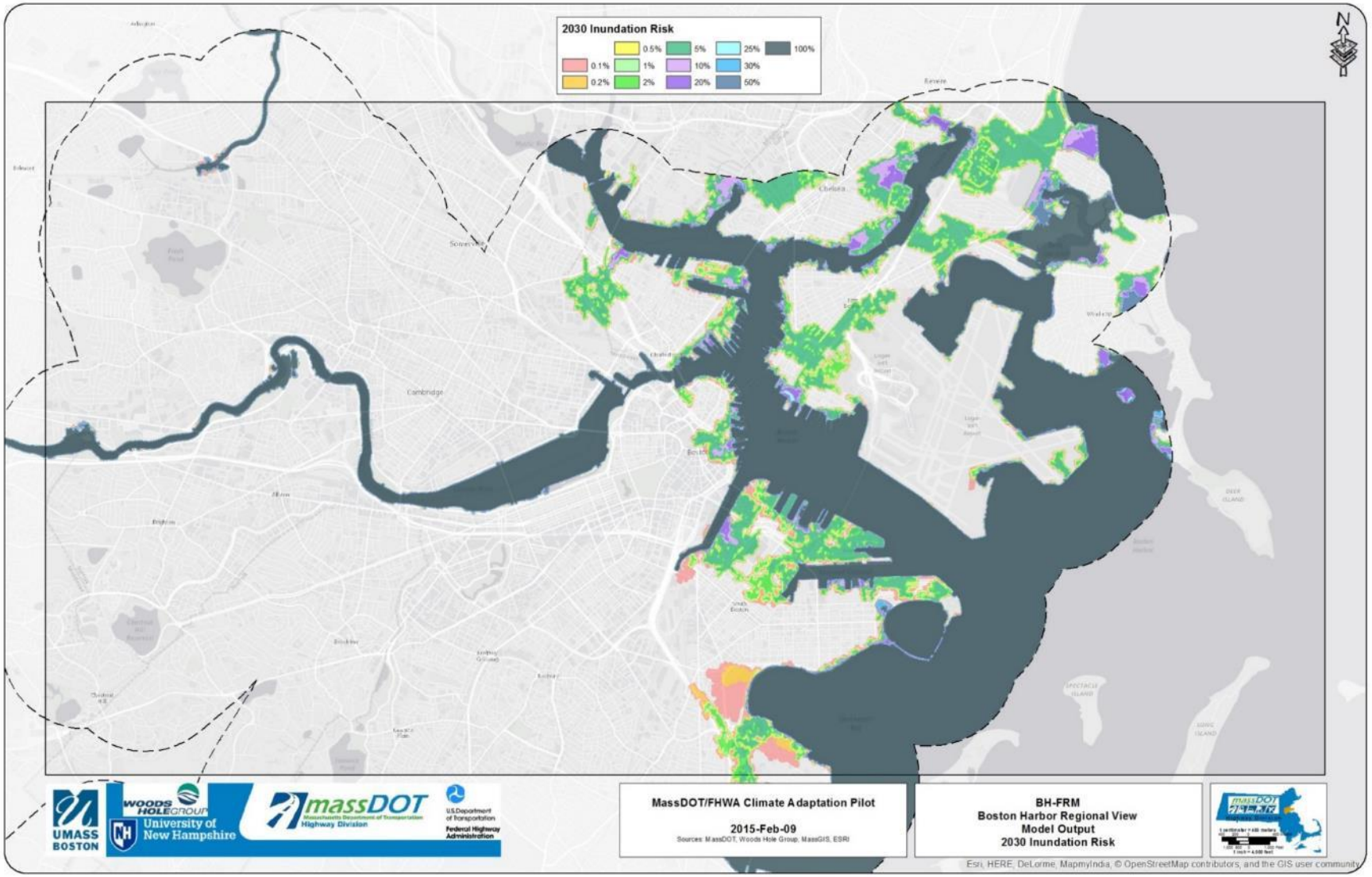
Source: Woods Hole Group

ADCIRC Model Grid - Boston

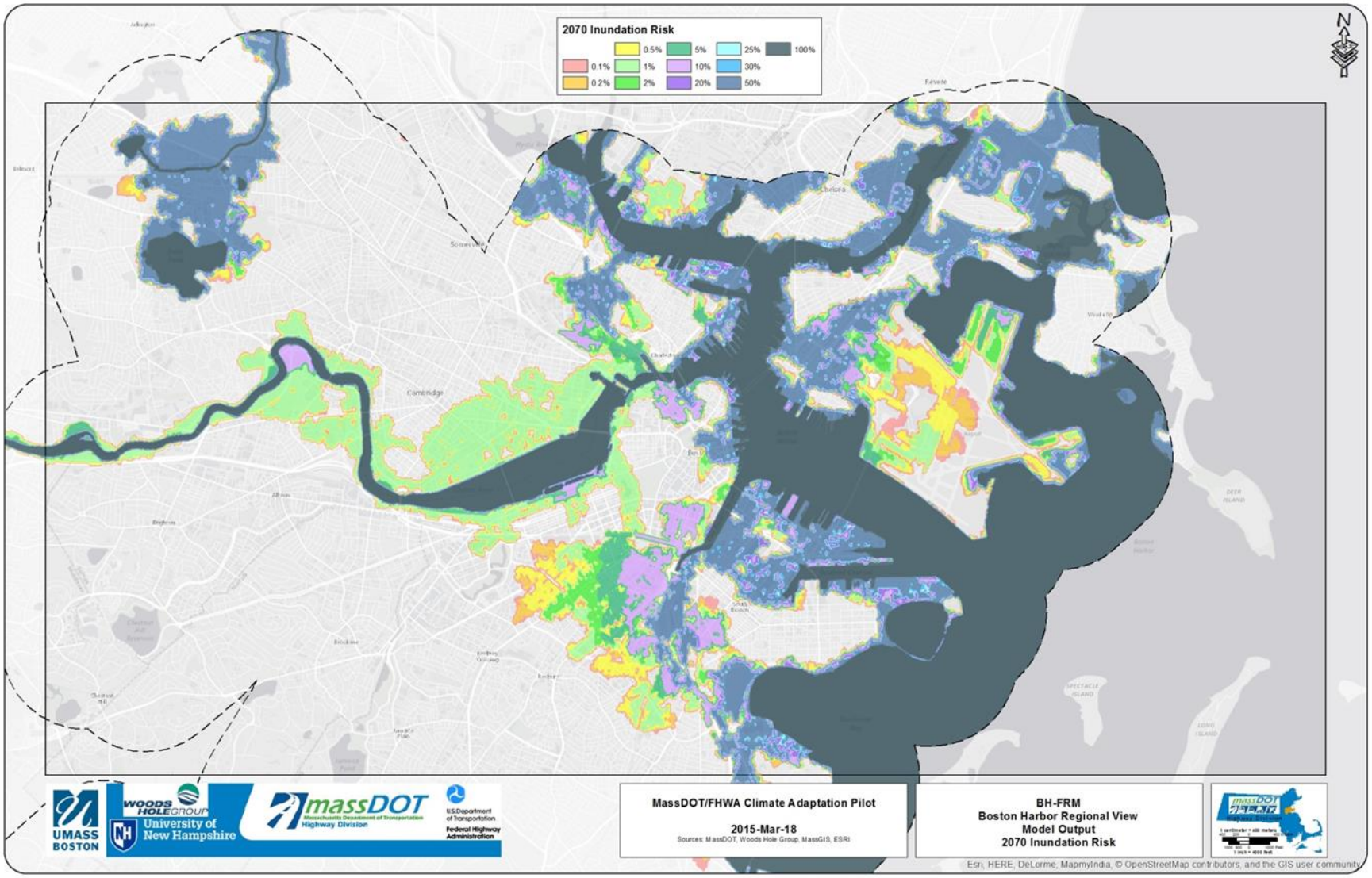


Source: Woods Hole Group

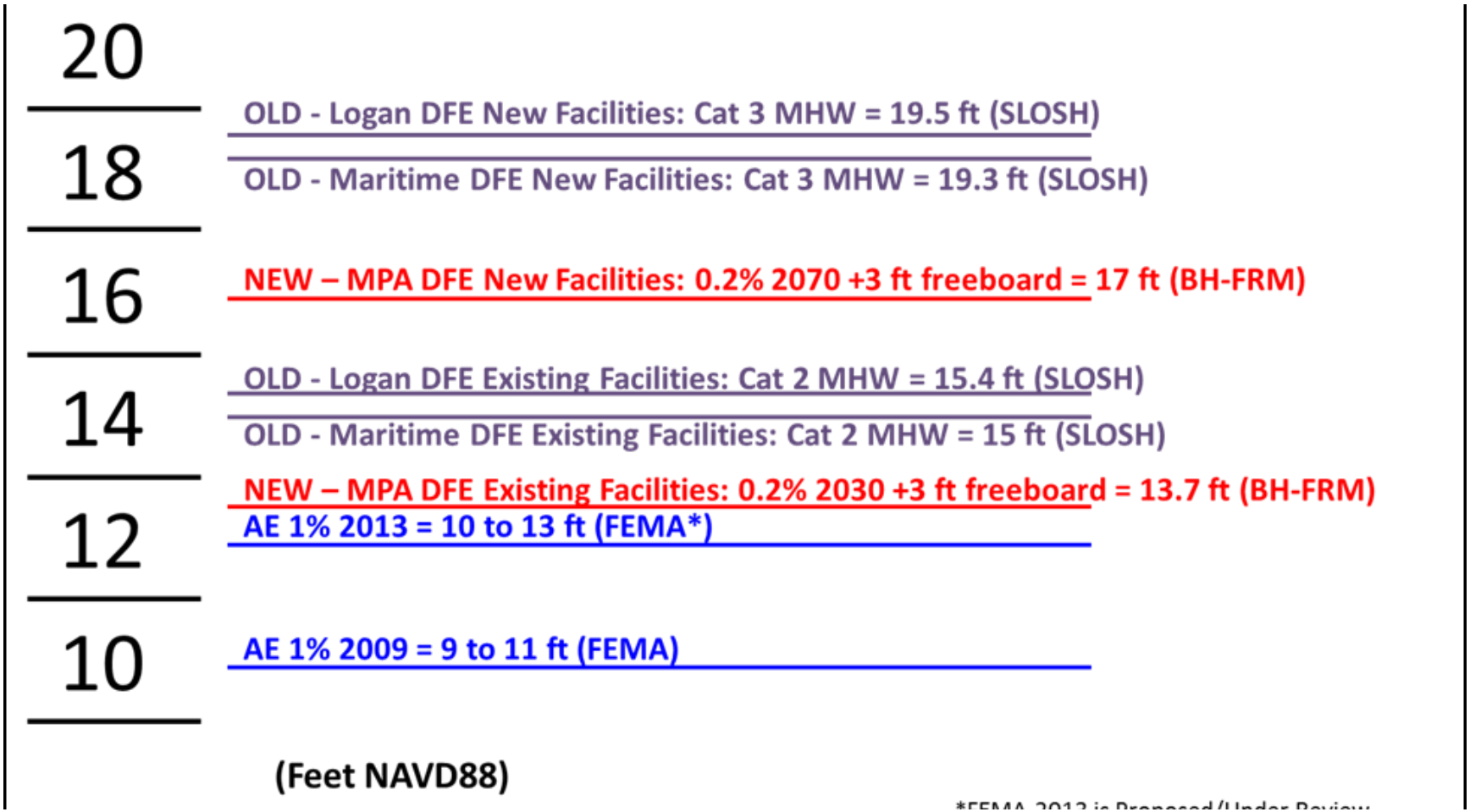
Flood Risk Model - 2030



Flood Risk Model - 2070



Design Flood Elevations (Probabilistic Model)




DESIGN FLOOD
EL. = 13.70'
FIRST FLOOR
EL. = 11.15'

Risk-Based Prioritization

Probability of Flooding

Determined based on Inundation Model results

Flooded in more storm scenarios → higher probability, higher priority

Consequence of Flooding

Criticality Score X Occupancy Category

Based on role in disaster preparedness, response, recovery

Based on ASCE/SEI 24-05 Standard for Flood Resistant Design and Construction

Higher consequence → higher priority

Depth of Flooding

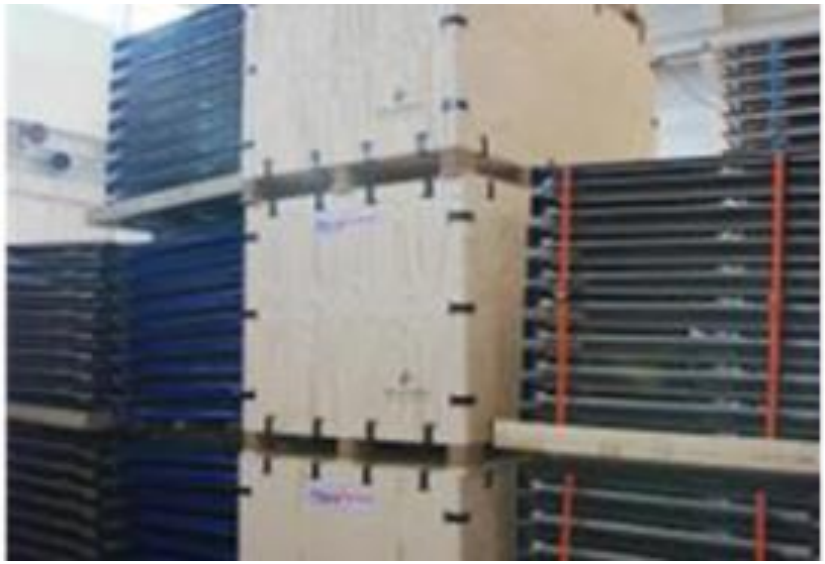
Further distinguish among assets with same Probability and Consequence

Higher depth → higher priority

Status of Temporary Flood Barriers Procurement

- AquaFence successful bidder
  - Logan Airport – 4 facilities
  - Conley Terminal - 2 facilities
  - Fish Pier – 3 Facilities
- Ready for deployment in September 2015

Access Stairs

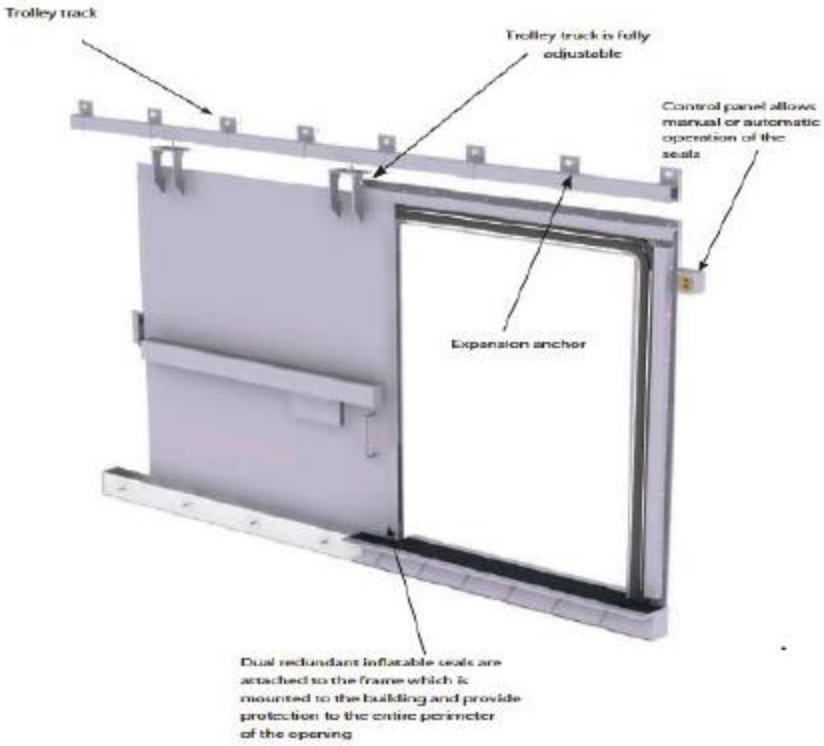


Stored Barriers

Deployed Barriers

Common Recommendations – Overhead Doors

Type C1
(< 4 ft. Water)

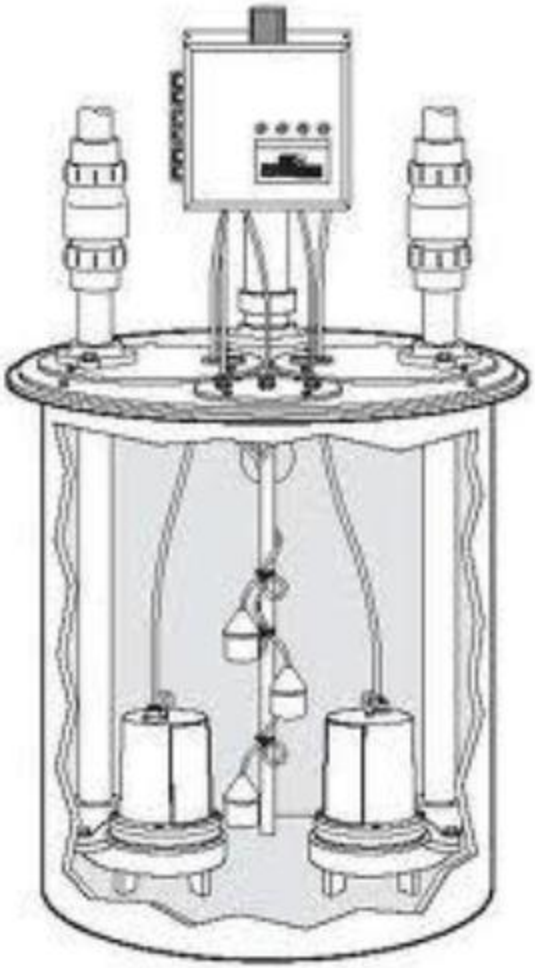


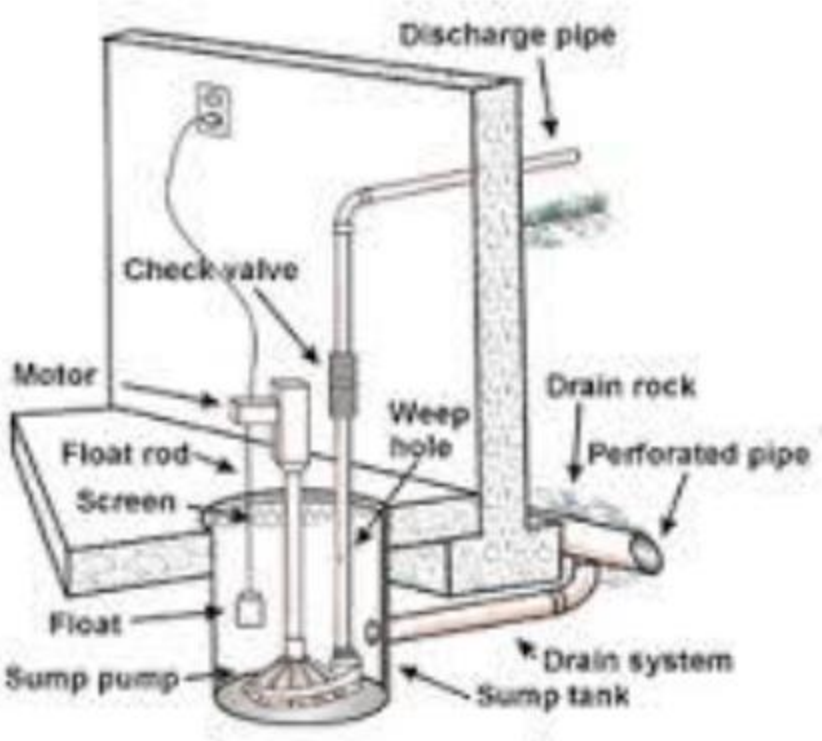
Type C2
(> 4 ft. Water)

Common Recommendations – Hydrostatic Relief Valve for Slabs

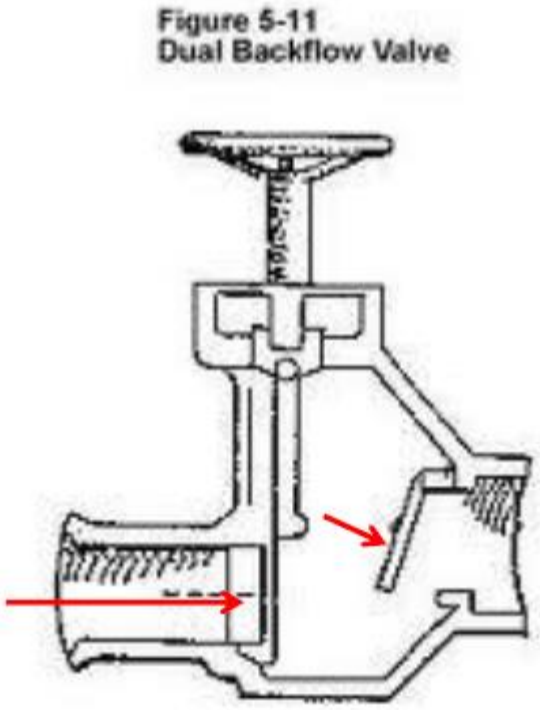
Excess water pressure relieved through slab

Common Recommendations –
Sump Pump System to Remove Water





Common Recommendations – Shut-Off Valve for Sewer and Drainage



Prevent backflow into flood-protected areas

Common Recommendations –
Seal Electrical Conduits Entering Building

Common Recommendations – Pedestrian Doors

Type A1.1
(> 4 ft. Water)

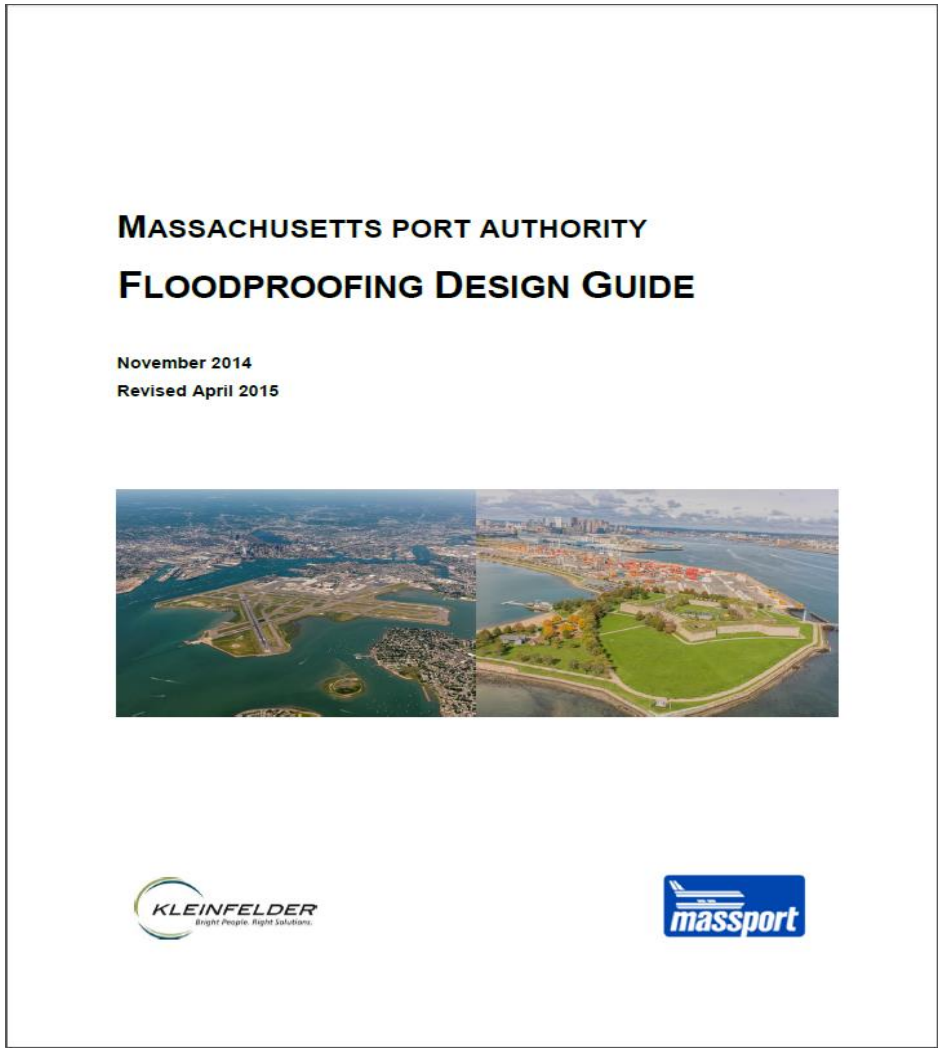
Type A2.2
(< 4 ft. Water)

Type B2.1
(< 4 ft. Water)

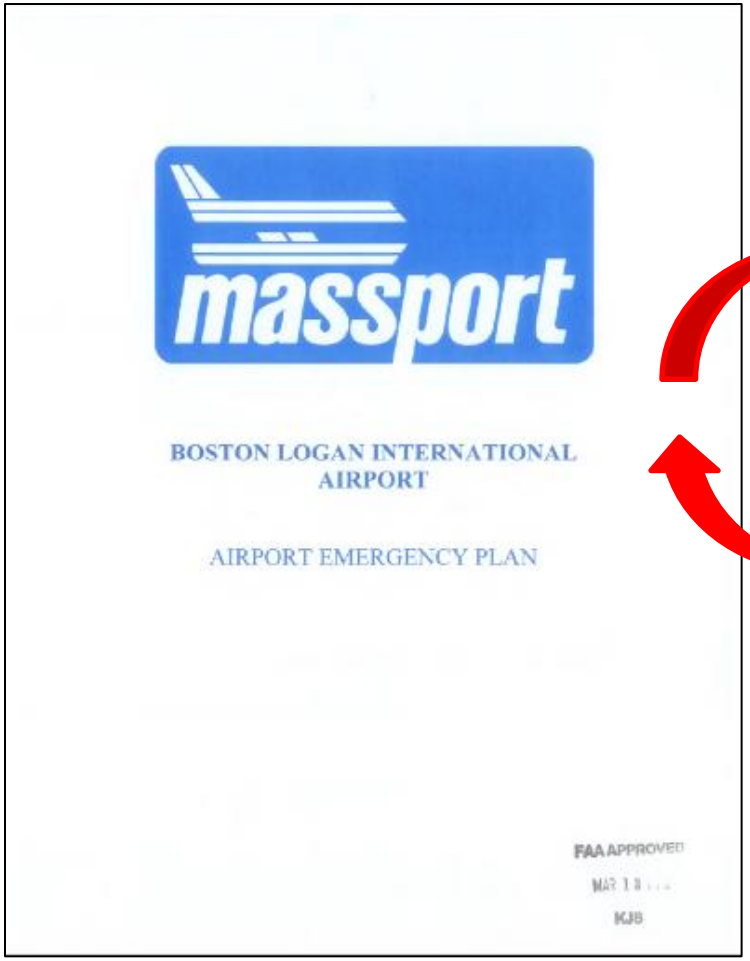
Floodproofing Design Guidelines

Floodproofing Design Guide:

- Design Flood Elevations
  - New Facilities
  - Existing Facilities
- Floodproofing Strategies
  - Wet Floodproofing
  - Dry Floodproofing
- Performance Standards
- Reviews and Approvals



Airport Coastal Flood Operations Plan


massport

BOSTON LOGAN INTERNATIONAL AIRPORT

AIRPORT EMERGENCY PLAN

FAA APPROVED

MAR 1 8 . . .

KJB


massport

LOGAN INTERNATIONAL AIRPORT

COASTAL FLOOD OPERATIONS PLAN

August 18, 2015

Flood Operations Plans - Highlights

- Separate Plans for Airport and Maritime
- Extensions of Existing Emergency Plans
- Reliance on existing command structure

Guiding Principles for Flood Ops Plan Development:

1. Safety should be the first priority
2. Plan development should be stakeholder-driven
3. Flood operations should be integrated with all-hazards emergency management system
4. Preparedness operations should maximize business continuity by minimizing disruptions and speeding recovery
5. Operating assumptions and prescribed actions should realistically reflect available resources
6. The Flood Ops Plan should be more than a document

Primary Tasks

1. Engage with stakeholders to assess/evaluate existing decision making protocols and priorities
2. Develop draft flood operations plan
3. Engage with stakeholders to review available resources
4. Develop final facility-wide flood operations plan
5. Develop final asset-level flood operations plans
6. Training and table top exercises

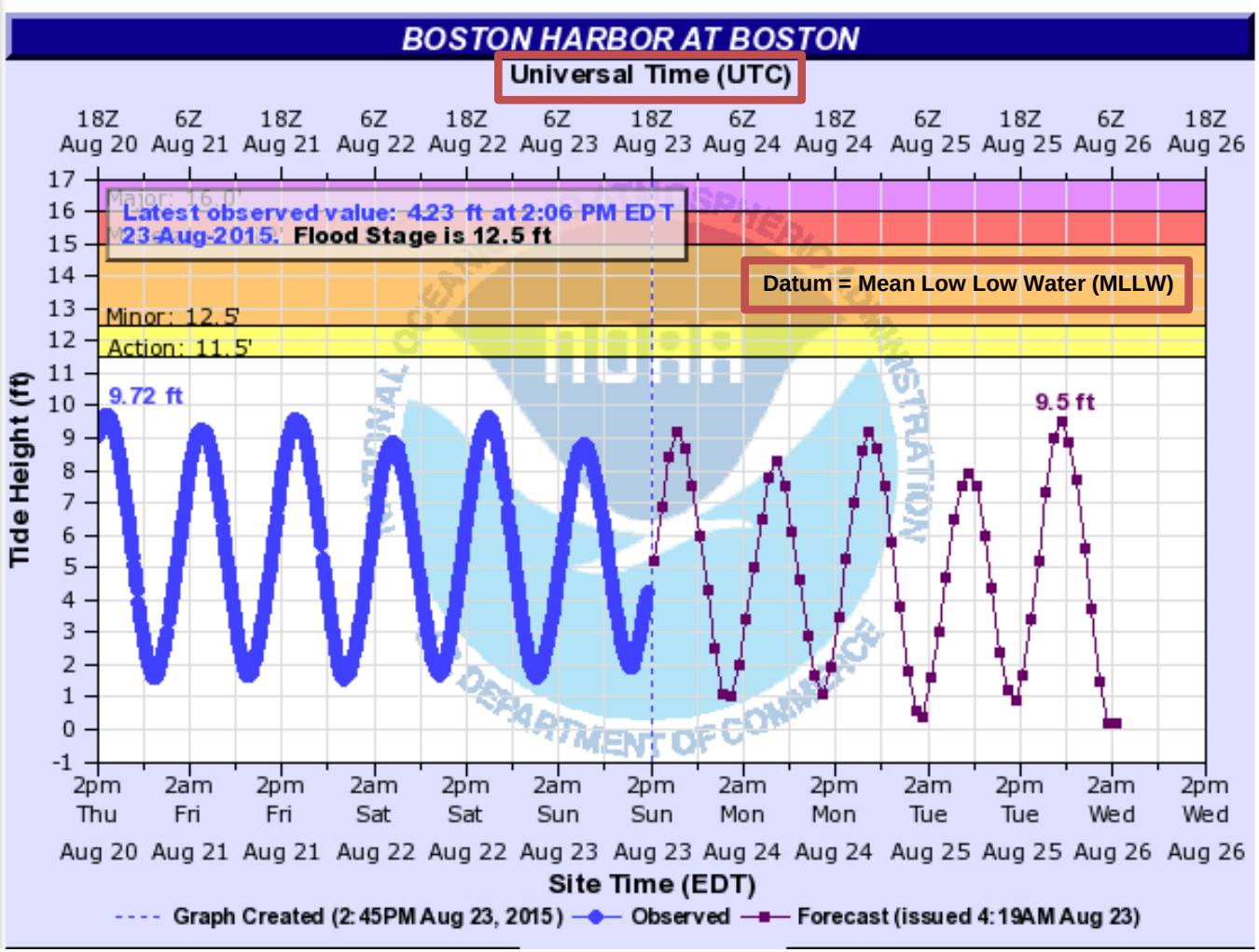
- Coordination
- Plan Maintenance
- Human Resources Planning
- Training
- Notifications
- Raising, Relocating, Backing-up Essential Records/Files
- Raising Equipment/Stock
- Fuel Supply Coordination
- Hazard Removal and Relocation
- Electrical Power-down and Restoration
- Drainage and Sewer Shutoff

- Testing and Fueling Emergency Generators
- Installing Temporary Barriers/Closures
- Testing and Fueling Flood Pumps
- Vehicle Relocation
- Evacuation
- Water Level Monitoring
- Personnel Safety
- Post-flood transportation
- Cleaning and Storing Barriers/Closures
- Inspection, Damage Assessment, and Reporting

Flood forecasts drive the action plan

National Weather Service

Advanced Hydrologic Prediction Service



Flood forecasts drive the action plan

DESCRIPTION	FLOOD FORECAST DATA
Date and time of report	10/30/15 13:00
Date and time of arrival of flood elevation greater than or equal to 9.0 ft. NAVD88	10/31/15 12:30
Maximum flood elevation forecasted (ft. NAVD88 vertical datum)	12.5 ft. NAVD88
Anticipated wave height at time of maximum flood elevation (ft.) (if available)	Harbor: 2-3 ft. East-Facing Airport: 7 -9 ft.
Date and time of maximum flood elevation	10/31/15 14:00
Date and time of recession of flood to elevation below 9.0 ft. NAVD88	10/31/15 18:00
Duration of predicted flooding above elevation 9.0 ft. NAVD88 from start to recession	5 hours, 30 minutes

Airport Coastal Flood Operations Plan - Timelines

Pre-Flood

72, 48, 24, 12, 6 hours

During Flood

Post-Flood

12 hours & 12+ hours

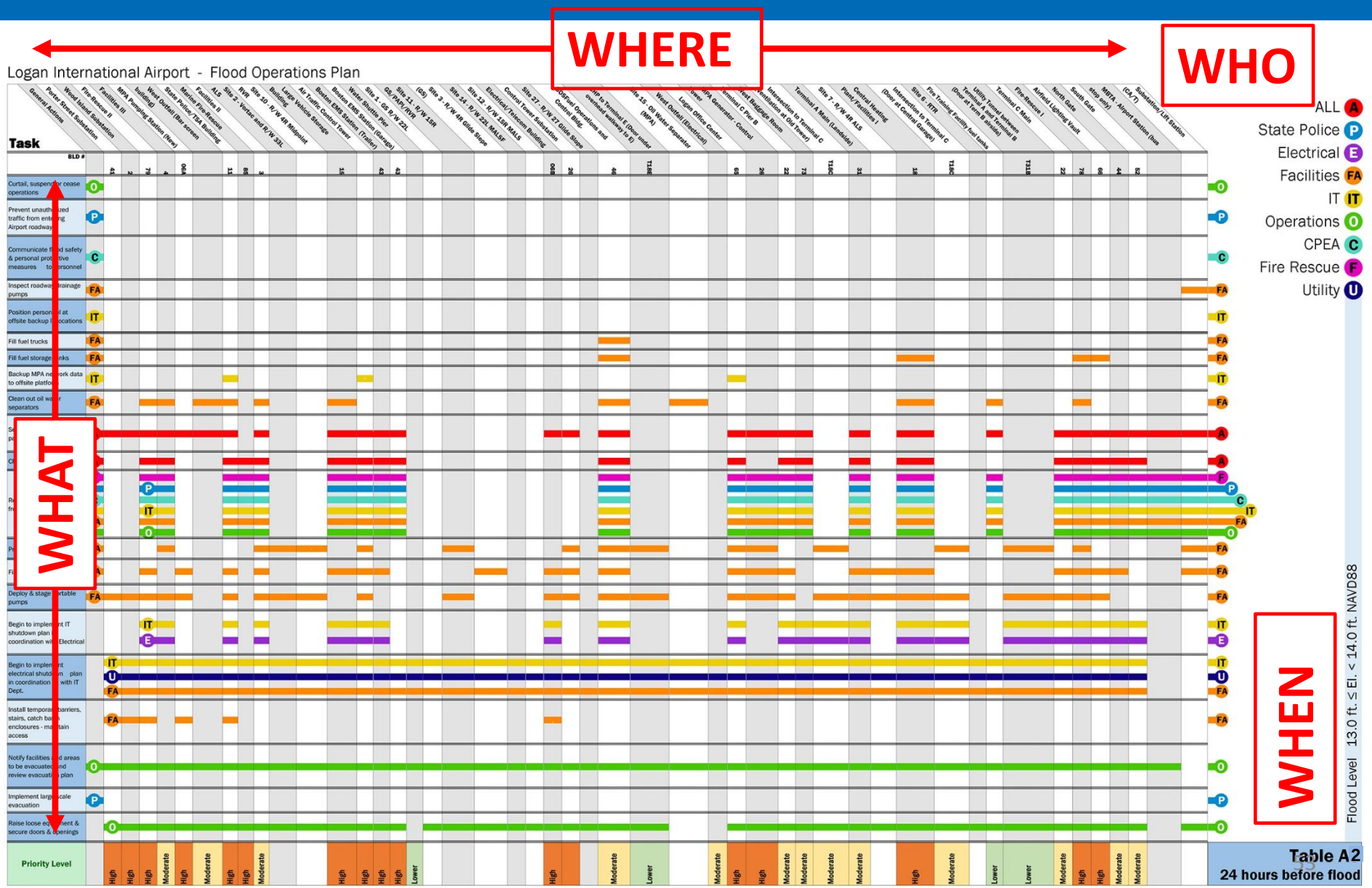
Table A1 – Buildings & Structures at Risk of Flood

TABLE A1 LOGAN AIRPORT

Water Elevations at which Response and Recovery Actions are Necessary
ft.NAVD88 First Floor ft Critical Elevation Indicated

No.	Name	<9.0	9.0≤El.<10.0	10.0≤El.<11.0	11.0≤El.<12.0	12.0≤El.<13.0	13.0≤El.<14.0	14.0≤El.<15.0	15.0≤El.<16.0	16.0≤El.<17.0	17.0≤El.<18.0	Priority
41	Porter Street Substation				10.98							High
2	Wood Island Substation					11.15						High
79	Fire-Rescue II				10.04							High
06A	MPA Pumping Station (New)				10.26							High
4	Facilities III				10.05							Moderate
	West Outfall (Bar screen building)				10.44							Moderate
11	State Police/TSA Building				10.59							High
85	Marine Fire-Rescue				10.6							High
3	Facilities II				10.76							Moderate
15	Large Vehicle Storage Building					11.15						High
26	Air Traffic Control Tower					11.37						High
43	Boston EMS Station (Trailer and garage)					11.84						High
	Water Shuttle Pier					11.91						Lower
06B	Electrical/Telecom Building						12.36					High
26	Control Tower Substation						12.45					High
46	BOSFuel Operations and Control Building						12.69					Moderate
T18E	CHP to Terminal E (Door under overhead walkway to E)						12.86					Lower
	West Outfall (Electrical)							13.15				Moderate
65	Logan Office Center							13.28				High
26	MPA Generator - Control Tower							13.3				High

Table A2 –Flooding Actions and Timelines

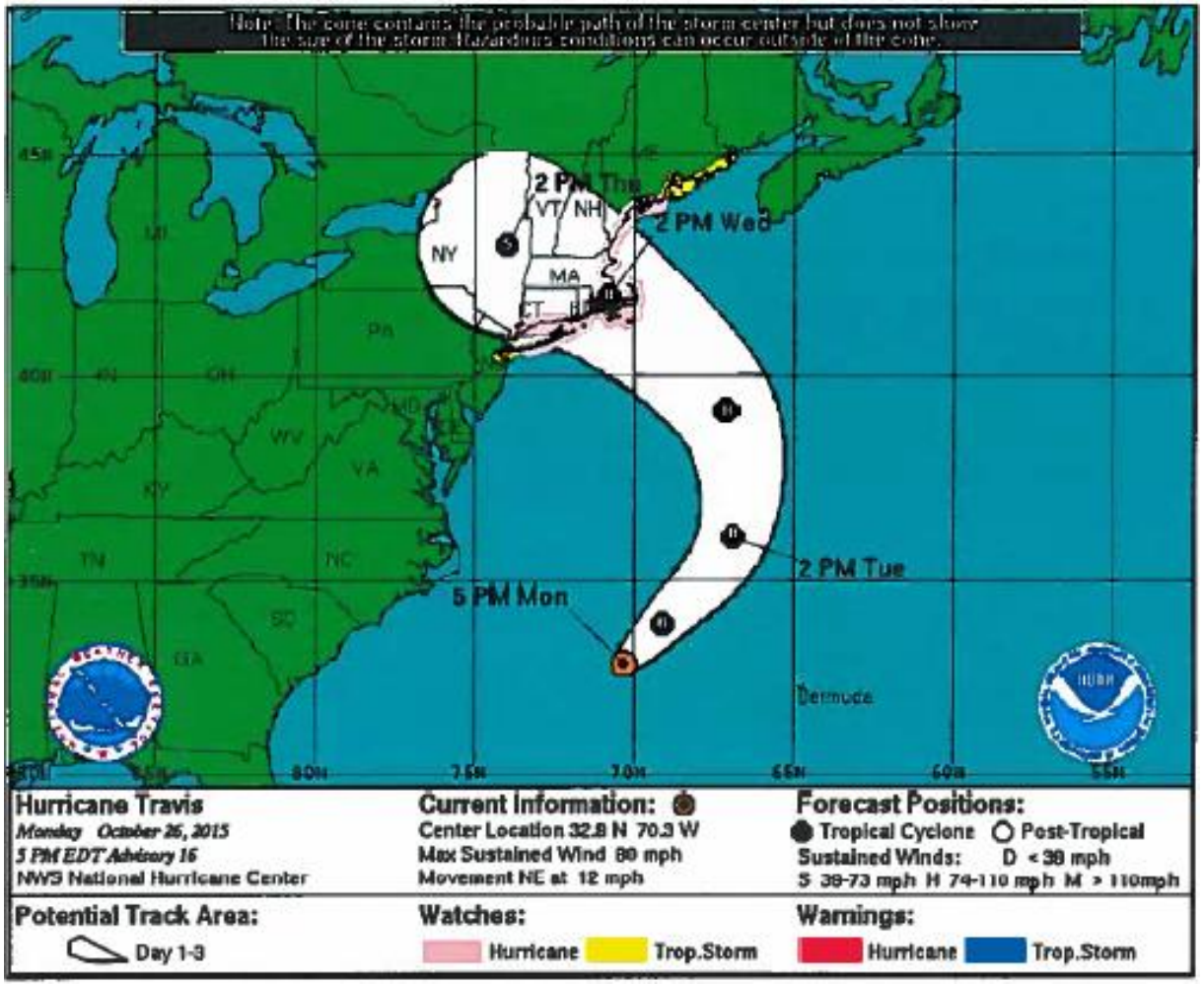


Appendix B
Areas at Risk: Max Flood Elevation ≤ 11 ft. NAVD88

*Note: Drainage system has not been modeled so map assumes tide gates are open and water is collecting at low points due to backflow and/or rainfall

Table Top Exercises

- Will run through a simulated flooding scenario
- Will work through the Operations Plans



Discussion