



# Resiliency | Massport



A pathway to a more resilient future



NWWWS 11/17/15

# 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





# Phase I Study Areas: Logan and Seaport

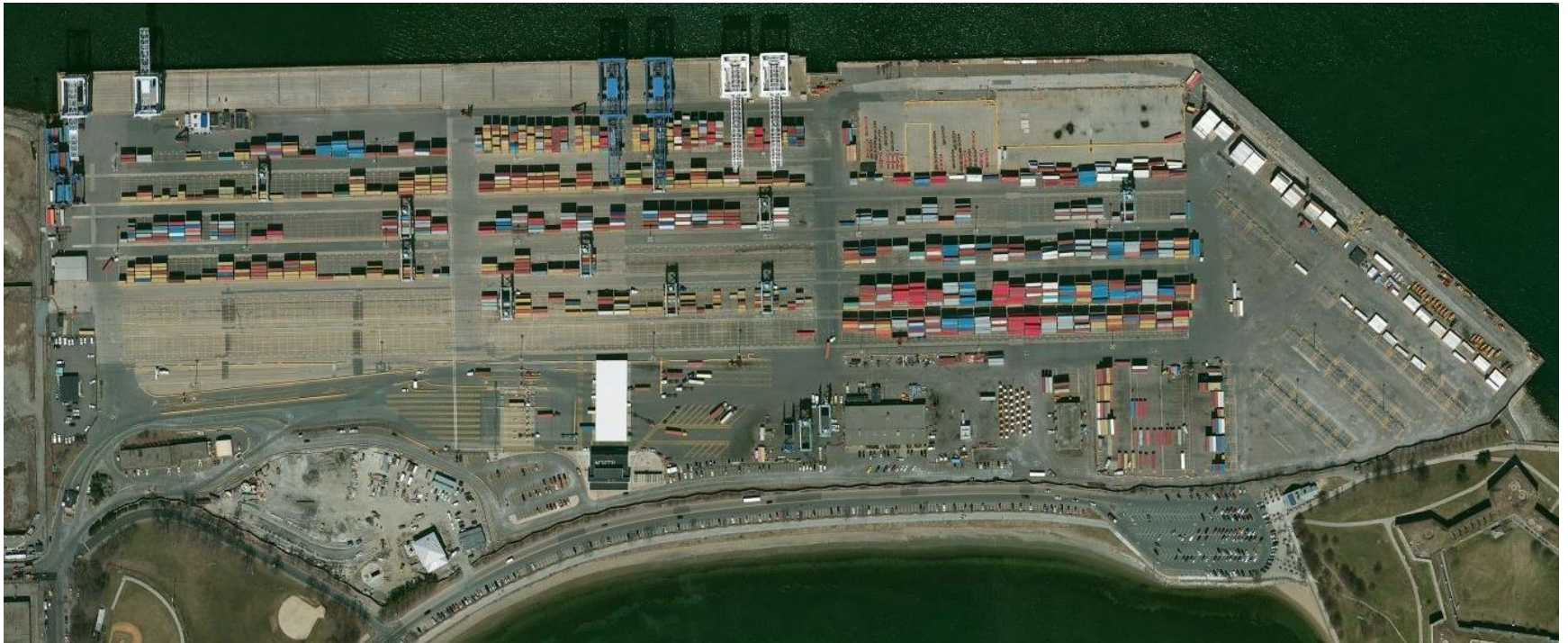


# Port of Boston

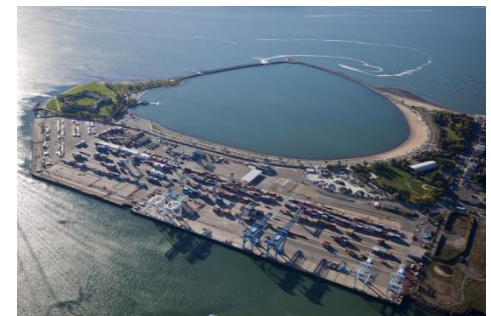
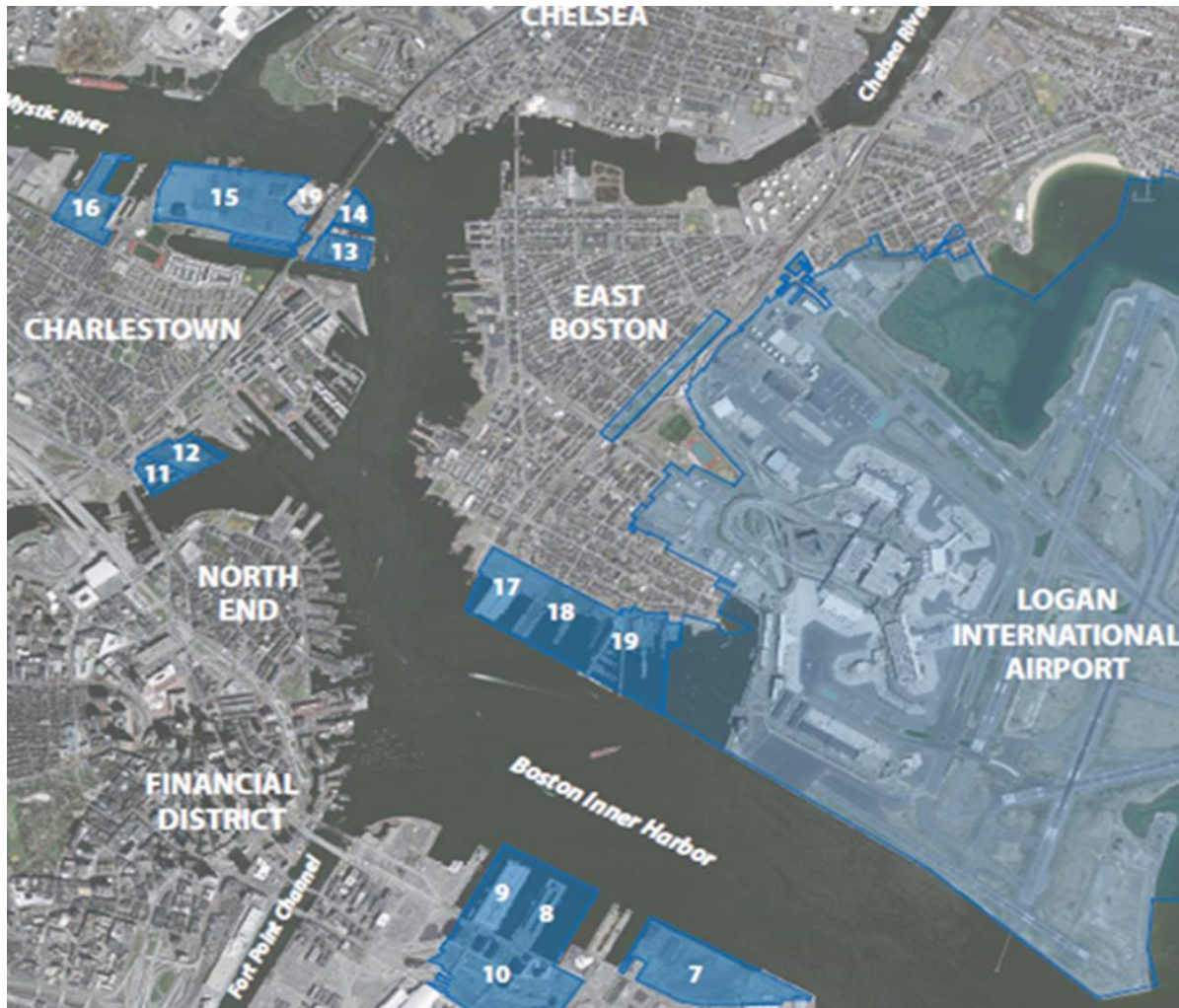


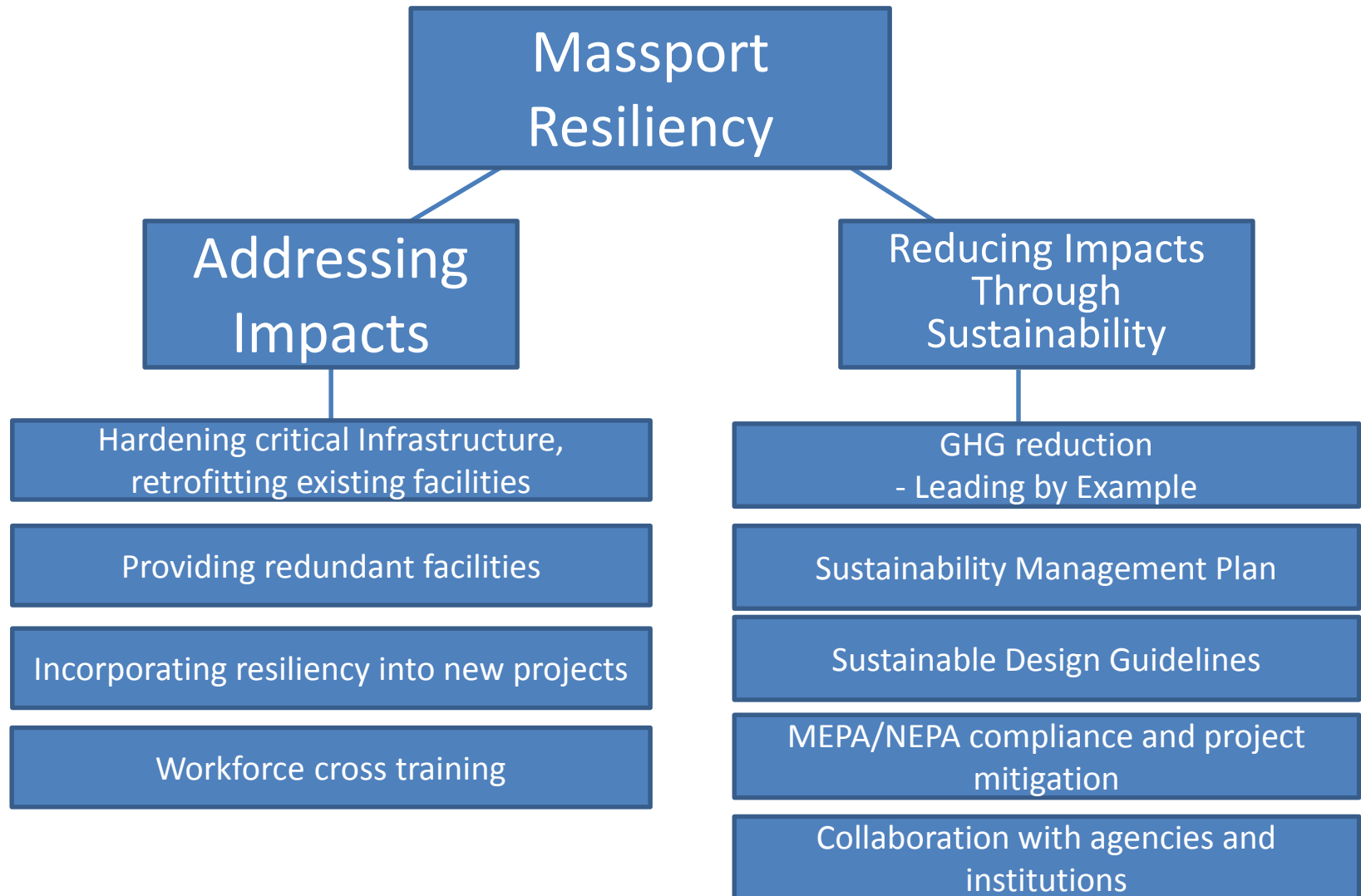


# Conley Terminal



# Real Estate Holdings







# Resiliency Program Goals

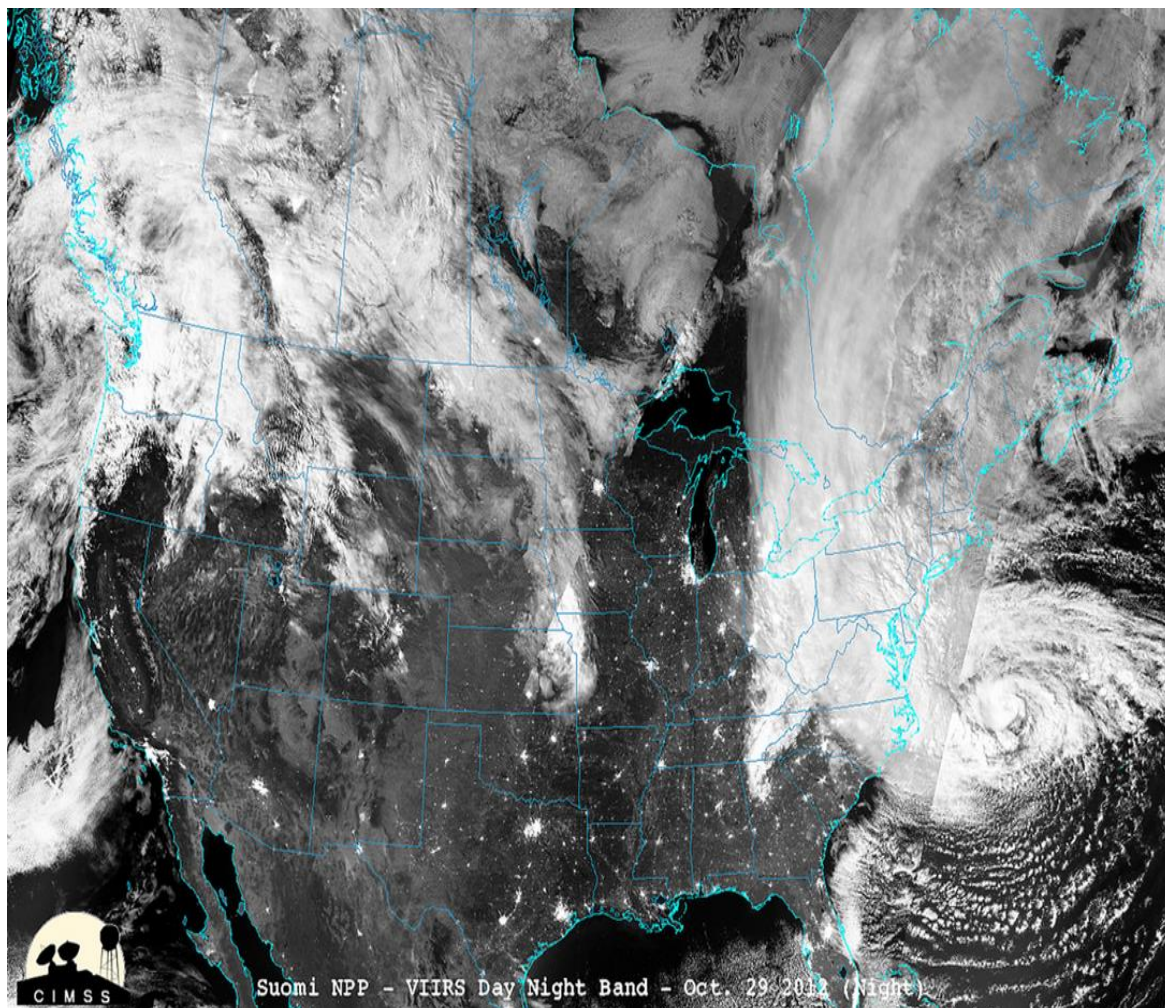


- Become an innovative and national model for resiliency planning and implementation within the port authority.
- Take responsibility for improving our overall infrastructure and operational resilience.
- Increase our business value and (contextual community responsibilities) through improved resiliency.
- 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.

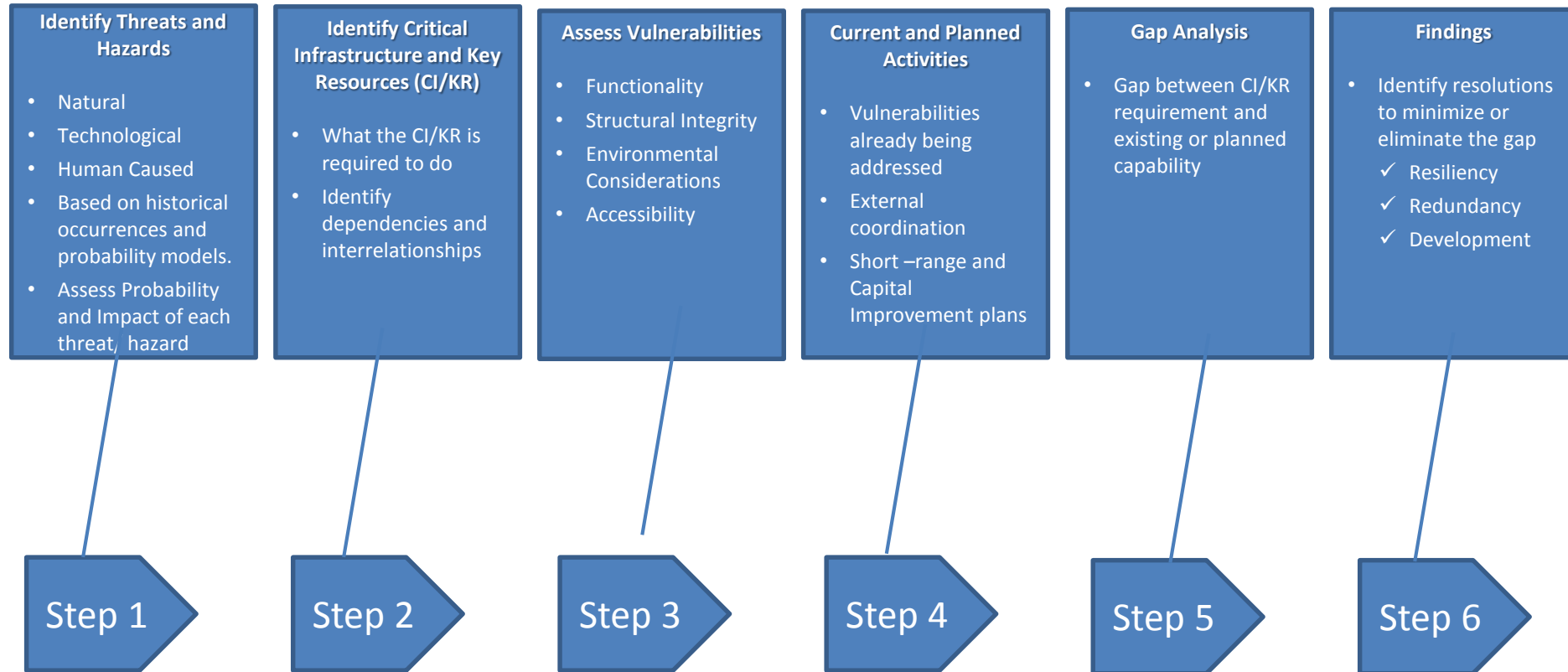




# Drivers for Action



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

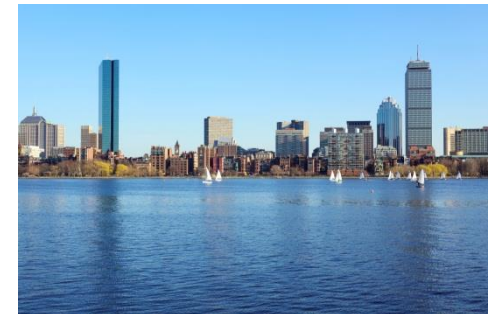




# Critical Infrastructure/Key Resources



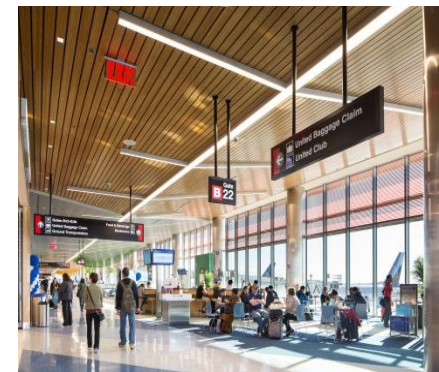
Utilities	Transportation	
Electrical/Vaults/Sub Stations/Distribution etc. Drainage Generators Water	Parking Surface Roads Elevated Roads Tunnels Bridges	Transit Taxi Shuttle Rental Car
Fuel Systems	Human Capital	
Aviation Fuel Ground Fuel Generator Fuel	Workforce HR Functions Qualified Maintenance Security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



# Criticality Grouping



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





# 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
<ul style="list-style-type: none"><li>• Earthquake</li><li>• <b>Flood*</b></li><li>• <b>High winds*</b></li><li>• <b>Hurricane*</b></li><li>• <b>Sea Level Rise*</b></li><li>• Tornado</li><li>• Tsunami</li><li>• Fire</li><li>• <b>Winter Storm*</b></li></ul>	<ul style="list-style-type: none"><li>• Data Loss</li><li>• Power Loss</li></ul>	<ul style="list-style-type: none"><li>• Fire/Accident</li><li>• Sabotage</li><li>• Terrorism Acts (Bomb Blast)</li></ul>



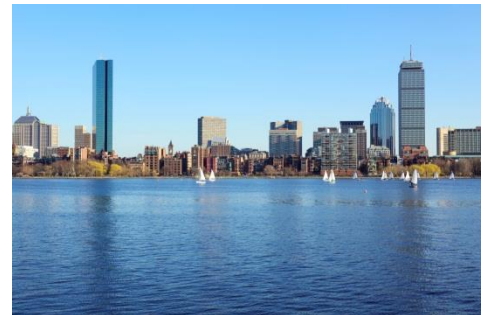
\* Addressed in DIRP Study for Logan and Maritime

# 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





# Disaster Infrastructure Resiliency Planning (DIRP)



## Goals of the project:

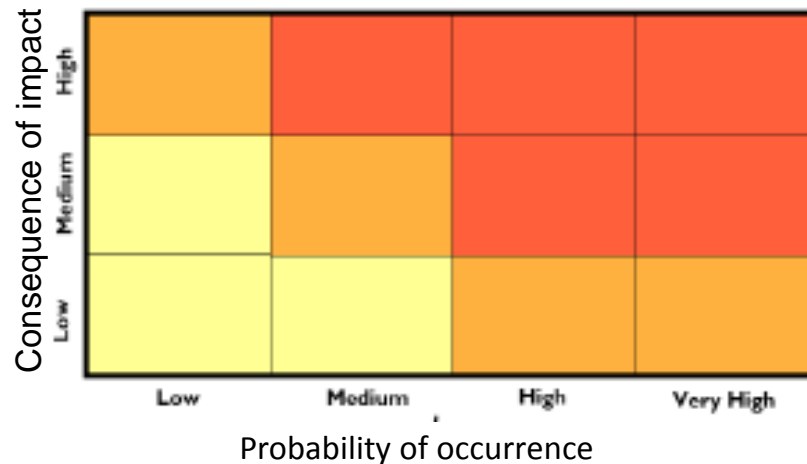
- Understand Massport's vulnerability to climate impacts
- Develop short-term and long-term resiliency strategies

## Project approach:

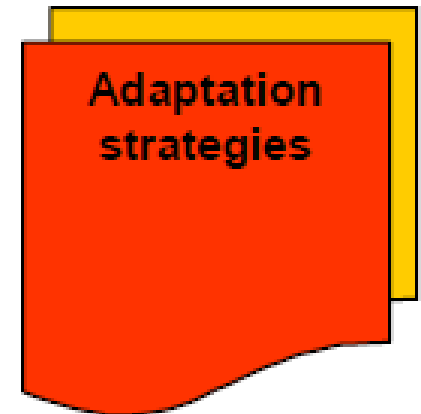
1 Climate projections



2 Vulnerability and risk assessment



3 Adaptation planning & design

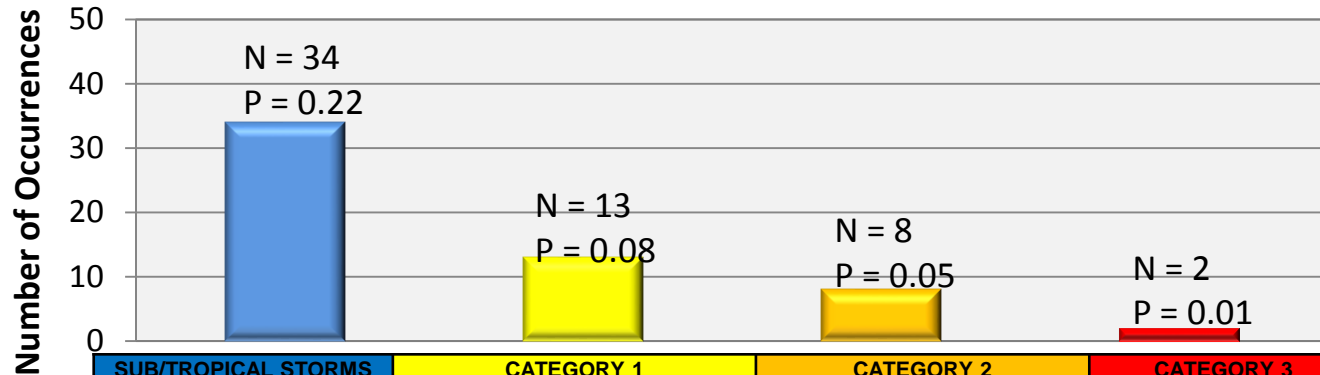


# Boston Logan International Airport





# Historic Occurrence of Hurricanes – Boston (1858-2013)

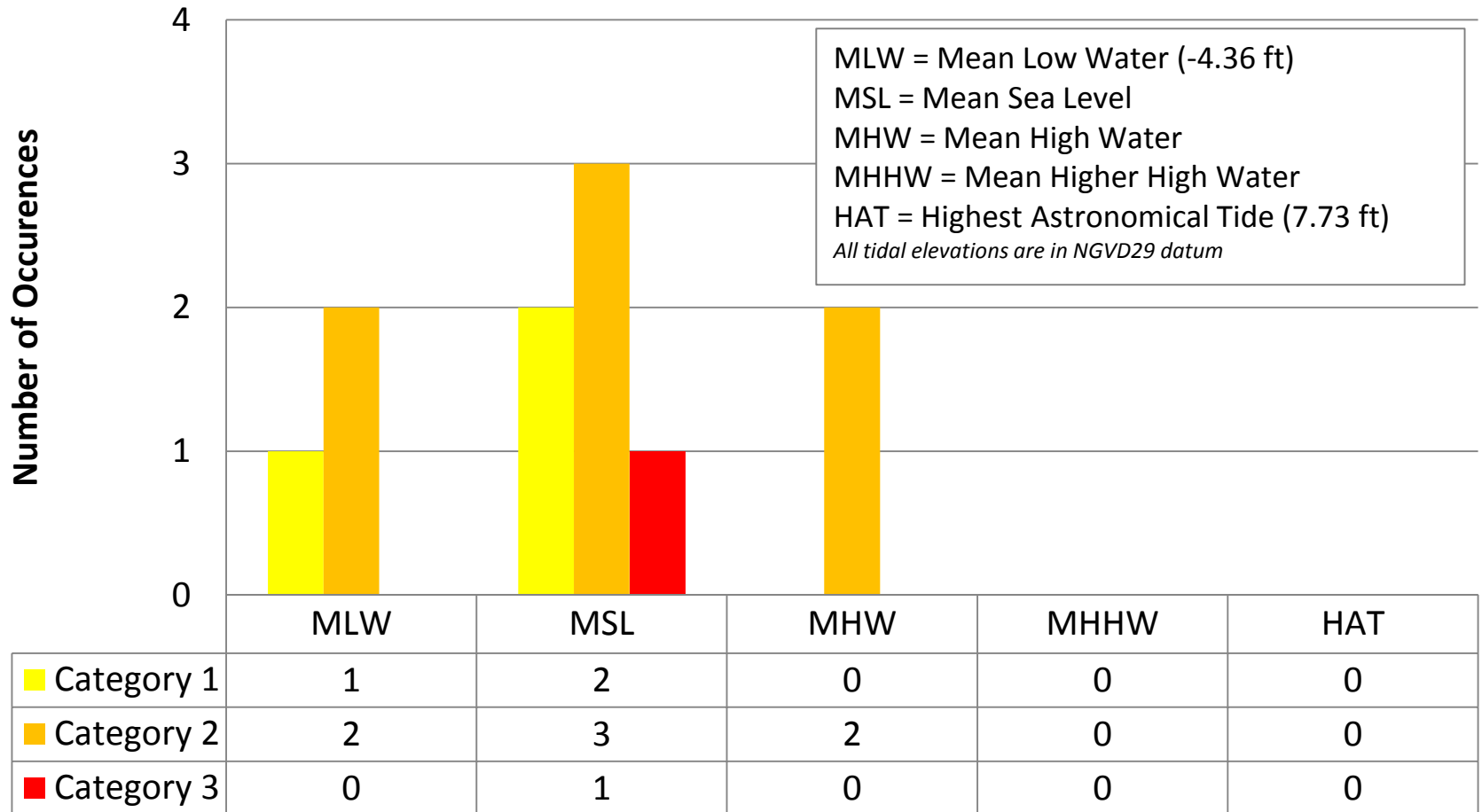


N = Number of Occurrences  
P = Annual Probability

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

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

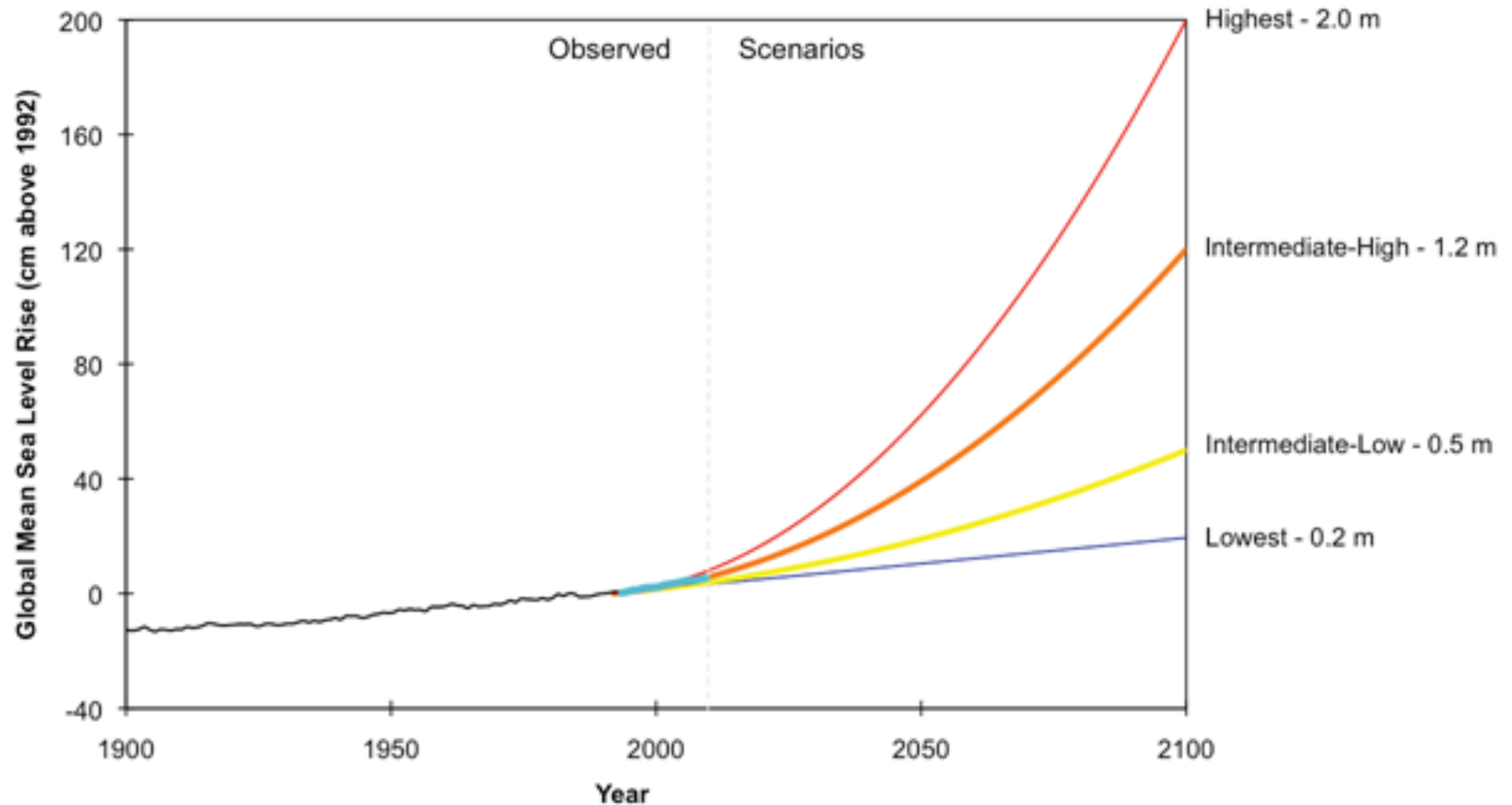
# Tide Levels at Peak Hurricane Storm Surge - Boston (1923-2013)



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

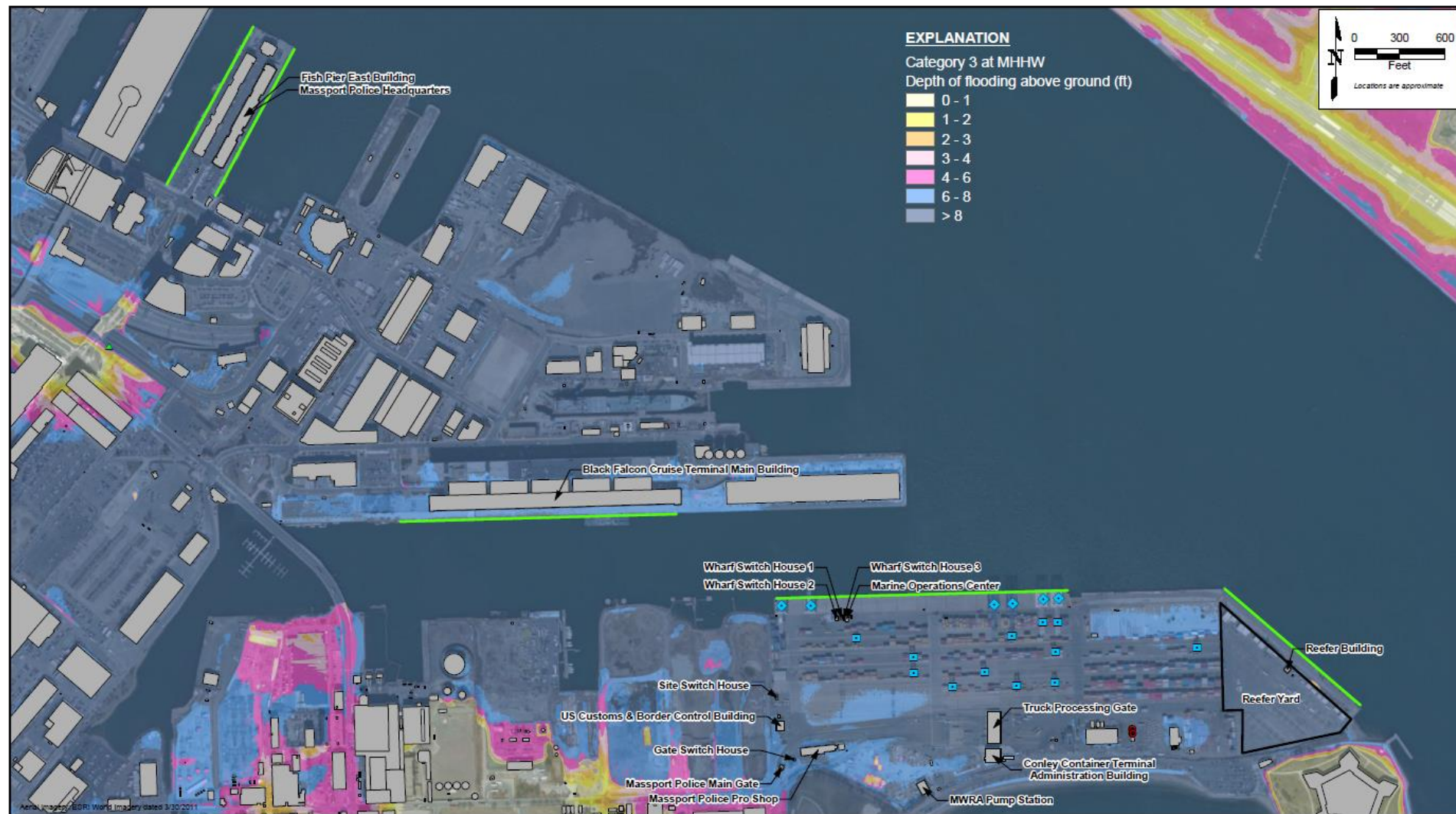


Global mean sea level rise scenarios provided by NOAA as part of the National Climate Assessment report published in December 2012.

# South Boston - Flooding from Category 2 Hurricane at MHHW

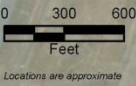


# South Boston - Flooding from Category 3 Hurricane at MHHW





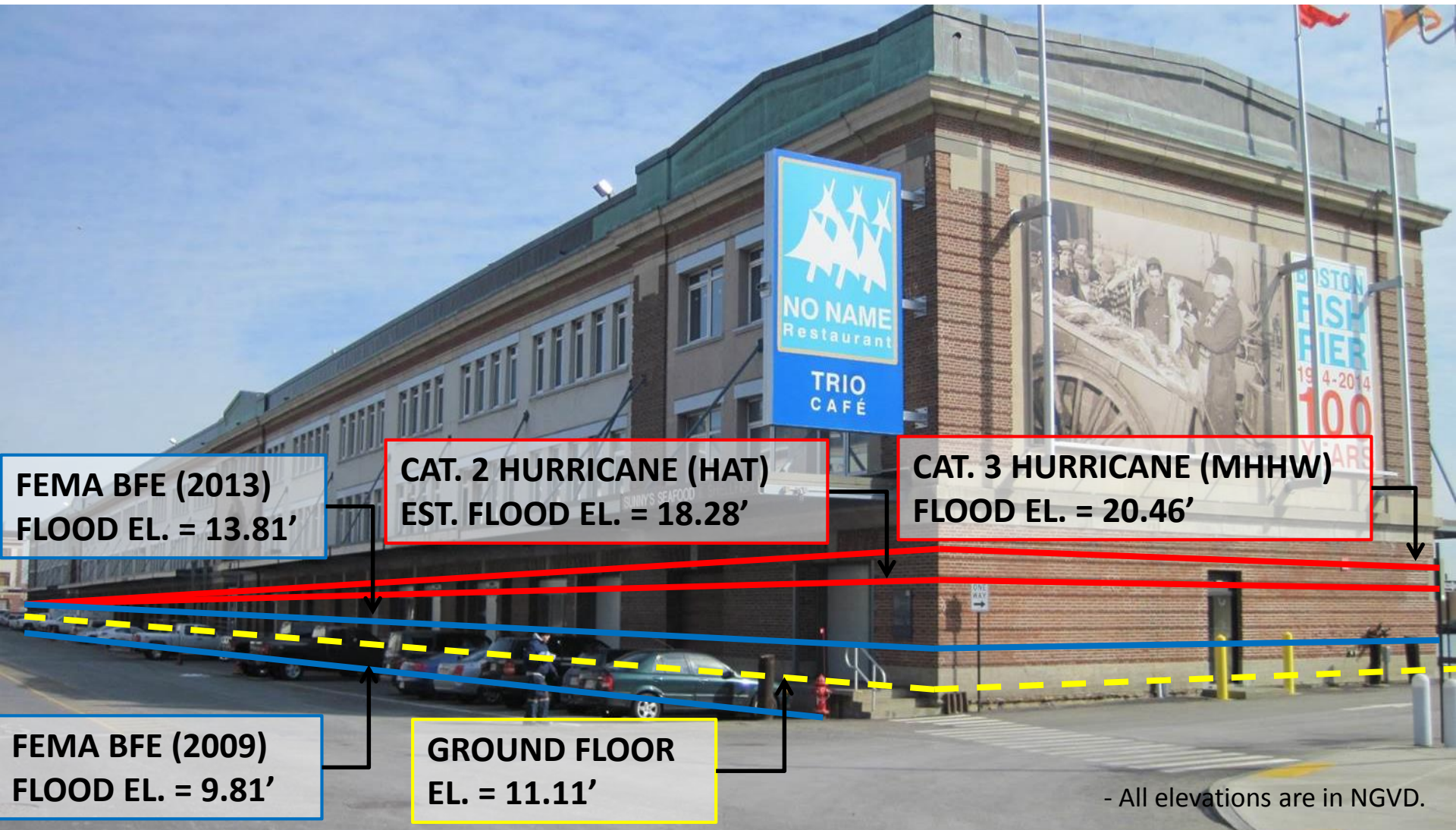
# Old & New FEMA Zones Compared – South Boston



Locations are approximate

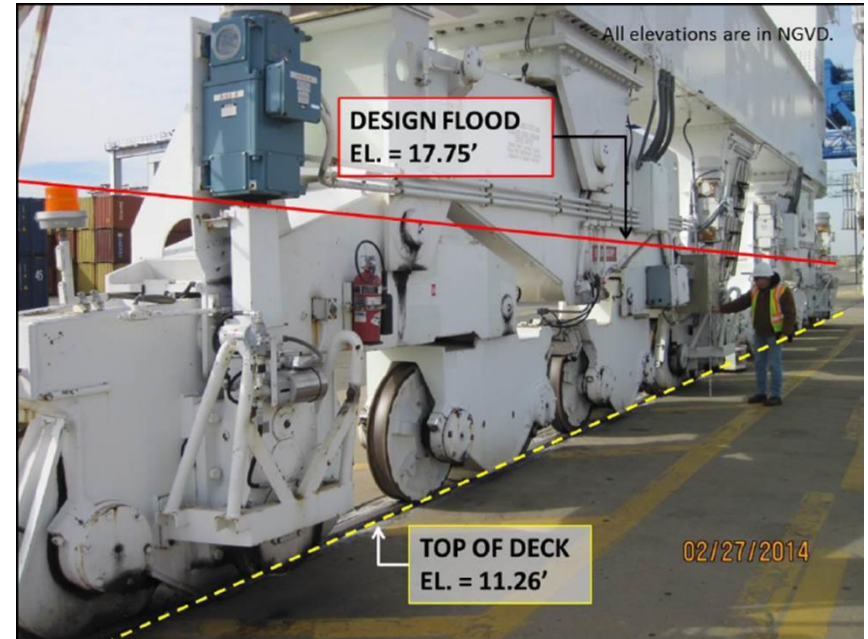
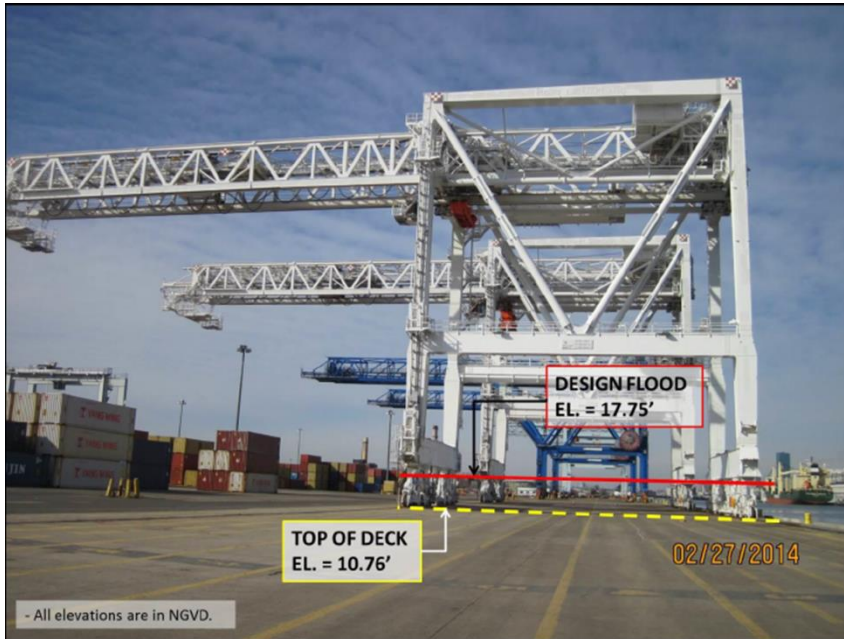
Aerial imagery: ESRI World Imagery dated 3/30/2011

# Fish Pier East – Design Flood Elevations



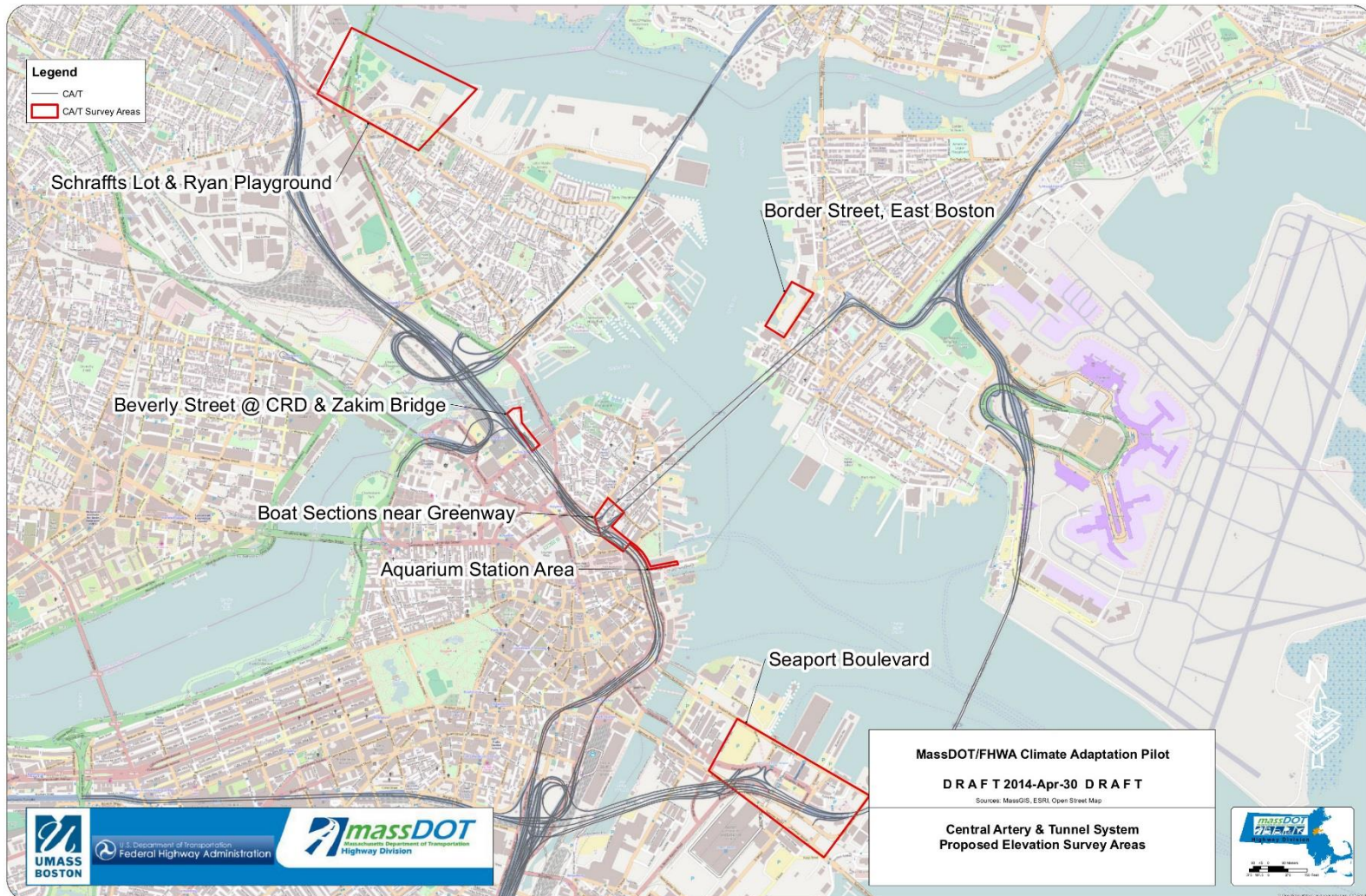


# Conley – Vessel Berths and Cranes





# Geographic Context

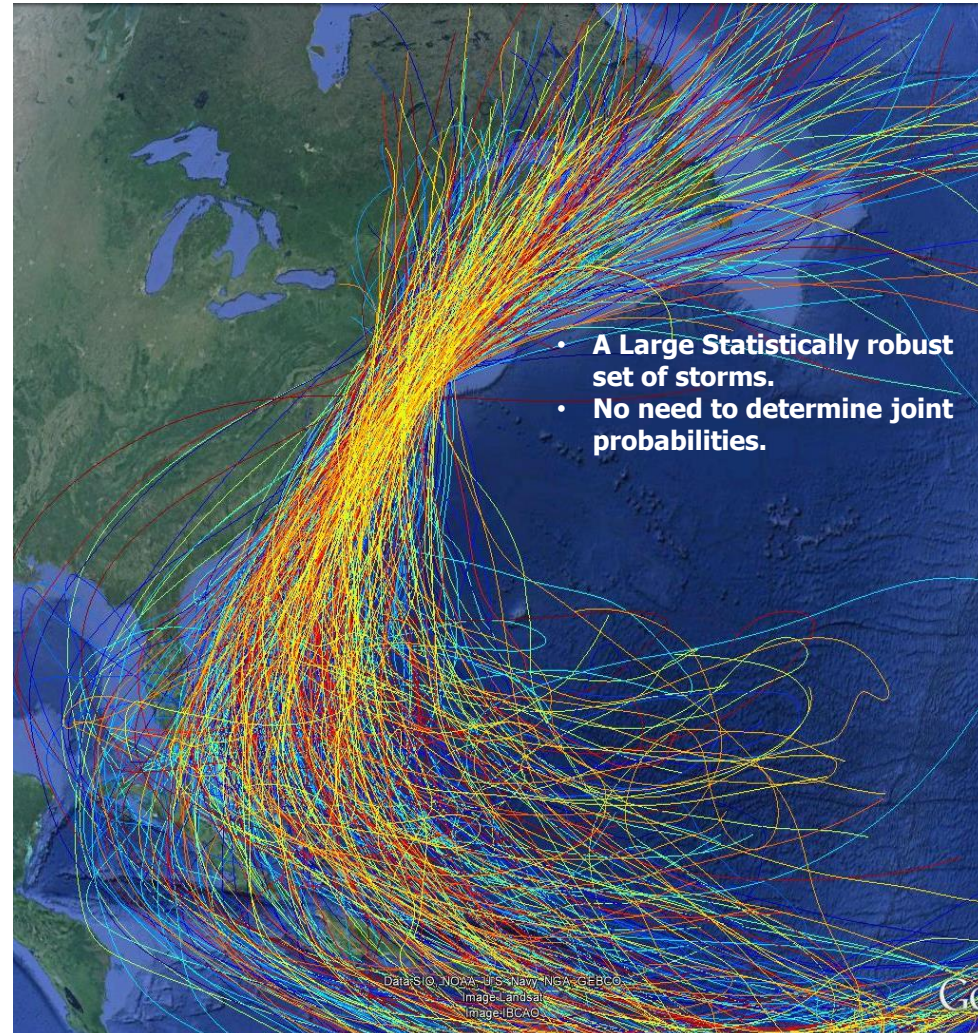
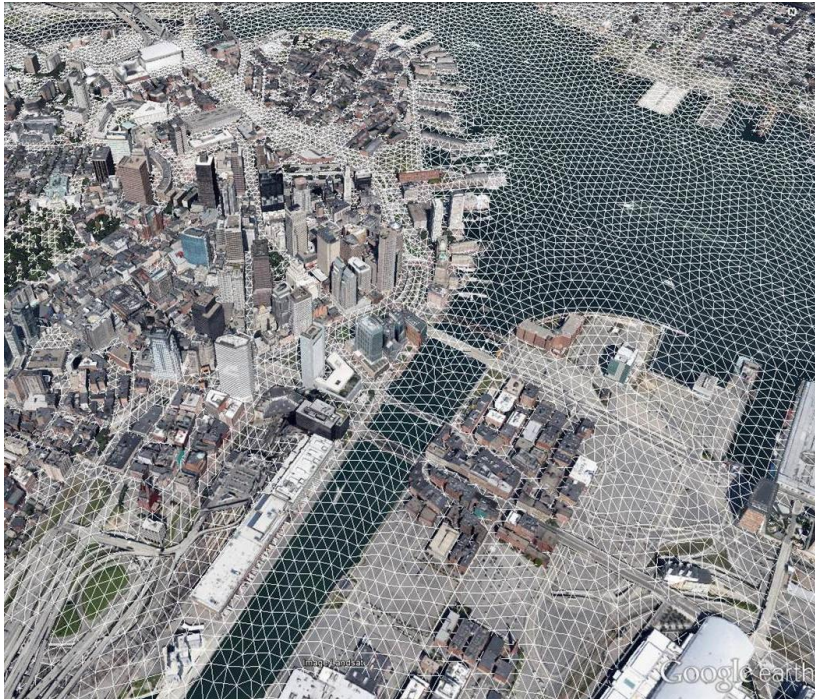




# Storm Climatology



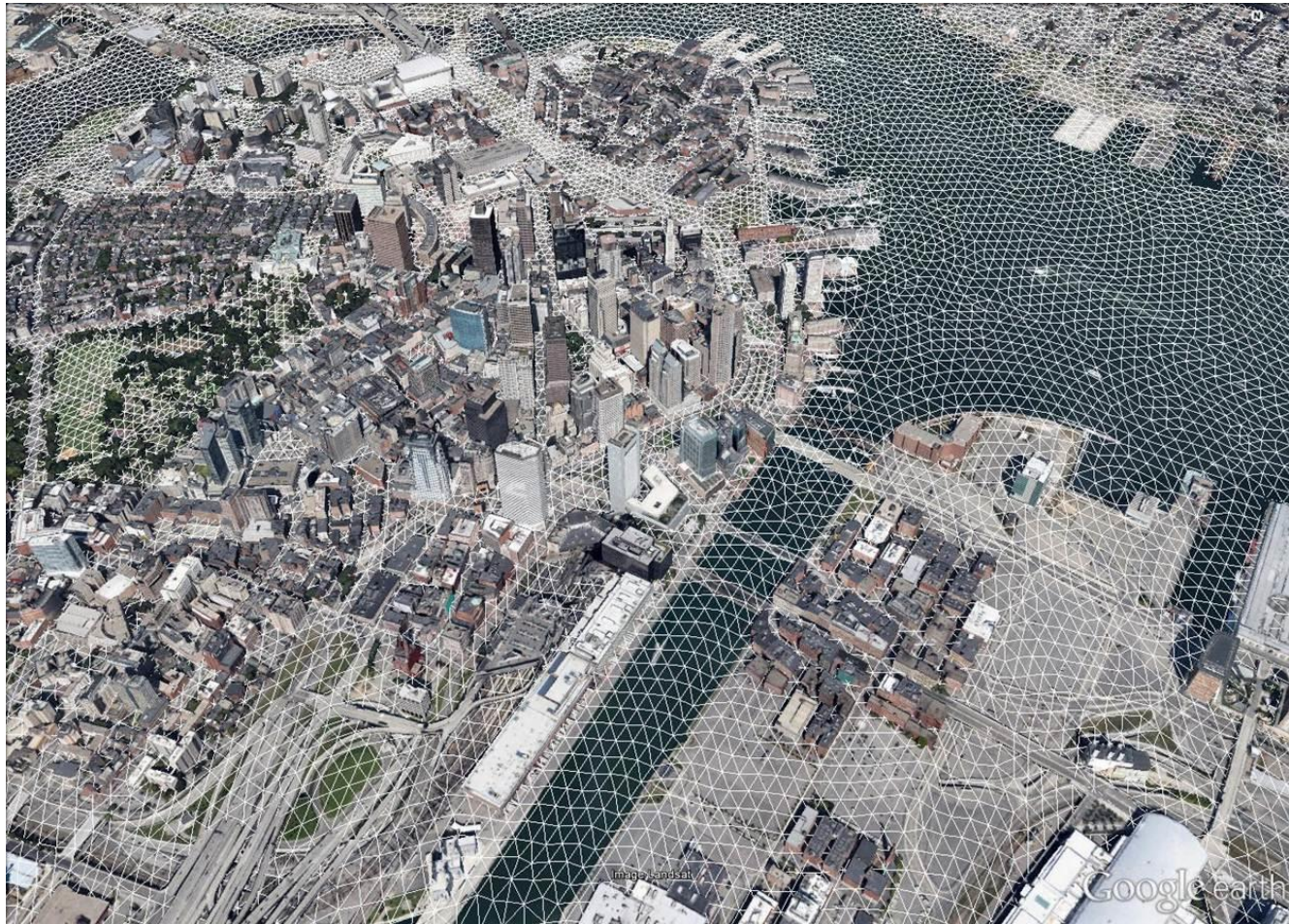
- Includes both tropical and extra-tropical storm sets



Source: Woods Hole Group



# ADCIRC Model Grid - Boston



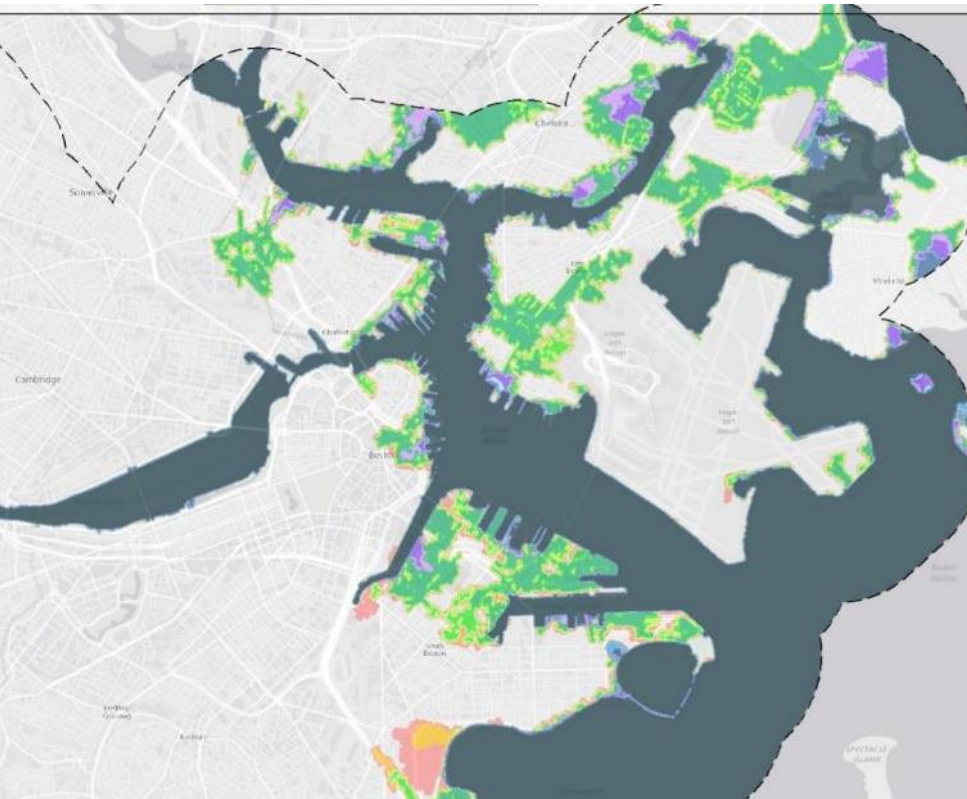
Source: Woods Hole Group



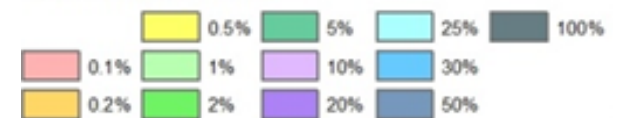
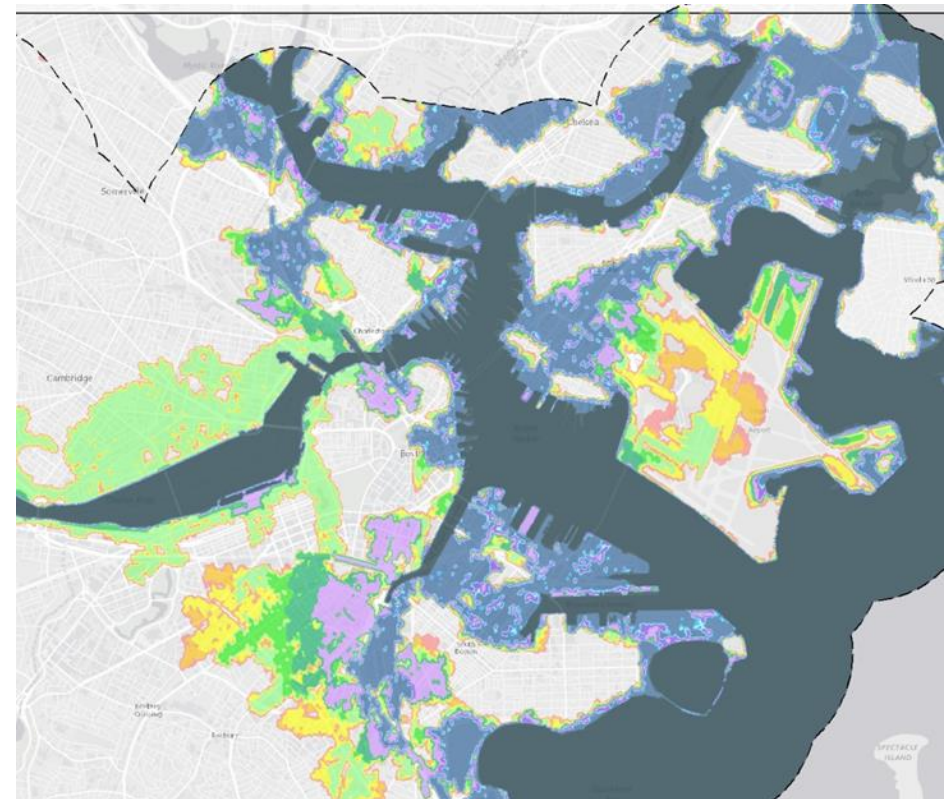
# Flood Risk Model



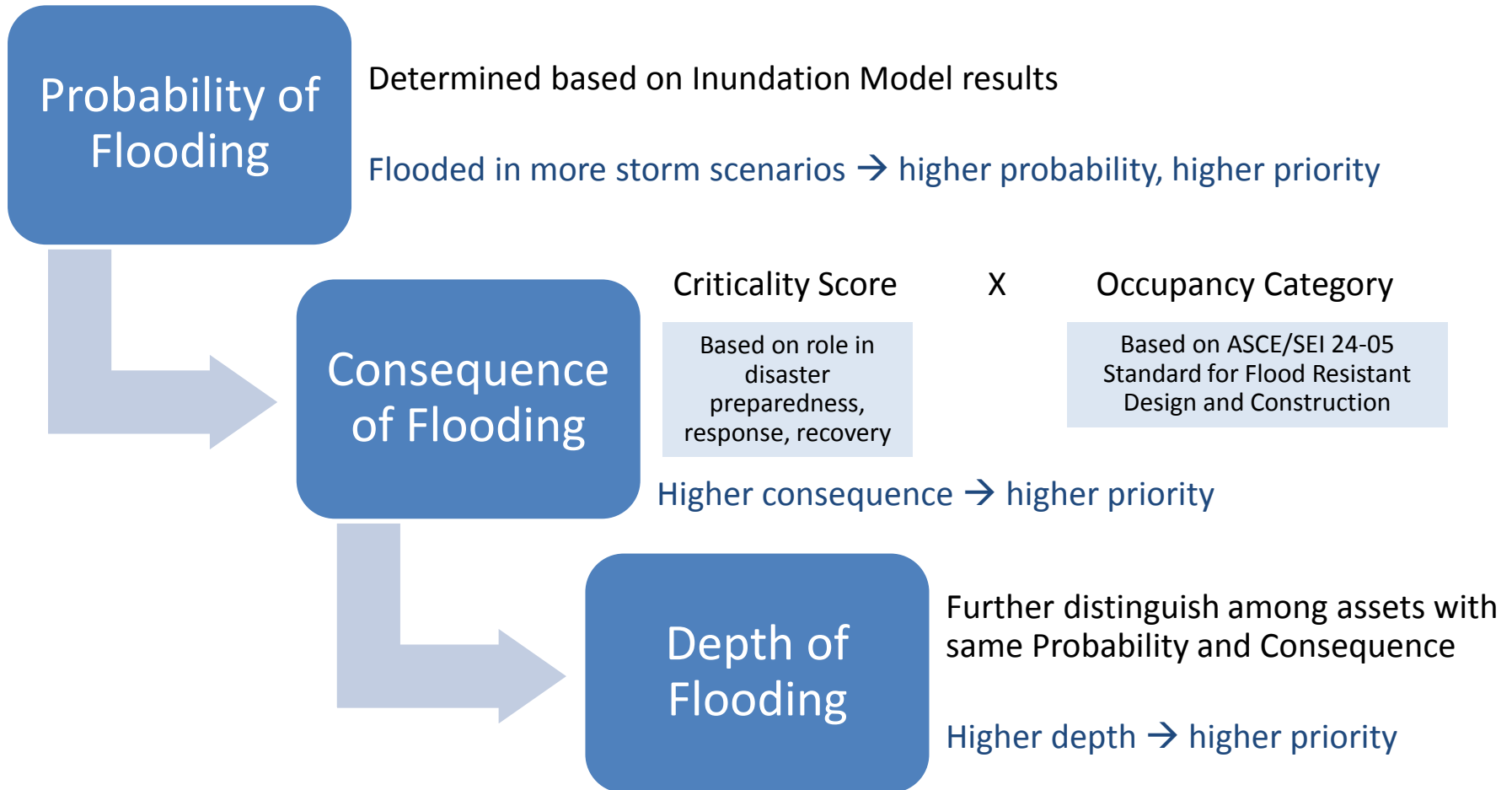
- 2030



- 2070



# Risk-Based Prioritization



# Tier 1 – Probable Exposure in BH-FRM 2030



Facility	Asset Name(s)	Critical Functions	Consequence of Flooding Score	Probability of Flooding (BH-FRM)
<b>TIER 1: HIGHER PROBABILITY OF EXPOSURE (FLOODING IN BH-FRM 2030 SCENARIO)</b>				
<b>TIER 1A</b>	<b>HIGHER CONSEQUENCE (SCORE = 8-12)</b>			<b>(2030)</b>
Fish Pier	East Building, West Building, Electrical	Multiple	12	2%
Conley	Site Switch House	Electrical	9	2%
Logan	Fire-Rescue II	Public Safety	8	2%
Logan	Porter Street Substation	Electrical	12	0.2%
Conley	Wharf Switch Houses 1-3, Marine Operations	Electrical	9	0.2%
Logan	MPA Pumping Station, Electrical Building, Ge	Water	8	0.2%
Logan	State Police & TSA Building	Public Safety	8	0.2%
Logan	Wood Island Substation	Electrical	12	0.1%
Logan	Marine Fire-Rescue	Public Safety	8	0.1%
<b>TIER 1B</b>	<b>INTERMEDIATE CONSEQUENCE (SCORE = 4-7)</b>			<b>(2030)</b>
Logan	Facilities III	Maintenance	4	1%
Conley	Berths 11-12	Access	6	0.2%
Conley	Rubber Tire Gantry Cranes	Cargo	4	0.2%
Conley	Vessel Cranes 1-6	Cargo	4	0.2%
Logan	West Outfall (Bar Screen Building)	Drainage	4	0.2%
Conley	Fuel Island and USTs	Fuel	6	0.1%
Logan	Facilities II	Maintenance	6	0.1%
<b>TIER 1C</b>	<b>LOWER CONSEQUENCE (SCORE = 1-3)</b>			<b>(2030)</b>
Haul Road	Haul Road Sump Pump	Drainage	2	5%
Conley	Interchange Facility	Cargo	1	5%
Conley	Reefer Building and Yard	Electrical	1	5%



# Floodproofing Design Guidelines



## Floodproofing Design Guide:

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

### MASSACHUSETTS PORT AUTHORITY FLOODPROOFING DESIGN GUIDE

November 2014  
Revised April 2015



# Design Flood Elevations (Probabilistic Model)



20

OLD - Logan DFE New Facilities: Cat 3 MHW = 19.5 ft (SLOSH)

18

OLD - Maritime DFE New Facilities: Cat 3 MHW = 19.3 ft (SLOSH)

16

NEW – MPA DFE New Facilities: 0.2% 2070 +3 ft freeboard = 17 ft (BH-FRM)

14

OLD - Logan DFE Existing Facilities: Cat 2 MHW = 15.4 ft (SLOSH)

OLD - Maritime DFE Existing Facilities: Cat 2 MHW = 15 ft (SLOSH)

12

NEW – MPA DFE Existing Facilities: 0.2% 2030 +3 ft freeboard = 13.7 ft (BH-FRM)

AE 1% 2013 = 10 to 13 ft (FEMA\*)

10

AE 1% 2009 = 9 to 11 ft (FEMA)

(Feet NAVD88)

\*FEMA 2013 is Proposed/Under Review

# New Construction





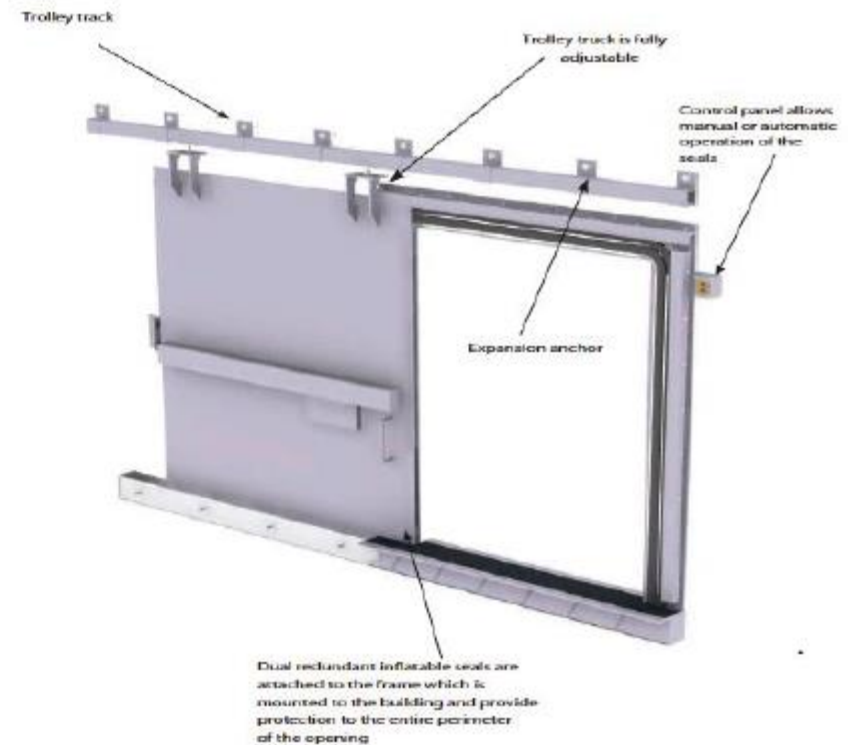
# Common Recommendations – Seal Electrical Conduits Entering Building



# Common Recommendations – Overhead Doors



Type C1  
(< 4 ft. Water)

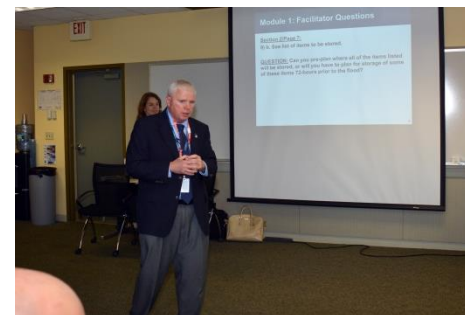


Type C2  
(> 4 ft. Water)

# DRAFT HEAVY WEATHER AND FLOOD OPERATIONS PLAN FOR MASSPORT'S



## MARITIME FACILITIES



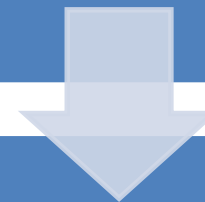


## Pre-Flood

72, 48, 24, 12, 6 hours



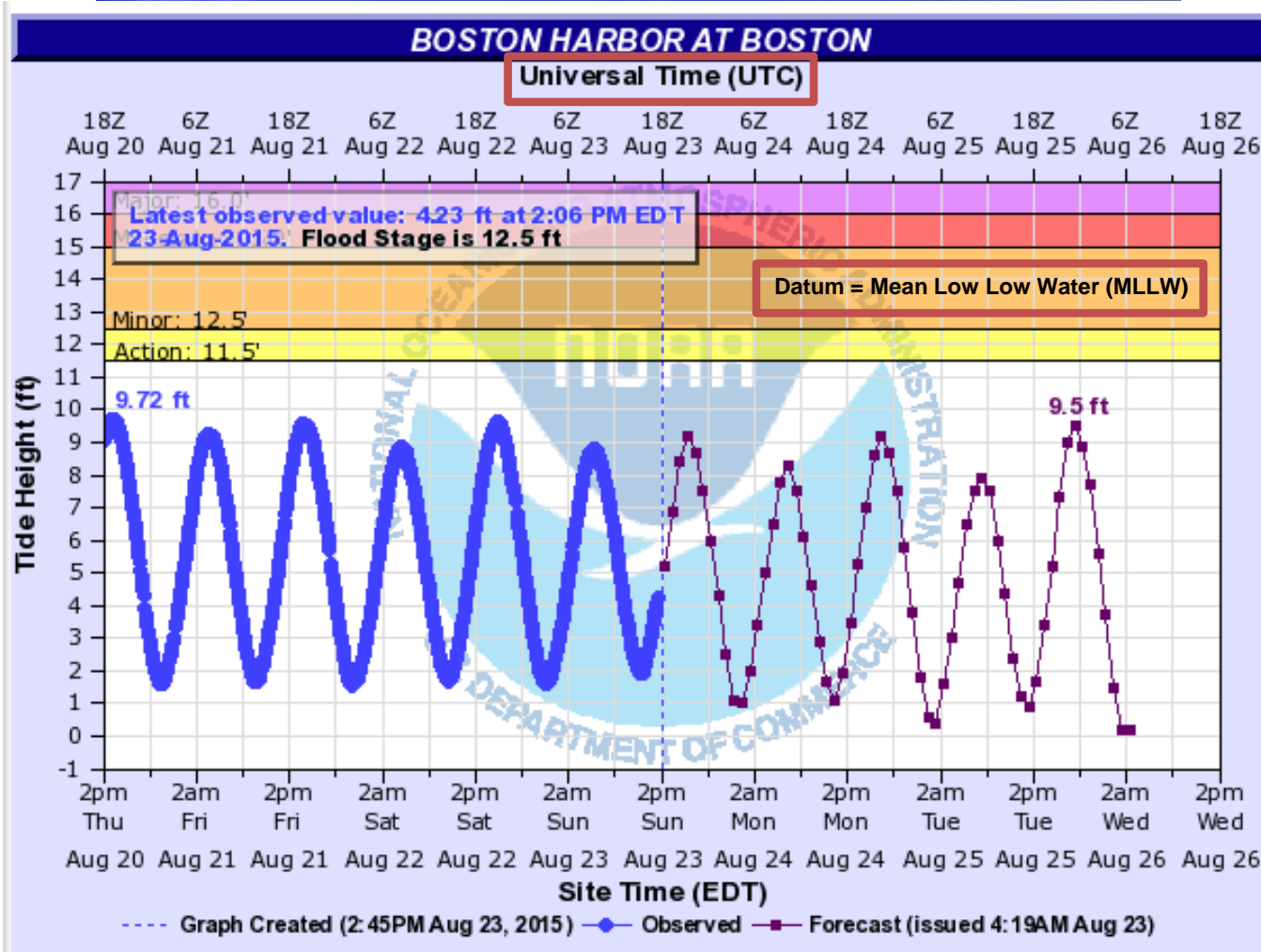
## During Flood



## Post-Flood

12 hours & 12+ hours

# Flood forecasts drive the action plan



# 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



# Table A2 –Flooding Actions and Timelines



**WHERE**

**WHO**

Logan International Airport - Flood Operations Plan

Task	Location																												Who		
	BLD #	7B	7C	7D	7E	7F	7G	7H	7I	7J	7K	7L	7M	7N	7O	7P	7Q	7R	7S	7T	7U	7V	7W	7X	7Y	7Z	7AA	7AB			
Curtail, suspend or cease operations	O																														O
Prevent unauthorized traffic from entering Airport roadway	P																														P
Communicate flood safety & personal protective measures to personnel	C																														C
Inspect roadways drainage pumps	FA																														FA
Position personnel at offsite backup locations	IT																														IT
Fill fuel trucks	FA																														FA
Fill fuel storage tanks	FA																														FA
Backup MPA network data to offsite platform	IT																														IT
Clean out oil water separators	FA																														FA
Deploy & stage portable pumps	FA																														FA
Begin to implement IT shutdown plan in coordination with Electrical	IT																														IT
Begin to implement electrical shutdown plan in coordination with IT Dept.	E																														E
Install temporary barriers, stairs, catch basins enclosures - maintain access	IT																														IT
Notify facilities and areas to be evacuated and review evacuation plan	FA																														FA
Implement large scale evacuation	O																														O
Raise loose equipment & secure doors & openings	P																														P
Priority Level		High	High	High	Moderate	High	High	High	Moderate	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	

**WHAT**

**WHEN**

- ALL **A**
- State Police **P**
- Electrical **E**
- Facilities **FA**
- IT **IT**
- Operations **O**
- CPEA **C**
- Fire Rescue **F**
- Utility **U**

Flood Level 13.0 ft. ≤ El. < 14.0 ft. NAVD88

**Table A2**  
24 hours before flood





# Procure Temporary Flood Barriers



- 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



