



Memorandum

To: Philip Lemnios, Town Manager, Chris Krahforst, Conservation Administrator
From: Anne Herbst, Metropolitan Area Planning Council
Date: May 19, 2022
Subject: Massachusetts Coast Flood Risk Model, Hull Impact Analysis

Introduction

This memo summarizes projected sea level rise impacts on the Town of Hull using the Massachusetts Coast Flood Risk Model (MC-FRM) developed by the Woods Hole Group under contract to the Massachusetts Department of Transportation. The MC-FRM simulates historic and future hurricanes and nor'easters and integrates analysis of storm surge, wind, and wave run-up and overtopping. The analysis includes projections of the probability and depth of flooding for future scenarios of 1.2 feet, 2.4 feet, and 4.2 mean sea level.¹

The MC-FRM future sea level scenarios are based on projections developed by the Northeast Climate Adaptation Science Center (NE CASC) for Massachusetts and referenced in the Massachusetts State Hazard Mitigation and Climate Adaptation Plan. As shown in Figure 1 below, 1.2 feet, 2.4 feet, and 4.2 feet mean sea level match the NE CASC “high” scenario for the years 2030, 2050, and 2070 respectively. The series of future projections developed by NE CASC are based on varying assumptions regarding future greenhouse gas emissions and land-based ice melt.

Recognizing the wide range of scenarios for future sea level rise and the likelihood of changing projections over time, this report does not focus on the years 2030, 2050, and 2070, but rather on the projections of future relative mean sea level. Figure 1 depicts recent sea level trends from

¹ Mean Sea Level is not the same as sea level rise. Mean Sea Level is described in feet above a standardized zero-point elevation, or “datum”, which can be used to compare elevations anywhere. The Mean Sea Level scenarios simulated in the MCFRM study are 1.2 ft (2030), 2.4 ft (2050), and 4.2 ft (2070) above the North American Vertical Datum 1988 (NAVD88). The MCFRM coastal flooding sea level scenarios reflect the following sea level rise since 2000 sea level:

- “2030”: 1.395 ft sea level rise (1.2 ft NAVD88)
- “2050”: 2.595 ft sea level rise (2.4 ft NAVD88)
- “2070”: 4.395 ft sea level rise (4.2 ft NAVD88)

the Boston Harbor tide gage and each of the NE CASC sea level rise scenarios. The NE CASC high scenario is a conservative scenario as is customarily provided for planning purposes.

Boston Relative Mean Sea Level (feet NAVD88)									
Scenario	Summary	2030	2040	2050	2060	2070	2080	2090	2100
Intermediate	Intermediate scenario primarily based on medium and high emissions scenarios and accounts for possible higher ice sheet contributions to sea level rise (Unlikely to exceed 83% probability given a high emissions pathways)	0.7	1.0	1.4	1.8	2.3	2.8	3.4	4.0
Intermediate-High	Intermediate-high scenario primarily based on high emissions scenarios and accounts for possible higher ice sheet contributions to sea level rise (Extremely unlikely to exceed 95% probability given a high emissions pathway)	0.8	1.2	1.7	2.3	2.9	3.6	4.3	5.0
High	High scenario primarily based on high emissions scenarios and accounts for possible higher ice sheet contributions to sea level rise (Extremely unlikely to exceed 99.5% probability given a high emissions pathway)	1.2	1.7	2.4	3.2	4.2	5.2	6.4	7.6
Extreme (Maximum physically plausible)	Highest scenario primarily based on high emissions scenarios and accounts for possible higher ice sheet contributions to sea level rise and consistent with estimates of physically possible "worst case" (Exceptionally unlikely to exceed 99.9% probability given a high emissions pathway)	1.4	2.2	3.1	4.2	5.4	6.8	8.4	10.2

Source: resilient MA, 2018

Table 1: Northeast Climate Adaptation Science Center sea level projections.

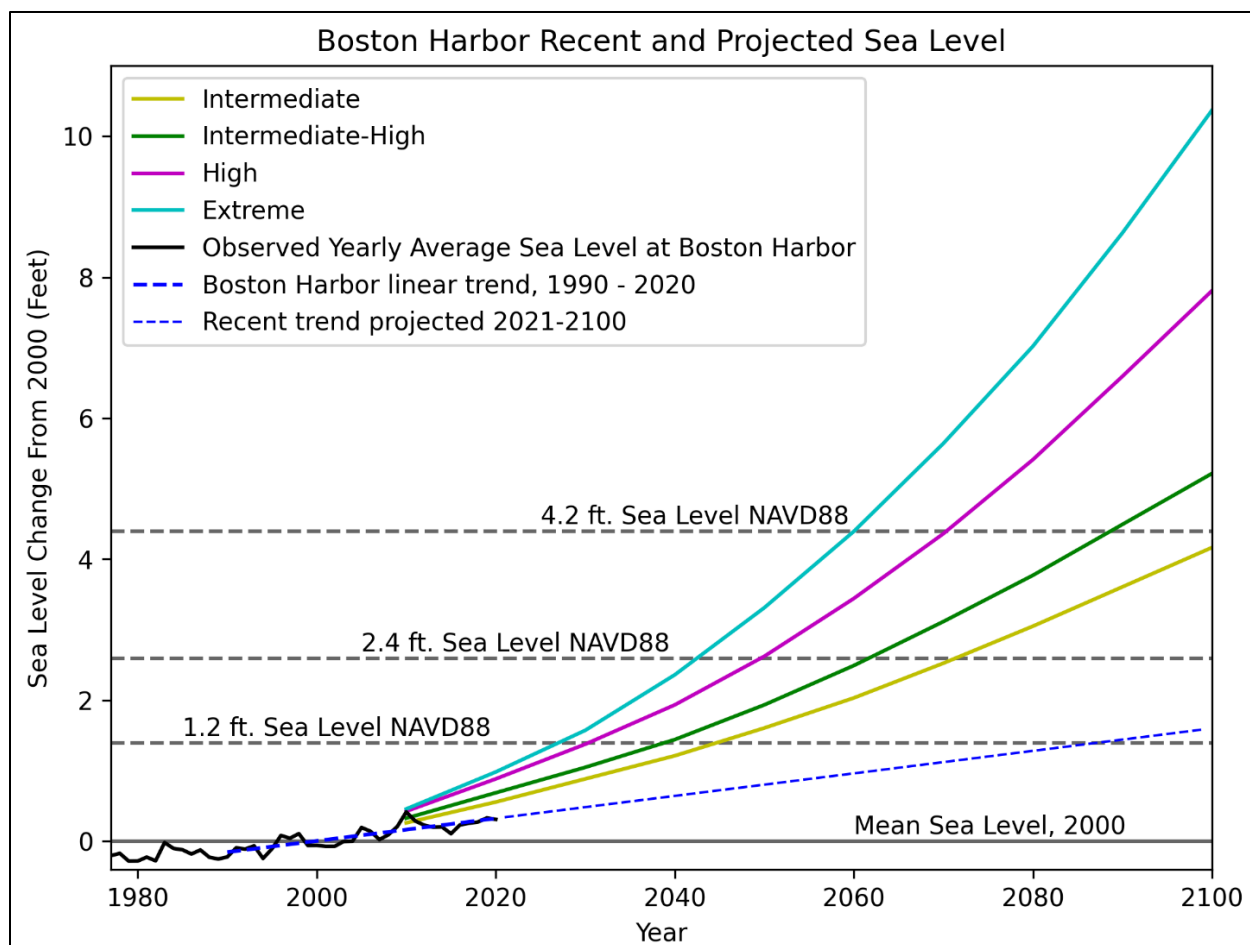


Figure 1: Boston Harbor tide gage observations and NE CASC future projections

In February of this year, NOAA released updated sea level rise projections for the United States and coastal regions². As shown in Table 2, the range of projections, particularly for 2050 is considerably narrower than the scenarios from NE CASC. In Figure 2, the NOAA projections are superimposed on the NE CASC projections.

² [Global and Regional Sea Level Rise Scenarios for the United States \(windows.net\)](https://www.windows.net/global-and-regional-sea-level-rise-scenarios-for-the-united-states)

Northeast US	2050	2100
Low	1.2 ft.	2.0 ft.
Intermediate-Low	1.3 ft.	2.6 ft.
Intermediate	1.4 ft.	4.3 ft.
Intermediate-High	1.6 ft.	5.2 ft.
High	1.8 ft.	6.9 ft.

Table 2: NOAA Sea Level Rise Projection for the Northeast United States

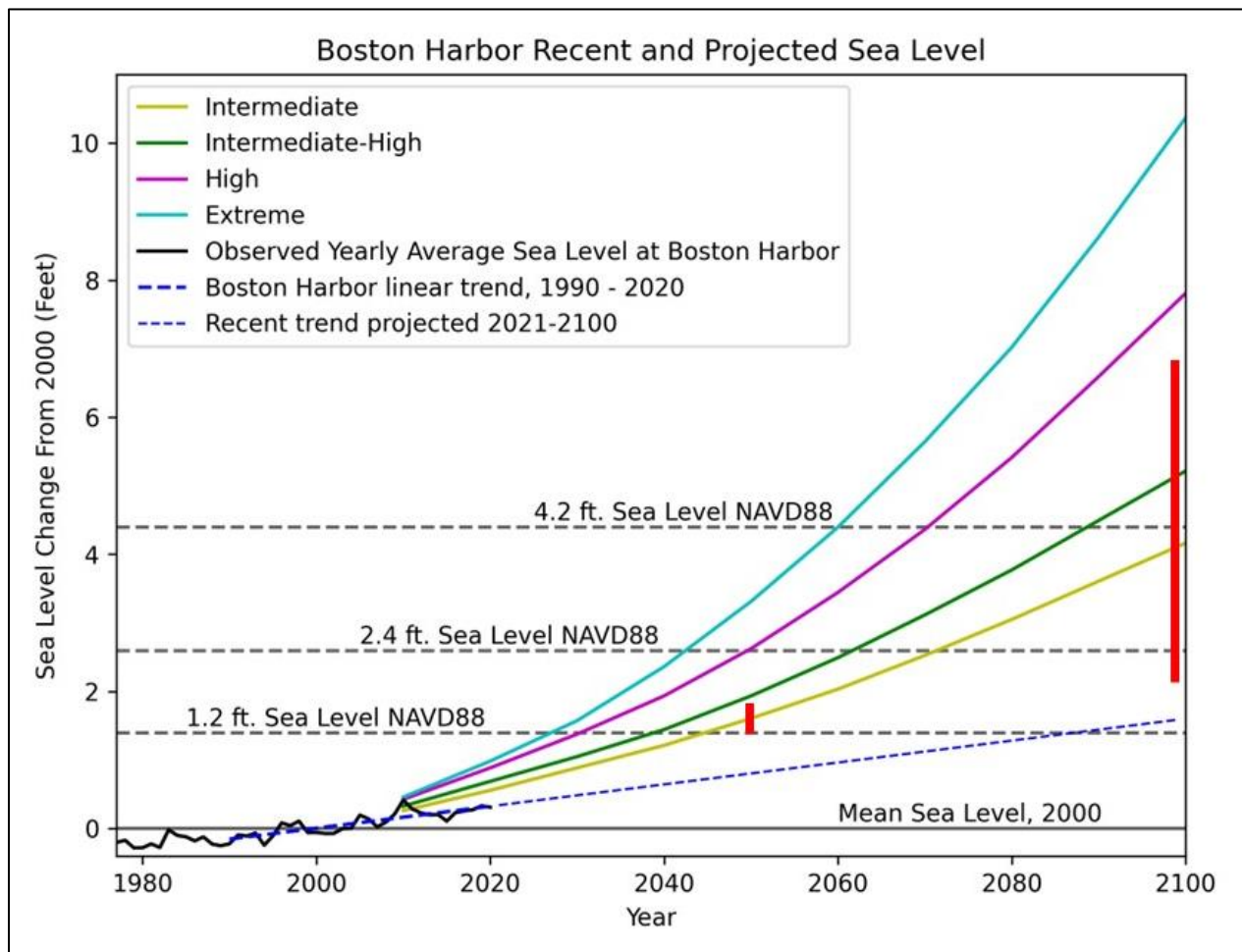


Figure 2: 2022 NOAA Technical Report, sea level rise projections added in red

Analysis

MAPC reviewed impacts to parcels, structures, and property values for storms with a 1%, 10%, and a greater than 50% annual chance of flooding for future projected scenarios of 1.2, 2.4, and 4.2 feet mean sea level. The results are summarized in Table 3 below. The extent of impact of the 1% chance storms does not increase significantly from 1.2 to 4.2 feet mean sea level. This limited increase in the extent of impact reflects the realities of Hull's topography where low-lying barrier beach transitions fairly sharply to drumlins and hills. Further, this suggests that the primary concern for Hull is an increasing frequency and depth of flooding in areas currently located in the FEMA 1% chance flood zones.

A significant proportion of properties and property value is projected to be impacted by storms that have a greater than 10% chance, or a greater than 50% chance of flooding annually. With 1.2 feet mean sea level, nearly half of Hull's properties are projected to have a greater than 10% chance of flooding annually, and ten percent of properties are projected to have a greater than 50% chance of flooding annually. With 2.4 feet mean sea level, nearly seventy percent of properties are projected to have a greater than 10% chance of flooding annually, and over half will have a greater than 50% chance of flooding each year. Currently a relatively small number of properties and areas of town are subject to flooding with frequencies as high as every ten years, and very few are subject to flooding as often as every other year. Repeated flooding is likely to pose significant challenges to protecting properties as well as town roads, seawalls, dunes, and other infrastructure.

Sea Level Scenarios	Flood Probability	Percentage of Parcels Impacted	Percentage of Buildings Impacted	Percentage of Property Value Impacted
FEMA FIRM	1% chance	71%	61%	74%
1.2 feet	1% chance	69%	62%	70%
	10% chance	48%	44%	48%
	50% chance	10%	5%	11%
2.4 feet	1% chance	73%	67%	74%
	10% chance	68%	63%	69%
	50% chance	52%	50%	46%
4.2 feet	1% chance	75%	69%	78%
	10% chance	71%	67%	72%
	50% chance	60%	59%	56%

Table 3: Impacts to parcels, buildings, and property value

Maps

Map 1 displays the extent of flooding projected during the 1% annual chance storm for the three mean sea level scenarios. The additional areas projected to be flooded with 2.4 feet and 4.2 feet mean sea level are quite small, as the proportion of town projected to flood increases only from 69% to 73% to 75% of parcels.

Map 2 displays the annual chance of flooding with 1.2 feet mean sea level. Atlantic Avenue at Crescent Beach, the Hampton Circle Playground area, Nantasket Avenue at Stoney Beach, the Dust Bowl, and the Channel Street areas are projected to have a greater than 50% annual chance of flooding.

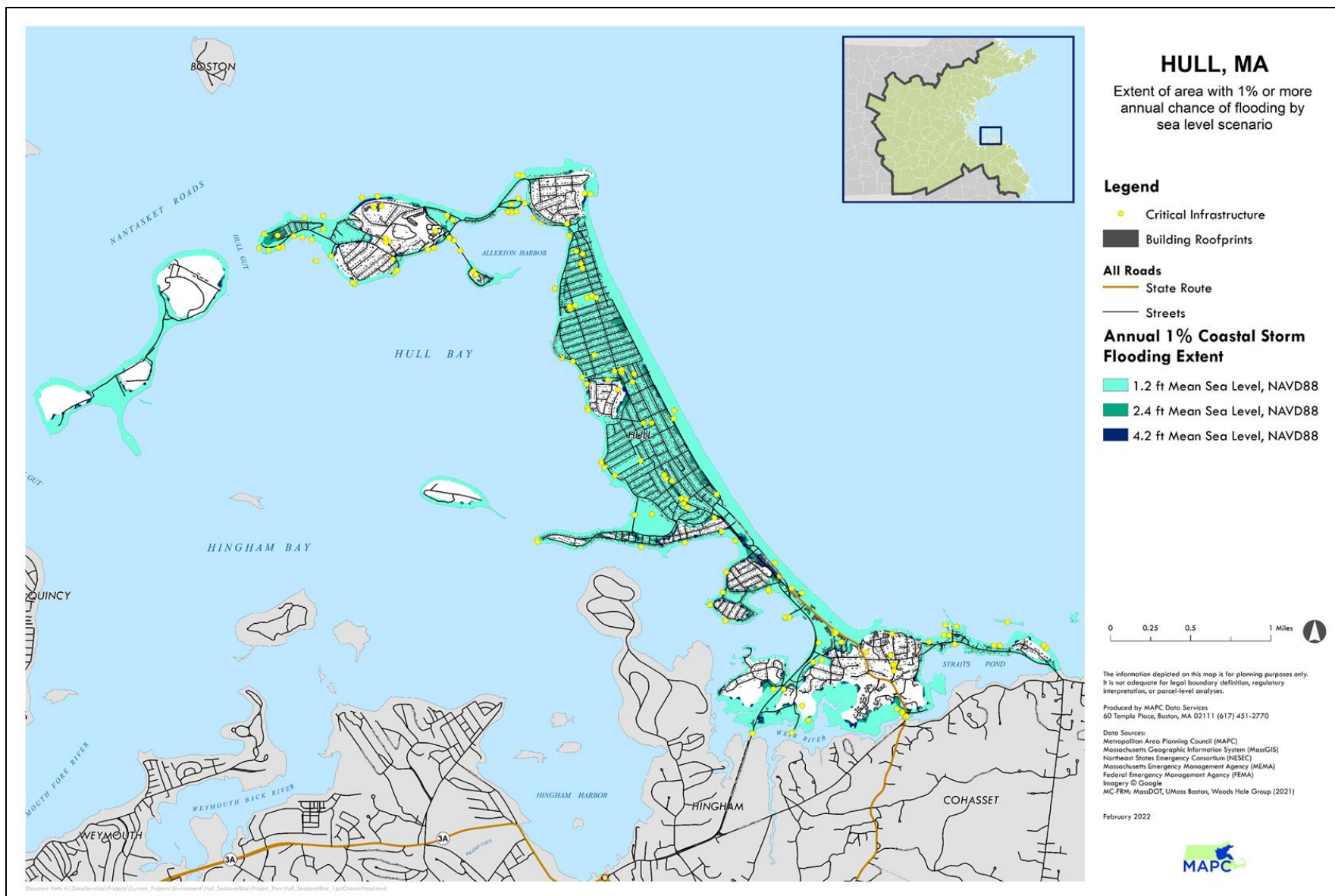
Map 3 displays the depth of flooding in the 1% annual chance storm with 1.2 feet mean sea level. The Bayside area from Revere Street to Strawberry Hill is projected to have flood depths ranging from five up to ten feet. While the likelihood of flooding in this area is relatively low (5% to 10%) due to the protection provided by the seawall on the bayside and the height of Nantasket Ave, the depth of flooding reflects lower elevations in this area. Depths for the Hampton Circle Playground area also range from five to up to ten feet.

Map 4 displays the annual chance of flooding with 2.4 feet mean sea level. Most of the areas subject to flooding are projected to have a 50% or greater chance of annual flooding. The high school area ranges from a less than .5% chance up to a 10% annual chance of flooding.

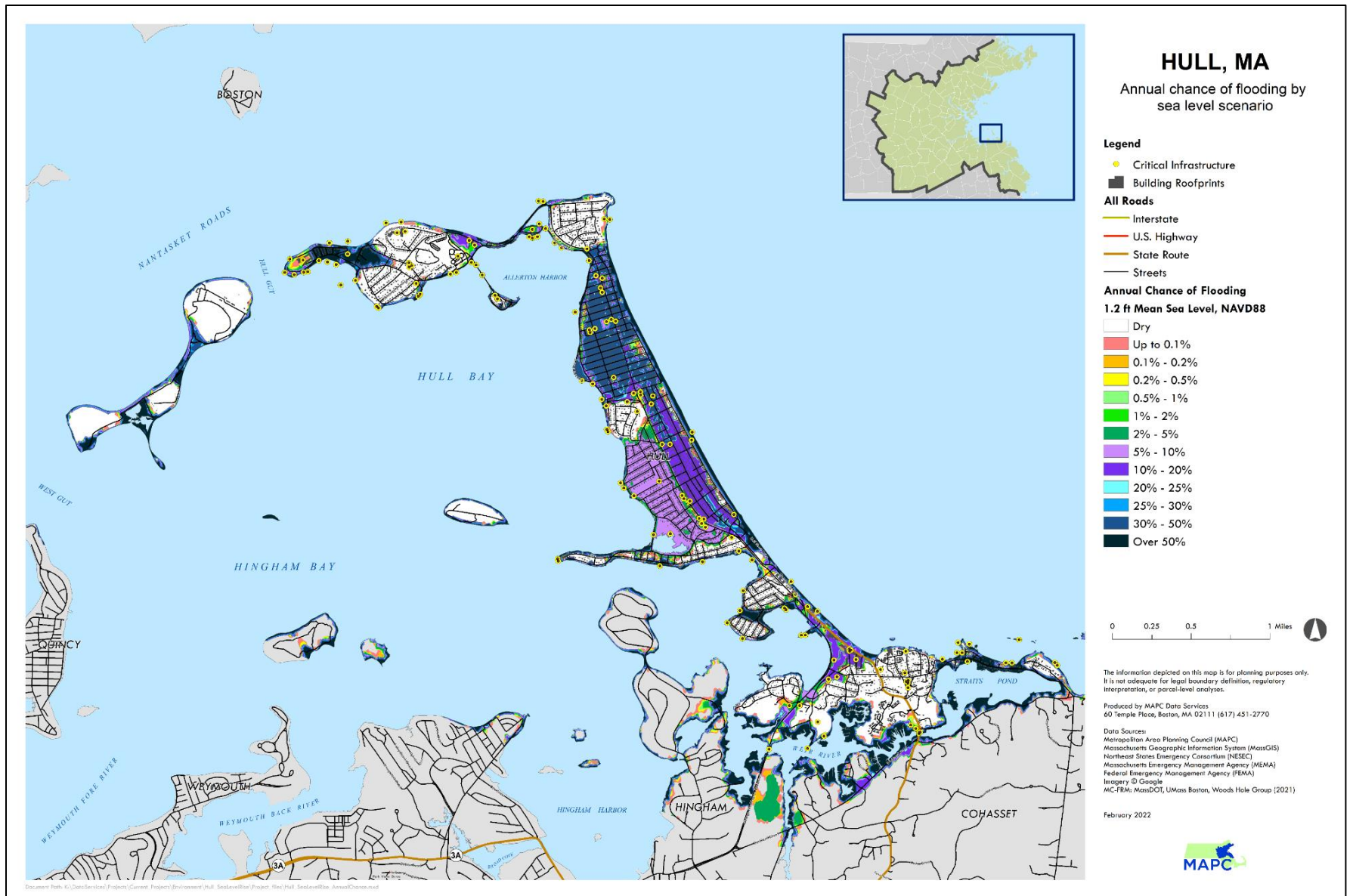
Map 5 displays the depth of flooding in the 1% annual chance storm with 2.4 feet mean sea level. The Hampton Circle Playground area, Bayside from Revere Street to Strawberry Hill, Nantasket Avenue at Stoney Beach, the Dust Bowl, and Channel Street have projected flood depths of up to ten feet.

Map 6 displays the annual chance of flooding with 4.2 feet mean sea level. As is true with 2.4 feet mean sea level, most areas are projected to have a greater than 50% chance of flooding.

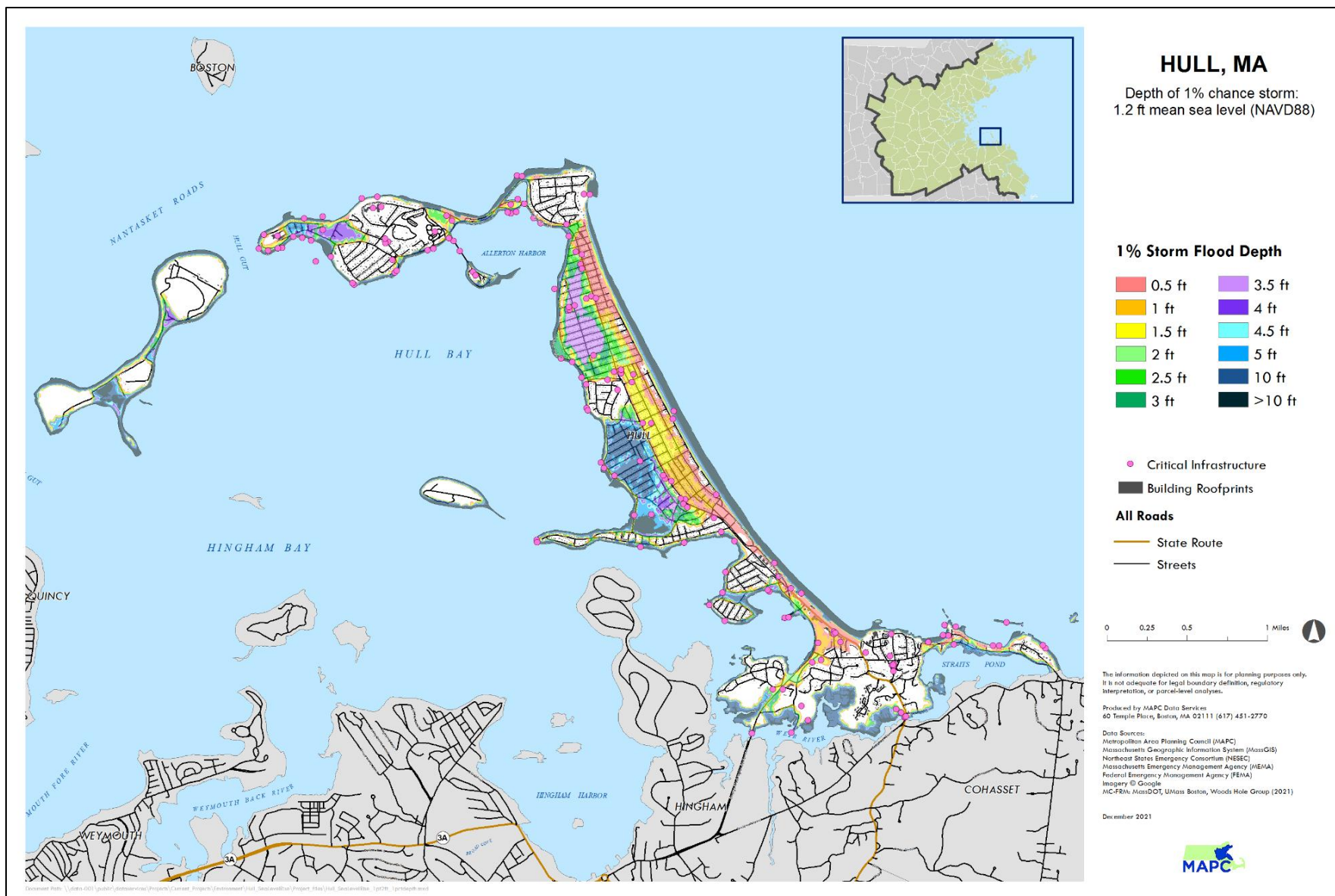
Map 7 displays the depth of flooding in the 1% annual chance storm with 4.2 feet mean sea level. Up to ten feet of flooding is projected for the majority of the areas subject to the 1% annual chance storm.



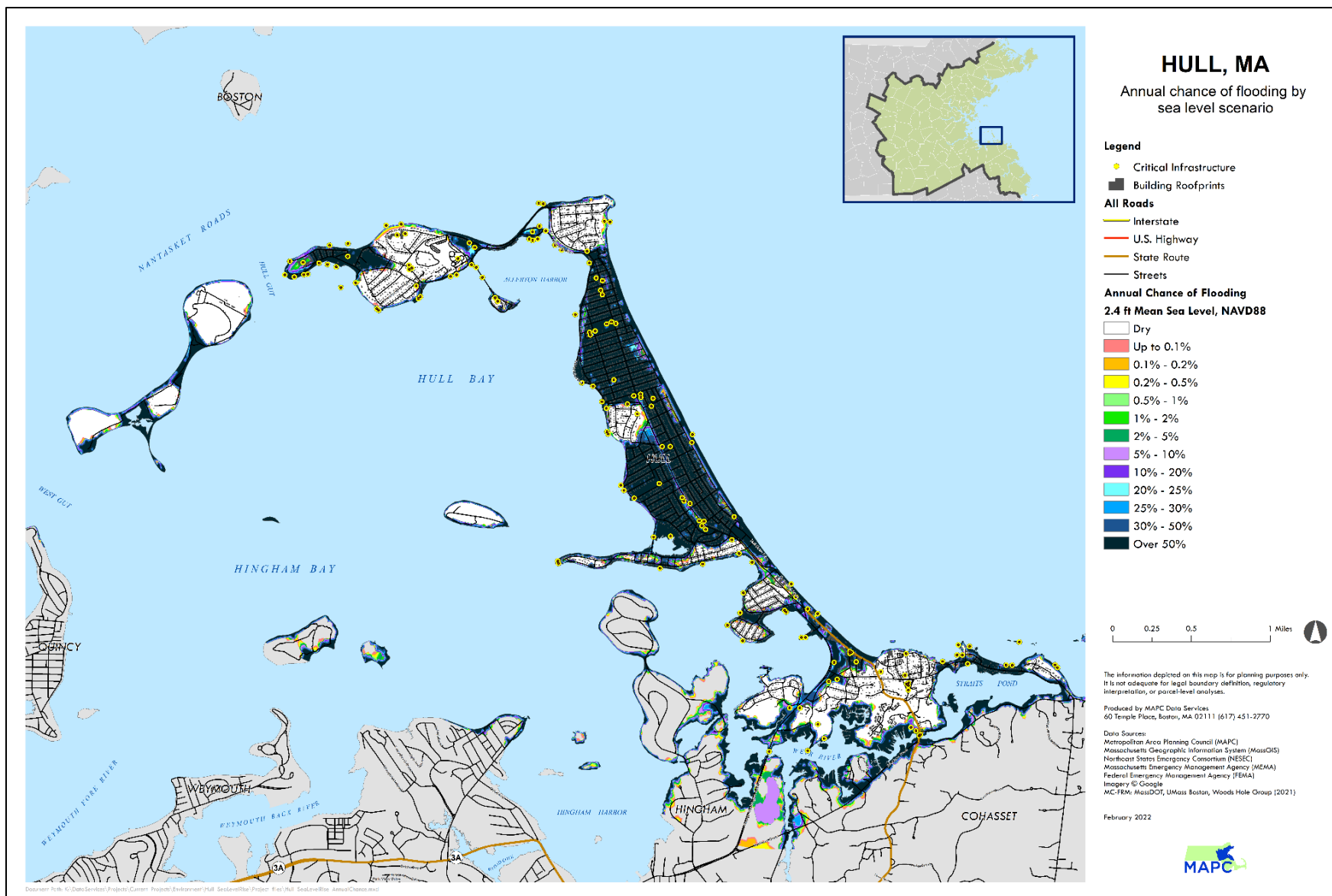
Map 1: Extent of 1% annual chance of flooding with 1.2 feet, 2.4 feet, and 4.2 feet mean sea level.



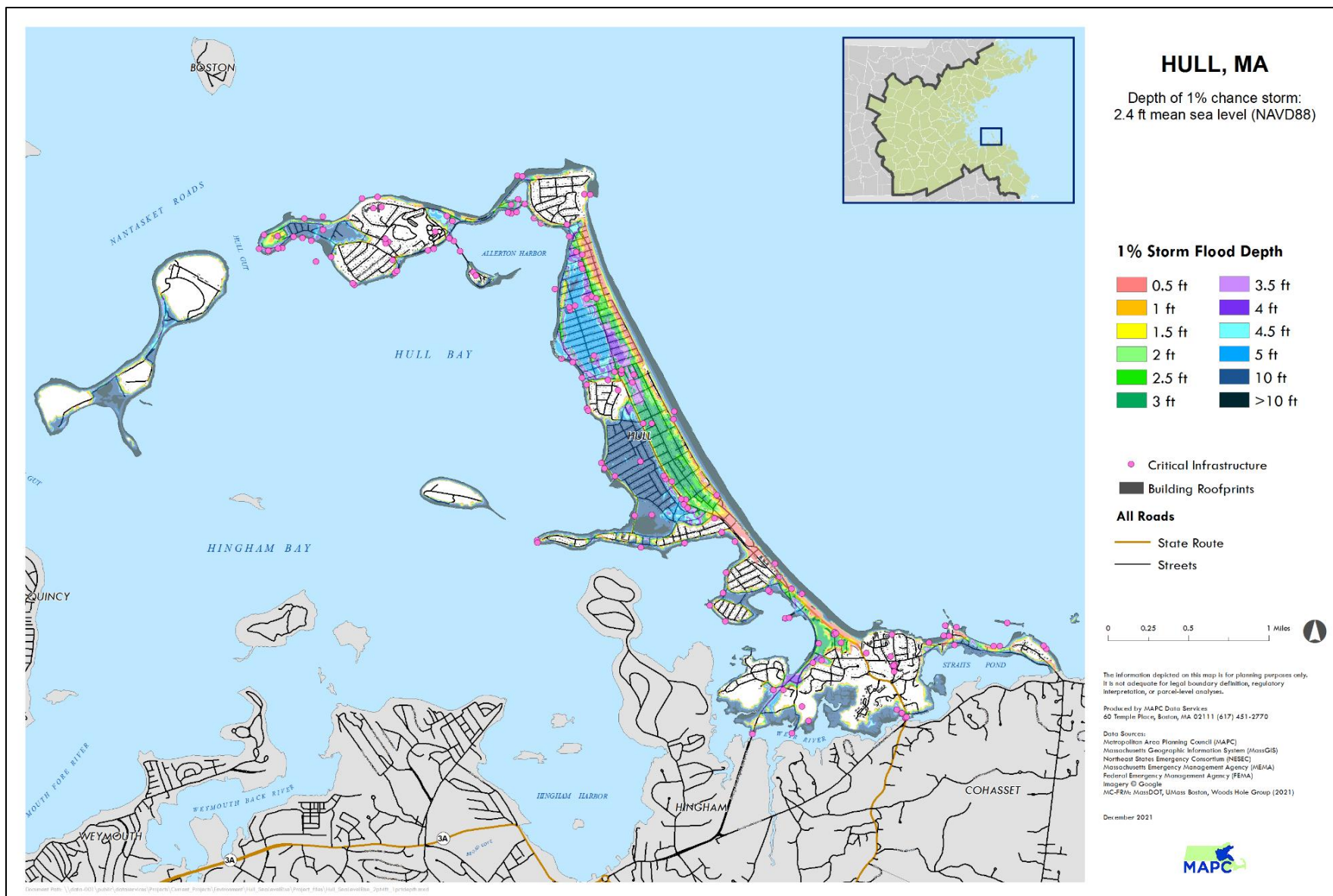
Map 2: Annual chance of flooding with 1.2 feet mean sea level.



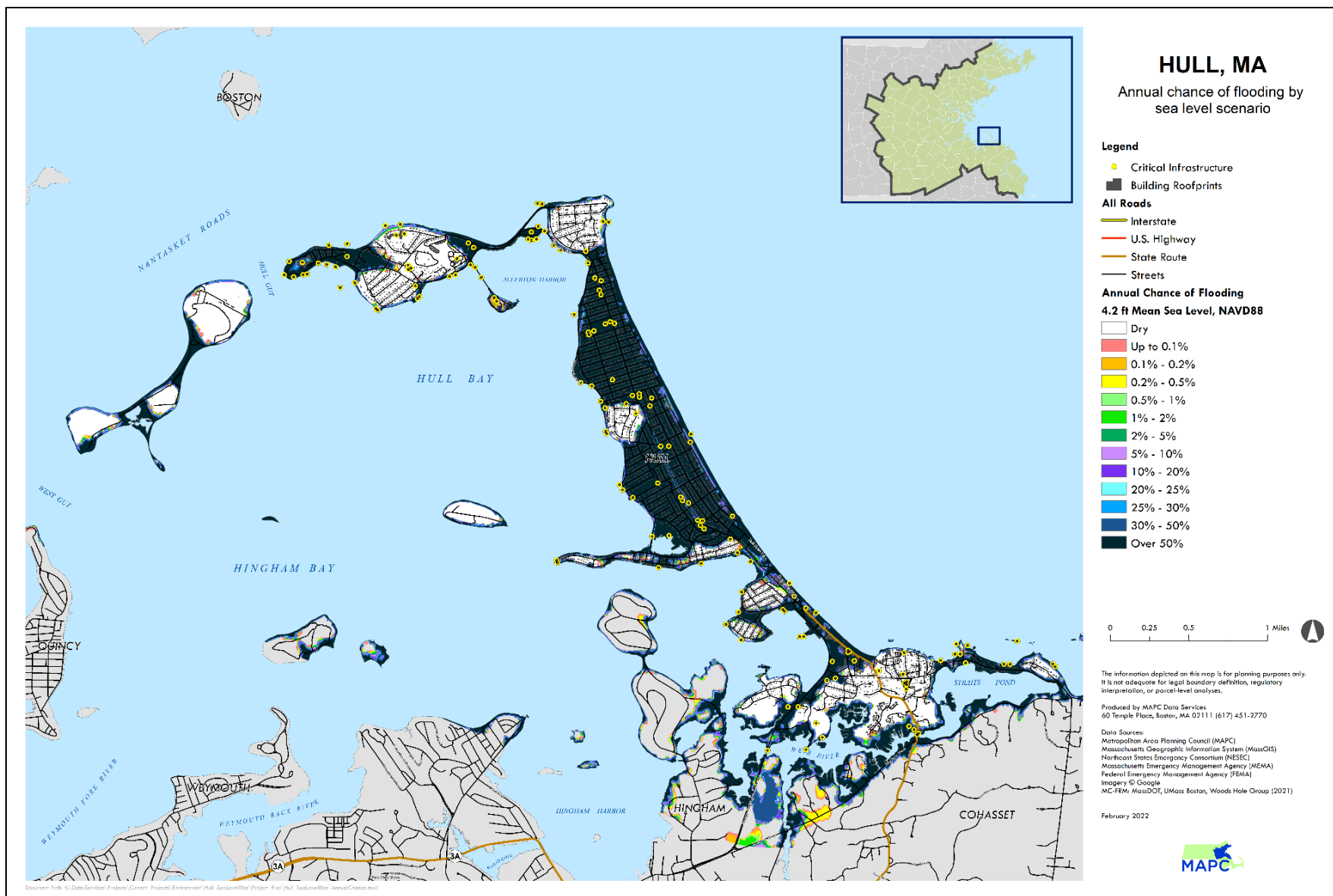
Map 3: Depth of flooding with 1% annual chance storm and 1.2 feet mean sea level.



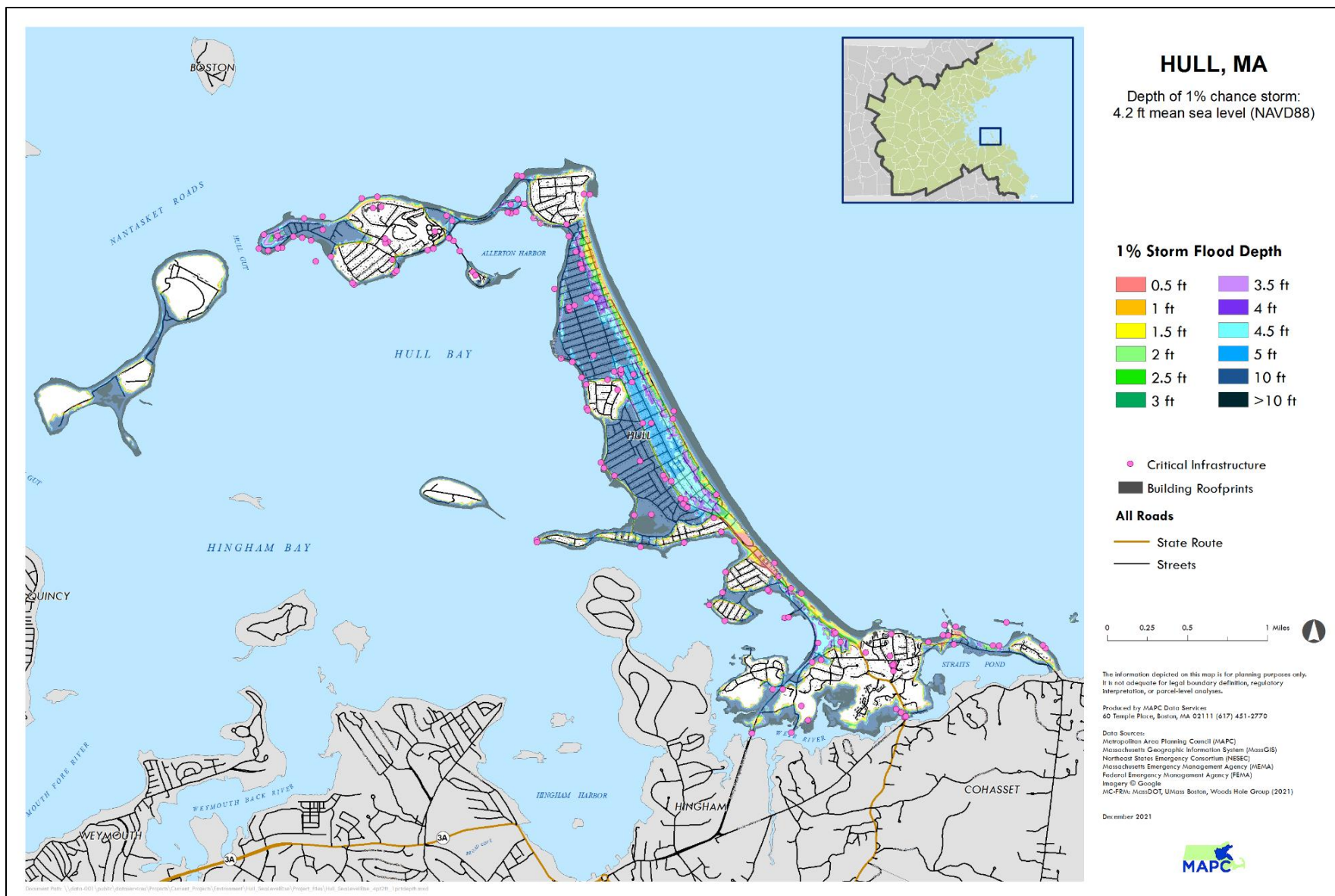
Map 4: Annual chance of flooding with 2.4 feet mean sea level.



Map 5: Depth of flooding with 1% annual chance storm and 2.4 feet mean sea level.



Map 6: Annual chance of flooding with 4.2 feet mean sea level.



Map 7: Depth of flooding with 1% annual chance storm and 4.2 feet mean sea level.

Critical Infrastructure

MAPC reviewed impacts to critical infrastructure for storms with a 1%, 10%, and 100% annual chance of flooding for the 1.2, 2.4, and 4.2 feet mean sea level scenarios. The results are summarized in Table 4 below. Although the MC-FRM “Modeling Overview and Frequently Asked Questions” indicates that the model resolution is high enough to analyze individual buildings, the information in Table 4 should serve only as an initial indicator of potential risk. The critical infrastructure locations are taken from the Town of Hull Hazard Mitigation Plan 2018 Update. The locations are approximate and, particularly along the shoreline, a small divergence from actual locations could have a significant impact on projections. In addition, facilities that are elevated or flood-proofed may be protected from flooding despite projections of flood depth.

Critical Infrastructure	1.2 feet				2.4 feet				4.2 feet			
	100% chance	10% chance	1% chance	1% chance Depth	100% chance	10% chance	1% chance	1% chance Depth	100% chance	10% chance	1% chance	1% chance Depth
Lillian M Jacobs School	No	No	No	0	No	No	No	0	No	No	No	0
Gould Hall	No	No	No	0	No	No	No	0	No	No	No	0
Hull Police Dept	No	No	No	0	No	No	No	0	No	No	No	0
Hull Fire Dept- Green Hill	No	No	No	0	No	No	No	0	No	No	No	0
McTighe Manor	No	No	No	0	No	No	No	0	No	No	No	0
Hull Town Hall	No	No	No	0	No	No	No	0	No	No	No	0
Village Fire Station	No	No	No	0	No	No	No	0	No	No	No	0
Fuel Depot	No	No	No	0	No	No	No	0	No	No	No	0
Public Safety Dispatch Center	No	No	No	0	No	No	No	0	No	No	No	0
Hull Landfill	No	No	No	0	No	No	No	0	No	No	No	0
Hull Public Library	No	No	No	0	No	No	No	0	No	No	No	0
Allerton Hill Bluff	No	No	No	0	No	No	No	0	No	No	No	0
Hull Cemetery	No	No	No	0	No	No	No	0	No	No	No	0
Jacobs School Heliport	No	No	No	0	No	No	No	0	No	No	No	0
3 Water Tanks in Bunker	No	No	No	0	No	No	No	0	No	No	No	0
Communications Tower	No	No	No	0	No	No	No	0	No	No	No	0
Nantasket Hotel	No	No	No	0	No	No	No	0	No	No	No	0
St. Nicholas United Methodist	No	No	No	0	No	No	No	0	No	No	No	0

Waste Water Pump Station A	No	No	No	0	No	No	No	0	No	No	Yes	1.3
DCR Hdq., Fuel Station, Barracks	No	No	No	0	No	No	Yes	0.7	No	Yes	Yes	1.7
Drinking Water Booster Pump	No	No	No	0	No	No	Yes	0.9	No	Yes	Yes	1.7
Boy Scout Building	No	No	No	0	No	No	Yes	1.1	No	Yes	Yes	1.8
Nantascot Lodging	No	No	No	0	No	No	Yes	1.4	No	Yes	Yes	3.1
Hull High School	No	No	No	0	No	No	Yes	2.0	No	Yes	Yes	3.8
Hull Medical Facility	No	No	No	0	No	No	Yes	2.2	No	Yes	Yes	3.9
Sunset Bay Marina	No	No	No	0	No	No	Yes	2.2	No	Yes	Yes	4.0
Bermaken	No	Yes	Yes	0.2	No	Yes	Yes	0.5	No	Yes	Yes	2.2
Wellspring	No	No	Yes	0.2	No	Yes	Yes	1.5	No	Yes	Yes	3.3
Burgins Parking Lot Heliport	No	No	Yes	0.2	No	Yes	Yes	0.2	No	Yes	Yes	0.8
Cumberlands Farms	No	No	Yes	0.2	No	Yes	Yes	0.5	No	Yes	Yes	1.3
Nantascot Beach Lodging	No	Yes	Yes	0.2	No	Yes	Yes	1.7	No	Yes	Yes	3.4
Sandpiper	No	Yes	Yes	0.2	No	Yes	Yes	1.5	No	Yes	Yes	3.1
Water Pump	No	No	Yes	0.3	No	No	Yes	0.3	No	No	Yes	5.1
Nantasket Preschool	No	Yes	Yes	0.3	No	Yes	Yes	2.1	No	Yes	Yes	3.9
Hull Wind Mill 1	No	No	Yes	0.4	No	Yes	Yes	2.0	No	Yes	Yes	3.9
Neighborhood Housing	No	Yes	Yes	0.4	No	Yes	Yes	2.3	No	Yes	Yes	4.0
Knights of Columbus	No	No	Yes	0.6	No	Yes	Yes	1.9	No	Yes	Yes	3.7
Nantasket Pharmacy	No	No	Yes	0.6	No	Yes	Yes	1.6	No	Yes	Yes	3.4
North River Bus Company	No	No	Yes	0.6	No	Yes	Yes	2.1	No	Yes	Yes	3.9
Verizon Communications Tower	No	Yes	Yes	0.7	No	Yes	Yes	2.7	No	Yes	Yes	4.3
Roller Hockey Park Heliport	No	Yes	Yes	0.8	No	Yes	Yes	2.8	No	Yes	Yes	4.4
Tri Town Baptist Church	No	No	Yes	0.9	No	Yes	Yes	1.9	No	Yes	Yes	3.0
Hull Teen & Woman's Clinic	No	No	Yes	1.0	No	Yes	Yes	2.5	No	Yes	Yes	3.8
Hull Sewer Plant	No	Yes	Yes	1.0	No	Yes	Yes	2.7	No	Yes	Yes	4.4
Seven-Eleven	No	No	Yes	1.0	No	Yes	Yes	2.6	No	Yes	Yes	4.4
Hull Community Nursery School	No	Yes	Yes	1.1	No	Yes	Yes	2.7	No	Yes	Yes	4.4
L Street Playground Heliport	No	No	Yes	1.1	No	Yes	Yes	2.9	No	Yes	Yes	4.6
Hadassah Way Temple Complex	No	Yes	Yes	1.2	No	Yes	Yes	2.9	No	Yes	Yes	4.7

Newport Road Dike	No	Yes	Yes	1.2	No	Yes	Yes	1.4	No	Yes	Yes	1.7
Municipal Light Dep't.	No	No	Yes	1.2	No	Yes	Yes	2.3	No	Yes	Yes	3.3
Saint Anne's Church	No	Yes	Yes	1.2	No	Yes	Yes	3.0	No	Yes	Yes	4.7
Hull Fire Dept	No	Yes	Yes	1.2	No	Yes	Yes	3.0	No	Yes	Yes	4.8
DPW Barn	No	No	Yes	1.2	No	Yes	Yes	3.3	No	Yes	Yes	4.8
Daley and Wanzer	No	Yes	Yes	1.2	No	Yes	Yes	2.9	No	Yes	Yes	4.7
Hull Lifesaving Museum	No	No	Yes	1.3	No	Yes	Yes	3.5	No	Yes	Yes	5.8
Mariners Park Heliport	No	No	Yes	1.3	No	Yes	Yes	2.9	No	Yes	Yes	4.8
Anne Scully's Senior Center	No	Yes	Yes	1.3	No	Yes	Yes	3.1	No	Yes	Yes	4.8
Cumberland Farms	No	Yes	Yes	1.4	No	Yes	Yes	3.1	No	Yes	Yes	4.9
Kenberma Play Ground Heliport	No	No	Yes	1.4	No	Yes	Yes	3.3	No	Yes	Yes	5.0
DPW Salt Shed	No	No	Yes	1.5	No	Yes	Yes	3.6	No	Yes	Yes	5.2
Allerton Post Office	No	Yes	Yes	1.6	No	Yes	Yes	3.3	No	Yes	Yes	5.1
Waste Water Pump Station 6	No	Yes	Yes	1.6	No	Yes	Yes	3.4	No	Yes	Yes	5.2
Beach Avenue Barrier Dunes	No	Yes	Yes	1.7	No	Yes	Yes	2.1	No	Yes	Yes	2.7
Communications Shed	No	Yes	Yes	1.7	No	Yes	Yes	3.7	No	Yes	Yes	5.4
Waste Water Pump Station 3	No	No	Yes	1.7	No	Yes	Yes	3.8	No	Yes	Yes	5.4
US Post Office	No	No	Yes	1.8	No	Yes	Yes	3.6	No	Yes	Yes	5.3
Hull Public Housing	No	Yes	Yes	2.0	No	Yes	Yes	3.5	No	Yes	Yes	5.3
Storm Water Pump Station	No	No	Yes	2.7	No	Yes	Yes	3.6	No	Yes	Yes	4.4
Pt. Allerton Coast Guard Station	No	Yes	Yes	2.8	No	Yes	Yes	4.1	No	Yes	Yes	6.0
Hull Memorial School	No	Yes	Yes	2.9	No	Yes	Yes	4.7	No	Yes	Yes	6.4
Hull Wind Mill 2	No	Yes	Yes	2.9	No	Yes	Yes	5.0	No	Yes	Yes	6.6
Emergency Operations Center	No	Yes	Yes	3.0	No	Yes	Yes	4.8	No	Yes	Yes	6.6
Memorial School Shelter	No	Yes	Yes	3.1	No	Yes	Yes	4.9	No	Yes	Yes	6.7
Village Grocery Store	No	No	Yes	3.2	No	Yes	Yes	5.0	No	Yes	Yes	6.7
Dust Bowl Heliport	No	Yes	Yes	3.7	No	Yes	Yes	5.4	No	Yes	Yes	7.2
Storm Water Pump Station	No	Yes	Yes	4.2	No	Yes	Yes	6.0	No	Yes	Yes	7.7
Waste Water Pump Station 1	No	Yes	Yes	4.6	No	Yes	Yes	6.3	No	Yes	Yes	8.0
WBZ TV Towers	No	No	Yes	4.7	No	Yes	Yes	6.6	No	Yes	Yes	8.3

Waste Water Pump Station 5	No	No	Yes	5.4	No	Yes	Yes	7.2	No	Yes	Yes	8.9
Gas Line	No	Yes	Yes	6.7	No	Yes	Yes	7.9	No	Yes	Yes	8.8
Waste Water Pump Station 9	No	Yes	Yes	7.5	No	Yes	Yes	9.2	No	Yes	Yes	11.0
Waste Water Pump Station 4	No	Yes	Yes	8.2	No	Yes	Yes	9.9	No	Yes	Yes	11.7
Life Saving Boat House	No	Yes	Yes	9.2	No	Yes	Yes	11.0	No	Yes	Yes	12.8

Table 4: Impacts to Critical Infrastructure