Assessing New Jersey's Exposure to Sea-Level Rise and Coastal Storms: A Companion Report to the New Jersey Climate Adaptation Alliance Science and Technical Advisory Panel Report

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EXECUTIVE SUMMARY

Undertaken by Rutgers University on behalf of the New Jersey Climate Adaptation Alliance (NJCAA) Advisory Committee, this Companion Report to *Assessing New Jersey's Exposure to Sea-Level Rise and Coastal Storms: Report of the NJ Climate Adaptation Alliance Science and Technical Advisory Panel* (STAP Report) provides context for New Jersey citizens, practitioners and decision makers to better understand: how New Jersey municipal decision makers and municipal professionals consider the use of coastal hazard data; how climate change impacts from sea-level rise and changes in coastal storms are being addressed in some other areas of the Northeast; and the degree to which coastal climate change impacts are currently being addressed in New Jersey.

The STAP Report considered three key issues of import to New Jersey's coastal communities: projections for sea-level rise in coastal areas of New Jersey; factors to consider when assessing vulnerability to coastal hazards; and conditions to use when assessing exposure. Neighboring jurisdictions in the Northeastern United States, such as the City of Boston, State of New York, and State of Rhode Island have identified projections of sea-level rise for use in planning, assessment, and in some instances, regulatory purposes. The STAP projections are consistent with Federal projections for New Jersey and utilize an approach similar to that followed by the City of Boston; the data used by the STAP (which included projections for The Battery in New York City) are also consistent with sea-level rise projections for New York City used by the State of New York.

Engagements with municipal decision makers and professionals affirm that there is a greater recognition regarding sea-level rise impacts to New Jersey coastal areas as a result of increased awareness following Hurricane Sandy and a greater support for regulatory measures, such as additional freeboard height above the minimum State standard, to protect people and property. Municipal decision makers and professionals desire a more holistic approach to resilience guided by a statewide vision for planning and implementation. They also have concerns that there may be a false sense of security regarding long-term resiliency among residents given post-Sandy emphasis on home elevations, fearing residents will avoid evacuating during storm events because they feel secure in their elevated homes, while not considering the roadways, infrastructure and critical facilities that remain exposed and non-resilient. When asked about sea-level rise data in municipal decision making, these decision makers and professionals noted that sea-level rise planning numbers need to be consistent within and between State agencies. In addition, local officials suggest that integrating sea-level rise projections with local knowledge about historic flooding can inform decision making. They suggest using historic flood data as a reference point to communicating current and future impacts.

Interviews with State officials and review of publicly available information found that climate change impacts on coastal flooding are not uniformly addressed in New Jersey; such impacts are expressly addressed when required as a contingency of Federal funding or where mandated by Federal programs, but they are not accounted for in current State regulatory schema. The Federal Flood Risk Management Standard (FFRMS) expressly considers increases in flood risk expected to result from climate change for federally funded projects. Although the Climate Informed Science Approach is the preferred approach for determining flood elevation and the corresponding floodplain, under the FFRMS, the Freeboard Value Approach is 1 foot higher than current New Jersey State standards and similar to the more restrictive ordinances implemented by some New Jersey municipalities. New Jersey's coastal municipalities with higher elevation standards have authorized such standards because these provide discounts on flood insurance rates; reflect flooding conditions that are observed on the ground; or, in at least one case, because sea-level rise is identified as a concern. Current Federal, State and local regulations address future new construction or substantial improvement to existing structures. Existing structures in coastal areas that have not been elevated to account for sea-level rise and changes in coastal flooding or existing structures located in coastal communities that have not implemented other flood damage reduction actions to account for sea-level rise and changes in coastal flooding (such as those incentivized through the Community Rating System (CRS)), may continue to be vulnerable to changes in coastal storms and sea-level rise.

Although the STAP Report does not specify a level of freeboard or minimum elevation requirement, it identifies the current state of science with respect to sea-level rise and coastal storms specific to New Jersey. The STAP framework illustrates a method to apply this science, including the sea-level rise projections to assess future coastal flood exposure across the State within the context of historic flood events as well as within the context of the 100-year flood. This represents a well-recognized approach in floodplain management and is familiar to decision makers and residents. This approach is also consistent with the FFRMS Climate Informed Science Approach in that it examines how sea-level rise will influence extreme water level events and suggests scenarios appropriate to the particular risk inherent in the types of projects under consideration.

INTRODUCTION

The New Jersey Climate Adaptation Alliance is a network of policymakers, public and private sector practitioners, academics, nongovernmental organizations, and business leaders designed to build climate change preparedness capacity in New Jersey. Through an extensive stakeholder engagement process, the Alliance identified a series of policy recommendations related to climate change preparedness for New Jersey (NJCAA, 2014). Consistent with these recommendations, the Alliance Advisory Committee requested Rutgers University convene a Science and Technical Advisory Panel (STAP) from Fall 2015 to Spring 2016 to identify planning options for practitioners to enhance the resilience of New Jersey's people, places, and assets to regional sea-level rise (SLR) and coastal storms and the resulting flood risk. As such, the STAP issued *Assessing New Jersey's Exposure to Sea-Level Rise and Coastal Storms: Report of the New Jersey Climate Adaptation Alliance Science and Technical Advisory Panel* (Kopp et al., 2016).

Preparedness for coastal flooding involves many actors including municipal, state and federal decision makers; leaders and practitioners from a range of public and private sectors; scientists; and residents and businesses in coastal communities. Thus, in addition to the STAP Report, the Alliance Advisory Committee also suggested the need for this multi-faceted Companion Report to provided context for New Jersey citizens, practitioners and decision makers to better understand: how New Jersey municipal decision makers and municipal professionals consider the use of coastal hazard data; how climate change impacts from sea-level rise and changes in coastal storms are being addressed in some other areas of the Northeast; and the degree to which coastal climate change impacts are now being addressed in New Jersey. Each of these Companion Report objectives is discussed in the sections that follow concluding with a synthesis of findings and ways in which the STAP Report can inform coastal resiliency practice in New Jersey. More in-depth discussion and analyses can also be found in this Companion Report's Appendices.

Before we address the Companion Report objectives, it is helpful for the reader to note that a primary focus of the STAP effort has been on preparedness to plan for future coastal flooding. Therefore, the reader should understand that this Companion Report is intended to provide context that distinguishes between risk from current flooding and future risk from climate change impacts of sea-level rise and changes in coastal storms. Existing buildings, structures and assets that are at risk currently for coastal flooding may be at increased risk from sea-level rise and changes in coastal storms depending upon a number of factors including their lifetime, location and flood protection measures (such as flood-resistant construction and design materials, break away walls, and flood vents to allow for entry and exit of flood waters). Buildings, structures, and other assets in coastal communities that have yet to be built or are in areas that may not be identified as at risk from current coastal flooding may be at risk if they are or planned to be located in areas that are vulnerable to future sea-level rise depending upon their lifetime, location and flood protection measures. It is also important for the reader to understand that municipal standards can exceed Federal and State standards as they do in some places in New Jersey. Finally, the geographic focus of this report is on coastal areas of New Jersey that are at risk from increase in flooding due to anticipated sea-level rise and changes in coastal storms; coastal areas in this context refer to areas with tidally flowed waters. For a first approximation of areas that may benefit from the STAP Report, see NJDEP list of municipalities with tidally flowed waters at http://www.nj.gov/dep/cmp/access/mpamunis.htm. [1]

STAP REPORT RECAP

Readers are encouraged to read the STAP Report in its entirety; however, to provide additional context for this Companion Report, a short recap is provided herein. As noted, the STAP was convened to help identify planning options for practitioners to enhance the resilience of New Jersey's people, places, and assets to regional sea-level rise (SLR), coastal storms, and the resulting flood risk. Table 1 represents the outcomes of the STAP process, summarized in *Assessing New Jersey's Exposure to Sea-Level Rise and Coastal Storms: Report of the New Jersey Climate Adaptation Alliance Science and Technical Advisory Panel* (Kopp et al., 2016).

Table 1: Projected SLR Estimates for New Jersey (ft.)

	Central Estimate	Likely Range	1-in-20 Chance	1-in-200 Chance	1-in-1000 Chance
Year	*50% probability SLR meets or exceeds…*	*67% probability SLR is between…*	*5% probability SLR meets or exceeds…*	*0.5% probability SLR meets or exceeds…*	*0.1% probability SLR meets or exceeds…*
2030	0.8 ft	0.6 – 1.0 ft	1.1 ft	1.3 ft	1.5 ft
2050	1.4 ft	1.0 – 1.8 ft	2.0 ft	2.4 ft	2.8 ft
2100 Low emissions	2.3 ft	1.7 – 3.1 ft	3.8 ft	5.9 ft	8.3 ft
2100 High emissions	3.4 ft	2.4 – 4.5 ft	5.3 ft	7.2 ft	10 ft

Estimates are based on Kopp et al. (2014). Columns correspond to different projection probabilities. For example, the 'Likely Range' column corresponds to the range between the 17th and 83rd percentile; consistent with the terms used by the Intergovernmental Panel on Climate Change (Mastrandrea et al., 2010). All values are with respect to a 1991-2009 baseline. Note that these results represent a single way of estimating the probability of different levels of SLR; alternative methods may yield higher or lower estimates of the probability of high-end outcomes.

[1] Where related terms are expressly defined for programmatic purposes (i.e., coastal communities under the NJ state program office coordinating the CRS program) or for regulatory purposes (tidal flood hazard area under N.J.A.C. 7:13) such terms are expressly qualified in this Companion Report.

Among the issues considered by the STAP, three key issues of import to New Jersey's coastal communities include:

- Projections for sea-level rise in coastal areas of New Jersey.
- Factors to consider when assessing vulnerability to coastal hazards.
- Conditions to use when assessing exposure.

Projections for Sea-Level Rise in Coastal Areas of New Jersey

Based on the STAP, the future effects of sea-level rise in coastal areas in New Jersey are summarized with respect to a 1991–2009 baseline (equivalently, a year 2000 baseline) mean sea level datum, as the following:

- It is likely[2] that coastal areas of New Jersey will experience sea-level rise between 1.0 and 1.8 feet prior to 2050, regardless of future greenhouse gas emissions. Under a worst-case scenario, these communities could see as much as 2.8 feet of sea-level rise by 2050 (See Table 1).

- Sea-level rise after 2050 increasingly depends upon the evolution of future global greenhouse gas emissions. The STAP used the Representative Concentration Pathways (RCPs) to represent possible high-greenhouse-gas-emission and low-greenhouse-gas-emission futures (Moss et al., 2010; van Vuuren et al., 2011). The high-emissions scenario is based on RCP 8.5 and represents a world in which there are few efforts to limit greenhouse gas emissions. The low-emissions scenario is based on RCP 2.6 and represents a world in which future greenhouse emissions levels are greatly reduced to provide a good chance of meeting the international goal of avoiding global mean temperatures more than 2°C (3.6° F) above pre-industrial levels.

    - Under the **high-emissions scenario**, it is likely that coastal areas of New Jersey will experience between 2.4 and 4.5 feet of sea-level rise by 2100.

    - Under the **low-emissions scenario**, it is likely that coastal areas of New Jersey will experience between 1.7 and 3.1 feet of sea-level rise by 2100.

    - A **worst case** sea-level rise of 10 feet of sea-level rise in coastal areas of New Jersey is physically possible (See Table 1).

- Across scenarios, the likely range of sea-level rise in 2100 spans from 1.7 feet to 4.5 feet. However, regardless of scenario, there is at least a 1-in-20 chance of sea-level rise exceeding 1.7 feet before 2050 (See Table 1).

- Higher sea levels will increase the baseline for flooding from coastal storms and, therefore, the impacts of coastal storms. STAP members concluded that there was no clear basis for deviating from the Intergovernmental Panel on Climate Change (IPCC)'s conclusions when projecting changes in future storms to serve as planning guidance for New Jersey. The IPCC concluded the global frequency of tropical cyclones (i.e., hurricanes) is not projected to increase, while maximum wind speeds will likely increase. Precipitation intensity during tropical cyclones is

[2] In the sense used by the STAP, the 'likely' range is estimated to have a 2-in-3 chance of matching the realized future; there is an estimated 1-in-6 chance of higher sea-level rise and an estimated 1-in-6 chance of lower sea-level rise.

likely to increase. The global frequency of extratropical cyclones (i.e., nor'easters) is not likely to change substantially; however, precipitation associated with winter storms is likely to increase (Stocker et al. 2013). Changes to extratropical storm tracks in the North Atlantic are possible but have not been reliably established. Changes in the frequency, intensity and tracks of storms is an area of active research and the STAP concluded there is no definitive consensus regarding such changes.

Factors to Consider When Assessing Vulnerability to Coastal Hazards

Assessing the exposure of people, places and assets in New Jersey requires practitioners to consider several factors:

- The rate at which sea level rises is particularly important to consider, as natural assets such as salt marshes (which provide critical functions including flood protection and fisheries habitat) may not be able to keep pace with sea-level rise.

- Some places and assets are inherently more vulnerable by their nature. For example, a pier designed to handle continuous exposure to water and storms may be less vulnerable to flooding than a road not designed to endure permanent inundation.

- Vulnerabilities and consequences can be economic, environmental or social. Damages to some places or assets can be more consequential than to others. For example, damage to a vulnerable road may not be highly consequential if it only serves as access to a recreational facility. On the other hand, a pier may serve as a critical link for distributing goods to the nation, and thus even minor damages might have comparatively higher consequences.

Conditions to Use When Assessing Exposure

After considering the vulnerabilities of assets and the consequences of damage to those assets, what conditions should practitioners evaluate to assess exposure?[3]

- Use two projections, with one being a sea-level rise estimate in the likely range and one being a high-end estimate, in order to assess exposure to a range of future flood conditions.

- Incorporate projected sea-level rise estimates to develop future water levels by adding the estimates to current or historic water levels that represent at least three flooding conditions: permanent inundation, tidal flooding, and coastal storms. Options for determining the water levels associated with future events include NOAA's Annual Exceedance Probability (AEP) at a nearby tide gauge, FEMA's Base Flood Elevation (BFE)[4], or in reference to an historic event storm tide (e.g., Hurricane Sandy, 1992 Nor'easter).

The STAP also highlighted an alternative, more sophisticated method (Buchanan et al., 2016) that uses the full projected probability distribution of sea-level rise and accounts for the flood-risk tolerance and time horizons of different projects.

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[3] See NOAA's "What Will Adaptation Cost" for an example step-by-step process guide.https://coast.noaa.gov/data/digitalcoast/pdf/adaptation-report.pdf .

4 The elevation to which floodwater is anticipated to rise during the base flood which is the flood having a one percent chance of being equaled or exceeded in any given year. This is also referred to as the "100-year flood" (FEMA, 2016a; FEMA, 2016e).

The STAP has provided illustrative examples of different methods for applying the sea-level rise projections in the STAP report. The examples reflect the concepts described above for incorporating sea-level rise into flood exposure assessments for people, places, and assets in New Jersey using Atlantic City, NJ for illustrative purposes.

MUNICIPAL CONSIDERATIONS IN THE USE OF COASTAL HAZARD DATA IN NEW JERSEY

A series of engagements with municipal decision makers and municipal professionals was undertaken in Fall 2015 to understand how coastal hazard data are currently used at the local level, how these data may or may not influence local decisions and to ultimately inform how the work of the STAP can be informative for municipalities. These engagements included a Resilience Professionals Retreat, a focus group interview with members of the Atlantic and Cape May County Coastal Coalition, and one-on-one interviews with municipal officials in communities where municipal freeboard[5] requirements exceed State requirements. Additional information was gathered from complementary efforts including a facilitated dialogue with representatives from municipalities that received resilience planning support following Hurricane Sandy and phone interviews with users of web-based mapping tools to understand how such tools inform local decision making. *Appendix A Municipal Use of Coastal Hazard Data and Tools* of this Companion Report provides a complete and in-depth report on these engagements that are summarized below.

Observations from the suite of engagements include:

- greater recognition of the impacts of sea-level rise as a result of increased awareness following Hurricane Sandy (October 2012);

- greater support for regulatory measures such as additional freeboard above the minimum State standard, to protect people and property;

- an acute need for disaster readiness, response, and recovery training and professional requirements; and

- a need for increased resilience planning knowledge among local officials with decision making authority.

Municipal representatives cited a desire for more education and information among residents and professionals and perceived a greater interest for historic flooding information among home buyers. Municipal representatives and resilience professionals acknowledged increased dialogue in communities about resilience, yet noted the need for a more holistic approach to resilience guided by a statewide vision for planning and implementation in New Jersey. Identified was the diversity of views among different professionals and decision makers in terms of what resilience means and whether municipalities really are more resilient or if they just think are, thus generating a concern among some municipal professionals that there may be a false sense of security regarding long-term resiliency among residents as a result of post-Sandy emphasis on home elevations. In more than one of these engagements, municipal decision makers and professionals expressed the fear that residents will avoid

[5] Freeboard is a factor of safety usually expressed in feet above a flood level for purposes of floodplain management and is intended to compensate for the many unknown factors that could contribute to flood heights greater than the height calculated for a selected size flood and floodway conditions, such as wave action, bridge openings, and the hydrological effect of urbanization of the watershed (FEMA, 2016).

evacuating during storm events, feeling secure in their elevated homes, while not considering the roadways, infrastructure and critical facilities that remain exposed and non-resilient.

When asked about the use of sea-level rise data in municipal decision making, officials noted multiple sources of data can be redundant, confusing and maybe conflicting and that planning numbers need to be consistent within and between State agencies. In addition to having climate data that are consistent, local officials indicated a need to integrate sea-level rise projections with local knowledge about historic floods to better inform decision making. These local officials suggested the need for local context to relate what sea-level rise planning numbers mean for their communities. There was the suggestion that the State should decide on sea-level rise projection consensus for the municipalities to ensure consistency. Proactively planning for sea-level rise varies by community and approach with some municipalities incorporating sea-level rise (e.g., using inundation modeling for infrastructure projects), some thinking about the future, while others function on a short-term (4 to 5 year) planning timeline. Respondents noted that statewide sea-level rise guidance would be most effective if set as a consistent standard statewide to ensure consistency among agencies and different levels of government jurisdiction. Some respondents noted that statewide consistency is more important than the actual numbers.

The use of historic flood data as a reference point to current conditions, along with future sea-level rise conditions and changing land use patterns, was suggested as a way of communicating current and future impacts. Framing issues with respect to the cost of sea-level rise impacts compared to the benefits of adaptation actions can assist local decision makers in communicating the need for projects to address increased flooding into the future. The concept of a “Long-Term State Resilience Plan” was a theme raised in these engagements to address risk and vulnerability to sea-level rise, as well as other climate change impacts such as heat and riverine flooding.

EXAMPLES OF HOW COASTAL HAZARDS FROM CLIMATE CHANGE ARE BEING ADDRESSSED BY OTHER AREAS IN THE NORTHEAST

Neighboring jurisdictions in the Northeastern United States, such as the City of Boston, the State of New York and the State of Rhode Island, have identified projections of sea-level rise for use in planning, assessment and in some instances, regulatory purposes through statutory (New York), Executive Order (Boston) or rulemaking (Rhode Island) mechanisms (BRAG, 2016; 6 NYCRR Part 490; RICRMC, 2016). Rhode Island’s Coastal Resource Management Agency utilized Federal projections by the National Oceanic and Atmospheric Administration (NOAA) tailored to the tide gage at Newport, Rhode Island (RICRMC, 2016). Similar to the New Jersey STAP, the City of Boston’s experts closely followed the approach of Kopp et al. (2014), although they incorporated different projections about the future of the Antarctic ice sheet (DeConto and Pollard, 2016). The STAP projections are consistent with Federal projections (both Parris et al., 2012 and U.S. Army Corps of Engineers, 2016) for New Jersey (see Kopp et al., 2016). In addition, the published findings of Kopp et al. (2014) utilized by the STAP included sea-level rise projections for The Battery in New York City, which are consistent with the projections for New York City codified by New York State (Kopp et al., 2016; 6 NYCRR Part 490). Figure 1 illustrates the relationship of the STAP projections for New Jersey with Federal projections for New Jersey (U.S. Army Corps of Engineers, 2016). It is important for practitioners to understand that they are able to use federal planning tools, or other available resources, to approximate the conclusions reached by the STAP. For example, a practitioner choosing to plan for SLR in 2050 under a high emissions scenario, could use the NOAA Intermediate High Estimate to approximate a value for the ‘likely range’ suggested by the STAP for New Jersey at that point in time (See Figure 1a).

Figure 1a: High Emissions [RCP 8.5] SLR Projections for New Jersey (Atlantic City) Compared to Federal SLR Projections

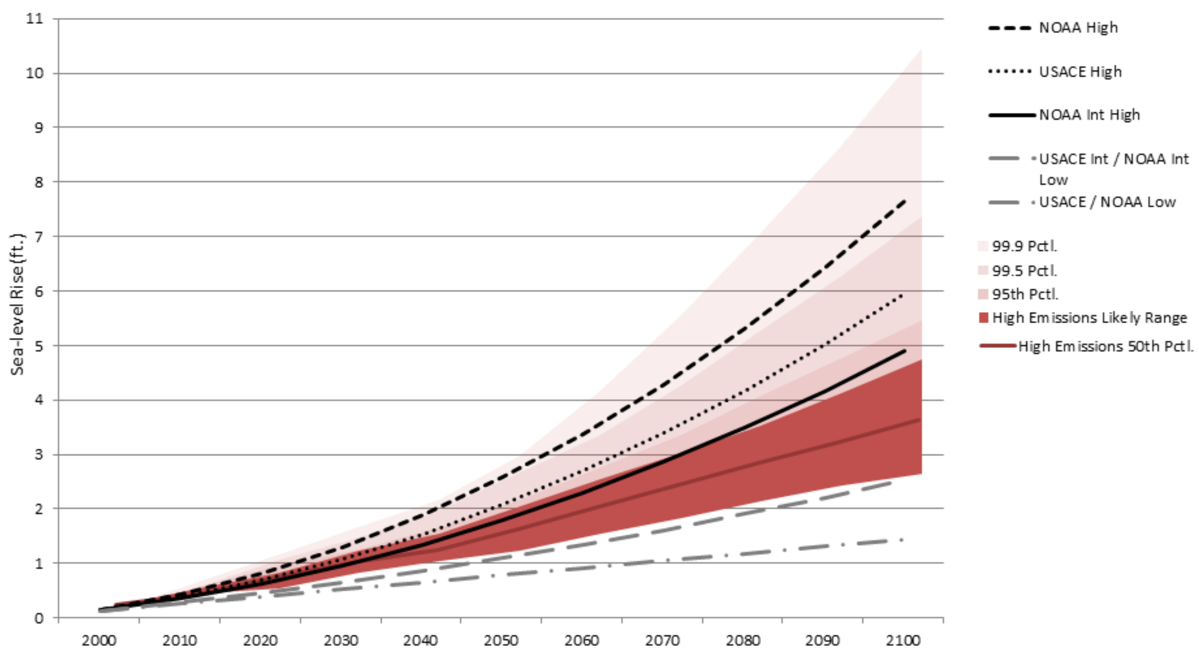
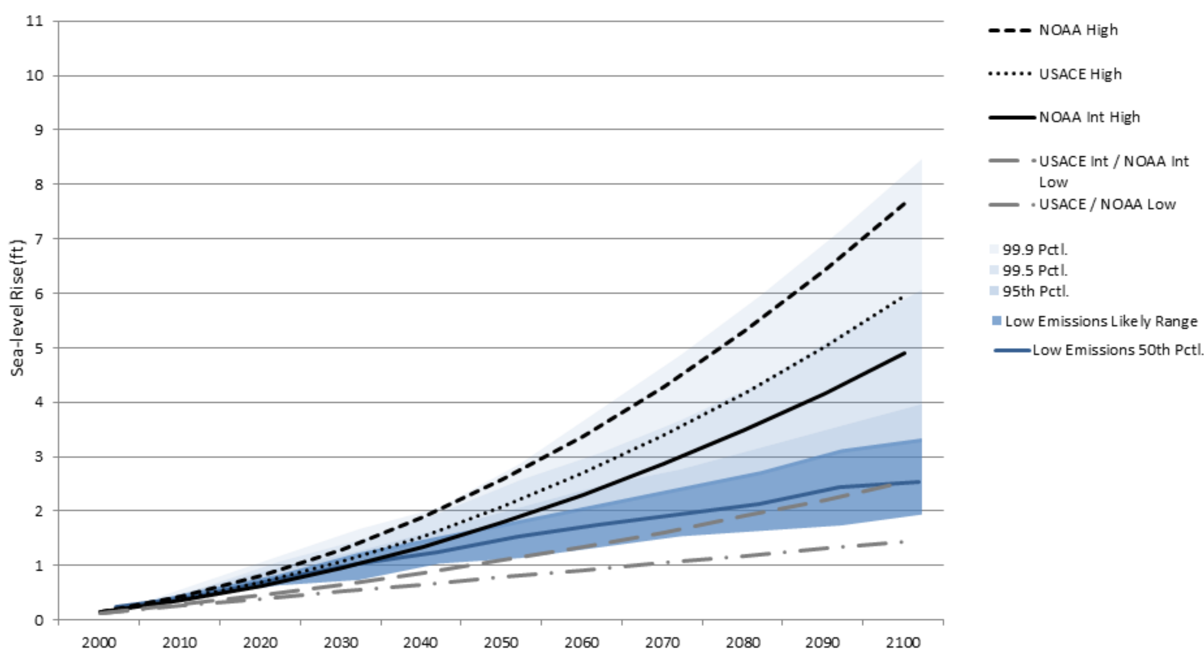


Figure 1b: Low Emissions [RCP 2.6] SLR Projections for New Jersey (Atlantic City) Compared to Federal SLR Projections



Figures 1a and 1b: SLR Projections for New Jersey (Atlantic City) Compared to Federal Projections: *Projections for high-emissions (red) and low-emissions scenarios (blue), based on (Kopp et al., 2014). Solid Lines = 50th percentile; Shaded Area = likely ranges (17th – 83rd percentile); 83rd – 95th percentile, 95th – 99.5th percentile, and 99.5th – 99.9th percentile. All sea levels are with respect to a 1991-2009 baseline. Note that these results represent a single way of estimating the probability of different levels of SLR; alternative methods may yield higher or lower estimates of the probability of high-end outcomes. Federal projections are based on data from the Sea-Level Change Curve Calculator (2015.46) available at http://www.corpsclimate.us/ccaceslcurves.cfm. Federal estimates are expressed* *in feet relative to Local Mean Sea Level for the year 2000 at the Atlantic City, NJ tide gauge using NOAA's regional rates.*

REGULATION AND PRACTICE IN ADDRESSING COASTAL FLOODING AND CLIMATE CHANGE IMPACTS IN NEW JERSEY

The objective of this section is to understand the degree to which coastal flooding, including coastal climate change related impacts such as sea-level rise or changes in coastal storms, are being addressed in New Jersey through Federal, State or municipal approaches. This section first provides a summary of coastal elevation standards and guidance applicable in New Jersey then describes in more detail Federal and State programs that address coastal flood hazards and coastal climate resiliency. Also provided are examples of some New Jersey coastal municipalities that have developed elevation ordinances that are more restrictive than State requirements. A discussion of some State of New Jersey projects and programs that consider sea-level rise and coastal flooding is also provided.

The information for these analyses came from publicly available documents as well as interviews and correspondence with New Jersey State officials. *Appendix B Regulation and Practice In Addressing Coastal Flooding And Climate Change Impacts In New Jersey* of this Companion Report provides a more in-depth report of the analyses that are summarized below.

Summary of Coastal Elevation Standards and Guidance Applicable in New Jersey

Table 2 provides a synthesis of coastal elevation standards and guidances applicable in New Jersey. Express consideration of climate impacts in coastal areas is addressed in Hurricane Sandy Federal Supplemental Funding, the Federal Flood Risk Management Standard (applicable to Federal actions such as funding construction or improvements in floodplains New Jersey) and at the municipal level (one example) in New Jersey. These standards and guidances are discussed in greater detail in the sections that follow which address programs at the Federal, State and local level.

Federal and State Programs Addressing Coastal Flood Hazards

National Flood Insurance Program

The National Flood Insurance Program (NFIP) was created by Congress in 1968 and is administered by the Federal Emergency Management Agency (FEMA) to provide flood insurance as financial protection to homeowners, renters and business owners; to be eligible, a property must be located in a community that participates in the NFIP through the adoption and enforcement of municipal ordinances that meet or exceed FEMA requirements for flood risk reduction (FEMA, 2016c). In fact, the NFIP standards are minimum standards and floodplain management regulations adopted by a State or community which are more restrictive are encouraged (44 CFR 60.1). Private property owners that receive loans from an FDIC-supervised institution for properties located in a flood hazard area are required to purchase flood insurance (12 CFR 339.3). The elevation components for NFIP-participating communities center on new construction or substantial improvement of structures in the flood hazard area being at or above the base flood elevation (i.e., BFE) (44 C.F.R.1.60)[6].

[6] Substantial improvement means any reconstruction, rehabilitation, addition, or other improvement of a structure, the cost of which equals or exceeds 50 percent of the market value of the structure before the "start of construction" of the improvement (See FEMA, 2016d for complete definition).

Table 2. Coastal Flood Elevation Standards and Guidance Applicable in New Jersey [1]

Program	Applicability	Standard	Considers Climate Change Impacts (sea-level rise; coastal storm changes)
National Flood Insurance Program (44 C.F.R.1.60)	New construction or substantial improvement to structures in flood hazard area	> BFE [2] in Special Flood Hazard Area[3]	No
Hurricane Sandy Federal Supplemental Funding Program (HUD, 2013)	All Sandy-related residential, commercial, or infrastructure rebuilding projects supported by Federal Sandy Funding under PL 113-2 [4]	BFE +1 ft	Yes [5]
Executive Order 11988 and Executive Order 13690 (Federal Flood Risk Management Standard)	All Federal actions where federal funds are used to build, substantially improve, or repair substantially damaged structures and facilities in and around floodplains.	Agencies can use one of four approaches: (1) Climate Informed Science Approach (CISA) (2) Freeboard value Approach (FVA) Non-critical action: BFE+2 ft Critical action [6]: BFE +3ft (3) 0.2% or 500 year Flood Elevation Approach [7] (4) Elevation and flood hazard area that results from any other method identified in FFRMS updates.[8]	Yes
NJ Uniform Construction Code (N.J.A.C. 5:23-3.14)	New construction or substantial improvement or repair of substantial damage in flood hazard area (100-year flood zone) and coastal high hazard area (Coastal V or Coastal A Zones) [9]	BFE +1 ft for Residential dwellings BFE +2ft or 500 year flood elevation whichever is higher applies to two categories of buildings and structures: 1) Essential facilities [10] in Flood Hazard Areas and 2) Essential Facilities and Buildings and structures in which a large number of persons assemble (e.g., schools, theaters, museums) in Coastal High Hazard areas (Coastal V Zones) or Coastal A Zones. [11] In Coastal V or Coastal A Zones these standards apply to the minimum elevation of bottom of lowest horizontal structural member.	No
NJ Flood Hazard Area Control Act (N.J.A.C. 7:13)	Construction or development in flood hazard areas	BFE +1 ft in Tidal Flood Hazard Area for railroad and roadway construction or reconstruction and for construction of lowest floor of new habitable buildings or substantially improved buildings that were substantially damaged due to a natural disaster. [12]	No
Asset Management Guidance and Best Practices: Managing Utility Assets in NJ (NJDEP Undated)	Elements for new drinking water and wastewater projects seeking funds under NJ Environmental Infrastructure Finance Program.	Elevate critical structures and system components above FEMA 500-year flood elevation	Not expressly, mentions storms as a threat
Infrastructure Flood Protection Guidance and Best Practices (NJDEP Undated)	Elements for new drinking water and wastewater projects seeking funds under NJ Environmental Infrastructure Finance Program	Elevate critical infrastructure above the 500-year flood elevation.	Not expressly, mentions 100-year floodplain flood area design flood elevation as proven inadequate based on flooding from Hurricane Sandy and other recent storms.

Program	Applicability	Standard	Considers Climate Change Impacts Such as Sea-Level Rise or Changes in Coastal Storms
Stone Harbor, NJ Municipal Code Chapter 300, §300-14 (2013)	New residential construction and substantial improvement for flood hazard areas and coastal high hazard areas	BFE +2 ft (in coastal high hazard areas, i.e., V Zones, this construction shall be elevated on pilings or columns so that the lowest horizontal structural member of the lowest floor is at BFE +2 level)	No: done to conform with updated FEMA Flood Maps and to increase Community Rating System Points for discounts on flood insurance (The Gazette of Middle Township, 2013)
City of Hoboken, NJ Municipal Code Chapter 104, §104-17 (2013)	New construction and substantially improved residential and nonresidential structures	BFE +2 ft for essential facilities (fire, rescue, hospitals, etc.) in 100 year floodplain and Coastal A Zone (includes landward limit of areas affected by waves greater than 1.5 feet during the 1%, i.e., 100 year flood) BFE +3 ft for essential facilities in Coastal V Zone (Coastal high hazard areas-subject to high velocity wave action) BFE+2 ft for buildings with schools or day care centers (Coastal A or V Zone) BFE +2 ft for residential structures in Coastal V Zone BFE +2 ft for facilities that manufacture, process, handle, store or use or dispose of hazardous material in Flood Hazard Area (100 year flood plain) and Coastal A Zone. BFE +3 ft for facilities that manufacture, process, handle, store or use or dispose of hazardous material in Coastal V Zone	Yes: "Freeboard is a margin of safety to account for sea level rise, waves, debris, miscalculations, lack of data or other environmental changes"
Borough of Little Silver, NJ, Municipal Code Chapter 22, §22-5.2 (2013)	New construction or substantial improvement	>BFE +4 ft for lowest floor including basement of residential structures in flood hazard area BFE +3ft or as required by UCC whichever is more restrictive for all new construction or substantial improvement recommended elevated on pilings or columns so lowest horizontal member of lowest floor elevated to this level in Coastal High Hazard Area (V Zone)	No: values based on flooding observed by the municipal engineer in the Borough (Little Silver Planning Board, 2013)

[1] Note this includes some Municipal ordinances as examples where the standards are more stringent than State regulations.

[2] BFE or Base Flood Elevation is the elevation to which floodwater is anticipated to rise during the 100-year storm (FEMA, 2016a).

[3] Special Flood Hazard Area is the area that will be inundated by the flood event having a 1-percent chance of being equaled or exceeded in any given year (commonly referred to as the 100-year storm) (FEMA, 2016c).

[4] Projects under Housing and Urban Development Community Development Block Grant; Health and Human Services Social Services Block Grants and Head Start; FEMA Hazard Mitigation Grant Program and Public Assistance Program; EPA State Revolving Fund; DOT Federal Transit Administration Emergency Relief Program and some Federal Railroad and Federal Highway Administration Projects.

[5] HUD (2013) noted at the time this "Uniform Federal Risk Reduction Standard for Sandy Rebuilding Projects" was to take into account increased risk the region is facing from extreme weather events, sea level rise and other impacts of climate change and that this is the same standard that many communities in the region (including the entire State of New Jersey) had already adopted. This minimum elevation standard required structures to elevate their bottom first floor one foot higher than the most recent guidance by FEMA at that time. The Federal Flood Risk Management Standard Freeboard Value Approach (EO 11988 and EO 13690) described in the next row of this table has since identified a higher freeboard standard for Federally funded actions.

[6] A critical activity is any activity for which even slight chance of flooding would be too great in terms of impacts to human safety, health and welfare (WRC, 2015).

[7] Implementing guidelines caution this approach may not be appropriate in coastal areas unless local wave effects in addition to stillwater flooding included (WRC, 2015).

[8] FEMA (August 2016) proposed rules to implement FFRMS for its own projects or projects it funds for new construction, substantial improvement or to address substantial damage selecting the FVA to establish the floodplain for non-critical actions and for critical actions to use the FVA or CISA for critical actions, but only if the elevation established under the CISA is higher than the FVA (81 FR 57401).

[9] 'Substantial improvement' means any reconstruction, rehabilitation, addition, or other improvement of a structure, the cost of which equals or exceeds 50 percent of the market value of the structure before the 'start of construction' of the improvement. This term includes structures which have incurred 'substantial damage,' regardless of the actual repair work performed. 'Substantial damage' means damage of any origin sustained by a structure whereby the cost of restoring the structure to its before damaged condition would equal or exceed 50 percent of the market value of the structure before the damage occurred." This language also applies to same terms under NFIP. (N.J.A.C. 5:23-6.3A).

[10] Essential facilities include emergency response and recovery facilities, hospitals, health care facilities, power stations, etc.

[11] Coastal high hazard areas or V zones are areas where wave heights for the 1%-annual-chance flood are 3 feet or more (FEMA, 2015b). Coastal A zones are defined by FEMA as portions of the 1%-annual-chance flood zone landward of the V Zone where wave heights are less than 3 feet (FEMA, 2015b); however, in the context of this UCC standard Coastal A Zones are treated like coastal high hazard areas in areas where wave action is in excess of 1.5 feet or if the community has designated a Coastal A zone (ASCE, 2015).

[12] A June 2016, NJDEP rule proposal would require the standard apply to the lowest horizontal structural member for new habitable buildings in Coastal A or V Zones to be consistent with NJ UCC rules as well as would prohibit multi-residential buildings from being constructed in the V Zone (N.J.R. 1014(a))

Federal Flood Risk Management Standard

To improve national resilience to current and future flood risks, including increases in flood risk expected to result from climate change, in January 2015 the President reissued Executive Order (EO) 11988, Floodplain Management (42 FR 26951), and amended some of its provisions via EO 13690 (80 FR 6425), Establishing a Federal Flood Risk Management Standard (FFRMS) and a Process for Further Soliciting and Considering Stakeholder Input. The FFRMS, which builds on the Federal floodplain management framework in place since issuance of the original EO 11988 in 1977, requires all future federal investments in and affecting floodplains to meet the level of flood resilience established by the Standard. Following the cabinet-level Water Resource Council's issuance of interagency implementing guidelines in October 2015 (WRC, 2015), Federal agencies are working to incorporate the new requirements into applicable policies, regulations, and programs.

EO 11988 applies to all Federal actions[7] in or affecting floodplains and as outlined in EO 11988 and the EO 11988 / EO 13690 implementing guidelines, agencies must first consider alternatives to siting a project in a floodplain and use natural systems, ecosystem processes and nature-based approaches in the action, where possible. If none of the alternatives outside of the floodplain are practicable, agencies must then seek to avoid adverse effects of the action and minimize harm.

The most significant policy change to EO 11988 made by EO 13690 was the shift away from basing application of EO 11988 on use of the base (1-percent-annual-chance or 100-year) flood and corresponding horizontal floodplain, which solely consider historical flood events, to using the so-called "FFRMS flood elevation and floodplain," which are intended to account for both current and future flood risks. The requirement to determine and apply the FFRMS flood elevation and corresponding floodplain applies only to the subset of Federal actions that are Federally funded projects, that is, where Federal funds are used to build, substantially improve, or repair substantially damaged structures and facilities in and around floodplains (WRC, 2015).

There are four approaches for determining the FFRMS flood elevation and corresponding floodplain applicable to Federally funded projects:

- Climate-Informed Science Approach (CISA) – The elevation and flood hazard area that result from using the best-available, actionable hydrologic and hydraulic data and methods that integrate current and future changes in flooding based on climate science.

- Freeboard Value Approach (FVA) - Determined by adding 2 feet to the base flood elevation (BFE, or 100-year flood elevation) to determine the vertical flood elevation and corresponding horizontal floodplain for non-critical actions, or adding 3 feet to the BFE for critical actions[8].

- 0.2-Percent-Annual-Chance Flood Approach (0.2PFA) - The area subject to flooding by the 0.2-percent-annual-chance (500-year) flood. The implementing guidelines (WRC, 2015) caution that using this method may not be appropriate in coastal areas unless the agency has determined

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[7] A Federal action is any activity including acquiring, managing, and disposing of Federal lands and facilities; providing Federally undertaken, financed or assisted construction and improvements; and conducting Federal activities and programs affecting land use such as water and related land use resource planning, regulating, and licensing activities (80 FR 6425).

[8] A critical action is any activity for which even a slight chance of flooding would be too great in terms of impacts to human safety, health and welfare (WRC, 2015).

that the 500-year data to be applied include local wave effects (scour and erosion, wave heights, wave run-up, and overtopping) in addition to stillwater (surge) flooding.

- The elevation and flood hazard area that results from using any other method identified in an update of the FFRMS (WRC, 2015).

The Water Resources Council notes that CISA is the preferred approach when data to support it are available (WRC, 2015). [9]

Federal Hurricane Sandy Funding

The FFRMS builds upon recommendations of both the Hurricane Sandy Rebuilding Task Force, which noted in April 2013 that all projects funded with Federal Sandy Supplemental Funding (Public Law 113-2) should meet a consistent flood risk reduction standard and the Hurricane Sandy Rebuilding Strategy, which recommended the U.S. government create a national minimum flood risk reduction standard taking into account data on current and future flood risk, including the increased risk the region is facing from extreme weather events, sea-level rise and other impacts of climate change for federally-funded projects (HUD, 2013; Brown, 2014).

Thus, Sandy-related building projects supported by Federal funding are required to meet a minimum uniform standard (e.g., elevating structures 1 foot above base flood elevation using best available FEMA data or hardening structures that cannot be elevated in some circumstances). The Federal government encouraged State and local governments to review local conditions and, where appropriate, build to an even higher standard where they are planning critical infrastructure projects and/or where future conditions indicate higher risk (HUD, 2013).

New Jersey Uniform Construction Code

The International Building Code, which references the American Society of Civil Engineers (ASCE) flood resistant design criteria for the design and construction of buildings in flood hazard areas has been adopted in the State of New Jersey's Uniform Construction Code (N.J.A.C. 5:23-3.14). New Jersey has also adopted the International Residential Code which addresses the design and construction of one- and two-family dwellings and townhouses (N.J.A.C.5:23-3.21). Thus, buildings, structures and dwellings proposed for construction within the flood hazard area (100-year flood zone) in New Jersey that are subject to the UCC, have to meet the applicable reference standard. In general, these include a minimum elevation requirement of 1-foot of freeboard above the base flood elevation (also referred to as BFE)[10] for residential dwellings; for essential facilities (e.g., emergency response and recovery facilities, hospitals, health care facilities, power stations, etc.) the elevation requirement is 2-foot of

[9] In August 2016, one Federal agency, FEMA, proposed rules to incorporate the FFRMS and establish the floodplain using the FVA approach for non-critical actions and for critical actions to use the FVA floodplain or the CISA approach but only if the elevation established under the CISA is higher than that under the FVA approach. This proposal applies to FEMA actions where FEMA directly builds a new facility for its own operations as well as actions that a non-Federal entity takes using Federal funding (such as a State or local government building using Federal grant funds) (FR 57401). FEMA cited a number of reasons for taking this hybrid approach to implementing the FFRMS. One reason FEMA cited relates to the numerous published reports and tools available to provide scenario-based projections of sea-level rise in coastal floodplains but FEMA pointed out the lack of such approaches to account for the uncertainties with respect to projected future precipitation and associated flooding in riverine floodplains. FEMA expects that as agencies implement the FFRMS, more data will become available to support incorporation of broader-based inland and riverine application of the FFRMS (81 FR 57401). For actions that do not meet the definition of FEMA Federally funded project, FEMA will continue to set the floodplain as the area subject to a one-percent or greater chance of flooding in any given year (or are subject to 0.2 percent annual chance of flooding any given year for critical actions). A “critical action” is any activity for which even a slight chance of flooding would be too great (81 FR 57401).

[10] ASCE uses Design Flood Elevation to acknowledge that some communities adopt flood hazard maps that depict flood hazard areas in addition to the Special Flood Hazard Areas on FEMA's Flood Insurance Rate Maps (ASCE, 2015).

freeboard above the BFE or elevation to the 500-year flood elevation, whichever is higher (ASCE, 2015; NJDCA, 2013). In coastal high hazard areas (V Zones) or Coastal A zones[11], the standard of 2-foot of freeboard above the BFE or elevation to the 500-year flood elevation (whichever is higher) also applies to buildings where a large number of persons assemble such as theatres, schools, museums (ASCE, 2015; NJDCA, 2013). The UCC requirements apply to new construction and to substantial improvement or repair of substantial damage[12] to an existing building (N.J.A.C. 5:23-6A).

New Jersey Flood Hazard Area Control Act

The State of New Jersey also has freeboard requirements for construction or development in flood hazard areas pursuant to the Flood Hazard Area Control Act (N.J.S.A. 58:16A-50 et seq.). In flood hazard areas, railroads and roadways must be constructed or reconstructed at least 1 foot above the Design Flood Elevation (DFE) which in tidal areas is equivalent to the FEMA BFE (based on the 100-year elevation) (N.J.A.C. 7:13-12.6). The lowest floor of new habitable buildings or substantially improved buildings that were substantially damaged due to a natural disaster must be constructed at least 1 foot above the DFE (N.J.A.C. 7:13-12.5). Addressing sea-level rise is not a stated intent of the New Jersey freeboard standards; the design flood used in NJDEP's FHACA regulations (which in non-tidal areas is larger than the 100-year floodplain mapped by FEMA), was established in 1974 to account for the fact that development and stormwater runoff can and does increase fluvial (i.e., non-tidal flooding) (Mazzei, 2016). On June 20, 2016, the New Jersey Department of Environmental Protection (NJDEP) proposed new rules (still pending as of this writing) to address inconsistencies existing between the FHACA rules and the UCC freeboard requirements related to the location of the bottom of the lowest horizontal structural member of new buildings within a V zone or Coastal A zone; i.e., it cannot be less than one foot above the flood hazard area design flood or lower than the elevation required by the UCC (48 N.J.R.1014(a)).

State of New Jersey Requirements With Respect To Coastal Climate Resiliency

Interviews were conducted with officials from three State of New Jersey agencies including the New Jersey Department of Community Affairs (NJDCA), NJ Environmental Infrastructure Trust (NJEIT), and the New Jersey Department of Transportation (NJDOT) to ascertain how coastal climate change impacts were being addressed by the State of New Jersey. Review of publicly available documents and additional correspondence with officials of the Passaic Valley Sewerage Commission provided supplemental information.

In general, these State programs adhere to Federal requirements (through regulation or as a condition of receiving Federal funds) or national guidance developed by professional societies that establish design standards and incorporation of these into State programs, policies and regulations with information or data relevant to New Jersey, as appropriate. NJDOT incorporates American Association of State and Highway Transportation Officials (AASHTO) design standards into NJDOT projects. NJDOT also coordinates with other Federal (e.g., Federal Highway Administration, U.S. Army Corps of Engineers, U.S. Coast Guard, U.S. Geological Survey) and State agencies (NJDEP) depending upon the nature of a particular project.

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[11] Coastal high hazard areas or V zones are areas where wave heights for the 1%-annual-chance flood are 3 feet or more (FEMA, 2015b). Coastal A zones are defined by FEMA as portions of the 1%-annual-chance flood zone landward of the V Zone where wave heights are less than 3 feet (FEMA, 2015b); however, in the context of this UCC standard Coastal A Zones are treated like coastal high hazard areas in areas where wave action is in excess of 1.5 feet or if the community has designated a Coastal A zone (ASCE, 2015).

[12] substantial improvement means any reconstruction, rehabilitation, addition, or other improvement of a structure, the cost of which equals or exceeds 50 percent of the preconstruction market value; substantial damage means damage of any origin sustained by a structure whereby the cost of restoring the structure to its pre-damaged condition is equal or exceeds 50 percent of the market value of the structure before the damage occurred."

As noted previously, NJDCA also relies on professional organizations and scientific and technical experts at the national level to develop construction codes that are subsequently adopted by the State of New Jersey. NJDCA provides training for local officials and these municipal officials implement and enforce the codes. An exception to this process relates to Federal Flood Insurance Rate Maps that must be adopted directly by municipalities to participate in the NFIP (44 CFR 60.3).

Interviews with the NJEIT confirmed that funding through the NJEIT (that included Federal Sandy Supplemental Funds) has become contingent upon resiliency components set forth in various NJ Department of Environmental Protection (NJDEP) guidance documents.

A review of these NJDEP guidance documents related to resiliency standards for water and wastewater infrastructure was conducted. Several set forth best practices and operational checklists related to emergency response planning, operations and maintenance and vulnerability analyses for water and wastewater utilities (NJDEP, Undatedb; NJDEP, Undatedc; NJDEP, April 2016b; NJDEP, April 2016a). Several identify keeping assets outside of flood-prone areas or relocating them from these areas (NJDEP, Undatedb; NJDEP, Undateda). Elevation of critical infrastructure above the 500-year flood elevation is identified as a resiliency measure (NJDEP, Undatedb) and as a requirement for Federal and State financed water and wastewater projects, citing Executive Order 11988 (42 FR 26951) (NJDEP, Undatedd). One of these NJDEP guidances, (Undatedd) acknowledges that elevation and floodproofing requirements in NJDEP drinking water rules need to be amended for consistency.

New Jersey Municipalities With More Restrictive Coastal Elevation Ordinances

The NFIP's Community Rating System (CRS) rewards increased flood protection with flood insurance discounts for property owners in communities that go beyond minimum standards for floodplain management (FEMA, 2015). CRS operates on a point system that corresponds to flood insurance discounts; additional points can be awarded for various activities that will improve flood protection, including higher regulatory standards, such as requiring freeboard values. Under CRS, FEMA can also give credits for flood damage reduction activities, such as comprehensive floodplain management plans, relocating or retrofitting flood prone structures, and maintaining drainage systems where existing development is at risk. CRS points can also be realized for municipalities where substantial improvements to existing structures must meet new construction requirements for projects where the total cost of improvement to the structure is less than the FEMA threshold of 50% of the structure's pre-improvement market value (FEMA, 2013).

An analysis of data regarding New Jersey communities[13] (current as of August 2016) provided and confirmed by the New Jersey State NFIP Coordinator's Office found 22 communities[14] in New Jersey have higher freeboard standards than the freeboard standards under the UCC or FHACA; 20 of those 22 communities (91%) are considered coastal communities by the State NFIP Coordinator's Office[15]. These municipalities use freeboard values similar to the FFRMS and in at least one case, higher freeboard values than the FFRMS. Communities do not have to participate in the CRS to have higher freeboard

[13] The State of New Jersey NFIP Coordinator's Office tracks all 565 New Jersey municipalities plus Princeton Boro and the NJ Meadowlands Commission (Gould, 2016)

[14] The New Jersey State NFIP Coordinator's Office note these data include those municipalities for which they are aware of higher freeboard standards; these data may be an underestimate (Ruggeri and Gould, 2016)

[15] These are communities that have areas located in V zones or Zones Considered to be Limits of Moderate Wave Action (LIMWA), i.e., the inland limit of the area expected to receive 1.5 foot or greater breaking waves during the 1-percent annual chance flood event (FEMA, 2015a).

standards; 9 such coastal communities do have higher freeboard standards than the UCC or FHACA standards but are not current participants in the CRS as per the data provided by NJDEP.
We include examples of 3 New Jersey municipalities with more stringent freeboard ordinances for illustration purposes: Stone Harbor, Hoboken, and Little Silver. Stone Harbor has freeboard standards that include the lowest floor be 2 feet above BFE for residential new construction or substantial improvement for flood hazard areas in coastal high hazard areas; this construction shall be elevated on pilings or columns so that the lowest horizontal structural member of the lowest floor is at this level (Stone Harbor, NJ, Municipal Code Chapter 300, §300-14(2013)). The Stone Harbor ordinance was developed to conform with updated FEMA flood maps and to increase points in the CRS (The Gazette of Middle Township, 2013).

Hoboken has adopted a series of higher freeboard standards for all new construction and substantially improved residential and non-residential structures in flood hazard areas depending upon the flood hazard location and the building type. A few examples: essential facilities (fire, rescue, hospitals, etc.) must be 2 feet above base flood elevation in the 100 year floodplain and the Coastal A Zone and 3 feet above base flood elevation in the Coastal V Zone; buildings with schools or day-care facilities in the Coastal A or V Zone must meet a freeboard standard of 2 feet above base flood elevation; residential structures in the Coastal V zone must meet a freeboard standard of 2 feet above base flood elevation; and facilities that manufacture, process, handle, store, use or dispose of hazardous materials are subject to a 2 foot freeboard in the 100 year floodplain and the Coastal A Zone and a 3 foot freeboard standard in the Coastal V Zone. (City of Hoboken, NJ, Municipal Code Chapter 104, §104-17 (2013)). In its ordinance, the City of Hoboken defines freeboard "as a margin of safety to account for sea-level rise, waves, debris, miscalculations, lack of data or other environmental changes" (City of Hoboken, NJ, Municipal Code Chapter 104, §104-17 (2013)).

A third example is the Borough of Little Silver whereby new construction or substantial improvement of any residential structure within the flood hazard area shall have the lowest floor, including the basement, elevated at or above the base flood elevation plus 4 feet; in the coastal high hazard area, all new construction or substantial improvement is recommended to be elevated on pilings or columns so that the bottom of the lowest horizontal structural member of the lowest floor (excluding the pilings or columns) is elevated 3 feet above the base flood elevation or as required by the UCC, whichever is more restrictive (Borough of Little Silver, NJ, Municipal Code Chapter 22, §22-5.2 (2013)). Little Silver did not expressly identify sea-level rise or changes in coastal storms as a basis for its more stringent ordinance; the values were based on flooding observed by the Borough's municipal engineer (Little Silver Planning Board, 2013).

Examples of Sea-Level Rise and Coastal Flooding In New Jersey Projects and Planning Activities
A few examples are provided to understand how sea-level rise and coastal flooding is currently being incorporated into hazard and resiliency planning in New Jersey through Federal mechanisms. One example in New Jersey can be found with the resiliency project underway at the Passaic Valley Sewerage Commission (PVSC), which treats roughly 25% of the total wastewater in the State of New Jersey (PVSC, 2016). The facility was struck with a 12-foot wall of water from Newark Bay during Hurricane Sandy and therefore, to mitigate against storm surge and further rise in water levels, PVSC has developed a conceptual design for the construction of a floodwall in two sections with a 50 year design life at a cost of $75 million (Rotolo, 2015; PVSC, 2015). As a requirement of projects receiving support through Federal Sandy Supplemental Funding (90% from FEMA and 10% through the NJ Environmental Infrastructure Trust), PVSC's project has considered a design standard to meet both Federal and State requirements (NJDEP, Undated d; Rotolo, 2016). The design for the East section, adjacent to Newark

Bay, exceeds the NJDEP EIT requirement for critical infrastructure to be elevated to a 500-year flood elevation by incorporating sea-level rise values (2.6 feet by 2070), modeled wave heights, overtopping and an additional 2 feet to account for uncertainty, for a total of 21 feet NAVD[16] in height. PVSC's consultant noted that there is no specific guidance regarding what sea-level rise value to use; the 2.6 feet value was chosen as the 75th percentile from the New York City Panel on Climate Change and also compared to values developed by the U.S. Army Corps of Engineers (high estimate) and found to be comparable. The West floodwall (which is set further back from Newark Bay) is designed to be 5 feet above the 0.2% or 500-year flood elevation (PVSC, 2015). PVSC expects to complete this project in the year 2020 (Rotolo, 2016). In looking at sea-level rise projections for 2070, the projected sea-level rise of 2.6 feet identified by PVSC's consultant is close to the 83rd percentile cited by the STAP (2.8 feet), within the likely range of estimates under a high emissions scenario.

Another example of projects implementing climate change impacts in coastal areas relates to State Hazard Mitigation Planning. A FEMA-approved State Hazard Mitigation Plan is required for states to receive certain types of non-emergency disaster-related assistance to facilitate long-term strategies for protecting people, places and assets from hazard events. Consideration of climate change adaptation, including challenges posed by higher sea levels and intense storms are now required as part of the risk assessment in state hazard mitigation planning (FEMA, 2016b). The incorporation of sea-level rise was added to the Coastal Erosion section of New Jersey's 2014 Hazard Mitigation Plan (Tetra Tech, 2014). With respect to coastal erosion, the plan cites an estimated 31,995 people and an estimated $10 billion in building replacement cost value are potentially vulnerable to coastal erosion in New Jersey (Tetra Tech, 2014). The sea-level rise analysis uses a 2050 planning horizon and the range of lowest to highest national sea-level rise estimates from Parris et al. (2012) applied to the 100-year floodplain. Excluding those counties along the Delaware Bay and the tidally influenced Delaware River, 12,000 critical facilities are identified as being at risk from 0.3 to 2 feet of sea-level rise in 2050 (Tetra Tech, 2014). Parris et al. (2012) do not take regional sea-level rise into account, but when adjusting their curves for regional sea-level rise as noted in the STAP report, the STAP projections are consistent with Parris et al. (2012). The State HMP analysis did not adjust for local conditions and therefore the sea-level rise projections utilized in the State HMP are lower than the adjusted sea-level rise projections available in the US Army Corps of Engineers Sea-Level Change Calculator tool (Huber and White, 2015). Note that as part of the FEMA-approved Hazard Mitigation Plan development process, a number of New Jersey counties have already incorporated climate change considerations, including municipal sea-level rise, into their plans or pending plan revisions (Maxwell-Doyle, 2016; Baker, 2014; Tetra Tech EM, 2010).

A third example of sea-level rise incorporation into projects underway is the Rebuild By Design Hudson River: Resist, Delay, Store, Discharge initiative with $230 million of U.S. Department of Housing and Urban Development Superstorm Sandy Community Development Block Grant Funds to the State of New Jersey to reduce flooding from storm surge, high tide and heavy rainfall events and enhance resiliency in Hoboken and parts of Weehawken and Jersey City (NJDEP, Undatede). The project will result in design and partial implementation (hard infrastructure and landscaping features for the "Resist" component and pilot programs for the other three components). Consideration of the impacts from climate change including projected impacts from sea-level rise and its impacts on the frequency and degree of flooding is a stated project goal of the project pursuant to Federal funding requirements (79 FR 62182; NJDEP, Undatede). As such, NJDEP notes that it is conducting a comprehensive feasibility study to evaluate the level of flood risk reduction benefits that can be achieved in the study area and will consider high tides, sea-level rise, storm surge and rainfall events using NOAA sea-level rise scenarios developed for the

[16] North American Vertical Datum or NAVD (see Kopp et al., 2016 for discussion of NAVD)

National Climate Assessment (NJDEP, Undatede). The project design, permitting and site plan development phase is slated for 2016-2019 and final completion scheduled for 2022 (NJDEP, Undatedf).

For additional planning information, see *Mitigation Assessment Team (MAT) Report: Hurricane Sandy in New Jersey and New York, Building Performance Observations, Recommendations and Technical Guidance* (FEMA, 2013a) which provides a detailed analysis of causes of building failure from the storm event and related flooding; the information is used to make recommendations on building siting, design and construction and often results in amendments to NFIP regulations and standards (Mauriello, 2016).

FINDINGS AND WAYS IN WHICH THE STAP REPORT CAN ASSIST WITH NEW JERSEY COASTAL RESILIENCY PRACTICE

Below we summarize our findings by topics covered in our analysis.

Municipal Considerations

- Municipal decision makers and practitioners affirm there is a greater recognition regarding sea-level rise impacts to New Jersey coastal areas as a result of increased awareness following Hurricane Sandy and a greater support for regulatory measures, such as additional freeboard height above the minimum State standard, to protect people and property.

- A more holistic approach to resilience, guided by a statewide vision for planning and implementation, is desired among municipal decision makers and practitioners.

- Municipal decision makers and practitioners have concerns that there may be a false sense of security regarding long-term resiliency among residents given post-Sandy emphasis on home elevations. They fear residents will avoid evacuating during storm events, feeling secure in their elevated homes, while not considering the roadways, infrastructure and critical facilities that remain exposed and non-resilient.

- Sea-level rise planning numbers need to be consistent within and between State agencies. In addition to having climate data that are consistent, local officials indicated a need to integrate sea-level rise projections with local knowledge about historic floods to better inform decision making.

- Municipal decision makers and practitioners suggested using historic flood data as a reference point to communicating current and future impacts.

STAP Projections Compared with Other Projections For New Jersey and The Northeast

- Climate change hazards tailored to local conditions are being addressed in other areas of the Northeast such as Boston, New York State and Rhode Island.

- The sea-level rise projections of the STAP are consistent with Federal projections for New Jersey.

- The approach of Kopp et al. (2014), which was utilized by the STAP (and led by the chair of the STAP, Professor Robert Kopp), was followed with modification regarding the future of the

Antarctic ice sheet by the City of Boston; the data from Kopp et al. (2014) include projections for The Battery in New York City and are consistent with those used by the State of New York.

Regulation and Practice in Addressing Coastal Flooding and Climate Change Impacts In New Jersey

- At the current time, consideration of climate change impacts to address coastal flooding is not uniformly addressed in New Jersey. Such impacts are expressly addressed when required as a contingency of Federal funding under Hurricane Sandy Supplemental Funds (such as the PVSC or Rebuild By Design Projects mentioned above) or where mandated by Federal programs such as FEMA in the State Hazard Mitigation Plan or county multi-jurisdictional hazard mitigation plans. One municipal government we are aware of (Hoboken) expressly considers sea-level rise and coastal climate change impacts in its freeboard standard.

- Existing NFIP standards to address flooding do not account for climate change impacts in coastal areas such as sea-level rise and changes in coastal storms.

- The FFRMS expressly considers increases in flood risk expected to result from climate change and requires all future federal investment in and affecting floodplains to meet the level of readiness in the Standard.

- The FFRMS includes four approaches for determining flood elevation and the corresponding floodplain but the implementing guidelines note that the climate-informed science approach (CISA) is the preferred approach for Federal agencies to use when such data are available.

- A freeboard value approach (using the 100-year flood elevation) under the FFRMS is 1 foot higher than current New Jersey statewide standards and similar to the more restrictive standards implemented by some New Jersey municipalities; however, in at least one municipality, the freeboard values are higher than the FFRMS.

- Federal agencies are still working to incorporate the FFRMS into policies, regulations and programs.

- The FFRMS apply to projects where Federal funds are used to build, substantially improve or repair substantially damaged structures and facilities in and around floodplains.

- As Federal agencies complete their implementation of the FFRMS, it would be reasonable to conclude that State agencies would have to adhere to applicable Federal agency requirements where Federal funds are used to build, substantially improve, or repair substantially damaged structures and facilities in and around floodplains pursuant to the Federal standard.

- One Federal agency, FEMA, recently (August 2016) proposed rules to implement the FFRMS for its own projects or for projects it funds for new construction, substantial improvement or to address substantial damage selecting the Freeboard Value Approach (FVA) to establish the floodplain for non-critical actions and for critical actions to use the FVA or Climate Informed Science Approach (CISA) for critical actions, but only if the elevation established under the CISA is higher than the FVA.

- Existing New Jersey regulations to address flooding (UCC and FHACA) do not account for climate change impacts in coastal areas such as sea-level rise and changes in coastal storms.

- Current NJDEP Guidance (NJDEP, Undatedb) identifies elevation of critical infrastructure above the 500-year flood elevation as a resiliency measure. Use of the 500-year flood elevation in coastal areas is cautioned against by the FFRMS implementing guidelines as most 500-year data published on FEMA Flood Insurance Rate Maps do not account for local wave effects and may only include stillwater flooding. The 500-year flood elevation is likely to be lower than the effective (current) 100-year BFE, and may be lower than the BFE plus the applicable freeboard (2 feet for non-critical actions or 3 feet for critical actions). The implementing guidelines under the FFRMS note that if not using the CISA in coastal areas, Federal agencies should use the Freeboard Value Approach at a minimum, and should not use any 500-year data that lack local wave effects.

- There are an estimated 20 communities considered as coastal communities by the New Jersey State NFIP Coordinator's Office that have higher freeboard standards than the UCC or FHACA freeboard standards.

- New Jersey municipalities with higher elevation standards in coastal areas have authorized such standards because they provide discounts on flood insurance rates; reflect flooding conditions that are observed on the ground; or in at least one case, identify sea-level rise as a concern.

- Current Federal, State and local regulations address future new construction or substantial improvement to existing structures. Existing structures in coastal areas that have not been elevated to account for sea-level rise and changes in coastal flooding or existing structures located in coastal communities that have not implemented other flood damage reduction actions to account for sea-level rise and changes in coastal flooding (such as those incentivized through the CRS), may continue to be vulnerable to changes in coastal storms and sea-level rise.

<u>Using the STAP Report</u>

- Although the STAP Report does not specify a level of freeboard or minimum elevation requirement, it identifies the current state of science with respect to sea-level rise and coastal storms specific to New Jersey. The STAP framework illustrates a method to apply this science, including the SLR projections to assess future coastal flood exposure across the State within the context of historic flood events as well as within the context of the 100-year flood, a well-recognized approach in floodplain management and familiar to decision makers and residents.

- The STAP Report notes that a practical approach practitioners can use is to apply two sea-level rise projections (one sea-level rise estimate in the likely range and one value above the likely range) to assess a range of future flood conditions. Communities desiring to plan for future coastal flood exposure can use the STAP approach for establishing adaptation planning options. In the STAP Report example, a range of water level projections for Atlantic City were generated based on two sea-level rise estimates (likely range and one high end estimate) for varying conditions of inundation, recurrent flooding, and coastal storms. Up to 48 different water levels are generated in this example for these combinations of sea-level rise and projected conditions, providing communities with the flexibility to evaluate a range of values for planning purposes.

- The STAP approach is consistent with the FFRMS Climate Informed Science Approach in that both examine how sea-level rise will influence extreme water level events and both suggest using scenarios appropriate to the particular risk inherent in the types of projects under consideration. Therefore, the STAP approach can be helpful for implementing the FFRMS in New Jersey. For example, both approaches cite the use of higher projection estimates for projects where tolerance to risk is low and the consequences high, such as for projects with a long lifespan where the consequences for loss could be catastrophic.

- The STAP approach is also consistent with the CISA approach in that it uses the analysis of Kopp et al. (2014) that adjusts global sea-level rise for local conditions and it provides projections of sea-level rise that are consistent with those cited under the CISA approach, such as Parris et al. (2012). Similar to the STAP recommendation, the FFRMS is to be updated at least every five years to account for changes in climate and other factors affecting flood risk and for incorporation of new actionable science (WRC, 2015).

- The STAP approach might have applicability to assist communities with their CRS applications; however, further exploration would be necessary via discussion with State and Federal officials.

Appendix A
Municipal Use of Coastal Hazard Data and Tools
Appendix A by Lisa Auermuller, Jacques Cousteau National Estuarine Research Reserve

Background

Since Superstorm Sandy, "resilience" has been the word du jour. Communities have been in recovery and/or resilience-building mode over the past four years. While municipalities become more "resilient", the amount of science-based data they use to inform their decision-making remains unknown. This report is a supplement to the New Jersey Climate Adaptation Alliance's (NJ CAA) Scientific and Technical Advisory Panel (STAP). The STAP's charge was to identify and evaluate the most current science on sea-level rise (SLR) projections and changing coastal storms, consider the implications for the practices and policies of local and regional stakeholders, and provide practical options for stakeholders to incorporate science into risk-based decision processes. A subsequent meeting of resilience practitioners was facilitated to provide insights on barriers and opportunities for integrating the STAP's outcomes into practice.

This report reviews the variety of ways local municipal decision makers and municipal professionals consider the use of coastal hazard data, especially in the post – Sandy "resilience" context. Factors behind decisions like exceeding minimum standards, engagement in the Community Rating System (CRS) and engagement of local officials with residents about coastal hazard issues are explored.

Data Collection

These findings are the result of a suite of engagements with local municipal decision makers and municipal professionals. These engagements included a Resilience Professional's Retreat, a focus group interview with members of the Atlantic and Cape May County Coastal Coalition, and one on one phone interviews with municipal officials in communities where the municipal freeboard requirement exceeded the state minimum standard. In some cases there was some overlap between individuals within these groups. More specifics about each of the data collection activities are provided:

- **Resilience Professionals Retreat –** A Resilience Professionals Retreat hosted was hosted by the Jacques Cousteau National Estuarine Research Reserve (JC NERR) on September 30, 2015. This event was aimed at planning and engineering consulting professionals who are hired by municipalities for projects, but don't work directly as municipal staff. Six professionals attended along with JC NERR and Bloustein School staff. The intent of this event was to speak candidly, utilizing a focus group format, about the professionals' experiences working with municipalities on post-Sandy recovery planning and improving resilience. Topics discussed included: What "resilience" means to professionals?; What is the current "state" of resilience in New Jersey?; What has been done well with regards to resilience?; What would the ultimate resilience project look like?; What resilience barriers and opportunities exist?; What are your information needs?, and; How useful are the current resilience tools?

- **Interview with the Atlantic and Cape May County Coastal Coalition Members** – The Atlantic and Cape May County Coastal Coalition (ACMC CC) is a diverse set of municipal staff, elected and appointed officials, local business and interested stakeholder groups who have been meeting monthly throughout Atlantic and Cape May County since Super Storm Sandy. The implementation strategy and focus of their meetings is mainly professional sharing and group discussions pertaining to current and future coastal hazards. They have expanded since Sandy to form smaller working groups focused on topics that require more in-depth discussion.

On October 1, 2015, an in person, group interview was conducted with members of the ACMC CC during one of their regularly scheduled monthly meetings. Eight participants actively participated in the discussion. Questions posed to the group included: If you have chosen to exceed minimum standards, why have you done so and with what information?; Has there been a significant difference in how the community reacts to inundation mapping projects over the last few years (since Sandy)?; When talking about sea-level rise do you understand the difference in projections; Would you find state-wide sea-level rise/inundation guidance options useful to you in your municipal decisions making/planning?

- **Interviews with Municipalities Exceeding Minimum Freeboard Standards** – New Jersey has a state mandated one foot of freeboard, but municipalities can choose to exceed these minimum requirements and be more locally restrictive. Between December 2, 2015 and December 15, 2015, a total of 10 individuals, representing seven municipalities, participated in 30 minute long phone interviews. The interviewees were those individuals charged with making decisions about or enforcing freeboard requirements for their municipalities. All the interviewed municipalities had freeboard standards that exceeded the 1 foot freeboard minimum state requirements. Some had freeboard requirements as much as 3 feet in specific high risk coastal zones.

  Questions asked during each of the interviews were: Do you understand sea-level rise (SLR) numbers and the differences in projection factors? Do you currently use SLR inundation projections in your municipal planning/decision making? Is there consensus in your decision making sphere on how to plan for SLR, surge inundation, etc.? What time scales are your decisions/planning made on? If you have chosen to exceed minimum standards in freeboard, why have you done so and with what information? Do you communicate inundation risk to other municipal leaders? Local residents? Has there been significant differences in how the community reacts to inundation mapping projects over the last few years? Would you find statewide SLR guidance options useful in your municipal decision making/planning? How could they be presented / provided to be most useful?

- **Supplemental Data Collection:**

Other complementary efforts from which information has been integrated included the results of a Resilience Café hosted by the Rutgers Bloustein School. All municipalities that had received "resilience" planning support from JC NERR, NJ Future, Sustainable Jersey and the Department of Community Affairs were invited. The world café style of facilitation was employed to get the most feedback and open dialogue with participants. Facilitators and note takers were assigned to each topic and each topic had a series of questions. Topics included: The Resiliency Experience, Metrics and Indicators, State Policies, Planning and Ordinances, and Vulnerability Assessment.

Additional content for this report came from a web tools usability test phone interview study completed by the Rutgers Geography Department, conducted primarily with New Jersey users of web-based mapping tools such as FEMA Maps, NJ Adapt.org, NJ Flood Mapper.org, and/or Surging Seas. Fifteen interviewees participated in individual phone interviews regarding their use of web-based mapping tools in support of decision making and planning.

Observations from Engagements

The data collected from the suite of engagements with local municipal elected officials and staff has been distilled into a series of observation thematic areas.

- **Sandy's Impact on Coastal Municipal Decision Making**

Municipalities overwhelmingly agreed that since Sandy, topics like flooding and coastal hazards are almost daily conversation. The tenor of those discussions covers a variety of topics, including:

- Greater recognition regarding sea-level rise impacts to New Jersey coastal areas as result of increased awareness following Hurricane Sandy;
- Greater support for regulatory measures, such as an additional freeboard height above the minimum State standard, to protect people and property;
- An immediate need for training for disaster readiness and storm response in New Jersey coastal communities;
- The need for professional training requirements for individuals participating in disaster response as well as for floodplain managers - currently only five states (not including New Jersey) have training requirements, and;
- Limited disaster response, recovery and resilience preparedness knowledge among local decision-making officials as evidenced by the challenges they faced in issuing post-Sandy substantial damage determinations.[17]

Sandy was the impetus for the creation of the Atlantic and Cape May County Coastal Coalition. This is an ideal example of a group of regional decision makers meeting monthly to discuss coastal hazard issues. Their meetings are ongoing exchanges of professional information and regional commonalities.

Municipal representatives did note differences in how their communities' react to inundation events and mapping since Sandy. Locals are taking much more notice of flooding impacts and are more sensitive to these types of events. There is desire for more education and more information by both homeowners and professionals. Residents with substantially damaged properties have more flooding fears since Sandy. Municipal staff noted a change in the historic flooding information requested since Sandy, especially when people are buying homes. One official noted the real estate market has changed, with a large number of tear downs and rebuilds. Additionally, residents are realizing financial savings in flood insurance with home elevations. While Sandy allowed for increased conversations and more open and forward looking dialogue, municipal decision makers, staff and professionals noted that Sandy could have provided the opportunity for new master planning and rebuilding ideas. There was an overall feeling that there was no BIG thinking after Sandy – resilience professionals felt the NY Rising[18] approach was more ideal in that regional recovery plans were developed and these plans had effective recovery implementation plans. Each NY Rising Plan:

- Was locally-driven by a Planning Committee that assessed storm damages and current risk, identified community needs and opportunities, and developed recovery and resiliency strategies; and

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[17] A substantially damaged building is one that has incurred damage of any origin whereby the cost of restoring the building to its before damaged condition would equal or exceed 50% of the market value of the building before the damage occurred (see FEMA National Flood Insurance Definitions last accessed June 14, 2016 at https://www.fema.gov/national-flood-insurance-program/definitions#S)

[18] http://stormrecovery.ny.gov/community-reconstruction-program

- Details projects and implementation actions to help fulfill those strategies.

Each participating New York community was allotted between $3 million and $25 million of Community Development Block Grant – Disaster Recovery (CDBG-DR) dollars to implement elements of their plans. New York State also worked to help communities identify other federal, state, local, non-profit, and private resources to supplement this funding.

Respondents who criticized the New Jersey post-Sandy approach cited decisions such as the dispersal of small grants to individual municipalities as not encouraging well-known, resilience planning principals. Interviewees felt Sandy recovery lacked a "holistic approach" that would have incorporated a statewide vision for New Jersey with respect to resilience planning and implementation. This narrowly focused attitude was further enhanced by municipalities wanting things rebuilt quickly for recovery of local tax ratables. While some savvy municipalities cited the pooling of multiple small grants together to do better planning, many municipalities noted that they didn't have the in-house capacity to apply for grants or a good understanding of the complex issues associated with long-term resilience.

- **What is resilience anyway?**

Resilience. Respondents noted the difference in definitions for resilience. The engineering definition for resilience includes the ability for a system to rebound from an event; whereas, the definition through an environmental, long-term lens, includes the reality that adapting should be emphasized over merely rebounding (Holling, 1996). Interviewees were questioned: Are elevated houses built right on the shore really resilient? Does resilience mean that fewer buildings get destroyed with another Sandy? Is resilience just people's desire to just get "back to normal", and "what is "normal"? Respondents noted that due to the large amount of financial interest along the areas with extreme risk and exposure, New Jersey is innately not resilient. Also noted was the impact of home rule in New Jersey, which fosters implementation of resiliency planning by

Author's Insights

- ❖ Sandy allowed a resilience discussion that was not happening prior.
- ❖ Municipalities need guidance, direction and direct technical assistance to plan for resilience.
- ❖ Communities lack direction on the ways to promote resilience immediately after a disaster.
- ❖ Inconsistencies in guidance and direction from state and federal agencies (and even among and between state agencies) complicate resilience implementation at the municipal level.
- ❖ Municipalities fear a false sense of security and false sense of long-term resilience arising from residents as a result on the post-Sandy emphasis on home elevations. In more than one of the engagements, municipal professionals and decision makers, expressed concern that residents will avoid evacuating during storm events, feeling secure in their elevated homes, while not considering the roadways, infrastructure and critical facilities that remain exposed and non-resilient.
- ❖ Real long-term resilience planning faces challenges such as municipal reliance on tax ratables, a lack of regional considerations and a lack of state guidance on planning for future coastal hazards.

individual municipalities as opposed to planning as regional coastal systems.

Respondents agreed that academics, engineers, planners and municipal decision makers all have different views about resilience, but resilience needs to include these diverse perspectives - and more. Currently, just being involved in "resilience planning" seems beneficial to municipalities, especially when the insurance and reinsurance industries have been more actively pushing municipalities to think about the impacts of future coastal hazards. The question remains: are municipalities *really* more resilient or do they just think they are?

- **Agency Disconnects**

There was substantial agreement that between the Federal Emergency Management Agency (FEMA), (including the Community Rating System (CRS)), New Jersey Board of Public Utilities (BPU), NJ Department of Community Affairs (DCA) and the New Jersey Department of Environmental Protection (NJDEP) there is lack of consensus with building codes, floodplain regulations and freeboard standards. These disconnects and sometimes contradictions trickle down to the local Construction Code Officials who are left to make decisions between conflicting floodplain mandates and standards. A specific example was provided whereby DCA building code language does not agree with the NJ DEP freeboard standard. This disconnect is serious enough to put the state of New Jersey at fault in meeting the National Flood Insurance Program (NFIP) standards.

Specific recommended improvements included hosting a consistency meeting between NJDEP and DCA to ensure regulatory language doesn't allow room for flexibility and different interpretations. (Note that subsequent to these interviews in June 2016, NJDEP proposed new rules that are still pending as of this writing but which are intended to reconcile some of these inconsistencies). It was also suggested that all these agencies should sit down with local Construction Code Officials and Floodplain managers, hear and see real world examples of the between-agency disconnects and understand the issues it causes "on the ground". The goal of this meeting would be for all agencies dealing with floodplain issues to come to consensus on streamlined, consistent language.

- **Measuring Freeboard is Not Standardized**

Local officials do not have a consistently agreed upon method for measuring freeboard. Some indicated they measure "1 foot to the lowest horizontal member", others start measurements at the "top of the block with variances at the floor joists". Still others have ordinances that mandate that everything below the Base Flood Elevation (BFE) be flood proof and water resistant. In regulatory standards there are references to "design flood elevation" (DFE), which is always higher than the BFE unless an ordinance is passed otherwise, but municipal representatives indicated that no one locally uses that language.

Questions arose from local officials about the process of awarding CRS points to communities for exceeding minimum freeboard standards when there is no standard language and measurement. Also, having different measurement and freeboard requirements between municipalities is challenging for building professionals, contractors and local residents who are usually even less familiar with the intricacies of floodplain rules. It was also noted that there is so much disparity in freeboard heights from municipality to municipality because the CRS points incentivize them to go higher - thus not standardized. A recommended solution for this issue was that guidance and specificity in heights, elevations and where to measure heights from would be especially helpful to achieving consistency and standards across municipal boundaries.

- **Freeboard: The Pros and the Cons**

Establishing higher freeboard requirements has numerous benefits but local representatives also noted there are drawbacks. The numbers of positive benefits are numerous - Higher freeboard helps protect homes and homeowners. It lessens flood insurance for residents and it helps minimize homeowner confusion with rebuilding. Some communities viewed higher freeboard decisions as a start to planning for the future. Likewise, it was noted that higher regulatory standards can act as a very good communication tool for the local municipalities to start engaging their residents about the difference between current and future hazard risks. An incentive provided by municipalities to encourage residents to consider additional freeboard could be modeled after Hull, Massachusetts where the town offers $500 as a rebate on building department fees, once the homeowner provides documentation that they've built the house 2 feet higher than it would otherwise be required by ordinance.

The negative aspects of higher freeboard heights were significant. Higher homes can mean access issues to elderly residents. Locals noted that residents complain about the loss of privacy with elevated homes "looking down" into the yards of neighbors. In some case municipalities have even eliminated decks on the 2^{nd} and 3^{rd} floors to abate the privacy concerns. Some municipalities cited the concern that higher home elevations will "change the nature" of the community, especially in historic areas.

- **Exceeding Freeboard Minimum Standards**

Super Storm Sandy had a major impact on municipalities' voluntarily increasing freeboard beyond the 1 foot state mandate. Sandy provided the opportunity for municipal decision makers to institute higher regulatory standards, with minimal resistance to the additional freeboard heights. At the same time, Increased Cost of Compliance (ICC) funding after Sandy allowed homeowners to make sustainable improvements, like home elevations, with a decreased financial burden. Municipalities noted that their freeboard requirement helps to get homes elevated above BFEs and qualify for reduced flood insurance rates.

Another major incentive for higher freeboard standards is FEMA's CRS which gives municipalities "points" for exceeding the minimum standards. For municipalities, freeboard can be a win – win: more freeboard means an improved CRS rating and adds a safety factor for the residents. Lower flood insurance can be an enormous motivation for municipalities, like ones interviewed, where the lack of a cumulative repetitive loss provision (as part of their floodplain management ordinance) is resulting in the private flood insurance companies reconsidering residential policies. Similarly, another municipality interviewed stated that private flood insurance has not been an option for many years now.

CRS provides the economic incentive for decision making regarding higher standards. It also allows flexibility in higher standards by rewarding partial credits for extra freeboard even if it is just regulated in specific municipal zones. Municipal representatives noted that as more and more communities look towards the CRS as a way to offset insurance rates, and the CRS point system becomes more and more restrictive, municipalities who want to sustain their CRS rating may need to look towards these higher regulatory standards or risk increases in flood insurance discounts residents are accustomed to. CRS also provides a "portfolio of resilience actions" – like higher standards and green infrastructure and allows the municipality to associate those decisions with the CRS program.

Municipalities do not always institute higher freeboard standards across the board or in uniform ways. On Flood Insurance Rate Maps (FIRMS) coastal high hazard areas, labeled as "V zones" are the areas where the computed wave heights for the 1%-annual-chance flood are 3 feet or more. V zones are subject to more stringent building requirements and different flood insurance rates than other zones shown on the FIRM because these areas have a higher level of risk from flooding than other areas. For some municipalities, requiring higher freeboard in "A" zones and regulating them more like "V" zones, adds additional protection for those properties. In other municipalities, additional freeboard is more of an educated suggestion. In another municipality, freeboard of 3 feet is required in properties mapped with BFEs of 8,9,10 feet and 2 feet in other specific known vulnerable sections of the municipality. For a municipality with cottage construction and a historic district, the freeboard considerations were very specific to maintain the charm and character. In yet another municipality the X zone along the ocean (the areas of minimal flood hazard, outside the Special Flood Hazard Area with a 0.2-percent-annual-chance flood) was mandated to the adjacent "A" zone for elevation requirements. A municipality with an across the board 2 foot freeboard stated that the 2ft height made sense as it required construction to be improved and buildings to be rebuilt more uniformly.

One community also noted another standard that they have voluntarily exceeded, in addition to freeboard, is the substantial damage/improvements threshold. Most municipalities conform to the FEMA set threshold at 50% of the value of the home for improvement/repair permits accumulated over a 10 year period. When a municipality sets this percentage lower, the house has to meet the higher standards more quickly, and the municipality earns additional CRS points for higher standards.

- **Municipal Use of Sea-Level Rise Data**

Locally people know what floods now and know that it will get worse. It is commonly this local knowledge that is used in decision making. When asked about the use of sea-level rise data in municipal decision making, there was agreement that multiple sources of data can be redundant and confusing and may be conflicting. Such sea-level rise planning numbers need to be consistent within and between State agencies. In addition, to having climate data that are consistent, local officials indicated a need to integrate sea-level rise projections with local knowledge about historic floods to better inform decision making. It was agreed that municipal technical professionals understand sea-level projections but municipal leaders usually take the "stand back" approach and let the professionals "deal with it". It was stated that the state should decide on sea-level rise projection consensus for the municipalities to ensure consistency.

In some communities everyone is onboard with the proactive approach in other communities the only agreement is who will make the decision and the decision making process. For some municipalities the timescales for municipal planning is very project dependent – mitigation is done on a 4-5 year timeframe; remediation is done on a shorter timeframe. For other municipalities, post – Sandy planning has been slightly reactionary, short term, today, immediate. Yet, some municipalities are thinking about the future. For example, inundation models are being used for infrastructure projects like planning flap valves on storm drains and installing and mitigating municipal pumps.

One community is strategizing the utilization of sea-level rise information by starting the discussion with their Green Team (which is likely to be a receptive audience) and then to moving up to the planning board. Their theory is to start with the grass roots and to integrate municipal long-term planning and decision making slowly.

- **Sea-level Rise and Inundation Guidance**

When asked if statewide SLR guidance options would useful in municipal decision making/planning, there was agreement that recommendations won't work but legislation will. It was stressed that there needs to be consistency in these numbers between all the agencies – with some interviewees saying the consistency is more important than the actual numbers. Specific feedback included ensuring the New Jersey DEP and New Jersey DCA approve and incorporate regulatory standards in tandem with one another to ensure the floodplain regulations and the building codes requirements are consistent. Municipalities wanted to see regulation regarding sea-level rise planning coming with funding for implementation. It was thought that regulatory guidance would be especially useful when making longer-term infrastructure decisions like the street elevations and the installation of pumps. It was also stressed that state documentation would be useful but decisions are often very localized and localized implementation guidance would be welcomed.

Conclusions

- **Messaging about Future Coastal Hazards**

Day-to-day practical issues make long-term thinking very challenging. It was recognized that people are starting to think about current and future flooding as something that has to be dealt with. The recent updates to the New Jersey's coastal flood maps and the increased costs of flood insurance through the National Flood Insurance Program have helped people become more aware of floodplain issues.

The municipal interviewees offered their suggestions on how best to message sea-level rise and future inundation to other local decision makers and residents. A specific suggestion was to use the past as a reference by having people recall where the water was and how often it used to flood, compared to now. The use of historic flood data, overlaid with currently land use patterns, could be very effective in communicating current and future impacts.

It was suggested that messaging should refer to how regular flooding and inundation will affect everyday life. It was also recommended that local decision makers need to have answers for residents when they ask questions like, "what is the point of mitigation activities when we are going to be flooded on every high tide in 50 years?" Decision makers need to be able to talk to residents about the ongoing and increasing needs for large scale municipal projects to address increased flooding overtime. Answers to questions should be framed in quantifying the cost/benefits of the mitigation and adaptation work needed. A communication strategy was cited in messaging the use of higher regulatory standards which are implemented locally to help protect property damage and save residents money on insurance premiums.

- **Current Utilization of Resilience Tools**

It was recognized that tools like Rutgers' www.NJFloodmapper.org are being used as a reference by professionals and local municipal staff. It was also felt that if there were consensus on planning for sea-level rise, it would encourage more use of this and similar mapping tools.

The web-tools usability testing administered by Rutgers' Geography Department resulted in findings and recommendations that provide insight into the future direction of coastal hazard tools. These results suggest that the main reasons web-maps are used instead of or to supplement desktop-based GIS and analog maps include: high accessibility and mobility, ease of use, relevancy of information, and expectation of providing the most up-to-date information. Many practitioners compare web-map data/information with desktop and analog maps to leverage respective strengths. For example, the high spatial resolution and ability to better identify regulatory boundaries (e.g., flood zones) is one reason web-based maps are used instead of or to supplement analog maps.

The specific uses of web tools relied greatly on the sectors the users represented. Many government sector participants only use the regulatory tool (i.e., FEMA Maps) because they cannot use non-regulatory tools without mandates. The non-profit sector participants use non-regulatory tools, not regulatory tools due to their resilience-related missions that emphasize potential future conditions. Most private sector participants use regulatory tools and are not using the non-regulatory tools due to lack of time and knowledge about how to use them, but they see the value of non-regulatory tools and want to use them. A current barrier to broad web tool utilization could be the lack of a governmental mandate to consider future inundation and sea-level rise models in planning. Another barrier is the lack of incentives for practitioners not constrained to the regulatory tools to learn how to use non-regulatory tools. One way to overcome this barrier is to add tool training modules to licensure courses.

- **State Level Municipal Resilience Planning Guidance**

The concept of a "Long-Term State Resilience Plan" arose through the collection of ideas shared by interviewees. This state level observation is identified in light of the New Jersey Climate Adaptation Alliances' desire to better prepare NJ for climate change.

A "Long-Term State Resilience Plan" could include risk and vulnerability assessments and indicators of risks for a number of impacts of a changing climate. Impacts should at least include heat, economics, riverine flooding, and sea-level rise. One cited advantage of creating a state-wide risk and vulnerability assessment was the ability of this Plan to become the State-guided standard for assessments. Currently there is a wide range of interpretations and levels of understanding as to what constitutes a vulnerability assessment. Risk and vulnerability assessments could be completed based on guidance from local decision makers and include facilities that they view as critical facilities and municipal assets. These would include, but not be limited to, utility authorities, pumping facilities, sewage treatment facilities, police stations, public works yards, town halls, emergency shelters, firehouses, water treatment plants and senior facilities. A further observation is that municipal leaders often did not list open space as "critical infrastructure" which might suggest that these natural areas and their ecosystem services are not currently being identified as critical assets for municipalities.

The focus of this plan could be on long-range mitigation action planning; much like an enhanced state-level hazard mitigation plan where master planning and mitigation planning are blended. The plan could also include a state-wide fiscal impact analysis to assess the impact on municipal governments as ratables and infrastructure becomes exposed and more and more vulnerable. The plan could include long-range actions as well as resilience strategies that can be implemented now. Ideally this plan and the associated analysis could be downloadable by county and/or municipality and could be used in resilience planning. A community of practice could be established within the professional and municipal decision maker spheres to ensure it is being utilized, meeting their needs and updated as needed.

Municipal decision makers indicated they would be served best by a comprehensive set of resilience strategies if these strategies included answers on: What the options are? What are the "best practices"? ; What will it cost?; Where has this been implemented before?; Are there model ordinances that guide these options?

APPENDIX B
REGULATION AND PRACTICE IN ADDRESSING COASTAL FLOODING AND CLIMATE CHANGE IMPACTS IN NEW JERSEY

The objective of this analysis is to understand the degree to which coastal flooding, including coastal climate change related impacts such as sea-level rise or changes in coastal storms, are being addressed in New Jersey either through Federal, State or municipal approaches. This appendix provides: a summary of coastal elevation standards and guidance applicable in new Jersey; a discussion of Federal programs and New Jersey programs that address current and future coastal flood risk; a discussion regarding municipalities with coastal elevation ordinances that are more restrictive than State or Federal requirements and some specific examples where sea-level rise and coastal flooding are being addressed in New Jersey projects and planning activities. The information for these analyses came from publicly available documents, interviews and correspondence with New Jersey State officials.

Federal and State Programs Addressing Current Flood Risk

The National Flood Insurance Program (NFIP) was created by Congress in 1968 and is administered by the Federal Emergency Management Agency (FEMA) to provide flood insurance as financial protection to homeowners, renters and business owners; to be eligible, a property must be located in a community that participates in the NFIP through the adoption and enforcement of municipal ordinances that meet or exceed FEMA requirements for flood risk reduction (FEMA, 2016c). In fact, the NFIP standards are minimum standards and floodplain management regulations adopted by a State or community which are more restrictive are encouraged (44 CFR 60.1). Private property owners that receive loans from an FDIC-supervised institution for properties located in a flood hazard area are required to purchase flood insurance (12 CFR 339.3). The elevation components for NFIP-participating communities center on new construction or substantial improvement[19] of structures in the flood hazard area being at or above the base flood elevation (i.e., BFE[20]) (44 C.F.R.1.60).

Complementing NFIP elevation requirements are the additional specificity of flood resistant design criteria developed by the American Society of Civil Engineers (ASCE) that are used as a referenced standard by the International Building Code (IBC) for the design and construction of buildings and structures in flood hazard areas. Where the IBC is adopted, such as in the State of New Jersey's Uniform Construction Code (N.J.A.C. 5:23-3.14), the ASCE reference standard is regulatory. New Jersey has also adopted the International Residential Code which addresses the design and construction of one- and two-family dwellings and townhouses (N.J.A.C.5:23-3.21). Thus, buildings, structures and dwellings proposed for construction within the flood hazard area (100-year flood zone) in New Jersey that are subject to the UCC, have to meet the applicable reference standard. In general, these include a minimum elevation requirement of 1-foot of freeboard above the base flood elevation (also referred to as BFE)[21] for residential dwellings; for essential facilities (e.g., emergency response and recovery facilities, hospitals, health care facilities, power stations, etc.) the elevation requirement is 2-foot of freeboard above the BFE or elevation to the 500-year flood elevation, whichever is higher (ASCE, 2015;

[19] Substantial improvement means any reconstruction, rehabilitation, addition, or other improvement of a structure, the cost of which equals or exceeds 50 percent of the market value of the structure before the "start of construction" of the improvement (See FEMA, 2016d for complete definition).

[20] The elevation to which floodwater is anticipated to rise during the base flood which is the flood having a one percent chance of being equaled or exceeded in any given year. This is also referred to as the "100-year flood" (FEMA, 2016a; FEMA, 2016e).

[21] ASCE uses Design Flood Elevation to acknowledge that some communities adopt flood hazard maps that depict flood hazard areas in addition to the Special Flood Hazard Areas on FEMA's Flood Insurance Rate Maps (ASCE, 2015).

NJDCA, 2013). Note that in coastal high hazard areas, which include the V Zone (area where wave height can be 3 feet or greater) and the Coastal A Zone (area landward of the V Zone where wave heights may be between 3 and 1.5 feet), the minimum elevation is measured from the lowest horizontal structural member (ASCE, 2015; NJDCA, 2013; NJAFM, 2015). In addition, in coastal high hazard areas, the standard of 2-foot of freeboard above the BFE or elevation to the 500-year flood elevation (whichever is higher) also applies to buildings where a large number of persons assemble such as theatres, schools, museums (ASCE, 2015; NJDCA, 2013). The UCC requirements apply to new construction and to substantial improvement or repair of substantial damage[22] to an existing building (N.J.A.C. 5:23-6A).

The State of New Jersey also has freeboard requirements for construction or development in flood hazard areas pursuant to the Flood Hazard Area Control Act (N.J.S.A. 58:16A-50 et seq.) whereby the regulations address both tidal flood hazard areas and fluvial flood hazard areas (N.J.A.C. 7:13)[23]. For example, in flood hazard areas, railroads and roadways must be constructed or reconstructed at least 1 foot above the Design Flood Elevation (DFE) which in tidal areas is equivalent to the FEMA BFE (based on the 100-year elevation) (N.J.A.C. 7:13-12.6). With respect to buildings in flood hazard areas, the lowest floor of new habitable buildings or substantially improved buildings that were substantially damaged due to a natural disaster must be constructed at least 1 foot above the DFE (N.J.A.C. 7:13-12.5). On June 20, 2016, NJDEP proposed new rules to align with inconsistencies existing between the FHACA rules and the UCC freeboard requirements. Under the proposed rules, if a proposed new habitable building (residential, multi-dwelling, critical building) is entirely or partially located within a V zone or Coastal A zone, the bottom of the lowest horizontal structural member cannot be less than one foot above the flood hazard area design flood or lower than the elevation required by the UCC, with certain exceptions for buildings in a Coastal A zone where an engineer or architect certifies that the building's foundation is designed in accordance with the Uniform Construction Code; in addition, this rule proposal prohibits a multi-residence building from being constructed in the V Zone (48 N.J.R. 1014(a)). The proposed rule will not be final until it goes through a public comment period and adoption.

New Jersey Municipalities With More Restrictive Coastal Elevation Ordinances

The NFIP's Community Rating System (CRS) rewards increased flood protection with flood insurance discounts for property owners in communities that go beyond minimum standards for floodplain management (FEMA, 2015). CRS operates on a point system that correspond to flood insurance discounts; additional points can be awarded for various activities that will improve flood protection, including higher regulatory standards, such as requiring freeboard values. Under CRS, FEMA can also give credits for flood damage reduction activities, such as comprehensive floodplain management plans, relocating or retrofitting flood prone structures, and maintaining drainage systems where existing development is at risk. CRS points can also be realized for municipalities where substantial improvements to existing structures must meet new construction requirements for projects where the total cost of improvement to the structure is less than the FEMA threshold of 50% of the structure's pre-improvement market value (FEMA, 2013).

[22] substantial improvement means any reconstruction, rehabilitation, addition, or other improvement of a structure, the cost of which equals or exceeds 50 percent of the preconstruction market value; substantial damage means damage of any origin sustained by a structure whereby the cost of restoring the structure to its pre-damaged condition is equal or exceeds 50 percent of the market value of the structure before the damage occurred."

[23] Fluvial flood hazard areas are those in which the flood hazard area design flood elevation is governed by stormwater runoff as opposed to the tidal flood hazard area design flood elevation which is governed by flooding from the Atlantic Ocean (see N.J.A.C. 7:13)

An analysis of data regarding New Jersey communities [24](as of August 2016) provided and confirmed by the New Jersey State NFIP Coordinator's Office found:

- 72 of 567 (13%) of New Jersey communities participate in the CRS.
- 135 of 567 (24%) of New Jersey communities are considered coastal communities[25] by the New Jersey State NFIP Coordinator's Office.
- 47 of 135 (35%) of New Jersey communities considered by the New Jersey State NFIP Coordinator's Office as coastal communities participate in the CRS.
- 47 of 73 (64%) of New Jersey communities that participate in the CRS are considered coastal communities by the New Jersey State NFIP Coordinator's Office.
- 22 communities[26] in New Jersey have higher freeboard standards than those required by New Jersey under the UCC or the FHACA.
- 11 of 22 (50%) of New Jersey communities with higher freeboard standards than those required by New Jersey under the UCC or FHACA participate in the CRS.
- 20 of 22 (91%) New Jersey communities with higher freeboard standards than those required by New Jersey under the UCC or FHACA are considered coastal communities by the NJ State NFIP Coordinator's Office (Gould, 2016).

The above data show 22 communities in New Jersey have higher freeboard standards than those under the UCC or FHACA; 20 of those 22 communities (91%) are considered coastal communities by the State NFIP Coordinator's Office[27]. Communities do not have to participate in the CRS to have higher freeboard standards; 9 such coastal communities do have higher freeboard standards than the UCC or FHACA standards but are not current participants in the CRS as per the data provided by NJDEP.

We include examples of 3 New Jersey municipalities with more stringent freeboard ordinances for illustration purposes: Stone Harbor, Hoboken, and Little Silver. Stone Harbor has freeboard standards that include the lowest floor be 2 feet above BFE for residential new construction or substantial improvement for flood hazard areas (in coastal high hazard areas, this construction shall be elevated on pilings or columns so that the lowest horizontal structural member of the lowest floor is at this level) (Stone Harbor, NJ, Municipal Code Chapter 300, §300-14(2013)). The Stone Harbor ordinance was developed to conform with updated FEMA flood maps and to increase points in CRS (The Gazette of Middle Township, 2013).

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[24] The State of New Jersey NFIP Coordinator's Office tracks all 565 municipalities plus Princeton Boro and the NJ Meadowlands Commission. (Gould, 2016)

[25] These are communities that have areas located in V zones or Zones Considered to be Limits of Moderate Wave Action (LIMWA), i.e, the inland limit of the area expected to receive 1.5 foot or greater breaking waves during the 1-percent annual chance flood event (FEMA, 2015a).

[26] The New Jersey State NFIP Coordinator's Office note these data include those municipalities for which they are aware of higher freeboard standards; these data may be an underestimate (Ruggeri and Gould, 2016)

[27] These are communities that have areas located in V zones or Zones Considered to be Limits of Moderate Wave Action (LIMWA), i.e., the inland limit of the area expected to receive 1.5 foot or greater breaking waves during the 1-percent annual chance flood event (FEMA, 2015a).

Hoboken has adopted a series of higher freeboard standards for all new construction and substantially improved residential and non-residential structures in flood hazard areas depending upon the flood hazard location and the building type. A few examples: essential facilities (fire, rescue, hospitals, etc.) must be 2 feet above base flood elevation in the 100 year floodplain and the Coastal A Zone and 3 feet above base flood elevation in the Coastal V Zone; buildings with schools or day-care facilities in the Coastal A or V Zone must meet a freeboard standard of 2 feet above base flood elevation; residential structures in the Coastal V zone must meet a freeboard standard of 2 feet above base flood elevation; and facilities that manufacture, process, handle, store, use or dispose of hazardous materials are subject to a 2 foot freeboard in the 100 year floodplain and the Coastal A Zone and a 3 foot freeboard standard in the Coastal V Zone. (City of Hoboken, NJ, Municipal Code Chapter 104, §104-17 (2013)). In its ordinance, the City of Hoboken defines freeboard "as a margin of safety to account for sea level rise, waves, debris, miscalculations, lack of data or other environmental changes (City of Hoboken, NJ, Municipal Code Chapter 104, §104-17 (2013)).

A third example is the Borough of Little Silver whereby new construction or substantial improvement of any residential structure within the flood hazard area shall have the lowest floor, including the basement, elevated at or above the base flood elevation plus 4 feet; in the coastal high hazard area, all new construction or substantial improvement is recommended to be elevated on pilings or columns so that the bottom of the lowest horizontal structural member of the lowest floor (excluding the pilings or columns) is elevated 3 feet above the base flood elevation or as required by the UCC, whichever is more restrictive (Borough of Little Silver, NJ, Municipal Code Chapter 22, §22-5.2 (2013)). Little Silver did not expressly identify sea-level rise or changes in coastal storms as a basis for its more stringent ordinance; the values were based on flooding observed by the Borough's municipal engineer (Little Silver Planning Board, 2013).

Federal Flood Standards That Expressly Address Climate Change

To improve national resilience to current and future flood risks, including increases in flood risk expected to result from climate change, in January 2015 the President reissued Executive Order (EO) 11988, *Floodplain Management* (42 FR 26951), and amended some of its provisions via EO 13690 (80 FR 6425), *Establishing a Federal Flood Risk Management Standard (FFRMS) and a Process for Further Soliciting and Considering Stakeholder Input.* The FFRMS, which builds on the Federal floodplain management framework in place since issuance of the original EO 11988 in 1977, requires all future federal investments in and affecting floodplains to meet the level of flood resilience established by the Standard.

Following the cabinet-level Water Resource Council's issuance of interagency implementing guidelines for EOs 11988 and 13690 in October 2015 (WRC, 2015), Federal agencies are working to incorporate the new requirements (described below) into applicable policies, regulations, and programs. Although implementation is still in progress, a review of the FFRMS is instructive for understanding how Federal floodplain management is incorporating sea-level rise and other climate change impacts into resiliency planning and on-the-ground projects.

Unchanged from the 1977 version, EO 11988 applies to all Federal actions[28] in or affecting floodplains. As outlined in EO 11988 and the EO 11988 / EO 13690 implementing guidelines, agencies must first

[28] A Federal action is any activity including acquiring, managing, and disposing of Federal lands and facilities; providing Federally undertaken, financed or assisted construction and improvements; and conducting Federal activities and programs affecting land use such as water and related land use resource planning, regulating, and licensing activities (80 FR 6425).

consider alternatives to siting a project in a floodplain and use natural systems, ecosystem processes and nature-based approaches in the action, where possible. If none of the alternatives outside of the floodplain are practicable, agencies must then seek to avoid adverse effects of the action and minimize harm. Public notification and engagement are required throughout the agency's decision-making process.

The most significant policy change to EO 11988 made by EO 13690 was the shift away from basing application of EO 11988 on use of the base (1-percent-annual-chance or 100-year) flood and corresponding horizontal floodplain, which solely consider historical flood events, to using the so-called "FFRMS flood elevation and floodplain," which are intended to account for both current and future flood risks. The requirement to determine and apply the FFRMS flood elevation and corresponding floodplain applies only to the subset of Federal actions that are Federally funded projects, that is, where Federal funds are used to build, substantially improve, or repair substantially damaged structures and facilities in and around floodplains (WRC, 2015). Through use of the FFRMS flood elevation and floodplain, Federal agencies will be taking steps to ensure that Federal investments are more resilient to flooding and last as long as intended.

EOs 11988 and 13690 and their implementing guidelines provide four approaches for determining the FFRMS flood elevation and corresponding floodplain applicable to Federally funded projects:

- Climate-Informed Science Approach (CISA) – The elevation and flood hazard area that result from using the best-available, actionable hydrologic and hydraulic data and methods that integrate current and future changes in flooding based on climate science. Per the implementing guidelines (WRC, 2015), a CISA elevation should be developed using data and information: (1) from the National Climate Assessment or other best available, actionable science; (2) from disciplines such as atmospheric, coastal, hydrologic and oceanographic sciences; and (3) that capture the impacts of future land cover changes, erosion, and vertical land movement on flood hazards**.** Guidance for the CISA approach (Appendix H of WRC, 2015) directs Federal agencies to use the Parris et al. (2012) or similar global mean sea-level rise scenarios, adjusted to reflect local conditions (local relative sea level, or LRSL), including any regional effects such as vertical land motion. The guidance continues to note that LRSL conditions should be combined with surge, tide, and wave data using methods appropriate to policies, practices, criticality, and consequences.

- Freeboard[29] Value Approach (FVA) - Determined by adding 2 feet to the base flood elevation (BFE, or 100-year flood elevation) to determine the vertical flood elevation and corresponding horizontal floodplain for non-critical actions, or adding 3 feet to the BFE for critical actions[30]. FEMA's base flood elevations in coastal areas account for local wave effects (scour and erosion, wave heights, wave run-up, and overtopping) in addition to stillwater (surge) flooding. The 2 and 3 foot freeboard values are intended to account for uncertainties in future conditions (WRC, 2015). These freeboard values are in line with flood resistant design and construction standards

[29] Freeboard is a factor of safety usually expressed in feet above a flood level for purposes of floodplain management and is intended to compensate for the many unknown factors that could contribute to flood heights greater than the height calculated for a selected size flood and floodway conditions, such as wave action, bridge openings, and the hydrological effect of urbanization of the watershed (FEMA, 2016).
[30] A critical action is any activity for which even a slight chance of flooding would be too great in terms of impacts to human safety, health and welfare (WRC, 2015).

of the American Society of Civil Engineers or with various states' freeboard requirements (ASCE, 2015; ASFPM, 2015).

- 0.2-Percent-Annual-Chance Flood Approach (0.2PFA) - The area subject to flooding by the 0.2-percent-annual-chance (500-year) flood. The implementing guidelines (WRC, 2015) caution that using this method may not be appropriate in coastal areas unless the agency has determined that the 500-year data to be applied include local wave effects (scour and erosion, wave heights, wave run-up, and overtopping) in addition to stillwater (surge) flooding. If wave effects are not included (as is the case with most 500-year data published on FEMA FIRMs), the 500-year flood elevation is likely to be lower than the effective (current) 100-year BFE, and may be lower than the BFE plus the applicable freeboard (2 feet for non-critical actions or 3 feet for critical actions). Thus, if not using the CISA in coastal areas, agencies should use the FVA at a minimum, and should not use any 500-year data that lack local wave effects (WRC, 2015).

- The elevation and flood hazard area that results from using any other method identified in an update of the FFRMS (WRC, 2015).

The FFRMS states that CISA is the preferred approach Federal agencies should use when data to support it are available (WRC, 2015). When applying one of the other FFRMS approaches (FVA or 0.2PFA), agencies must use the best available information for floodplain determination. Such data could be effective FIRMs, new preliminary FIRMs or Flood Insurance Studies, or advisory flood data issued by FEMA after a disaster (80 FR 6425; WRC, 2015). In August 2016, one Federal agency, FEMA, proposed rules to incorporate the FFRMS and establish the floodplain using the FVA approach for non-critical actions and for critical actions to use the FVA floodplain or the CISA approach but only if the elevation established under the CISA is higher than that under the FVA approach. This proposal applies to FEMA actions where FEMA directly builds a new facility for its own operations as well as actions that a non-Federal entity takes using Federal funding (such as a State or local government building using Federal grant funds) (FR 57401). FEMA cited a number of reasons for taking this hybrid approach to implementing the FFRMS. One reason FEMA cited relates to the numerous published reports and tools available to provide scenario-based projections of sea-level rise in coastal floodplains but FEMA pointed out the lack of such approaches to account for the uncertainties with respect to projected future precipitation and associated flooding in riverine floodplains. FEMA expects that as agencies implement the FFRMS, more data will become available to support incorporation of broader-based inland and riverine application of the FFRMS (81 FR 57401). For actions that do not meet the definition of FEMA Federally funded project, FEMA will continue to set the floodplain as the area subject to a one-percent or greater chance of flooding in any given year (or are subject to 0.2 percent annual chance of flooding any given year for critical actions). A “critical action” is any activity for which even a slight chance of flooding would be too great (81 FR 57401).

Per the EO 11988 / EO 13690 implementing guidelines, the FFRMS is not intended to be a flood elevation standard, but rather a flood resilience standard: *The vertical flood elevation and corresponding horizontal floodplain determined using the approaches in the FFRMS establish the level to which a structure or facility must be resilient.* This may include using structural or nonstructural methods to reduce or prevent damage; elevating a structure; or, where appropriate, designing it to adapt to, withstand and rapidly recover from a flood event. That is, for some types of projects, the most appropriate technique to achieve the resilience standard will be to elevate the structure or facility (e.g., elevating a building’s first floor to or above the required elevation). For other projects, the standard could be met through floodproofing, armoring, or other appropriate engineering design techniques that allow the project to withstand and rapidly recover from a flood event (e.g., protective armoring of a roadway or pipeline).

The EO 11988 / EO 13690 implementing guidelines retain the flood resilience standard from the 1978 implementing guidelines for EO 11988 (43 FR 6030) for actions that are not Federally funded projects (and thus not subject to the FFRMS). For such actions, agencies are directed to use the base (100-year) flood elevation and corresponding horizontal floodplain for non-critical actions; for critical actions, agencies should use the 0.2-percent-annual chance (500-year) flood elevation and corresponding horizontal floodplain (WRC, 2015).

The FFRMS builds upon recommendations by both the Hurricane Sandy Rebuilding Task Force, which noted in April 2013 that all projects funded with Federal Sandy Supplemental Funding (Public Law 113-2) should meet a consistent flood risk reduction standard, as well as the Hurricane Sandy Rebuilding Strategy, which recommended that the U.S. government create a national minimum flood risk reduction standard taking into account data on current and future flood risk, including the increased risk the region is facing from extreme weather events, sea-level rise and other impacts of climate change for federally-funded projects (HUD, 2013; Brown, 2014). The April 2013 requirement for Sandy Supplemental Funding set a uniform minimum standard that Sandy-related building projects supported by Federal funding were required to meet (e.g., elevating structures 1 foot above base flood elevation using best available FEMA data or hardening structures that cannot be elevated in some circumstances); however, at that time the Federal government encouraged State and local governments to review local conditions and where appropriate build to an even higher standard where they are planning critical infrastructure projects and/or where future conditions indicate higher risk (HUD, 2013).

State of New Jersey Requirements With Respect To Coastal Climate Resiliency

Interviews were conducted with officials from three State of New Jersey agencies including the New Jersey Department of Community Affairs (NJDCA), NJ Environmental Infrastructure Trust (NJEIT), and the New Jersey Department of Transportation (NJDOT to ascertain how coastal climate change impacts were being addressed by the State of New Jersey. Review of publicly available documents and additional correspondence with officials of the Passaic Valley Sewerage Commission provided supplemental information.

In general, these programs adhere to Federal requirements (through regulation or as a condition of receiving Federal funds) or national guidance developed by professional societies that establish design standards and incorporation of these into State programs, policies and regulations with information or data relevant to New Jersey, as appropriate . For example, NJDOT incorporates American Association of State and Highway Transportation Officials (AASHTO) design standards into NJDOT projects. NJDOT also coordinates with other Federal (e.g., Federal Highway Administration, U.S. Army Corps of Engineers, U.S. Coast Guard, U.S. Geological Survey) and State agencies (NJDEP) depending upon the nature of a particular project. Post Hurricane Sandy, one focus of NJDOT has been on elevating mechanical and electrical equipment and replacing signs on roadways that have suffered aluminum fatigue and could be impacted by heavy winds.

As noted previously, building codes are also an example of where professional organizations and scientific and technical experts at the national level work to develop construction codes that are adopted by the State of New Jersey; NJDCA provides training for local officials and these municipal officials implement and enforce the codes. An exception to this process relates to Federal Flood

Insurance Rate Maps that must be adopted directly by municipalities to participate in the NFIP (44 CFR 60.3).

Interviews with the NJEIT confirmed that funding through the NJEIT (that included Federal Sandy Supplemental Funds) has become contingent upon resiliency components set forth in various NJ Department of Environmental Protection (NJDEP) guidance documents.

A review was conducted of these NJDEP guidance documents related to resiliency standards for water and wastewater infrastructure. Several set forth best practices and operational checklists related to emergency response planning, operations and maintenance and vulnerability analyses for water and wastewater utilities (NJDEP, Undatedb; NJDEP, Undatedc; NJDEP, April 2016b; NJDEP, April 2016a). Several identify keeping assets outside of flood-prone areas or relocating them from these areas (NJDEP, Undatedb; NJDEP, Undateda). Elevation of critical infrastructure above the 500-year flood elevation is identified as a resiliency measure (NJDEP, Undatedb) and as a requirement for Federal and State financed water and wastewater projects, citing Executive Order 11988 (42 FR 26951) (NJDEP, Undatedd). One guidance, NJDEP (Undatedd) acknowledges that elevation and floodproofing requirements in NJDEP drinking water rules need to be amended for consistency. Table B-1 summarizes these NJDEP guidance documents.

Table B-1 New Jersey Department of Environmental Protection Guidance Documents Related to Resiliency [31]

Asset Management Guidance and Best Management Practices: Managing Utility Assets in New Jersey (NJDEP Undatedb) -standards and best practices in this guidance document required elements for new drinking water and wastewater projects seeking funds under NJ Environmental Infrastructure Finance Program (NJEIFP). -critical assets that are vulnerable to threats (including storms) that could compromise system operation should be considered for higher priority in asset management plan. -resiliency measures include: relocating assets outside flood-prone areas; elevating critical structures and system components above the FEMA 500-year flood elevations, and/or flood-proofing facilities; and ensuring auxiliary power redundancies.
Auxiliary Power Guidance and BMPS (NJDEP Undateda) -required for new projects seeking funding under NJEIFP. -auxiliary power equipment cannot be located within flood hazard area (N.J.A.C. 7:13), or as prescribed in Federal and/or State Sandy relief funding criteria; or if not feasible must be elevated or flood-proofed. -fuel storage for 48 hours of operation for facilities surrounded by flood waters or otherwise isolated and therefore incapable of having fuel replenished immediately. -For forecast events, capacity to store fuel reserves to maintain operations for 3 days (note under N.J.A.C. 7:13 there are provisions for how fuel is to be stored in a flood hazard area)
Emergency Response Preparedness/Planning Guidance and Best Practices: Wastewater (NJDEP Undatedc) -NJPDES permittees must have an emergency plan that includes a vulnerability analysis estimating the extent to which they are affected by natural disasters. (N.J.A.C. 7:14-6.12). - (NJDEP Undatedc) notes pre-incident planning continually reevaluates and improves planning including implementation of retrofit, physical and operational improvements to reduce vulnerability.

[31] Other NJDEP resiliency guidances may exist but these are for illustrative purposes.

Operations and Maintenance Assessment Guide for Wastewater Treatment Plants (NJDEP April 2016b) -Provides treatment plant personnel with tools to evaluate and improve their Operations and Maintenance (O&M) Manual. -O&M manuals should be updated routinely especially with respect to the Emergency Response Plan (a component of the manual). -Includes an O&M manual assessment form checklist of NJDEP requirements for wastewater treatment works operation, maintenance and emergency conditions also described in the NJDEP guidance (See NJDEP Undatedc).
Infrastructure Flood Protection Guidance and Best Practices (NJDEP Undatedd) -Recognizes that in many cases the 100-year floodplain or flood hazard area design flood elevation (See N.JA.C. 7:13) inadequate as a minimum design standard based on flooding experienced during Hurricane Sandy and other recent storms. -Identifies EO 11988 which it will follow for federal and state financed projects: critical actions (pursuant to EO11988) for which Federal funding is provided is required to avoid or be elevated above the 500-year flood elevation unless impacts cannot be avoided (requiring consideration of minimization of impacts to, restoration and preservation of the floodplain). -Notes NJ to apply the standard above to projects receiving State funding and USEPA will require for any projects it administers funding. -Infrastructure projects that do not receive Federal or State assistance are subject to NJDEP rules; however, the guidance encourages "serious consideration be given to maximizing protection of critical system components" for such projects through additional resilience options of "avoidance, elevation, and flood-proofing." -Cites a series of NJDEP rules that have elevation and floodproofing requirements for wastewater and drinking water systems and "recognizes the need to amend these rules for consistency and expects to accomplish this in future rulemaking". - NJDEP guidance suggests additional resilience measures beyond current requirements: 1) floodplain avoidance by constructing all critical infrastructure outside 500-year floodplain or if not feasible or for non-critical infrastructure, construction should occur outside the flood hazard area; 2) elevate critical infrastructure above 500-year floodplain or as required in the Uniform Construction Code (UCC) whichever is higher or if not feasible or for non-critical infrastructure, elevate in accordance with the UCC or one foot above the flood hazard area design flood elevation (see N.J.A.C. 7:13) whichever is higher; and 3) flood proofing to make buildings impermeable to the passage of water. -Also provides alternative resiliency measures for drinking water and sewer main crossings to make them watertight; ability to withstand loads and scour from floodwaters (in the case of bridges) up to the flood hazard area design flood elevation; and locating valves for drinking water systems outside the flood hazard area. -Considerations for access roads to new/reconstructed facilities at least the same flood protection elevation as the facility and may need to be higher for specific areas where flooding could exceed the 100-year flood elevation; for existing facilities access should be maintained to extent practicable during flooding event or, an emergency plan should address access and egress for worker safety and to maintain system operation.
Guidance for Pretreatment Programs During Emergency Situations (NJDEP 2016a) - For wastewater treatment plant owners and operators and those indirect users that discharge to the treatment plants to meet pretreatment objectives in emergency situations. -Indirect users are subject to local wastewater owner/operator requirements including development and implementation of emergency plans. -Local wastewater agencies should have an emergency plan which includes a list of Significant Indirect Users prioritized by volume highlighting users with high loading and/or toxic pollutants, as well as identify locations of critical conveyance structures such as outfalls of combined sewer overflows or pumping stations. -Significant indirect users that are critical infrastructure such as hospitals, generating stations, water purveyors, or airports should also be highlighted in the plan. -Local agencies should map all significant industrial users and their relationship to critical conveyance structures and transition this to a GIS electronic format. -On-site storage capacity for Significant Indirect Users is to be identified to safely store wastewater until the emergency passes and maximized prior to the onset of a predictable emergency.

Table B-2 is a synthesis of the coastal elevation standards and guidance applicable in New Jersey that have been described in this analysis, noting which expressly consider climate change impacts such as sea-level rise and coastal storms.

Examples of Sea-Level Rise and Coastal Flooding In New Jersey Projects and Planning Activities

A few examples are provided to understand how sea-level rise and coastal flooding is being incorporated into hazard and resiliency planning in New Jersey through Federal mechanisms. One example in New Jersey can be found with the resiliency project underway at the Passaic Valley Sewerage Commission (PVSC), which treats roughly 25% of the total wastewater in the State of New Jersey (PVSC, 2016). The facility was struck with a 12-foot wall of water from Newark Bay during Hurricane Sandy and therefore, to mitigate against storm surge and further rise in water levels, PVSC has developed a conceptual design for the construction of a floodwall in two sections with a 50 year design life at a cost of $75 million (Rotolo, 2015; PVSC, 2015). As a requirement of those projects receiving support through Federal Sandy Supplemental Funding (90% from FEMA and 10% through the NJ Environmental Infrastructure Trust), PVSC's project has considered a design standard to meet both Federal and State requirements (NJDEP, Undated d; Rotolo, 2016). The design for the East section, adjacent to Newark Bay, exceeds the NJDEP EIT requirement for critical infrastructure to be elevated to a 500-year flood elevation by incorporating sea-level rise values (2.6 feet by 2070), modeled wave heights, overtopping and an additional 2 feet to account for uncertainty, for a total of 21 feet NAVD[32] in height. PVSC's consultant noted that there is no specific guidance regarding what sea-level rise value to use; the 2.6 feet value was chosen as the 75th percentile from the New York City Panel on Climate Change and also compared to values developed by the U.S. Army Corps of Engineers (high estimate) and found to be comparable. The West floodwall (which is set further back from Newark Bay) is designed to be 5 feet above the 0.2% or 500-year flood elevation (PVSC, 2015). PVSC expects to complete this project in the year 2020 (Rotolo, 2016). In looking at sea-level rise projections for 2070, the projected sea-level rise of 2.6 feet identified by PVSC's consultant is close to the 83rd percentile cited by the STAP (2.8 feet).

Another example relates to State Hazard Mitigation Planning. A FEMA-approved State Hazard Mitigation Plan is required for states to receive certain types of non-emergency disaster-related assistance to facilitate long-term strategies for protecting people, places and assets from hazard events. Consideration of climate change adaptation, including challenges posed by higher sea levels and intense storms are now required as part of the risk assessment in state hazard mitigation planning (FEMA, 2016b). The incorporation of sea-level rise was added to the Coastal Erosion section New Jersey's 2014 Hazard Mitigation Plan (Tetra Tech, 2014). With respect to coastal erosion, the plan cites an estimated 31,995 people and an estimated $10 billion in building replacement cost value are potentially vulnerable to coastal erosion in New Jersey (Tetra Tech, 2014). The sea-level rise analysis uses a 2050 planning horizon and the range of lowest to highest national sea-level rise estimates from Parris et al. (2012) applied to the 100-year floodplain. Excluding those counties along the Delaware Bay and the tidally influenced Delaware River, 12,000 critical facilities are identified as being at risk from 0.3 to 2 feet of sea- level rise in 2050 (Tetra Tech, 2014). Parris et al. (2012) do not take regional sea-level rise into account but when adjusting their curves for regional sea-level rise as noted in the STAP report, the STAP projections are consistent with Parris et al. (2012). The State HMP analysis did not adjust for local conditions and therefore the sea-level rise projections utilized in the State HMP are lower than the adjusted sea-level rise projections available in the US Army Corps of Engineers Sea-Level Change Calculator Tool (Huber and White, 2015). Note that as part of the FEMA-approved Hazard Mitigation

[32] North American Vertical Datum or NAVD (see Kopp et al., 2016 for discussion of NAVD)

Table B-2. Coastal Flood Elevation Standards and Guidance Applicable in New Jersey [1]

Program	Applicability	Standard	Considers Climate Change Impacts (sea-level rise; coastal storm changes)
National Flood Insurance Program (44 C.F.R.1.60)	New construction or substantial improvement to structures in flood hazard area	> BFE [2] in Special Flood Hazard Area[3]	No
Hurricane Sandy Federal Supplemental Funding Program (HUD, 2013)	All Sandy-related residential, commercial, or infrastructure rebuilding projects supported by Federal Sandy Funding under PL 113-2 [4]	BFE +1 ft	Yes [5]
Executive Order 11988 and Executive Order 13690 (Federal Flood Risk Management Standard)	All Federal actions where federal funds are used to build, substantially improve, or repair substantially damaged structures and facilities in and around floodplains.	Agencies can use one of four approaches: (1) Climate Informed Science Approach (CISA) (2) Freeboard value Approach (FVA) Non-critical action: BFE+2 ft Critical action [6]: BFE +3ft (3) 0.2% or 500 year Flood Elevation Approach [7] (4) Elevation and flood hazard area that results from any other method identified in FFRMS updates.[8]	Yes
NJ Uniform Construction Code (N.J.A.C. 5:23-3.14)	New construction or substantial improvement or repair of substantial damage in flood hazard area (100-year flood zone) and coastal high hazard area (Coastal V or Coastal A Zones) [9]	BFE +1 ft for Residential dwellings BFE +2ft or 500 year flood elevation whichever is higher applies to two categories of buildings and structures: 1) Essential facilities [10] in Flood Hazard Areas and 2) Essential Facilities and Buildings and structures in which a large number of persons assemble (e.g., schools, theaters, museums) in Coastal High Hazard areas (Coastal V Zones) or Coastal A Zones. [11] In Coastal V or Coastal A Zones these standards apply to the minimum elevation of bottom of lowest horizontal structural member.	No
NJ Flood Hazard Area Control Act (N.J.A.C. 7:13)	Construction or development in flood hazard areas	BFE +1 ft in Tidal Flood Hazard Area for railroad and roadway construction or reconstruction and for construction of lowest floor of new habitable buildings or substantially improved buildings that were substantially damaged due to a natural disaster. [12]	No
Asset Management Guidance and Best Practices: Managing Utility Assets in NJ (NJDEP Undated)	Elements for new drinking water and wastewater projects seeking funds under NJ Environmental Infrastructure Finance Program.	Elevate critical structures and system components above FEMA 500-year flood elevation	Not expressly, mentions storms as a threat
Infrastructure Flood Protection Guidance and Best Practices (NJDEP Undated)	Elements for new drinking water and wastewater projects seeking funds under NJ Environmental Infrastructure Finance Program	Elevate critical infrastructure above the 500-year flood elevation.	Not expressly, mentions 100-year floodplain flood area design flood elevation as proven inadequate based on flooding from Hurricane Sandy and other recent storms.

Program	Applicability	Standard	Considers Climate Change Impacts Such as Sea-Level Rise or Changes in Coastal Storms
Stone Harbor, NJ Municipal Code Chapter 300, §300-14 (2013)	New residential construction and substantial improvement for flood hazard areas and coastal high hazard areas	BFE +2 ft (in coastal high hazard areas, i.e., V Zones, this construction shall be elevated on pilings or columns so that the lowest horizontal structural member of the lowest floor is at BFE +2 level)	No: done to conform with updated FEMA Flood Maps and to increase Community Rating System Points for discounts on flood insurance (The Gazette of Middle Township, 2013)
City of Hoboken, NJ Municipal Code Chapter 104, §104-17 (2013)	New construction and substantially improved residential and nonresidential structures	BFE +2 ft for essential facilities (fire, rescue, hospitals, etc.) in 100 year floodplain and Coastal A Zone (includes landward limit of areas affected by waves greater than 1.5 feet during the 1%, i.e., 100 year flood) BFE +3 ft for essential facilities in Coastal V Zone (Coastal high hazard areas-subject to high velocity wave action) BFE+2 ft for buildings with schools or day care centers (Coastal A or V Zone) BFE +2 ft for residential structures in Coastal V Zone BFE +2 ft for facilities that manufacture, process, handle, store or use or dispose of hazardous material in Flood Hazard Area (100 year flood plain) and Coastal A Zone. BFE +3 ft for facilities that manufacture, process, handle, store or use or dispose of hazardous material in Coastal V Zone	Yes: "Freeboard is a margin of safety to account for sea level rise, waves, debris, miscalculations, lack of data or other environmental changes"
Borough of Little Silver, NJ, Municipal Code Chapter 22, §22-5.2 (2013)	New construction or substantial improvement	>BFE +4 ft for lowest floor including basement of residential structures in flood hazard area BFE +3ft or as required by UCC whichever is more restrictive for all new construction or substantial improvement recommended elevated on pilings or columns so lowest horizontal member of lowest floor elevated to this level in Coastal High Hazard Area (V Zone)	No: values based on flooding observed by the municipal engineer in the Borough (Little Silver Planning Board, 2013)

[1] *Note this includes some Municipal ordinances as examples where the standards are more stringent than State regulations.*

[2] *BFE or Base Flood Elevation is the elevation to which floodwater is anticipated to rise during the 100-year storm (FEMA, 2016a).*

[3] *Special Flood Hazard Area is the area that will be inundated by the flood event having a 1-percent chance of being equaled or exceeded in any given year (commonly referred to as the 100-year storm) (FEMA, 2016c).*

[4] *Projects under Housing and Urban Development Community Development Block Grant; Health and Human Services Social Services Block Grants and Head Start; FEMA Hazard Mitigation Grant Program and Public Assistance Program; EPA State Revolving Fund; DOT Federal Transit Administration Emergency Relief Program and some Federal Railroad and Federal Highway Administration Projects.*

[5] *HUD (2013) noted at the time this "Uniform Federal Risk Reduction Standard for Sandy Rebuilding Projects" was to take into account increased risk the region is facing from extreme weather events, sea level rise and other impacts of climate change and that this is the same standard that many communities in the region (including the entire State of New Jersey) had already adopted. This minimum elevation standard required structures to elevate their bottom first floor one foot higher than the most recent guidance by FEMA at that time. The Federal Flood Risk Management Standard Freeboard Value Approach (EO 11988 and EO 13690) described in the next row of this table has since identified a higher freeboard standard for Federally funded actions.*

[6] *A critical activity is any activity for which even slight chance of flooding would be too great in terms of impacts to human safety, health and welfare (WRC, 2015).*

[7] *Implementing guidelines caution this approach may not be appropriate in coastal areas unless local wave effects in addition to stillwater flooding included (WRC, 2015).*

[8] *FEMA (August 2016) proposed rules to implement FFRMS for its own projects or projects it funds for new construction, substantial improvement or to address substantial damage selecting the FVA to establish the floodplain for non-critical actions and for critical actions to use the FVA or CISA for critical actions, but only if the elevation established under the CISA is higher than the FVA (81 FR 57401).*

[9] *'Substantial improvement' means any reconstruction, rehabilitation, addition, or other improvement of a structure, the cost of which equals or exceeds 50 percent of the market value of the structure before the 'start of construction' of the improvement. This term includes structures which have incurred 'substantial damage,' regardless of the actual repair work performed.'Substantial damage' means damage of any origin sustained by a structure whereby the cost of restoring the structure to its before damaged condition would equal or exceed 50 percent of the market value of the structure before the damage occurred." This language also applies to same terms under NFIP. (N.J.A.C. 5:23-6.3A).*

[10] *Essential facilities include emergency response and recovery facilities, hospitals, health care facilities, power stations, etc.*

[11] *Coastal high hazard areas or V zones are areas where wave heights for the 1%-annual-chance flood are 3 feet or more (FEMA, 2015b). Coastal A zones are defined by FEMA as portions of the 1%-annual-chance flood zone landward of the V Zone where wave heights are less than 3 feet (FEMA, 2015b); however, in the context of this UCC standard Coastal A Zones are treated like coastal high hazard areas in areas where wave action is in excess of 1.5 feet or if the community has designated a Coastal A zone (ASCE, 2015).*

[12] *A June 2016, NJDEP rule proposal would require the standard apply to the lowest horizontal structural member for new habitable buildings in Coastal A or V Zones to be consistent with NJ UCC rules as well as would prohibit multi-residential buildings from being constructed in the V Zone (N.J.R. 1014(a))*

Plan development process, a number of New Jersey counties have already incorporated climate change considerations, including municipal sea-level rise, into their plans or pending plan revisions (Maxwell-Doyle, 2016; Baker, 2014; Tetra Tech EM, 2010).

A third example of sea-level rise incorporation into projects underway is the *Rebuild By Design Hudson River: Resist, Delay, Store, Discharge* initiative with $230 million of U.S. Department of Housing and Urban Development Superstorm Sandy Community Development Block Grant Funds to the State of New Jersey to reduce flooding from storm surge, high tide and heavy rainfall events and enhance resiliency in Hoboken and parts of Weehawken and Jersey City (NJDEP, Undatede). The project will result in design and partial implementation (hard infrastructure and landscaping features for the "Resist" component and pilot programs for the other three components). Consideration of the "impacts from climate change " including projected impacts from sea-level rise and its impacts on the frequency and degree of flooding is a stated project goal of the project pursuant to Federal funding requirements (79 FR 62182; NJDEP, Undatede). As such, NJDEP notes that it is conducting a comprehensive feasibility study to evaluate the level of flood risk reduction benefits that can be achieved in the study area and will consider high tides, sea-level rise, storm surge and rainfall events using NOAA sea-level rise scenarios developed for the National Climate Assessment (NJDEP, Undatede). The project design, permitting and site plan development phase is slated for 2016-2019 and final completion scheduled for 2022 (NJDEP, Undatedf).

For additional planning information, see *Mitigation Assessment Team (MAT) Report: Hurricane Sandy in New Jersey and New York, Building Performance Observations, Recommendations and Technical Guidance* (FEMA, 2013a) which provides a detailed analysis of causes of building failure from the storm event and related flooding; the information is used to make recommendations on building siting, design and construction and often results in amendments to NFIP regulations and standards (Mauriello, 2016).

At the current time, consideration of climate change impacts to address coastal flooding is not uniformly addressed in New Jersey. Such impacts are expressly addressed when required as a contingency of Federal funding under Hurricane Sandy Supplemental Funds (such as the PVSC or Rebuild By Design Projects mentioned above) or where mandated by Federal programs such as FEMA in the State Hazard Mitigation Plan or county multi-jurisdictional hazard mitigation plans. One municipal government we are aware of (Hoboken) expressly considers sea-level rise and coastal climate change impacts in its freeboard standard. As Federal agencies complete their implementation of the FFRMS, it would be reasonable to conclude that State agencies would have to adhere to applicable Federal agency requirements where Federal funds are used to build, substantially improve, or repair substantially damaged structures and facilities in and around floodplains pursuant to the Federal standard.

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